JOURNAL OF THE EGYPTIAN SOCIETY OF CARDIO-THORACIC SURGERY

Submit Manuscripts: Editorial office
Journal of the Egyptian Society of Cardio-Thoracic Surgery
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GUIDLINES FOR AUTHORS

Journal of The Egyptian Society of Cardio-Thoracic Surgery (J. Egypt. Soc. Cardiothorac. Surg.)

Editorial Office
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The Journal of the Egyptian Society of Cardio-Thoracic Surgery [ISSN 1110-578 X] is the official publication of the Egyptian Society of Cardio-thoracic Surgery. The journal is published every three months .

General Instructions

Every submission must include:
Cover letter, indicating the category of article , the Complete manuscript, including title page, abstract, text, tables, acknowledgments ,references ,illustrations .

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A.Conditions for Publication Form which includes disclosures regarding freedom of investigation and conflicts of interest, signed by all authors. In single Author publication an additional Senior Consultant Signature is required.
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C.Written permission from unmasked patients appearing in photographs is also required.

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Revised manuscripts must be submitted in
three parts as Microsoft word-processing files :
(1) cover letter with responses to reviewers' comments
(2) revised, marked manuscript showing additions and deletions
(3) revised, unmarked manuscript.

General Information

Three copies of the Manuscripts should be sent preferably prepared in Microsoft Word , typed *double-spaced* throughout (including title page, abstract, text, references, tables and legends) with one (1) inch (2.5 cm) margins all around. Place Author name and page number in the upper right corner of each page.
Manuscripts written in ***12*** point ***Arial*** or ***Times New Roman*** fonts are preferred (Note: Do not submit your manuscript in PDF format it causes problems in processing your submission.)
Arrange manuscript as follows: (1) title page, (2) abstract, (3) text, (4) acknowledgments, (5) disclosures if required, (6) references, (7) tables and (8) legends. Number pages consecutively, beginning with the title page as page 1 and ending with the legend page.
If your manuscript contains illustrations, in addition to submitting them online, you must send two sets of original illustrations to the editorial office labeled with manuscript number, first author, and figure number on back.
Tables and figures should be provided separate from the text while there position in the text should be marked on the manuscript.

Word Limits by Category of Manuscript

Original articles should not exceed 4500 words including title page, abstract of 150-200 words, text, figure legends *and references*. The combined total of illustrations and tables should not exceed 10 and the number of references should not exceed 40.

New Technology articles are limited to 2500 words including title page, abstract, text, figure legends and *references.* The number of tables should not exceed three; the number of illustrations should not exceed six if tables are included; eight if there are no tables. The number of references should not exceed 10.

Case reports and **"The way I do it"** articles are limited to a total of 1500 words including title page, abstract, text, references and figure legends. For each illustration subtract 100 words and for each table subtract 300 words from the word limit. References are limited to eight. A "The way I do it" article should be a description of a useful surgical technique and contain descriptive, illustrative material.

Images in cardiothoracic surgery are limited to 350 words including title and text and to two, possibly three figures. The entire contribution must fit on one printed page .

Review articles are limited to 6500 words including title page, abstract, text, figure legends and *all references*. The total number of references should not exceed 80. Subtract 100 words for each illustration and 300 words for each table.

Our surgical heritage articles are limited to 2500 words including title page, abstract, text, figure legends and references. Subtract 100 words for each illustration and 300 words for each table.

Correspondence (Letters to the Editor) and **commentaries** are limited to 500 words. Subtract 100 words for each illustration and 300 words for each table.

Editorials are limited to 2500 words including references. Subtract 100 words for each illustration and 300 words for each table.

Manuscript Preparation

Title Page (first page)

The title is limited to 100 characters and spaces for original manuscripts and to 80 characters and spaces for all other categories of manuscripts. The title may not contain acronyms or abbreviations. All submissions, including correspondence, must have a title.

Running Head Supply a short title of 40 characters and spaces.

Authors List all authors by first name, all initials, family name and highest academic degree using "MD, PhD" for holders of both degrees (if more then 7 Authors justify).

Institution and Affiliations. List the name and full address of all institutions where the work was done. List departmental affiliations of each author affiliated with that institution after each institutional address.

Meeting Presentation If the paper has been or is to be presented at the annual meeting of The Society, provide the name, location and dates of the meeting.

Keywords Provide up to 5 keywords selected from the appended list to describe the manuscript. Do not use any keywords that are not on the list..

Word Count Provide the electronic total word count of the entire manuscript including title page, abstract,text,figure legends and entire reference list.

Corresponding Author Provide the name, exact postal address with *postal code, telephone number, fax number and e-mail address* of the author to whom communications, proofs and requests for reprints should be sent.

Abstract Page (Second page)

Original articles

Provide a structured Abstract, no longer than 250 words, divided into four sections:

Background or objective, Methods, Results, Conclusions. Avoid abbreviations and acronyms. Indicate the abstract word count below the abstract.

New Technology

Provide an abstract,of no longer than 175 words, divided into four sections: Purpose, Description, Evaluation and Conclusions.Indicate the abstract word count below the abstract. [Disclosure stating the source of all funds to the study , plus "freedom of investigation" freedom from outside interests and freedom to fully disclose all results;these statements are mandatory for all new technology articles only]

Case reports "The way I do it" articles, review articles and our surgical heritage articles. Provide an unstructured abstract of 100 words.

Images, correspondence, commentaries, editorials and updates. No abstract is required.

Text should be organized as follows: Introduction, Material (or Patients) and Methods, Results, and Comment.Cite references,illustrations and tables in numeric order by order of mention in the text.

Avoid abbreviations Consult the *American Medical Association Manual of Style,* 9th edition, for recommended abbreviations. Define abbreviations at first appearance in the text. *If 8 or more abbreviations or acronyms are used, provide a separate table of abbreviations and acronyms.*

Measurements and weights should be given in standard metric units. Statistical nomenclature and data analysis. Follow the "Guidelines for Data Reporting and Nomenclature" published in The Annals of Thoracic Surgery (1988;46:260-1).
Footnotes. Type footnotes at the bottom of the manuscript page on which they are cited. Suppliers. Credit suppliers of drugs, equipment and other brand-name material mentioned in the article within parentheses in text, giving company name, city and country .

Acknowledgments

Grants, financial support and technical or other assistance must be acknowledged at the end of the text before the references.

References

Identify references in the text using arabic numerals in brackets on the line. Type references double-spaced after text or acknowledgments beginning on a separate sheet. Number consecutively in the order in which they appear in the text. Journal references should provide inclusive page numbers; book references should cite specific page numbers. Journal abbreviations should conform to those used in Index Medicus. follow the formats outlined below:

Journal Article Jones DR, Stiles BM, Denlinger CE, Antie P .Pulmonary segmentectomy: results and complications.Ann

Thorac Surg 2000;76:343-9(List *all* authors if 6 or fewer; otherwise list first 3 and add "et al.")

Chapter in Book

12. Vinten-Johansen J, Zhao Z-Q, Guyton RA. Cardiac surgical physiology. In: Cohn LH, Edmunds LH Jr, eds. Cardiac Surgery in the Adult. 2nd ed. New York, NY: McGraw-Hill; 2003:53-84.

Internet Address

3.1996 NRC Guide for the Care and Use of Laboratory Animals. Available at: http://www.nap.edu/readingroom/books/labrats/contents.html. Accessed October 20, 2003.

Tables;

Tables should be typewritten double-spaced on separate sheets (one to each page). Do not use vertical lines. Each table should be numbered (Arabic) and have a title above. Legends and explanatory notes should be placed below the table. Abbreviations used in the table follow the legend in alphabetic order. Lower case letter superscripts beginning with "a" and following in alphabetic order are used for notations of within-group and between-group statistical probabilities.

Figure Legends

Figure Legends should be numbered (Arabic) and typed double-spaced in order of appearance beginning on a separate sheet. Identify (in alphabetical order) all abbreviations appearing in the illustrations at the end of each legend. Give the type of stain and magnification power for all photomicrographs. Cite the source of previously published material in the legend and indicate permission has been obtained. Proof of permission must be surface mailed or faxed to the editor .

Illustrations

You must send two sets of original illustrations to the editorial office labeled with manuscript number, first author, and figure number on back.
Images or figures are submitted online as one or more separate files that may contain one or more images. Within each file containing images, use the figure number (eg, Figure 1A) as the image filename. The system accepts image files formatted in TIFF and EPS. Powerpoint (.ppt) files are also accepted, but for line drawings only and you must use a separate Powerpoint image file for each Powerpoint figure.
Most illustrations will be reproduced at a width of one column (8.25 cm; 3 1/4 inches). Black, white and widely crosshatched bars are preferable; do not use stippling, gray fill or thin lines.

Instructions:

Identify print proofs of figures on the back with figure number and name of the first author; when necessary, indicate the top with an up arrow
Please include hardware and software information, in addition to the file names, with figures submitted electronically or on disk
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Color images need to be CMYK, at least 300 dpi.
Gray scale images should be at least 300 dpi .
Line art (black and white or color) and combinations of gray scale and line art should be at least 1200 DPI .

Cover letter:

Include with the manuscript a cover letter that provides 1) the category of manuscript (e.g., original research, Brief Communication, Letter to the Editor); 2) statement that the material has not been previously published or submitted elsewhere for publication; 3) information about any personal conflicts of interest of any of the authors; and 4) names of sources of outside support for research, including funding, equipment, and drugs .You may also submit the name of one reviewer of your choice. You should include that individual's mailing address, telephone number, fax number, and e-mail address.

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Consultant statistician and statistical methods:

All manuscripts with statistical analysis are required to undergo biostatistical review .The most appropriate way is to involve a biostatistician consultant or coauthor from the investigators' home institution . Manuscripts may undergo further biostatistical review by the journal after submission. Additional information on statistical methods can be found in "Uniform Requirements for Manuscripts Submitted to Biomedical Journals"(www.acponline.org/journals/resource/unifreqr.htm).

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Checklist:

A] Cover letter

- Letter to the Editor
- Manuscript category designation .
- Single-journal submission affirmation .
- Conflict of interest statement (if appropriate).
- Sources of outside funding.
- Signed Statistical Collaboration .

B] Complete manuscript

- Title page .
- Title of article
- Full name(s), academic degrees, and affiliation(s) of authors.
- Corresponding author .
- Telephones, fax, and e-mail address
- Abstract (250 words; double-spaced) .
- Ultramini-abstract (50 words; double-spaced) .
- Text (double-spaced).
- References (double-spaced; separate pages).
- Tables (double-spaced; separate pages).
- Figures (separate files; on hardcopy; properly identified),
- Figure legends (double-spaced; separate pages) .
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Purpose of Peer Review

First is to evaluate objectively the science of the submitted paper and second is to provide a constructive critique indicating how the paper could be or could have been improved by the authors. Reviewers should respect the authors' efforts and avoid disparaging or unpleasant comments.Reviewers should comment on language editing if needed.

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Reviewers should accept assignments to review manuscripts that are within their sphere of expertise, which they plan to review within the 21 day deadline. Reviewers should decline assignments for which a conflict exists between the reviewer and authors or between the reviewer and commercial products that are integral to the content of the article.

Category of the Manuscript

The broad categories of papers for which peer review is undertaken are (1) original scientific articles; (2) new technology papers; (3) case reports, The way I do it articles and images; and (4) review articles. The editor and/or associate editors review correspondence, invited commentaries, editorials, surgical heritage submissions and ethical and statistical papers.

General Requirements for Publication

The paper should conform to the format and restrictions for the category to which it belongs and be written in good, readable English. The paper should address an important or interesting subject and provide new and original information. Illustrative material should be well chosen and of good quality.

Original Scientific Article

The reviewer should assess the articles' interest to readers; strengths and weaknesses; originality; clarity of text, tables, illustrations and figure legends; presentation; analysis of results; credibility of results; importance of the findings; depth of scholarship; relationship of the results to the existing literature; and presence of marginally relevant or unnecessary archival material. Ethical issues, such as prior publication of all or part of the data; plagiarism; transgression of human or animal rights; or dishonesty should be noted, if detected.

Original scientific articles are usually one of three types: prospective, retrospective, or observational studies. For prospective studies the protocol of the study is planned before data are collected. The most common form is the 'Prospective, randomized controlled trial', which is well suited for many experimental animal studies and some human trials. Retrospective studies use data recorded before the study protocol was designed.. Most original scientific articles in clinical disciplines, particularly surgery, are retrospective, but modern statistical models are now available to analyze objectively retrospective data using a variety of statistical methods. Observational studies record observations of one or more groups of patients. These studies may record changes in various laboratory or biochemical tests in response to procedures or other therapy or determine the indications, efficacy and safety of a new procedure or laboratory or diagnostic test.

The following topics are offered to help guide the reviewer's assessment of an original scientific article. Not all topics are relevant to every article.

- 'Title' should reflect the content of the article and be concise and clear'Abstract' should indicate the purpose of the study, subjects and methods used, most important results and the main conclusions supported by results.
- 'Introduction' should indicate the rationale and focus of the study and state the purpose or hypothesis.
- 'Methods' should present the design of the study, fully describe the number and subjects and exclusion and inclusion criteria; whether subjects were enrolled consecutively; methods used to gather data, including follow-up data; methods by which control and experimental groups were assembled; the primary outcome variable; secondary outcome variables; how outcome measurements were made and validated; the statistical design of the study; and the statistical methods used to analyze the study.
- 'Results' should concisely present the most important findings in text and relegate to tables data of lesser importance. Data should be reported as means or medians with appropriate indicators of variance and exact p values in tables and text. Figures should be well selected to highlight important findings and should not be used to present data of lesser significance. Survival and event curves should indicate specified confidence limits or subjects at risk. Regression diagrams should include the regression equations, regression coefficient and exact p value in the figure legend. Figure legends should adequately and clearly describe the important information illustrated.
- 'Comment' should not repeat results, but should point out the significance and conclusions of the new data, integrate the authors' new data with that in the prior literature, draw inferences and conclusions regarding the question or purpose addressed by the study and point out the limitations of the study. The 'Comment' section should not be a review of the literature.
- References should be properly cited, reasonably current, accurate, in proper format and selected. Important omissions should be noted.

New Technology

Articles describing new technology are necessarily descriptive and do not pose or test a hypothesis. These articles evaluate new devices, systems, machines, equipment, instruments, monitors, implantable material and similar technology designed for improving patient care and outcomes. The reviewer is asked to evaluate the efficacy, safety and indications of the new technology and the rigor, completeness and

objectivity of the evaluation study.

Topics which the reviewer should consider include:

- Probable importance or usefulness of the technology.
- Problem or task that the technology addresses.
- Newness and innovation of the technology.
- How well the technology is described and illustrated.
- Protocol used for evaluation.
- Methods used to test the technology; and the results obtained.
- Reasons for selecting the methods of testing and evaluation.
- All studies used in the evaluation.
- Ease and difficulties in application including successes and failures.
- Advantages, complications and late adverse events of the new technology.
- Whether are included or should be included in the evaluation.

The conclusion section should summarize the indications, deficiencies and drawbacks. The article should have an objective, dispassionate tone and avoid the enthusiasm of an advertisement or endorsement.

The reviewer needs to inspect the 'Disclosure statement' after the text, before References. This statement should disclose the source of funds used for the evaluation study and whether or not the product was purchased, borrowed or donated by the manufacturer or inventor. Conflicts of interest statements for authors are managed by the editorial staff.

Case Reports, How to Do It, Images

Case reports describe interesting presentations of disease and innovative management of the patient's or patients' problem. How to Do It articles emphasize innovations in the operative management of technical challenges and new ways of doing things. Images, which must fit on one printed page, are graphics of interesting presentations of disease within the chest.

Reviewers should evaluate the clarity and completeness of the case or procedure descriptions and the selection and quality of the illustrative material. Reviewers should also note whether or not the paper adheres to the format restrictions enumerated in "Information for Authors". The reference list should be selective rather than inclusive.

Review Article

Reviewers should assess the importance of the subject matter, need for the review and probable interest to readers. Reviews of very rare and unusual diseases are discouraged; subject matter should be sufficiently broad to have instructional and practical value for readers. Reviewers should note if authors have respected the format and restrictions of this category as stated in "Information for Authors".

The 'Introduction' should provide the rationale for reviewing the subject matter and provide the outlines of what is included and not included in the review. In the 'Methods' section reviewers should assess the methods used to search for articles, including search words and databases probed. The body of the review should be well organized with well chosen topical headings arranged in logical order. Within each topical heading the material should be presented in an integrated, comprehensive, objective manner. Statements should be referenced accurately. Reviewers should look for a "summing up" of the topical content βεφορε the author proceeds to the next topic. Reviewers should reject topical presentations consisting of "one sentence précis of referenced articles" arranged serially.

The review should provide a general overview of the subject matter assessing progress, pointing out deficiencies in present management and indicating opportunities and directions of future work. The reviewer should also assess the selection of references and note important absences or trivial inclusions.

Footnote:

This editor carefully reads all reviews and respects the time and effort that each reviewer has expended on behalf of the author and all readers . The reviewer remains anonymous; there is no reward beyond listing on the annual thank you list. The reviewer should direct his or her critique to the authors in the style and format that suits them best. The recommendation to the editor is made separately with or without additional comments.

Events of Interest

13th Egyptian Society of Cardio-Thoracic Surgery Annual Meeting Organized by the Department of Cardio-Thoracic Surgery Kasr ElEini Hospital Cairo University.

Timing : 14-17 March 2006
Location: Cairo – Egypt
Email : rumnrtvl@link.net

9 September 2005
Leicester United Kingdom
Surgery of the Aorta Masterclass
Royal College of Surgeons of England
Raven Department of Education, The Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, London, WC2A 3PE
Phone: +44 (0)20 7869 6331/6340
Fax: +44 (0)20 7869 6329
Email:cardiothoracics@rcseng.ac.uk

9 - 10 September 2005
Montreal, PQ Canada
Canadian Association of Thoracic Surgeons 2005 Annual Meeting
Fairmont Queen Elizabeth
For information, contact:
JoanneClifton
910 W. 10th Avenue, 3rd Floor, Vancouver, B.C. V5Z 4E3
Phone:604-875-5355
Fax:604-875-4036
Email: jclifton@interchange.ubc.ca
Additional information: http://www.cags-accg.ca

15 - 18 September 2005
Buenos Aires Argentina
PICS/ENTICHS- 2005 - Pediatric Interventional Cardiac Symposium and Emerging New Technologies in Congenital Heart Surgery
Congenital Heart Center, The University of Chicago Children's Hospital, 5841 S. Maryland Ave., MC 5040, Chicago, IL 60637
Phone:1773702-2500
Fax:1773702-4187
Email: ebacha@surgery.bsd.uchicago.edu
http://www.picsymposium.com

17 September 2005
Lugano Switzerland
2rd Cardiosurgical Lugano Meeting: Mini Invasive Approaches in Cardiac Valvular Surgery: State of the Art 2005
Cardiocentro Ticino, Via Tesserete 48, CH-6900 Lugano
Phone: +41 91 805 31 92
Fax: +41 91 805 31 67
Email: annapaola@cardiocentro.org
http://www.cardiocentro.org

18 - 22 September 2005
Buenos Aires Argentina
The 4th World Congress of Pediatric Cardiology and Cardiac Surgery
Congresos Internacionales, Lima 355 Pb. -
(C1073AAG) - Buenos Aires - Argentina
Phone: +54 (11) 4382-5772
Fax: +54 (11) 4382-5730
Email: pccs@congresosint.com.ar
http://www.congresosint.com.ar/pccs2005/

24 September 2005
Barcelona Spain
Annual Techno-College of EACTS-ESTS
The European Association for Cardio-Thoracic Surgery
3 Park Street, Windsor, Berks, SL4 1LU, UK
Phone: +44 (0)1753 832 166
Fax: +44 (0)1753 620407
Email: info@eacts.co.uk
Additional information: http://www.eacts.org

24 September 2005
Barcelona Spain
5th European Conference on Perfusion, Education and Training
The European Board of Cardiovascular Perfusion

City Hospital Triemli Zurich, Birmensdorferstrasse 497, 8063 Zurich, Switzerland
Phone: +41 1 466 2189
Fax: +41 1 466 2745
Email: gravesebcp@gmx.ch
Additional information: http://www.ebcp.org/

25 - 28 September 2005
Barcelona Spain
4th EACTS-ESTS Joint Meeting
3 Park Street, Windsor, Berks, SL4 1LU, UK
Phone: +44 (0)1753 832 166
Fax: +44 (0)1753 620 407
Email: info@eacts.co.uk
Additional information: http://www.eacts.org

29 - 30 September 2005
Liverpool NHS Trust United Kingdom
Aortic Surgery Symposium "Current Trends"
Miss S. J. Bradley
The Cardiothoracic Centre Liverpool NHS Trust, Thomas Drive, Liverpool L143PE, UK
Phone: 0 151 293 2463
Fax: 0151 220 2254
Email: sarah.bradley@ctc.nhs.uk
Additional information: http://www.ctc.nhs.uk

29 - 30 September 2005
St. Louis, MO United States
Contemporary General Thoracic Surgery
Eric P. Newman Education Center, Washington University Medical Center
Continuing Medical Education
Phone: 1 314 362-6891
Fax: 1 314 362-1087
Email: CME@wustl.edu
Additional information: http://cme.wustl.edu/

29 September - 2 October 2005
Bermuda
42nd Annual Pennsylvania Association for Thoracic Surgery Meeting
Elbow Beach Resort
Mary Ann Wertan, RN, Director
100 Lancaster Avenue, 280 MSB, Wynnewood, PA 19096
Phone: 1 610 896-9255 ext 231
Email: WertanM@mlhs.org

13 - 15 October 2005
Newport Beach, CA United States
International Valve Symposium at Newport Beach
Hoag Hospital, One Hoag Drive, PO Box 6100, Newport Beach, CA 92658
Phone: 1 800 514-HOAG (4624)
Fax: 1 949 764-5820
Email: NBartelt@hoaghospital.org

26 - 30 October 2005
Zurich Airport Switzerland
HeartLab 2005 (Practical Courses on Less Invasive CardioVascular Surgery)
Department of Cardiovascular Surgery, Centre Hospitalier Universitaire Vaudois , CHUV, CH-1011 Lausanne, Switzerland
Phone: 41 21 314-2280
Fax: 41 21 314-2278
Email: Ludwig.von-Segesser@chuv.hospvd.ch
Additional information: http://www.heartlab.org/

8 - 10 November 2005
Fort Collins, CO United States
3rd Annual Meeting of the Cardiobioassist Association
Colorado State University, Department of Clinical Sciences, 300 W. Drake Road, Fort Collins, Co 80523
Phone: 1 970 297-4450
Fax: 1 970 297- 4450
Email: Eric.Monnet@ColoState.EDU
Additional information: http://cb2a.org/

10 - 12 November 2005
Orlando, FL
Fifty-Second Southern Thoracic Surgical Association Annual Meeting
633 N. Saint Clair Street, Ste. 2320, Chicago, IL 60611
Phone: 800-685-STSA
Fax: 312-202-5801
Email: stsa@stsa.org

19 November 2005
Brussels Belgium
The Belgian 10th Anniversary Congress on Cardio-Thoracic Surgery
Department of Thoracic Surgery, UZ Gasthuisberg, Herestraat 49, B-3000 Leuven
Phone: +32-16-34 42 60
Fax: +32-16-34 46 16
Email: margriet.goedhuys@uzleuven.be
Additional information: http://www.bacts.org

20 - 23 November 2005
Manila Philippines
17th Biennial Congress of Association of Thoracic and Cardiovascular Surgeons of Asia (ATCSA)
Congress Secretariat: PATACSI Office / ATCSA Secretariat 2F, Philippine Heart Centre, East Ave., Quezon City 1100, Philippines
Phone: (63-2)925-2401 local 3216
Fax: (63-2)929-3826
Email: info@atcsa.org
Additional information: http://www.atcsa.org

1 - 2 December 2005
Leipzig Germany
PIONEERING TECHNIQUES IN CARDIAC SURGERY:
Promedica International CME, a California Corporation
2333 State Street, Suite 203, Carlsbad, CA 92008
Phone: 1 760 720-2263
Fax: 1 760 720-6263
Email: pioneering@promedicacme.com

15 - 16 December 2005
Advanced Cardiac Surgery
Royal College of Surgeons of Edinburgh
Phone: +44 (0)113 297 6205
Fax: +44 (0)20 7869 6329
Email: cardiothoracics@rcseng.ac.uk

16 - 17 January 2006
Katowice Poland
Reconstructive Surgery of the Aortic root- stentless valves and aortic repair approved by EACTS
II Dept Cardiac Surgery, Silesian Medical University
Email: M.J.Jasinski- Course Director:
marekjas@poczta.on

30 January - 1 February 2006
New Orleans, LA United States
42nd Annual Meeting of The Society of Thoracic Surgeons
633 N. Saint Clair Street, Suite 2320
Chicago, Illinois 60611-3658
Phone: 312-202-5800
Fax: 312-202-5801
Email: sts@sts.org

1 - 3 February 2006
Applied Basic Science for Cardiothoracic Surgical Trainees
Royal College of Surgeons of England
Phone: 0131 668 9209
Email: l.judge@staff.rcsed.ac.uk

31 May - 2 June 2006
Introductory Thoracic Surgery
Raven Department of Education, The Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, London, WC2A 3PE
Phone: +44 (0)131 668 9209
Fax: +44 (0)20 7869 6329
Email: cardiothoracics@rcseng.ac.uk

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Obituary

Loss of the "The Fortune" and "The Founder"

Abdel Khalik Ismail Sarwat (1932-2004)

"Thoughtfulness for others, generosity, modesty and self-respect are the qualities which make a real gentleman or lady"

Thomas H. Huxley

Dr. Abdel Khalik Ismail Sarwat died March 27th, 2005 at age 73 years. Dr. Abdel Khalik was an outstanding clinician, and clinical teacher whose career was driven by intellectual curiosity. He applied the words of John Wooden "Be more concerned with your character than your reputation, because your character is what you really are, while your reputation is merely what ohich confidence and ability to perform shall cease to exist. Dr. Abdel Khalik graduated from Medical School at the University of Cairo in 1955 and entered surgical residency under the direction of Professor Salah El-Mallah. He was appointed to the Faculty of the University of Cairo in 1958 as a General Surgeon.

Patience, persistence and perspiration make an unbeatable, described by Napoleon Hill , combination for success. Abdel Khalik 's interest focused on the developing specialties of thoracic and cardiac surgery in the 1960's and his active participation in the surgical research laboratories supported his growing interest in chest pathology so he had the diploma of higher studies in chest diseases and tuberculosis in April 1960.

It is good to dream, but it is better to dream and work. Faith is mighty, but action with faith is mightier. Laziness may appear attractive, but work gives satisfaction. He had his first Fellowship from the Royal College of Surgeons of Edinburgh in March 1964, and his second Fellowship from the Royal College of Surgeons of London in May 1964.

As Joshua L. Liebman said : "Maturity is achieved when a person postpones immediate pleasures for long-term values" -He decided to go to USA to complete his thoracic career; that was why he had ECFMG from Los Angeles in February 1972. At the same year in June he had Diploma in the surgery of transplantation from UCLA. In addition to his scientific papers, he was a fellow of the International College of Surgeons and the American College of Chest Physicians & Surgeons (1981).

After return from the states he paved the thoracic surgical practice in the hospitals of the Ministry of Health & Population (MHP). Firstly, at Abbassia Chest Diseases with Dr. Gamal Abu-Senna. Secondly, at El-Marg Chest Hospital with Dr. Zakaria Masoud. Lastly, after a 36-year practice both in cardiac and thoracic practice with his colleages Dr. Hamdy El-Sayed , Mohamed El-Fiky, and Ismail Sallam , he founded a new fully dedicated thoracic service, 'The Thoracic Surgery Service' in 1996 and became the first chief of thoracic surgery at the Ain-Shams University Hospital , a position he filled with distinction even after his retirement at age 60.

The Egyptian Society of Cardio-Thoracic Surgery elected Dr. Abdel Khalik to Honorary Membership in 1993, only the eighth person given that prestigious award. His acceptance speech at age 72 years is a model of grace, humor and demonstrates his lifelong commitment to intellectual curiosity .

Among his many accomplishments during his career, the facet that pleased him the most was his association

with more than seventy residents and fellows that he trained. He delighted in their achievements and followed their careers with great interest. To all of us who benefited from his enormous intellect, caring demeanor and intellectual curiosity, we celebrate the life of " Abdel Khalik Sarwat Basha "as he was affectionately known; a life well lived. He was believing in sentences of Arthur James Balfour "The best thing to give to your enemy is forgiveness; to an opponent, tolerance; to a friend, your heart; to your child, a good example; to a father, deference; to your mother, conduct that will make her proud of you; to yourself, respect; to all men, charity".

With great sorrow, Ain-Shams Medical School bids farewell to one of our organization's leading surgeons, who had been a major figure in the educational and training practice in cardiothoracic surgery of Egypt and the Arab world for close to half a century.

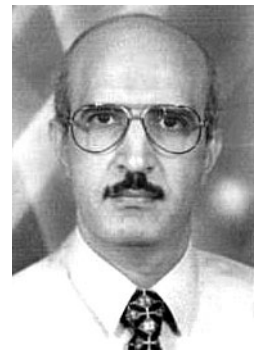
Ezzeldin A. Mostafa

References

1. Mostafa EA, Ali AM, Maklad AS, Mostafa MM, El-Sayed HM, Sarwat AK. Pulmonary arterio-venous fistulas. Proceedings of the 9th Annual Ain-Shams Medical Congress 1986;9:597-612.
2. Mostafa EA, Ali AM, Maklad AS, Mostafa MM, El-Sayed HM, Sarwat AK. Bypass of the obstructed superior vena cava. Proceedings of the 9th Annual Ain-Shams Medical Congress, 1986;9:613-627.
3. Ali AM, Mostafa EA, El-Saegh MM, Shoeb MA, Bassiony MF, Tageldin MA, Sarwat AK. Intrapleural tetracyclines in the managment of malignant pleural effusions. Benha Med.J.1987:4(2):25
4. Ali AM, Mostafa EA, Kamar ZA, El-Maraghy, MM, Sarwat AK. The increasing chest wall tumors. Egypt. J. Surg. 1987;6(2);75
5. Sarwat AK, Mostafa EA, Ali AM, Kamar ZA. Malignant fibrous histocytoma. In thoracic practice. J. Egypt . Soc. Path. 1988;7(1):167.
6. Mostafa EA, Ali AM, Maklad AS, Mostafa MM, Tantawy MA, Sarwat Ak. Delayed traumatic diaphragmatic hernia. Benha Med. J. 1989;6(1):9.
7. Mostafa EA, Zaghloul TS, El-Saegh MM, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. The surgical treatment of coarctation of the aorta: Follow-up study of 25 years. Egypt. Heart. J. 1989;21:127
8. Mostafa EA, Ali AM, Kamar ZA, Sarwat Ak. Rhabdomyosarcoma of the chest wall. J. Cancer Institute 1989:11:50.
9. Mostafa EA, Tantawy MA, El-Saegh MM, Shoeb MA, Ali MA, Sarwat AK. Surgical treatment of pulmonary hydatidosis in children. Sci Med. J. Cai. Med. Synd 1989; 4: 34-37
10. Mostafa EA, Ali AM, Kamar ZA, Sarwat AK. Sarcoma of the lung. J. Egypt. Soc. Path. 1990;10(1):201-213.
11. Mostafa EA, El-Battawy Ma, El-Sayegh TM, Ali AM, Sarwat AK, Kamar ZA . Diffuse malignant mesotheliomas of the pleura. J. Egypt. Soc. Path. 1990;11(1): 397-410.
12. Mostafa EA, Ali AM, Kamar ZA, Sarwat AK. Neurogenic tumors of the thorax. J. Egypt. Soc. Path. 1990;(1): 201-213.
13. Mostafa EA, Ali AM, Kamar ZA, Sarwat AK. Mediastinal germ cell tumors: A clinico-pathological study of 22 cases. J. Egypt. Soc. Path. 1990;11(2): 399-412.
14. Mostafa EA Mostafa MM, El-Saegh MM, Ali AM, Bassiony MF, Maklad AS, Shoeb MA, Zaghloul TS, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. Ruptured Aneuysms of the sinus of Valsalva In Egyptian patients. Egypt. Heart. J..1993;42:139-150.
15. Mostafa EA, Mostafa MM, Tantawy MA, El-saegh MM, Shoeb MA, Lotfi S, Sallam Ia, Sarwat AK, El-Fiky MS, El-Sayed HM. Pericardiectoomy for constrictive pericarditis: Early and late results. Egypt. Heart. J. 1993;43:17-23.
16. Mostafa EA. Attia IM, El-Kirdany AB, Saber WA, Zaghloul TS, Tantawi MA, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. The surgical treatment of atrial myxomas: Clinical experience and Late results in 38 patients. Egypt. Heart. J. 1996;52:31-38.

Death of "The Enlighter" and dimming of "The Candle"

Mohmad Monir Abdel Fattah El-Saegh (1951-2004)



People are eternally divided into two classes, the believer, builder, and praiser, and the unbeliever, destroyer and critic.
John Ruskin

There are two kinds of people, those who do the work and those who take the credit. Try to be in the first group; there is less competition there. Indira Gandhi

One machine can do the work of fifty ordinary men. No machine can do the work of one extraordinary man. Success is the maximum utilization of the ability that you have. The secret of success, as Mark Twainbelieve said, is making your vocation your vacation. His most remarkable feature, however, was his eyes. His gaze, sharp and piercing, lent his already powerful and deeply thought-out arguments an additional force which might convince, or enrage, but ensured they could never be simply dismissed. "He just seemed too strong to die," said one of the many who loved him, learning of his sudden passing away that day.

You can learn new things at any time in your life if you're willing to be a beginner. If you actually learn to like being a beginner, the whole world opens up to you. Monir graduated from Medical School at Ain-Shams University in 1975 and entered surgical residency under the direction of Professor Hamdy M. El-Sayed . These became watershed years in Monir's life as he became friends with many of the future leaders in Egyptian cardiac surgery and was entranced with the value of a surgical research laboratory.

He was appointed to the Faculty of Ain-Shams University in 1979 as a General Surgeon. Dr. Monir's interest focused on the developing specialties of vascular and cardiac medicine . and his active participation in the surgical research laboratories supported his growing interest in cardiovascular patho-physiology so he had the Master degree cardoiovascular medicine in 1981.

In addition to his scientific papers [1-21], and among his many accomplishments during his career, the facet that pleased him the most was his association with residents and fellows that he trained. He delighted in their achievements and followed their careers with great interest. To all of us who benefited from his enormous intellect, caring demeanor and intellectual curiosity, we celebrate the life of 'Dr Monni ' as he was affectionately known; a life well lived.

There are two primary choices in life: to accept conditions as they exist, or accept the responsibility for changing them. Blessed are those who can give without remembering and take without forgetting. In matters of style, swim with the current; in matters of principle, stand like a rock. The shy man will not learn; the impatient man should not teach. Monir was, without a doubt, an exceptional man. He has been aptly described as a warrior-knight. Opinions and judgments did not vary widely about his career and choices. All people loved him passionately. Oh, my friend, it's not what they take away from you that counts. It's what you do with what you have left. Kindness in words creates confidence. Kindness in thinking creates profoundness. Kindness in giving creates love. The vision that you glorify in your mind, the ideal that you enthrone in your heart ?this you will build your life by, and this you will become. To his family of Samia and their three children, Monir was a model of loyalty, the power of positive thinking and perseverance.

Ezzeldin A. Mostafa

References

1. Ali AM, Mostafa EA, El-Saegh MM, Shoeb MA, Bassiony MF, Tageldin MA, Sarwat AK. Intra-pleural tetracyclines in the management of malignant pleural effusions. Benha Med.J.1987:4(2):25
2. Shoeb MA El-Saegh MM, Tantawy MA, Mostafa EA, Bassiony MF, Sallam IA, Sarwat AK. EL-Fiky MS, El-Sayed HM. Experience of Ain-Shams University in open heart surgery for acquired valvular diseases (1986-1987). Sc. J. Az. Med Fac. (Girls) 1987;5(2):89

3. El-Saegh MM, Shoeb MA , Tantawy MA, Mostafa EA, Zaghloul TS, Ali MA, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. Surgical treatment of congenital subvalvular aortic stenosis: Techniques and recommendations. Sc. J. Az Med Fac. (Girls) 1987;5(2):89
4. Shoeb MA, Bassiony MF, Zaghloul TS, Tantawy MA, El-Saegh MM, Mostafa EA, Ali MA Sarwat AK. Palliative systemic to pulmonary shunts using expanded poly-tetra-fluoro-ethylene (Gore-Tex) grafts. Egypt. J. Pedi. 1988;5(1):139
5. El-Saegh MM, Ali MA, ,Zaghloul TS, Mostafa EA Shoeb MA, Maklad AS, Mostafa MM, El-Saegh MM, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. Surgical aspects of coronary artery disease. Egypt. Heart. J. 1989;21:119.
6. Mostafa EA, Zaghloul TS, El-Saegh MM, Sallam IA, Sarwat Ak, El-Fiky MS, El-Sayed HM. The surgical treatment of coarctation of the aorta: Follow-up study of 25 years. Egypt. Heart. J.1989;21:127
7. Mostafa EA, Tantawy MA, El-Saegh MM, Shoeb Ma, Ali Ma , Sarwat AK. Trans-atrial closure of ventricular septal defects. Sci. Med. J. Cai. Med. synd, 1989; 4:29 – 33.
8. Mostafa EA, Tantawy MA, El-Saegh MM, Shoeb MA, Ali MA, Sarwat Ak. Surgical treatment of pulmonary hydatidosis in children. Sci Med. J. Cai. Med. Synd 1989; 4:34-37.
9. Tantawy MA, El-Saegh MM, Shoeb MA, Mostafa EA, Abdel Fattah MM. A four-year experience in vascular access procedures for hemodialysis in chronic renal failure. Sci. Med. J. Cai. Med. Synd. 1989; 4:38-42.
10. Ali AM, Maklad AS, Mostafa MM, El-Saegh MM, Shoeb MA, Mostafa EA, Zaghloul TS, El-Fiky Ms, El-Sayed HM. Closure of ventricular septal defects in patients with pulmonary hypertension. Ii Cuore 1990;7(3):299-303.
11. El-Saegh MM, Ali AM Shoeb MA, El-Sayegh TM, Mostafa EA, El-Kirdany AB, Maklad AS, Mostafa MM Mostafa EA, El-Fiky MS. Surgical correction of congenital heart diseases in adults and adolescents. Egypt. Heart. J.1991;36: 22
12. El-Saegh MM, Mostafa EA, Shoeb MA, Zaghloul TS, El-Kirdany AB, Lotfi SA, El-Sayegh TM. Emergency repoperation for malfunctioning cardiac prosthetic valves. Egypt. Heart. J. 1992:41:73-84.
13. Mostafa EA Mostafa MM, El-Saegh MM, Ali AM, Bassiony MF, Maklad AS, Shoeb MA, Zaghloul TS, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. Ruptured Aneurysms of the sinus of Valsalva In Egyptian patients. Egypt. Heart. J. 1993;42:139-150.
14. El-Saegh MM, Ali MA, El-Sayegh TM, Mostafa EA Zaghloul TS, Saber WA. Trans-septal approach for mitral valve surgery: A safe altenative when the needs call . Texas heart Institute J, 1993;20:23-27.
15. Mostafa EA, El-Saegh MM, Mostafa MM, Saber WA. Initial experience of valvuloplasty for mitral valve disease: Ain-Shams University, Cairo. Egypt. Heart. J 1993;42: 73-80.
16. Saber WA, El-Kirdany AB, Lotfi SA, Mostafa EA, El-Saegh MM, Ali MA, Sallam IA. The use of internal mammary artery , as a coronary bypass graft. Egypt. Heart. J. 1993;42:123-128.
17. Mostafa EA, Mostafa MM, Tantawy MA, El-saegh MM, Shoeb MA, Lotfi S, Sallam IA, Sarwat AK, El-Fiky MS, El-Sayed HM. Pericardiectoomy for constrictive pericarditis: Early and late results. Egypt. Heart. J. 1993;43:17-23.
18. El-Sayegh TM, El-Saegh MM, Shoeb MA, El-Kirdany AB, Lotfi SA, Saber WA, Mostafa EA, Zaghloul TS, El-Sayed HM, Sallam IA. Open heart surgery in the first 2 years of life. Egypt. Heart. J. 1993;43:89-94.
19. Zaghloul TS, El-Saegh MM, Ali MA, Mostafa EA, Maklad AS, Bassiony MF. Chylothorax after cardiothoracic surgery. Saudi Heart J. 1993;4(2):12.
20. Zaghloul TS, El-Saegh MM, Mostafa EA, Ali MA Darwaza AK, El-Sayegh TM, Hassouna A., Osman W, Bassiony, MF. Cardiac valve replacement combined with myocardial revascularisation. Egypt. Heart. J. 1994;44:103-108.
21. Hassouna A, El-Fiky MM, El-kirdany AB, Zaghloul TS Mostafa EA, Shoeb MA, Tantawy MA, El-Saegh MM. Palliative surgery in congenial cyanotic heart disease: A 20-year experience evaluation. Egypt. Heart. J. 1996;53: 49:55.

The Warrior

Major General Doctor : Abdel Kader Othman Hassan FRCS 1928 – 2004.

Abd El Kader Othman Hassan Previous head of the Cardio – Thoracic surgical department at Maadi Armed Forces Hospital 1973 – 1981, Former Consultant and Professor of Cardio-Thoracic Surgery Military Medical Despite this surrounding he remained very humble and devoted most of his time to service ordinary &poor patients without looking to any financial reward or benefit to gain during this distinguished career .

Academy

Dr. Abdel Kader was an example to follow in every aspect. He shared in all the wars the Egyptian Army fought starting from 1956 when he was captured for 8 months in Ghaza while serving at Al Zohoor Hospital.

After which he was honored with:

- The first Note of military service.
- Medal of good example.
- 1973 October war Medal.
- Yemen War Medal.

This In addition to several Medical Certificates of distinction granted from the Egyptian Medical Syndicate and Egyptian Society of Cardio – thoracic surgery 2003

Many were the Colleagues , Nurses , Ancillary Staff and patients whose lives have been enriched by the help and friendship of Dr. Othman who kept as well very loyal to his previous Professors and attached to his students.

During his service he treated many of famous personnel like President Anwar El Sadat (1981) former Emperor Reza Bahlawi of Iran(during his stay in Egypt) .

Dr Abdel Kader was one of the pioneers who drove the open heart surgery forwards in Egypt .After retirement from the military service 1981 he continued to serve at National Health Insurance Hospitals and before complete retirement from Medical practice, he donated for free his personal surgical instruments to one of the Egyptian Hospital .

Mr Abdel Kadr had a distinguished Post Graduate Cardio-Thoracic training at Hare-Field Hospital during his stay in England 1963 – 1964 . During that period he succeeded as well to pass the Fellowship Examination At the Royal College of surgeons of Edinburgh 1963.

By the end of his training at Hare-Field He has been offered a permanent Cardio-Thoracic surgery job and this was an exceptional offer which he declined preferring to return back to Egypt transferring the experience he acquired overseas to his country serving his people; which he did until he died

what a Great Man !!

Yasser M W Hegazy

STATISTICS

National Adult Cardiac Surgical Register : Initial collective Data of 6 collaborating Centers ,For the year ; 2004-2005

YASSER M W HEGAZY, MD,FRCS

Egyptian Society of Cardio-Thoracic Surgery On behalf of the Egyptian Society of Cardio-Thoracic Surgery We are trying to present the crude Aggregate Anonymous Adult Cardiac Surgical data of 6 major operating Units in Egypt .

Although there are around 42 registered centers practicing cardio-thoracic surgery in Egypt ; as an initial step we succeeded to collect data from 6 centers only . We hope that the number of participating Centers will increase next years until we or somebody to follow reach the target of presenting a full recorded data for the total number of centers practicing adult cardiac surgery in Egypt. **The Collaborating Centers were (arranged in alphabetical order) :**

1. Al Azhar University
2. Insurance 6 october hospital
3. Kasr El Aini Hospital
4. Maadi Military Hospital
5. Nasser Institute
6. National Heart Institute

Table 1. Centers in Egypt practicing cardiac surgery

Center	University NHI	Health Insurance	Military	private	other
No	17	8	3	12	2
		Total No. = 42			

NHI= National Heart Institute.

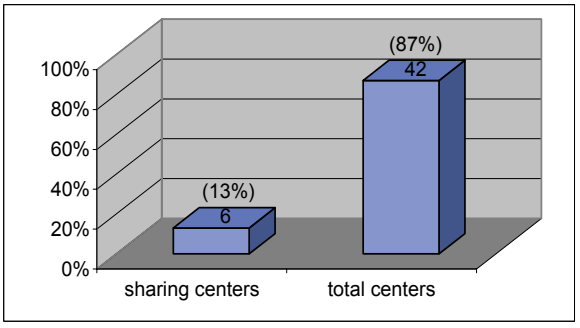


Fig 1. Number of Cardio-Thoracic centers who shared in the collective data collection for the year 2004-2005 from the total number of Centers practicing adult cardiac surgery in Egypt.

[Table 2.] shows the total number of cases done in the 6 sharing Centers with a total number of mortalities 247 (5.02%) which is a figure approaching the European and North American standards.

Table 2. Total No. of cases done in the six Main Sharing Centers

total	mortality	%
4919	247	5.02

Collective data provided from the above named 6 Centers is presented in [Table 3.] segregated according to type of surgery , without identification of separate Center Data . This policy was set by the Society Board in order to encourage the remaining centers to come forwards with their data next time .

Table 3. Initial Collective Data of the 6 Contributing Centers

Item	Number of cases operated upon	Mortality	
		No	%
CABG	2713	118	4.3
Valve Surgery	2023	112	5.5
Complex Surgery	74	8	10.8
Other	109	9	8.2

Complex = combined surgery (e.g. Valve +CABG) Other = Thoracic Aorta surgery (e.g. Aneurysm , dissection…)Or IHD surgery (e.g. VSD , Aneurysm …)

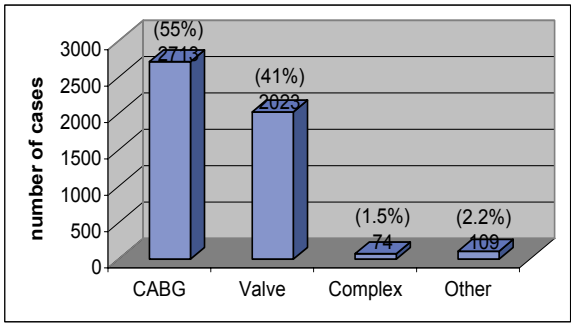


Fig2. Total number of adult cardiac cases performed in different types of surgery .

Valve Surgery

From the data gathered we tried to analyze the total number of cases performed in different types of surgery specially valvular and ischemic; [Table 4] .

Table 4.Total Valve surgery

TOTAL	mortality	%
2023	112	5.5

shows the total number of valvular procedures performed on adult patients while [Table 5.] divides them into separate categories according to the type of valvular surgery undertaken showing the total number of cases and mortality for each. while [Table 5.]

Table 5. Valvular Surgery

Item	No.	Mortality	
		No	%
Mitral valve repair	87	2	2.2
Mitral valve Replacement	989	56	5.6

divides them into separate categories according to the type of valvular surgery undertaken showing the total number of cases and mortality for each.

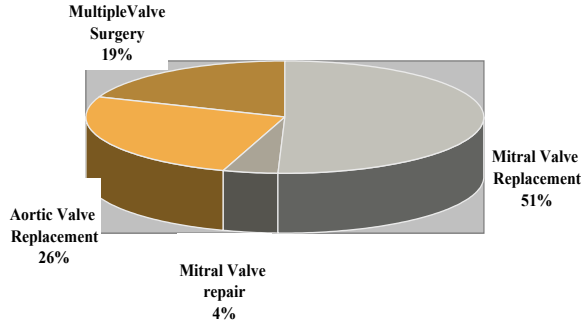


Fig3. Adult cardiac cases performed in according to the different type of valvular surgery undertaken

Coronary Artery Bypass Grafting

These collective data shows that the share of coronary artery surgery is now surpassing the valvular surgery which was at certain stage in Egypt the main portion of our work.

Still the Off-Pump Coronary surgery is far away from the western practice but yet has the coming years to evolve; may be in the next collective data collection.

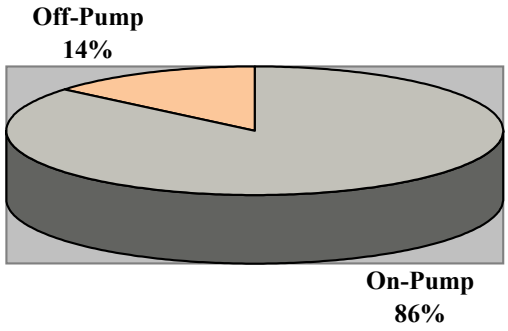
Table 6. Total CABG cases done in six centers 2004-2005.

TOTAL	mortality	%
2713	118	4.3

Table 7.On-Pump versus Off-Pump Myocardial Revascularization

Item	Total Number	Mortality	
		No	%
On- Pump	2337	103	4.4
Off- Pump	376	15	3.9

Fig4. On-Pump versus Off-Pump Myocardial Revascularization



Our main goal is to encourage the use of Unified Data registering sheet (suggested by the Society last year) ; Whether completed electronically or filled written on paper.

We hope to reach the day when all the Cardiac cases operated upon Egypt are fully registered .

We will remainAnonymous Consultant and Center wise In order to encourage all the Egyptian Centers to come forwards with their data .Until we achieve that goal we will go step by step wishing next time that more centers are going to collaborate in this work.

Aiming to have an Annual Vector of the Egyptian Cardiac Surgical Work , producing Data from all entries to be used for the basic aggregate and advanced statistical analysis .

As data collection and its statistical analysis remain the corner stone for any advancement in the field whether nationally or internationally ;I would like to introduce the next Statitics topic written in series by Dr Ahmed Hassouna ; who is trying to clarify some basic statistical tools needed for all the researchers and clinicians .. Yasser MW Hegazy

Statistics For Clinicians
Coronary Artery Bypass Grafting

Ahmed A. Hassouna, MD

The four basic indices Mean (m), variance (S^2), standard deviation (SD) and standard error of mean (SEM) are the usual indices of numerical measurements or observations and are the basis of most of the statistical tests used to compare those measurements as well.

The mean value (m) is calculated by dividing the sum ($\sum$) of all values (x_i) by the number of those values (n); or $m = \sum (x_i) / n$. Let's take a simple example and imagine 2 groups of patients: group (a) consisting of 3 men aging 49, 50 and 51 years, while group (b) is formed of a 99 years very old man, a 50 years old man and a very young 1 year old child. Although the mean age of both groups is 50 years [m = (49 + 50 + 51)/3 = (99 + 50 + 1)/ 3 = 50], yet no one can ever consider that both groups are comparable as regards the studied variable which is age. The mean alone is not only meaningless but can shadow very important information, which is in our case: the close proximity of individual values of the first group and their wide variability in the second group. The variance (S^2), the standard deviation (SD) and the standard error of means (SEM) are 3 measures that were created to uncover this information. In other words, to show the extent of deviation of individual values from the mean: the more the individual values are dispersed away from the mean; the larger these measures of deviation will be.

The variance (S^2) was designed to represent the mean of those deviations by summing ($\sum$) the differences between each of the individual values and the mean (x_i-m) and then dividing this sum by the number of values (n). However, statisticians were faced by 2 technical drawbacks: First, simple deviations may be either positive or negative and, when summed, positive values may be annulated by negative ones. In our example, the sum of deviations = (49-50) + (50 -50) + (51-50) = (1) + 0 + (-1) = 0 and (1-50) + (50 -50) + (100-50) = (49) + 0 + (-49) = 0. Of course this extreme example where the sum of deviations equals zero is not the rule and was mending to show a possible effect of such annulations. The best solution was to square those deviations $(x_i\text{-m})^2$ to get ride of the signs (+ or -) before summing them. In other words, the sum of deviations was replaced by the sum of squared deviations. However, this was not all as follows.

Secondly, the mean of such deviations was thought to be obtained as usual by dividing the sum of squared deviations $\sum (x_i\text{-m})^2$ by the sample size (n). However, the sum of squared deviations is not divided by (n) but by (n-1) and this also needs some explanation: Let's take group (a) and calculate the sum of squared deviations or $\sum (x_i\text{-m})^2$: $(49\text{-}50)^2 + (50\text{-}50)^2 + (51\text{-}50)^2 = 1 + 0 + 1$. It is obvious that only 2 variations were taken into consideration $(49\text{-}50)^2$ and $(51\text{-}50)^2$ and that the middle one $(50\text{-}50)^2$ equaled zero because its value was

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the mean itself. In other words, only 2 variables were free to vary around the mean while the third which is the mean itself was not free to do so. As the variance was designed to describe the variations around the mean, and as in any sample one of the individual values may be the mean itself, it was more appropriate to subtract this 1 (that do not vary around the mean because it is the mean itself) from the number of values in the denominator. This correction was suggested not only on this theoretical basis, but after computing the variance with repeated samples with the use of (n). The values obtained did not have the desired property of averaging around the population variance and subtracting 1 from the number of values appeared to straighten such bias. The value n-1 is called the degree of freedom (df) and variance is better defined as sum of squared deviations divided by the (df) $= \sum (x_i\text{-}m)^2 / n\text{-}1$.

The Standard deviation (SD) is the square root of variance ($= \sqrt{S^2}$) and the Standard error of mean (SEM) is the square root of the variance after being divided by the number of values $= \sqrt{(S^2/n)}$.

In group (a):

$S^2 = [(49\text{-}50)^2 + (50\text{-}50)^2 + (51\text{-}50)^2] / (3\text{-}1) = 2 / 2 = 1$.

$SD = \sqrt{1} = 1$ and $SEM = \sqrt{(1 / 3)} = 0.58$

In group (b):

$S^2 = [(99\text{-}50)^2 + (50\text{-}50)^2 + (1\text{-}50)^2] / (3\text{-}1) = [2401 + 0 + 2401] / 2 = 2401$.

$SD = \sqrt{2401} = 49$ and $SEM = \sqrt{(2401 / 3)} = 28.3$

As we can easily notice, the age of group (a) patients was homogenous as evidenced by the small variance, SD and SEM in comparison to the calculated mean, while group (b) patients were far from being so. Variance is mostly used in mathematical equations of statistical tests; SD and SEM are commonly used for data presentation and the question rises: which of them should one use and when? While the SD measures the deviation of the individual values (x_i) from the calculated mean (m), the SEM measures the deviation of the calculated mean (m) from the real mean (M) of the population from which our values (x_i) were selected.

In the words of our example, the mean age of our group (a) patients is 50 years and the calculated SD of 1 is very small compared to the calculated mean and reflects the homogeneity of the individual values and their near proximity to the mean. The calculated SEM (0.58) reflects the deviation of the calculated mean itself (50 years) from the true mean or grand mean or the mean age of the population from which our sample study was issued. Both SD and SEM are deductible the one from the other ($SEM = SD/\sqrt{n}$) but the latter is of more sense for studies carried out on large groups of patients and hence, have more chance to approach the true mean values of the population, compared to small samples. This is part of the central limit theorem: the more we add values, the more our values have a tendency to accumulate around the mean

In other words, the larger is our sample size (n), the more our calculated mean (m) approaches the true mean (M) of the population and, consequently, the smaller SEM will be. This is the theoretical basis for taking into consideration the sample size in calculating such deviation (i.e. SEM) by dividing the variance by n before taking its square root.

The mathematical equations:

$m = \sum (x_i) / n$

$S^2 = \sum (x_i\text{-}m)^2 / n\text{-}1$

$SD = \sqrt{S^2}$

$SEM = \sqrt{(S^2 / n)} = SD / \sqrt{n}$.

CARDIOVASCULAR

Antegrade Perfusion Through Right Axillary Artery Cannulation for Surgery of Acute Type A Aortic Dissection

Said Abdel Aziz MD

Background: **The standard cannulation of the femoral artery as an arterial inflow for cardiopulmonary bypass (CPB) for repair of acute aortic dissection carries the risk of malperfusion. Arterial inflow perfusion through the right axillary artery is more likely to perfuse the true lumen and should be an advantage in repairing acute type A aortic dissection. It also decreases the risk of atheroemboli and allows the possibility of antegrade cerebral perfusion during hypothermic circulatory arrest.**

Methods: In a period of 39 months (between May 2001 and October 2004) 23 patients have been operated upon for acute type A aortic dissection. The arterial inflow for cardiopulmonary bypass was established through cannulation of the right axillary artery in 13 patients (axillary{A} group), whereas the femoral artery cannulation was performed in the other 10 patients (femoral{F} group). Their ages ranged from 32 to 66 years (mean=51±9.6) and from 32 to 58 years (mean=46.5±8.3) for the axillary and femoral groups respectively. Eleven patients (84.6%) were males and 2 patients (15.4%) were females in group {A}, while in group {F}the male to female ratio was 9(90%) to 1(10%). All patients had hypothermic circulatory arrest (HCA). Retrograde cerebral perfusion (RCP) was done in all patients of the F group and in 9 patients of the A group while antegrade cerebral perfusion was done in 4 patients of the A group.

Results: **Major neurological complications occurred in one patient (8%) in group A and in three patient (30%) in group F. hospital mortality for all patients was 8.9% (2 of 23 patients). One patient in each group. The wound healing of the axillary artery is excellent in all patients while the femoral group patients experienced wound infection in 2 patients (20%).**

Conclusions: **arterial perfusion through the right axillary artery for acute type A aortic dissection is safe, easy and reliable procedure that is applicable to most of the patients and may improve surgical results. It allows antegrade perfusion of the true lumen from the start of the operation, therefore avoids the problem of organ malperfusion during CPB and allows easy antegrade cerebral perfusion during HCA.**

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Arterial cannulation in preparation for repair of a dissection involving the ascending aorta has been performed through the femoral artery, being the most common alternative cannulation site for cardio pulmonary bypass. However, in femoral artery cannulation many disadvantages exist, such as retrograde aortic flow with the increased risk of embolization of luminal debris into the brain, propagation of a retrograde dissection, lower limb ischemia, wound complications and especially, end organ ischemia caused by malperfusion [1,2]. In contrast, cannulation of the right axillary artery enables antegrade perfusion through the true lumen. Therefore, it may avoid cerebral embolization and organ malperfusion and may reduce the rate of neurological and malperfusion complications [3,4].

The aim of this study was to identify whether antegrade perfusion through cannulation of the Rt. axillary artery may improve the results of surgery for acute aortic dissection and pay especial attention to the feasibility of the technique and its possible complications.

Patients and methods

In a period of 39 months (between May 2001 and October 2004) 23 patients have been operated upon for acute type A aortic dissection. The arterial inflow for cardiopulmonary bypass was established through cannulation of the right axillary artery in 13 patients (axillary{A} group), whereas the femoral artery cannulation was performed in the other 10 patients (femoral{F} group). Their ages ranged from 32 to 66 years (mean=51±9.6) and from 32 to 58 years (mean=46.5±8.3) for the axillary and femoral groups respectively. Eleven patients (84.6%) were males and 2 patients (15.4%) were females in group {A}, while in group {F}the male to female ratio was 9(90%) to 1(10%). The indication for operation was acute aortic dissection type A in all patients of both groups and all patients were operated on an emergency basis after the diagnosis was established. The diagnosis was made on the basis of echocardiography combined with computed tomography in all cases. Also arterial duplex of both carotid and femoral arteries was done in most patients. No specific arteriographic visualization or duplex study of the axillary was performed.

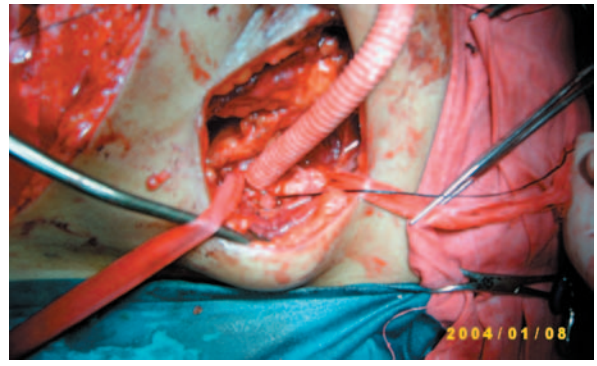
Anatomical consideration:

The axillary artery, a continuation of the subclavian artery, begins at the outer border of the first rib and ends normally at the interior border of the teres major muscle. The pectoralis minor muscle crosses it and divides it into three parts: proximal (1_{st}), posterior (2_{nd}) and distal (3_{rd}) to the muscle. The first part of the axillary artery usually gives one small branch (superior thoracic artery). The most important structure related to the first part of the axillary artery is the axillary vein [5]

Surgical technique

The patient is placed in the standard supine position and the arms are near the body as for the usual open heart procedure. Routinely, the arterial blood pressure in group {A}is monitored by bilateral radial artery cannulation, while in group {F} one radial artery- usually the right- is cannulated and usually, but not always, one femoral may be cannulated.

A small skin incision is made 1 cm below and parallel to the middle and lateral parts of the clavicle. The pectoralis major muscle is partly separated from the clavicle. The cephalic vein is mobilized in the deltopectoral groove and retracted to gain access to the deeper subclavian space. The axillary artery, identified by palpation, is freed from connective tissue and separated from lateral pectoral nerve branches. The thoraco-acromial artery is controlled with a snare. Two umbilical tapes are passed around the exposed axillary artery proximally and distally. After heparinization the proximal and distal part of the exposed segment are clamped and then a longitudinal incision in the axillary artery is performed. An 8 mm tube graft is anastomosed end to side to the axillary artery using 6/0 prolene running suture to which the arterial line is connected. The clamps on the axillary artery are removed (Fig. I).



For venous cannulation we use a two-stage cannula in the right atrium After decannulation the tube graft is cut 1cm. away from the axillary artery and this small stump is closed longitudinally in 2 rows using a 6/0 Prolene running suture.

Al cases have been performed through median sternotomy. Cardiopulmonary bypass was instituted and

patients were cooled down to a core temperature ranging from 17ºC to 24ºC. all patients went into circulatory arrest that ranged from 33 to 70 minutes (mean: 49±12 minutes) in the A group and from 23 to 59 minutes (mean: 38.9±13 minutes) in the F group. Retrograde cerebral perfusion via the superior vena cava was done in all cases of the F group and in 9 cases (69%) of the A group, while the other 4 cases (30.7%) of group A, antegrade cerebral perfusion was performed. The mean duration of RCP was 26±19.8 minutes and 32±13 minutes in group A and F respectively. The duration of total bypass time and other operative procedures were shown in table 1.

Table 1: Operative data

	Group A	Group F
Bentall procedure	9 (69%)	6 (60%)
Supracoronary replacement	5 (38%)	4 (40%)
Arch&Hemiarch replacement	4 (30.7%)	4 (40%)
Total bypass time (min.)	87-177 (mean=123.7±30.4)	75-179 (mean=127.7±32.5)
Circulatory arrest time (min.)	33-70 (mean=49±12.08)	23-59 (mean=38.9±13.6)
RCP (min.)	Mean=26.2±19.8	Mean=32.2±13.07
Antegrade CP (min.)	Mean=16±25.5	-----
Major neurological Complication	1 (8%)	3 (30%)
Wound infection	0%	2 (20%)

RCP=retrograde cerebral perfusion, CP=cerebral perfusion

Results

The hospital mortality for all patients was 8.9% (2 of 23 patients). One patient (8%) in group A and one patient (10%) in group F. the procedures performed in all patients were almost the same in both groups as described in table 1. Major neurological complications occurred in one patient (8%) in group A and in three patient (30%) in group F. That patient in group A did not regain his consciousness after the operation because of the development of big cerebral infarction (preoperatively, he was presented with cerebral complications due to extension of the dissection into the right carotid artery). On the other hand, the three patients in group F, one of them did not regain his consciousness after the operation because of the development of big cerebral infarction and the other two developed peripheral neurological deficit in the form of upper limb monoplegia in one patient and lower limb paraplegia in the other.

The cannulation of the right axillary artery was successful in all patients except one patient in whom the artery was involved in the dissection process as proved by the high resistance of the arterial CPB flow and in that patient we shifted to femoral artery cannulation. During the surgical procedure the brachial plexus was not injured and was easily identified and dissected away. Also, there was no axillary artery thrombosis, no local hematoma, and no local ischemia or intraoperative or postoperative malperfusion of the arm. The wound healing of the axillary artery is excellent in all patients while the femoral group patients experienced wound infection in 2 patients (20%) and femoral lymphatic vessels injury in one patient but without affection of the lymphatic drainage of that lower limb.

Discussion

Our experience demonstrates that this method of arterial cannulation (right axillary artery) is technically feasible instead of the femoral artery.

Cannulation of the right axillary artery was easy in all our patients. A synthetic 8mm. graft -to- artery anastomosis with graft cannulation secures easily cannulation without problems as reported by other authors (6&7). Many others reported direct right axillary artery cannulation (4&8). In group A patients, conversion to femoral artery cannulation was necessary in one patient because of high resistance of the arterial CPB flow and such situation was also reported by Schachner et al in two patients of their study group because of significant resistance in the artery during advancement of the cannula in one patients and in the other because CPB flow was insufficient (4).

The femoral artery cannulation has the disadvantage of possible complications such as hematoma, nerve injury, lymph fistula and wound infection (9) while the right axillary artery cannulation does not have these complications as observed in our study and other many studies (4,7&8). Moreover, the axillary artery is also rarely involved in the atherosclerosis process as the femoral artery.

The only possible problem of axillary artery cannulation is the involvement of the subclavian artery in the process of dissection with an intimal flap in the innominate artery that can cause retrograde carotid dissection

and cerebral malperfusion (10). We faced this problem in one patient in whom we shifted to femoral artery cannulation.

Malperfusion is one of the major factors contributing to the morbidity and mortality associated with acute aortic dissection (4&11) and cannulating the right axillary artery not only reliably perfuse the true lumen from the start of the operation, but also eliminates the extra step of cannulating the aortic graft after doing the distal anastomosis. In addition, by using a graft sutured directly to the axillary artery, perfusion to the right upper limb is maintained.

Some consider that one of the major advantages of right axillary artery cannulation is the possibility of antegrade cerebral perfusion during deep hypothermic circulatory arrest (6). This procedure has been simplified by clamping the innominate artery for right carotid artery perfusion and by using only the selective cannulation of the left carotid artery. we have done this technique in 4 patients of the A group and we observed no significant postoperative neurological problems, moreover, this method of cerebral perfusion gave us more time during the deep hypothermic circulatory arrest to replace or repair the aortic arch.

Our study has some important limitations. It is an observational study and presents our preliminary experience with a small number of patients and to have good results we need to study a larger group of patients.

In conclusion, cannulation of the right axillary artery for acute type A aortic dissection is safe, easy and reliable procedure that is applicable to most of the patients and may improve surgical results. It also, offers several advantages over femoral artery cannulation. (1) the axillary artery is generally free from atherosclerosis even in the presence of aortoiliac disease. (2) it provides antegrade perfusion of the true lumen from the start of the operation, therefore avoids the problem of organ malperfusion during CPB. (3) it allows easy antegrade cerebral perfusion during DHCA.

References

1. Eugene J, Aronow WS, Stemmer EA. Retrograde aortic dissection during cardiopulmonary bypass. Clin Cardiol 1981;4:356-359.
2. Borst HG. Surgical treatment of aortic dissection. New York: Churchill Livingston, 1996;31-33.
3. Neri E, Massetti M, Capannini G, Carone E, Tucci E, Diciolla F, Prifti E Sassi C. axillary artery cannulation in type A aortic dissection operations. J Thorac Cardiovasc Surg 1999;118:324-329.
4. Schachner T, Vertacnik K, Laufer G, Bonatti J. axillary artery cannulation in surgery of the ascending aorta and the aortic arch. Eur J Cardiothorac Surg 2002;22:445-447.
5. Gray's anatomy: the anatomical basis of medicine and surgery. The axillary artery.38 edition.Churchill Livinstone. Harcourt Brace and Company limited,1999 page 1537.
6. Mazzola A, Gregorini R, Villani C, Di Eusanio M. Antegrade cerebral perfusion by axillary artery and left carotid artery inflow at moderate hypothermia. Eur J Cardiothorac Surg 2002;21:930-931.
7. Sinclair MC, Singer RL, Manley NJ, and Montesano RM. Cannulation of the axillary artery for cardiopulmonary bypass: Safeguards and pitfalls. Ann Thorac Surg 2003;75: 931-934.
8. Pasic M, Schubel J, Bauer M, et al. Cannulation of the right axillary artery for acute type A aortic dissection. Eur J Cardiothorac Surg 2003;24:231-236.
9. Bichell DB, Balaguer JM, Aranki SF, Couper GS, Adams DH, Rizzo RJ, Collins JJ, Cohn LH. Axilloaxillary cardiopulmonary bypass: a practical alternative to femorofemoral bypass. Ann Thorac Surg 1997;64:702-705.
10. Imanaka K, Kyo S, Tanabe H, Ohuchi H, Asano H, Yokote Y. Fatal intraoperative dissection of the innominate artery due to perfusion through the right axillary artery. J Thorac Cardiovasc Surg 2000;120:405-406.
11. Whitlark JD, Goldman SM, Sutter FP. Axillary cannulation in acute ascending aortic dissections. Ann Thorac Surg 2000;69:1127-1129.

Comparison of Graft Flow in Off-pump and Conventional Coronary Artery Bypass Grafting

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Objectives: **Patency of the anastomosis is a concern in patients undergoing off-pump coronary revascularization. Transient time flow is a tool for measurement of graft flow and assessing the patency of anastomosis .The aim of this study is to compare graft flow between off-pump and conventional coronary artery bypass grafting using transient time flow technique.**

Patient And Methods: **Transient time flow was measured in 28 and 25 cases that underwent conventional coronary artery bypass grafting (CCABG) and off- pump coronary artery bypass (OPCAB) technique respectively. Graft patency was assessed by flow curve, mean flow and pulsatility index (PI). Average flow was compared between individual grafts in both groups.**

RESULTS**: No statistical significant difference was found in graft flow between these two techniques. Average flow was 34.25+19.28 ml/min in LIMA to LAD graft, 21.40+4.60 ml/min in radial artery to OM /Diag. graft and 19.65 + 8.9 ml/min in SVG to RCA /PDA graft in CCABG and 31.07 + 17.18 ml/min, 22.21 + 5.7 ml/min and 20.11 + 10.70 ml/min in OPCAB group.**

Conclusion**: No significant difference was found in graft blood flow in CABG performed with either conventionally or using off-pump-technique. Transient time flow is a useful tool in operative room to assess the graft patency in coronary artery bypass grafting surgery.**

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Off – pump coronary artery bypass surgery (OPCAB) has become a widely accepted procedure. Many trials report better outcomes in OPCAB compared with conventional coronary artery bypass grafting (CCABG). OPCAB reduces morbidity, need for blood transfusion and intensive care and hospital stay compared to CCABG [(1)(2)]. However, there is a concern about the quality of anastomosis and graft patency because of the technical difficulty in performing anastomosis in OPCAB procedures [(3)]. Transient time ultrasound principle for flow measurement was introduced recently into cardiac surgery. It is an accurate method that is available in operative room (OR), easy to use and can be used for assessment of graft blood flow. [(4)(5)(6)]. The aim of this study is to compare graft flow by transit time flow method between OPCAB and CCABG.

PATENTS AND METHODS:

Patient population:

Transient flow measurement records were collected and analyzed in con-

secutive 53 patients who were scheduled for elective first time multivessel single coronary artery bypass grafting during the period from January 2004 to February 2005. Twenty-eight cases were operated upon using CCABG and 25 patients using OPCAB technique. All cases received standardized perioperative and anesthetic care. Cardiac enzyme release was routinely done at the day of surgery and at postoperative day one. Analysis of creatine kinase and creatine kinase MB fraction release at day of surgery was done.

Surgical Technique:
Conventional Cabg (Ccabg):

CCABG operations were performed in moderate hypothermia (32°C) using roller, non-pulsatile cardiopulmonary bypass (CPB) (Cobe-Century-USA), and membrane oxygenator (Capiox, Sx-Terumo-Corp.Tokyo-Japan). Cold antegrade multidose blood cardioplegia was used for cardiac diastolic arrest.

The OPCAB procedures were done via median sternotomy and each coronary artery was stabilized in turn using the Medtronic Octopus III Tissue Stabilization System (Medtronic, Inc, Minneapolis, MN). Starfish repositioner (Medtronic Inc., Minneapolis, MN) or a deep pericardial stitch was used for repositioning and exposing the target vessels. Intracoronary shunts (Clear View, Arteriotomy shunts, Medtronic Inc., USA) were used in all patients to aid visualization during the distal anastomosis of the grafts. Surgical blower (Medtronic Inc., Minneapolis, MN, USA) was used routinely to aid visualization during performing anastomosis. Norepinephrine and volume expansion were used to maintain hemodynamics during positioning of the heart for anastomosis of the target vessels.

Types of The Conduits:

Conduits used for bypass included left internal mammary (IMA) and right internal mammary artery (IMA) which were used as non-pedicled in situ grafts, left radial artery (RA), and saphenous vein grafts (SVG). The left internal mammary artery was anastomosed end-to-side to the left anterior descending (LAD) coronary artery. The right mammary artery was used for revascularization of right coronary artery (RCA) or posterior descending artery (PDA) .The radial artery was usually anastomosed to branches of the circumflex artery, i.e. obtuse marginal branches (OM) or diagonal branches (Diag.). One or more saphenous vein grafts (SVG) were used to complete revascularization of the remaining stenosed coronary arteries. In all patients, single conduit was used for grafting of each stenotic coronary artery .The Order of anastomosis, anastomotic technique and type of sutures used did not differ in the two groups.

Transient Time Flow Measurement:

Flow was measured (milliliters per minute {ml/min}) by the transient time method with the Veri Q System (CM 4008, Medi Stem AS, Oslo, Norway). Probes size 2 to 5 mm (Quik Fit Probe) to fit with the actual vessel size were used. (Fig. 1)

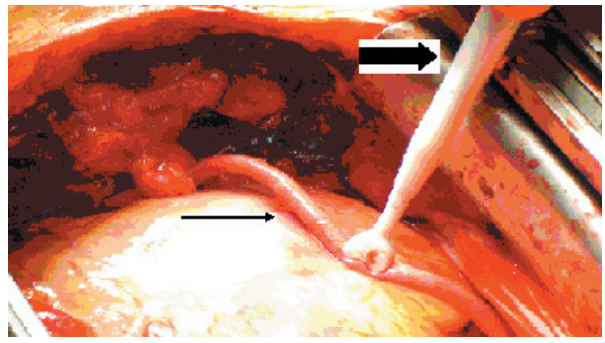


Fig. 1 measurement of the flow Measurement of graft flow using probe size 3 mm (thick arrow) in vein graft to posterior descending coronary artery (thin arrow)

Graft flow was measured in arterial and venous grafts and recorded after completion of proximal and distal anastomosis, weaning of patients from CPB and before heparin reversal. Flow was assessed by flow curve, mean flow rate and pulsatility index (PI) (Fig. 2)

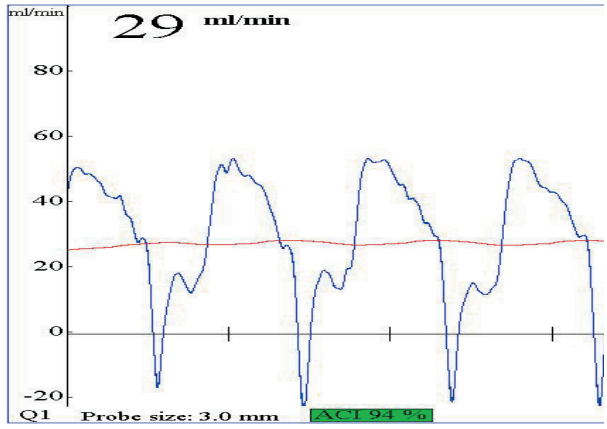


Fig. 2 Transient time flow measurement
Transient Time Flow measurement of left internal mammary artery (LIMA) to left anterior descending coronary artery (LAD).Shown are bypass flow (QI),flow curve , mean flow (29ml/min), pulstility index (PI)(2.6), probe size used(3.0 mm) , and percentage of probe contact with the graft (ACT) (94%).

Graft flow less than 10 ml/min or PI more than 5 usu-

ally was a sign that necessitates revision of the graft.

Statistical Analysis:

Values are expressed as mean + standard deviation (SD). Comparisons between the two groups were performed using t-test. A P-value of 0.05 or less was considered significant. Analysis was done using SPSS program (SPSS, 7.5 for windows, Minu Tab, USA).

Results:

The preoperative characteristics of all the studied patients are shown in Table 1.

Table (1): Preoperative data:

	CCABG	OPCAB	Significance
Age (Years) *	62.28 ±8.83	61.60 ± 7.71	**NS
Body Mass Index (kg/m²) *	26.05 ± 4.03	25.55 ± 3.54	NS
EuroSCORE (standard) *	2.35 ± 2.51	2.63 ± 0.78	NS
EuroSCORE (logistic %) *	3.08 ± 2.36	2.96 ± 1.51	NS
Ejection fraction (%) *	49.60 ± 10.40	48.00 ± 10.99	NS
Serum creatinine (u mol/l)*	96.80 ± 26.75	106.48 ± 62.6	NS
Hematocrite level (%) *	36.63 ± 4.27	38.22 ± 3.56	NS
Hypertension (number)	11/25	13/28	NS
Diabetes (number)	8/25	11/28	NS
Smokers (number)	9/25	10/28	NS

**** Data were presented as mean + SD***
NS** = Non significant

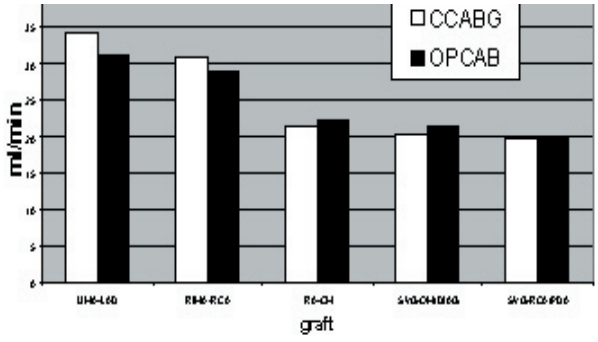
The preoperative characteristics of all the studied patients are shown in Table 1. No significant differences were found between these two groups (CCABG and OPCAB). Intraoperative data showed increased number of grafts per patient in CCABG group compared to OPCAB group. This difference was statistically significant. It also showed that there was a significant increase in number of patients who needed norepinephrine in OPCAB patients compared to CCABG patients (Table 2).

Table (2): Intraoperative variables

	CCABG	OPCAB	Pvalue
No. of distal anastomosis / patient	3.39 ± 0.81	2.72 ± 0.84	0.006
Use of Norepinephrine	6/28 (21%)	18/28 (64.3%)	0.00
Cross clamp time (minutes)	63.67 ±20.57	-	-
Total bypass time (minutes)	95.85 ±25.28	-	-

Total number of grafts was 95 in CCABG group versus 68 in OPCAB group. LIMA was grafted to LAD in all patients in both groups except one patient in OPCAB group; in that case LIMA was grafted to a reasonable diagonal artery. RA was used in 20/28 (85%) in CCABG group and in 16/25 (64 %) in OPCAB group. RIMA was used in 8/28 (28%) in CCABG and 10/25 (40%) OPCAB groups respectively.

Saphenous vein was used to complete revascularization in both groups. Comparison of individual graft flow between patients who underwent revascularization using CCABG and those who underwent OPCAB did not show statistical significance difference in these two techniques. The mean flow in LIMA to LAD anastomosis was 34.25 ± 19.28 versus 31.07 ±17.18 ml/min, RIMA to RCA/PDA 30.88 ± 9.43 versus 29.00 ±9.21 ml/min, RA to OM/Diag. 21.40 ± 4.60versus 22.21 +5.7 ml/min, and SVG to RCA/PDA were 19.65 ± 8.9 versus 20.11 ±10.70 ml/min in CCABG and OPCAB groups respectively (Table 3 and Fig. 3).



Two grafts were revised in the CCABG group duo to high PI and low flow, one graft was kinked and raanas-

tomosis was done for the second graft. Flow measurement was satisfactory after that. A statistical significant difference was found in between the two groups regarding greater amount of blood loss and longer period of mechanical ventilation postoperatively in CCABG group. Patient that underwent OPCAB had lesser cardiac enzyme release, shorter stay in intensive care unit and hospital stay compare with those who underwent CCABG. (Table 4)

Table (4): Postoperative outcomes

Variable	CCABG	OPCAB	P value
Blood loss (ml)	959.82 ± 448.01	703.32 ±214.48	0.012
Ventilation time (hours)	19.14 ± 8.21	11.92 ± 5.78	0.001
Creatine kinase (umol/l.)	28.82 ± 29.21	15.66 ± 26.05	0.091
Creatine kinase MB(umol/l)	3.95 ± 2.57	1.65 ±2.29	0.002
Intensive Care Unit stay (Days)	2.46 ±1.17	2.12 ±0.52	0.182
Length of stay (Days)	10.07 ±4.17	7.52 ±1.15	0.005

Discussion:

Cardiopulmonary bypass has been used for decades in CABG. It offers bloodless field and motionless heart that enables surgeon to perform a precise microvascular anastomosis of conduits to the coronary arteries (7). OPCAB or beating heart surgery is getting popular due to documented advantages on reducing morbidity, need for blood transfusion, hospital stay and simplicity (2,8). Despite many techniques (silastic snares or sutures, coronary concluders, intracoronary shunts and use of surgical blower) to control bleeding at arteriotomy sites and to facilitate bloodless field, there is still concerns about anastomotic quality and hence graft patency (9,10). Absence of hemodynamic compromise and probing of the anastomosis were used by surgical team to confirm the graft patency. Other methods have also been used to assess the quality of grafting and evaluate any technical errors while the patient is still in OR and the sternum is opened. Intraoperative angiography, although it is considered as gold standard technique in evaluating graft patency, has several limitation as it is invasive, time consuming and not always accessible in the operative room (3). Other methods such as thermal angiography and electromagnetic graft flow measurement can be used but they are difficult in interpretation and inaccurate (11, 12, 13). Epicardial ultrasound is a promising technique that may prove to be noninvasive, rapid and inexpensive technique for intraoperative assessment of anastomotic quality (14) .The transient time flow method for measurement of graft flow is based on the Doppler principle that directly measure mean blood volume flow. Several studies have demonstrated that this method is reliable and easy to perform (4, 5, 7, 15). In this study total graft flow in OPCAB group was found to be comparable with CCABG. When comparing individual grafts, LIMA to LAD graft in OPCAB had a non-significant lower mean flow compared to CCABG; this difference may be attributed vasoconstrictor effect of norepinephrine that was usually needed when performing OPCAB procedure to maintain hemodynamic stability. Schmitz and colleagues (11) demonstrated a significantly lower flow in cases done using OPCAB technique. They explained the lower mean graft flow in LIMA graft based on the absence of vasodilator effect of global ischemia in on-pump CABG and the use of vasoconstrictors during off- pump CABG. The mean flow in other grafts was not significantly different in between the two groups. This is in contrast to the finding of Schmitz et al. (10), who used SVG as a sequential graft to the rest of the stenotic coronary arteries while no sequential grafts were used in the current study. Kjaergard et al. (16) detected no difference between arterial or venous graft flow. Interestingly they also did not found any significant differences between men and women .The mean flow rate in arterial grafts (LIMA-LAD flow was 33.7 +2.0ml/min in CCABG and 34.4+2.9 ml/min in OPCAB) and venous grafts (SVG-anastomosis flow was 30.4 ml/min in CCABG and 37.8 +5.4 ml/min in OPCAB) were similar to those of other studies (17). In a recent study, no statistical significant difference was found between conventional and off-pump CABG regarding arterial or venous grafts. The mean flow in all cases in LIMA to LAD graft flow was 37.4 + 23.5 ml/min and in SVG anastomosis graft it was 21.2+ 36.0 ml/min. (18). Graft patency was shown to be similar one year after surgery using angiography evaluation in conventional CABG and off- pump technique (19). To confirm accuracy of transient time flow technique as method of assessment of graft patency and assure that there no difference in graft patency in coronary artery grafting with or without the cardiopulmonary bypass still need further large studies .

Conclusion:

No .difference was found in graft blood flow in CABG performed with either conventionally or using off-pump-technique. Transient time flow measurement is a helpful tool that can be used in assessing the graft patency in both on and off- pump CABG beside other clinical and laboratory markers.

:Acknowledgement

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:Reffernces

1- Haase M , Sharma A , Fieltiz A , Uchino S , Rocktaeschel J , Bellomo R et al . On-pump coronary artery surgery versus off-pump exclusive arterial coronary grafting: A matched cohort comparison. An Thorac Surg 2003; 75: 62-67.

2- Raja SG and Dreyfus GD. Off-pump coronary artery bypass surgery: to be or not to be done? Current best available evidence. J Cardiothorac. Vasc. Anesthesia 2004; 18(4): 486-505.

3- Jaber SF, Koenig SC , BhaskerRao B , VanHimbergen DJ , Cerrito PB , Ewert DJ et al . Role of graft flow measurement technique in anastomosic quality assessment in minimally invasive CABG .Ann Thorac Surg 1998; 66: 1087-92.

4- Canver CC , Dame DA . Ultrasonic assessment of internal thoracic artery graft flow in the revascularised heart. Ann Thorac Surg 1994;58:135-138.

5- Matre K , Birkland S , Hessevik I , Segadasl L . Comparison of transit time and Doppler ultrasound methods for measurement of flow in aortocoronary bypass grafting during cardiac surgery. Thorac Cardiovasc Surg 1994;42:170-174.

6- Walpoth BH , Bosshard A , Genyk I , Kipfer B , Berdat PA , Hess OM et al . Transient time flow measurement for detection of early graft failure during myocardial revascularization. Ann Thorac Surg 1998; 66: 1097-200.

7- Mack JM. Advances in the treatment of coronary artery disease. Ann Thorac Surg 2003;76:s2240-2245.

8- Jarvanin O , Laurikka J , Tarkka MR . Off-pump versus on pump coronary bypass. Comparison of patient characteristics and early outcomes. J Cardiovasc (Torino) 2003; 44(2): 167-172.

9- Cooley DA. Beating heart surgery for coronary revascularization: is it the most important development since the introduction of the heart –lung machine? Ann Thorac Surg 2000; 70:1779-81.

10-Mehta Y, Juneja R. Off-pump coronary artery bypass grafting: New developments but a better outcome? Curr Opin Anaesth 2002; 15:9-18.

11-Schmitz C, Ashraf O ,Schiller W , Preusse CJ , Esmailzadeh B , Likungu JA et al . Transient time flow measurement in on-pump and off pump coronary artery surgery .J Thorac Cardiovasc Surg 2003; 126: 654-650.

12-Laugie YA , Haxhe JP , Buche M , Schoevardts JC . Intraoperative electromagnetic flow meter measurement in coronary artery bypass grafts. Ann Thorac Surg 1994; 57: 357-364.

13-Balacumaraswami L , Taggart DP . Digital tools to facilitate intraoperative coronary artery bypass patency assessment. Semin Thorac Cardiovasc Surg 2004; 16(3): 266-271.

14- Budde RP, Meijer R, Bakker PF, Borst C, Grundeman PF . Endoscopic localization and assessment of coronary arteries by 13 MHz epicardial ultrasound. Ann Thorac Surg. 2004 ;77(5):1586-92

15-D'Annona G , Karamanounkian HL , Salerno TA ,Schmid S , Bergsland J . Flow measurement in coronary surgery. Heart

Y. An evaluation of the intraoperative transient time measurement of coronary bypass flow. Eur J Cardiothorac Surg 2001; 19:848-52.

18-Leong DKH, Ashok V, Nishkantha A , Shan YH, and Sim EKW. Transit-Time Flow Measurement is essential in coronary artery bypass grafting. Ann Thorac Surg 2005; 79:854-857.

19-Widimsky P, Straka Z, Stros P, Jirasek K, DvorakJ, Votava J, et al. One-year coronary bypass graft patency: A Randomized comparison between off-Pump and on-Pump Surgery Angiographic Results of the PRAGUE-4 Trial. Circulation 110; 3418 – 3423: 2004.

Surgical Left Main Ostioplasty; An Alternative Option in Selected Cases of Left Main coronary artery Stenosis

Mostafa Abdel-azim, MD

Objective : **Left main coronary artery stenosis associated with diffuse coronary artery disease is not uncommon. However, isolated ostial left main stenosis is a rarity constituting less than 1% of total patient population referred to surgery.**

Methods : **Although surgical revascularization with LIMA to LAD remains the gold standard, in some cases its use may not be possible or prudent as in cases of post chest wall irradiation, morbidly obese patients with borderline pulmonary function and others.**

Result : **Here we share our experience with 5 patients who underwent surgical ostial left main ostioplasty in the period between June 1998 and June 2003. Access to the left main was approached through complete transection of the aorta for optimum visualization rather than the traditional posterior or anterior approach.**

Conclusion : **All patients had uneventful procedure and recovery. Three of the five patients underwent early catheterization to confirm left main patency. Early and mid term follow up was free of ischemic events and patients were back to there full functional capacity.**

The incidence of left main coronary artery (LMCA) stenosis associated with multivessel coronary artery disease is not uncommon, accounting for about 10-15% of cases referred in the daily practice of most cardiac centers. On the other hand, isolated ostial or proximal LMCA stenosis with free distal coronary tree is a rarity accounting for only 0.5-1% of cases [1].

Stenosis of the left main coronary artery (LMCA) is an anatomic lesion with a malignant nature and with a highly lethal course when untreated. The preferred treatment of this disorder has traditionally been conventional coronary artery bypass surgery, and the best long term option would be the utilization of the ITA to the LAD [2]. In some cases, harvesting the ITA is not possible or prudent (discussed later).

Several efforts have been made directly against the pathological lesion in the LMCA by means of endarterectomy and onlay patch angioplasty. The initial experience of these attempts was depressing with a high mortality rate and frequent restenosis at the site of reconstruction [3, 4, and 5].

Better techniques for cardioprotection and cardiopulmonary bypass inspired Hitchcock and coworkers in 1983 [5] to revive and modify the angioplasty procedure of LMCA stenosis resulting in excellent outcome. This was followed by others reporting similar results. Dion and colleagues [6, 7] with the largest single experience of the procedure- have further delineated the indications and contraindications and also refined the technique. Principally, a venous or pericardial patch has been used for the angioplasty with acceptable early to midterm results.

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Classically, there have been two surgical approaches to reach the LMCA, the anterior and the posterior approach each with its own advantage and disadvantage. Here, we share our experience with a newly described surgical approach, which is in our view provides optimum exposure to conduct such a procedure optimally and safely [8, 9].

PATIENTS AND METHODS

In the period from June 1998 to June 2003, we operated on five consecutive patients who suffered from isolated significant (> 75%) ostial or proximal LMC stenosis with no distal coronary artery disease or associated cardiac disease.

Two of the patients were males 45 and 52 years of age respectively. Both were hyperlipidaemic with positive family history of ischemic heart disease (IHD). The etiology of there stenosis was atherosclerotic in nature. Three patients were females, two with a history of previous radical mastectomy followed by chest wall irradiation 7 and 10 years ago. The last patient was of undetermined etiology, however she was complaining of progressive lower back pain and stiffness. She was followed up by our rheumatology colleagues to rule out ankylozing spondylitis or other rheumatoid disease. All patients suffered from rapidly progressive course (less than 6 months) suffering from angina class III or IV on presentation [10, 11].

All patients underwent full routine preoperative evaluation including cardiac catheterization and echocardiography. All had preserved LV function except for the last patient who had an EF of 40%.

The operation is performed using the standard anesthetic and monitoring techniques. After median sternotomy, a piece of pericardium 2x3 cm is harvested and kept aside in wet gauze. The ascending aorta is totally freed from its relationship to the main and right pulmonary artery. The dissection commenced before cardio-pulmonary bypass (CPB) and completed thereafter. Perfusion is started utilizing an aortic cannula in the distal ascending aorta and bicaval cannulation with tapping lowering the patients' systemic temperature to 32C. Left atrial vent is inserted.

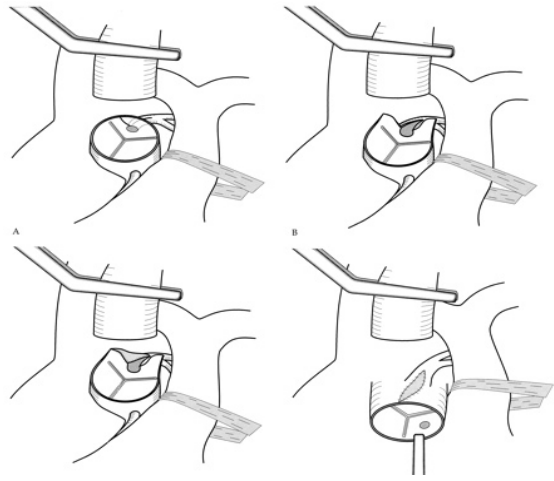
Myocardial protection is achieved by initial antegrade blood enriched cardioplegia followed by subsequent doses every 20 minutes retrogradely directly into the right atrium utilizing Fabian's technique after snaring down onto the caval cannulae and tugging on the main PA with a tape around it.

The aorta is completely transected 1.5 cm distal to the origin of the RCA. With downward and anterior retraction on the aortic root together with retraction of the main pulmonary artery upward and to the left provides excellent exposure and access to the LMC artery.

An incision is started into the left coronary sinus 5 mm to the left of commissure between the left and non-coronary cusp and extending it into the LMCA 5 – 10 mm distal to the stenosis or just proximal to the bifurcation of the LMCA.

The pericardial patch is tailored to the appropriate size and sutured into place as an onlay patch with a 6/0 prolene suture up to the level of the transverse aortotomy. The aortotomy is closed with a running 5/0 prolene suture.

This technique was also described by Liska and colleagues in 1999 [12] (Fig. 1).



(fig 1)

Mean aortic cross clamp was 65 min (53 -76) and mean perfusion time was 90 min (80-109).

(Figure 1; Diagramatic representation of the surgical technique, (a) complete transection of the aorta with retraction of the main pulmonary artery to the left (b) incision in the left coronary sinus extending into the left main coronary artery (c) placement of the an onlay patch on the incision (d) completion of the onlay patch to be followed by re-approximation of the aortic ends, Liska et al, 1999.)

RESULTS

All patients had uneventful postoperative course with stable hemodynamics and without ischemic EKG changes. There were no significant elevations of the enzymatic markers to indicate perioperative MI. The patients were extubated with a mean ventilation time of 8.6 hrs. (6-15). Mean blood loss was 560 mls (400-850) with no reentry for bleeding. All patients were

discharged from ICU within the first 48 hrs. There were no neurological, renal or respiratory complications. One patient developed superficial wound infection which was cleared within 10 days with appropriate antibiotics.

All patients received thrombo-prophylatic regimen, in the form of concomitant use of coumadin and clexane (40 u bid subcutaneously) till INR catches up and maintained between: 1.8-2.2 thereafter and for the next 3 months. Aspirin at a dose 150mg/day is commenced since day one and continued thereafter for life.

The first three patients underwent coronary angiography before hospital discharge (Fig. 2). In the three cases the left main ostia were widely patent. On the other hand, the last two patients also underwent TEE before hospital discharge and both were very satisfactory. All patients underwent exercise EKG after 3 months of the operation and again after one year. All were negative for ischemia. Also, patients were followed by regular clinic visits. None had ischemic complaints or was readmitted for ischemic events. All had a NYHA class of I or II.

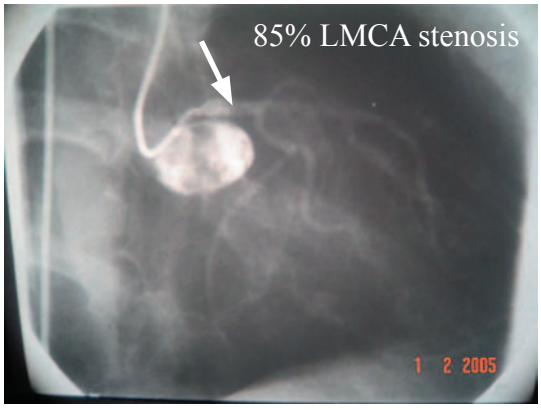


Fig 2 (a)

(Figure 2. (a) Pre-operative angiogram of the second patient (b) Post operative angiogram of the same patient)

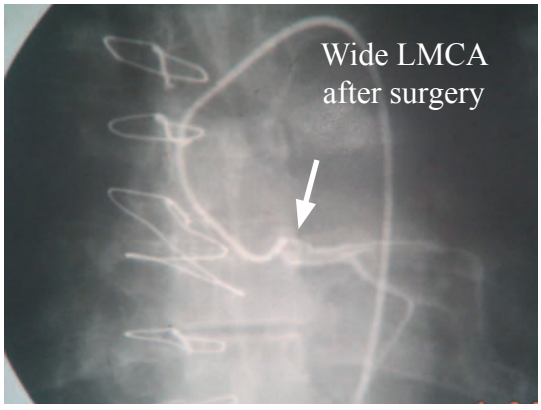


Fig 2 (b)

DISCUSSION

The LMCA can, from an anatomical standpoint, be divided into three parts, the ostial region, the midsegment, and the distal segment. The most common etiology to LMCA stenosis is arteriosclerosis, and accounts for the vast majority of LMCA stenosis engaging particularly the midpart and distal bifurcation, often associated with two or three-vessel coronary disease. LMCA stenosis is found in approximately 10-15% of the patients subjected to coronary artery bypass surgery [10, 11].

On the other hand, isolated stenosis of the ostial region or the first third of the LMCA is substantially less common with an observed prevalence of approximately 0.5-1%. This entity of LMCA stenosis also has a more diversified etiology and is often related to inflammatory processes of the aortic wall, e.g., syphilitic aortitis, Takayasu aortitis, rheumatoid arthritis, and post-irradiation treatment [13]. Such a rare entity is most frequently seen in middle-aged women. It is characterized by rapid development of unstable angina refractory to medical treatment and a high incidence of sudden death due to the complete absence of collateral coronary circulation. The morphologic basis is the progressive fibrous thickening of the ostial intima with otherwise normal coronary arteries and without the presence of aortic wall lesions. Three of our patients fell in this category.

Coronary artery bypass grafting is an excellent and safe treatment for LMCA stenosis, however with some potential limitation, such as complete graft dependant perfusion because of the progressive occlusion of the coronary ostium, and the risk of arteriosclerosis to the venous grafts if the ITA or other arterial conduits are not used [2]. It also has a theoretical negative effect by perfusing large areas of the myocardium retrogradely. Direct surgical angioplasty of LMCA offers a good alternative by restoring native antegrade flow and also by maintaining access to the distal coronary vessels allowing for future percutaneous transluminal coronary angioplasty of peripheral lesions if need arise. It can also be useful in patients with intramyocardial coronary arteries.

Also, in some patients the use of ITA is not possible or prudent. For example we had two patients who had previous chest wall irradiation and it was not possible to utilize their ITA. Also, there is an increased risk of wound infection or respiratory embarrassment in morbidly obese poorly controlled diabetic or COPD patients with borderline pulmonary functions respectively. In such subset of patients, surgical LMCA ostioplasty could be a good alternative option.

Also, it has the potential advantage of sparing conduits if CABG is needed in the future. Again, it reduces the potential injury of ITA to LAD or distal conduit emboliza-

tion if future redo surgery is required [14, 15, and 16].

The main limitation for the application of such a technique is the presence of extensive calcification either the aortic wall or the LMCA.

Technically there have been two principal methods described on how to access the LMCA, the posterior, and the anterior approach. The posterior incision has the advantage of avoiding an acute angle of the patch at the junction between the LMCA and the aortic wall, which could possibly cause a stenosis. On the other hand, the posterior approach has the disadvantage of a less good exposure of LMCA and vice versa for the anterior approach [16, 17].

In our study, the ascending aorta was instead transected, which resulted in an excellent visualization of LMCA and also the proximal part of LAD and the circumflex artery. An oblique incision was made in the aortic wall extending into the roof of the LMCA thus avoiding an acute angle of the patch at the ostial junction. We advocate this approach, because it combines the beneficial properties of both the posterior and anterior techniques. A similar approach was described by Eishi et al [17] and Liska et al [12].

Several investigators have advocated various methods or studies to assess the mid and late term results of LMCA ostioplasty surgery. Some attempted the use magnetic resonance imaging [18] or spiral computed tomography [19] as noninvasive tools for follow-up assessment of reconstruction patency. Both were found to have limited accuracy and high cost. Others reported [20] the use of TEE is an accurate semi-invasive tool for such an assessment. The LMCA anatomy and patency can be optimally delineated. In our study, we performed early postoperative TEE instead of angiography in the last two patients and indeed the results were accurate and satisfactory.

CONCLUSION

In conclusion, our experience suggests that surgical reconstruction of the LMCA is safe and effective surgical method for the treatment of isolated left main stenosis. It offers several advantages over conventional revascularization. Although the previously described anterior or posterior approaches provided good results, the newly introduced technique of transection of the ascending aorta allowed optimum visualization and access of the LMCA. Early catheterization demonstrated excellent results. Clinical follow-up showed no residual symptoms of ischemic heart disease. Long-term patency is still to be evaluated.

REFRENCES

1. Edwards FH, Clark RE, Schwartz M. Coronary artery bypass grafting: The Society of Thoracic Surgeons national database. Ann Thorac Surg 1994;57:12–9.
2. Loop FD, Lytle BW, Cosegrove DM, et al. Influence of the internal mammary artery graft on 10-year survival and other cardiac events. N Engl J Med 1986;314:1– 6.
3. Effler DB, Sones FM, Favaloro R, et al. Coronary endarterectomy with patch graft reconstruction: clinical experience with 34 cases. Ann Surg 1965;162:590–601.
4. Favaloro RG, Effler DB, Groves LK, et al. Severe segmental obstruction of the left main coronary and its division. Surgical treatment by the saphenous vein graft technique. J Thorac Cardiovasc Surg 1970;60:469–82.
5. Hitchcock JF, Robles de Medina EO, Jambroes G. Angioplasty of the main coronary artery for isolated left main coronary disease. J Thorac Cardiovasc Surg 1983;85:880– 4.
6. Dion R, Verhelst R, Matta A, Rousseau M, et al. Surgical angioplasty of the left main coronary artery. J Thorac Cardiovasc Surg 1990;99:241–50.
7. Dion R, Elias B, El Khoury G, et al. Surgical angioplasty of the left main coronary artery. Eur J Cardiothorac Surg 1997;11:857– 64.
8. Eishi K, Sasaki H, Nakano K, et al. Superior approach to the left main coronary artery or surgical angioplasty. J Thorac Cardiovasc Surg 1997;113:609–11.
9. Bortolotti U, Milano A, Balbarini A, et al. Surgical angioplasty for isolated coronary ostial stenosis. Tex Heart Inst J 1997;24:366–71.
10. Loop FD, Lytle BW, Cosgrove DM, et al. Atherosclerosis of the left main coronary artery: 5 year results of surgical treatment. Am J Cardiol 1979;44:195–201.
11. Barner HB, Naunheim KS, Kanter KR, et al. Coronary ostial stenosis. Eur J Cardiothorac Surg 1988;2:106 –12.
12. Liska J, Jonsson A, Lockowandt U, et al. Arterial patch angioplasty for reconstruction of proximal coronary artey stenosis. Ann Thorac Surg 1999;68:2185-90.
13. Thompson R. Isolated coronary ostial stenosis in a woman. J Am Coll Cardiol 1986;7:997–1003.
14. Schmuziger M, Christenson JT. Surgical patch ostiumplasty of the left main coronary artery. Thorac Cardiovasc Surg 1996;44:27–30.
15. Bortolotti U, Milano A, Balbarini A, et al. Surgical angioplasty for isolated coronary ostial stenosis. Tex Heart Inst J 1997;24:366–71.
16. Dion R, Puts JP. Bilateral surgical ostial angioplasty of the right and left coronary arteries. J Thorac Cardiovasc Surg 1991;102:643–5.
17. Eishi K, Sasaki H, Nakano K, et al. Superior approach to the left main coronary artery for surgical angioplasty. J Thorac Cardiovasc Surg 1997;113:609-11.
18. Briffa NB, Clarke S, Kugan G, et al. Surgical angioplasty of the left main coronary artery: follow-up with magnetic resonance imaging. Ann Thorac Surg 1996;62:550 –2.
19. Meseguer J, Hurle´ A, Ferna´ndez-Latorre F, Alonso S, et al. Left main coronary artery angioplasty: midterm experience and follow-up with spiral computed tomography.Ann Thorac Surg 1998;65:1594– 8.
20. Sharoni E, Erez E, Shapira Y, et al. Transesophageal echocardiography evaluation and follow-up of left main coronary artery patch angioplasty. Eur J Cardiothorac Surg 2003;23:585–8.

The Use Of Injectable Paracetamol As An Adjunct For Postoperative Pain Management After Off-pump Fast-track Coronary Artery Bypass Grafting Surgery

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Abstract:In this prospective, double-blind, randomized, placebo-controlled study; was designed to evaluate the analgesic efficacy, safety and morphine-sparing effects of the recently administered injectable paracetamol in off-pump fast-track coronary artery bypass grafting (CABG) surgery.

Methods: **Forty adult patients undergoing off-pump fast-track CABG were enrolled in the study. In ICU, patients received morphine 5 mg IV and either paracetamol 1 gm IV every 6 hours (paracetamol group) or IV placebo (control group) and were allowed patient controlled analgesia (PCA) machine with morphine when fully conscious.**

Results: **Paracetamol coupled to morphine PCA provided better analgesia at 6 and 12 hours (Visual analogue scale was 4.11 ±0.69 and 4.04 ±0.74 for paracetamol group vs. 4.6 ±0.74 and 4.66 ±0.89 for control group at 6 and 12 hours, respectively) and less sedation at 12 and 18 hours (Ramsay sedation scale > 3 in 64.7% and 47.05% in paracetamol group and 93.4% and 80% in control group at 12 and 18 hours, respectively) than morphine PCA alone. Morphine consumption in the first 24 hours was 27% higher in control group (31.26 ±5.72 mg) compared to paracetamol group (24.58 ±3.04 mg). Incidence of nausea (but not vomiting) was statistically higher in control group than paracetamol group (40% vs. 23.5%).**

Conclusion: **IV paracetamol coupled to morphine PCA provided better analgesia, less sedation and definite morphine-sparing effect when compared to morphine PCA al**

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Optimization of pain relief after cardiac surgery has proved to be difficult with no one modality of therapy providing ideal efficacy with an acceptable side effect profile (1). Pain after cardiac surgery is associated with sternotomy, leg vein harvesting, pericardiotomy, and chest tube insertion. Good postoperative pain control is essential to ensure adequate breathing, as well as to reduce the number of ischemic episodes after coronary artery bypass grafting surgery (2).

Postoperative pain management after cardiac surgery has been mainly based on parenteral opioids (3). The main concern for using high doses of opioids in the postoperative period is the risk of sedation and respiratory depression. Opioids have also been associated with other side effects includ-

ing confusion, nausea, vomiting, ileus, biliary spasm, pruritus and urinary retention (4). In the last 10 years, "fast-track" technique became widely adopted in coronary artery bypass grafting (CABG) surgery, aiming to reduce total cost of surgery, shorten intensive care and hospital stay, and improve resource use (5, 6).

Fast-tracking of cardiac patients involves rapidly awakening the patients after surgery, with earlier removal of endotracheal tubes and thus spending shorter time in intensive care unit (5). Yet, this technique added more challenge to the management of postoperative pain after cardiac surgical procedures as fast-track patients receive much lower doses of opioids intra- and postoperatively with the consequence that patients are in pain after surgery and a postoperative analgesic that is not a respiratory depressant is advantageous (1).

Non-steroidal anti-inflammatory analgesic drugs (NSAIDs) have been shown to reduce morphine requirements in variety of surgical procedures and are devoid of CNS side effects typical of narcotics (7-9). NSAIDs exert their anti-nociceptive action by blocking the peripheral synthesis of prostaglandins through inhibition of cyclo-oxygenase enzyme (although a central mechanism has recently been proposed). Yet, cyclo-oxygenase enzyme inhibition also causes platelet dysfunction, may cause renal impairment by blood flow redistribution in kidneys and is responsible for gastrointestinal symptoms (10). Therefore, NSAIDs have not been used widely in cardiac surgical patients due to these concerns (2).

Paracetamol, a non-opiate analgesic, was not used routinely in postoperative pain management after adult cardiac surgery because it was only available in oral or rectal form, which is inconvenient for use in unconscious postoperative adult patients. Intravenous paracetamol (Perfalgan®, Bristol-Myers Squibb, France) was launched in April 2004 for the short-term treatment of moderate pain, especially following surgery, and for the short-term treatment of fever in adults, adolescents and children (11). Although no clinical trials were available on the use of IV paracetamol in the postoperative management of pain, especially following cardiac surgery, an injectable pro-drug form of paracetamol (propacetamol) was investigated recently for postoperative pain management (12-15).

This study was designed to evaluate the analgesic efficacy, safety and morphine-sparing effect intravenously administered paracetamol as an adjunct to patient-controlled (PCA) opioid postoperative analgesia after off-pump coronary artery bypass grafting surgery.

Patients and Methods:

After the approval of the hospital's ethics committee, this study was conducted on forty adult patients, scheduled for off-pump coronary artery bypass grafting (CABG) surgery during the period from August 2004 to January 2005. Preoperative exclusion criteria included age above 75 years old, body weight less than 55 kg or more than 100 kg, history of allergy to any of the study drugs, history of drug abuse, renal impairment (creatinine > 130 ?mol/L), liver impairment (Child's classification 2 or more), impaired left ventricular function (EF < 35%), and inability to operate the PCA machine. Intraoperatively, patients whose surgical decision was changed from multi-vessel grafting to one-vessel graft and patients whose surgery necessitated using cardiopulmonary bypass (CPB) either due to major hemodynamic instability or difficulty in positioning the heart during grafting were excluded. Postoperatively, patients who failed to be extubated or failed to regain consciousness within 2 hours after arrival to ICU, patients who needed re-exploration for postoperative bleeding, hemodynamically unstable patients (hypotension, high inotropic support, excessive bleeding), and patients who were in excessive pain or agitation that necessitated the administration of sedative and analgesic drugs other than the two study drugs (paracetamol and morphine) were excluded.

A written informed consent was obtained from each patient. In the preoperative anesthetic visit, patients were taught about the use of patient-controlled analgesia machine and visual analogue scale and the study protocol and design were explained extensively. Midazolam 7.5 – 15 mg was administered orally to all patients at the night of surgery. Morphine 10 mg was administered to all patients by intramuscular injection half-an-hour before sending the patient to operating room (OR) and 5-mL blood sample was obtained for serum cortisol assessment. All patients were sent to OR at 07:20 AM.

Upon arrival to OR, oxygen was supplied to all patients by nasal cannula, ECG electrodes and pulse oximetry probe were attached. Midazolam IV was given in increments of 1 – 2 mg to a maximum dose of 10 mg. A 20-gauge arterial catheter was inserted in the non-dominant arm's radial artery under local anesthetic infiltration unless radial artery was to be harvested for grafting. Baseline readings of heart rate, peripheral oxygen saturation (SpO2) and invasive arterial blood pressure (systolic, diastolic, and mean) were obtained before induction of anesthesia.

Anesthesia was induced using a combination of fen-

tanyl 1 – 3 ?g/kg and propofol 1.5 – 2 mg/kg. Muscle relaxation was provided with pancuronium 0.15 mg/kg and patient was ventilated with a mixture of O2 and N2O (50% : 50%) and sevoflurane 2 – 3% for 3 minutes and then endotracheal intubation was performed.

After induction of anesthesia, a flow-directed, balloon-tipped pulmonary artery catheter (CritiCathTM Pulmonary Artery Catheter, Becton-Dickinson Critical Care Systems Pte Ltd, Singapore) was inserted and baseline hemodynamic profile (cardiac index, peripheral vascular resistance, pulmonary vascular resistance, pulmonary artery wedge pressure) was obtained.

Anesthesia was maintained with sevoflurane (1 – 3%) in O2 : N2O mixture in a ratio of 50% : 50% (Ohmeda Modulus SE Anesthesia Machine, Datex-Ohmeda, Madison, WI, USA). Increments of pancuronium (0.02 – 0.03 mg/kg) were administered every 45 minutes throughout surgery. Fentanyl 0.5 ?g/kg boluses were administered on skin incision, sternotomy and hourly thereafter till time of skin closure. Patients were mechanically ventilated using Datex-Ohmeda 7900 anesthesia ventilator (Datex-Ohmeda, Madison, WI, USA) with a tidal volume of 7 – 10 mL/kg and respiratory rate of 12 – 14 / minute to keep EtCO2 between 35 – 40 mmHg.

All patients were operated through median sternotomy. Conduits for bypass depended on patient characteristics and included left and right internal mammary arteries (LIMA and RIMA), left radial artery, and saphenous vein grafts. After harvesting conduits and making pericardial sling, heparin (150 IU/kg) was administered, and supplemental doses were added, as needed, to maintain activated clotting time (ACT) between 200 – 250 seconds. At first left internal mammary (LIMA) anastomosis to left anterior descending artery (LAD) was done and then the proximal anastomosis followed by distal ones. Each coronary artery was stabilized in turn using the Medtronic Octopus III Tissue Stabilization System (Medtronic Inc., Minneapolis, MN, USA). Starfish Repositioner (Medtronic Inc., Minneapolis, MN, USA) or deep pericardial stitch was used for positioning and exposure of the heart. Intracoronary shunts (Clearview Arteriotomy Shunts, Medtronic Inc., Minneapolis, MN, USA) were used in all patients to maintain distal coronary perfusion during the distal anastomosis of the grafts and to aid visualization during anastomosis. After completing the anastomoses, the total dose of heparin administered was reversed with protamine in a 1 : 1 ratio. Cell saver (Bret2, Cobe Cardiovascular Inc., Division of Sorin Biomedica, USA) was used from the start of the operation in all the patients. After revascularization, meticulous hemostasis, insertion of chest drains, and closer of median sternotomy was done.

Immediately after skin closure, volatile anesthetics were shut off and patients were ventilated with a mixture of oxygen in air, muscle relaxant was reversed with neostigmine 0.05 mg/kg and atropine 0.01 – 0.02 mg/kg when Train-of-Four (TOF) reading was 0.5, and patients were transferred to intensive care unit (ICU) intubated but spontaneously breathing and ventilation was manually assisted by self-inflating Ambu-bag. On arrival to ICU, patients were connected to mechanical ventilator on pressure support mode of 5 – 10 cmH2O to achieve a tidal volume of at least 7 mL/kg. In ICU, patients were divided randomly into two groups. The first group (paracetamol group) received morphine 5 mg IV bolus and IV paracetamol 1 gm (Perflagan ®, 1 gm in 100 mL, Bristol-Myers Squibb, France) over 30 minutes and then 6 hourly for the first 24 hours. The second group (control group) received morphine 5 mg IV bolus and a placebo in the form of 100 mL of normal saline over 30 minutes and 6 hourly thereafter for 24 hours. ICU team was blinded to patient's group. Patients were routinely extubated within the first 2 hours after end of surgery provided that they could breathe adequately (spontaneous tidal volume $^{3}\geq$ 7 mL/kg), regained adequate airway protective reflexes and conscious level was suitable for extubation (Glasgow Coma Scale of at least 12).

In ICU, patients were continuously monitored for ECG, pulse oximetry and invasive arterial blood pressure using Datascope Expert monitor (Datascope Corp., Patient Monitoring Division, Paramus, NJ, USA). These data was recorded on arrival to ICU, hourly for the first 4 hours in ICU then 4 hourly for 24 hours. Pulmonary-artery-catheter-derived hemodynamic profile was obtained on arrival to ICU and then 6-hourly for the first 24 hours or more frequently if required by the treating staff.

Patient-controlled analgesia pump (PCA Plus Micro Delivery Device, Abbott Laboratory, Chicago, IL, USA) was provided to all patients as soon as they were fully conscious and was adjusted to deliver 1-mg bolus of morphine per demand with a lock-out interval of 20 minutes without a background infusion. The total dose of morphine delivered to the patient through the PCA machine in the first 24 hours was recorded. Patient's were asked to assess their pain on the previously explained visual analogue scale every 6 hours for first 24 hours half-an-hour after administration of the study drugs (IV paracetamol or placebo). Also, Ramsay sedation scale (table 1) was assessed 6 hourly for 24 hours.

Table (1): Ramsay Scale for assessment of depth of sedation.

Level	Patient Response
1	Anxious, agitated, or restless
2	Cooperative, oriented, tranquil
3	Quite, responds to verbal commands
4	Asleep, brisk response to forehead tap or loud verbal stimulus
5	Asleep, sluggish response to forehead tap or loud verbal stimulus
6	Unresponsive, comatose

Blood samples for serum cortisol assessment were obtained on arrival to ICU and 6 hours and 24 hours after the end-of-surgery. Time to discharge from ICU and hospital as well as overall morbidity and mortality were recorded. Hypotension was defined as systolic arterial blood pressure lower than 100 mmHg or 30% lower than baseline preoperative reading. Hypoxia was defined as peripheral oxygen saturation < 91% on oxygen 4 – 6 L/minute by simple facemask. Arrhythmia was defined as any rhythm other than normal sinus rhythm except for infrequent atrial or ventricular extrasystoles (< 6 / minute). Bleeding was defined as blood loss of more than 200 mL/hr for the first 3 hours or more than 100 mL/hr in any subsequent hour. If bleeding could not be corrected by medical measures and rate of blood loss was still above the normal rates for the subsequent hour, the patient was returned to OR for exploration and was excluded from the study. Patients were asked to report to the attending staff if they experienced nausea or pruritus. Also, vomiting, excessive sedation not necessitating reintubation, or reintubation due to any cause whether hemodynamic or respiratory were reported.

Data were presented as mean ±standard deviation, median and range, or number and percentage as appropriate. Between-group comparisons were done using unpaired Student's t test for numerical variables and Chi square test for categorical variables. A P value of 0.05 or less was considered statistically significant.

Results:

Forty consecutive patients scheduled to undergo multi-vessel off-pump coronary artery bypass grafting and not having any of the preoperative exclusion criteria were enrolled in this clinical trial. Three of the studied patients were excluded intraoperatively because of the need to employ cardiopulmonary bypass because of hypotension that didn't respond to inotropic medications in two patients, and because of difficulty to position the heart in the third patient because of the distribution of his distal anastomotic sites.

The remaining 37 patients were divided in a double-blind random fashion on arrival to ICU into two groups; paracetamol group (19 patients) and control group (18 patients). After the commencement of administration of the study drug and placebo in the two groups, five more patients were excluded, two in the paracetamol group and three in the control group, either because of failure to extubate or not regaining consciousness within 2 hours from arrival to ICU, hemodynamic instability, or returning the patient to OR for re-exploration. None of the remaining patients had severe pain (VAS $^{3}\geq 6$) not responding to study analgesic drugs or agitation needing the administration of other analgesic or sedative drugs.

The two groups were comparable as regards age (66.29 ±4.99 vs. 64.46 ±4.10 years) sex (male : female ratio 13 : 4 for paracetamol group vs. 12 : 3 for control group), weight (78.47 ±9.67 vs. 80.26 ±8.76 kg), height (170.58 ±6.67 vs. 171.66 ±7.12 cm), operative time (4.38 ±0.40 vs. 4.31 ±0.33 hours), and number of grafts (3.47 ±0.94 vs. 3.4 ±0.91(table 2).

Table (2): Demographic and operative data in the two groups.

Parameter	Paracetamol Group (n = 17)	Control Group (n = 15)	P Value
Sex (M:F)	4 : 13	3 : 12	
Age (years)	66.29 ±4.9	64.46 ±4.1	0.135
Weight (kg)	78.47 ±9.6	80.26 ±8.7	0.296
Height (cm)	170.58 ±6.6	171.66 ±7.1	0.331
Operative time (hrs)*	4.38 ±0.4	4.31 ±0.3	0.290
No. of Grafts	3.47 ±0.9	3.4 ±0.9	0.415

Operative time: Time from entering operating room to arrival to ICU.

Table (3): Hemodynamic measurements in the two studied groups.

	Paracetamol Group (n = 17)				Control Group (n = 15)			
	SBP	**DBP**	**HR**	**SpO_2**	**SBP**	**DBP**	**HR**	**SpO_2**
Preop.	136 ± 18.	75 ± 9.	65 ± 9.	97 ± 1.4	130 ± 18.	77 ± 10.	68 ± 9.	97 ± 2.3
Admission to ICU	104 ± 25.	68 ± 12.	108 ± 10.	95 ± 1.2	113 ± 16.3	69 ± 13.	106 ± 8.	96 ± 1.9
1 hr	114 ± 14.	67 ± 11.	92 ± 6.9	96 ± 2.0	115 ± 16.	66 ± 9.	97 ± 9.	97 ± 1.8
2 hr	108 ± 14.	67 ± 11.	94 ± 8.1	96 ± 2.0	107 ± 15.	68 ± 11.	100 ± 11.	96 ± 1.5
3 hr	98 ± 15.	57 ± 10.	83 ± 15.	97 ± 1.9	97 ± 15.	58 ± 10.	78 ± 12.	98 ± 1.3
4 hr	97 ± 15.	48 ± 6.	71 ± 11.	97 ± 2.0	92 ± 14.	44 ± 6.	68 ± 12.	98 ± 1.2
8 hr	114 ± 20.	55 ± 9.	68 ± 8.8	99 ± 2.1	110 ± 19.	47 ± 8.	73 ± 11.	98 ± 1.2
12 hr	111 ± 20.	48 ± 5.	63 ± 11.	98 ± 2.2	108 ± 18.	46 ± 4.	64 ± 11.	97 ± 1.3
16 hr	112 ± 20.	55 ± 8.	62 ± 11.	98 ± 2.1	106 ± 19.	51 ± 8.	66 ± 11.	96 ± 1.4
20 hr	122 ± 18.	52 ± 9.	69 ± 12.	98 ± 2.0	119 ± 18.	53 ± 7.	68 ± 12.	98 ± 1.8
24 hr	108 ± 17.	47 ± 8.	65 ± 11.	97 ± 2.2	106 ± 17.	42 ± 7.	64 ± 11.	98 ± 1.9

SBP = systolic blood pressure (mmHg); DBP = diastolic blood pressure (mmHg); HR = heart rate (beat per minute); SpO2 = peripheral oxygen saturation (%); Preop. = preoperative; 1, 2, 3, 4, 8, 12, 16, 20, 24 hr = hours from admission to ICU.
****, P < 0.05, significant difference when compared to control group.***

Table (4): Pulmonary artery catheter derived measurements in the two studied groups.

	Paracetamol Group (n = 17)				Control Group (n = 15)			
	CI	**SVR**	**PVR**	**PCWP**	**CI**	**SVR**	**PVR**	**PCWP**
Before Skin Incision	3.50 ± 0.4	1304 ± 24	209 ± 5	11.64 ± 2.2	3.32 ± 0.2	1312 ± 27	215 ± 5	11.29 ± 2.3
Arrival to ICU	3.13 ± 0.3	1289 ± 26	214 ± 5	11.58 ± 2.0	3.10 ± 0.3	1277 ± 27	213 ± 5	11.47 ± 2.4
6 hrs	3.10 ± 0.3	1292 ± 25	216 ± 5	11.12 ± 1.	3.33 ± 0.3	1282 ± 27	207 ± 5	10.76 ± 2.2
12 hrs	3.09 ± 0.3	1316 ± 245	244 ± 80	10.64 ± 1.6	3.06 ± 0.2	1162 ± 271	176 ± 51	10.8 ± 2.4
18 hrs	3.07 ± 0.3	1325 ± 258	247 ± 60	9.41 ± 3.1	2.96 ± 0.3	1228 ± 268	195 ± 54	10.23 ± 2.2
24 hrs	2.72 ± 0.3	1298 ± 24	219 ± 5	8.62 ± 2.8	2.86 ± 0.3	1334 ± 25	222 ± 4	9.43 ± 2.6

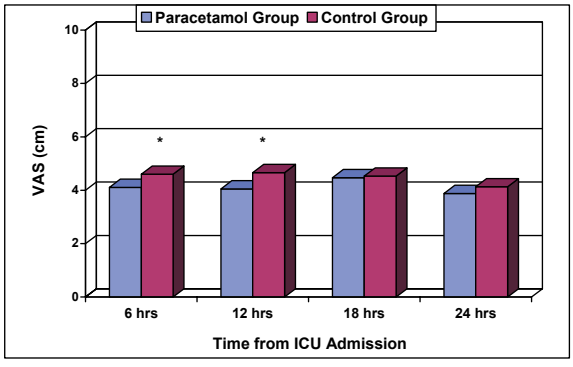

*Figure (1): Visual analogue scale in the two studied groups. *, Statistically significant difference when paracetamol group was compared to control group (P < 0.05).*

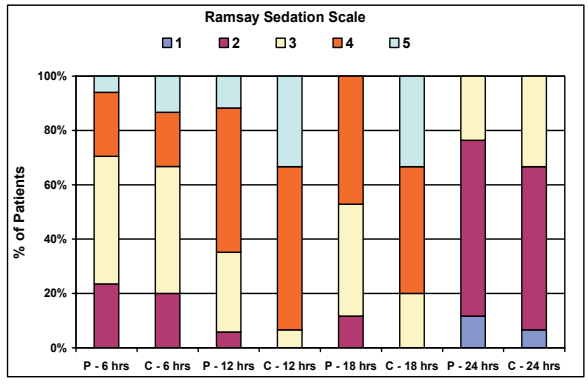

Figure (2): Ramsay scale for sedation in the two studied groups. P, Paracetamol group; C, Control group.

Also, blood pressure and pulse oximetry data were comparable preoperatively and for the first 24 hours after surgery. Heart rate was significantly lower in the paracetamol group at 1, 2, and 8 hours postoperatively but showed comparable readings thereafter (table 3). Pulmonary artery catheter derived hemodynamic data (cardiac index, pulmonary capillary wedge pressure, systemic vascular resistance and pulmonary vascular resistance) were comparable in the two groups, apart from lower systemic vascular resistance and pulmonary vascular resistance at 12- and 18-hour readings in the control group. Systemic vascular resistance and pulmonary vascular resistance were, in general, slightly lower in the control group compared to paracetamol group, but these differences were not statistically significant except at the times mentioned above (table 4).

Visual analogue scale data showed better analgesia in the paracetamol group at 6 hours (4.11 ±± 0.69 for paracetamol group vs. 4.6 ±± 0.74 for control group, P = 0.033) and 12 hours (4.04 ±± 0.74 for paracetamol group vs. 4.66 ±± 0.89 for control group, P = 0.023) and was comparable in the two groups at 18 and 24 hours (figure 1). Ramsay sedation scale showed less sedation in the paracetamol group at 12 hours (patients showing sedation scale > 3 were 11 / 17 patients [64.7%] in paracetamol group vs. 14 / 15 patient [93.4%] in control group) and at 18 hours (8 / 17 patients [47.05%] having sedation scale > 3 in paracetamol group vs. 12 / 15 [80%] in control group) and was comparable in 6- and 24-hour readings (fig 2)

Morphine consumption in the first 24 hours was significantly lower in the paracetamol group (24.58 ±± 3.04 an control group (31.26 ±± 5.72 mg) (figure 3) .

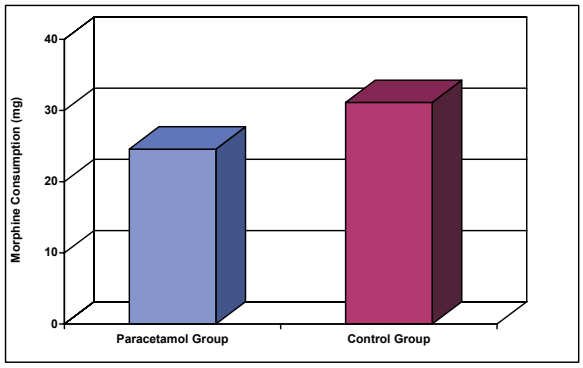

Figure (3): Morphine consumption (mg) in the first 24 hours in the two studied group. Paracetamol group

Morphine dose was 27% higher in control group than in paracetamol group. Time to discharge from ICU as well as time to discharge from hospital were comparable between the two groups (figure 4).

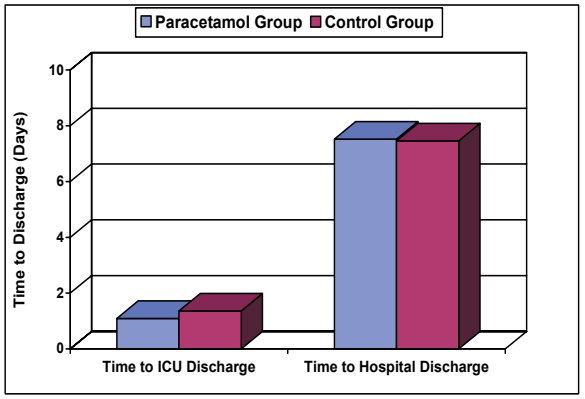

Figure (4): Time to ICU discharge and time to hospital discharge in the two groups of the study. The difference between paracetamol group and control group was statistically non-significant.

Serum cortisol values were also comparable in the two studied groups (figure 5).

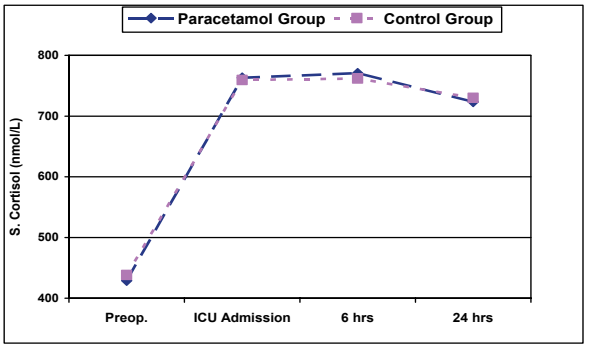

Figure (5): Serum cortisol levels in the two studied groups at different times of the study. There was no statistically significant differences between the two groups

There was no mortalities in the two studied groups. Nausea was significantly higher in the control group than in paracetamol group. Vomiting showed higher incidence in the control group than in the paracetamol group but the difference was not statistically significant. None of our patients needed reintubation due to desaturation or excessive sedation; and also no complaints of pruritus were recorded (table 5).

Discussion:

Acute pain is common after cardiac surgery and can keep patients from participating in activities that prevent postoperative complications such as deep breathing exercises and getting out of bed (17).

Table (5): Morbidity and mortality in the two studied groups.

	Paracetamol Group (n = 17)	Control Group (n = 15)
Hypotension	3 / 17 (17.6%)	2 / 15 (13.2%)
Hypoxia	2 / 17 (11.7%)	2 / 15 (13.2%)
Reintubation	0 / 17 (0%)	0 / 15 (0%)
Arrhythmias	4 / 17 (23.5%)	4 / 15 (26.4%)
Bleeding (not necessitating surgical exploration)	3 / 17 (17.6%)	2 / 15 (13.2%)
Pruritus	0 / 17 (0%)	0 / 15 (0%)
Nausea	4 / 17 (23.5%) *	6 / 15 (40%)
Vomiting	2 / 17 (11.7%)	2 / 15 (13.2%)
Cardiac arrest	0 / 17 (0%)	0 / 15 (0%)
Death	0 / 17 (0%)	0 / 15 (0%)

Data are provided as number of patients (%).
**** P < 0.05, Statistically significant difference when compared to control group.***

The value of multimodal or balanced analgesia in postoperative pain relief, including the use of non-steroidal anti-inflammatory drugs (NSAIDs), is well established in noncardiac surgery (18). Balanced analgesia comprising a combination of opioids, NSAID, and paracetamol may reduce the requirement for opioids postoperatively and potentially benefit the patient by improving the quality of pain relief and decreasing the incidence of opioid-induced side effects (19-21). The rationale behind this therapy is that analgesic drugs acting through different mechanisms result in additive or synergistic analgesia (22).

Paracetamol is widely used to supplement postoperative analgesia after cardiac surgery either by nasogastric or rectal routes (23). Schuitmaker et al. (1999) demonstrated, in a prospective randomized study in cardiac surgical patients, that paracetamol given by nasogastric route was slowly absorbed due to delayed gastric emptying and nasogastric tube losses, where absorption half-life was 1.49 hours and time to maximum concentration was approximately 240 minutes (23). Also, Goldhill et al. reported that the time to reach maximum concentration after oral paracetamol was increased from 14.1 minutes preoperatively to 225.4 minutes postoperatively (24). Rectal paracetamol had an absorption half-life of 2.02 hours in Schuitmaker's study (23). The rectal route of administration is also inconvenient and embarrassing for adult patients, especially when fast-tracking is employed as the patients are fully awake within few hours after surgery.

In this study, we investigated the use of paracetamol through the intravenous route to overcome the delay in absorption and reduced bioavailability of oral and rectal preparations of this drug in the setting of postoperative cardiac surgical procedures.

Intravenous paracetamol was not introduced in the market except very recently. The commercially available product, Perfalgan ® is available in the form of 1 gm paracetamol in 100 mL of aqueous solution. Few clinical trials of IV paracetamol are available till now. The intravenous pro-drug form of paracetamol, propacetamol, have been compared to IV paracetamol. Propacetamol 2 gm is bioequivalent to 1 gm of IV paracetamol for clinical use (11). In this study, we compared our results to other studies where paracetamol was given by nasogastric and/or rectal routes and to studies that investigated IV propacetamol as no studies of IV paracetamol for postoperative analgesia after cardiac surgery, or other major surgeries, were available to us till the end of the study.

The hemodynamic data of the two groups were comparable except for lower heart rate in the paracetamol group at 1, 2 and 8 hours and lower systemic and pulmonary vascular resistance in the control group at 12 and 18 hours. The lower heart rate in patients receiving paracetamol compared to those receiving placebo can't be attributed to better analgesia only as many factors in postoperative cardiac surgical patients besides analgesia determine blood pressure and heart rate, including preoperative medications, cardiac function, volume status of the patient, and active control of hemodynamic parameters using inotropes, vasodilators and beta-blockers. Also, the lower vascular tone in control group patients can't be simply attributed to receiving a higher total dose of morphine, as it is also affected by intravascular volume load, pain, inotropic drug usage, and administration of vasodilators.

Visual analogue scale for pain was significantly lower in patients receiving paracetamol at 6 and 12 hours in ICU. Yet, at 18 and 24 hours, there was no significant difference in VAS between patients receiving placebo and those receiving paracetamol in addition to morphine by PCA. This early better analgesia can be explained by the fact that, in the first few postoperative hours, patients are not yet fully conscious to be able to use PCA machine efficiently, thus few hours would pass before they receive a reasonable analgesic dose of morphine. The dose most patients self-administer in the first six-hour time interval is usually much less than the subsequent intervals. So, analgesia in the early postop-

erative period is mainly dependent on regularly administered medications, i.e. morphine 5-mg IV bolus given on arrival to ICU and paracetamol in the paracetamol group onlySchug et al. (25) have suggested that a combination of paracetamol and morphine in orthopedic and general surgery results in improved quality of pain relief and patient satisfaction compared to the use of morphine alone. Zhou et al. (26) investigated the use of IV propacetamol, ketorolac, and placebo combined with patient-controlled analgesia for patients undergoing total hip or knee replacement procedures and proved a significantly greater improvement in pain relief than placebo from 45 minutes until 5 hours after its injection. Also, in a randomized controlled clinical trial, Hernandez-Palazon et al. (27) proved that pain scores were significantly lower in patients who received propacetamol with morphine by PCA device after spinal fusion surgery. On the contrary, Lahtinen et al. (3) investigated the efficacy of propacetamol as a complementary analgesic to opioids after cardiac surgery and stated that it didn't enhance opioid-based analgesia in coronary artery bypass grafting patients. Also, Aubru et al. (28), in a study on 550 patients, came to the conclusion that intravenous propacetamol had no benefit as regards pain relief in patients with severe postoperative pain.

In our study, IV paracetamol had a statistically significant morphine-sparing effect. Morphine consumption in the first 24 hours was 21.4% lower in patients who received paracetamol than controls. Similar results came out of Lahtinen's study (3), where cumulative oxycodone consumption was 13% lower in patients receiving IV propacetamol compared to patients receiving placebo after cardiac surgery. In 2004, Fayaz et al. (1) studied the opioid sparing effects of diclofenac and paracetamol administered rectally. Twenty-four-hour morphine consumption was reduced by approximately 40.5% in patients receiving diclofenac, but when diclofenac and propacetamol were used in combination that reduction in morphine administered by PCA was 67.5%. Hernandez-Palazon et al. (27) also proved morphine-sparing effect in patients receiving IV propacetamol in combination with morphine administered by patient-controlled analgesia after spinal fusion surgery. Morphine sparing effect of paracetamol has also been demonstrated after gynecological (29) and orthopedic surgery (30). In Lahtinen et al. (3) study, on the contrary, IV propacetamol did not decrease cumulative morphine consumption when administered in combination with morphine PCA for postoperative pain after cardiac surgery.

Sedation was assessed using Ramsay scale, with a score of "1" indicating anxious, agitated patient and "6" indicating unconscious, comatose patient. Ramsay scale for sedation showed less sedation in the paracetamol group at 12 (patients showing sedation scale > 3 were 11 / 17 patients [64.7%] in paracetamol group vs. 14 / 15 patient [93.4%] in control group) and 18 hours (8 / 17 patients [47.05%] having sedation scale > 3 in paracetamol group vs. 12 / 15 [80%] in control group) and was comparable in 6 and 24 hours readings. Similar results were shown in Fayaz et al. (1) study in which patients who received diclofenac / paracetamol by the rectal route were significantly more awake compared to patients who received diclofenac rectally alone or placebo. Also, when IV propacetamol in combination with morphine administered by PCA was compared to morphine PCA and placebo for postoperative pain management after spinal fusion surgery, most patients in the placebo group obtained a greater degree of sedation on postoperative day 3 (27).

Incidence of nausea was significantly higher in the placebo group (40% vs. 23.5% for the control group and paracetamol group respectively). This may be attributed to the higher dose of morphine used in this group. Yet, incidence of vomiting was comparable in the two groups (11.7% for paracetamol group vs. 13.2% for control group). This may be due to the routine early use of antiemetics on-demand for patients complaining of nausea. In Fayaz et al. (1) study, postoperative nausea and vomiting (PONV) was the most common adverse event, and the incidence of postoperative nausea and vomiting was less in both the diclofenac group and the combined diclofenac and paracetamol group, which used significantly less morphine postoperatively, than in the placebo group. This comes in contradiction with Lahtinen's study (3) on propacetamol as adjunctive treatment for postoperative pain after cardiac surgery, where IV paracetamol failed to reduce any of the opioid adverse effects when given in a dose of 2 gm every six hours for 3 days after surgery and also contradicting with Aubrun's study (28) in 2003, where intravenously administered propacetamol did not change the incidence of morphine-related side effects.

Time to ICU discharge tended to be shorter in the paracetamol group versus control group, but the difference was not statistically significant (26.23 ±± 6.84 hours vs. 32.8 ±± 9.28 hours for the paracetamol and control groups respectively, P = 0.0504). Also, time to hospital discharge was very close in the two groups (7.52 ±± 1.12 days for paracetamol group vs. 7.46 ±± 0.99 days for control group). The reason may be that both ICU discharge and hospital discharge after CABG surgeries are related to many factors, analgesia not being the most important of which, e.g. hemodynamic stability, postoperative blood loss, overall general condition

of the patient, and occurrence of complications.

Serum cortisol level measured preoperatively and on ICU admission then at 6 and 24 hours showed no significant differences between the two groups. Actually, there is no definite data confirming that serum cortisol or any other stress response indicator can be precisely used to weigh the efficiency of one analgesic regimen over another.

Conclusion:

The use of injectable paracetamol (Perfalgan®) combined with morphine PCA for postoperative pain management after off-pump fast-track coronary artery bypass grafting surgery yielded better analgesia, lower morphine consumption and less incidence of opioid-related side effects (nausea, sedation) than when morphine PCA was used alone. There was no significant difference between the paracetamol group and the control group as regards hemodynamic profile and time to ICU and hospital discharge. IV paracetamol may be included in the management of postoperative pain after adult cardiac surgery in combination with opioids. The increase in overall cost in minimal, putting in mind the high overall cost of cardiac surgical procedures.

References:

1. Fayaz MK, Abel RJ, Pugh SC, Hall JE, Djaiani G, Mecklenburgh JS. Opioid-sparing effects of diclofenac and paracetamol lead to improved outcomes after cardiac surgery. J Cardiothorac Vasc Anesth 2004; 18 (6) :
2. Mangano DT, Siliciano D, Hollenberg M, Leung JM, Browner WS, Goehner P, Merrick S, Verrier E. Postoperative myocardial ischemia. Therapeutic trials using intensive analgesia following surgery. Anesthesiology 1992; 76 : 342 – 53.
3. Lahtinen P, Kokki H, Hendolin H, Hakala T, Hynynen M. Propacetamol as adjunctive treatment for postoperative pain after cardiac surgery. Anesth Analg 2002; 95(4) : 813 – 9.
4. Hynninen MS, Cheng DCH, Hussein I, Carroll J, Aumbhagavan SS, Yue R, Karski JM. Non-steroidal anti-inflammatory drugs in treatment of postoperative pain after cardiac surgery. Can J Anaesth 2000; 47 (12) : 1182 – 7.
5. Cheng DCH. Pro: Early extubation after cardiac surgery decreases intensive care unit stay and cost. J Thorac Cardiovasc Surg 1995; 9 : 460 – 64.
6. Cheng DCH, Karski J, Peniston C. Early tracheal extubation after coronary artery bypass graft surgery reduces cost and improves resource use: A prospective randomized controlled trial. Anesthesiology 1996; 85 : 1300 – 10.
7. Laitinen J, Nuutinen L. Intravenous diclofenac coupled with PCA fentanyl for pain relief after total hip replacement. Anesthesiology 1992; 76 ; 194 – 8.
8. Rorarius MGF, Suominen P, Baer GA, Romppanen O, Tuimala R. Diclofenac and ketoprofen for pain treatment after elective caesarean section. Br J Anaesth 1993; 70 : 293 – 7.
9. Hommeril J-L, Bernard J-M, Gouin F, Pinaud M. Ketoprofen for pain after hip and knee arthroplasty. Br J Anaesth 1994; 72 : 383 – 7.
10. Bailey K, Karski J, Zulys V, Carroll J. Safety of indomethacin in the early postoperative period following aortocoronary bypass surgery. Can J Anaesth 1994; 41 : A 41.
11. Topol A. Intravenous paracetamol. New Medicines Profile, Issue No. 04/11, November 2004.
12. Varrassi G, Marinangeli F, Agro F, Aloe L, De Cillis P, De Nicola A, Giunta F, Ischia S, Ballabio M, Stefanini S. A double-blinded evaluation of propacetamol versus ketorolac in combination with patient-controlled analgesia morphine: analgesic efficacy and tolerability after gynecologic surgery. Anesth Analg 1999; 88 : 611 – 6.
13. Siddik SM, Aouad MT, Jalbout MI, Rizk LB, Kamar GH, Baraka AS. Diclofenac and/or propacetamol for postoperative pain management after cesarean delivery in patients receiving patient controlled analgesia morphine. Reg Anesth Pain Med 2001; 26 (4) : 310 – 5.
14. Mimoz O, Incagnoli P, Josse C, Gillon M-C, Kuhlman L, Mirand A, Soileux H, Fletcher D. Analgesic efficacy and safety of nefopam vs. propacetamol following hepatic resection. Anaesthesia 2001; 56 : 520 – 5.
15. Van Aken H, Thys L, Veekman L, Buerkle H. Assessing analgesia in single and repeated administrations of propacetamol for postoperative pain: comparison with morphine after dental surgery. Anesth Analg 2004; 98 (1) : 159 – 65.
16. Ramsay MA, Savege TM, Simpson BR, Goodwin R. Controlled sedation with alphaxalone-alphadolone. BMJ 1974; 2 : 656 – 9.
17. Milgrom LB, Brooks J-A, Qi R, Bunnell K, Wuestefeld S, Beckman D. Pain levels experienced with activities after cardiac surgery – Pain Management. Am J Crit Care 2004; 13 (2) : 116 – 25.
18. Kehlet H, Dahl JB. The value of multi-modal or balanced analgesia in postoperative pain relief. Anesth Analg 1993; 77 : 1048 – 56.
19. Rhodes M, Conacher I, Morritt G. Non-steroidal anti-inflammatory drugs for postthoracotomy pain. J Thor Cardiovasc Surg 1992; 103 : 17 – 20.
20. Gillies GWA, Kenny GNC, Bullingham RES. The morphine-sparing effect of ketorolac tromethamine. Anaesthesia 1987; 42 : 727 – 31.
21. Reasbeck PG, Rice ML, Reasbeck JC. Double-blind controlled trial of indomethacin as an adjunct to narcotic analgesia after major abdominal surgery. Lancet 1982; 2 : 115 – 8.
22. Dahl JB, Kehlet H. Non-steroidal anti-inflammatory drugs; rationale for use in severe postoperative pain. Br J Anaesth 1991; 66 : 703 – 12.
23. Schuitmaker M, Anderson BJ, Holford NHG, Woollard GA. Pharmacokinetics of paracetamol in adults after cardiac surgery. Anaesth Intensive Care 1999; 27 (6) : 615 – 22.
24. Goldhill DR, Whelpton R, Winyard JA, Wilkinson KA. Gastric emptying in patients the day after cardiac surgery.

Anaesthesia 1995; 50 : 122 – 5.
25. Schug SA, Sidebotham DA, McGuinnety M, Thomas J, Fox L. Acetaminophen as an adjunct to morphine by patient-controlled analgesia in the management of acute postoperative pain. Anesth Analg 1998; 87 : 368 – 72.
26. Zhou TJ, Tang J, White PF. Propacetamol versus ketorolac for treatment of acute postoperative pain after total hip or knee replacement. Anesth Analg 2001; 92 (6) : 1569 – 75.
27. Hernandez-Palazon J, Tortosa JA, Martinez-Lage JF, Perez-Flores D. Intravenous administration of propacetamol reduces morphine consumption after spinal fusion surgery. Anesth Analg 2001; 92 (6) : 1473 – 6.
28. Aubrun F, Kalfon F, Mottet P, Bellanger A, Langeron O, Coriat P, Riou B. Adjunctive analgesia with intravenous propacetamol does not reduce morphine-related adverse effects. Br J Anaesth 2003; 90 (3) : 314 – 9.
29. Jespersen TW, Christensen KS, Kjaersgaard-Anderson P, Somer S, Juhl B. Postoperative analgesia with morphine versus morphine and paracetamol. A double-blind clinically controlled study with a placebo. Ugeskr-Laeger 1989; 151 : 1615 – 8.
30. Delbos AJ, Boccard E. The morphine sparing effect of propacetamol in orthopaedic postoperative pain. J Pain Sympt Man 1995; 10 : 279 –

Surgical Management Of Discrete Supravalvular Aortic Stenosis By Extended Patch Aortoplasty

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Objective: Supravalvular aortic stenosis is the rarest form of left ventricular outflow obstruction.Several techniques for symmetric reconstruction of the aortic root in congenital supravalvular aortic stenosis had been described. In this study, we demonstrate our experience with the extended patch aortoplasty technique.

Materials & Methods: Between October 2001 and March 2005, 11 patients with discrete supravalvular aortic stenosis had pantaloon patch aortoplasty in Abu-El Reech students' Hospital. They were 4 males, and 7 females ranging in age from 1½-9 years (mean age 5.2 years). Three patients (33%) had manifestations of Williams syndrome. All of the patients had the typical harsh ejection systolic murmur. One patient (9%) had associated hypoplastic aortic arch. No associated other cardiac anomalies or significant valvular aortic stenosis were present. The peak gradient across the obstruction ranged from 70-120 mmHg. All the patients underwent pantaloon shaped pericardial patch aortoplasty through an inverted Y-shaped incision in the aorta under deep hypothermia (28^{o}) to enlarge the right and non coronary sinuses.

Results: No operative mortality or morbidity occurred in our study. The peak gradient across the obstruction dropped markedly [0-30 mmHg (mean 10)]. During surgery four patients (40%) had thickened aortic cusps without significant valvular aortic stenosis. After surgery, the typical harsh ejection systolic murmur dis-.appeared completely

Conclusions: Extended patch aortoplasty produces symmetrical enlargement of the right, and non coronary sinuses. It provides more physiologic pattern, preserves the valve function better than augmentation of the non-coronary sinus only. It is technically .easy, yet it should be done accurately

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Supravalvular aortic stenosis (SVAS) represents an important feature of Williams syndrome (Elfin facies, and mental retardation), but it is also found in a familial form or as sporadic cases. The underlying cause is now known to be a spontaneous or an inherited mutation of the elastin gene on chromosome 7 [1]. The defining feature of the malformation is aortic narrowing at the level of the sinotubular junction but in some cases, there is narrowing of the entire ascending aorta, and arch branches. SVAS

may also occur as part of a generalized arteriopathy involving both the systemic, and pulmonary arteries[2]. There are three morphologic variations: (a) Seventy five percent of supravalvular anomalies consists of discrete hhour glass deformity, which consists of an extreme apparent wasting of the aorta at distal extent of sinuses of valsalva, i.e. above the aortic valve commissures in association with some dilatation of sinuses of Valsalva, and absence of post-stenotic dilatation Fig. (1). (b) More diffuse narrowing is detected in 25% of children. It consists of thickening of the aortic wall with a narrow lumen that may extend over a variable distance and may reach the aortic arch, and its branches. (c) In addition there may be a localized membrane immediately above the valve[3]. Histologic examination of the hourglass and membranous types revealed intimal thickening, medial disorganization, and thickening, with areas of necrosis, and calcification. The intimal thickening may involve the edges of the aortic valve leaflets occasionally which may become adherent to the intimal shelf producing stenosis of the inlet into the sinus of Valsalva thereby causing coronary insufficiency. In extreme cases, the proliferative process may extend into, and narrow or even obstruct the ostium of the coronary artery [4,5].

It was also found that significant coronary artery abnormalities were found in 49% of cases with thickening of the intima and media. In addition to the effects of left ventricular pressure after load, patients are at risk for myocardial ischemia due to coronary osteal stanosis, decreased blood flow to the coronary sinus, and hypertension related coronary arteriosclerosis[2]. Associated anomalies include valvular aortic stenosis, multiple peripheral pulmonary artery stenosis, narrow aortic arch which may involve its branches and VSD [4, 5].

The diagnosis of supravalvular aortic stenosis depends mainly on echo cardiography, as the patient is usually asymptomatic. Right ventircular hypertrophy may suggest concomitant pulmonary obstruction, coronary angiography may be needed to show any coronary in sufficiency. Supravalvular aortic stenosis usually occurs with idiopathic hypercalcemia of infancy, since both conditions have a similar set of features. During clinical examination there may be difference in the measurement of blood pressure between the two limbs due to peripheral arterial stenosis [3].

Surgical repair was first described by placement of a tear-drop or diamond shaped patch across the supravalvular ring. The short term results were acceptable, and it remained the technique of choice for many years. However, a report by keane, and his colleagues noted that a significant portion of patients (75%) of patients has a gradient grater than 30 mmHg. Flaker and his colleagues also reported residual gradient and aortic insufficiency[6,7], Fig. (2, 3).

The extended patch technique, described by Flaker and his colleagues in 1975, provides more symmetric augmentation of the aortic root. This is done by inserting an inverted bifurcated patch into the non coronary, and the right coronary sinuses[6]. The aim of this report is to demonstrate our experience with this technique.

Patients & Methods:

Between October 2001 and March 2005, 11 patients underwent surgical correction for congenital supravalvular aortic stenosis in Abu El Reech students' Hospital. They were 4 males and 7 females ranging in age from 1½-9 years. Three patients had Williams syndrome. All of them were discovered during routine medical examination by the presence of a murmur. All of the patients had typical harsh ejection systolic murmur. One patient had associated hypoplatic aortic arch. None of our patients had other associated cardiac anomalies or significant valvular aortic stenosis. Echocardio-graphic examination was the cornerstone for diagnosis by measuring the cardiac dimensions (posterior wall, and septal wall thickness), and the peak, and the mean gradients across the level of obstruction. The operation was indicated when the peak pressure gradient is 50 mmHg or more, or if there was evidence of coronary insufficiency either by angiography (none of our patients reported an ischemic chest pain). In our patients, the peak gradient ranged from 70-120 mmHg.

Surgical Technique:

Cardiopulmonary bypass was established after cannulation of the distal ascending aorta and the right atrial appendage in the standard fashion. Deep hypothermia (28%) with aortic cross-clamping and cold blood antegrade crystalloid cardioplegic protection were used. A left atrial vent was inserted through the right superior pulmonary vein. A longitudinal incision was made in the ascending aorta. It was extended distally to the level of the aortic cross-clamp, and proximally as an inverted Y into both the non coronary, and right coronary sinuses of Valsalva. The aortic valve, and subvalvular areas were examined to exclude obstruction at those levels.

A pericardial patch approximately the diameter of the ascending aorta was prepared. A wedge was taken from one end of the graft to accommodate the area of aorta around the right coronary ostium giving a pantaloon shape to the patch Fig. (4). The patch was sewn to the aortic in cision using running 6/0 polypropylene

suture.

After completion of the anastomosis, the suture line was tested, and the aorta was declamped. Before closure of the sternum, control of systemic blood pressure was manndatory by vasodilators (Nipride on Tridil). In the ICU, the patient was weaned from the ventilator when the hemodynamics became stable and the chest tube drainage was average. A postoperative echo was done immediately after surgery to measure the gradient across the level of obstruction. The patients didn't receive anticoagulation.

Results:

No operative mortality or morbidity in our study. The peak gradient across the obstruction dropped to 0-30 mmHg (mean 10) immediately after surgery. During surgery four patients (40%) had thickened aortic cusps without significant gradient across the valve. After surgery, the typical harsh ejection systolic murmur disappeared.

Discussion:

The morphologic spectrum of SVAS had been well defined since 1970. The concept of an isolated supravalvular membrane had been abandoned, and it had become clear that in most but not all cases the supravalvular narrowing is part of a general disease of the arterial wall with a genetic origin. However, the reason that the stenosis is most prominent at the sinotubular junction remains subject to speculation. Because the sinotubular junction is at the level of the tops of the valve commissures, the geometry of the entire aortic valve apparatus is disturbed[7]. Abnormalities of the valvular tissues are said to be found in 30-54% at operation or necropsy. Stamm and his colleagues, examined the angiograms, and the echocardio-grams of 37 patients, and studied eight pathologic specimens. They found that partial adhesion of the leaflets to the stenosing ridge was observed in 54% of cases, and the leaflets were thickened, and less mobile in 30% of cases. Forty-five percent of angiograms showed evidennce of coronary osteal stenosis. The sinuses of Valsalva were significantly enlarged in 75% of cases[8].

The goals of surgical repair should be (1) relief of stenosis (2) restoration of normal root geometry and (3) allowance of growth of site of repair[9].

In the present study, only two cases (2/11) were found to have bicuspid aortic valves during surgery. This was contrary to the usual description of the morphology of the disease by Delius, and his colleagues who reported that 47% of there patients had bicuspid aortic valves[10].

During surgery 40% of patients had thickened aortic valve cusps but without significant obstruction at the valvular level as detected by preoperative echocardiographic examination. This explains why aortic valvotomy was not done during the surgical procedure. On the other hand Stamm, and his colleagues performed digital or sharp valvotomy of the aortic cusps in 5 cases (5/56), moblization of the tethered aortic cusps in 5 cases (5/56), and aortic valve replacement in 2 cases despite the absence of echocardiographic evidence of obstruction in their report[2].

The study of Stamm was conducted to compare between three techniques to repair discrete supravalvular aortic stenosis; the diamond shaped patch, the extended patch aortoplasty by pantaloon patch (1975), and 3- sinus reconstruction technique described by Brom in (1988). They concluded that the last two technique are more physiologic. They added that they provide symmetrical sinus enlargement and are associated with lower mortality and reoperation rates than the first one[2]. This may be attributed to the fact that this technique only enlarges the noncoronary sinus.

Resection of the fibromuscular ridge above the left coronary cusp which was carried out in one case in the present study was frequently attempted by many surgeons. However it was proved impossible in most cases because the ridge usually represent a constriction of the thickened aortic wall rather than a circumscribed fibrous stricture[2] . Such resection allows the left cusp to assume a normal position. However, in some cases an incision into the left sinus and patch repair might be required before normal positioning of the left cusp[10].

In the present work pericardial patch was used which was concomitant with what Delius and his colleagues reported. They stated that pericardium or polytetrafluroethylene were perferable as patch materials. Such assumption was based upon the failure of neointimal lining of Dacron patch leaving a thrombotic surface resulting in treansient ischaemic attacks in one of their cases[10].

After surgery the gradient dropped markedly, this coincides with results of Brown and his colleagues who showed that the mean pressure gradient was reduced to 21 mmHg in the early postoperative period[11].

The extented patch aortoplasty technique first described by Doty and his colleagues should be done accurately. The surgeon should take care of the following points: (1) The longitudinal limb of the incision should extend up as far as the cross clamp, while the transverse limb should extend down to the bottom of the coronary sinus. (2) While making the aortotomy incision, the bifurcation point should start well above the area

of discrete narrowing, (3) The incisions across the fibrosing ring should be done approximatly 180 degrees apart. (4) The limb of the incision into the right coronary sinus is made to the left of the right coronary ostium this means that the patch is put stradling the right coronary ostium. (5) In cases with previous aortotomy, the incision is made at the site of previous aortic incision. (6) The suture line starts at the point of bifurcation of the inverted Y incision, and then extends to either side. (7) The surgeon should intend to oversize the width of the patch to accommodate the eventual growth of of the vascular system to prevent recurrence. (8) The fibrous ridge should be removed from the aortic wall to free the aortic cusps. (9) After the suture crosses the area of the right coronary artery ostium care should be taken to ensure that it is patent. (10) The surgeon should be very careful while taking bites at either ends of the incision (in the bottom of the non-coronary, and right coronary sinus), because taking additional sutures at this area, after release of the aortic clamp is extremely difficult. (11) Closure of the pericardium or part of its length is done, as some patients may need aortic valve replacement in the future.

Delius, and his colleagues, studied the long term results of 15 cases who had extended aortoplasty between 1975 and 1983, they concluded that the main risk factors for residual gradient after surgery or reoperation is the pathologic condition of the aortic valve and bicuspid aortic valve[10].

Pathologic changes of coronary arteries, and myocardial ischemia in SVAS have been described by many authors. Although they are rare, they are strong indications of early surgery. The pathologic changes in the arterial wall may be attributed to elevated pressure inside the vessels due to obstruction at the sinotubular junction or due to generalilzed arteriopathy[12, 13]. In addition to severe ventricular hypertrophy, coronary circulation of patients with severe arteriopathy may be more sensitive to changes in blood pressure during the perioperative period[14]. In the present study, none of our cases had coronary insufficiency.

Limitations of the study

Due to rarity of the disease, the number of patients in the present study was few, that is 11 cases were operated upend during a period of 4 years. The largest study which was conducted by Brown and colleagues collected the data of 73 patients over a period of 28 years. They were operated upon between 1962-2000. This would represent the same average number of patients per year in our study .

Conclusions:

Supravalvular aortic stenosis is a rare form of left ventricular outflow tract obstruction. It occurs mostly with Williams syndrome. There are three types, hourglass, membranous, and diffuse. The first two types have the same pathological features, and the same surgical management. Many years ago surgical procedures entailed putting a teardrop or diamond shaped patch. This was modified later on by Doty and his colleagues, who described the technique of extended aortoplasty. It produces symmetrical enlargement of right and non coronary sinuses and more physiologic flow pattern, and preserves the aortic valve function. It is also associated with the least re-operation rate.

References:

1- Stamm C, Friehs I, Ho SY, Moran AM, Jonas BA and Del Nipo PJ: Congenital supravalvular aortic stenosis. Eur. J. Cardiothoracic Surg., 2001 Feb.; 19(2):195-202.

2-Stamm C, Kreutzer C, Zurakowski D, Nollert G, Friehhs I, Mager JE, Jonas RA and del Nido PJ: Forty-one years of surgical experience with congenital supravalvaulvar aortic stenosis. J. Thoracic Cardiovasc. Surg., 1999, 118: 874-85.

3-Glenn's: Glenn's thoracic, and cardiovascular surgery. Edited by Arthur E. Baue, Alexander S. Geha, Hillel Laks, graeme L. Hammond, Keith S. Naunheim. Prentice-Hall International, 1996.

4- John W. Kirklin, Brian G. and Barratt Boyes: Cardiac surgery. Edited by John W. Kirklin, and Brian Co., Barratt Boyes, Churchill Livingstone, 1993.

5-Van Son JA, Edwards WP and Danielson GK: Pathologyy of coronary arteries, myocardium, and great arteries in supravalvular aortic stenosis. J. Thorac. Cardiovasc. Surger., 1994; 108:21-8.

6-Flaker G, Teske D, Kilman J, Hosier D and Wooley C: Supravalvular aortic stenosis: a 30 years clinical perspective with patch aortoplasty. Am. J. Cardiol., 1983; 51:256-60.

7-Stewart S, Alexon C and Manning J: Extended aortoplasty to relieve supravalvular aortic stenosis. Ann. Thorac. Surg., 1988; 46:427-9.

8-Stamm C, Li J, Ho SY, Redington AN and Anderson RH: The aortic root in supravalvular aortic stenosis: the potential surgical relevance of morphologic changes. J. Thorac. Cardiovasc. Surg., 1997; 114:16-24.

9-Myers JL, Waldhausen JA, Cyran SE, Gleason MM, Weber HS and Baylen BG: Results of surgical repair of congenital supravalvular aortic stenosis. J. Thorac. Cardiovasc. Surg., 1993, 105:281-8.

10-Delius RE, Steinberg JB, L'Ecuger T, Doty DB and Behrendt DM: Long-term follow-up of extended aortoplasty for supravalvular stenosis. J. Thorac. Cardiovasc. Surg., 1995; 109:155-63.

11-Brown JW, Ruzmetov M, Viay P and Turrentine

MW: Surgical repair of congenital supravalvular aortic stenosis in children. Eur. J. Cardiothoracic Surg., 2002 Jan.; 21(1):50-6.
12-Braunstein PW Jr, Sade RM, Crawford FA Jr and Oslizok RC: Repair of supravalvular aortic stenosis: cardiovascular, and morphological results. Ann. Thorac. Surg., 1990, 50:700-7.
13-Chard RB and Cartmil TB: Localized supravalvular aortic stenosis, a new technique for repair. Ann. Thorac. Surg., 1993; 55:782-784.
14-Sharma BK, Fujiwara H, Hallman GL, Oh DA, Reul GJ and Cooley DA: Supravalvular aortic stenosis: a 29-year review of surgical experience. Ann. Thorac. Surg., 1991, 51:1031-9.

Fig. (1): Typical hourglass deformity of the aorta (After Flaker et al., 1983)

Fig. (2): Date of operation grouped according to surgical technique for augmentation of aortic root in SVAS (After stamm et al., 1999).

Fig. (3): Surgical technique used for relief of suprvavalvular aortic stenosis. A diamond shaped patch in the non coronary sinus (After stamm et al., 1999).

Fig. (4): Surgical technique used for relief of suprvavalvular aortic stenosis. A Pantaloon shaped patch in the right and non coronary sinuses (After stamm et al., 1999).

Fig. (5): Surgical technique used for relief of suprvavalvular aortic stenosis. The 3-sinus reconstruction technique (After stamm et al., 1999).

Total circulatory arrest and retrograde cerebral perfusion during ascending aorta and arch surgery

Said Abdel Aziz, MD

Background: **Recently we have used total circulatory arrest under deep hypothermia in association with retrograde cerebral perfusion as an adjunct to cerebral protection during operations on the ascending aorta and aortic arch. The purpose of this study was to evaluate the impact of RCP on the outcome of patients submitted to ascending aorta or aortic arch surgery.**

Methods: **Between January 1999 and December 2003, 32 patients underwent operations on the ascending aorta and aortic arch or both. Patients were divided into two groups A and B. Group A included 15 patients who underwent operations on the ascending aorta and aortic arch using deep hypothermic circulatory arrest (DHCA) alone, while the other 17 patients of group B underwent operations on the ascending aorta and aortic arch using (DHCA) and retrograde cerebral perfusion (RCP). The mean age was 53.3 ±10.5 years for patients in group A where it was 54.2 ±11.6 years in group B. They underwent operations on the ascending aorta and aortic arch or both for acute aortic dissection (type A) (11 patients 73.3%in group A & 15 patients,88.2%in group B) or chronic aneurysm of the ascending aorta and aortic arch {4 patients (26.6%) & 2 patients (11.7%) in group A and B respectively}. Six patients (40%) in group A and 7 patients (41.2%) in group B went to the operating room on emergency basis while the remaining patients were elective. All patients were submitted to deep hypothermia (nasopharyngeal temperature=18°c), total circulatory arrest (mean=35.6±12min. & mean=36 ±11.2min.) for group A & B respectively, and retrograde cerebral perfusion via the superior vena cava (mean=29.5 ±10.9) for group B patients only. Bentall procedure was performed in ten patients in each group while supracoronary tube graft replacement of ascending aorta was done in 5 (33.3%) and 7 (41.2%) patients in group A and B respectively. Aortic arch or hemiarch replacement was performed in 3 patients (20%) in group A and in 5 patients (29.4%) in group B. Associated coronary artery bypass grafting was done for 2 patients (11.7%) in group B only. The ICU stay and hospital stay for group A patients were 3.5±1.1 days and 13.2±3.1 days respectively; whereas that for group B patients were 3.1±1 days and 11±2.5 days respectively.**

Results: **All patients in both groups were similar with regard to the presence of preoperative risk factors, age, emergent status and indications for operation. There were three (20%) hospital deaths in group A patients versus two (11.7%) deaths in group B patients. The incidence of transient neurologic dysfunction was not significantly different between DHCA alone (3 patients =20%) and DHCA with RCP (3 patients =17.6%). Their was no permanent neurological deficit in group B patients while in group A patients, there were 2 patients with stroke, one died on the 7th day and**

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the other recovered with permanent hemiplegia.
Conclusion: **Systemic deep hypothermia (18ºc) and retrograde cerebral perfusion are easy to establish, safe and may improve brain protection during ascending aorta and aortic arch surgery.**

One of the challenges presented to the cardiovascular surgeon during the repair of ascending aorta and transverse arch is the provision of both cardiac and cerebral protection. Cardiopulmonary bypass (CPB) and circulatory arrest made graft replacement of the ascending aorta and the aortic arch easier. A safe circulatory arrest period, however, has been difficult to quantify. Circulatory arrest for less than 30 minutes appears to be safe and it is associated with a higher incidence of stroke if it exceeds 45 minutes, whereas circulatory arrest periods more than 65 minutes are associated with increased mortality(1). In 1964, Borst and colleagues(2) reported the use of deep hypothermic circulatory arrest to repair a traumatic aneurysm of the distal aortic arch. In 1970s, Griepp and associates(3) established the value of this technique for resection and grafting of more extensive aneurysms of the aortic arch. Currently, some surgeons use it routinely in all cases of aortic dissection(4). Mills and Ochsner (5) in 1980 first used retrograde cerebral perfusion (RCP) through the superior vena cava in a patient to treat a major air embolus and prevent brain damage. By 1986, Ueda and colleagues (6) had developed the clinical application of RCP as it is currently used for brain protection during circulatory arrest period. We report our clinical experience using both deep hypothermic circulatory arrest and retrograde cerebral perfusion in managing this challenging problem.

Patients and methods

Between January 1999 and December 2003, 32 patients underwent operations on the ascending aorta and aortic arch or both. Patients were divided into two groups A and B. Group A included 15 patients who underwent operations on the ascending aorta and aortic arch using deep hypothermic circulatory arrest (DHCA) alone, while the other 17 patients of group B underwent operations on the ascending aorta and aortic arch using (DHCA) and retrograde cerebral perfusion (RCP).

The male/female ratio is 12/3 and 15/2 in group A and B respectively. The mean age was 53.3±10.5 (range, 32 to 70) years for patients in group A where it was 54.2±11.6 (range, 32 to 71) years in group B. Emergency operation was performed for 6 patients (40%) in group A and for 7 patients (41.2%) in group B and the rest of operations were elective. The aortic pathology and preoperative data were listed in table 1.

Table 1: Preoperative data

Characteristics	Grpoup A (DHCA)	Group B (DHCA&RCP)
Total number	15	17
Age (years)	53.3±10.8	54.2±11.6
Male/Female	12/3	15/2
Hypertension	10 (66.6%)	14 (82.4%)
Diabetes Mellitus	9 (60%)	11 (64.7%)
Pulmonary disease	2 (13.3%)	2 (11.7%)
Acute type A dissection	11 (73.3%)	15 (88.2%)
Chronic aneurysm	4 (26.6%)	2 (11.7%)
Emergency operation	6 (40%)	7 (41.2%)

DHCA: deep hypothermic circulatory arrest. RCP: retrograde cerebral perfusion.

Operative technique

Operations were performed through a median sternotomy and total cardiopulmonary bypass (CPB) with DHCA. As for the site of arterial cannulation for CPB, the ascending aorta and the femoral artery were used in cases of group A, while in patients of group B, the right axillary artery, the innominate artery and the femoral artery were used.

Cardiopulmonary Bypass and Retrograde Cerebral Perfusion

A standard cannulation technique was adopted for all the cases, allowing the option of retrograde cerebral perfusion if judged necessary. The basic perfusion circuit comprised a 1/2-inch venous line and a 3/8-inch arterial segment. Cannulation for cardio-pulmonary bypass was undertaken with separate superior vena cava (SVC) and inferior vena cave (IVC) cannulas and a left ventricular vent, returning the blood to the arterial inflow line. A parallel 1/4-inch cannula was connected between the arterial return and the SVC cannula by means of Y connections primed and clamped at both ends. Bypass was instituted with non-pulsatile flows of 2.4L.min .m , and a mean arterial pressure of 50 to 60 mmHg was maintained by intermittent use of alpaha stimulants. The patients were cooled to a nasopharyngeal temperature of 18ºc with gradual reduction in the systemic flow as the

nasopharynageal temperature decreased. Cooling was done over 45 minutes and may be more in patients of group B while in patients of group A it was done over variable periods of time which are usually less than 30 minutes. In group B patients the distal anastomosis between the aorta and the vascular prosthetic graft was performed using the open technique (no aortic cross clamp), whereas in group A patients it was done while the aorta was cross clamped.

When RCP was used in patients of group B, the SVC cannula was snaired (using Nylone tape) to isolate the SVC from the general circulation. RCP was initiated at 200 ml/min up to300 to 400 ml/min to keep the central venous pressure around 25 to 30 mmHg. This pressure was measured by separate single-lumen left internal jugular venous cannula isolated from any drug infusions. During the period of circulatory arrest and at the same time with RCP, the femoral arterial cannula was used to infuse arterial blood in the lower half of the body by a rate of 300 to 500 ml per minute to keep the descending aorta and its branches relatively full of blood, this technique was only done for patients of group B.The IVC cannula was left opened to allow free venous drainage from the lower half of the body and coming blood from the arch vessels ostia was returned to the blood reservoir by pump suction from within the open aortic arch(figure. I).

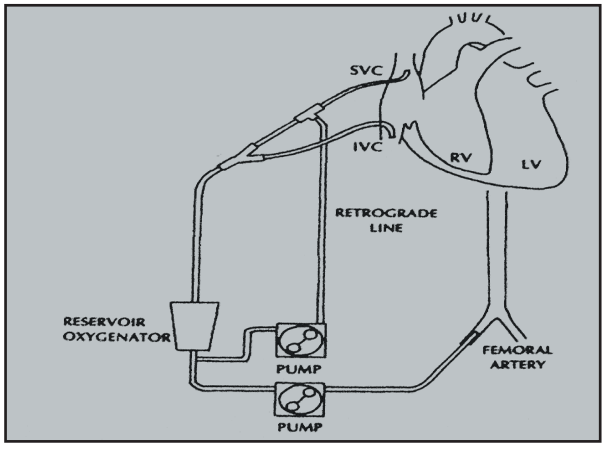

Figure 1: Diagram showing cannulation for cardiopulmonary bypass and retrograde cerebral perfusion. SVC= superior vena cava. IVC=inferior vena cava. RV=right ventricle. LV=left ventricle.

Rewarming was done retrogradely, through the femoral artery, in all patients of group A, while in patients of group B, it was done antegradely through the previously cannulated right axillary or innominate artery.

Bentall operation (replacement of the aortic valve and ascedinding aorta with reimplantation of the coronary arteries) was performed in 10 patients in each group while supracoronary tube graft replacement of ascending aorta was done in 5 (33.3%) and 7 (41.2%) patients in group A and B respectively. Aortic arch or hemiarch replacement was performed in 3 patients (20%) in group A and in 5 patients (29.4%) in group B. Associated coronary artery bypass grafting was done for 2 patients (11.7%) in group B only.

The mean cardiopulmonary bypass time and circulatory arrest time were almost equal in both groups (126±32 minutes for group A versus 130±28 minutes for group B) (35±12 minutes for group A versus 36±11 minutes for group B). The mean retrograde cerebral perfusion time for group B patients was 29±10 minutes. Table 2 shows the operative characteristics of both groups. The ICU stay and hospital stay for group A patients were 3.5±1.1 days and 13.2±3.1 days respectively; whereas that for group B patients were 3.1±1 days and 11±2.5 days respectively (figure. 2)

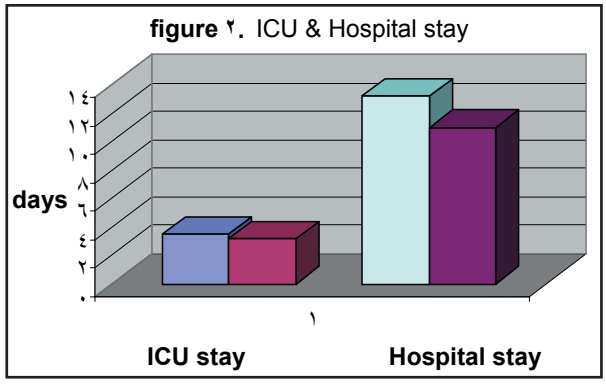

Table 2: Operative characteristics.

Characteristics	Grpoup A (DHCA)	Group B (DHCA&RCP)
Bentall procedure	10 (66.6%)	10(58.2%)
Supra-coronary tube graft	5 (33.3%)	7 (41.2%)
Arch & hemiarch replacement	3 (20%)	5 (29.4%)
Associated CABG		2 (11.7%)
Total pump time	126.6±32.8 min.	130±28.9 min.
Total circulatory arrest time	35.6±12 min.	36±11.2 min.
RCP time		29.4±10.9 min.

CABG: coronary artery bypass grafting. RCP: retrograde cerebral perfusion.

Results:

All patients in both groups were similar with regard to the presence of preoperative risk factors, including hypertension, diabetes mellitus, renal impairment, pulmonary disease and peripheral vascular disease. The groups were also similar in age, emergent status and indications for operation. Important preoperative characteristics were listed in table 1.

Mortality and morbidity:

We have three (20%) hospital deaths in group A patients versus two (11.7%) deaths in group B patients. In group A patients, one patient died intraoperative because of uncontrollable bleeding and the other two patients, one died on the 7th postoperative day because he did not regain his consciousness at all due to extensive cerebral infarction, while the other one died after 3 weeks due to mediastinitis. For patients of group B, we had one patient died 15 days after uncomplicated replacement of the ascending aorta for acute type A aortic dissection due to rupture of the dissected intra-abdominal aorta after uncontrolled episode of severe hypertension and The other patient died on the 2$_{nd}$ post-operative day because of myocardial failure.

Neurologic dysfunction and adverse outcome:

The incidence of transient neurologic dysfunction was not significantly different between DHCA alone (3 patients =20%) and DHCA with RCP (3 patients =17.6%). In group A patients, one patient had unilateral upper limb monoparesis that improved by physiotherapy and the other two patients had delayed consciousness recovery due to brain oedema. On the othe side 2 patients suffered post-operative confusion and psychosis for few days and disappeared spontaneously without treatment and the third patient had post-operative paraplegia that was improved completely after 3 months.

Their was no permanent neurological deficit in group B patients while in group A patients, there were 2 patients with stroke, one died on the 7th day and the other recovered with permanent hemiplegia.

Discussion:

Experimental studies have shown that RCP supplies only 20% to 25% of the metabolic requirements of the brain as most of the blood is shunted through the collaterals before it reaches the capillaries of the brain; however, when combined with topical cooling, RCP helps maintain cerebral hypothermia and has a flushing effect to remove air from the cerebral vascular bed (7&8). On the basis of these findings and the favorable clinical results, many centers have advocated the routine use of RCP during DHCA(9,10&11).

Bavaria and associates (12) reported that RCP decreased mortality rate from 38% to 7% and stroke rate from 48% to 0%. Many other workers - (Coselli & LeMaire(13); Ehrlich and colleagues(14) and Safi and colleagues(15) - also reported dramatic improvement in their results using supplemental RCP with DHCA compared to DHCA alone.

In the current study, we found no significant difference between DHCA alone and DHCA with RCP with regard to operative mortality (20% versus 11.7%) and transient neurologic dysfunction (20% versus 17. 6%). These findings support the hypothesis that RCP remains optional during the procedures involving the arch, as long as the core body temperature is low (16). RCP may be mandatory, however, when using circulatory arrest under only moderate systemic hypothermia (temperature = 19 to 28, mean of 23). This technique was introduced by the Toronto group (17) in which, RCP was necessary to keep the brain cool during the brief periods of hypothermic circulatory arrest (HCA). However, the stroke rate was 13.3% in group A patients and 0% in group B patients which encouraged us to expand the use RCP with DHCA.

In our series, although we did not find a significant difference in the cerebrovascular events – either stroke or transient neurologic dysfunction - between the two groups as regard to rewarming retrograde through the femoral artery or antegrade through the right axillary artery, yet David and associates (18) noted that cerebrovascular accident rate decreased from 15% to 4% and the mortality rate tend to fall from 20% to 9% when rewarming was performed antegrade rather than retrograde. Similarly, Moon and co-workers identified rewarming retrograde, rather than antegrade, as an independent risk factor for transient neurologic dysfunction (19%). It is important to note, however, that these findings may have been influenced by the initial decision to cannulate through the femoral artery in patients believed to have significant proximal atheromatous aortic disease. The more frequent use of axillary artery cannulation in appropriate patients can eliminate the need to reposition the inflow arterial cannula during rewarming and may improve the neurologic recovery.

Finally, the Mount Sinai group (20) stated that early clinical and laboratory results regarding RCP for thoracic aortic surgery were promising. However, it is unclear whether RCP provides effective cerebral perfusion, metabolic support, washout of embolic material, or improved neurological and neuropsychological outcome.

Nevertheless, RCP remains in common use worldwide.

In conclusion systemic deep hypothermia (18ºc) and retrograde cerebral perfusion are easy to establish, safe and may improve brain protection during ascending aorta and aortic arch surgery, however, more time and patients are required for better evaluation.

References:

1. Svensson LG, Crawford ES, Hess KR,et al. Deep hypothermia with circulatory arrest. Determinants of stroke and early mortality in 656 patients. J Thorac Cardiovasc Surg.1994; 106:19-31.
2. Brost HG, Schaudig A, Rudolph W. Arteriovenous fistula of the aortic arch: repair during deep hypothermia and circulatory arrest. J Thorac Cardiovasc Surg.1964; 48:443.
3. Griepp RB, Stinson EB, Hollingsworth JF, Buehler D. prosthetic replacement of the aortic arch. J Thorac Cardiovasc Surg.1975; 70:1051-63.
4. Bavaria JE, Woo YL, Hall RA, et al. Circulatory management with retrograde cerebral perfusion for acute type A aortic dissection. Circulation.1996; 94(suppl II): 173-6.
5. Mills NL, Ochsner JL. Massive air embolism during cardiopulmonary bypass. Causes, prevention, and management. J Thorac Cardiovasc Surg.1980; 80:708-717.
6. Ueda Y, Miki S, Kusuhara K,et al. Surgical treatment of aneurysm or dissection involving the ascending aorta and aortic arch, utilizing circulatory arrest and retrograde cerebral perfusion. J Cardiovasc Surg.1990; 31:553-8.
7. Midulla PS, Gandsas A, Sadeghi AM et al. Comparison of retrograde cerebral perfusion to antegrade cerebral perfusion and hypothermic circulatory arrest in a chronic porcine model. J Card Surg 1994;9:560-575.
8. Juvonen T, Weisz DJ, Wolfe D, et al. Can retrograde perfusion mitigate cerebral injury after particulate embolization? A study in a chronic porcine model. J Thorac Cardiovasc Surg 1998;115:1142-1159.
9. Lytle BW, McCarthy PM, Meaney KM, Stewart RW, Cosgrove DM. Systemic hypothermia and circulatory arrest combined with arterial perfusion of the superior vena cava. Effective intraoperative cerebral protection. J Thorac Cardiovasc Surg 1995;109:738-743.
10. Usui A, Abe T, Murase M. Early clinical results of retrograde cerebral perfusion for aortic arch operations in Japan. Ann Thorac Surg 1996;62:94-104.
11. Okita Y, Takamoto S, Ando M, Morota T, Matsukawa Right, Kawashima Y. Mortality and cerebral outcome in patients who underwent aortic arch operations using deep hypothermic circulatory arrest with retrograde cerebral perfusion: no relation of early death, stroke, and delirium to the duration of circulatory arrest. J Thorac Cardiovasc Surg 1998;115:129-138.
12. Bavaria JE, Woo YJ, Hall RA, Carpenter JP,Gardner TJ. Retrograde cerebral and distal aortic perfusion during ascending and thoracoabdominal aortic operations. Ann Thorac Surg 1995;60:345-353.
13. Coselli JS, LeMaire SA. Experience with retrograde cerebral perfusion during proximal aortic surgery in 290 patients. J Card Surg 1997;12:322-325.
14. Ehrlich MP, Fang WC, Grabenwoger M, et al. Impact of retrograde cerebral perfusion on aortic arch aneurysm repair. J Thorac Cardiovasc Surg 1999;118:1026-1032.
15. Safi HJ, Petrik PV, Miller CC. Brain protection via retrograde cerebral perfusionduring aortic arch aneurysm repair. Updated in 2001. Ann Thorac Surg 2001;71:1062-1063.
16. Wong CH, Bonser RS. Does retrograde cerebral perfusion affect risk factors for stroke and mortality after hypothermic circulatory arrest? Ann Thorac Surg 1999;67:1900-1903.
17. Moshkovitz Y, David TE, Caleb M, Feindel CM, de Sa MPL. Circulatory arrest under moderate systemic hypothermia and cold retrograde cerebral perfusion. Ann Thorac Surg 1998;66:1179-1184.
18. David TE, Armstrong S, Ivanov J, Barnard S. Surgero for acute type A aortic dissection. Ann Thorac Surg 1999;67: 1999-2001.
19. Moon MR and Sundt III TM. Influence of retrograde cerebral perfusion during aortic arch procedures. Ann Thorac Surg 2002;74:426-431.
20. Reich DL, Uysal S, Ergin A, Griepp RB. Retrograde cerebral perfusion as a method of neuroprotection during thoracic aortic surgery. Ann Thorac Surg 2001;72:1774-1782.

Neurological Complications Following Adult Open-Heart Operations and Its Predisposing Factors

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objective: **Neurological injury is a devastating complication of cardiac surgery that results in a longer duration of hospitalization, increased costs and increased likelihood of death. Such injury can affect any level of the central nervous system, and its manifestations are broad, ranging from neurocognitive dysfunction to frank stroke.**

During the period June 2003 to December 2004, a total of 432 adult patients underwent various types of open heart surgical procedures. Most of these patients (315) subjected to coronary artery bypass grafting (73.1 %), (64) patients underwent mitral valve replacement (14.8%), (28) patients underwent aortic valve replacement (6.5%), (14) patients underwent double mitral and aortic valve replacement (3.3%), and the last (10) patients underwent excision of left atrial myxoma (2.3%). (18) Patients (4.1%), developed new neurological signs after surgery. The latter formed three groups: Group (I) consisted of 2 patients with severe neurological deficits, who never regained consciousness and died in spite of intensive support of vital systems. Group (II) consisted of 4 patients with postoperative clinical evidence of focal cerebral infraction (2 had hemiplegia and 2 showed alteration of memory), all of them had residual defects at discharge. Group (III) was composed of 12 patients with minor neurological deficits after surgery (hemiparesis, gait disturbance, mental changes) which had cleared up by discharge.

Conclusion: **Such neurological complications after an otherwise successful cardiac surgery represent a devastating outcome for patients and their families, and the social and economic impacts are enormous. Several factors are identified including atheromatus embolism, carotid occlusive disease, air embolism, valve calcification, atrial fibrillation and severe perioperative hypotension.**

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Neuropsychiatric dysfunction from embolic and low-flow phenomena accompanying open-heart procedures has been well recognized. Such disorders significantly increase perioperative mortality and hospitalization time and can lead to a decrease in the patient's quality of life. *(*1)

Early studies of intracardiac operations emphasized the association of neurological complications with air or particulate emboli from calcified valves or thrombi within the heart chambers and from the cardiopulmonary bypass circuit. *(2,* 3)

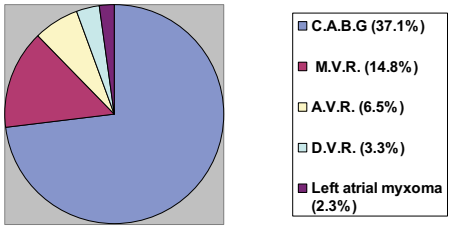
Reported potential mechanisms of the effects of cardiopulmonary bypass are the microembolization and macroembolization of gas, particulate matter and inadequate cerebral perfusion pressure or flow. However, studies on the impact of conventional, uncomplicated cardiopulmonary bypass are rare and

usually are performed on small, selected groups of patients. Furthermore, the multifactorial nature of neurologic dysfunction after cardiopulmonary bypass makes the results of such investigation controversial. *(*4)

We undertook this prospective study to determine the incidence of neurological complications after adult open heart operations, and the associated preoperative and intraoperative risk factors, including the characteristics of cardiopulmonary bypass that might predispose the patients to such neurologic complications following surgery.

Patient & Methods

This is a prospective study of the patients for neurological complications that developed postcardiac surgery. All patients who underwent adult open heart surgery during the period June 2003 to December 2004 at Ain Shams University Hospitals were included in the study. These included mitral valve replacement, aortic valve replacement, double valve replacement, coronary artery bypass grafting and excision of atrial myxoma. (Fig. "1"). Patients who underwent close heart surgery, repair of aortic coarctation, dissecting or non-dissecting thoracic aneurysm were excluded from the study.



C.A.B.G. (coronary artery bypass grafting), M.V.R (mitral valve replacement), A.V.R. (aortic valve replacement), D.V.R. (double valve replacement).

Figure (1): Types of open heart operation performed.

Data collected included: Age, sex, preoperative diagnosis including the New York Heart Association functional classification score (NYHA), Rhythm, ejection fraction and valve or coronary lesion. It also included presence or absence of diabetes and hypertension, cardiopulmonary bypass and aortic cross clamp times and pre and postoperative neurological deficits. Carotid duplex is done only in some selected cases (patients above 60 years and those with preoperative neurological event).

Results:

During the study period, 432 patients underwent adult open heart surger*y. (Table* 1)

Of them, 315 patients (73.1%) underwent coronary artery bypass grafting .47 patients were NYHA class (IV) and 268 patients were NYHA class (III). Their age range was 50 to 74 years (mean 54± 7). 278 patients were males while 37 patients were females. The rhythm was sinus in 312 patients and atrial fibrillation in 3 patients. The atherosclerosis was affecting the left main coronary artery in 106 patients, four vessels in 23 patients, three vessels in 151 patients and two vessels in 35 patients. The ejection fraction range was 42 to 56% (Mean 44± 6), 297 patients were diabetic, 309 patients were hypertensive and cerebrovascular disease was present preoperatively in 2 patients. The cross clamp time range was 25 to 85 minutes (Mean 38±11) and the bypass time range was 35 to 105 minutes (Mean 46± 12).

64 patients (14.8%) underwent mitral valve replacement because of mitral stenosis which was calcific in 22 patients and non calcific in 12 patients, mitral regurge in 15 patients and prosthetic valve malfunction and thrombosis in 15 patients. NYHA class was (IV) in 26 patients and (III) in 38 patients. Their age range was 22 to 46 years (Mean 24±5). 30 patients were males and 34 patients were females. Sinus rhythm was present in 46 patients while atrial fibrillation was present in 18 patients. The ejection fraction range was 40 to 54% (Mean 44±7). None of the patients was diabetic or hypertensive and only one patient had preoperative neurological event. The cross clamp time range was 25 to 42 minutes (Mean 27±5) and the cardiopulmonary bypass time range was 40 to 62 minutes (Mean 45±5).

Aortic valve replacement was done in 28 patients (6.5%), 7 patients were NYHA class (IV), 17 patients were NYHA class (III), and 4 patients were NYHA class (II). Their age range was 18 to 36 years (Mean 23±5). 16 patients were males and 12 patients were females, the sinus rhythm was present in 27 patients and only 1 patient had atrial fibrillation. Aortic stenosis was the diagnosis in 15 patients, 8 of them were calcific while 7 were non calcific. Aortic regurge was the diagnosis in 13 patients, their range of ejection fraction was 45 to 58% (Mean 48±6), of cross clamp time was 25 to 36 minutes (Mean 26±4) and of bypass time was 38 to 51 minutes (Mean 41±2). None of them was diabetic or hypertensive and none of them had preoperative neurological event.

Double valve replacement was done in 14 patients (3.3%). 5 patients were NYHA class (IV) and 9 patients were NYHA class (III). 8 patients were males and 6 patients were females. The rhythm was sinus in 12 patients and atrial fibrillation in 2 patients. The diagnosis was calcific mitral and aortic stenosis in 6 patients, non calcific mitral and aortic stenosis in 2 patients, and mitral and aortic regurge in 6 patients. Their range of age was

23 to 48 years (Mean 24±7), of ejection fraction was 44 to 56% (Mean 45±4), of cross clamp time was 48 to 86 minutes (Mean 50±9) and of bypass time was 62 to 107 minutes (Mean 65±9). None of them was hypertensive or had preoperative neurological event. But only one patient was diabetic.

10 patients (2.3%) subjected to excision of left atrial myxoma. 2 patients were NYHA class (IV), 6 patients were NYHA class (III) and 2 patients were NYHA class (II). 3 patients were males and 7 patients were females. The diagnosis was left atrial myxoma in all patients and all of them had sinus rhythm. Their range of age was 40 to 48 years (Mean 43±4), of ejection fraction was 50 to 60% (Mean 52±5), of cross clamp time was 17 to 32 minutes (Mean 20±6) and of bypass time was 35 to 43 minutes (Mean 36±2). One patient was diabetic, one patient was hypertensive and one patient had preoperative neurological event.

Table (1)

Clinical variables	C.A.B.G patients	M.V.R patients	A.V.R patients	D.V.R patients	Left atrial myxoma patients
Pre-operative					
Number	315 (73.1%)	64 (14.8%)	28 (6.5%)	14 (3.3%)	10 (2.3%)
NYHA class	IV (47patients) III (268 patients)	IV (26 patients) III (38 patients)	IV (7 patients) III (17 patients) II (4 patients)	IV (5 patients) III (9 patients)	*IV* (2 patients) *III* (6 patients) *II* (2 patients)
Age	50-74 years (mean 54 ± 7)	22-46 years (mean 24 ± 5)	18-36 years (mean 23 ± 5)	23-48 years (mean 24 ± 7)	40-48 years (mean 43 ± 4)
Sex					
Male	278 patients	30 patients	16 patients	8 patients	3 patients
Female	37 patients	34 patients	12 patients	6 patients	7 patients
Rhythm	Sinus (312 patients) A.F. (3 patients)	Sinus (46 patients) A.F. (18 patients)	Sinus (27 patients) A.F. (1 patient)	Sinus (12 patients) A.F. (2 patients)	*Sinus* (10 patients)
Diagnosis	Left main disease (106 patients) 4 vessel disease (23 patients) 3 vessel disease (151 patients) 2 vessel disease (35 patients)	Calcific M.S (27 patients) Non calcific M.S (12 patients) M.R. (15 patients) Prosthetic valve malformation (15 patients)	Calcific A.S (8 patients) Non calcific A.S (7 patients) A.R. (13 patients)	Calcific M.S & A.S (6 patients) Non calcific M.S &A.S (2 patients) M.R.&A.R (6 patients)	*Left atrial myxoma*
Ejection Fraction	42-56% (mean 44 ± 6)	40-54 years (mean 44 ± 7)	45-58 years (mean 48 ± 6)	44-56 years (mean 45 ± 4)	50-60 years (mean 52 ± 5)
Diabetes	+ve (297 patients)	-ve	-ve	+ve (1 patient)	+ve (1 patient)
Hypertension	+ve (309 patients)	-ve	-ve	-ve	+ve (1 patient)
Previous cerebro-vascular disease	+ve (2 patients)	+ve (1 patient)	-ve	-ve	+ve (1 patient)
*** Intra-operative**					
Cross clamp time	.min 25-85 (mean 38 ± 11)	.min 25-42 (mean 27 ± 5)	min. (mean 26 25-36 (± 4	.min 48-86 (mean 50 ± 9)	.min 32 – 17 (mean 20 ± 6)
Bypass time	.min 35-105 (mean 46 ± 12)	.min 40-62 (mean 45 ± 5)	.min 38-51 (mean 41 ± 2)	min. (mean 62-107 (65 ± 9	.min 43 – 35 (mean 36 ± 2)

C.A.B.G (Coronary artery bypass grafting), M.V.R (Mitral valve replacement), A.V.R. (Aortic valve replacement), D.V.R. (Double valve replacement), M.S. (Mitral stenosis), M.R (mitral regurge), A.S (Aortic stenosis), A.R (Aortic regurge), A.F (Atrial fibrillation).

Neurological complications:

18 patients (4.1%) suffered neurological sequalae. The average age of these patients was 60.7 years, 72% were hypertensive and about 78% were diabetic. The clinical profile of these patients is shown in (Table 2). 11 patients had coronary artery bypass grafting, 4 patients had mitral valve replacement, 2 of them were redo operations, 1 patient had aortic valve replacement, one patient had double valve replacement and one patient had excision of left atrial myxoma. (Table 3)

Three categories of neurological events were identified. Group (I) consisted of 2 patients (0.46%) who never regained consciousness and died after intensive support of vital systems. Group (II) consisted of 4 patients (0.92%) with postoperative clinical evidence of focal cerebral infarction; all of them had residual defects at discharge. Group (III) consisted of 12 patients (2.72%) with minor neurological deficits after surgery which had cleared up by discharge.

Patient	Age (in years)	Sex	Diagnosis	Surgery	C.P.B	A.C.C	Neurological complication	Risk factors identified
Group (I)								
1	64	male	3 vessel disease	C.A.B.G	73	47	Persistent coma & seizures	Previous neurological event
2	72	male	Left main disease	C.A.B.G	85	56	Persistent coma & seizures	Atheromatus aorta
Group (II)								
3	48	female	Calcific M.S.	M.V.R	62	41	Left sided hemiplegia	Calcific mitral valve
4	62	female	3 vessel disease	C.A.B.G	68	42	Confusion & left sided hemiplegia	Previous neurological event
5	58	male	4 vessel disease	C.A.B.G	76	52	Right sided hemiplegia & aphasia	-ve
6	56	female	Prosthetic valve thrombosis	M.V.R.R	54	38	Left sided hemiplegia & seizures	Prosthetic valve thrombosis, A.F., re-operation
Group (III)								
7	48	male	Calcific A.S	A.V.R	55	39	Left sided hemiparesis & seizures	Calcific aortic valve
8	63	male	3 vessel disease	C.A.B.G	58	40	Fluctuating conscious level & irritability	Perioperative hypotension
9	47	female	Non calcific M.S & A.S	D.V.R	68	58	Left hemiparesis	A.F., left atrial thrombus
10	68	male	3 vessel disease	C.A.B.G	56	39	Irritability & confusion	Carotid artery disease
11	56	male	3 vessel disease	C.A.B.G	61	43	Right hemiparesis	Perioperative hypotension
12	46	female	Left atrial myxoma	Excision	43	26	Irritability & confusion	Myxoma
13	51	female	Prosthetic valve malformation	M.V.R.R	64	46	Left hemiparesis & confusion	Reoperation
14	67	male	3 vessel disease	C.A.B.G	65	48	Left hemiparesis & confusion	Atheromatus aorta
15	58	female	3 vessel disease	C.A.B.G	61	42	Irritability & confusion	A.F.
16	48	male	3 vessel disease	C.A.B.G	62	38	Irritability & confusion	-ve
17	44	female	Calcific M.S.	M.V.R	50	37	Right hemiparesis	Calcific mitral valve, A.F., Previous neurological event
18	58	male	3 vessel disease	C.A.B.G	61	40	Irritability & confusion	Perioperative hypotension

Table (2): Profiles of patients who developed neurological complications

Type of surgery	Total	Neurological complication	Percentage (%)
Coronary artery bypass grafting	315	11	3.5
Mitral valve replacement	64	4	6.3
Aortic valve replacement	28	1	3.6
Double valve replacemrnt	14	1	7.1
Left atrial myxoma excision	10	1	10.0

Table (3): Types of open heart operation and prevalence of neurological complication .

Group (I)

2 patients did not awaken after the operation. One of them had preoperative cerebrovascular disease and subjected to hypotension postoperatively and cardiopulmonary resuscitation and vasopressor support were required. The patient was subsequently comatosed with recurrent attacks of convulsions and died on the 10th postoperative day. The second patient, in whom atheromatus emboli were suspected, had an asymptomatic left carotid artery bruit with 60% internal carotid artery stenosis. Since this patient had unstable angina and no neurological symptoms, it was elected to proceed with coronary revascularization alone. The patient had a severely diseased ascending aorta, necessitating the use of sequential grafts and fewer proximal anastomoses. Postoperatively, he was comatosed and had flaccid quadriplegia.

A computed tomographic scan showed multiple scattered cerebral infracts. The patient suffered cardiac arrest on the 15th postoperative day and died.

Group (II)

Focal neurological deficits were noted on recovery from anesthesia in 4 patients. Two patients had left sided hemiplegia with convulsions in one of them. They were subjected to mitral valve replacement because of calcific mitral stenosis in one and prosthetic mitral valve thrombosis in the other. They improved by the time and discharged with left sided hemiparesis in the first one and left arm paresis in the second. The two other patients of this group were subjected to coronary bypass grafting. They developed unilateral deficits attributable to inadequate cerebral perfusion in the form of left sided hemiplegia and confusion in the first one who had preoperative cerebral stroke. However, he improved moderately and discharged with left sided hemiparesis. The second patient developed right sided hemiplegia with aphasia which improved markedly and he was discharged with paresis of the right upper limb. In this patient there was no evident problem intra or post operatively, till the development of the neurological event, therefore inadequate cerebral perfusion was suspected.

Group III

This group included 12 patients, 4 patients had left sided hemiparesis, two of them had variable degrees of confusion and one patient had generalized convulsions. 2 patients had right sided hemiparesis. The last 6 patient had irritability, disorientation and psychological abnormalities.

Embolization was blamed in 8 patients from atheromatus aorta in 1 patient, from calcific aortic valve in 1 patient, from calcific mitral valve in 1 patient, from the left atrium in 2 patients, from left atrial myxoma in 1 patient, from carotid artery atheroma in 1 patient and in the form of air from cardiac chambers in a reoperation case. Perioperative hypotension was blamed in 3 patients while in only one patient there were no evident risk factors. All patients of this group showed marked improvement after the administration of dehydrating and neurotropic drugs. However, the outcome of the different patients with neurological complications has been summarized in Table (4).

Table (4): Outcome of neurological deficits.

Study group	No. showing marked improvement	No. discharged with residual deficit	No. of deaths
(I (2 patients	0	0	2
(II(4 patients	0	4	0
(III (12 patients	12	0	0
(Total (18 patients	(66.6%) 12	(22.2%) 4	(11.2%) 2

Group (I): Patients unresponsive after operation.
Group (II): Patients with early focal neurological deficits.
Group (III): Patients with minor neurological deficits.
Table (4): Outcome of neurological deficits.

Discussion:

Neurologic complications after open heart surgery substantially increase mortality, put a strain on health–care resources and reduce the clinical effectiveness of the procedure. (5-7)

Such complications present as either neuropsycho-

logical dysfunction or stroke, defined as overt focal central nervous system deficit of acute onset and lasting more than 24 hours.The etiologies of these two distinct types of cerebral dysfunction are probably not identical. (8)

Macroembolization from the surgical field is thought to be the most common cause of stroke associated with cardiopulmonary bypass. (9, 10)

Other etiologies are gaseous or air emboli, severe hypotension and underperfusion, intrinsic cerebrovascular disease and thromboemboli from the left ventricle. (11)

The reported incidence of neurologic complications after open heart surgery varies from 0.8 to 3.2% in retrospective studies. (12, 13). And from 1.5 to 5.2% in prospective studies (14, 15). The frequency of severe postoperative neurologic disorders in the present study (4.1%) is in line with these previous findings.

Severe atheromatous involvement of the ascending aorta often accompanies coronary artery occlusive disease. This can present problems with cannulation, at times necessitating use of femoral artery for bypass and also with cross-clamping, often requiring repeated application of a partial-occlusion clamp. However, in most instances the operation can be done without the occurrence of cerebral dysfunction. (16)

In the present series, 1 patient who was unresponsive after the operation and another one with left sided hemiparesis and confusion had severe aortic disease with suspected atheromatus emboli. The first patient died while the second one demonstrated marked improvement in neurological function. Careful aortic clamping against low pressures, use of cross-clamps with soft Jaws (17), or use of a single cross-clamp period for construction of both proximal and distal anastomoses might be considered.

Alternatively, it may be necessary to use an internal mammary artery or gastroepiploic artery graft, to use the brachiocephalic vessels for the site of the proximal anastomosis (18), or to perform y-grafts with fewer proximal anastomoses.

One may occasionally have to resect a portion of the aorta and provide continuity from the graft to the aorta with an aortic patch of Dacron or Gore-Tex material. (19)

Neurological deficits after open heart surgery may be ascribed to inadequate cerebral perfusion. (16)

In this series, perioperative hypotension associated with low cardiac output state resulted in hypoxic cerebral damage with minor neurological deficit occurred in 3 patients which had cleared up by discharge.

Reoperation is associated with increased severity of the disease, increased impairment of myocardial function and sub-optimal general condition. The distorted anatomy and extensive adhesions increase the risk of improper deairing and re-exploration as a result of post-operative hemorrhage. These factors increase the risk of mortality and morbidity including neurological complications. (20)

In this series, 2 patients who subjected to mitral valve re-replacement developed neurological complications in the form of left sided hemiplegia with seizures in the first one and left sided hemiparesis with confusion in the second. The first one discharged with residual neurological deficit while the second one discharged neurologically free.

No consistent view exists regarding the relationship between neurological complications and cerebrovascular disease. Berner et al, showed that the rate of perioperative neurological complications increased with the severity of carotid artery stenoses and occlusions. (21)

Whereas, Schultz et al, showed no significant increase in perioperative stroke in symptom-free patients with carotid artery stenosis. (22)

In our study, carotid duplex was not done routinely preoperatively in coronary artery disease patients and done only in patients above 60 years and those with preoperative neurological symptoms. Only one patient from those who developed postoperative neurological complications had preoperative carotid disease but because he was in unstable angina and the patients had no neurological symptoms, so the decision was to proceed with coronary artery bypass graft. Because of the reported 1.5 to 6% incidence of concomitant coronary artery and carotid artery occlusive disease, it is advisable that patients with carotid artery bruits or neurological symptoms should be evaluated with carotid duplex or carotid angiography prior to coronary operations. (23)

Although atrial fibrillation is thought to be a benign arrhythmia, 4 of 18 patients who suffered from postoperative neurological complications had atrial fibrillation. All of them were anticoagulated preoperatively. One patient had in addition left atrial thrombus, one had prosthetic valve thrombosis and one had calcific mitral valve. So it is not clear whether atrial fibrillation alone is a risk factor for development of neurological complications or not.

Embolization is thought to be the most common cause of postoperative neurological complications. There are several potential sources of emboli during cardiac surgery. These include intra-cardiac thrombus, atherosclerotic plaques from ascending aorta, large and micro-particulate matter, microaggregate matter, air and or gaseous emboli. Intra cardiac thrombus may be atrial or ventricular in origin. Large particulate matters are

released during the excision of calcified aortic or mitral valve. Micro-particulates are formed from the plastic and other material from the disposable components of the pump oxygenator. Microaggregate matter formation develops from the residue of destroyed red and white blood cells, platelets, serum lipids fibrin, fibrinogen degradation products and denatured proteins. (24-26)

Air and gaseous microemboli occur in every operation which involves the use of the bypass machine and usually originate from the oxygenator, reservoir, pumps and/or cardiac chambers. (20)

In our study, embolization was incriminated to be the cause of postoperative neurological complications. The source of emboli was atheromatus aorta in 2 patients, calcific mitral and aortic valve in 3 patients, and left atrial thrombus in 1 patient, left atrial myxoma in 1 patient and prosthetic valve thrombosis in 1 patient.

Some studies (27, 28) have demonstrated that previous cerebrovascular disease is powerful predictor of postoperative stroke, whereas others (20, 30) have not found such an association.

In this series, 3 of 18 patients who developed postoperative neurologic complications had preoperative neurological event.

In our study, 2 of the patients who developed neurological complications had no evident risk factor to explain such complications. This may be attributed to microembolization from the cardiopulmonary bypass or to inadequate cerebral perfusion during bypass. So, one might infer that higher flow rates and pressures would be advisable in hypertensive patients and in those with uncorrectable minor carotid artery disease.

Conclusion

Such severe neurological complications after an otherwise successful cardiac surgery represent a devastating outcome for patients and their families and the social and economic impacts are enormous.

Several risk factors were identified, the main ones being calcification of the replaced mitral or aortic valves, left atrial thrombus, atrial fibrillation, carotid artery disease, atheromatus aorta, inadequate cerebral perfusion during cardiopulmonary bypass and perioperative hypotension associated with severe low cardiac output, tamponad or cardiac arrest. A detailed, structured neurological and neuropsychiatric assessment, both pre and post-operatively should be conducted on all patients who undergo open heart surgery. This will ensure that an accurate incidence of all types of neurological complications can be ascertained. A large scale prospective study is also needed to elucidate all risk factors for neurological complication

References

(1) Youri.M.Ganushchak, Erik J.Fransen, Cees Viser, Dick de Jong and Jos G.Massen: Neurological complications after coronary artery bypass grafting related to the performance of cardiopulmonary bypass. Chest, 125, 6:2196-2205, June, 2004.

(2) Gilman S: Cerebral disorders after open-heart operations. N Engl J Med 272:489, 1965.

(3) Javid H, Tufo HM, and Najafi: Neurological abnormalities following open-heart surgery. J Thorac Cardiovasc Surg 58:502, 1969.

(4) Robert M Bojar, Hassan Najafi, Giacomo A Delaria, Cyrus serry and Marshall Goldin: Neurological complications of coronary revascularization. Ann Thorac Surgery Vol.36 No.4 October 1983.

(5) Murkin JM: Etiology and incidence of brain dysfunction after cardiac surgery. J Cardiothorac Vasc Anesth 1999, 13: 12-17.

(6) Taylor KM: Central nervous system effects of cardiopulmonary bypass. Ann Thorac surg 1998, 66:520 – 524.

(7) Utley JR: Techniques for avoiding neurologic injury during adult cardiac surgery. J Cardiothorac Vasc Anesth 1996, 10:38-43.

(8) Nussmeier NA and Fish KJ: Neuropsychological dysfunction after cardiopulmonary bypass: a comparison of two institutions. J Cardiothorac Vasc Anesth 1991, 5:584-588.

(9) Mills NL and Everson CT: Atherosclerosis of the ascending aorta and coronary artery bypass: pathology, clinical correlates and operative management. J Thorac Cardiovasc Surg 1991, 102:546-53.

(10) Wareing TH, Davila VG, Daily BB, Murphy SF, Schechtman KB, Barzilai B, and Kouchoukos NT: Strategy for the reduction of stroke incidence in cardiac surgical patients. Ann Thorac Surg 1993, 55:1400-1408.

(11)Utley JR and Stephens DB: Prevention of major perioperative neurological dysfunction – a personal perspective. Perfusion 1986, 1:135-142.

(1) Kolh PH, Torchiana DF and Buchely MJ: Atheroembolization in cardiac surgery, the need for preoperative diagnosis. J Cardiovasc Surg (Torino) 1999, 40:77-81.

(13)Ahlgren E and Aren C: Cerebral complications after coronary artery bypass and heart valve surgery, risk factors and onset of symptoms. J Cardiothorac Vasc Anesth 1998, 12: 270-73.

(14)Mckhann GM, Goldsborough MA and Borowiczl M: Predictors of stroke risk in coronary artery bypass patients. Ann Thorac Surg 1997, 63:516-21.

(15)Newman MF, wolman R and Kanchuger: Multicenter preoperative stroke risk index for patients undergoing coronary artery bypass graft surgery. Multicenter study of perioperative ischemia. Circulation 1996, 94: II 74-II 80.

(16)Robert M, Hassan N, Giacomo A, Cyrus S and Marshall G: Neurological complications of coronary revascularization. Ann Thorac Surg 1983, 36:426-32.

(17)Rousou JH and Engelman RM: Modified Fogarty clamp for the fragile aorta. Ann Thorac Surg 1981, 32: 515-22.

(18)Weinstein G and Killen DA: Innominate artery-coronary

bypass graft bypass graft in a patient with calcific aortitis. J Thorac Cardiovasc Surg 1980, 79:312-20.
(19)Robicsek F and Rubenstein RB: Calcification and thickening of the aortic wall complicating aortocoronary grafting: a technical modification. Ann Thorac Surg 1980, 29:84-90.
(20)Singh A, Bert A and Feng W: Neurological complications during myocardial revascularization using warm- body, cold-heart surgery. Eur J Cardio-thorac Surg 1994, 8: 259-64.
(21)Brener BJ, Brief DK, Alpert J, Goldenkranz RJ and parsonnet V: The risk of stroke in patients with asymptomatic carotid stenosis undergoing cardiac surgery: a follow-up study. J Vasc Surg 1987, 5:269-79.
(22)Schultz RD, Sterpetti AV and Feldhaus RJ: Early and late results in patients with carotid disease undergoing myocardial revascularization. Ann Thorac Surg 1988, 45: 603-609.
(23)Yoshihiro S, Kiyoharu, N, Yoshikado,S, Junjirou K, and Shinichi T: Strategies for CABG patients with carotid artery disease and perioperative neurological complications. J Heart Vessels, 2000, 15:129-34.
(24)Stump DA, Rogers AT, Hammon JW and Newman SP: Cerebral emboli and cognitive outcome after cardiac surgery .J Cardiothorac Vasc Anesth 1996, 10:113-9.
(25)Nussmeier NA: Adverse neurologic events: risks of intracardiac versus extracardiac surgery .J Cardiothorac Vasc Anesth 1996, 10:113-9.
(26)Scarlett M and Spencer H: Severe neurological complications post-open heart surgery. The Jamaican Experience. West indian Med J 2001, 50:297-303.
(27)Murkin JM: Etiology and incidence of brain dysfunction after cardiac surgery. J Cardiothorac Vasc Anesth 1999, 13:12-17.
(28)Redmond JM, Greene PS and Goldsborough MA: Neurologic injury in cardiac surgical patients with a history of stroke. Ann Thorac Surg 1996, 61:42-47.
(29)Craver JM, puskas JD and weintraub: Octogenarians undergoing cardiac surgery: outcome and comparison with younger age groups. Ann Thorac Surg 1999, 67: 1104-1110.
(30)Beall AC, Jones JW and Guinn: Cardiopulmonary bypass in patients with previously completed stroke. Ann Thorac Surg 1993, 55: 1383-1384.

Off-pump versus on-pump CABG: Short term results of composite arterial grafts

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Background: **Composite arterial grafting is by itself a complex technique as much as the off-pump technique. Combining two complex procedures is a questionable issue. We investigated the safety of the off-pump technique in total arterial coronary artery bypass grafting (CABG) using composite grafts based on our experience with this procedure over the last year.**
Methods: **In the period from October 2003 to October 2004, 50 consecutive patients were submitted to CABG using composite arterial grafts. Patients who had diffuse coronary artery disease and patients who needed emergency operations were excluded from this study. Patients were randomly assigned to one of two groups: Group I (on-pump CABG) and group II was (off-pump CABG).**
Results: **We operated on 29 patients in group I and 21 patients in group II. There were no significant differences between the two groups in terms of preoperative characteristics apart from significantly lower ejection fraction in group II. Operative time was significantly shorter in group II (p=0.005), although the number of distal anastomoses was comparable in the two groups group I (2.7 ± 0.7) and group II (2.86 ± 0.65) There was no mortality in both groups. There was no statistical significance between the two groups regarding the incidence of post-operative complications apart from bleeding which was significantly lesser in group II.(p=0.003)**
Conclusion: **Off-pump CABG, combined with composite arterial grafts is a safe procedure on the short-term and had only minor advantages over the On-pump technique.**

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Neither arterial grafts nor off-pump technique were popular with the begging of the 1970s when Favalaro1 popularized coronary artery bypass grafting(CABG) using saphenous vein grafts (SVGs) and cardiopulmonary bypass(CPB). However, performing CABG in a motionless field without the complications of CPB derived the pioneering efforts of Benetti2 and Buffalo3 in the 1980s to adopt and improve the off-pump technique.

However, due to the trust of most surgical teams in conventional CABG using CPB, the natural resistance to change routine procedures and the doubts about the quality of anastomoses performed during off-pump operation kept this technique isolated for many years. By time, with the development of technical variations- such as the interruption of coronary flow with soft silicone snares, use of drugs to reduce heart rate and oxygen demand, and mechanical stabilizers-the off-pump procedure became safe, effective, reproducible and popular as reported by Shennib4, Gründeman5 and Calafiore6 in the 1990s.

The expanded use of arterial grafts was developing parallel to this achievement in the off-pump CABG. The superiority of the internal mammary artery grafts in terms of patency rates and long-term survival was confirmed by the

work of Loop7 and Fiore8. However,

The increased need for more arterial conduits raised the idea of using the radial artery by Acar9.Moreover, in order to avoid the anatomical limitations of in situ internal mammary arteries, and to reproduce the physiology of the arterial conduits as a third order branch- composite arterial conduits have been proposed and extensively studied by Tector10, Calafiore11and Tatoulis12.

It would seem logical to combine the advantages offered by the off-pump technique with those of total arterial myocardial revascularization; however up to date clinical data are still lacking, mainly owing to the belief that composite arterial grafting may be too technically demanding to be performed using the off-pump technique.

Patients and Methods

Patient's selection criteria

From October 2003 to October 2004, 50 consecutive patients underwent coronary surgery by our team using composite arterial grafts in new Kasr El-Aini teaching hospital, Faculty of Medicine, Cairo University. Patients who needed an emergency CABG and patients who had diffusely diseased coronary arteries with poor distal runoff were excluded from this prospective study. Patients were randomly assigned to group I (on-pump CABG) or to group II (off-pump CABG). The type of surgery was discussed with all patients included in this study. However, the surgeons were allowed to change the operative technique at any time after randomization.

Surgical technique

All patients underwent total arterial CABG with composite grafts. After midline sternotomy the left internal mammary (LIMA) was harvested as pedicled conduits. Skeletonization was applied whenever BIMA were harvested. BIMA harvesting was avoided in patients with insulin dependent diabetes and/or morbid obesity defined as body mass index (BMI)>30.

A preoperative assessment of the radial artery (Allen test) in the non dominant arm was carried out for all patients scheduled for radial artery harvesting. The radial artery was harvested with its satellite veins and surrounded connective tissue to avoid arterial wall damage. In order to avoid spasm, systemic verapamil infusion 5mg/hour and topical application of a warm cocktail composed of: 300ml ringer solution, 5 mg verapamil 2.5 mg nitroglycerine, 1000 unit of heparin and 0.02 mg of 8.4% sodium bicarbonate.

We routinely perform composite arterial grafts in a Y configuration with an 8-0 polypropylene running suture before institution of CPB. For both groups heparinization was employed as 4 mg/kg/weight. It was controlled by the activated coagulation time (ACT) with 400 seconds being accepted as the minimum value. In group I standard CPB was instituted and warm cardioplegia was used for myocardial protection. In group II target vessel stabilization was achieved with the Octopus® IV vacuum stabilizer system (Medtronic, Minneapolis. USA).

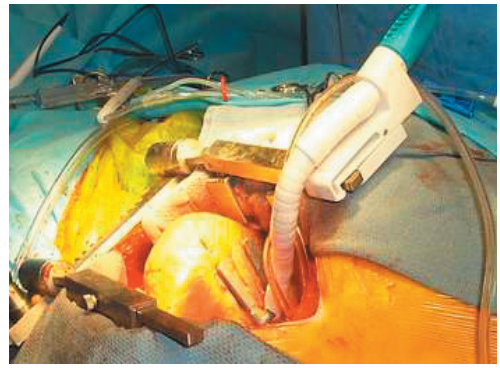

Fig. 1: Octopus stabilizer mounted on a sternal retractor to expose the posterolateral surface of the heart.

Exposure of the lateral and inferior vessels was obtained by means of a pericardial stitch positioned between the inferior pulmonary veins (Fig.2) and by rotation of the operating table. It was kept in the trendelenburg position and rotated to the left or right side according to the different coronary vessels. Target vessels were occluded proximally by a silicone loop (Surg-I loop®, Scanalan international, Saint Paul. USA).

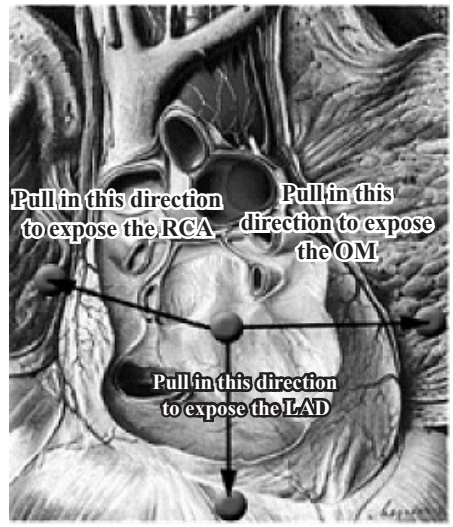

Fig.2: Illustrative diagram showing the relative position of the suture on the posterior pericardium in relation to the heart and the different directions of pulling on it.

We used two different configurations to perform the composite grafts. In the type I configuration the free right internal mammary artery is anastomosed to the LIMA as a Y-graft. In type II configuration the radial artery is anastomosed to the LIMA as a Y-graft. Either RA or right internal mammary artery (RIMA) was used to revascularize the left system as separate or sequential grafts. In both groups RA or SVG are used as free grafts to revascularize the right coronary system.

Distal anastomoses were performed In group I according to the following order: right coronary, marginal branches of the circumflex artery, diagonal, and finally the left anterior descending coronary, while in group II distal anastomoses were performed according to the following order: anterior descending coronary, diagonal, right coronary and finally the marginal branches of the circumflex artery.

In both groups, polypropylene 7/0 sutures with 8mm needles were used for distal anastomoses, while polypropylene 6/0 sutures with 13mm needles were used for proximal anastomoses of SVGs to the aorta while polypropylene 7/0 with 11mm needles were used for the proximal anastomoses of the free RA grafts.

In both groups, all distal anastomoses were performed prior to proximal anastomoses. Heparin was neutralized at the end of the procedure using a 1:1 proportion of protamine sulphate.

Follow-up and statistical analysis

Patients were evaluated at a follow-up of 1, 6, and 12 months by a personal interview. We arranged for a stress isotope scintigraphy at 6 months for all patients and angiography at 12 months for patients who had recurrence of angina or those having residual ischemia on scintigraphy.

Statistical analysis was done using SPSS version 7.0 for Windows© and Microsoft® Excel© 2000.Preoperative and postoperative data were analyzed using the X^2 test or Fisher's exact test for discrete variables and the unpaired *t* test or Mann-Whitney U test for continuous variables (expressed as mean ± standard deviation / median). A *p* value less than 0.05 was considered to be significant.

Results

Preoperative Data

Univariate analysis of preoperative patient characteristics and risk factors showed a homogenous distribution between the two groups apart from ejection fraction which was significantly lower in the off-pump group(p=0.001). Preoperative data are shown in Table 1. Renal impairment was defined as creatinine>1.4 mg/dl and obesity defined as body mass index>30.

Table1: Distribution of preoperative data

	Group I	Group II	p value
Age(years)	53±6*	50.5±6*	NS
Sex(M/F)	27/2	19/2	NS
Hyper-tension	24%(7/29)	24%(5/21)	NS
Diabetes	45%(13/29)	48%(10/21)	NS
COPD	34%(10/29)	38%(8/21)	NS
Renal mpairment	3%(1/29)	9.5%(2/21)	NS
Obesity	14%(4/29)	14%(3/21)	NS
Unstable angina	14%(4/29)	14%(3/21)	NS
EF (%)	58±10*	47±7*	0.001
AMI	24%(7/29)	24%(5/21)	NS
IMI	17%(5/29)	19%(4/21)	NS

M=male; F=female; COPD=chronic obstructive pulmonary disease; EF=ejection fraction; AMI=anterior myocardial infarction; IMI= inferior myocardial infarction. *= data expressed as mean± standard deviation

Operative data

We operated on 29 patients with the on-pump technique(group I) versus 21 patients with the off-pump technique (group II).Type 1 configuration of composite arterial grafts was used in 10.3 %(3/29) of patients in group I while it was used in 9.5% of patients (2/21) in group II. Type II configuration was used in 93.1% of patients in group I and 90.5% of patients in group II with no statistical significance.

In both groups, All RIMAs were anastomosed proximally to the LIMAs. All RIMAs were not used to perform sequential distal anastomoses. RA grafts were used to perform sequential distal anastomoses more frequent in group I than in group II (Table 2).

Table2: Conduits used in the study

	Group I	Group II	p value
BIMA	3/29(10.3%)	2/21(9.5%)	NS
RA	28/29(96.5%)	20/21 (95%)	NS
Seq RA	13/29(44.8%)	8/21(38%)	NS
SVG	9/29(31%)	8/21(38%)	NS

BIMA=bilateral internal mammary artery; RA= radial artery (used either in a separate or sequential manner), Seq=sequential radial artery grafts to obtuse marginal and diagonal, two obtuse marginals, or obtuse marginal and ramus; SVG=saphenous vein graft.

Only one radial artery in each group was used to revascularize the right coronary artery system with the proximal end anastomosed to the aorta. All other radial artery grafts were anastomosed proximally to the LIMA to form the composite grafts.

There was no statistically significant difference between the two groups as regards the number of distal anastomoses. (2.7±0.7 in group I versus 2.86±0.7 in group II, p=0.4). The distribution of grafts was shown in figure 3.

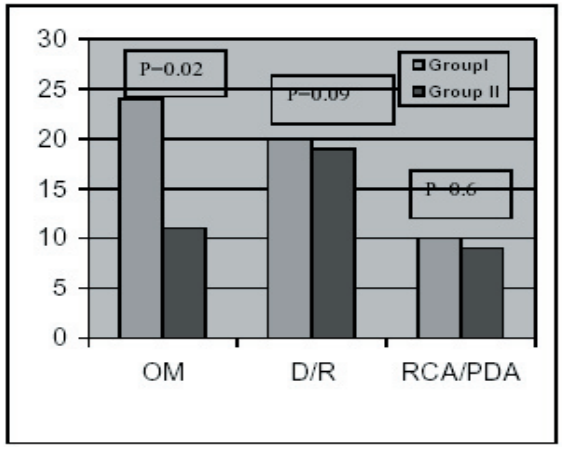

Fig.3: Distribution of grafts: OM=obtuse marginal; D=diagonal; R=ramus; RCA right coronary artery; PDA=posterior descending artery

The goal of performing the off-pump technique was achieved in 42 % of patients. There was no mortality in both groups. Operative time was significantly shorter in group II (3h22 min.±29 min.) than group I (3h42 min.±18 min.) with p=0.005. Conversion to the CPB was required in 2 patients of the off-pump group (9.5%) due to unfavorable anatomy of the native coronary vessels (extensive calcification and thrombosis that necessitated end arterctomy procedure). No conversion to CPB was required due to haemodynamic instability.

ICU and hospital Data

There was no statistical significance between the two groups regarding the incidence of post-operative complications apart from bleeding which was significantly lesser in group II as shown in table 3. There was no mortality, perioperative infarction, cerebrovascular accidents, or acute renal failure in both groups. The length of postoperative hospital stay was significantly higher in group I (8±1.3 days) than group II (7±1 days); p=0.01.

Table3: Immediate postoperative data

	Group I	Group II	*p* value
Mechanical Ventilation	6.5±5.5 hours* Median=4 hours	4.5±1.8 hours* Median=4 hours	NS
ICU stay	50±16 hours*	43±13 hours*	NS
Atrial fibrillation	2/29(6.7%)	3/21 (14.3%)	NS
Arterial graft spasm	1/29(3.4%)	1/21(4.8%)	NS
Bleeding	423±194 ml*	296±232 ml*	0.003
Blood transfusion	8/29(27.5%)	5/21(23.8%)	NS
Reopening for bleeding	1/29(3.4%)	0/21	NS
Inotropic support	11/29(37.9%)	3/21(14.8%)	NS

****Data expressed as mean± standard deviation***

Follow up data

Patients of group I were followed for 8.9±2.3 months, while patients of group II were followed for 9.6±2.9 months. There were no late deaths. Recurrence of angina was higher in the off-pump group (4.8%) than the on-pump group (3.4%), although statistically insignificant. Group I patient had a basal anerolateral ischemia as shown by Stress myocardial scintigraphy while angiography revealed a new 50% lesion in the first diagonal. Group II patient had an anerolateral ischemia and mild anastomotic stenoses in the LAD and the OM. 4 month's postoperatively, one patient of group II had an inferior myocardial infarction. Stress myocardial scintigraphy revealed inferior scarring and angiography revealed a SVG occlusion.

Discussion

Although there is enough data supporting the superiority of off-pump technique over the conventional CABG using the cardiopulmonary bypass in some high risk patients13, still there is no enough evidence to support the superiority of this technique in low-risk patients.

The use of arterial grafts gained an incremental popularity over the last decade Because of their long term benefits as regards the patency rates, freedom from angina/myocardial infarction, and patient survival14. This creates the need for more arterial grafts, in order to achieve the goal of total arterial revascularization. The radial artery (being the most popular alternative) arranged as composite grafts proved to overcome the anatomical limitations of in situ grafts10, 12.

In our study, the preoperative characteristics of the patients who belong to both groups were comparable

apart from ejection fraction which was significantly lower in the off-pump group. Despite that, patients in both groups could be classified as low-risk population**.** The adoption of off-pump technique for patients with poorer left ventricular function matched the findings of Bouchard and Cartier15 that despite cardiac elevation and transient hypotensive episodes, a beating-heart operation can provide adequate myocardial protection compared with cardioplegic arrest.

The off-pump technique was feasible in all patients with no emergency conversion to cardio-pulmonary bypass due to haemodynamic instability or major ventricular arrhythmias.

As regards the major concern of many surgeons about the completeness of myocardial revascularization, there was no statistically significant difference between the two groups as regards the number of distal anastomoses. (2.7±0.7 in group I versus 2.86±0.65 in group II).

Despite the completeness of revascularization in group II, There was a statistically significance difference between the two groups as regards the number of distal anastomoses to obtuse marginal vessels (23 for group I versus 9 for group II, p=0.02). In a similar study, Muneretto and associates found that there were no differences in terms of location of target coronary vessels, despite that they adopt the sequential technique. They attributed their success to the use of Guidant axius vacuum stabilizer system and the *Xpose* device for posterolateral vessels (Guidant corporation-cardiac surgery) 16.

Arterial graft spasm was higher in the off-pump group, although statistically insignificant. This was attributed to hypothermia as patients' temperature usually drifts to 34°c by the end of the operation. Adjusting the room temperature and topical rewarming with warm saline solved this issue.

There was a significant reduction in overall blood loss (p=0.003), and operative time (p=0.005), in the off-pump group. Moreover, there was an insignificant reduction in mechanical ventilation, inotropic support, blood transfusion, and reopening for bleeding. Those advantages of the off-pump technique were considered conservative compared to other similar study done by Pandey and associates17 who found that off-pump technique significantly reduces blood loss, inotropic support, and ventilation time (p<0.001).

In the off-pump group, ICU stay was insignificantly shorter while there was a marginal difference in hospital stay. So the reduction in total operative costs was only marginal if ever present. Fouda18 stated in a similar study that his results failed to reach significant statistical difference between the two groups of patients, nevertheless, like others, he have seen over the last few years that off-pump patients do really recover somewhat faster than on pump patients. This will only remain as an observation among surgeons doing off-pump surgery unless it can be supported with strong statistical evidence.

Recurrence of angina was similar in the two groups; however the anastomotic stenoses in the second group patient raised the traditional question about the quality of anastomoses in the off-pump technique. In our work, this observation remains marginal as there is no statistical significance to make it an accountable issue. Moreover, Graft patency is difficult to interpret because many factors (severity of coronary artery disease, quality of conduit, and so on), as well as the technical quality of the anastomosis, affect graft patency. Large prospective, randomized trials with a high percentage of angiographic follow-up need to be performed to account for all these variables. 19

Their was no arterial graft occlusion and the only graft that was found to be occluded is a saphenous vein graft anastomosed to the right coronary artery. These results coincides with the work of Widimsky 20, Kim 21and their colleagues who found that the patency of arterial coronary bypass grafts done on the beating heart is excellent and equal to grafts done on pump while saphenous graft patency per patient was lower in the off-pump group.

Conclusion

Off-pump composite arterial grafting is a safe procedure in the short term as regards mortality and postoperative morbidity. It offers only minor advantages over the on-pump technique as significant reduction in operative time, postoperative bleeding and hospital stay.

References

1- Favalaro RG. Saphenous vein graft replacement of severe segmental coronary artery occlusion. Ann Thorac Surg 1968; 5:334-9

2- Benetti FJ. Direct coronary surgery with saphenous vein bypass without CPB. J Thorac Cardiovasc Surg 1985; 26: 217-222

3- Buffalo E, Andrade JCS, Succi JE. Direct myocardial revascularization without CPB. J Thorac Cardiovasc Surg 1985; 33:26-29.

4- Shennib H, Lee AGL, Akin J. Safe and effective method of stabilization for coronary artery bypass grafting on the beating heart. Ann Thorac Surg 1997; 63:998-992

5- Gründeman PF, Borst C, Van Herwaarden JA, et al. Haemodynamic changes during displacement of the beating heart by the Utrecht octopus method. Ann Thorac Surg 1997; 63: 588-592.

6- Calafiore AM, Vitolla G, Mazzei V, et al. The Last operation: technique and results before and after stabilization era. Ann Thorac Surg 1998; 66:998-1001.
7- Loop FD, Lytle BW, Cosgrove DM, et al. Influence of the internal mammary artery on 10-years survival and other cardiac events. New Eng J Med 1986; 314:1-6
8- Fiore AC, Naunhiem KS, Dean P, et al. Results of internal thoracic artery grafting over 15 years: single versus double grafts. Ann Thorac Surg 1990; 49:202-208.
9- Acar C, Jebara VA, Portoghese M, et al. Revival of the radial artery for coronary artery bypass grafting. Ann Thorac Surg 1992; 54:652-660.
10- Tector AJ, Amundsen S, Schmahl TM, et al. Total revascularization with T grafts. Ann Thorac Surg 1994; 57:33-39.
11- Calafiore AM, Giammarco G, Luciani N. Composite arterial conduits for a wider arterial myocardial revascularization. Ann Thorac Surg 1994; 58:185-190.
12- Tatoulis J, Buxton BF, Fuller JA, et al. Total arterial coronary revascularization: technique and results in 3220 patients. Ann Thorac Surg 1999; 68:2093-2099.
13-Belleghem Y.V., Case F., Maene L., et al. Off-pump coronary surgery: surgical strategy for the high-risk patient. Cardiovascular Surgery 2003;11: 75–79.
14- Lytle BW, Blackstone EH, Loop FD, et al. Two internal thoracic artery grafts are better than one. J Thorac Cardiovasc Surg 1999; 117:855-872.
15-Bouchard D, Cartier R. Off-pump revascularization of multivessel coronary artery disease has a decreased myocardial infarction rate. Eur J Cardiothorac Surg 1998;14(Suppl 1):20 4.
16-Muneretto C, Bisleri G, Negri A, et al. Off-pump coronary artery bypass surgery: Technique for total arterial myocardial revascularization: A prospective randomized study. Ann Thorac Surg 2003; 76:778-783.
17-Pandey R, Grayson A, Pullan DM, et al. Total arterial revascularisation: effect of avoiding cardiopulmonary bypass on in-hospital mortality and morbidity in a propensity-matched cohort . Eur J Cardiothorac Surg 2005; 27:94-98.
18-Fouda M. Off-pump beating heart coronary artery bypass surgery in low-risk patients: does it really enhance early recovery? Annals of Saudi Medicine 2001;21: 5-6.
19- Mariani M.A., D'Alfonso A., Grandjean GJ. Total Arterial Off-Pump Coronary Surgery: Time to Change Our Habits? Ann Thorac Surg 2004;78:1591–7
20- Widimsky P., Straka Z., Stros P., et al. One-Year Coronary Bypass Graft Patency : A Randomized Comparison Between Off-Pump and On-Pump Surgery Angiographic Results of the PRAGUE-4 Trial . Circulation. 2004;110: 3418-3423
21-kim KB. , Lim C., Lee C. Off-pump coronary artery bypass may decrease the patency of saphenous vein grafts. Ann Thorac Surg 2001;72:S1033-S1037

Can Lidocaine Protect Against Cerebral Dysfunction Of Cpb In Hypertensive Patients ?

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Objective: **The objective of this study is to investigate whether intraoperative administration of lidocaine can reduce the incidence of cerebral dysfunction in hypertensive patients undergoing cardiac surgery with CPB .**
Methods: **Fifty Hypertensive patients scheduled for cardiac surgery with CPB were enrolled randomly into 2 groups: lidocaine group and control group. They were subjected to the same method of anaesthesia, same monitoring process and same CPB and myocardial preservation technique. Lidocaine group received 2 mg.kg-1 lidocaine bolaus dose over 5 min. and then infusion of 4 mg.min–1 starting at skin incision till the end of surgery. The control group received normal saline at the same volume, rate and time. A battery of neurocognitive tests were performed at the preoperative and predischarge days.Jugular bulb oxygen saturation (Sjvo2) and S-100 b protein were determined at different measuring points.**
Results: **The results of this study revealed that the incidence of postoperative cognitive dysfunction was significantly less in lidocaine group. Sjo2 was significantly reduced during rewarming in control group and not in lidocaine group. S-100 b protein was elevated significantly after one hour of CPB in both groups, but the elevation was more significant in control group.**
Conclusion: **We can conclude that lidocaine has a protective effect against cerebral insult of CPB in hypertensive patients. it prevents jugular bulb desaturation during rewarming and reduce the release of S-100-b protein.**

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Despite the technological advances in cardiac-surgery, anaesthesia, monitoring devices and CPB, the period of bypass still contributes to significant morbidity in many patients. In particular cerebral injury is a significant problem for patients and their care givers. Postoperative stroke and cognitive dysfunction are still seen in up to 4.9% and 59% respectively(1,2). It is proved that cardiac surgical patients exhibit more neurocognitive problems than non cardiac surgical control(3,4).

Hyperensive patients are more vulnerable to cerebral insult due to impairment of cerebral autoregulation mechanisms. Two major mechanisms have been proposed to explain the occurrance of cerebral dysfunction after cardiac surgery: intraoperative cerebral embolism and hypoper-fusion(5). Considerable evidence suggests a correlation between the intraoperative embolic load and postoperative neuropsychological dysfunction(6,7). Moreover, low perfusion pressure and rewarming during CPB cause an imbalance between oxygen supply and demand of the brain manifested by Jugular venous desaturation(8). In both mechanisms ischemic injury is the common pathway causing cerebral dysfunction. S-100 protein “an ischemic marker” has been

reported to be increased significantly during CPB and it has a high predictive value with respect to early postoperative neuropsychological disorders(9).

Strategies to prevent embolic brain injury in cardiac operations included: arterial filters(10), reduced manipula-tion of atheromatous aorta(11), improved removal of residual air and depris from the heart after open chamber procedures(12), and preven-tion of bubble formation in CPB(13). There is also interest in pharmacho-logic cerebral protection. Although some agents such as thiopental, Ca++ channel blockers, and N-methyl-D-aspartate antagonists have been shown to protect against ischemic brain injury in vivo; they are only effective at high concentrations. The neurotoxic and systemic effects of these agents have limited their routine use as neuroprotective agents(14).

Previous studies found that lidocaine at low concentration could protect against anoxic brain damage in vetro without affecting electro-physiological activity(15), reduce infarct size in a model of transient focal ischemia in rats(16), and improved cerebral protection provided by retrograde cerebral protection in dogs(17,18).

The objective of this study is to investigate whether intraoperative administration of lidocaine in the antiarrhythmic dose can reduce the incidence of cerebral dysfunction in hypertensive patients undergoing cardiac surgery with CPB.

Patients and methods

This study was carried out in Cardiac Surgery Unit of Zagazig University Hospital. After informed consent, 50 hypertensive patients scheduled for elective valve replacement or CABG surgery with cardiopulmonary bypass (CPB) were allocated randomly into one of two groups: **group I**, the control group and **group II**, lidocaine group

Hypertension was defined as arterial blood pressure of ≥ 140/90 for at least 6 months before surgery.

Exclusion criteria included: emergency surgery, history of neurological or psychatric disease, DM, renal impairment, active liver disease, age > 70 years, preoperative heart failure or ejection fraction ≤40%, inability to perform neurocognitive tests.

Neuropsychological testing:

Neurocognitive test battery was administered the day before surgery, and the day before hospital discharge (9th day).

Neurological tests:

Included motor, sensory and cranial nerves examination .

Cognitive function assessments:

Cognitive functions were assessed in several behavioral areas:

1-The short module of Randet memory test(19): requires subject to recall the details of short story immediately after it has been read to him and after 30 minutes delay.

2-The digit span subtest of Weschier Adult Intelligence Scale-revised (WAIS-R)(20): requires subjects to repeat a series of digits that have been orally presented to them both forward and in an independent test in reverse order.

3-The Benton revised visual retention test(21): requires the subject to draw from memory a series of geometric shapes following 10-seconds exposure.

4-The digit symbol sub-test of WAIS-R(20): requires subjects to reproduce within 90 seconds as many coded symbols as possible in blank boxes beneath randomly generated digits, according to scheme for pairing digits with symbols.

5-The trial making test (part B)(22): requires subjects to connect, by drawing a line, a series of numbers and letters in sequence (i.e. 1 – A, 2 – B) as quickly as possible.

Patients management:
Anesthesia and CPB:

All patients were premedicated with oral diazepam 10 mg the night before surgery and medazolam 0.05 mg.kg–1 + morphine 10 mg 30 minutes before entering the operating room. After IV canulation and before anesthesia induction, arterial canula-tion (usually radial artery) was performed for continuos arterial pressure measurement and frequent blood gas analysis. Anesthesia was induced in all patients with fentanyl 10mg.kg–1 and sleeping dose of thiopental 2 – 4 mg. kg–1. Teracheal intubation was facilitaed with pancuronium 0.15 mg. kg–1. Anesthesia was maintained with propofole 6 – 12 mg. kg–1, and intermittent doses of fentanyl 4 mg. kg–1 ±± 0.5% isoflorane when necessary. After anesthesia induction a triple lumen CVP catheter was inserted through right internal jugular vein for CVP monitoring and drug administration, and a single lumen catheter was inserted retrogradly through the left internal jugular vein for jugular bulb blood sampling and its position was verified by X-ray.

Monitoring:

Monitoring for all patients included: ECG, ABP, CVP, urine output, O2 saturation, endtidal CO2, ABG, and nasopharyngeal tempera-ture.

Myocardial preservation:

It was fulfilled in all patients by moderate systemic hypothermia (32°C) and cold (4°C) crystalloid antigrade cardioplegia.

CPB:

The bypass circuit included a rollar pump, and a membrane oxygenator. It was primed with 1000 cc latated ringer solution and 500 cc of hydroxyle starch, 50 mg heparin and 1 g.kg–1 mannitol were added to the priming solution. The pump flow was non pulstile at a rate of 2 – 2.4 l.m – 2. min–1. PCO2 uncorrected for tempera-ture was maintained at 35– 40 mmHg. The patients were cooled to 32°C and hematocrit was kept at 22 – 25%. Mean arterial pressure during bypass was maintained at 50 – 80 mmHg by increasing pump flow or 4mg boluses of norepinephrin if hypotension occur and by increasing the depth of anesthesia for treatment of hyper-tension. Blood glucose level was maintained < 200 mg.dl– 1 using isulin infusion if needed. The re-warming rate was not more than 1°C core temperature per 3 minutes.

Tested drug administration:

In lidocaine group, lidocaine was administered as a bolous of 2 mg.kg–1 over 5 minutes started with skin incision followed by infusion of 4 mg. min–1 untill the end of operation. Another dose of 4 mg.kg–1 was added to the priming solution.

In control group, normal saline was added at the same time, volume and rate.

Blood sampling:

• Jugular bulb samples were withdrawn at the following points:

After induction of anesthesia, before establishment of CPB, at established cooling to 32°C, during rewarming at 35°C, one hour after the end of CPB and 6 hours after CPB.

• 5 ml of arterial blood were also withdrawn for protein S-100-b determination at the following points:

After induction of anaesthesia, before CPB, 30 minutes of CPB, one hour of CPB, 4 hours after CPB and 6 hours after CPB..

The samples were centrifuged and frozen till the time of analysis for protein S-100-b level. Protein S-100-b was measured with commercial Songetec S-100 R-kit (Songetec Medical – Sweden). This is a monoclonal, 2–site immunoradiodiametric assay. The Songetec as-say measures the beta subunit of protein S-100 which is specific for Schwann and glial cell damage. The sample is intubated with I125 monoclonal antibody to S-100 protein. A concentration of > 0.2 mg.L– 1 is considered pathological.

Statistical analysis:

Data are represented as mean ±±SD. Changes from preoperative to predischarge on neuropsychological tests was assessed with paired t-test. Significant impairment was defined as decline of one or more standard deviation or more than 20% of preoperative test.

One way ANOVA was used for intergroup com-parisons, while repeated measures ANOVA was used for intragroup comparisons. P< 0.05 was considered significant.

Results

Fourty seven patients completed the study. Two patients died due to non-neurological complications, one in the control group and one in the lidocaine group. One patient in the control group refused to complete the neurocognitive tests. Demographic, preoperative and operative data of the patients of the 2 groups are listed in table (1).

Table (1): Demographic, preoperative and operative data of both study groups

Parameter	Control group (n=23)	Lidocaine group (n=24)
Age (years)	43±1	39.7±12.
Gender, male (%)	13 (56.5)	15 (62.5)
Weight (kg.)	63±11	64±
Preoperative MAP (mmHg)	110±1	116±12.
Type of surgery		
AVR	11	13
DVR	8	7
CABG	4	4
Ischemic time (min.)	100.8±2	98.6±1
CPB time (min.)	130±2	121±1
Epinephrin (mμg.kg-1/min)	0.07±0.00	0.083±0.01

No significant difference was found between the patients of the two study groups as regard age, weight, preoperative and operative parameters.

No patient in the two study groups showed motor or sensory defects. When compared to preoperative tests, postoperative cognitive performance tested by digit span forward, digit span backward, Benton visual reten-tion, digit symbol and trial making part were significantly reduced in control group ($p<0.05$). Twelve patients (52.1%) in control group showed impairment of > 2 cognitive tests while in lidocaine group only 6 patients (25%) showed impairment of > 2 cognitive tests (Table 2).

Table (2): Neurological test scores (mean ±SD)

Test	Group	Preoperative	Predischarge
Randt immed	Control	8.1±3.	8.3±3.
	Lidocaine	8.3±3.	8.5±
Randt delayed	Control	6.2±3.	5.7±3.7
	Lidocaine	6.3±3.	5.1±3.4
Digit span. Forward	Control	7.4±1.	7±1.4
	Lidocaine	7.35±2.	7.2±1.
Digit span backward	Control	5.6±2.	5.1±2.3
	Lidocaine	5.4±	5.33±1.
Benton visual retension	Control	5.3±2.	4.8±2.
	Lidocaine	5.1±2.	5±1.
Digit symbol	Control	39.±1	33±14
	Lidocaine	37±1	35±10.3
Trial making test (bβ	Control	138±7	159±82
	Lidocaine	136±7	140±7

P < 0.05 in comparison with preoperative vlaue.

Jugular bulb oxygen saturation (Sjvo2) was significantly elevated in the two groups at established cooling to 32°. On the other hand, during rewarming to 35° control group showed a high significant reduction in Sjvo2 ($p<0.001$), while the reduction in the lidocaine group was non-significant ($p>0.05$). At this point, there was a jugular bulb desaturation in control group (Sjvo2 = 43.8±±2.7%) while in lidocaine group there was no desaturation (Sjvo2 = 67±±18.7%). (Table 3).

Table (3): Jugular bulb saturation at different measuring points (mean ±SD)

Time	Control group	Lidocaine group
1	63.7±15.2	61.2±15.3
2	66.6±10.8	70±2
3	75.6±17.4%	85.4±9.8%**
4	43.8±2.8%*	67±18.9%°
5	56.4±14	66±13%
6	55.6±6	63.4±7.9%

1-After anesthesia induction.
2-Before establishment of CPB.
3-At establishmed cooling (32°)
4-During rewarming (35°).
5-One hour after the end of CPB.
6-6 hours after the end of CPB.
* $p < 0.05$ *in comparison with baseline*
** $p < 0.001$ *in comparison with baseline*
° $p < 0.05$ *in comparison with control group*

Serum protein S-100 b started to elevate during CPB in both groups, but the elevation was more significant in control group. It reached its peak one hour of CPB. This peak level was 7.5mg.L–1 ($p<0.001$) in control group while it was only 3 mg.L–1 in lidocaine group. The level of S-100 b protein was still significantly elevated in control group 6 hours after CPB, but in lidocaine group it almost returned to its baseline value 6 hours after CPB (Table 4).

Table (4): Serum S-100 ? protein (?g.L–1) at different measuring points (mean ±±SD)

	Control group	Lidocaine group
1	0.1±±	0.13±±0.
2	0.12±±.1.	0.15±±0.
3	0.5±±0.3	0.43±0.5
4	7.5±±4.1**	3±±1.9
5	5.5±±5.2**°	0.6±±0.8
6	3.5±±0.7*	0.17±±

1-After induction. 2- Just before CPB
3- 30 min of CPB 4- 1 hour of CPB.
5- 4 hours after CPB 6- 6 hours after CPB
* $p < 0.05$ *in comparison with baseline*
** $p < 0.001$ *in comparison with baseline*
° $p < 0.05$ *in comparison with other group*
°° $p < 0.001$ *in comparison with other grou*

Discussion

Neurological and neurocognitive problems after cardiac surgery remain irritating causes of postoperative morbidity and prolonged hospitaliza-tion. Although technological advances over the past decades have greatly improved the safety of cardiac surgery, the incidence of postopera-tive cognitive dysfunction remains frequent(1,3). The prevailing opinions about the cause of neurobehavioural complications are that they result from hypoperfusion, embolism, infla-mmation or a combination of the three(23,24). A strategy to ameliorate the damaging processes and reduce the risk of adverse neurobehavioral outcomes may require further improvement of the techniques in cardiac surgery, CPB, and peri-operative patient management. Another possible treatment that is attracting more attention is the pharmachological cerebral protection. Hypertensive patients may need more care for neuroprotection as hypertension might impair the cerebral autoregulation mechanism and so it is considered a risk factor for post-bypass cerebral insult(25). The effect of lidocaine in protecting the ischemic brain have been demonstrated by many animal and human studies(7,11). The possible mechanisms for cerebral protection by lidocaine include decelaration of ischemic trans-membrane ion shift, reduction of cerebral metabolic rate(26), and reduction of ischemic excititoxin release(27).

The results of the present study confirmed that there was significant incidence of cognitive dysfunction after cardiac surgery (52.1% in control group and 25% in lidocaine group). This is in agreement with many studies who reported neuro-cognitive dysfunction after CPB in normotensive patients(28,29). However the incidence of cognitive dysfunction is higher in the present study (52.1% in control group) because of hyper-tension. Moreover, our results demonstrated that intraoperative administration of lidocaine significan-tly reduced the incidence of early postoperative cognitive dysfunction in hypertensive patients.

Wang et al (2002)(30) also proved the protective effect of lidocaine against early postoperative cognitive dysfunc-tion in normotensive patients. In this study, lidocaine prevent jugular bulb desaturation during rewarming. Jugular bulb oxygen saturation indicates the global balance of cerebral metabolic rate and cerebral blood flow and is used to estimate the adequacy of flow/metabolism coupl-ing in the brain, and so lidocaine might reduce cerebral metabolism during the period of supply-demand uncoupling. The relation between jugular desaturation (Sjvo2 < 50%) and cognitive dysfunction was suggested by Croughwell et al (31). In this study, there was a significant elevation of protein S-100 b level one hour after CPB in both study groups but the elevation was more significant and persisted for longer duration in control group. The level of protein S-100 b in control group was still significantly elevated 6 hours after CPB, while in lidocaine group it returned to its pre-bypass level. The beta sub-unit of protein S-100 is highly brain specific and is well-established marker of cerebral injury after cardiac surgery with CPB(32,33). So, the results of this study give a biochemical proof that cerebral insult in lidocaine group is less than that in control group.

Further investigations at the cellular level will be required to detect the mechanism by which lidocaine protect against cerebral injury and define the effective intracellular concentration.

We can conclude that lidocaine has neuroprotective effect in hypertensive patients undergoing cardiac surgery with CPB. Considering its relative safety, wide use as antiarrhythmic drug, and wide availability, it may be used routinely for neuroprotection especially in high risk patients even if its effect is small or transient.

Study limitations: Small number of patients.Also, the delayed neurocognitive effect of CPB was not assessed in this study.

References

1- Darbut D, Lo YW, Gold JP, et al.: Impact of embolization during cronary artery bypass grafting on outcome and length of stay. Ann Thorac Surg 1997; 63: 998 – 1002.

2- Stump DA, Fedorko L, Brooker R, et al.: Biochemical markers of brain injury, embolic load, bypass time and neurobehavioral deficits after CABG surgery: is there a relationship? [Abstract]. Ann Thorac Surg 1997; 62 : 920.

3- Ropper AH, Wechsler LR, Wilson LS: Cartoid bruit and the risk of stroke in elective surgery. N Engl J Med 1982; 307: 1388 – 40.

4- Shaw PJ, Bates D, Cartlidge NEF, et al.: Neurologic and neuropsycho-logic morbidity after major surgery. Stroke 1987; 18: 700 – 6.

5- Selens OA, Goldsbrough MA, Borowica LM, et al.: Neurobehavioral sequelae of CPB. Lacent 1999; 353: 1601 – 6.

6- Moody DM, Bell MA, Challa VR, et al.:Brain microemboli during intracrdiac surgery or aortography. Ann neurol 1990; 28: 477 – 86.

7- Pugsley W, Klinger L, Paschalis C, et al.: The impact of microemboli during CPB on neuropsychological functioning. Stroke1994; 25: 1393 – 9.

8- Croughwell ND, Frasco P, Blumenthal JA, et al.: Warming during CPB is associated with jugular bulb desaturation. Ann Thorac Surg1992; 53: 827 – 32.

9- Kilminster S, Treasure T, McMillan T, et al. : Neuropsychological change and S-100 protein release in patients undergoing cardiac surgery. Stroke1999; 30: 1869 – 1874.

10- Treasure T: Interventions to reduce cerebral injury dur-

ing cardiac surgery - the effect of arterial line filtration. Perfusion1989; 4: 147.
11- Menkis AH, St Amand MA, Murkin JM, et al.: Epiaortic scanning can influence surgical management during cardiac surgery. Ann Thorac Surg1997; 64: 919.
12- Rescigno G, Riom H, Nottin R, et al.): Doppler analysis of the left venting line: an effective and simple technique to control heart de-airing. Cardiovascular surg1995; 3: 65 – 9.
13- Mitchell SL, Willcox T, McDougall C, et al.: Emboli generation by the medtronic Maxima hard-shell adult venous reservoir in CPB circuit. Perfusion1996; 11: 145 – 55.
14- Baiping L, Cottrel JE, Kass IS.: Neuroprotective effect of low dose of lidocaine in a rat model of transient focal ischemia. Anesthesiology2001; 95: 445 – 51.
15- Fries E, Amorin P, Chambers G, et al.: The importance of sodium for anoxic transmission damage in rat hippocampal slices: mechanism of protection by lidocaine. J of Physiol1995; 4 84: 557 – 65.
16- Shokunbi MT, Gelb AW, Miller DJ, et al.: Continuous lidocainee infusion and focal feline cerebral ischemia. Stroke1990; 21: 107 – 11.
17- Wang D, Wu X, Zhou Y, et al.: Lidocaine improved the cerbral protection by retrograde cerrebral infusion: an experimental study. Chin Med J (Engl) 1998; 111: 885 – 90.
18- Wang D, Wux, Zhong Y, et al.: The effect of lidocainee on improving the cerebral protection provided by retrograde cerebral perfusion: a neuropathological study. J of Cardio-thorac Vasc Anesth1999; 13: 176 – 80.
19- Randt CT, Brown ER, Osborne DP: A memory test for longitudinal measurement of mild to moderate deficits. Clinical neuropsychology1980; 4: 184 – 94.
20-Wechsler D.: The Wechsler adult intelligence Scale-revised (manual). Psychological corporation1981.
21- Benton AL, Hansher K.: Multilingual aphasia examination. Iowa city IA, University of Iowa Press1976.
22- Reitan RM: Validity of the trial making test as an indicator of organic brain damage. Percept Most Skills1958; 8: 271 – 6.
23- Graham DI.: The brain and cardiac surgery. Harwood Academic Publishers2000; 87 – 111.
24- Brown WR, Moody DM, Challa VR.: Cerebral fat embolism from CPB. J Neuropathol Exp Neurol1999; 58: 109 – 19.
25- Schmidt M, Scheunert T, Chirmer U, et al.: Hypertension as a risk factor for cerebral injury during CPB. Anaesthesia2001; 56: 133 – 138.
26- Sakabe T, Maekawa T, Ishikawa, et al.: The effects of lidocainee on canine cerebral metabolism and circulation related to the EEG. Anesthesiology197427-Taylor CP, Burke SP, Weber MI.: Hippocampal slices: glutamate over flow and cellular damage from ischemia are reduced by sodium-channel blockade. J Neurosci: Methods1995; 59: 121 –8.
28- Smith PCL, Treasure T, Newman SP, et al. : Cerebral consequences of CPB. Lancet1986; 1: 823 – 825.
29- Pugsley W, Treasure T, Kinger L, et al.: Microemboli and cerebral inmpairment during cardiac surgery. Vasc Surg1990; 24: 34 – 43.
30- Wang D, Xinmin Wu, Jun Li, et al. : The effect of lidocaine on early postoperative cognitive dys-function after coronary artery bypass surger. Aneth Anlg2002; 95: 1134 – 41.
31- Croughwell ND, Newman MF, Blumenthal JA, et al.: Jungular bulb saturation and cognitive dysfunction after CPB. Ann Thorac Surg1994; 58: 1702 – 8.
32- Johnsson P, Lundquist C, Lindgren A, et al.: Cerebral complications after cardiac surgery assessed by S-100 protein and NSE level in blood. J Cardiothorac and Vasc Anesth1995; 9: 694 – 9.
33- Blomquist S, Jonsson P, Luhrs C, et al.: The appearance of S-100 protein in serum during and immedia-tely after CPB: a possible marker for cerebral injury. J Cardiothorac Vasc Anesth 1997; 11: 699 – 703.

Sternotomy Approach for The Modified Blalock-taussig Shunt: Advantages And Disadvantages

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Background: **Modified Blalock Taussig shunt was used to be done through thoracotomy incision. Since 1990, sternotomy has been the preferred approach for construction of MBT shunt. It was done in neonates, and young infants. In this study we investigate the sternotomy approachs, and we test the hypothesis that sternotomy incision yields less mortality and morbidity.**

Methods: **75patients had median sternotomy. The age of the patients ranged from 9 months to 30 months (mean of 13.2 months). The weight ranged from 6 Kg to 15 Kg (mean 9.8 Kg). 34 were males (45%), and 41 (55%) were females.**

Results: **Excessive shunt flow, end shunt failure were not reported in our study. Superficial wound infection occurred in 3/54 patients in the sternotomy group. Re-exploration for bleeding was done in 8 cases (14%) in the thoracotomy group, and 3 (4%) in the sternotomy group. Finally the early mortality rate was 2/54 (5.5%) in the thoracotomy group due to excessive shunt flow, and it was not reported in the sternotomy group. During second stage surgery to do a carvopulmonary anastomosis the incidence of PA distortion in the thoracotomy group was 5.5% while in the sternotomy group it was not apparent.**

Conclusions: **The sternotomy route is technically easier , and is associated with fewer shunt failure than the classic thoracotomy approach. It provides better exposure to the surgeon, yet it has the disadvantage of excessive shunt flow.**

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Recently, primary repair had been the preferred approach to the neonate or young infant with a cardiac anomaly who has two ventricles. However, when only one functional ventricle is present or pulmonary blood flow is reduced, an initial palliative systemic to pulmonary arterial shunt is mandatory. The shunt should not supply excessive pulmonary blood flow that might result in elevated pulmonary vascular resistance or impair ventricular performance secondary to excessive volume load. Of the numerous options for the connection between the systemic, and pulmonary circulations have been described; the shunt that has generally been accepted as most likely to fulfill these criteria is the modification of the Blalock-Taussig shunt in, which a PTFE tube graft is inserted between the subclavian and pulmonary arteries(1). Its popularity is due to the

predictability of blood flow through it, the diameter of the subclavian artery limits flow so that it is rarely excessive, yet the flow is great enough to provide good palliation. The operation is technically more difficult in neonates due to small caliber of the vessels, short length, and delicate structure of the wall of the vessels(2,3).

Selected Abbreviations:

LMBTS : Left sided modified Blalock Taussig shunt
LSCA : Left subclavian artery
MBTS : Modified Blalock Taussig shunt
PA : Pulmonary artery
PTFE : Polytetrafluoroethylene
RMBTS : Right sided modified Blalock Taussig shunt

Patients and Methods:

During the period from January 2002 till December 2004, 75 patients who had complex cyanotic congenital heart lesions underwent Modified Blalock Taussig shunt at Abu El-Rich Students', Hospital. Through median sternotomy. Table (1)

Table (1): The diagnostic categories for our patients.

	Sternotomy
Tetralogy of Fallot with small Pas	28 (37%)
Transposition complex (TGA VSD Ps)	23 (30%)
Single ventricle (DORV)	7(9%)
Pulmonary atresia with VSD	12 (16%)
Tricuspid atresia	5 (8%)
Total	75

Technique of MBTs through Median Sternotomy:

Median sternotomy was made extending to few millimeters above the sternal notch. The thymus gland was completely removed. An inverted T shaped incision was made in the pericardium over the RA, and the aorta leaving it intact over the right ventricle to avoid injury during resternotomy. Sharp dissection of the right PA, and the brachiocephalic artery was done free of the peri-adventitial tissue. To enable smooth, and unobstructed dissection of these vessels, the aorta must be retracted to the left, and the superior vena cava was retracted to the right, and the right atrial appendages was retracted inferiorly after being anchored by a stitch of prolene 4/0. The right PA was clamped to ensure that single lung perfusion was able to sustain adequate oxygenation. The innominate vein crossing infront of the neck vessels was retracted superiorly to optimize access to the graft, and to ensure proximal, and distal control of vessels.

A PTFE graft of suitable diameter was selected, and the proximal end was beveled. A C-clamp was applied to the distal innominate, and proximal subclavian arteries. An arteriotomy was made on the inferior aspect, and an anastomosis created between the PTFE graft, and the distal innominate/proximal subclavian arteries junction with a continuous monofilament (polypropylene or PTFE) suture. In few cases we used Gore-Tex suture which produces less stitch holes, but it was not available in all cases because it is expensive. A second clamp was then applied distally across the graft, permitting removal of the C-clamp from the innominate, and subclavian arteries. The graft was then passed underneath the innominate vein, and cut to the final length, heparin was administered (1 mg/Kg). A C-clamp was applied to the right PA. The PA was opened longitudinally, and the distal anastomosis between the PTFE graft, and the PA completed. The clamp was released to the allow back bleeding from the PA. Hemostasis was ascertained and antegrade flow was permitted by releasing the clamp on the graft. In thoracotomy cases the lung was allowed to inflate, and chest tube inserted. Before closure of the wound in all cases, blood gas analysis was done to test oxygen saturation.

The following complications were looked for during the early postoperative period

1. Shunt failure: Which may present by complete occlusion, or progressive desaturation
2. PA distortion.
3. Wound infection includes cellulites of the skin requiring antibiotics, wound suppuration, and mediastinitis.
4. Excessive shunt flow
5. Bleeding
6-Horner's syndrome
7. Recurrent laryngeal nerve injury
8. Chylothorax.

All patients were admitted to the ICU after surgery, blood pressure, heart rate, and oxygen saturation monitoring was done. Routine blood gas analysis was done to detect early desaturation, or metabolic acidosis due to the low cardiac output.

An open shunt should result in a drop in, diastolic blood pressure, increase in the pulse pressure, and increase in arterial oxygen saturation. The continuous

flow murmur of the shunt could be heard over the infraclavicular region. If there is any doubt, immediate echocardiographic examination in the ICU should be done.

Chest X-ray was important to show if there was any pulmonary overflow due to excessive shunt flow. The ideal oxygen saturation level to proceed to extubate the patients was different from case to another according to pre-operative state of the patients, and to what degree they were cyanotic, the pre-operative oxygen saturation, and the hemodynamic state of the patient. It is well known that if oxygen saturation is 85% or above it will be very satisfactory.

The inotropic support (if was used in some cases) was withdrawn gradually, according to the hemodynamic status clinical condition of the patient, and guided by the blood pressure, the central venous pressure oxygen saturation, and peripheral temperature. Heparin was started post-operatively after the chest tube drainage had decreased. Then the patients received oral aspirin, when they started oral feeding, and was discharged on oral aspirin (75 mg daily).

Although the thoracotomy approach was not used in our study , it is important to give a note about its details

The fourth intercostals space is chosen for entry. The lung is retracted, the parietal pleura and the periarterial tissue over the right pulmonary artery are dissected free, in older patients who are markedly cyanotic, excessive collateral vessels may have developed, and must be lightly coagulated to minimize bleeding. The pulmonary artery is dissected.. On the right side, the site where the pulmonary artery divides into the right upper, and right lower lobe divisions, these branches must be identified. Then, the subclavian artery is dissected free, and mobilized.. The anastomosis is completed, in the same way as in cases with median sternotomy.

Results:

The mean diameter of the conduit material was 4. The age of the patients ranged from 9 months to 30 months, mean of 13.2 months. The weight ranged from 6 Kg to 15 Kg (mean 9.8Kg) 34 (45%) were males, and 41 (55%) were females.

Shunt failure occurred in 3/75 (4%) patients. The cause was occlusion of the shunt in two cases due to small graft size in which the graft was replaced by a larger size the third case, had kinking at the site of anastmosis with the subclavian artery which needed revision. Excessive shunt flow was reported in two cases (2.6%), one of them was due to large size of the graft ((6) in relation to the size of the PA. Superficial wound infection occurred in 4 patients (5%) , which were managed properly by repeated dressing and antibiotics.

Re-exploration for bleeding was done in 3 patients (4%) the early mortality rate was 2/75 (2.6%) due to excessive shunt flow in one case, and shunt occlusion in the other .In our study, the early mortality rate was 2/54 (5.5%) in the thoracotomy group, due to excessive shunt flow causing heart failure, while there was no early mortality in the sternotomy group.

Discussion:

MBTs was traditionally performed through thoracotomy incision. . There are several disadvantages of this approach. (1) The incidence of shunt failure is higher in thoracotomy cases than sternotomy cases. Odim, and his colleagues(4) compared the thoracotomy, and sternotomy approaches, he reported 10/52 (19%) incidence of shunt failure in the thoracotomy, compared to 4/52 (7.7%) in the sternotomy groups. In our study the incidence of shunt failure was 4%. Theses results may be explained by the better exposure provided by sternotomy approach.. (2) Distortion of the pulmonary artery at subsequent surgery after Blalock-Taussig shunt (Cavopulmonary anastomosis) is more reported in thoracotomy, than sternotomy cases, because the median sternotomy approach limits the dissection to the proximal part of the pulmonary artery before the take-off of the upper lobe branch. Any distortion of the PA can be incorporated into the future Glenn or Fontan procedure through the sternotomy approach (5) .In the study of Odim 11.5% of his patients with thoracotomy incision and 7.6% of patients in the sternotomy group required pulmonary artery plasty(4). (3). Because the anastomosis is done with the distal part of the pulmonary artery in thoracotomy patients, this produces unequal blood flow the right, and left lungs, more preferential flow to the side of construction, and subsequent uneven growth of the pulmonary artery branches(4). (4) In the thoracotomy approach, the patient is placed in lateral position on one side, which interferes with respiration through that lung, while the other lung is being compressed to give the surgeon field to perform the anastomosis. This situation may result in drop in oxygen saturation during surgery(5). (5) Injury of sympathetic fibers which causes Horner's syndrome is a common complication after thoracotomy incision. This occurs during dissection around the left SCA, where is the ansa cervicalis. It occurred in 3% of cases of Odim who had thoracotomy incision. Furthermore, the right recurrent laryngeal nerve is liable to be injured during dissection around the right subclavian artery at the apex of the chest. However these complication were not reported in our study. In the older age cyanotic patients, with small pulmonary arteries, the presence of multiple systemic to pulmo-

nary collaterals, make the thoracotomy incision very hazardous(2). In neonates, who remained cyanotic after BT shunt because of their pathology, their anomalies were more often complicated by delayed healing than in sternotomy cases. Late, scoliosis has been reported to occur among patients with thoracotomy incision. It has been noted that development of chest wall to lung collaterals occurs after thoracotomy incision(4).

On the other hand median sternotomy is gaining increasing favor because it allows for exposure of extra length of the proximal part of PA (1-2 Cm) than the thoracotomy incision, hence the incidence of distortion of the PA is very low. It was not reported in our cases, however it was reported in 7.6% of cases who had sternotomy incsion while it occurred in 11.5% in the thoracotomy group in the study of Odim, and his colleagues. Sternotomy approach produces equal blood flow to both lung, and hence equal growth of both right, and left branches. Better exposure provided by sternotomy incision prevents kinking of the vessels during the anastomosis, and allows the surgeon to use a wider graft which decreases the incidence of shunt failure, and decreases the risk of injury to the right recurrent laryngeal and sympathetic nerve. It also avoids the risk of lung compression, and its subsequent respiratory compromise especially in very sick neonate, which may oblige the surgeon to institute cardiopulmonary bypass. In redo surgery when the patient needs further surgery the previous shunt is easily to be taken down through sternotomy(7*8).

However, sternotomy incision carries the risk of excessive shunt flow which may lead to low cardiac output. This occurs if the proximal anastomosis of the shunt is placed more proximal on the innominate/ subclavian arterial system. This was observed by Odim and his colleagues when he reported excessive shunt flow in 3/52 cases in the sternotomy group (5.7%), and in one case (1.9%) in the thoracotomy group(4) . In our study it occurred in two patients (2.6%), one of them due to large size of the graft. In addition, there is risk of injury to great vessels or the heart during the second stage operation in sternotomy patients, this can be avoided by opening the pericardium in an inverted T shaped incision to prevent the RV wall from adherence to the sternum(8). It was also reported by Odim, and his colleagues that pericardial effusion requiring drainage occurred in 6% of patients after sternotomy incision(4).

There are some situations in which sternotomy approach is the first choice: [1] The surgeon may delay the decision to do a cavopulmonary anastomosis (which is more physiologic, as it provides 30% of the cardiac output to the pulmonary circulation) or to do a MBT shunt (it supplies only 10% of cardiac output, its main advantage is to augment the size of the pulmonary artery branches). This applies to the following forms of pathology: (a) Cases of pulmonary atresia alone or if associated with Tetralogy of Fallot, when the surgeon couldn't get enough cather data catheter about the size of the PA, and its branches, and the pulmonary artery wedge pressure, this occurs if the angiographer fails to introduce the tip of the catheter inside the pulmonary artery. So, the decision is delayed during surgery to assess the size, and pressure inside the pulmonary artery, and its branches. (b) Patients of Fallot atresia, and patients of TGA-VSD-PS who are ideal candidates for homograft replacement, but due to lack of homografts, they need MBT shunt or better a Glenn shunt according to the size of the PAs.(9) [2] When the decision, to do a total correction in Tetralogy of Fallot cases, a MBT shunt or a palliative outflow patch. This applies to cases with borderline McGon ratio (1.3-1.5). The surgeon has to wait to see the size of pulmonary artery branches during surgery(9). [3] In cases of P. atresia, the surgeon may be confronted with serious drop of oxygen saturation during surgery if it is done during thoracotomy especially after compressing the lung,, and he may need to institute cardiopulmonary bypass. This occurred in only two cases in our study as the lung is not compressed as in the thoracotomy approach. In these cases , we didn't need cardiopulmpnary bypass, and the condition was controlled by manual ventilation, and early declamping of the PA after doing the anastmosis. . [4] In addition, applying the vascular clamp on the pulmonary artery through thoracotomy may be hazardous, in cases of pulmonary atresia when there are big collaterals supplying the branches. [5] In neonates, sternotomy incision is mandatory not only to have a wider anastomosis with the proximal PAs, but also to avoid the complications related to thoracotomy incision which are delayed healing, hazardous bleeding, and bad cosmetic appearance.

Conclusion:

Modified Blalock Taussig shunt is most used type of shunts. It can be performed via thoracotomy or sternotomy incision. Sternotomy approach facilitates the surgical technique, and provides good cosmosis. It is especially indicated in neonates, and when the decision is taken during surgery, whether to do a MBT shunt or a cavopulmonary anastomosis.

Sternotomy approach has the following advantages, better exposure which allows the surgeon to do the anastmosis more easy, Low incidence of kinking of the vessels and even if there is PA distortion it could be repaired by being incorporated in the cavopulmonary

anasthmosis if it will be done . Moreover, it provides equal blood flow to both lungs . However, it had the disadvantage of excessive shunt flow if the anastomosis was done more proximally.

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References:

1. Bove, E.L.; Sondheimer, H.M.; Kravey, R.E.W.; Byrum, C.J.; Blackman, M.S. and Parker, F.B. (1984): Subclavian-pulmonary artery shunts with polytetrafluoroethylene interposition grafts. Ann. Thorac. Surg., 37:88-97.
2. Glenn's (1996): Glenn's Thoracic And Cardiovascular Surgery. Edited by: Arthur E.Baue, Alexander S. Geha Hillel Laris, Graeme L. Hammond, Fund Keith Maunheim, Prentice-Hall International
3- DeLeval, \M.R.; Mxkay , R.; Jones, Stark, J. and MacArtaney, F.J., (1981): Modified Blalock-Taussig shunt; use of subclavian artery orifice as flow regulator in prosthetic systemic to pulmonary artery shunts. J. Thorac. Cardiovase. Surg., 81:112-119
4. Jonah Odim, Michael Portzky, David Zurkoski, Gil Wernovsky, Redmond P. Burke, John Mayer, Aldo R. Castaneda, and Richard A. Jonas (1995): Sternotomy approach for the Modified Blalock-Taussig shunt. Circulation, 92(Suppl. II):256-11-261.
5. Amato, J.J.; Marbey, M.L.; Bush, C.; Galdieri, R.J. and Cotroneo, J.V. Bushong (1988): Systemic-pulmonary polytetrafluoro-ethylene shunts in palliative operations for congenital heart disease. J. Thorac. Cardiovasc. Surg., 95: 62-69.
6. Moulton, A.L.; Brenner, J.L.; Ringel, R.; Nordenberg, A.; Berman, M.A. and Sohaila, A. Burns (1985): Classic venous modified Blalock-Taussig shunts in neonates and infants. Circulation, 72(Suppl. II):11-35-11-44.
7- Laks, H., Fargan, L.; Barner, H.B. and Willman, V.L. (1978): The Blalock Taussing shunt in the neonates. Ann. Thorac.. Surg., 25:220-24.
8. Hesham Shawky: Personal Communication.
9.. E.Mostafa: Personal Communication.

Primary Repair Of Tetralogy Of Fallot In The First Year Of Life: Impact Of Transannular Patch On Operative Mortality And Morbidity

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Background: **There has been much controversy regarding the ideal timing for complete correction of patients with cyanotic tetralogy of Fallot (TOF). The arguments hinge on the morbidity and mortality of the operation. Young age and the requirement for transannular patch (TAP) reconstruction of the right ventricular outflow tract (RVOT) are thought to adversely affect the results of intracardiac repair of TOF.**

Objectives: **The purpose of this retrospective study is to evaluate the current results of full repair of TOF in infancy with special stress on the effect of TAP on mortality and morbidity.**

Methodology: **From October, 2000 to July, 2004, 30 patients ≤ 12 months of age with symptomatic TOF underwent primary full repair of TOF at our hospital. Patients who underwent initial palliative shunt were excluded. Preoperative, operative, and postoperative data were reviewed.**

Results: **The mean age at repair was 10.1±2.1 months. There was no operative mortality. However, one patient died 15 days following discharge from hospital. TAP was required in 93.3% of the patients. The median time of mechanical ventilation was 23.5 hours (range, 10 to 480 hours). Six patients (20%) required mechanical ventilation more than 48 hours. The median length of stay in the intensive care was 2 days (range, 2 to 20 days). The median duration of hospital stay was 9.5 days (range, 7 to 60 days). At follow-up 2-36 months later (median 12 months), there were no late deaths or reoperations. All except one were asymptomatic. Postoperative Echocardiography showed that right and left ventricular systolic functions were normal in all patients. The mean peak gradient across the RVOT was 26±1.9mmHg (range, 10 to 80 mmHg). All except 3 patients had free pulmonary regurgitation. Two patients (6.6%) required intervention in the form of balloon dilatation and stenting of left pulmonary artery in on patient and stenting of RVOT in the other.**

Conclusions: **This retrospective review demonstrates that early full repair of TOF in the first year of life is associated with an excellent survival and a low incidence of postoperative morbidity regardless of age, and the requirement for TAP.**

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TOF was one of the first cyanotic congenital cardiac lesions to be treated with surgical intervention. Since the first Blalock-Taussig shunt in 1945, the philosophy of management of TOF has undergone considerable changes. With the development of cardiopulmonary bypass (CPB), full repair rather than palliation became the goal; however, total repair was deferred until later childhood. With increasing experience, improvements in CPB technique, and myocardial

protection, primary repair in infancy in symptomatic patients became common. [1-16] A major unresolved issue is the ideal timing for complete correction of patients with cyanotic tetralogy of Fallot (TOF). The arguments hinge on the morbidity and mortality of the operation. Young age, low weight, and the requirement for TAP reconstruction of the RVOT are thought to adversely affect the results of intracardiac repair of TOF.[4,6] The purpose of this retrospective study is to evaluate the current results of full repair of TOF in infancy. This study also would test the hypothesis that primary repair of TOF can be performed safely in symptomatic infants, regardless of age, weight or the use of TAP.

Patients and methods

Patients

From October 2000, to July 2004, 74 patients with symptomatic TOF were operated at our hospital. All patients ≤ 12 months of age who underwent primary full repair of TOF were the subject of this study. Patients who had pulmonary atresia and those who underwent initial palliative shunt were excluded. Patients who had an associated atrial septal defect and/or patent ductus arteriousus were included in this study. Patients' records were reviewed retrospectively. Preoperative, operative, and postoperative data were reviewed. The immediate postoperative study included the following: Thirty-day mortality, arrhythmias, complete heart block, neurological complications, the requirement for open chest, the use of inotropic support, durations of mechanical ventilation, ICU stays and total hospital stays. Patients were followed until their last clinic visit. Late postoperative evaluation included a complete physical examination, an electrocardiogram and two-dimensional and Doppler ECHO in all patients. The 30-day mortality was defined as death within the first month postoperatively.

Operative procedures: The operative technique was uniform throughout this study. Standard CPB with systemic hypothermia was instituted through an ascending aortic cannula and two venous cannulas with caval taping. After aortic cross-clamping, the myocardium was protected with topical hypothermia and cold blood cardioplegic solution was used in a dose of 20-30mL initially and 10-15mL/kg every 20-30 minutes. Before removal of the aortic-cross clamp a warm blood perfusion was given for 2-3 minutes. Conventional ultrafiltration was done during CPB in all patients and modified ultrafiltration was used according to surgeon preference. Operative repair was as follow: After initiation of CPB, a right atriotomy was performed and the atrial septum was inspected. Working through the tricuspid valve, a moderate resection of the parietal and septal extensions of the infundibular septum was performed. The dissection was carried upward to the level of pulmonary annulus. Hegar dilators were passed through the tricuspid valve into the RVOT to estimate its size. If the annular diameter at this point was less than the mean normal diameter predicted by Rowlatt and colleagues [17], then the main pulmonary artery was incised. Additional subvalvar infundibular muscle was resected through the pulmonary valve if necessary. In order to relieve the obstruction at the annular level, while trying to preserve as much valvar function as possible, we utilized a technique of limited transannular patching. The longitudinal pulmonary arteriotomy was extended across the pulmonary annulus only as far as necessary, often only a few millimeters onto the infudibulum. In addition the transannular incision was performed through the commissure (usually the anterior), and exactly splitting it, and a very narrow elliptical pericardial patch was used to augment the annulus. The malalignment-type ventricular septal defect was closed with bovine pericardium using interrupted horizontal mattress sutures with Teflon pledgets. Ductus arteriosus and atrial septal defects were simultaneously closed. Temporary ventricular electrodes were placed in all patients.

Follow-up: Patients were followed until their last clinic visit. Late postoperative evaluation included a complete physical examination, an electrocardiogram and two-dimensional and Doppler ECHO in all patients.

Statistical analysis: was performed using SPSS statistical program for windows (SPSS 11 Inc., Chicago, Illinois). Data are expressed as frequencies, medians with ranges and, means ±standard deviation, as appropriates. A *P* value of ≤ 0.05 was considered significant.

Results

Preoperative characteristics: - There were 30 patients met our inclusion criteria. Preoperative characteristics are shown in .

There were 20 boys and 10 girls. Their mean age at the time of the operation was 10.1±2.1 months (range, 5 to 12 months). The mean body weight was 8.0± 2.3 kg, (range 4.5 to 16 kgs).One patient had a morbid obesity. Early repair was performed electively for hypoxic spells in 18 patients (60 %,) and for persistent hypoxemia (Saturation ≤ 75%) in 6 patients (20%).

Six patients (20%) were operated on emergency/urgent basis due to severe desaturation during cardiacatheterization or multiple cyanotic spells. One patient had Trisomy 21.

Table I. Table I: Preoperative Data.

Variable	Results
Age (month)	10.1±2.1 (15-12)*
Weight (kg)	8.0±2.3 (4.5-16)*
BSA (m^2)	0.39±0.07 (0.27-0.65)*
Room air saturation (%)	77±16.7 (30-98)*
Preoperative hemoglobin (mg/L)	156±29 (109-230)*
Sex	
Male	20 (66.6%)**
Female	10 (33.3 %)**
History of cyanotic spells	18 (60 %)**
B-Blocker use	18 (60%)**
Trisomy 21	1 (3.3%)**
hypospadius	2 (6.6%)**

**** Values are expressed as mean ± SD with the range in parentheses.***
***** Values are expressed as the number of the patients with the percentages in parentheses.***

All patients underwent preoperative ECHO examination. The preoperative ECHO data are shown in Tables II and III .

Table II: Preoperative ECHO Data.

Variable	Mean	Range
Right ventricular outflow tract peak gradient (mmHg)	75.2±14	50-106
Pulmonary annulus size (mm)	6.7±2.1	2-12
Left pulmonary artery size (mm)	5.7±1.2	3-8.0
Right pulmonary artery size (mm)	5.8±1.3	4-9.0

Table III: Associated cardiovascular defects.

Defects	No. of patients (%)
Atrial septal defect	7 (23.3%)
Patent ductus arteriousus	3 (10%)
Right aortic arch	5 (16.6%)
Bilateral Superior vena cava	3 (10%)
LPA stenosis	2 (6.6%)
Coronary anomalous	2 (6.6%)
Situs inversus	1 (3.3%)
Aorto-pulmonary collaterals	
Significant	1 (3.3%)
Insignificant	2 (6.6%)

Apart from the typical features of TOF, the significant preoperative ECHO findings were associated atrial septal defect in seven patients (23.3%) and patent ductus arteriousus in 3 patients (10%). Associated intrathoracic abnormalities were noted in 11 patients, including right aortic arch in 5 patients (16.6%), and bilateral superior vena cava in 3 patients (10%). Two patients (6.6%) had significant stenosis of the proximal portion of LPA. One patient had situs inversus. Preoperative cardiac catheterization was performed in 5 patients (16.6%) to clarify coronary artery anatomy, to better define the pulmonary artery anatomy, or to identify aortopulmonary collaterals. One patient had significant major aortopulmonary collaterals. Two patients had multiple insignificant aortopulmonary collaterals. Two patients had coronary artery abnormality in the form of left anterior descending from right coronary artery in one patient and a single coronary artery in the other.

Operative characteristics: (Table IV) Mean CPB time for repair was 137±34 minutes, and the mean cross-clamp time was 107±29 minutes. The operative approach to close the VSD was through the right atrium in all patients. The RVOT was resected by the transatrial approach with additional resection through the pulmonary valve in all patients. A TAP was required in 28 patients (93.3%). Branch pulmonary arterioplasty was performed in 2 patients. In 3 patients, pop-off interatrial septal defects were left electively. No patients required placement of a right ventricle to pulmonary artery conduit as the patient with anomalous origin of the left anterior descending from the right coronary underwent a very limited ventriculotomy extension from the pulmonary annular incision which was sufficient to relief the infundibular obstruction without injuring the left anterior descending artery. In two patients, the sternum was left open at the end of procedure because of tissue edema and low cardiac output postoperatively.

Table IV: Intraoperative data

Variable	Results
Cardiopulmonary bypass time(min)	137±34 (85-219)
Cross-clamp time(min)	107±29 (64-176)
Temperature C^o	30(28-32)
Use of TAP	28(93.3%)
Pulmonary arterioplasty	2(6.6%)
Use of modified ultrafiltration	17(56.6%)
Open chest	2(6.6%)
Elective Pop-off interatrial septal defect	3(10%)

**** Values are expressed as mean ± SD with the range in parentheses.***
***** Values are expressed as the number of the patients with the percentages in parentheses.***

Postoperative characteristics:-

Early results: Tables V & VI show the early postoperative results. There were no deaths during the postoperative hospital stay. However, one patient (3.3%) died following discharge from the hospital, 25 days after surgical repair (15 days post discharge). It occurred in a 7-month old Down's syndrome infant who suffered from multiple cyanotic spells and operated urgently. He had an uncomplicated early postoperative course. Three days post discharge; he was readmitted with a picture of pericardial effusion.

Table V: Early postoperative results.

Variable	No. (%)
Thirty-day mortality	1 (3.3%)
Arrhythmias	
JET Treatment with amiodarone	3 (10%)
No treatment with amiodarone	12 (40%)
Peritoneal dialysis	1(3.3%)
Inotropes more than 48 hours	2(6.6%)
Neurological complications	0
Superficial wound infection	3 (10%)

Table VI: Early postoperative results.

Variable	Median	Range
Mechanical ventilation (hrs)	23.5	10-480
ICU Stay (days)	2	2-20
Total hospital stay (days)	9.5	7-60

ECHO showed that there was mild pericardial effusion with no signs of tamponade. The patient was discharged from our hospital in a stable condition. Ten days later he died in a local hospital, and his death is presumed to have been due to increasing pericardial effusion that led to cardiac tamponade. No patient developed a neurological deficit. Postoperative rhythm abnormalities included transient junctional ectopic tachycardia (JET) that occurred in 15 patients (50%). Of these patients only 3 patients showed signs of cardiovascular compromise and were treated with amiodarone. By the time of discharge all patients had reverted to a normal sinus rhythm. Two patients required high doses of inotropes for more than 48 hours. The median length of stay in the intensive care was 2 days (range, 2 to 20 days). The two patients who left the operating room with open chest underwent delayed chest closure on postoperative day 2 and 3. The median time of mechanical ventilation was 23.5 hours (range, 10 to 480 hours). Six patients (20%) required mechanical ventilation more than 48 hours. Table VII shows the factors that led to prolonged mechanical ventilation which included open chest in two patients, low cardiac output with acute renal failure in one patient, acute respiratory distress syndrome which required high frequency ventilation in one patient, severe reactive airway disease in a morbid obese patient, and the last one had preoperative major aortopulmonary collaterals (MAPCA) and it was difficult to wean him off ventilator except after cardiac catheterization and coiling of the collaterals. The median duration of hospital stay was 9.5 days (range, 7 to 60 days). Nine patients required hospital stay more than 10 days.

Table VII: Causes of prolonged mechanical ventilation ≥ 48ours

Variable	No. (%)
Open chest	2 (6.6%)
Low cardiac output	1 (3.3%)
Acute respiratory distress syndrome	1 (3.3%)
MAPCs	1 (3.3%)
Severe reactive airway	1 (3.3%)
Total	**6 (20%)**

Table VIII shows the factors that led to delayed discharge which included prolonged mechanical ventilation in the above mentioned 6 patients, repair of malrotation and gangrene in left foot secondary to femoral artery cannulation in one patient, postoperative fever with negative cultures in one patient, and repair of incisional hernia at the site of peritoneal dialysis wound in one patient. Three patients had superficial sternal wound infections that were treated conservatively.

Table VIII: Causes of prolonged hospital stay ≥ 10 days

Variable	No. (%)
Prolonged mechanical ventilation	6 (20%)
Malrotation & Gangrene	1 (3.3%)
Postoperative fever	1 (3.3%)
Repair of incisional hernia	1 (3.3%)
Insertion of a permanent pace maker	1 (3.3%)
Total	**9 (3 %)**

Late results:- Tables IX shows the late post operative results**.** Two patients could not be traced for follow-up as a substantial portion of our patients are referred to our hospital from other areas (in and out of the Saudi Arabia). The median follow-up of the survivors was12 months after surgery (range 2-36 months). There were no late deaths. There were no reoperations during the follow-up period.

Table IX: Postoperative late results

Variable	No. (%)
Late mortality	0
Rhythm	
SR	22 (73.3%)
SR with right bundle branch block	8 (26.6%)
Reoperation	0
Intervention	2 (6.6%)
Follow-up months	Median 12 (Range, 2-36)

All except one were asymptomatic. This patient was in congestive heart failure and responded well to intensive antifailure treatment. All patients were in normal sinus rhythm; a right bundle branch block pattern was present on electrocardiogram in 8 patients (26.6 %). No patient was taking anti-arrhythmic drugs. Echocardiography was performed in all patients available for follow-up (Table X). At the time of most recent follow-up, Echocardiography showed that right and left ventricular systolic functions were normal in all patients. The mean peak gradient across the RVOT was 26±1.9mmHg (range, 10 to 80 mmHg). All except 3 patients had free pulmonary regurgitation. One patient had severe Tricuspid regurgitation and 3 patients had moderate regurgitation. Six patients had a trivial, hemodynamically insignificant residual interventricular communications. Two patients (6.6%) underwent balloon dilatation and stenting. One patient, 19 months after primary repair, had diffusely small LPA (4mm) and a peak gradient of 35 mmHg. He underwent balloon dilatation and stenting of the left pulmonary artery. Follow-up ECHO showed patent stent and pressure gradient decreased to 17 mmHg. The other patient, 24 months after primary repair, had residual stenosis starting below the pulmonary valve with a peak gradient of 80 mmHg and required stenting of RVOT and the peak gradient decreased to 35 mmHg.

Table X: Post operative ECHO results

Variable	Value
Peak RVOT gradient (mmHg)	26±1.9 (10-80)
Free Pulmonary insufficiency	27 (90 %)
Tricuspid insufficiency	
Severe	1(3.3%)
Moderate	3 (10%)
Residual VSD	
Non significant	6 (20%)
Significant	0

Discussion

The traditional approach to the management of cyanotic infants with TOF has been initial shunt followed by a complete repair after the first 6 months of age. Improvements in cardiac anesthesia, cardiopulmonary (CPB) technology, better myocardial preservation, and postoperative intensive care have led to increasing trend to perform primary full repair in the first few months of life. The rationale for early primary repair is documented by several studies [1-16] and data favoring an early repair are increasing:

1. Rabinovitch and his colleagues [18] demonstrated that early repair of TOF could result in a normal number of alveoli and normal growth of proximal and peripheral pulmonary arteries.
2. The distensibility and growth potential of the pulmonary arteries following repair is probably related in part to the elastin content of the pulmonary arteries. The ability to synthesize elastin is probably maximal during the neonatal period and early infancy. [19]
3. Biopsies from the right and the left ventricles showed an abnormal increase in the fibrous component with age in the right ventricles, and this may be the substrate for arrhythmias and ventricular dysfunction. [20]
4. Electrophysiological studies by Ewing and colleagues [21] showed that ventricular arrhythmias may be decreased with early repair of TOF.
5. The study of Castaneda and colleagues [22] showed that the right ventricular hypertrophy is probably induced by RVOT obstruction and increases with age.
6. Some studies [23-25] demonstrated that ventricular arrhythmias are related to the timing of the operation rather than to the operation itself, and suggested that early operation may reduce the occurrence of late arrhythmias.
7. Borrow and colleagues [26] observed that early repair

of TOF may preserve left ventricular function especially with after-load stress using methoxamine.

In addition, initial aortopulmonary shunts are not without morbidity and mortality.[27,28] Aortopulmonary shunts are associated with shunt obstruction/occlusion, pulmonary artery distortion, volume overload of the left ventricle, and the potential for the development of pulmonary vascular obstructive disease. However, proponents of a two-stage approach emphasize on low morbidity and mortality of an initial aortopulmonary shunt and the potential for growth of the pulmonary arteries, avoiding a subsequent TAP. Advocates of the traditional approach would also argue that complete repair in small infants may carry an increased mortality and morbidity compared to delayed repair at older age. Age, weight and TAP have been implicated as independent risk factors for early repair. [4,6] In our study, we tried to clarify the role of these risk factors and we reviewed all patients less than 12 months who had undergone primary full repair of TOF in our hospital.

Effect of age and weight: The optimal age for TOF repair remain controversial. In the past**,** very young age had been considered as a risk factor for hospital mortality. Small size and immaturity of organs were believed to increase the vulnerability of the infant to the generalized insult of CPB or hypothermic arrest. However, in recent years, successful neonatal open heart surgery performed for a number of complex congenital anomalies encouraged the early repair of most congenital anomalies including TOF. This has been illustrated by Kirklin and colleagues [12] by reviewing their experience between 1967 and 1986. They reported a higher mortality in the subgroup of patients with younger age at the time of repair. As their experience and knowledge had grown, the incremental risk of young age was not apparent until age is less than 3 months. The incremental risk of young age may be related to the inability of the young right ventricle to adjust to volume overload after full repair. In our study, there were an insufficient number of deaths to include this as an outcome. The 30-day mortality was low 3% (1 of 30) and no statistical inferences could be drawn. It worthwhile to mention that this death occurred as a result of a preventive cause (Pericardial effusion). A better close observation of this patient would have prevented his death. Our results are consistent with other studies [1-16] and suggesting that primary repair of TOF can be performed with a low mortality. The reduction of age at which risk is increased is no doubt, in part, the result of the increasing technical experience in intracardiac surgery and the early post operative care in the very young. On the other hand, older age at repair was a risk factor for mortality early and late after repair. [16-29] Van Arsdell and his colleagues, [16] in an effort to define the optimal age for repair of TOF, reported their experience with 227 patients. The median age of repair was 14 months (range, 8 days to 9.6 years). They observed that the best survival and physiological outcomes were achieved with primary repair in children aged 3 to 11 months. Multivariate analysis demonstrated that an age less than 3 months was independently associated with increase morbidity but not mortality, and age more than 11 months was associated with increased mortality. Supporting this observation, Van Dongen and his colleagues [29] has found that age less than 3 months was associated with increased use of inotropic support, a higher incidence of organ dysfunction and a prolonged ventilator support. Murphy and his colleagues [30] also reported that mortality was related to older age at the time of repair (more than two years). This may be due to irreversible effect of long standing RV hypertrophy, cyanosis and polycythemia on cardiac structure and function. Gatzoulis and colleagues [31] reported that RV hypertrophy begin shortly after birth, continues as age increases, and begin to be irreversible by 4 year of age. This hypertrophy often requires extensive muscular resection, which may form a potential substrate for ventricular arrhythmias and dysfunction.

TAP and mortality: There is a general acceptance that an early approach to full repair of cyanotic TOF will be associated with a perceived increase in the need for TAP that would result in damaging the pulmonary valve. [9,32] This latter observation, however, does not appear logical for two reasons. First, the RVOT is unlikely to grow, as there is reduced flow through it. Second, the data reported from several studies, [3-6] repair was performed in severely symptomatic infants; infants with the worst anatomy (very small pulmonary annuli) were selected out to undergo surgery. In our study, all except two required TAP and this is in accordance other series [14,33] which showed incidences between 85% and 90%. The high incidence of TAP is reflective of the selection process for surgery rather than being intrinsic to young age as 40% of our patients were operated on emergency basis and/or for persistent hypoxemia reflecting worse anatomy.

TAP was observed to increase operative mortality as reported by Hammon and colleagues. [6] TAP increased operative mortality to 15.8% in infants compared with 0% in older children without TAP. Kirklin and colleagues [4] also reported that TAP was an independent incremental risk factor for mortality following primary repair of TOF.

On the other hand, in a review of 208 patients, Van Arsdell and his colleagues [16] observed that TAP was not associated with an increased operative mortality. Likewise Gustafson and colleagues [9] reported 0% mortality with the use of TAP.

In our study, we did not observe any short-term adverse effects with the use of TAP on postoperative morbidity and mortality.

TAP and Pulmonary insufficiency, in our study, although 90 % of our patients had free pulmonary incompetence, we did not observe any short-term adverse effect with the use of TAP on postoperative right ventricular function. The necessity of TAP in all of our infants reflects the severity of outflow tract obstruction, which required surgery early in life. The TAP should be made only large enough to adequately relieve the RVOT obstruction. It is desirable to preserve the pulmonary annulus and to have a competent valve, which permits normal exercise capacity and similar life expectancy to the general matched population. However, the presence of severe hypoplastic pulmonary annulus often precludes this from the technical point of view, and TAP is mandatory. This can be regarded as a drawback when considering early versus late repair. However, early repair requires simple division of the obstructing muscles and tailoring of a relatively narrow TAP to prevent aneurysmal dilatation most likely contributes to a better postoperative RV function. These advantages may outweigh the disadvantages of the inability to have a postoperative competent pulmonary valve.

Opponents of TAP point to the long-term risk of pulmonary insufficiency. Actually, all methods of relieving RVOTO can lead to pulmonary insufficiency even pulmonary valvotomy alone. Pulmonary insufficiency does not seem to have a deleterious effect on long-term studies. Ellison and colleagues [34] found in experimental animals that isolated pulmonary insufficiency was well tolerated over years. Calder and colleagues [35] observed that pulmonary insufficiency was well tolerated clinically and hemodynamically, unless there was distal pulmonary stenosis or branch stenosis. Murphy and colleagues, [36] by using mean right atrial pressure as an index of RV diastolic dysfunction, found no significant difference among different methods of RVOT reconstruction after TOF repair. Likewise, Walsh and colleagues[37] showed good exercise tolerance and good ventricular function in patients with TAP. In contrast, Oku and colleagues, [38] reported that late postoperative hemodynamics and ventricular function were poor in patients with moderate pulmonary stenosis and moderate pulmonary insufficiency compared with patients with mild residual stenosis and mild pulmonary insufficiency. Likewise, Zahka and colleagues [39] reported that ventricular arrhythmias were related to the severity of pulmonary regurgitation. In our study, all patients who underwent TAP patients had free pulmonary insufficiency postoperatively, and we did not observe a negative effect on early and mid-term results with the use of TAP on postoperative RV function. The absence of RV dysfunction may be related to the trans-atrial approach we used for the closure of the VSD and the small transannular patch**.** Some studies [40,41] demonstrated a higher incidence of right ventricular dysfunction with Trans-ventricular repair of TOF compared to the trans-atrial approach.

Postoperative arrhythmias did occur in 15(50%) of our patients, predominately JET. It was associated with the level of inotropic support required in the first 24 hours. It was transient and only 3 of them showed signs of cardiovascular compromise and were treated with amiodarone. The others were managed by minimization of inotropic support, maintenance dose of digoxin, and moderate surface cooling to a core temperature of ± 35^{o}C. By the time of discharge all patients had reverted to a normal sinus rhythm. Although our incidence of JET 50% is higher than that reported elsewhere [15,42], awareness of JET in the postoperative period has increased. Nevertheless, our data suggest that arrhythmias in the postoperative period should be considered seriously. This particularly important because early recognition and prompt, aggressive treatment is necessary to minimize morbidity and mortality. The incidence of JET, one of the most hemodynamically significant arrhythmias, has been reported to be increased with younger age of repair.[15,42] The non-sustained rate of arrhythmia may be attributed to the transatrial approach used in our study. Transventricular repair was associated with high-sustained arrhythmias [40,41] which may be induced by the ventricular scar.

In 3 patients, we electively induced pop-off inter-atrial septal defects at repair. We and others [43] believe that this provides a useful mechanism of decompressing the right ventricle in the immediate postoperative period and allows time for improvement of right ventricular compliance. Cardiac output is maintained at the expense of mild degree of arterial oxygen desaturation. This may also have decreased the number of patients requiring high doses of inotropes in our study (6.6%). It is worthwhile to mention that postoperative ECHO showed that the electively induced pop-off inter-atrial septal defect was closed with the improvement of the right ventricular function.

The freedom from reoperation in our series is excellent (0%). Only two patients (6.6%) required intervention during the follow-up period. In one patient, 24 months after primary repair, residual stenosis starting below the pulmonary valve was found and required stenting of RVOT. This may be related to our technique that includes non-aggressive resection of the RVOT muscles to prevent weakness of the right ventricular wall. In the other patient, 19 months after primary repair, a diffusely small LPA (4mm) was found and required balloon dilatation and stenting of the left pulmonary artery. Residual obstructions that include LPA origin were observed in some studies.[43,44] Ductal tissues have been reported to extend into this area. Constriction and fibrosis of this ductal tissue after the neonatal period (and hence after repair) may explain this stenosis. Extension of pericardial patch across LPA origin would have avoided this problem.

It was anticipated that there might be a clinically important increase in early postoperative morbidity associated with early repair of TOF. This is might be reflected in an increased duration of mechanical ventilation, hemodynamic support and a higher incidence of organ system failures. However, this concern was not observed in our study. Given that all patients who undergo repair of congenital heart disease will develop a certain degree of cardiorespiratory impairment, it is worth noting that only six patients (20%) of our patients required mechanical ventilation $\geq$ 48 hours. Two of them had preoperative comorbidity. One patient, with a morbid obesity, had a preoperative severe reactive airway in one patient. The other patient had associated MAPCs that led to flooding of the lungs and difficulty in extubation. This patient was extubated early after coiling of the MAPCs. This resulted in increased length of ICU stay, but there was no effect on short-term morbidity.

Although the number of patients in our study is small and the follow-up is still short, this study shed some lights on the effect of young age and the requirement for TAP on the outcome the surgical repair of TOF in infancy. A longer follow-up is needed for this group of patients to assess the long-term results of early repair of TOF.

Conclusions

This retrospective review demonstrates that early repair of TOF is associated with excellent survival and a low incidence of postoperative morbidity. Early definitive repair in severely cyanotic TOF is associated with an increased requirement for TAP but it did not have an impact on operative mortality or morbidity.

References

1. Barratt-Boyes B and Neutze J. Primary repair of tetralogy of Fallot in infancy using profound hypothermia with circulatory arrest and limited cardiopulmonary bypass. Ann Surg 1973; 178: 406-411.
2. Starr A, Bonchek L, and Sunderland C. Total correction of tetralogy of Fallot in infancy. Thorac Cardiovasc Surg 1973; 65: 45-57.
3. Tucker W, Turley K, Ullyot D, et al. Management of symptomatic tetralogy of Fallot in the first year of life. J Thorac Cardiovasc Surg 1979; 78: 494-501.
4. Kirklin J, Blakstone E, Pacifico A, et al. Routine primary repair vs. two stage repair of tetralogy of Fallot. Circulation 1979; 60: 373-379.
5. Kirklin JW, Blakstone E, Kirklin JK, et al. Surgical results and protocols in the spectrum of tetralogy of Fallot. Ann Surg 1983; 198: 251-265.
6. Hammon J, Henry C, Merrill W, et al. Tetralogy of Fallot: Selective surgical management can minimize operative mortality. Ann Thorac Surg 1985; 40: 280-284.
7. Zhao H, Miller D, Reitz B, et al. Surgical repair of tetralogy of Fallot. J Thorac Cardiovasc Surg 1985; 89: 204-220.
8. Kirklin J, Blackstone E, Colvin E, et al. Early primary correction of tetralogy of Fallot. Ann Thorac Surg 1988; 45: 231-233.
9. Gustafson R, Murray G, Warden H, et al. Early primary repair of tetralogy of Fallot. Ann Thorac Surg 1988; 45: 235-241.
10. Touati G, Vouche P, Amodeo A, et al. Primary repair of tetralogy of Fallot in infancy. J Thorac Cardiovasc Surg 1990; 99: 396-403.
11. Groh M, Melions J, Bove E, et al. Repair of tetralogy of Fallot in infancy: effect of pulmonary artery outcome. Circulation 1991; 84(Supp) III 206-212.
12. Kirklin J, Blakstone E, Joans R, et al. Morphological and surgical determinants of outcome after repair of tetralogy of Fallot and pulmonary stenosis: A two-institutional study. J Thorac Cardiovasc Surg 1992; 103: 706-723.
13. Uva M, Chardigny C, Galetti L et al. Surgery for tetralogy of Fallot at less than six months of age. J Thorac Cardiovasc Surg 1994; 107: 1291-1300.
14. Caspi J, Zalstein E, Zucker N, et al. Surgical management of tetralogy of Fallot in the first year of life. Ann Thorac Surg 1999; 68: 1344-1349.
15. Pigula F, Khalil P Mayer J. et al. Repair of tetralogy of Fallot in neonate and young infants. Circulation 1999; 100(Supp) II 157-161.
16. Van Arsdell G, Maharaj G, Tom J, et al. What is the optimal age of repair of tetralogy of Fallot? Circulation 2000; 102(Suppl III): III 123-129.
17. Rowlatt J, Rimoldi H, and Lev M. The quantitative anatomy of the normal child's heart. Pediatr Clin North Am 1963; 10: 499-587.
18. Rabinovitch M, Herrera-Deleon V, Castaneda A, et al. Growth and development of the pulmonary vascular bed in patients with tetralogy of Fallot with or without pulmonary atresia. Circulation 1987; 94: 498-503.

19.Rosenberg H, Williams W, Trusler G, et al. Structural composition of central pulmonary arteries. J Thorac Cardiovasc Surg 1985; 89: 204-220.
20.Hegerty A, Anderson R, and Deanfield J. Myocardial fibrosis in tetralogy of Fallot: effect of repair or part of natural history? J Am Coll Cardiol 1988; 11: 138A.
21. Ewing L, Gillette E, Zeigler V, et al. Only 8 % of postoperative tetralogy patients have inducible ventricular arrhythmias. J Am Coll Cardiol 1987; 9: 38A.
22.Castaneda A, Freed M, Williams R, et al. Repair of tetralogy of Fallot in infancy. J Thorac and Cardiovasc Surg 1977; 74: 372-381.
23.Deanfield J, Mc Kenna W, Presbitero P, et al. Ventricular arrhythmias in unrepaired and repaired tetralogy of Fallot: relation of age, timing of repair, and hemodynamic status. Br Heart J 1984; 52: 77-81.
24.Sullivan I, Presbitero P, Gooch V, et al. Is ventricular arrhythmia in repaired tetralogy of Fallot an effect of operation or a consequence of the course of the disease? A prospective study. Br Heart J 1987; 58: 40-44.
25.Kobayashi J, Hirose H, Nakano S, et al. Ambulatory electrocardiographic study of the frequency and the cause of ventricular arrhythmia after correction of tetralogy of Fallot. Am J Cardiol 1984; 54: 1310-1313.
26.Borrow K, Green L, Castaneda A, et al. Left ventricular function after repair of tetralogy of Fallot and its relationship to age at surgery. Circulation 1980; 61: 1150-1158.
27.Barbosa R, Somerville J, and Ross D. Aorto-right pulmonary artery anastomosis: long-term problems and results after correction. Am J Cardiol 1974; 33: 125-131.
28. Greenwood R, Nadas A, Rosenthal A, et al. Ascending aorto-pulmonary artery anastomosis for cyanotic congenital heart disease. Am Heart 1977; 14: 94-99..
29.Van Dongen E, Glansdorp A, Mildner R, et al. The influence of perioperative factors on outcomes in children aged less than 18 months after repair of tetralogy of Fallot. J Thorac and Cardiovasc Surg 2003; 126: 703-710.
30.Murphy J, Gersh B, Mair D, et al. Long term outcome in patients undergoing surgical repair of tetralogy of Fallot. N Eng J Med 1993; 329: 593-599.
31.Gatzoulis M, Balaji S, Webber S, et al. Risk factors for arrhythmia and sudden cardiac death late after repair of tetralogy of Fallot. Lancet 2000; 356: 975-981.
32.Hennein H, Mosca R, Urcelay G, et al. Intermediate results after complete repair of tetralogy of Fallot in infants. J Thorac and Cardiovasc Surg 1995; 109:332-344.
33.Kaushal S, Iyer K, Sharma R, et al. Surgical experience with total correction of tetralogy of Fallot in infancy (Abstract). Inter J Cardio 1996; 56: 35-40.
34.Ellison R, Brown W, Yeh T, et al. The significance of acute and chronic pulmonary valvular insufficiency. J Thorac Cardiovasc Surg 1970; 60: 549-551.
35.Calder A, Barratt-Boyes B, Brandt P, et al. Postoperative evaluation of patients with tetralogy of Fallot repaired in infancy. J Thorac Cardiovasc Surg 1980; 77: 701-709.
36.Murphy J, Freed M, Keane J, et al. Hemodynamic results after intracardiac repair of tetralogy of Fallot. Circulation 1980; 62: (Suppl I) 168-172.
37.Walsh E, Rockenmacher S, Keane J, et al. Late results in patients with tetralogy of Fallot repaired during infancy. Circulation 1988; 77: 1062-1067.
38.Oku H, Shirotani H, Sunakawa A, et al. Postoperative long-term results in total correction of tetralogy of Fallot: hemodynamic and cardiac function. Ann Thorac Surg; 1986; 41: 413-419.
39.Zahka K, Horneffler P, Rowe S, et al. Long-term valvular function after total repair of tetralogy of Fallot: relation to ventricular arrhythmias. Circulation 1988; 78 :(Suppl III) 14-23.
40.Katz N, Blackstone E, Kirklin J, et al. Late survival and symptoms after repair of tetralogy of Fallot. Circulation 1982; 65: 403-410.
41.Chandar J, Wolf G, Garson A, et al. Ventricular arrhythmias in postoperative tetralogy of Fallot. Am J Cardiol 1990; 65: 55-61.
42.Rouillard K, Hanley F and Dorostakar P. Early repair of tetralogy of Fallot is associated with a higher incidence of postoperative junctional ectopic tachycardia. (abstract). J Am Coll Cardiol 1998; 355.
43.Di Donato R, Joans R, Lang P, et al. Neonatal repair of tetralogy of Fallot with and without pulmonary atresia. Thorac Cardiovasc Surg 1991; 101: 126-137.
44.Elzenga N, and Gittenberger-de Groot A. The ductus arteriousus and stenosis of the pulmonary arteries in pulmonary atresia.(Abstract). Int J Cardiol 1986:11: 195-208.

Tracheal Reconstruction

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From January 1997 through 2004, 23 patients underwent tracheal resections and reconstructions. 18 of these patients had received ventilatory assistance at a time. 2 patients had undergone a prior attempt of tracheal reconstruction, 3 patients had had laser treatment, and 2 patients used to have regular tracheal dilatation. 3 patients had tracheal tumors. Follow-up was obtained by direct patient contact and was obtained in all patients.

The results have been classified as good, satisfactory, and death. The average length of follow-up was 3.2 years. We had two deaths. The results were good in 18 patients, and satisfactory in 3 patients.

Post-intubation tracheal injuries remain the most common indication for tracheal resection and reconstruction, despite identification of the causes of these lesions and development of techniques for their avoidance. Tracheal tumors are also an important indication for reconstruction of the trachea. We report our experience of tracheal reconstruction in a consecutive series of 23 patients treated in the last 8 years.

Methods

From January 1997 to December 2004 a total of 23 patients underwent primary tracheal resection and reconstruction for different causes of tracheal stenosis or obstruction. They included 13 females and 10 males with an age range of 1 to 52 years -mean 25 years-(table1). Follow-up was obtained by direct patient contact and was obtained in all patients.

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Age in years	No. of patients
10>	2
10-19	6
10-29	10
30-39	3
40-50	1
50<	1

Table 1. Age distribution

The main cause of airway stenosis was intubation and mechanical ventilation (18 patients). 9 patients had trauma that necessitated ventilatory support for sometime, 7 patients who needed ventilatory support after other kinds of operation followed by respiratory failure (5 patients post neurosurgical operations, 1 post cardiac surgery, and one after stormy gastric stapling for morbid obesity). One patient received ventilatory support for suicide attempts; one patient was ventilated as a result of faulty ingestion of pesticide.

The remaining 5 patients did not have any history of mechanical ventilation. Three patients had tracheal tumors (Fig.1), one patient had pulmonary artery sling that was compressing the trachea just before its bifurcation, and in the last patient the cause of tracheal stenosis could not be identified (idiopathic).

The length of mechanical ventilation varied from 4 to 80 days with mean of 17days. 14 patients had an existing tracheostomy when entered for tracheal reconstruction and it was used for the induction of anesthesia, 6 patients did not have tracheostomy and the other 3 patients had tracheostomy at a time but were intubated orally.

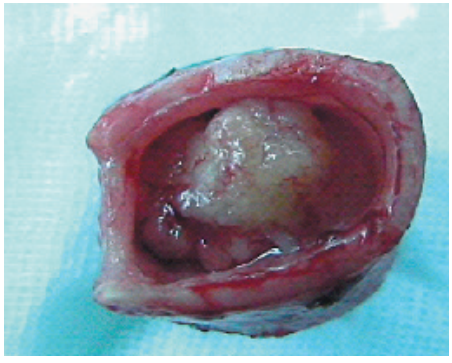

Fig.1. resected tracheal segment with adenoid cystic carcinoma.

18 patients had undergone prior attempts before referral. 8 patients had tracheostomy distal to the obstruction; one of them was done as an emergency procedure in the patient with idiopathic tracheal stenosis. 6 patients had tracheal dilatation once or more, 1 of them proceeded to reconstruction, 4 had tracheostomy followed by tracheal reconstruction, and the 6th had tracheostomy followed by its closure later with the insertion of a tracheal stent. This patient had a tracheoesophageal fistula (TOF) at a lower level. 2 patients had laser dilatation that was followed later by tracheostomy. 2 patients were referred to us with restenosis after unsuccessful tracheal reconstruction. The remaining 5 patients did not have any intervention before referral.

Although a careful preoperative endoscopic examination to assess the extent and the length of the stenotic segment and also the length of the normal airway remaining and the presence of active inflammatory process was our standard method of diagnosis, it was not always possible in all cases. In these cases we found that thin cuts CT (2mm) scan of the neck and the chest were very helpful and accurate to identify all the data about the lesion except the extent of inflammation. All patients underwent accurate laryngotracheal studies to determine the integrity of the vocal cords..

The lesions were located at the cervical level in 9 patients (39%), at the cervico-thoracic junction level in 11 patients (48%) and were intra-thoracic in 3 patients (13%). 4 patients had preoperative signs of tracheomalacia in the site of stenosis.

Operative techniques.

Surgical techniques have been detailed previously[1]. The operative approach was through a cervical collar incision in 9 patients (39%), cervical with sternal split in 8 patients (35%), cervical with full median sternotomy in 3 patients (13%)-one patient with along narrow segment that needed laryngeal drop, one patient with additional tracheo-esophageal fistula, and one patient who had previous reconstruction-. Median sternotomy was employed in only in one patient (4%) who had pulmonary artery sling. 2 patients (8%) underwent repair via a high posterolateral thoracotomy.

Surgical procedures were circumferential tracheal resections with end to end anastomosis in all patients, one patient had laryngeal drop, and one patient had repair of tracheo-esophageal fistula.

The patients were placed in a supine position with a bag beneath the shoulders and the head hyper-extended except for the two patients who had right posterolateral thoracotomy.

The anesthetic techniques have been described[2]. If the patient was tracheostomised; stomas are often used for intubation and the induction of anesthesia. If the patient did not have a stoma, a rigid bronchoscope was performed before intervention to assess the extent of the stenosis, to guide the intubation, or to dilate the stenotic segment with dilators and pediatric bronchoscopes with the patient under general anesthesia. In some cases the stenotic segment could segment could not be dilated and the endotracheal tube was positioned just above the stenotic segment. In another situation with an endobronchial tumor at the upper third of the trachea, a guide wire was passed by the side of the tumor with the help of the rigid bronchoscope then a size 3 endotracheal tube was passed along side the tumor over the guide wire.

The dissection is performed mainly on the anterior surface of the trachea and carefully on the lateral sides only in correspondence with the stenotic segment to avoid injury to the vascular supply and to the recurrent laryngeal nerves, which lie in the tracheo-esophageal groove. Then, the trachea is divided below the stenotic area, the ventilation is performed with a cross-field endotracheal tube, placed in the distal tracheal tract (fig.2), the original oro-tracheal tube is withdrawn by the anesthetist. The posterior surface of the trachea is also dissected then the two ends of the trachea are approximated together to make sure that the anastomosis will be without tension. During the anastomosis the ventilation is ensured from the cross-field tube. After the resection of the stenotic tract (Fig.3), the primary anastomosis is performed with four interrupted sutures of 4-0 polyglactin for the membranous part of the trachea. The cross-field endotracheal tube is then removed and these 4 sutures are tied with the knots outside the lumen while the head is maintained in the flexed position. An oral endotracheal tube is then passed by the anesthetist and guided by the surgeon in the lower segment of the trachea. Now about 8 to 14 interrupted sutures of 3-0 polyglactin are placed in the lateral and anterior aspects of the trachea (the cartilaginous part) and all the knots of the sutures are tied outside.

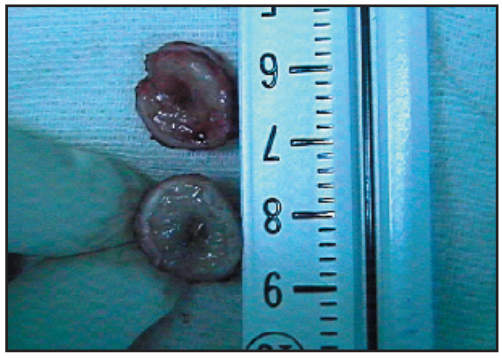

Fig.2. the lumen of the resected segment

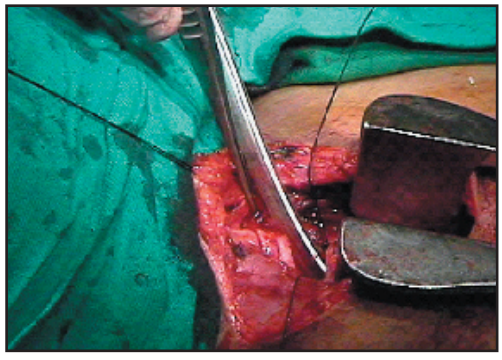

Fig.3. Ventilation across the surgical field

Anastomoses were covered with adjacent tissues, thyroid isthmus, cervical strap muscle, and other tissue including thymus and pericardial fat pad. Tissue was interposed, in general, between the trachea and innominate artery if the anastomosis was adjacent or if the artery had been previously dissected.

After the closure of the incision, a heavy suture is placed through the chin skin and the presternal skin: these sutures are tied with the neck in flexion to protect against sudden hyperextension. The patient is extubated in the operating room and is kept under observation for 24 to 48 hours in an intensive care unit.

In the one-year old patient with tracheal stenosis and pulmonary artery sling we used the cardiopulmonary bypass. We did not impose any myocardial ischemia, and the entire procedure was performed with a mild degree of hypothermia. The trachea was exposed between the superior vena cava and the aorta. We used 6-0 monofilament PDS polydioxanone for the anastomosis.

Cervical flexion is maintained with a suture from the submental crease of the chin to the presternal skin for 7 days after the operation. Laryngeal release described by Montgomery[3] was needed in only one patient in whom 4.5 cm were resected.

In one patient, in addition to the resection anastomosis, repair of tracheo-esophageal fistula was also done. This kind of repair was reported before[4]. This patient was assessed with virtual bronchoscopy reconstructed from CT scan. In this patient the after resection of the stenotic segment and trans-field ventilation to the lower segment of the trachea, the fistula was divided, and both the anterior wall of the esophagus and the posterior wall of the trachea were closed separately with interrupted 3-0 polyglactin. A muscle flap from the sternomastoid muscle was interposed between the trachea and the esophagus. Eventually, tracheal reconstruction was performed.

RESULTS

Follow-up was obtained by direct patient contact and was obtained in all patients. The results have been classified as good, satisfactory, and death. The results are described as good if the patient is functionally able to perform usual activities and if postoperative roentgenograms or bronchoscopic examinations show an anatomically good airway.

Results are considered satisfactory if the patients can perform normal activities but are stressed on exercise, if they have abnormalities such as a paralyzed vocal cord (totally or partially), or if significant narrowing is evident on either endoscopic or roentgenologic examination, even if the patient's level of activity does not clini-

cally evidence his. The average length of follow-up was 3.2 years . We had two deaths. The results were good in 18 patients, and satisfactory in 3 patients (table2).

Table 2. The overall results.

Good		Satisfactory		Death	
.No	%	.No	%	.No	%
18	79	3	13	2	9

The first mortality was the 1 year-old patient with pulmonary artery sling. He died in the first post operative day due to progressive hypoxemia. He had an intra operative event during the construction of the tracheal anastomosis where the aortic cannula was accidentally slipped. There was a major flooding of blood into the opened air way.

The second patient was a 52 year-old. She had gastric stapling for morbid obesity which was followed by abdominal complications. She was mechanically ventilated for 35 days without having a tracheostomy. In one and half month after extubation, she developed tracheal stenosis about 2 cm. above the carina. She had bronchoscopy and tracheal dilatation. She was explored via a right posterolateral thoracotomy and had tracheal resection with end to end anastomosis which went uneventful. She was weaned off mechanical ventilation with some difficulty on the 5th postoperative day. Her recovery was relatively slow but she was transferred to the room on her 9th postoperative day. She had a cerebral stroke on the 24th postoperative day, and died of the sequelae of the stroke on the 35th postoperative day.

3 patients had only satisfactory results. The first one was a 35 year-old male patient. He had post intubation tracheal stenosis which was treated with tracheostomy that was followed with tracheal reconstruction. He had post reconstruction tracheal restenosis then another tracheostomy was done below the level of repair. He was referred to us for redo surgery. The operation took about 8 hours due to the extensive inflammatory adhesions. He had post operative bilateral recurrent laryngeal nerve injury. He was mechanically ventilated for the first 14 hours postoperatively. He had laser cordotomy that improved his breathing pattern and he was discharged on the 16th postoperative day and was referred for speech therapy.

The second patient was a 23 year-old male patient. He also was referred for redo tracheal reconstruction after an unsuccessful repair. He had reconstruction that was complicated by bilateral recurrent laryngeal nerve injury. He also had laser cordotomy in the postoperative period. He had restenosis at the Anastomotic site which required repeated dilatation.

The third patient was a 26 year-old male. He had mechanical ventilation for 21 days after a motor car accident. He had tracheostomy after the closure of which he had tracheal stenosis. He had repeated tracheal dilatation. In one of these trials, he developed tracheo-esophageal fistula at a lower level than the stenotic segment. The tracheo-esophageal fistula was treated by insertion of a tracheal stent. The stent was dislodged and dropped in the right main bronchus closing the orifice of the right upper lobe bronchus. The patient was then referred to us for tracheal reconstruction and repair of the tracheo-esophageal fistula. He had successful reconstruction with repair of the tracheo-esophageal fistula and removal of the stent. This patient has evidence of tracheal restenosis not to the extent to necessitate intervention.

Prior Intervention:

Results in patients who had prior tracheal are listed in table (3). In the 2 patients who had previous resection and reconstruction, the outcome was only satisfactory none of them had good result compared with 86% good results in the 21 patients who did not have prior tracheal reconstruction.

Table 3. Results in comparison to previous intervention

Previous Intervention	Total .No	Good Outcome		Satisfactory Outcome		Mortality	
		.No	%	.No	%	.No	%
Tracheostomy	17	14	82	3	18	0	
Tracheal dilatation	6	4	66	1	17	1	17
Tracheal stent	1	0	-	1	100	0	-
Laser therapy	2	2	100	0	-	0	-
Tracheal reconstruction	2	0	-	2	100	0	-
No previous intervention	5	4	80	0	-	1	20

17 patients had tracheostomy before going to surgery. 14 of them (82%) had good outcome while 3 patients (18%) had only satisfactory outcome. In the remaining 6 patients who did not have tracheostomy, 4 patients (67%) were in the good outcome while 2 patients (33%) were in the mortality group. Although the mortality appear significantly higher in the second group, this is due to the small number of patients in this group as well as the causes of mortality were not directly related to the presence of tracheostomy. The other procedures of previous intervention included insertion of stents, previous laser therapy, and repeated tracheal dilatation. They did not seem to affect the results. None of the patients needed tracheostomy in the postoperative period.

Laryngeal releases.

One patient had a laryngeal release procedure to reduce tension on the anastomosis. The length of resection in this patient was 4.5 cm. This patient had a good outcome. .

Repair of Tracheo-Esophageal Fistula.

One patient underwent repair of a tracheo-esophageal fistula concomitantly with tracheal resection and reconstruction for stenosis. This patient had a satisfactory outcome.

Postoperative reintubation.

The need for reintubation after reconstruction indicated a problem. 8 patients (35%) needed postoperative intubation. Only 3 of them had good outcome. 3 patients had satisfactory outcome and the remaining 2 died in the postoperative period. Intubation was either done as failure to extubated the patients or was done on the operative day in all patients.

Complications.

Complications are summarized in table (4)

Table 4. Recorded complications.

Recurrent L.N. injury	2
Wound infection	3
dehiscence	2
Restenosis	2
pneumothorax	1
Cerebral stroke	1

Recurrent laryngeal nerve injury:

Two patients had recurrent laryngeal nerve injury. Both had previous tracheal reconstruction and one of them had another tracheostomy below the level of restenosis. There was extensive fibrosis at the site of tracheal reconstruction which made it almost impossible to avoid injury of the nerve during the procedure. Both patients needed mechanical ventilation for less than 24 hours. Both had laser cordotomy in the postoperative period to increase the cross section of the air way at the level of the cords. One patient had dehiscence of a small portion of the anastomosis anteriorly. He required reexploration and primary closure with the support of a muscle flap. The other developed restenosis at the anastomotic site nine months postoperatively. It was dealt with by repeated tracheal dilatation.

Dehiscence

Anastomotic dehiscence occurred in 2 patients. One patient had dehiscence of a small portion of the anastomosis anteriorly. He required reexploration and primary closure with the support of a muscle flap. The second patient had minimal leak was successfully managed with drainage of the cervical wound and antibiotics.

Restenosis

Restenosis at the anastomotic site occurred in two of the patients. One patient had redo tracheal reconstruction which was complicated by bilateral recurrent laryngeal nerve palsy. He developed restenosis at the anastomotic site nine months postoperatively. It was dealt with by repeated tracheal dilatation. The other was the patient with the concomitant repair of the tracheo-esophageal fistula with the reconstruction. He did not need intervention due to the limited exercise performance he had.

Infection

Infectious complications developed in 3 patients. Two of them were minor infections were treated only with intravenous antibiotics and one required operative debridement and closure of the anterior wall of the trachea with the help of a muscle flap.

Other

One postoperative pneumothorax occurred and treated with an intercostals tube and one patient had cerebral stroke which resulted in the patient's death.

DISCUSSION

The causes of postintubation stenosis have been well established[5-6]. Prevention is possible to a high degree by use of large volume, low pressure cuffs and careful management of tracheostomy tubes. However, the lesions continue to appear, most likely because of overinflation of nonelastic plastic cuffs and leverage on tracheostomy tubes. Tracheal tumors, although rare, are the second cause that leads to tracheal resection and reconstruction.

Conservative treatments in the form of repeated tracheal dilation, local and systemic steroids, cryosurgery, laser treatment, and prolonged or permanent stenting, have largely proved successful and without excessive complications only for highly selected lesions [7-9].

Recent years have seen a prolific increase in use of the laser for management of cicatrizial lesions of the airway[10]. However, experts in laser therapy agree that only thin web line strictures can be removed definitively

by laser treatment[11]. Laser resection provides only temporary benefit in patients with larger circumferential lesions. Furthermore, repeated laser resection undoubtedly increases the extent of injury in some cases. Failure rates with laser treatment range from 23% to 43%[12]. Segmental tracheal resection remains the preferred definitive treatment for postintubation stenosis.

The use of an endotracheal prosthesis could increase the length of stenosis and it is recommended avoiding this treatment in all patients who are candidates to receive surgical operations. It is believed that laser and endotracheal prosthesis should be used as a therapeutic option only in patients with absolute contraindications to surgery.

Regarding the surgical technique, we adopted the basic principles of tracheal reconstruction introduced by authors with large experience [1, 13-16]. These principles include avoidance of excessive anastomotic tension, maintenance of tracheal blood supply and meticulous dissection and anastomosis. We adopt interrupted absorbable sutures for anastomosis (3-0 or 4-0) in all patients.

In our series good or satisfactory results were obtained in 91% of all resections with a mortality rate of 9%.We believe that these good results are related to a careful selection of patients and to the strict adoption of technical details suggested by authors of huge experience in this field of surgery [13,15]. We excluded the patients with involvement of the subglottic region. We also did not operate on patients in whom the preoperative assessment showed inflammation and edema at the border of stenotic segment. The presence of active inflammation and edema is one of the main reasons for recurrence. In fact, patients with severe inflammatory signs should be excluded from surgery and re-evaluated after a suitable period of observation, until the stenosis is stabilized. We also excluded the patients with apparent tracheomalacia[17].

Our main complications and less satisfactory results were in patients who had undergone a prior failed reconstruction. Our early experience, the small number of the patients in this subgroup, and the extensive and complex nature of these prior procedures probably explain the unfavorable results in this small group. The lowered success rate in patients who had a failure of reconstruction before referral (0% good results versus 78%) confirms the intuitive conclusion that the first operation is most likely to succeed [18].

References

1. Grillo HC. Tracheal surgery. In: Ravitch M, Steichen F, eds. Atlas of general thoracic surgery. Philadelphia: WB Saunders, 1987:293-331.
2. Wilson RS. Anesthetic management for tracheal reconstruction. In: Grillo HC, Eschapasse H, eds. Major challenges. International Trends in General Thoracic Surgery. Philadelphia: WB Saunders, 1987:3-12.
3. Montgomery WW. Suprahyoid release for tracheal stenosis. Arch Otolaryngol 1974;99:255-60
4. Mathisen DJ, Grillo HC, Wain JC, Hilgenberg AD. Management of acquired nonmalignant tracheoesophageal fistula. Ann Thorac Surg 1991;52:759-65
5. Andrews MJ, Pearson FG. Incidence and pathogenesis of tracheal injury following cuffed tube tracheostomy with assisted ventilation. Ann Surg 1971;173:249-63
6. Cooper JD, Grillo HC. The evolution of tracheal injury due to ventilatory assistance through cuffed tubes: a pathologic study. Ann Surg 1969; 169:334-48.
7. Personne C, Colchen A, Leroy M, Vourc'h G, Toty L. Indications and technique for endoscopic laser resections in bronchology. J THORAC CARDIOVASC SURG 1986; 91:710-5.
8. Gaissert HA, Grillo HC, Mathisen DJ, Wain JC. Temporary and permanent restoration of airway continuity with the tracheal T-tube. J THORAC CARDIOVASC SURG 1994; 107:600-6.
9. Nashef SAM, Dromer C, Velly JF, Labrousse L, Couraud L. Expanding wire stents in benign tracheobronchial disease: indications and complications. Ann Thorac Surg 1992; 54: 937-40.
10. Sharpe D.A.C., Dixon K., Moghissi K. Endoscopic laser treatment for tracheal obstruction. Eur J Cardiothorac Surg 1996;10:722-726.
11. Shapshay S.M., Beamis J.F., Jr., Hybels R.L., Bohigian R.K. Endoscopic treatment of subglottic and tracheal stenosis by radial laser incision and dilatation. Ann Otol Rhinol Laryngol 1987; 96(6):661-664.
12. Mehta AC, Lee FYW, Cordasco EM, Kirby T, Eliachar I, DeBoer G. Concentric tracheal and subglottic stenosis: management using the Nd-YAG laser for mucosal sparing followed by a gentle dilatation. Chest 1993; 104:673-7.
13. Grillo H.C., Donahue D.M., Mathisen D.J., Wain J.C., Wright C.D. Postintubation tracheal stenosis. Treatment and results. J Thorac Cardiovasc Surg 1995; 109:486-493.
14. Grillo H.C., Mathisen D.J., Wain J.C. Laryngotracheal resection and reconstruction for subglottic stenosis. Ann Thorac Surg 1992; 53:54-63.
15. Pearson F.G., Cooper J.D., Nelems J.M., Van Nostrand A.W.P. Primary tracheal anastomosis after resection of the cricoid cartilage with preservation of recurrent laryngeal nerves. J Thorac Cardiovasc Surg 1975; 70:806-816
16. Maddaus M.A., Toth J.L.R., Gullane P.J., Pearson F.C. Subglottic tracheal resection and synchronous laryngeal reconstruction. J Thorac Cardiovasc Surg 1992; 104:1443-1450.
17. Anastomotic complications after tracheal resection: prognostic factors and management. Wright CD, Grillo HC, Wain JC, Wong DR, Donahue DM, Gaisser HA, Mathisen DJ. J Thorac Cardiovasc Surg. 2004 Nov; 128(5):731-9.
18. Postintubation tracheal stenosis Treatment and results Grillo HC, Donahue DM, Mathisen DJ, Wain JC, Wright CD. Thorac Cardiovasc Surg. 1995 Mar; 109(3):486-92; discussion 492-3.

CASE REPORT

Role of Transesophageal Echocardiography in Detecting Intraoperative Prosthetic Valve Dysfunction

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We encountered a rare complication of prosthetic mitral valve replacement : a "stuck" leaflet detected by transesophageal echocardiography. The patient was immediately managed without significant problem. We emphasize the importance of performing routine intraoperative transesophageal echocardiography in valve replacement as well as in valve repair and its use in detecting major problems.

The usefulness of intraoperative assessment of cardiac function with transesophageal echocardiography (TEE) has been established, particularly in valve repair [1,2]. We report a case of a stuck prosthetic valve leaflet detected by intraoperative TEE in a 42 y old gentleman with past history of Rheumatic fever and closed mitral commissurotomy 1980. The patient presented to us with mitral valve restenosis and severe Aortic valve disease (regurge / stenosis); Double valve replacement was carried out in a routine fashion without difficulty no leaflet preservationwas done. During weaning from cardiopulmonary bypass (CPB) , TEE window showed intermittent stucking of one of the mitral protheses leaflet in the closed position (mitral bileaflet prosthetic valve size 31 mm was used [fig.1]) .Coming off by pass although was smooth the periods of leaflet stucking increased.

CPB was hence resumed, heart arrested and the left atrium reopened. On inspection of the prosthesis, the leaflet on the side of the anterolateral commissure was stuck in the closed position because of residual tissue in the proximity . Normal valve function was restored by a 90-degree rotation of the prosthesis from Antianatomical to anatomical position by rotating the valve while in situ with the rotator. Patient then came off by pass smoothly , made a successful recovery and was discharged from the hospital 10 days later with well functioning prosthetic valve as proved by trans thoracic echocardiographic examination.

COMMENT

Intraoperative TEE during cardiac surgery permits immediate assessment of left ventricular function and native or prosthetic valve function[3] . Leaflet sticking due to residual tissue like that detected in the present case although

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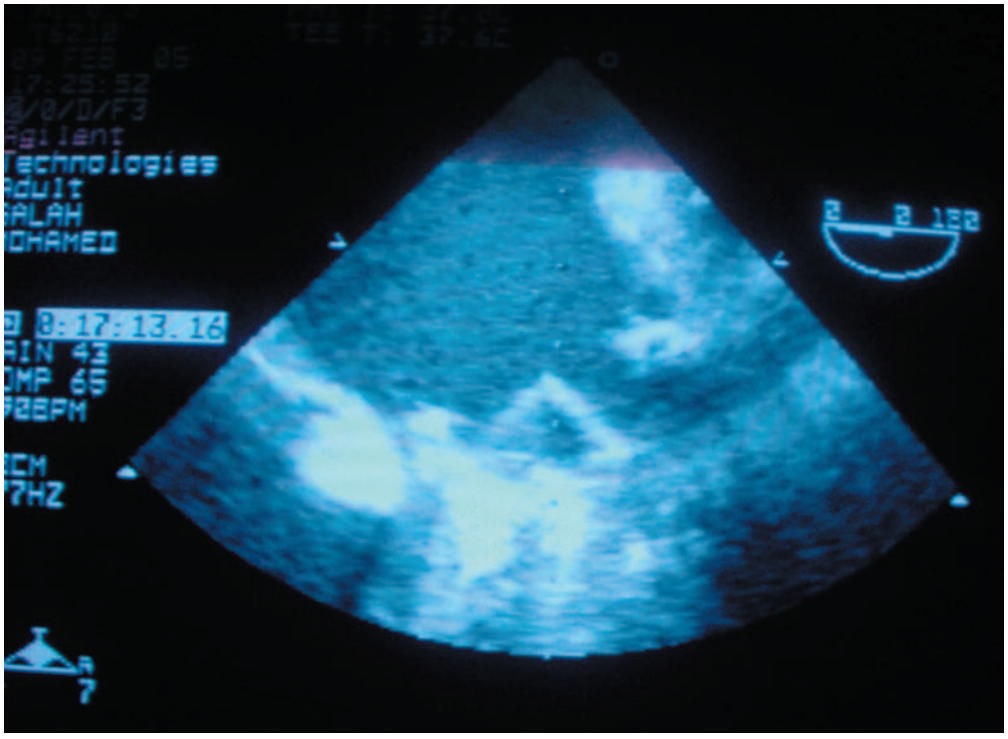

Fig □

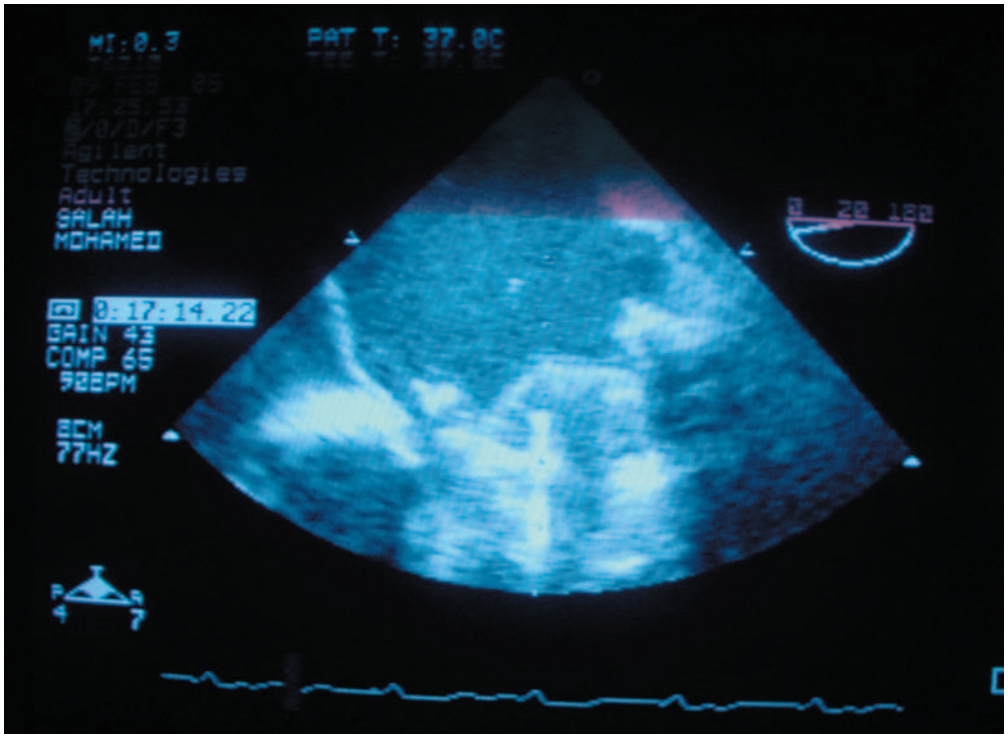

Fig 2. Intraoperative transesophageal echocardiogram showing both leaflets (arrow) of the prosthesis in the closed position.

considered rare with bileaflet prostheses is an immediate major complications interfering with proper valve function and may be lethal.

In conclusion, This case illustrates that TEE may play an invaluable role in the intraoperative assessment of mitral valve replacement as well as repair. We recommend its routine use in cardiac surgery from the initial phase of operation, for immediate management of unexpected events.

References

1. Bryan A.J., Barzilai B., Kouchoukos N.T. Transesophageal echocardiography and adult cardiac operations. Ann Thorac Surg 1995;59:773-779.
2. Jaggers J., Chetham P.M., Kinnard T.L., Fullerton D.A. Intraoperative prosthetic valve dysfunction: detection by transesophageal echocardiography. Ann Thorac Surg 1995;59:755-757.
3. Hiroshi Kumano, MD[a], Shigefumi Suehiro, MD, PhD[a], Toshihiko Shibata, MD[a], Koji Hattori, MD, PhD[b], Hiroaki Kinoshita, MD, PhD[a] .Stuck valve leaflet detected by intraoperative transesophageal echocardiography Ann Thorac Surg 1999;67:1484-1485

The Way I do it

Bi-atrial Electrocautry Maze- Amiodarone Protocol For The Treatment Of Atrial Fibrillation

Ezzedin A. Mostafa,MD

The Cox maze III procedure (The cut and suture technique) is the standard benchmark for AF surgery. It has the highest reported conversion rate to sinus rhythm with re-establishment of atrial transport function. It is primarily a method to enforce a blockade of the electrical wave front. The major reason for its limited use is the extensive nature of the procedure and the multiple suture lines giving rise to possible troublesome bleeding apart from the increase in cross clamp time. Different sources of energy have been used instead; namely cryo-ablation, radiofrequency waves, laser, and electrocautary.

The electrocautery (EC) maze is a cost-efficient, easily reproducible and quick method. A method using the creation of lesions by an ordinary unipolar surgical diathermy unit for creating linear lesions akin to the Cox maze procedure to create a pathway.

The operative technique:

All patients are placed on conventional CPB with bicaval venous cannulation (SVC cannula being passed through the right atrial appendage) and ascending aortic cannulation. On normo-thermic bypass with the non cross-clamped perfused beating heart, the right atrium is opened.

The initial cautery lesions are placed using the "spray mode" of an ordinary cautery pencil connected to a diathermy machine *(Valley Lab Force 40 S™ Valleylab, Inc.,CO*)set at **40 watts** and using the coagulation – spray setting. The output waveforms are as follows: *Valleylab Force 40 S™ – 500 kHz* damped sinusoidal bursts with a repetition frequency of 31.25 kHz, rated load of **300 ohms** and power output being 40 watts. The theoretical energy delivery is approximately **40 Joules** for every second of cauterization. Lesions are created by slow progression of the pencil such that the tissue blanched when the cautery arc is moved against the tissue. Since the spark mode arc is employed in an empty heart, alteration in conductivity (due to blood and charring) is typically avoided and the rate of progression of the cautery is primarily determined by blanching. This is approximately at the rate of around 1-2 seconds per centimeter. The cautery is never kept stationary as it has to be moved as soon as the tissue blanches. Inspection on the opposite side easily demonstrates the transmural nature of the burn visually. The pencil diathermy probe is used the ordinary "knife" tip and not a ball electrode. The tip actually does not come in contact with the tissue after the spark arc-gap is established. For this a knife tip would be better than a ball tip. In early experience, I have used the an elongated-tiped handle, then I have switched to the foot paddle use to act precisely on the atrial walls.

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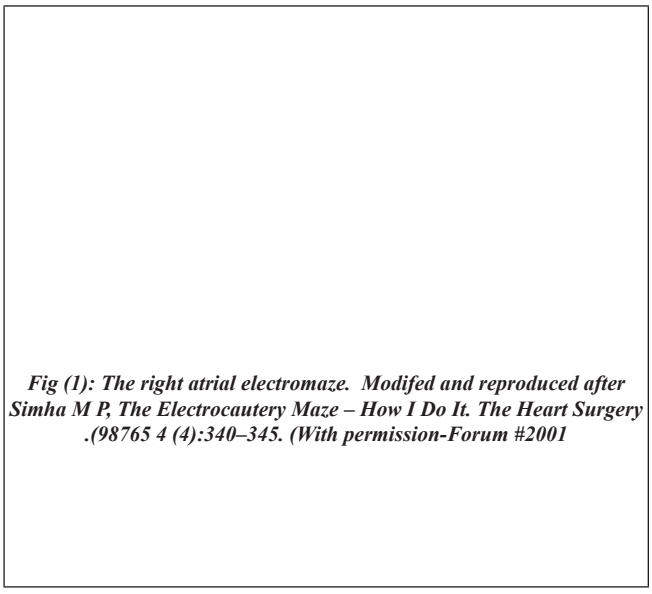

Fig (1): The right atrial electromaze. Modifed and reproduced after Simha M P, The Electrocautery Maze – How I Do It. The Heart Surgery .(98765 4 (4):340–345. (With permission-Forum #2001

The *right atrial* lesions are as follows: Remember the # 5 on your fingertips .

Step 1: From the posterior wall of the SVC – RA Junction (just caudal to the level of the SA node), down across the fossa ovalis to the IVC cannula veering towards the mouth of the coronary sinus and burning the inferior mouth of the coronary sinus including as much of the ostium as possible (Figure 1).

Step 2: From the IVC burning the atrial isthmus and proceeding to the tricuspid valve orifice at 5 o'clock (Figure 1).

Step 3: From the middle of lesion 1 laterally towards the atrial wall, burning the atrial "Crista" and proceeding further laterally to meet the atriotomy (Figure 1). The right sided lesions are performed on the beating perfused heart primarily to see the effect of ablation on the right side. Nearly 60% of cases revert to sinus rhythm or develop a slowing of the heart rate and intermittent P wave formation. The lesion at the coronary ostium can be precisely placed and thus heart blocks can be avoided.

Step 4: From the superior end of the atriotomy to the right atrial appendage stopping at the cannulation orifice.

Step 5: Restarting at the diametrically opposite point and continuing the lesion towards the dome of the left atrium. While placing this lesion, care must be taken to specifically search for the sinus node artery and the interrupt the cautery lesion for 3 mm on either side of the artery. The yellow fat pad indicating the area of the sinus node should be assiduously searched for and avoided during the placement of all lesions. The lesion near the sinus node artery is placed as it is found that this lesion usually caused a sudden conversion. While placing the right atrial lesions, I chose to keep this lesion as they had "visual comfort" when sinus rhythm was restored during the right sided lesions itself prior to arresting the heart. This lesion is extended as far as possible medially and is stopped short of the ascending aorta.

The retrograde cannula is placed back into the coronary sinus. Any tricuspid procedure that has been planned is performed. The atriotomy is closed and the heart is arrested with antegrade cold blood cardioplegia. During this period, if there is no left atrial thrombus, the left atrium is ligated externally with a silk/linen ligature. The left atriotomy is done after dissecting the interatrial (Sondergaard's) groove extensively (vertical left atriotomy). Any left atrial thrombus is evacuated and all lamellar thrombus in the atrial body is assiduously evacuated. The mitral valve procedure is performed.

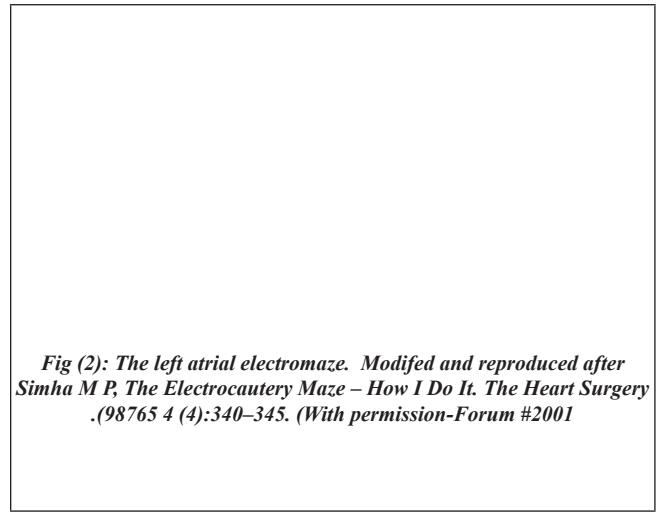

Fig (2): The left atrial electromaze. Modifed and reproduced after Simha M P, The Electrocautery Maze – How I Do It. The Heart Surgery .(98765 4 (4):340–345. (With permission-Forum #2001

The *left atrial* lesions are as follows: Remember the # 5 on your fingertips

Step1: If the left atrial appendage has not been ligated previously, it is now ligated externally.

Step2: The lesions are placed circumferentially at one centimeter from the pulmonary vein orifices. The cautery lesions are placed while controlled warm retrograde normokalemic reperfusion is being done.

Step3: A lesion touching each of the previous lesions and the mitral annulus at 5 o'clock connects all four lesions. (On a practical basis, if the gap between the left superior and inferior pulmonary vein is small, a common lesion can encircle both pulmonary veins). The peripulmonary lesion is made to touch the mitral annulus only at 5 o'clock to limit any chance of significant circumflex coronary artery injury.

Step4: A lesion is placed from this outer lesion to the ligated left atrial appendage.
Step5: In giant left atria with atrial diameter more than 7 cms, an optional cruciate lesion is placed within the circum-pulmonary vein lesion (Figure 2).
The left atriotomy is then closed. The heart is de-aired and the patient is weaned off CPB in the routine manner.
Trans-esophageal echocardiography (TEE) is done. Atrial and ventricular wires are placed. Care is taken to place the atrial wires as high as possible to enable sinus node recovery time (SNRT) studies.

Postoperative Care

Patients who are in sinus rhythm were put on an infusion of **amiadorone (10 mg/Kg/24 hours)** and then an oral **amiadorone 200 mg/day for three months**, and then stopped. Patients who had nodal rhythm were given intravenous **aminophylline (15 mg/Kg/24 hours)** with an initial 200-mg bolus on CPB, if there was nodal rhythm, and temporary atrioventricular pacing was instituted as and when required. *(Notice that all the numbers can be divided on # 5)*

Amiadorone was given primarily to ensure decreased atrial automaticity to offset the increased atrial tissue conduction speed that can cause transient AF despite adequate maze lesions. This is done to ensure maintenance of sinus rhythm postoperatively at all times to ease hemodynamic management in sick left ventricles. Since sinus rhythm begets sinus rhythm, addition of amiadorone, even though only three months, ensures maintenance of sinus rhythm and early return of atrial function. Multimodal attack of AF (maze + amiadorone + optional atrial pacing) ensures a controlled sinus rhythm throughout the immediate postoperative period and makes it smoother. The efficient return to sinus rhythm is also a surrogate marker for completeness of the lesions as it is known that inadequately performed maze procedures can result in a lower conversion rate to sinus rhythm.

All patients who were not on **coumadin** for valve replacement (i.e., repairs) were placed on **150-mg enteric-coated aspirin** life long.

References:

1. Simha M P, The Electrocautery Maze – How I Do It. The Heart Surgery Forum #2001-98765 4 (4):340–345, 2001 Online address: www.hsforum.com/vol4/issue4/2001-98

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QUIZ

DIRECTIONS: Select the most appropriate of the five answers.

1.The utilization of blood versus crystalloid potassium cardioplegic solutions differs in which of the following ways?

A.The volume and frequency and pressure at which the cardioplegic solution is delivered
B.Superiority of a specific potassium ion concentration
C.Alleged superiority of a blood vehicle because the heart is arrested in an oxygenated environment
D.Necessity for adjuvant use of calcium channel blocking agents
E.None of the above.

2.The most sensitive index for assessing the presence of postoperative myocardial necrosis following coronary revascularization is:

A.The development of new Q waves on the electrocardiogram.
B.The requirement for isotropic support in the perioperative period.
C.Presence of new "hot-spot" images by technetium 99m pyrophosphate myocardiall scintigraphy.
D.Elevation in serum of MB-band creative phosphokinase.
E.The development of complete left bundle branch block on the initial postoperative electrocardiogram.

DIRECTIONS: There are four choices for the answer to each of the following questions; one or more may be correct. Use this code to select the most appropriate response: A: (1) B:(1&3) C:(2&4) D:(4) E:(1-4)

3. Maintenance of uniform myocardial hypothermia during aortic cross-clamping is enhanced by:

1.Perfusion of cardioplegic solutions through completed distal coronary anastomoses.
2.Separate vena caval cannulalion and use of occlusive caval tapes.
3.Topical iced saline lavage.
4.Decreasing the systemic flow rate.

4.Optimal myocardial protection afforded by hypothermic potassium cardioplegia is achieved when:

1.The myocardial temperature is kept to less than 20°C.
2.The potassium concentration of the cardíoplegic solution is greater than 40 mEq per liter.
3.There is absence of electrocardiographic activity throughout the aortic cross-clamp period.
4.Steroids are added as adjuvants for membrane stabilization.

5.Intraoperative myocardium protection utilizing intermittent hypothermic potassium cardioplegia has been shown to be efficacious in:

1.Preserving myocardial high-energy phosphate compounds during ischemic periods of 60 minutes.
2.Preserving preoperative left ventricular ejection fraction when measured one week following coronary revascularization.
3.Decreasing the incidence of perioperative infarction following coronary revascularization.
4.Decreasing the incidence of postoperative supraventricular arrhythmias.

Answer Key:
These questions and the answers reprinted from Self-Education(Self-Assessment Syllabus in Thoracic Surgery (SESATS) by CCCETS.

1.E
2.D
3.E (1- 4)
4.B (1&3)
5.A (1-3)

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NOTES

MYOCARDIAL PROTECTION

1.Myocardial Perfusion

- Normally, subendocardial flow exceeds subepicardial flow
- Myocardial perfusion, however, is altered by cardiopulmonary bypass
- Narrow pulse pressure and variable mean pressure affects coronary perfusion pressure
- Wall tension is increased in the empty, smaller heart
- Ventricular fibrillation also increases wall tension
- Regulatory and inflammatory factors are released which affect coronary resistance
- Microemboli from the circuit and hemodilution impair oxygen delivery
- Endothelial and myocardial edema further affect perfusion
- Subendothelial vulnerability is increased by hypertrophy, coronary disease, fibrillation, cyanosis, shock, and chronic heart failure
- The acutely ischemic heart may have poor reflow to the injured area

2. Myocardial Ischemic Injury

A. Acute ischemic dysfunction

- Global myocardial ischemia
- Reversible contractile failure, mostly from change in perfusion pressure
- Immediate recovery as oxygen supply is restored

B. Stunning

- Reversible systolic and diastolic dysfunction, no myocardial necrosis
- Begins in subendothelium and progresses outward
- May be accompanied by endothelial dysfunction
- Results from ischemia-reperfusion insult, mediated by increased intracellular calcium accumulation
- Recovery occurs within hours to weeks

C. Hibernation

- Reversible chronic contractile depression
- Related to poor myocardial blood flow
- Recovery occurs within weeks to months

D. Necrosis

- Irreversible ischemic injury with myocardial necrosis
- Hypercontracture occurs first in the subendothelium and is more rapid in the hypertrophied heart
- Typically results in contraction band necrosis, rarely "stone heart"
- Osmotic and ionic dysregulation produce membrane injury and myocyte lysis

3. Cardioplegia

- Studies in animals have inconsistent correlation with clinical results due to species differences, extent of disease, and perioperative events that precipitate, extend, or enhance myocardial damage
- The goals of cardioplegia are to protect against ischemic injury, provide a motionless and bloodless field, and allow for effective post-ischemic myocardial resuscitation
- Cardioplegic techniques vary according to perfusate (blood vs. crystalloid), duration (continuous vs. intermittent), route (antegrade vs. retrograde), temperature (warm vs. cold), and additives
- Special consideration is required for the acutely ischemic heart and the neonate

4. Mechanisms of Cardioplegic Protection

- Mechanical arrest (potassium-induced) will reduce oxygen consumption by 80%
- Hypothermia will reduce consumption by another 10-15%
- Aerobic metabolism can be maintainted with oxygenated cardioplegia

- Hypothermic arrest is sustained with readministration every 15-30 minutes
- Retrograde delivery protects the left ventricle more completely than the right ventricle
- Prevent myocardial rewarming with systemic hypothermia, aortic and ventricular vents, and caval occlusion
- In acute ischemia, use warm induction with substrate enhancement (glutamate, aspartate)
- Reperfusion should be controlled, using warm, hypocalcemic alkaline cardioplegia
- This approach combats intracellular acidosis and rapid calcium infusion injury
- Retrograde or low-pressure antegrade perfusion is preferred for reperfusion
- Ensure uniform warming

5. Neonates and Children

- Children older than 2 months have similar myocardial physiology to adults
- The neonatal myocardium, however, is different in several ways
- Hypoxia is more easily tolerated
- There are greater glycogen stores and more amino acid utilization
- ATP breakdown is slower due to deficiency in 5' nucleotidase
- Multidose cardioplegia is disadvantageous
- Cyanosis may worsen resistance to ischemia
- Amino acid substrate enhancement is beneficial

6. Cardioplegia Composition

- Blood has the advantage of oxygen carrying capacity, histidine and hemoglobin buffers, free radical scavengers in RBCs, and metabolic substrates
- Blood also has improved rheologic and oncotic properties, which may lessen myocardia edema
- Buffers such as THAM, histidine, and NaHCO3 form a slightly alkaline solution for reperfusion that can counteract intracellular acidosis
- Small amounts of calcium (0.1-0.5 mM/L) restores calcium that has been chelated by citrate
- Potassium concentrations range from 10-25 mM/L, with the first dose being the highest
- Other substrates are being evaluated, including allopurinal, SOD, deferoxamine, adenosine, nucleoside transport inhibitors, and potassium-channel openers

CARDIOPULMONARY BYPASS

1. The Circulatory Environment

- Cardiopulmonary bypass is an abnormal circulatory state
- Non-pulsatile flow, hemolysis, hemodilution, foreign surface exposure, general stress response, and the inflammatory response all contribute

A. Mechanial components

- Roller pumps are slightly non-occlusive, resistance-independent, and may cause less blood trauma
- Centrifugal pumps are dependent on inflow or outflow resistance; will cease flow at very low inflow resistance and very high outflow resistance
- Venous drainage can be active or siphoned
- Active drainage requires vacuum through the venous reservoir or negative pressure from the pump

B. Heat exchanger

- The cooling or warming gradient is usually within 10-14 degrees of the patient's temperature
- This minimizes the tendency for gas to come out of solution and risk of air embolism
- Mixed blood temperature should be less than or equal to 38.5C
- The water bath should stay between 15 and 42C to prevent organ damage (too cold) and hemolysis (too warm)

C. Oxygenator

- Largest foreign surface contact area
- Membrane oxygenators can be microporous, hollow fiber, or silastic (true membrane)
- Gas flow is titrated to maintain PaO2 between 85 and 250mmHg to avoid O2 toxicity
- PCO2 is regulated by gas and blood flow through the membrane
- pH is controlled by adjusting the PaCO2
- alpha stat adjusts the pH to 37C, with the goal of providing optimal enzymatic function during hypothermia
- pH stat corrects the pH to the temperature of the patient's blood, with the goal of relative hypercarbia to increase cerebral blood flow

2. Mechanisms of Injury

A. Mechanical

- The foreign surfaces of the bypass circuit (boundary layer of oxygenator, heat exchanger, filters, tubing) interact with the blood
- Shear stresses include the pump, cardiotomy suction, and cannulae
- Microemboli can form as particles from the oxygenator, platelet aggregate, or fibrin aggregates, and are greatest within the first 15 minutes of bypass

B. Humoral

- Factor XII (Hageman factor), the alternative complement cascade (C3a), kallekrein, and plasminogen are activated in various degrees
- Other factors interrelate and amplify the inflammatory reaction, including the arachidonic acid cascade, interleukins, TNF, and PAF

C. Cellular

- Neutrophils play a major role in humoral activation and are sequestered in the lung, releasing cytotoxin and free radicals which increase vasoreactivity and vascular permeability
- Monocytes and mast cells also participate, although their role is unclear
- Lymphocytes have a minor role, if any
- Platelets are activated and elaborate GPIB, IIB, and IIIA
- Absolute number of platelets is reduced by 40% by the end of bypass, and the number of receptors is also decreased
- Endothelial cells are affected by abnormal flow, humoral factors, and local ischemia
- A wide variety of substances are expressed by the endothelium, including prostaglandins, thromboxanes, leukotrienes, and interleukins.

3. Miscellaneous

- Circulatory arrest with profound hypothermia (18-20C) is generally safe up to 45 minutes
- Over 60 minutes is associated with increased incidence of neurologic deficit
- The period between 45 and 60 minutes is unclear, as histologic injury seems to be greater than functional injury
- Maintain a gradient of 4-6C, as rapid cooling produces uneven cerebral cooling
- Retrograde and low flow cerebral perfusion are currently being evaluated
- Pulsatile flow has not been shown to be superior to non-pulsatile flow
- Lower ACT of 300-350 seconds is not associated with greater complications compared to standard ACT of 450
- Aprotinin will elevate the ACT (600-800), neutralizes the kallikrein cascade, and protects platelet receptors
- Protamine reactions occur through the classical component pathway and cause direct myocardial depression

READERS' CORNER

The JOURNAL reserves the right to edit letters submitted to "Readers' Corner" for brevity and clarity. Readers are advised to limit their letters to a maximum of 300 words.

Data Base For Congenital Cardiac Surgery And General Thoracic Surgery

Sir: I wish to thank Dr. Yasser Hegazy for his editorial article titled; " Egyptian national data base of cardiac surgery project of national adult cardiac surgical registry (*J Egypt. Soc. Cardiothorac. Surg. 2004;12(1):5-14)*. Probably, this is the first step in one-thousand-mile journey. I hope that the Society and the Journal will encourage the use of this system in all cardiac centers in Egypt and find a way for database for congenital cardiac surgery as well as general thoracic surgery.

Sherif Azab,MD
Ain-Shams University Hospital
Cairo, Egypt.

Teaching Function Of The Journal

Sir: I have read with interest the articles related to cardiopulmonary bypass and circulatory supporting systems in your Journal. May I suggest the following: First, to have a separate section for the CPB in the Journal. Second, to add teaching aids with resume protocol for some situations e. g., deep hypothermia and circulatory arrest (DHCA), and finally, to have protocol for emergency situations e.g., how to deal with air embolism? What to do in iatrogenic dissecting aneurysms? Etc.

Maha Nassar, MBBCH, MCVD
Ain-Shams University Hospitals
Cairo, Egypt.

Perfusion Section In The JOURNAL

Sir: Would you excuse me, I can bravely say that the teaching function of the Journal is a bit lacking. May I suggest the introduction of some teaching chapters to enrich the Journal in order to help the trainee in their carrier..

Walid Ismail, MBBCH,MSc.
Ain-Shams University Hospital
Cairo, Egypt.

Cardiac Anesthesia Section In The JOURNAL

Sir: I read with interest the articles dealing with cardiac anesthesia and I hope to find a separate section for it with a new separate section editor.

Ahmed Ibrahim,MD
Ain-Shams University Hospital
Cairo, Egypt.