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Guidelines For Authors

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

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The Journal of the Egyptian Society of Cardiothoracic 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.

Required disclosures;

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.

B. Written permission from the *publisher* (copyright holder) is required to reproduce any previously published table(s), illustration(s) or photograph(s) in *both print and electronic media*.

C. Written permission from unmasked patients appearing in photographs is also required.

Revised_Manuscripts:

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 **"how to 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 "how to 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 justifie).

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, Methods, Results, Conclusions**. Avoid abbreviations and acronyms. Indicate the abstract word count below the abstract.

*- **New Technology***

Provide a structured abstract, *no longer than 175 words*, divided into four sections:

Purpose, Description, Evaluation and Conclusions. Avoid abbreviations and acronyms. Indicate the abstract word count below the abstract. [Disclosure stating the source of all funds to the study, plus "freedom of investigation" which is defined as freedom from outside interests in controlling the study and having freedom to fully disclose all results;these statements are mandatory for all new technology articles only]

- ***Case reports, "how to 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 *(thirdpagecontinueuptoacknowledgments)*

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

8. 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

For figures submitted in electronic format, all images should be at least 5 inches wide. Graphics software such as Photoshop and Illustrator, should be used to create art.

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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Date of acceptance : letter is provided from the editor.

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) .*
- *Word count.*

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Electronic Publishing

Tips for preparing Word documents

1 Learn how to use the Word features under the Tools/ Autocorrect submenu. Some people turn off all autocorrection features because they are disconcerted by Word's default behaviour of adjusting capitalisation and reformatting type on the fly, but these features save a lot of time once you tune them in to match your expectations. In particular, if you have a long word like 'hypergammaglobulinaemia' that you need to type repeatedly, turn on `Replace text as you type' and add it to the replacement list.

2 Keep formatting to a minimum. Editors, much prefer manuscripts in a simple one-column layout. Only use fonts that everybody has on their computers: for example, Times New Roman for your main text font and Arial as your font for headings. Turn off type justification, automatic hyphenation, and automatic paragraph numbering. On the other hand, the use of bold, italic, superscript, and subscript text as appropriate is good.

3 Use styles and style tagging rather than formatting the article paragraph by paragraph. This makes it much easier to format an article as you write and easier again if you are asked to change the formatting later. For your level I headings, therefore, define a Heading l style, with the combination of font, spacing, and alignment that you want to use, and then apply this to each heading as you create it. To change all your level I headings later, simply redefine the style and all will be changed without having to select and manipulate each heading.

4 Format text as one continuous flow. Use a page break (Ctrl + Enter) to start a new page (e.g. after your title page) not a stream of hard returns. Put only one hard return between each paragraph,. Do not break the article up with Word's section breaks.

5 Keep table formatting simple and consistent. A common error is to place a column of separate items into a single table cell, with each item separated by a hard return: instead each data item should have a table cell of its own. Sometimes tables are formatted with tabs instead of cells: in this case, the key is to set the tab stops for the whole table so that one tab equals one column.

6 Image files should be sent as separate files. The same goes for Excel spreadsheets or charts. If you are embedding images in the file, it is probably best to do it at the end, after the text and references.

7 Be prepared to send the data used to generate graphs. Some publishers will use the data to regenerate the graphs according to their own style rules. In such a case, it helps if you send only the data that are actually shown in the graphs – not the spreadsheet with all of the data generated in the study.

What about PDF?

Send your Manuscript in a Word file. Don't send it as

PDF or any other word processor format.

PDF files are not editable in the same way as word processor files. Some publishers will ask for, or even create, a pdf file of your manuscript for use during the peer review process, but a Word file will also be required for editing and production.

Tips for preparing images

Do not make electronic images too small . No effective way exists to increase the resolution of an image beyond its original size, and if an image is reduced in size and saved, picture data is permanently lost. Image files therefore have to be created and saved at high resolution. For a colour image that is to be printed as 4 X 4 in., the required size is (4 X 300) X (4 X 300) = 1200 X 1200 = 1440 000 dots. In many image formats (e.g. tagged image file format, or tiff), each dot will take eight bits (one byte) to store, so the image file will be 1.44 megabytes

Compression techniques can reduce the size of the image file. Zip compression is safe, because it uses an algorithm that packs the data tighter without throwing any of it away; In Compression during which files are saved in jpeg format, select the option for large file size (maximum picture quality).

Guidelines for Reviewers

Purpose of Peer Review

The purpose of peer review for The *Journal of the Egyptian Society of Cardio-Thoracic Surgery* (JESCTS) is twofold. One is to evaluate objectively the science of the submitted paper and the other 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 are not asked to copyedit papers, but should comment if language editing is needed.

Acceptance of a Manuscript for Review

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, how to 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

Original scientific articles should provide new, reliable information that is relevant to the science and practice of cardiac and general thoracic surgery. 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 before 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.

VACUUM ASSISTED CLOSURE VERSUS OMENTAL FLAP IN MANAGEMENT OF MEDIASTINITIS AFTER CARDIAC SURGERY

Cardiovascular

Mohamad Fawzy Badr-Eddin,

Amr Mohamed Rouchdy,

Mohamed Abdelrahman Hussien

Objectives **Deep sternal wound infection (DSWI) following cardiac surgery is a serious problem; many strategies have been established to address this life threatening situation.**

Methods **From January 2013 to January 2014, 40 patients who had a postcardiac surgery medisatinitis were studied prospectively, all having surgical debridement of necrotic and infected tissue with removal of sternal wires under general anaesthesia then subdivided into two groups group (A): vacuum-assisted closure group (VAC), and group (B): omental flap group . We reviewed the outcome of both methods regarding hospital stay, wound healing duration, recurrent wound related problems (infection, sloughing or bleeding), inflammatory biomarkers and mortality.**

Results **Patients with vacuum had a significantly shorter hospitalization (28.2 days versus 35.4 days in omental flap group). 9/20(45%) patients treated with omental flap had complications, including persistent sepsis (2), chronic wound drainage (2), subcutaneous infection (4), and flap failure (1). These complications resulted in two deaths (10 %). In contrast, there was one early complication (5%) in the patients treated with vacuum in the form of persistent sepsis and secondary haemorrhage.**

Conclusion **VAC therapy is a safe and reliable option in the treatment of sternal wound infection in cardiac surgery. This study shows that VAC is superior to omental flap in poststernotomy mediastinitis. It may be used effectively before primary closure or as a preparation for secondary closure with vascularized tissue.**

KEY WORDS: **Mediastinitis- vacuum assisted- omental flap- sternotomy**

Postcardiotomy sternal wound complications remain challenging; the overall incidence is relatively low, between 1% and 3% however, this complication is associated with a significant mortality, usually reported to vary between 10% and 25% with no general consensus regarding the appropriate surgical approach to this problem, a wide range of wound-healing strategies have been established [1].

The definition of mediastinitis has been established by the Center for Disease Control and Prevention in the USA According to these guidelines, diagnosis of mediastinitis requires at least one of the following:

(1) An organism isolated from culture of mediastinal tissue or fluid

(2) Evidence of mediastinitis seen during operation.

(3) One of the following conditions: chest pain, sternal instability, or fever (>38 8C), in combination with either purulent discharge from the mediastinum or an organism isolated from blood culture or culture of mediastinal drainage[2]

Treatment of deep mediastinitis varied from debridement with open packing and drainage to closed irrigation with primary rewiring, followed by the introduction of pectoralis myocutaneous flaps , omental flap then Vacuum-assisted therapy[3]. Vacuum-assisted closure (VAC) therapy provokes wound healing through the application of

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negative pressure by controlled suction to the wound surface to accelerate healing[4,5] . On the other hand omental flaps conatain infrction through its superior immunological activity, and it's ability to absorb wound secretions[6] .

The aim of this study is to evaluate and to compare the effectiveness of application of negative pressure therapy (vacuum therapy) in patients with deep sternal wound infection (DSWI) versus patients managed by omental flap.

Patients and Methods

From January 2013 to January 2014, 40 patients who had mediastinits post cardiac surgery were studied in Cairo University hospitals and Nasr City health insurance hospital. After establishment of the diagnosis, all patients had a wound debridement and removal of wires under general anaesthesia , they were then divided into two groups :

Group A: The (VAC) group: suction system is applied over the wounds. VAC consists of polyurethane foam placed in the wound (fig 1) connected to suction unit. The wounds will be covered with a transparent sterile adhesive drape. The therapy unit will deliver intermittent negative pressure of 75–125 mmHg. The VAC dressings will be changed twice a week till the microbiological cultures become negative.

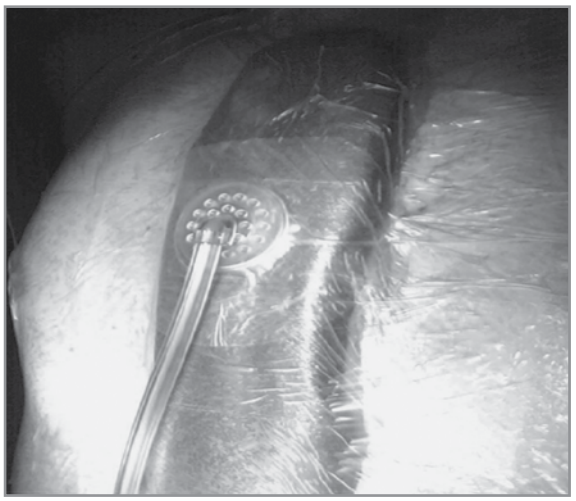


Fig 1. VAC therapy over a sternal wound

Group B: Omental flap is used to cover the defect, the sternotomy incision is extended for a few centimeters to access the abdominal cavity through the linea Alba . The omentum is mobilized from the major curvature of the stomach with its blood supply and is then brought up in to the chest through a diaphragmatic opening & fills the gap of the missing sternum quite adequately. The subcutaneous tissue and skin were then closed over the omental flap.

Patients' data were collected through history taking and physical examination to identify predisposing factors of mediastinitis (COPD, diabetes, hypertension, obesity, renal impairment, reopening and history of drug intake e.g. steroids or immunosuppression) and to assess the wound status and sternal stability. All patients had CRP level , wound culture and sensitivity and CT chest.

Operative data collected were : Type and duration of the original cardiac surgery, Cardiopulmonary bypass time and cross clamp time
. Patients were followed up after the intervention regarding: hospital stay, wound healing duration, recurrent wound related problems (infection, sloughing or bleeding), inflammatory biomarkers and mortality.

Statistical analysis of the results will be carried out according to the Arithmetic mean, standard deviation and "t" test for quantitative values, and the chi-square test for qualitative values expressed as proportions

Results

In this study, there were no significant differences in the age, gender or body mass index (BMI) between the 2 groups. Comparison of preoperative demographic data is shown in table (1). No significant differences were observed in variables related to the risk factors like obesity, COPD, postoperative reopening for bleeding, Diabetes, Hypertension, steroid intake, long ICU stay and renal failure (Table 2). Regarding the operative procedure, there was no significant difference in the type and duration of the initial surgical procedure, duration of aortic cross-clamp and/or bypass time between two groups. Operative procedure shown in (table 3).

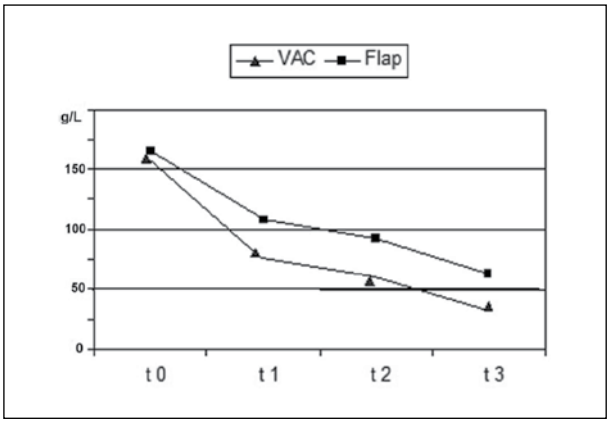
The majority of tissue cultures from mediastinitis patients showed Staphylococcus epidermidis (15patients), thirteen patients had Staphylococcus aureus, five had psudomonas, four had klebsilla and three patiens had MRSA in the tissue cultures. In both groups Staphylococcus epidermidis was detected in the majority of tissue cultures; 25 % in the VAC group versus 50 % in the omental flap (table 4).

The interval between primary surgery and development of mediastinitis was up to one week in 11 pateints in group A and 13 patients in group B, in 9 patients of group A and 7 patients of group B , the interval was more than a week. Timing of intervention for the diagnosed mediastinitis was generally within a week of detection after fully assessing and preparing the patients.

Hospitalization due to mediastinitis was 28.2± 3.6 days from the onset of diagnosis of mediastinitis in vac. Group compared to 35.4 ± 9.0 days in the omental flap group (P = 0.9778). In-hospital mortality was lower in the VAC group (5 %) compared to patients treated with omental flap (10 % P = 0.48). Out of the 20 patients who received vacuum therapy all underwent a procedure for closure. These procedures

were delayed wound closure with sternal refixation (n = 10), reconstruction with omentum (n=5) and pectoral muscle flap (n=5). Out of the 20 patients who received omental flap closure only, nine have complication of wound healing necessitating further management. Procedures done were Vacuum therapy (n = 5). Debridement and closure (n=3) and pectoral muscle flap (n=1). (table 5)

CRP counts were performed, at diagnosis of mediastinitis (t_0), at t_1 (3–7 days after t_0), at t_2 (8–13 days after t_0) and at t_3 (14–21 days after t_0). (Figure 5) shows the decline in C-reactive protein level in the VAC treated group more rapid than the omental flap treated group. Graph(1)



Graph : the fall in CRP level in both groups

	Vacuum (n = 20)	Flap (n = 20)	*p*
Age (years)	59.95 ± 6.3	60.0 ± 4.9	0.95
Range	46 – 67	49 – 67	NS
Gender			
Male	15 /20 (75.0%)	14/20 (70.0%)	0.72
Female	5/20 (25.0%)	6/20 (30.0%)	NS
BMI	31.7 ± 2.4	32.5 ± 2.2	0.25
Range	28 – 35	29 – 36	NS

Data are expressed as mean ± standard deviation. Data in parenthesis are percentages p= P value, NS= non significant

Table 1. Demographic data

	VAC group		Omental flap group		*p*
	No.	%	No.	%	
COPD	13	65	8	40	0.11
Reopening	6	30	9	45	0.32
Diabetes	12	60	12	60	1.0
Hypertension	11	55	8	40	0.34
Steroid intake	5	25	4	20	0.23
long ICU stay (> 2 days)	6	30	10	50	0.19
Renal failure	0	0	2	10	0.46

COPD= Chronic obstructive pulmonary disease, VAC= vacuum assisted closure, P= p value

Table 2. Risk factors of the studied groups

	VAC group		Omental flap group		*P*
	No.	%	No.	%	
Operation type					
AVR	1	5	2	10	0.44 NS
CABG	16	80	16	80	
MVR	2	10	0	0	
AVR + MVR	1	5	2	10	
Operation duration					
$\overline{X}$ ±SD	191 ± 30.2		200.5 ± 29.1		0.31 NS
Range	140 – 240		140 – 240		
Cross clamp time					
$\overline{X}$ ±SD	88.2 ± 21.3		98.9 ± 16.9		0.08 NS
Range	55 – 130		70 – 130		
Bypass duration					
$\overline{X}$ ±SD	114.5 ± 27.4		126.5 ± 19.3		0.11 NS
Range	60 – 160		100 – 160		

VAC= vaccum assisted closure, $\overline{X}$ ±SD = mean±standard deviation, P = p value, NS= non siginifcant

Table 3. Operative procedures

	Group A (VAC)		Group B (Omental flap)		*p*
	No.	%	No.	%	
Staph. aureus	8	40	5	25	0.31
MRSA	2	10	1	5	1.0
Staph. Epid	5	25	10	50	0.1
Pseudomonas	3	15	2	10	1.0
Klebsiella	2	10	2	10	1.0

Table 4. Culture results of the studied groups

	Vac group		Omental flap group		*P*
Complication					
No	19	100%	11	55%	< 0.001
Yes	1	0%	9	45%	
Farther procedures					
No procedures	0	0%	11	55%	< 0.001
Rewiring	10	50%	0	0%	<0.001
Omental flap	5	25%	0	0%	0.04
Rewiring + pectrol flap	5	25%	0	0%	0.04
Vacuum	0	0%	5	25%	0.04
Depridment	0	0%	3	15%	0.23
Myocat. Falp	0	0%	1	5%	1.0
Hospital stay					
$\overline{X}$ ±SD	28.2 ± 3.6		35.4 ± 9.0		0.002
Range	22 - 33		26 - 62		
Mortality	1	5%	2	10%	0.48

Table 5. Complication and further procedure in studied groups.

Discussion

Mediastinal infection is a life-threatening complication after open heart surgery. Its incidence did not regress , despite improvements in antibiotic therapy, and postoperative management over decades[7]. Although preoperative risk factors influenced the development of Deep sternal wound infection (DSWI), the continuous improvements in the management of DSWI lead to a significant lowering of related mortality and morbidity rates[8].

Vacuum-assisted closure (VAC) was introduced by Argenta and Morykwas in 1997 [9] Obdeijn and colleagues published the use of VAC to treat post-sternotomy mediastinitis 2 years later[10] . The uniform vacuum applied on the wound enhance the removal of extra discharges thus reducing local tissue tension. Consequently capillaries dilate, optimizing blood flow properties across the wound and enhancing the proliferation of granulation tissue and angiogenesis. Secretion and debris were continuously removed and the bacterial count drops[11,12]

The greater omentum flap is pedicled via the right as well as via the left gastro-epiploic artery, and properly fills the mediastinum, however, it represents a two-cavity intervention with all the complication possibilities associated with this and a mortality rate of 12-36%[13] In a Meta analysis of 6 observational studies, slight, but not significant, survival advantage for reconstruction with an omental flap rather than muscle flap[14]

The decision of implementing either modality was according to the preference and experience of the relevant surgeons. In our study, despite similar baseline characteristics, outcomes were more favorable for the Vacuum group. Patients with vacuum had a significantly shorter hospitalization Similar findings were found in a retrospective study done by (luckraz et al) [15]

In our cases Nine (45%) of 20 patients treated with omental flap had complications, these complications resulted in two deaths (10 %). In contrast, there were one early complication (5%) in the form of persistent sepsis and secondary hemorrhage in patients treated with vacuum.

This conforms to a Meta analysis of nonrandomized studies; Twenty-two retrospective studies including 2467 patients were eligible for inclusion. Patients treated with VAC had significantly lower mortality compared to those treated without VAC but it couldn't be highlighted as an independent predictor of survival and a well designed RCT is warranted to study the effects of VAC therapy, alone or in combination with other techniques, on mortality of patients with DSWIs[16]

C-reactive protein levels declined more rapidly, in-hospital stay was shorter, and survival tended to be higher in the VAC group compared to the omental flap group. Similar findings were found in a retrospective study by **Sjogren et al., (2005)**. **Ronny et al**., (2002) [17,18]

Although CT scan is done for all patients suspected to have mediastinitis, it carries no more information than clinical diagnosis (presence of retrosternal collection increases the suspicion of mediastinitis but it is not a clue for diagnosis as this collection is difficult to be differentiated from retrosternal fibrosis post sternotomy so **Schroeyers et al, (2001), Carmelo et al,. (1995), Yasuura et al,. (1998)** don't rely on it in diagnosis[19,21].

Importantly, we observed a significantly shorter ICU stay after flap closure for patients having been treated with the VAC system as compared with patients Without VAC system pretreatment. The reason for this might be associated with the better overall condition and the improved wound situation, with a consecutive reduction in bacterial colonization of patients pretreated with the VAC system before definitive surgery. Therefore, the risk of sepsis due to swept bacteria into the circulation is markedly diminished.

Reviewing the literature, there is a large consensus of early surgical debridement and vacuum application followed by plastic reconstruction provided a satisfactory rate of healing, decreased recurrence of infection, shorter hospitalization and a good survival rate compared to other modalities[22,2]

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Re-Implantation Aortic Valve Sparing in The Setting of Acute Ascending Aortic Dissection

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Alaa Farouk

Objective **the purpose of this study is to evaluate early results of re-implantation valve sparing surgical technique in acute aortic dissection.**

Methods **fifty patients (mean age 52 ± 11 years) operated on between march 2011, and April 2013. Marfan patients were excluded. Patients were followed up for 6 month after surgery.**

Results **The operative mortality was (12%) . Iscemic time was 154.1 ±16.67 min. Bypass time was 266-1 ± 17.8 min . ICU stay 4.38±1.85 days . Residual mild aortic regurge in (4/50) patients. At the last echocardiography 6 months after surgery(14/50) patients had no aortic regurge , (9/50) patients had mild regurge and (2/50) had moderate regurge.**

Conclusion **Valve preserving aortic root replacement (reimplantaion) is safe in the setting of acute aortic replacement. Despite the longer bypass and ischemic times , yet the mortality and the morbidity were within the acceptable average.**

Despite the popularity of valve sparing aortic surgery [1-10] Yet, remodeling has a high failure rate due to progressive dilation of aortic annulus[11,12]. Although it respects more the aortic root physiology[10]. Reimplantation has a better longevity regarding freedom from reoperation due to aortic regurge (AR), although being technically demanding and lengthy operation [13-15].

Aortic dissection is a life-threatening emergency with a higher mortality and morbidity[16]. Supra-commissural tube graft replacement with re-suspension of the commissures is the easiest and most commonly performed technique [17]. However, progressive dilatation of the diseased sinuses may lead eventually to aortic incompetence[18]. Composite graft replacement, although it represents a more radical approach to the pathology, it necessitates anticoagulation with it is negative impact on obliteration of the false lumen[19,20].

The purpose of this study is to evaluate prospectively the early results for patients undergoing re-implantation for acute ascending aortic dissection.

Patients and Methods

Patients

Between March2011 and April 2013 , 50 Patients with were operated emergently in Kasr El-Aini hospitals using the aortic valve sparing re-implantation technique for acute type"A" aortic dissection.

Surgical indications

All patients had macroscopically intact aortic leaflets, and aortic annular diameter less than 27 mm. Those patients had extensive dissection of more than one sinus of valsalva with or without significant aortic incompetence. Patients with connective

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tissue disorders(e.g. MARFAN) were excluded from this study. Computed Tomography and transthoracic echocardiography were done in all cases to confirm the diagnosis.

Surgical technique

Standard median sternotomy, and femoral artery exposure by a transverse incision above the crease. Followed by femoro-atrial canulation in 43 pateints. 7 patients had axillary artery canulation to achieve antegrade flow and avoidance of malperfusion. After establishment of cardiopulmonary bypass, a left ventricular vent was inserted. All patients were cooled to a nasopharyngeal temperature of 25°C to achieve a moderate hypothermic circulatory arrest (HCA). Retrograde cerebral perfusion was implemented a superior vena cava canula . Antegrade cold blood cardioplegia was used for myocardial protection.

The distal end was done first using open clamp technique and hypothermic circulatory arrest. After repair of the dissected aortic layers by several U-stitch Teflon pledgets , a running 3/0 polyproplene suture was used for the anastmosis. In case of presence of intimal tears in the transverse arch , then hemiarch or complete arch replacement was done. Otherwise , the distal anastmosis was done 1 cm proximal to the origin of the inominate artery.

Reimplantation was done via Excision of the diseased sinuses except for 5-8 millimeters, and detaching coronary artery buttons. The left ventricular outflow tract was dissected circumferentially to a level just below the aortic annulus. Then, placing the aortic cusps, annulus and sub-commissural triangles inside a straight tubular Dacron graft. Selection of the size of the graft depends on measuring the size of the aortic annulus with a standard valve sizer, and adding 7mm to it.

Haemostatic closure was secured with two suture lines. One by horizontal interrupted 2/0 braided polyester sutures enforced with Teflon pledgets, through the left ventricular outflow tract underneath the insertion of aortic cusps and tied on the outside. The second is done with a scalloped continuous 4/0 polypropylene sutures to align the base of the sinuses with the graft. The three commissures are suspended inside the graft and secured with pledgeted 3/0 polypropylene suture. Neoaortic sinuses were created by plicating the graft with 5/0 polypropylene suture at the level of the commissures . (Fig1) The left and right coronary buttons were re- implanted using 5/0 polypropylene running suture enforced with native pericardium. The cooptation level of the cusps are carefully inspected.

Follow- up

Transthoracic Echocardiography was done prior to discharge, and at 6 months postoperatively to grade residual or new aortic regurge. Patients were assessed clinically for complications within this time frame.

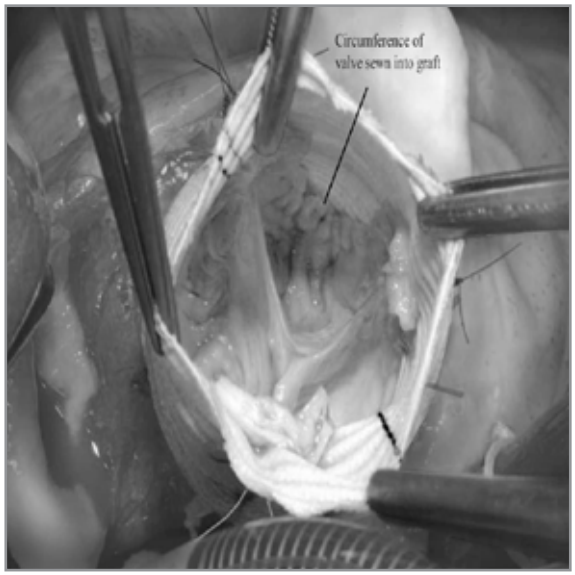

Fig 1. Aortic root after reimplantation, Showing proper leaflet coaptation.

Statistical Analysis

It was performed with the SPSS software (SPSS, Inc, Chicago, IL, USA). Values were expressed as mean ± standard deviation.

Results

The mean age of patients was 51.5±10.8 with a range from 36 to 72 years. 76 % of the patients had more than mild aortic regurge proved by transthoracic echocardiography at the time of initial diagnosis. Preopeative patient characteristics are presented in table (1).

Dacron graft sizes ranged between 28 and 32. Opeative data were presented in Table (2). 5 patients (10%) required a concomitant cardiac procedure. The mean ICU stay was 4.38***±1.85 days.*** The mean hospital stay was12**±2**.13 days. 6 patients (12%) had a delayed recovery more than 72 hours. 2 patients regained their conscious level after 5 days. 2 patients(4%) needed a temporary dialysis postoperatively due to renal impairment (serum Creatinine 2.5 mg/dl). 10 Patients had a temporary renal shut down not necessitating dialysis. Excessive drainage more than 1000 ml in the first 12 hours occurred in 7 patients (14%). 3 patients were closed over packs and for 24 hours. Re-opening for bleeding was done in 4 patients (8%). Transient heart block necessitating temporary pacing occurred in 6 patients (12%). Transient elevation of Liver enzymes above 3 folds occurred in 8 patients(16%). 7 patients had superficial wound infection, 1 patient had a deep mediastinitis necessitating rewiring and omental flap.

By the time of discharge from the hospital, 4 patients (8%) had a mild aortic regurge. Two of them deteriorated to moderate regurge at 6 months. 5 new patients developed mild aortic regurge at 6 months follow up. No patients required reoperation for more than moderate AR.

The hospital mortality rate was 12%(6/50). 1/50 patients died due to low cardiac output and failure to wean of bypass. (1/50) patient died due to excessive postoperative bleeding. (3/50) patients died postoperatively in the ICU. One for respiratory failure and two patients died due to multiorgan failure.

Age	51.5±10.8
Male gender (N, %)	42/50(84%)
Associated diseases	
Diabetes	11/50(22%)
Hypertension	38/50(76%)
Chronic obstructive lung disease	4/50(8%)
Renal impairment (Cr>2.5)	8/50(16%)
Cerebrovascular stroke	3/50(6%)
Lower Limb ischemia	2/50(4%)
Less than mild aortic regurge	12/50(24%)
Moderate aortic regurge	31/50(62%)
Severe aortic regurge	7/50(14%)
Left ventricular ejection fraction	
Associated cardiovascular pathology	
Mitral insufficiency	5/50(10%)
Bicuspid aortic valve	6/50(12%)
Aortic arch aneurysm	7/50(14%)
Cardiac tamponade	12/50(24%)

**Percentages are shown in parentheses , continuous variable with ± SD*

Table 1. Preoperative patient characteristics

Aortic annulus (mm)	23.31±1.78
Aortic root diameter	6.3±1
Graft Size (mm)	29.71±1.26
Hemi –arch replacement	7/50(14%)
Mitral valve repair	1/50(0.5%)
Caprol technique	11/50(22%)
Coronary artery bypass graft	4/50(8%)
Cross clamp time, (min)	154.1±15.67
Cardiopulmonary bypass time,(min)	266.1±6.24
Hypothermic circulatory arrest time(min)	17.54±6.24

Data in parentheses were expressed as percentages.

Table 2. Operative data

Discussion

Disssection of the ascending aorta proximal to the sinotubular junction necessitates aggressive resection of all dissected tissues. As the main pathology is usually confident to the aortic wall, the valve is rarely found diseased. 40-60% of patients had associated aortic regurge is related to the dilated sinuses and sinotubular junction[21] . Thus valve sparing ascending aortic reconstruction with Dacron graft seems a logical solution to preserve the left ventricular outflow tract (LVOT) complex function.

Still debates do exists between various techniques as glue repair of the dissected sinuses and resuspension of dissected commissures using layers of Teflon felt . The durability of this techniques are questioned as the diseased parts of the aorta are left behind[22,23].

Acute ascending aortic dissection is an absolute emergency with a high risk of mortality and morbidity[22]. Performing a complex valve sparing operation in this setting should be carefully judged. The mortality is this study was 12% which was within the average range (9.1% - 14.3%) [24, 25, 26]

Cross clamp time and cardiopulmonary bypass times were acceptable although they were longer at the begging of the learning curve. All associated pathologies as coronary artery bypass grafting(CABG) and mitral repair done in 5 patients were late in this study. Although no patients had a prior coronary angiography , the 4 pateints who had an associated CABG were due to right ventricular dysfunction after removal of the aortic cross clamp . saphenous vein graft was anastmosed to the right coronary artery, and proximally to the graft.

4/50 patients(8%) had mild Aortic incompetence(AI) prior to discharge from hospital out of 38 pateints who had more than moderate AI . All other patients had a competent aortic valve. All those patients were operated upon at the begging of the learning curve. Proper graft sizing and proper suspension of the commisssures within the graft are the key for long term durability of aortic valve repair. Sagging of one or more of the aortic valve leaflets and/or failure of coaptation of the leaflets due to large graft size are the direct causes of aortic valve repair failure.

Freedom from aortic regurge at 6 months postoperatively was 82%. Murashita T and colleagues reported 89% freedom from postoperative grade III or greater at 5 yars[25].

Concluison

Valve preserving aortic root replacement (reimplantaion) is safe in the setting of acute aortic replacement. Despite the longer bypass and ischemic times , yet the mortality and the morbidity were within the acceptable average. All patients were non-Marfan and had dissection extending proximal to the sinotubular junction.

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Off pump / on pump CABG? Which is safer for patients with preoperative non–dialysis dependent renal insufficiency

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Renal complications post CABG is associated with a significant increased mortality and morbidity. Patients with impaired renal functions preoperatively at a higher risk to develop renal complications postoperatively. There is controverse among results of previous studies which is better Off-pump coronary artery bypass grafting or on-pump bypass in patients with non dialysis dependent chronic renal disease (CKD). So aim of this randomized study to test which modality is better in this sector of coronary diseased patients. In this randomized study, 100 patients with preexisting (chronic kidney disease (CKD) stages 2 and 3, were randomly assigned on the day before surgery into two groups. Each group contained 50 patients, Group A, 50 patients (off pump) underwent beating heart revascularization, whereas group B, 50 patients (on pump) underwent conventional myocardial revascularization with CPB and cardiologic arrest of the heart. We evaluated the effect of off-pump and on-pump techniques on renal function assessed by serum creatinine and GFR from the perioperative day till 4 weeks postoperative. We found no statistically significant increase in mean value of serum creatinine or decrease in eGFR either in each group or in comparing both groups (on day 1, day3,day7 and 4 weeks postoperative).

Conclusion: **There is no significant difference between off pump and on pump CABG in patients with preoperative non–dialysis dependent renal insufficiency (CKD stage 2 and 3).**

Cardiopulmonary bypass could be associated with renal injury which varies from sub-clinical injury to renal failure requiring dialysis. Despite advances in anesthetic techniques and in perioperative management of cardiac surgical patients, acute renal failure remains a frequent and serious complication of cardiac surgery. Its incidence varies depending on definition and affects 1-5% of all patients (1). While it may often be regarded as a transient injury that recovers with conservative management in most patients, there is evidence supporting a significant increase in mortality and morbidity that accompanies perioperative renal dysfunction (2). Previous studies have used the serum creatinine level as the determinant of the severity of renal impairment. The serum creatinine level is affected by multiple factors other than eGFR, such as creatinine secretion and generation and extra-renal excretion. According to the National Kidney Foundation guidelines, the estimated glomerular filtration rate (eGFR) has been considered as the most reliable index of renal function (3).

Patients and methods

This Prospective randomized study was conducted in the period from January 2009 to December 2013 in Cardiothoracic Surgery Department, Zagazig University, Ahrar Hospital, and Nasser Institute Hospital.

In this study, 100 patients with preexisting (chronic kidney disease (CKD) stages2 and 3, based on National Kidney Foundation12 guidelines (3)were randomly assigned on the day before surgery into two groups.

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Stage	Description	GFR (mL/min/1.73 m^2)
1	Kidney damage with normal or ↑ GFR	≥90
2	Kidney damage with mild ↓ GFR	60–89
3	Moderate ↓ GFR	30–59
4	Severe ↓ GFR	15–29
5	Kidney failure	<15 (or dialysis)

TABLE 1. Stages of Chronic Kidney Disease

- *From National Kidney Foundation: K/DOQI clinical practice guidelines for chronic kidney disease 2002(4).*
- Group A, 50 patients (off pump) had beating heart revascularization, whereas group B, 50 patients (on pump) had conventional myocardial revascularization with CPB and cardioplegic arrest of the heart.

Patients with impaired left ventricular function (ejection fraction less than 30%), recent myocardial infarction (within the past 30 days), patients with eGFR more than 60 or less than 30 mL/min/1.73 m^2, history of acute renal failure, patients required emergency surgery and any cardiac surgeries in the past and also those who had concomitant surgical procedures with CABG were excluded from the study.

Anesthetic Technique

In all patients, anesthesia was induced with propofol infusion at 3 mg/kg per hour combined with remifentanyl infusion at 0.5 to 1 mg/kg per minute. Intubation was facilitated by rocuronium 0.6 mg/kg. Standard monitoring was used.

In the on-pump group, heparin was given at a dose of 400 IU/kg to achieve a target ACT of 480 seconds or above before going on CPB. The activated clotting time was monitored during the bypass period (every 15 minutes), and an additional doses of heparin (100 IU/kg) were administered when needed to achieve the target ACT.

The protocol of heparin administration in the off-pump group was different. Before starting anastomosis, heparin 200 IU/kg was administered. The target ACT was 250 to 350 seconds. Protamine was administrated at the end of the operation to reverse the effect of heparin and achieve ACT levels near to the preoperative levels in both groups.

Surgical Technique

A standard median sternotomy was done in both groups to achieve access to the heart in all patients with simultaneous harvesting of saphenous vein and left internal mammary artery by direct harvesting.

In the on pump group, Aorto-caval cannulation, with ascending aorta cannulation and two-stage right atrial cannulation were done to start CPB. Aorta was cross clamped and intermittent antegrade with retrograde hyperkalemic cold blood cardioplegia were used to arrest the heart. All patients were cooled to 28°C.

A non pulsatile flow was used. Flow throughout bypass was 2.2-2.4 L /m^2/ min and mean perfusion pressure was maintained between 60 and 70 mm Hg by adjusting the doses of nitroglycerine and phenylephrine/ dobutamine/ norepinephrine.

After finishing all distal anastomoses, the aortic cross-clamp was removed and the proximal anastomosis performed with partial clamping the ascending aorta**.** A cell-saving device and cardiotomy suction were used.

In the off pump group, Octopus tissue-stabilizing and Starfish cardiac positioned were used for stabilization of the heart and target coronary artery stabilization during doing distal anastomosis and exposure of the coronary vessels was facilitated by using deep pericardial sutures.

An intracoronary shunt was employed during the coronary anastomosis. Visualization of the anastomotic area was enhanced by using a humidified carbon dioxide blower/mister to disperse the blood from the anastomotic site during the distal anastomosis.

A mean systemic arterial pressure was above 65 mm Hg throughout the procedure with the use of changing position of the heart and selective

use of vasoconstrictors. Other measures to improve cardiac output such as elevation of feet , increasing the heart rate and intravenous fluids were used as appropriate when needed to maintain stable hemodynamics.

A standby perfusionist with bypass circuit mounted was available for all cases and intraoperative autotransfusion of shed mediastinal blood was carried out in both on- and off-pump cases.

Protamine sulfate (1:1 ratio) was used at the end of the procedure to reverse activated clotting time to the pre-operative values.

All patients in both groups were transferred to the cardiac intensive care unit and standard postoperative protocol for the patient management was employed.

Serum creatinine and eGFR were measured preoperatively, on the first five postoperative days daily and after discharge at 4 weeks and 8 weeks on follow up. GFR was measured by the MDRD formula (Modification of Diet in Renal Disease Study) equation

Estimated GFR (ml/min/1.73m^2) = 186 x (Creat. μmol/L / 88.4)$^{-1.154}$ x (Age)$^{-0.203}$ x (0.742 if female) x (1.210 if black) (5).

1 mg/dL creatinine = 88.4 μmol/L creatinine

Statistical analysis

Data were collected and analyzed using SPSS 17.0. Quantitative data were summarized as mean and standard deviation. Means between the two groups were compared using unpaired student "t" test and paired student "t" test were used to compare means inside the same group . Qualitative data were summarized as percentage and were compared using chi-squared ($\chi 2$) test or fisher's exact test (according to the expected count). P-value £ 0.05 was considered statistically significant.

Results

There were no statistically significant difference as regards to age ,gender history of DM, hypertension, ejection fraction , angina class, Euro Score ,serum creatinine , eGFR and Number of days angiogram was done before surgery between off pump and on pump groups of the study (Table 2).

Using unpaired t-test compare operative details, there were no statistically significant difference between both groups as regards to the operative data as shown in table 3.

	Off pump		On pump		P-Value
Age (years)	57.83±11.3		58.08±9.9		0.45
Gender					
MALE	31	62%	28	56%	0.54
FEMALE	19	38%	22	44%	
Angina class					
1	22	44%	23	46%	0.84
2	22	44%	22	44%	
3	6	12%	5	10%	
Ejection fraction					
-Good >50%	33		29		
-Moderate 30-50%	17		21		
Mean ±SD	55.9±11.7		56.2±10.9		0.45
Body surface area (M^2)	1.69±0.19		1.74±0.14		0.07
DM	27	54%	25	50%	0.69
Hypertension	40	80%	32	64%	0.08
Euro Score	3.906±1.8		3.84±2		0.57
Serum creatinine (μmol/L)	141.77±8.8		143.38±10.4		0.20
GFR	52.45±8.6		51.6±7.9		0.67
No. of days angiogram was done before surgery	29.93±9.03		30.69±8.5		0.33

Table2: Preoperative Data:

	Off pump	On pump	P-Value
No. of grafts	3.14±1.1	3.48±0.9	0.08
Cardiopulmonary bypass time (min.)	-	94.59±24.5	
Cross clamp time (min.)	-	66.53±12.5	

Table 3: Operative details

As regards to Postoperative outcome there was statistically significant increase in the mean duration of ventilation and total hospital stay while no statistically significant difference as regards to chest drainage in 24hours stay in ICU, and inotropic support >24h (Table4).

As regards to complications (dialysis, re-exploration, re-intubation and mortality), there was no statistically significant difference between both groups of the study (Table4).

Results showing that the eGFR in the postoperative period was slightly decreased than preoperative period in both groups but there was no statistically significant difference either between both groups or pre and post-operatively.

eGFR was reduced in the immediate postoperative period and gradually increasing to reach near the preoperative value by 8 weeks post discharge but no statistically significant difference either between two groups or with the preoperative values (Table 5).

We found no statistically significant difference of eGFR when comparing either Day 1and Day 3or day1and after 8week in each group as shown in table 6.

	Off pump	On pump	P Value
Duration of ventilation (hours)	7.632±3.5	9.408±4.4	0.014
Chest drainage in 24h (ml)	680.91±273.1	761.42±246.7	0.06
stay in ICU (hours)	49.83±14. 4	54.93±15.5	0.06
Total hospital stay (days)	7±1.1	7.82±1.2	0.003
Inotropic support >24h	19	24	0.31
Complications:			
- Dialysis	2 4%	3 6%	0.31
- Re exploration	1 2%	2 4%	0.37
- Re intubation	2 4%	2 4%	0.38
- Mortality	2 4%	2 4%	0.38

Table 4: Post operative outcome:

	OFF PUMP	ON PUMP	P-value
Preoperative	52.45±8.4	51.604±8.9	0.69
1st day	50.21±10.8	48.4±12.3	0.78
2nd day	50.02±11.7	49±11.6	0.67
3rd day	50.04±12.3	48.37±14.1	0.74
4th day	50.26±13.7	48.506±11.8	0.75
5th day	50.72±12.6	48.92±14.8	0.74
4 weeks post discharge	50.99±11.9	49.63±12.7	0.71
8weeks post discharge	51.59±13.4	50.13±11.9	0.72

Table 5: Unpaired t test compare mean value + S.D of eGFR between OFF PUMP and ON PUMP groups.

Post discharge	OFF PUMP	P-value	ON PUMP	P-value
Day 1 Day 3	52.45±8.4 50.04±12.3	0.91	51.604±8.9 48.37±14.1	0.94
Day 1 8weeks	52.45±8.4 51.59±13.4	0.67	51.604±8.9 50.13±11.9	0.81

There were no statistically significant difference of serum creatinine between OFF PUMP and ON PUMP groups from day 1 to 8 weeks post discharge as shown in Table 7.

	OFF PUMP (μmol/L)	ON PUMP (μmol/L)	P-value
Preoperative	141.77±8.8	143.38±10.4	0.20
1st day	143.93±17.5	144.79±17.9	0.40
2nd day	149.27±29.6	146.72±19.8	0.69
3rd day	148.93±24.3	149.12±22.7	0.48
4th day	148.93±29.6	152.52±26.9	0.26
5th day	148.08±27.8	149.28±27.1	0.41
4 weeks post discharge	148.26±33.1	149.69±32.8	0.41
8 weeks post discharge	144.87±18.5	146.4±18.6	0.34

Table 7: Unpaired t test compare mean value + S.D of serum creatinine between OFF PUMP and ON PUMP groups.

Discussion

Renal dysfunction is a well-recognized complication after coronary artery bypass grafting (CABG) and a risk factor for morbidity and mortality. Patients with renal impairment prior to CABG are considered to be in a higher risk of development of renal failure and need for renal replacement therapy.

CABG is done either with the use of CPB (on pump) or without (off pump). The usage of CPB represents a specific risk factor during cardiac surgery. The injurious effect of CPB on renal function is caused by several mechanisms including non-pulsatile perfusion, renal hypoperfusion, hypothermia, and increased levels of circulating catecholamines, cytokines, and free hemoglobin (6,7).

CPB induces transient renal injury in patients undergoing cardiac surgical procedures as evidenced by decreased tubular function and increased levels of markers of glomerular and tubular damage. Free plasma hemoglobin, elastase and endothelin, and free radicals including superoxide, hydrogen peroxide, and hydroxyl radicals may be generated during CPB and may determine injury in the renal brush-border membrane (8).

The presence of pre-existing renal dysfunction, diabetes, and hypertension preoperatively, add another risk factor to increase the transient renal injury effect of CPB (9). Changes in these parameters were essentially confined to the intraoperative and immediate postoperative periods and returned to baseline levels within 2 days (10).

The advent of OPCAB has allowed surgeons to take a different approach to the problem of postoperative morbidity. Off-pump CABG has precluded the need for CPB in many cases and has been reported to reduce postoperative morbidity and mortality, particularly in high-risk patients by avoiding the potentially undesirable effects of CPB that negatively affect postoperative renal function, such as inadequate perfusion pressure, renal hypoperfusion, non-pulsatile flow or inflammatory reactions (11,12).

The off-pump technique for coronary revascularization was disseminated in the early 1990s, there has been speculation that this technique may reduce the perioperative renal insult .Use of beating heart techniques means maintenance of pulsatile flow and no exposure to the extracorporeal circuit, with an anticipated reduction in the inflammatory cytokine response, normothermia, and a decreased requirement for vasoconstrictor administration to maintain target mean arterial pressure (13).

The effect of off-pump CABG (OPCAB) on postoperative renal impairment has also been controversial. Although it has been reported that OPCAB may minimize renal injury in elective patients with normal and impaired preoperative renal function and in high-risk patients (14,18), however other studies have failed to show such benefit (19-21).

In this study, we compared the off-pump CABG with the on-pump CABG in patients with preexisting non-dialysis-dependent renal dysfunction stages 2 and 3, based on National Kidney Foundation classification regarding its effect on kidney function and the need of dialysis postoperatively. The estimated glomerular filtration rate (eGFR) was estimated by the modification of diet in renal disease formula used to detect the effect on kidney function which gives more accurate estimation of kidney function than the level of serum creatinine which is affected by several factors.

Our results showed that the eGFR in the first 5 days was decreased in both groups from preoperatively value but was not statistically significant. On follow up at 4 and 8 weeks post discharge, eGFR was going up but still less than preoperative values in both groups but no significant difference either between

two groups or with the preoperative values.

Patients in the on-pump group showed a higher requirement for inotropic use and a higher blood loss but without statistical significance. The intubation time for the on-pump group was statistically significantly higher than that for the off-pump group. Three patients in the on-pump group required hemodialysis and two patients in the off-pump group.

In the study done by Pramodh and coleagues (22), they reported that the renal function is better pr served in patients undergoing off-pump coronary revascularization when compared to patients undergoing on-pump coronary revascularization. Another study by Sajja and his colleagues(23) evaluated the changes in renal function and clinical outcomes in patients with preoperative non–dialysis-dependent renal insufficiency undergoing primary coronary artery bypass grafting, They found that the on-pump coronary artery bypass grafting is more deleterious to renal function in patients with non–dialysis dependent renal insufficiency than off-pump group especially in diabetic patients.

Abu-Omar et al., (24) reported in their study that the on pump CABG had significantly lower postoperative creatinine clearance in comparison to the off pump CABG which associated with a reduction in postoperative renal injury.

Ascione and associates (25) demonstrated higher postoperative serum creatinine and urea levels in patients with preoperative non-dialysis dependent renal insufficiency undergoing on-pump CABG with a significant difference at 12 hours postoperatively as compared with those undergoing OPCAB surgery. In addition, in a further study they reported a significantly impaired renal tubular function as assessed by increased N-acetyl glucosaminidase activity in the on pump CABG group and they concluded that the off pump coronary revascularization offers a superior renal protection when compared with conventional coronary revascularization with cardiopulmonary bypass and cardioplegic arrest in first time coronary bypass patients(26).

Loef and associates (27) found significantly less changes in micro-albuminuria, free hemoglobin, fractional excretion of sodium and free water clearance as well as N-acetyl-D glucosaminidase as a marker for tubular function and damage, respectively, in patients undergoing OPCAB as compared with on pump CABG patients. They conclude that off-pump coronary surgery attenuates renal injury after surgical myocardial revascularization.

Hayashida and associates (28) found a significantly less increase in creatinine levels and a greater creatinine clearance in OPCAB patients as compared with the on pump CABG group. Postoperative recovery of free water clearance was more prompt in the OPCAB group.

In contrast to these findings, in a study by Gamoso and associates (29) including 690 patients, they reported no significant reduction of perioperative renal function in OPCAB patients could been found.

As well as Elmistekawy and his colleagues(30) reported also, Off-pump coronary artery bypass grafting does not preserve renal function to a greater extent than on-pump coronary artery bypass grafting and they also a trend to the reverse exists with no clinically harmful effects.

Asimakopoulos and colleagues (31) in their retrospective study of 704 consecutive patients. They found that coronary artery bypass grafting can be performed with minimal effect on postoperative renal function. The use of on- or off cardiopulmonary bypass techniques does not significantly affect postoperative estimated creatinine clearance or plasma creatinine levels.

According to the study done by Di Mauro et al, they concluded that off pump CABG is better than on pump when the preoperative renal function is within normal range but when there is preoperative renal function is abnormal; there is no significant difference between off pump and on pump surgical strategy on the postoperative outcome (32).

Conclusion

When on pump or off pump CABG used in patients with preoperative non- dialysis dependent renal insufficiency (CKD stage 2 and 3), there were no significant difference on the postoperative morbidity including the need for dialysis

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Early Extubation After Conventional Open Cardiac Surgery

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Hany Tman

Background: **Introduction of minimally invasive cardiac surgical techniques has advocated the advantage of early extubation. However with the limited supplies, facilities and resources we select conventional cardiac techniques including both standard surgical exposure (median sternotomy and conventional techniques including hypothermia, cardiopulmonary by-pass with cardiac arrest and optional myocardial protection) to determine the feasibility, efficacy and safety of early extubation.**

Patients and methods: **This study was conducted on 200 patients who underwent first time elective open heart surgery, Excluded from this study high risk patients (with any significant organ insult including EF% 50%<). Patients were randomly classified into 2 equal groups: Group (I) followed early extubation protocol , the extubation was done within 3 hours after arrival to surgical Intensive Care Unit (ICU). Group (II) with postoperative ventilatory support for several hours (≥12 hours). The surgical procedures were modified to achieve short duration of surgery, patients were extubation according to definite criteria, discharge from ICU and hospital was done according to fixed parameters and the outcomes of the patients were compared between the two groups.**

Results: **Both groups were matched regarding age, weight and gender. In group (I) early extubation was feasible in (94%) of patients while in (6%) of patients extubtion was delayed because of (bleeding-delayed recovery or need for high doses of inotropic support) the mean cardiopulmonary by-pass (CPB) and aortic cross clamp times were 79±22.1 and 58.4±21 min in group (I) versus 81.3+/- 29 min and 60.5+/-30 min in group (II) (P=NS). Chest infection occurred in 3 (3.1%) of patients in group (I) versus 8 (8%) patients in group (II) (P=S). Atelectiasis incidence was higher in group (II) (P<0.05) 6% versus 3.1% in group (I), pneumothorax was reported in 1.06% in group (I) versus 2% in group (II) (P=NS). ICU mortality was equal on both groups. The mean ICU stay was 32.2 +/- 3.4 hours in group (I) versus 57.1 +/- 44 hours in group II (P=S) . The mean hospital stay was 6.3±2.1 days in group (I) while it was 10.2±3.3 days in group (II) (P<0.01).**

Conclusion: **In our study early extubation was feasible in 94% of selected patients that offered significant reduction in ICU and hospital length of stay.**

Sedation and over night ventilation of cardiac surgical patients have been the standard protocol for several decades, the aims of that protocol are to avoid the respiratory insufficiently and to minimize the increased myocardial oxygen demand secondary to spontaneous breathing or the stress response after cardiopulmonary by-pass that may lead to myocardial ischemia [1].

Improvement in extracorporeal technology with membrane oxygenators, centrifugal perfusion, ultrafiltration and blood sparing techniques had reduced the whole-body inflammatory response after cardiopulmonary by-pass with subsequent rapid recovery after open heart surgery [2].

Use of inhalation based anaesthesia allows for early extubation for many postcardiopulmonary by-pass patients which offers patient comfort with reduction of Intensive Care Unit (ICU) stay and requirement due to marked reduction of respiratory complications [3].

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Patients and methods

This study was conducted on 200 patients who underwent first time elective open heart surgery in Cardiothoracic Surgery Department (Mansoura university Hospital and Damietta cardiology and gastroenterology center) from (2005 – 2013). Excluded from this study patients with significant renal, hepatic, pulmonary and cerebral insults, also patients with ejection fraction >50% were excluded. All patients were subjected to pre-operative clinical examination, laboratory investigations to exclude organ dysfunction, radiological and echocardiographic assessment were also done and coronary angio was done for some cases. Patients were randomly classified into 2 groups (N100, for each): group (I) early extubation group (at fewer than 6 hours postoperatively) [4].

Anaesthetic protocol

All patients were premedicated with midazolam (1 mg/kg) and morphine (10 mg) with intramuscular injections 45 minutes before entering the operating room. Heart rate, mean value of non invasive arterial blood pressure, oxygen saturation, and ECG were monitored (using Datex, Helsinki, Finland AS).

Anesthesia in all patients was based on moderate doses of fentanyl (10 to 20 μg/kg) and midazolam (0.05 to 0.15 mg/kg), supplemented with isoflurane (MAC< 1) for maintenance and propofol infusion (2.5-3 mg/kg/h) during cardiopulmonary bypass (CPB). Tracheal intubation and muscle relaxation was facilitated and maintained with esmerone loading dose (0.9mg/kg) and infusion at arte of 0.5 mg/kg/h.

Heart rate, mean value of invasive arterial blood pressure (through a radial artery catheter inserted under complete a septic condition in non dominant hand), central venous pressure, (through a right internal jugular vein catheter inserted under complete a septic condition), end tidal CO2, oxygen saturation, nasopharyngeal temperatures were monitored

Regarding (group II) after the completion of surgery, a bolus of intravenous morphine (2mg) was given and followed by a continuous infusion (2mg / h). Mechanical ventilation was done using SIMV mode as guided by blood gases analysis every hour . Tracheal extubation followed the same criteria of the fast track protocol .

Cardiopulmonary by-pass (CPB)

Standard CPB was performed using membrane oxygenators. Core temperature was allowed to decrease to 32°C during CPB, haematocrite concentration was maintained within 28-32% and the mean perfusion pressure was kept between 50 and 80 mmHg. Myocardial protection was achieved with antigrade blood cardioplegia (tipped or cold) through aortic root or direct via coronary ostia. Left ventricular vent via pulmonary artery was inserted or into right superior pulmonary vein. For better myocardial protection we used topical iced saline. Rewarming to 37°C prior to separation from CPB was done to avoid hypothermia. Criteria for early extubation (within 6 hours postoperatively) was done when patients were fulfilling the standard criteria for extubation.

Criteria	Criteria for extubation (5)
Haemodynamic	Normotension, heart rate <120 min. no signs of LCO or myocardial ischemia
Lung function	PaO_2 >80 mmHg and $PaCO_2$ <45 mmHg at FiO_2 50%, spontaneous respiratory rate <30 min. and tidal volume >5 ml/kg, PEEP <5 cm H_2O.
Muscle strength	Spontaneous smooth ventilation, can left head
Consciousness	Full contact with response to simple commands
Surgical complications	Bleeding <100 ml within last 30 minutes.

FiO_2 = fractional concentration of oxygen, LCO= low cardiac output, $PaCO_2$= arterial carbon dioxide tension, PaO_2= arterial oxygen tension, PEEP= positive end expiratory pressure [5].

After extubation: close monitoring and giving of analgesia during recovery period included intravenous pethidine 20-30 mg every 50-60 minutes and non steroidal anti-inflammatory drugs (NSED).

Surgical techniques

Every effort was done to:

- Minimize aortic cross clamp and CPB times.
- Avoid excessive cooling to allow rapid recovery and retain physiological body organs function.
- Avoid postoperative bleeding .

Special points in surgical techniques

1- In mitral valve replacement (MVR):

Every effort was done to preserve the whole sub-valvular apparatus (unless calcified or heavily fibrotic). This technique has better effect on the left ventricular function with good outcome regarding rapid postoperative recovery [6].

2- In aortic valve replacement (AVR):

Excision of the cusps may be performed while giving cardioplegia directly via coronary ostia to save time.

3- In tricuspid repair:

Usually done on a beating heart to avoid A-V block and to reduce the aortic clamp time.(7)

4- In ASD closure and after excision of atrial myxoma:

Closure of the right atrium was done after de-airing and removal of the aortic clamp.

5- In VSD closure:

We used continuous technique in suturing the patch to the defect boundaries as this technique is rapid and save (not associated with A-V block or postoperative residual defect) [7].

6- Right ventricular outflow reconstruction was done after removal of aortic cross clamp.

7- In Myocardial revascularization surgery:

Rewarming started with the first stitch of internal mammary anastomosis and the aortic clamp was removed with the last stitch and the proximal anastomosis was done on a beating heart.

8- We used blood cardioplegia rather than crystaloid as it offers rapid recovery of the myocardium wich reflects on the postoperative recovery [8].

9- We used strict haemostatic techniques as we used coagulants from the start of surgery to decrease total time of surgery and possibility of postoperative bleeding we used tranexamic acid (Cyclokapron) Our protocol was bleeding we an initial tranexamic acid bolus of 30 mg/kg was infused over 15 min followed by a 16 mg/kg/h infusion until chest closure with a 2 mg/kg load within the pump prime.

10- No patients in our study had platelet count <150,000 or prothrombin concentration <50%, acetyle salicylic acid and other antiplatelets were stopped at least 1 week before surgery.

ICU discharge criteria patient were discharged when fulfilling these criteria:

- Alert, cooperative and without cerebral insults.
- No inotropic support with good haemodynamic status.
- Adequate lung function.
- Minimal chest tube <20 ml/h for 4 successive hours.
- Urine output >0.5 ml/kg/h.
- No evidence of haemopericardium or haemopneumothorax[4].

Hospital discharge criteria:

- Stable rhythm for 24 hours.
- Stable pulmonary function.
- Satisfactory haemodynamic status.
- Ambulatory with adequate oral intake and good bowel habits.
- A febrile with satisfactory wound [2].

Regarding group II, extubation and discharge criteria followed the same as of the early extubation group.

Statistical analysis

Data were first tested for normality by Klomogorov-Smirnov test. Normally distributed continuous data were analyzed by using student t-test. Non-normally distributed continuous and ordinal data were analyzed using Mann-Whitey U test. Categorical data were analyzed by Chi-square or Fisher's exact test as appropriate. The results are presented as mean (SD), median (interquartile range), or number of patients as appropriate. A P value < 0.05 was considered statistically significant. Statistical analyses were performed using the SPSS for Windows, version 18

Results

	Group I	Group II	T-test / χ^2	P-Value
Age (years) ± SD	22.2±4.7	23.5±5.07	1.88	>0.05
Weight (kg) ± SD	70.1±8.7	72.3±**7.6**	1.904	>0.05
Sex(female/male)	52/48	54/46	0.8	>0.05

N.B: *Both groups were matched regarding age, weight and gender.*

Table 1. Demographic data of both groups

Applied on (N)	Success	Failure
100	94	6 A/E: - Bleeding (one case). - Delayed recovery (2 cases). - High dose of inotropic (3 cases).

Table 2. Success of early extubation protocol (group I)

Procedure	Group I		Group II	
	No. 100	%	No. 100	%
Repair of congenital defect:				
- ASD	16	16%	17	17%
- VSD	8	8%	7	7%
- AC canal	4	4%	5	5%
- Follot's tetrology (pink)	2	2%	1	1%
- Subaortic membrane	1	1%	1	1%
Total	**31**	**31%**	**31**	**31%**
Valve replacement:				
- MVR alone	22	22%	20	20%
- MVR tricuspid repair	9	9%	11	11%
- AVR	26	26%	28	28%
- DVR	5	5%	4	4%
Total	**62**	**62%**	**63**	**63%**
Excision of cardiac tumors:				
- Left atrial myxoma	2	2%	2	2%
Total	**2**	**2%**	**2**	**2%**
CABG:				
- Single graft	3	3%	2	2%
- 2 grafts	2	2%	2	2%
Total	**5**	**5%**	**4**	**4%**

N.B: *The 2 groups were cross matched regarding number of cases in each surgical category.*

Table 3. Surgical procedures in both groups No = 100 in each group

	Group I	Group II	T-test	P-Value
CPB (mean ± SD) minutes	79+/-22.1	81.3+/-29	0.618	>0.05
Aortic cross clamp time (mean ± SD) min.	58.4+/-21	60.5+/-30	0.562	>0.05
ICU stay (mean ± SD) hours	32.2+/-3.4	57.1+/-44	43.909	**<0.001**
Hospital stay (mean ± SD) days	6.3+/-2.1	10.2+/-3.3	9.751	**<0.001**

Table 4. Time factors in both groups

Table 5. Incidence of postoperative complications

	Group I(94)		Group II(100)		χ^2	P-Value
	No.	%	No.	%		
Re-intubation	1/94	1.06	1/100	1	0.002	>0.05
Chest infection	3/94	3.1	8/100	8	4.279	<0.05
Atelectasis	3/94	3.1	11/100	11	4.414	<0.05
Pneumothorax	1/94	1.06	2/100	2	0.279	>0.05
ICU mortality	1/94	1.06	1/100	1	0.002	>0.05
Aetiology :	Unexplained unexpected death (Fatal Arrhythmia)		Persitant low cardiac output status			

Discussion

During the past few years, fast track recovery protocols have received widespread acceptance and have contributed to significant reduction in postoperative hospital length of stay after conventional cardiac surgical techniques [9, 10].

Mechanical ventilation by itself impairs venous return and decrease cardiac output, Tachycardia and hypertension (in some patients) are other response that can occur secondary to mechanical ventilation these complications increase ICU stay and require more supplies for the patients [11].

Optimization in anasethetic management, advances in myocardial protection method and improvement in surgical techniques allow cardiac patients to be safely extubated early [2]. Potential benefits of early extubation that it fastens return of normal ciliary function, improves respiratory dynamics and coughing reflex with subsequent reduction of nosocomial pneumonia [12]. Family satisfaction improves dramatically when patients are extubated early [4].

The timing of early extubation has varied among different reports and precise definition has not been established, however, early extubation can be defined as removal of endotracheal tube within 8 hours after arrival to surgical ICU [4].

Culler and colleagues categorized postoperative extubation based on duration as early if <6 hours, intermediate between 6:12 hours and late if applied between 12 to 24 hours from arrival to surgical ICU [13].

Straka and colleagues introduced the term of ultra fast track that allows extubation in the operating room or within 1 hour after surgery [5].

Early extubation protocol can be achieved when it is applied on young and low risk population [4].

In our study we applied fast tack protocol on 100 patients undergoing first time elective open heart surgery (group I) the mean age was 22.2±4.7 years (young) and we excluded high risk patients from the study, then we compared the results with another 100 patients for whom conventional late extubation was done. Both groups were matched regarding demographic data and surgical procedures.

According to fast track protocol, 94 (94%) patients (out of 100) were able to be extubated at a mean time of (3.4.2±1.2 hours) after surgery, this finding was in line with the finding of ***Culler and colleagues*** who achieved (93.8%) feasibility of early extubation [13]. Selected patients with similar criteria as in our study, on the other hand some investigators [14, 15] reported 84%,and 85% success. As the mean age of their patients was above sixty years old

Walji and colleagues [2], were able to extubate 56% of their patients early but on revision of patients criteria we find that their mean age was 75 years (old patients) and not exclude high risk patients from their study.

The causes of extended ventilation in the remaining 6% of our patients were bleeding in one patient, delayed recovery in 2 patients and need of high doses of inotropic drugs in the remaining 3 patients.

Anaesthetic technique is an important factor in determining the feasibility for early extubation as patient must be fully conscious with adequate protective reflexes and good muscle power [12].

CPB has been thought to have many deleterious effects as it augments the whole body inflammatory response so short duration of aortic cross clamp and CPB times have been thought by some to be an important factors to allow application of fast track protocol [17]. In our study, some points in the surgical techniques were adopted aiming at reduction of CPB and aortic cross clamp time without harmful effect on the patients as in VSD closure we used the continuous technique in suturing the patch to the defect boundaries, this technique is safe, rapid, not associated with A-V block or postoperative residual defect [7], in each surgical category we applied this role, so aortic cross clamp and CPB times were 58±21 and 79±22 minutes in group I which were comparable with many authors as ***Djaiqni and colleagues*** who reported 59 and 78 minutes [18], Any how we are believed the opinion ***of Walji et al***. who said that with improved strategies of myocardial protection and improvement in by-pass circuit particularly membrane oxygenator technology the acual length of cross clamp and by-pass times are likely to become less critical. Instead the quality and precision of surgical techniques and methods of myocardial protection may become recognized as better determinants for clinical outcome [2].

Uses of low doses of inotropic drugs does not prevent early extubation, if the doses greater than 13 ug/kg/min dopamine or greater than 100 ng/kg/min adrenaline are needed , early extubation must be postpond since larger doses imply poor haemodynamic status [7], This protocol was applied on 3 patients (in group I) who required high doses of inotropic drugs to maintain satisfactory haemodynamic state and the extubation was delayed for more than 8 hours.

Chest infection occurred in 3.1% patients in group I (out of 94) in the form of bronchitis, bronchopneumonia and pneumonia, while in group II 8 (8%) patients developed chest infection these patients required treatment which was prolonged and with higher expense in group II compared with the coast in group I (P=0.05). This finding explained by the higher rate of pulmonary bacterial colonization that can occur with prolonged mechanical ventilation.

Postoperative pneumothorax was detected in one patient in group I (1.06%) and in 2 patients (2%) in group II (P>0.05) although pneumothorax is a well known complication of mechanical ventilation.

Pulmonary atelectiasis was detected in 3 patients in group I (3.1%) and in 11(11%) patients in group II (P=0.05) this finding can be explained by early endotracheal tube removal with return of ciliary function and improves respiratory dynamics and coughing reflex [11].

The incidence of re-intubation in group I was (1.06%) (one patient out of 94) versus 1% i.e. one patient in group II (P=N.S) the indication was surgical revision in both. This finding was matched with ***Culler and colleagues*** who concluded that early extubation was associated with lower risk of re-intubation and reported incidence ranged between 1:3.8% in multicenter comparative study [13].

Hospital mortality was equal in both groups one patient in each group (P=NS) denoting that early extubation did not affect mortality incidence

The mean duration stay in ICU for group I was (32.2±3.4 hours) versus 57±4.4 hours in group II ICU discharge was based on definite criteria which denoting that the patients were stable and need no further attendance the difference was statistically significant (P<0.05) this finding was reflected on hospital stay time which was 6.3+/-2.1 days in group I and 10.2±3 days in group II with statistically significant figure (P<0.05).

Many authors [14, 20, 21] reported similar results and concluded that early extubation was associated with shorter ICU stay with subsequent shorter hospital stay without adverse impact on postoperative outcome.

Conclusion

In our study after conventional open cardiac surgery techniques early extubation within 3 hours after surgery was feasible in selected patients depending on preoperative criteria, anaesthetic technique, nature of operative procedure and the condition of the patient at the end of surgery.

In our study, early extubation could be achieved in 94% of the selected patient offering significant reduction in the incidence of postoperative complication with subsequent reduction of ICU and hospital stay times compared with patients extubated later on.

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Predictors of Early Mortality After Repair of Total Anomalous Pulmonary Venous Connection

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Background **Preoperative risk factors for early mortality after repair of total anomalous pulmonary venous connection (TAPVC) have been changed recently due to modifications in the strategy of management of this complex congenital heart disease**

Methods: **A retrospective study of 44 patients who underwent repair of TAPVC from 2005 to 2013 were studied to evaluate outcomes and factors affecting early mortality in this sub-group of patients.**

Results: **We reviewed our results of 44 patients (31 male and 13 female, with a median age of 14 days (range from 1day to 2 years) who had been operated upon for repair of total anomalous pulmonary venous connection. we found that total bypass time (p = 0.002), the need for deep hypothermia and total circulatory arrest for repair (P = 0.01), the body surface area (P = 0.002), the presence of associated anomalies (P= 0.04) and the presence of early postoperative pulmonary venous stenosis (P = 0.007) to be independent risk factors for operative and early postoperative mortality after repair of TAPVC.**

Conclusions **Overall mortality among TAPVC was acceptable in our series. Early postoperative pulmonary stenosis, the presence of associated anomalies and body surface area are among the common risk factors for early mortality after repair of TAPVC.**

KEYWORDS: **TAPVC, TAPVR, anomalies of the pulmonary veins.**

TAPVC as a congenital anomaly is a rare, though heterogeneous anomaly, accounting for only 1 to 2% of congenital heart disease [1]. In some variants, it represents the only true surgical emergency in congenital heart surgery (1-4)

Surgical repair of TAPVC has historically been associated with a significant risk of early mortality, with reports in the literature ranging from 10% to 50%. Mortality continues to be associated with some risk factors, including previous surgery for pulmonary venous obstruction, longer cardiopulmonary bypass times, longer circulatory arrest duration, complex operative repairs, and single-ventricle anatomy.(5)

Recent reports of TAPVC repair have indicated an improvement in surgical outcomes over time (6). Among the numerous perioperative management strategies that might have influenced this improvement are aggressive preoperative stabilization, minimization of invasive preoperative work-up, new operative techniques, and sophisticated postoperative management, including extracorporeal membrane oxygenation (ECMO) and nitric oxide. (7)

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Patients and methods

Preoperative Data

Between 2005 and 2013, fourty four patients were operated upon for repair of TAPVC at Ospedale Infantile Reghina Margherita, Turin, Italy and Miser Children Hospital, Cairo, Egypt. About 70% (31/44) were male and 30% (13/44) were female

babies. Surgery was done at a median age of 14 days ranging from 1 day to 2 years. The mean weight and body surface area (BSA) was 3.8 ± 1.6 kgm and 0.22 ± 0.598 cm2 respectively. Twenty patients had supracardiac TAPVC, 11 patients had cardiac type, 10 patients with infracardiac type and 3 patients had mixed type TAPVC. About 30% of patients had preoperative pulmonary venous obstruction and 70% were operated without obstruction. Nine patients had associated anomaly apart from atrial septal defect (ASD) and patent ductus arteriosus (PDA). Patients with associated anomalies percludding biventricular repair were excluded from the study. Twenty three patients were hemodynamically stable without any inotropic support, 15 patients had small doses of inotropic support without mechanical ventilation and 6 patients were on maximum inotropic support with or without mechanical ventilation.

Statistical analysis

The collected data were organized, tabulated and statistically analyzed using SPSS version 19 (Statistical Package for Social Studies). Continuous data were presented as range with mean ± standard deviation (SD) since the data are skewed and not normally distributed. Differences between mean values among alive and dead patients were compared using Mann-Whitney test as the variables were found to be skewed. For categorical variable, the number and percentage were calculated. Differences in frequencies between different categories were test by Fisher exact and Monte Carlo exact tests. Binary logistic regression was performed for variables significantly affecting mortality. The level of significance was adopted at $p < 0.05$

Operative technique

Early in our study, repair was done using deep hypothermic circulatory arrest, then with modifications of the bypass techniques the operation was carried on using continuous cardiopulmonary bypass with moderate hypothermia and brief periods of low flow bypass. After aortic and bicaval cannulation, cardiopulmonary bypass (CPB) was commenced with cooling of the patient. Cardioplegic arrest was achieved with either St Thomas or Custodiol HTK (**Histidine-tryptophan-ketoglutarate)** cardioplegic solution. The repair was done either through the intracardiac or extracardiac approache as described by many and the anastomosis between the common pulmonary venous confluence and the left atrium was done using continuous suture with either non absorbable suture material (prolene 6/0) or absorbable suture material (polydioxanone 5/0) . In the setting of cardiac type TAPVC to the coronary sinus, the repair is done through the intracardiac approach with complete unroffing of the coronary sinus and closure of the ASD with a large pericardial patch. In the setting of a mixed type TAPVC, more than one technique was used to redirect the pulmonary venous return to the left atrium depending on the variations on the anomalous veins. After weaning from cardiopulmonary bypass, the decision as to ligate the vertical vein or to leave it open was done depending on the left atrial size and pressure and weather to primary close the sternum or to transfer the patient to the ICU with according to the hemodynamic status of the patient.

Results

Mortality

The overall mortality in our series was 34.1% . 9.1% were operative mortality and the remaining was early postoperative mortality (Fig 1). In our series the body weight was not a risk factor for operative or early postoperative mortality while body surface area is one of the significant predictors for operative and early postoperative mortality where the mean BSA for the alive and died patients were 0.22±0.07 and 0.22±0.08 respectively (p = 0.002) (tab. 1).

Variables	Alive	Died	Z	p
Age in days:			1.587	0.113
Range	1-420	1-300		
Mean ±SD	67.72±105.77	50.00±94.33		
Body weight in Kg:			1.295	0.195
Range	2-8	2-10		
Mean ±SD	3.88±1.38	3.66±2.06		
Body surface area:			3.145	0.002*
Range	0.17-0.48	0.15-0.47		
Mean ±SD	0.24±0.07	0.22±0.08		

Table 1. Comparison of mean age in days, body weight and body surface area among studied patients in relation to mortality.

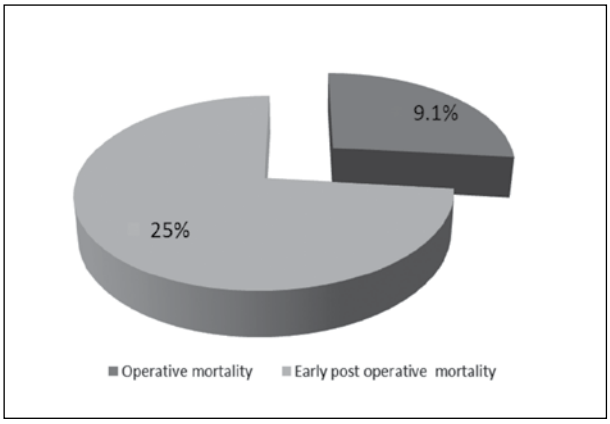

Fig 1. Mortality among studied patients

Preoperative variables	Alive		Died		*P*
	n	%	n	%	
Gender:					1.000
Males	20	64.5	11	35.5	
Females	9	69.2	4	30.8	
Type of TAPVC					0.955
Supra cardiac	12	60.0	8	40.0	
Cardiac	8	72.2	3	27.3	
Infra cardiac	7	70.0	3	30.0	
Mixed	2	66.7	1	33.3	
Obstruction:					0.177
Absent	22	73.3	8	26.7	
Present	7	50.0	7	50.0	
Associated disease:					0.044*
Absent	26	74.3	9	25.7	
Present	3	33.3	6	66.7	
Stability:					0.470
1	13	56.5	10	43.5	
2	7	70.0	3	30.0	
3	4	80.0	1	20.0	
4	5	83.3	1	16.7	

Table 2. Comparison of preoperative variables in relation to mortality

The aortic cross clamping time was found to be insignificant predictor for operative or early mortality in our patients group while the time of cardiopulmonary bypass and the need for deep hypothermia and total circulatory arrest were found to be associated with high early postoperative mortality. In our study, 2 patients out of 18 patients who did not need DHCA died early postoperatively while 50% of 26 patients who needed DHCA died either operatively or early postoperatively. Also the time of cardiopulmonary bypass in the a live and died groups were125.14±58.82 and 195.8±64.29 minutes (p = 0.002) respectively (tab. 3).

Also, in our study, the patient gender, the type of TAPVC, the presence or absence of preoperative pulmonary venous obstruction, the type of cardioplegia, the surgical approach, ligation of the vertical vein or not, the cardiac rhythm on coming of bypass and closing the sternum or leaving it open were found to be insignificant factors for prediction of early postoperative mortality(tab. 2,3,4,5). On the other hand, the presence of associated cardiac lesions and the presence of early postoperative pulmonary stenosis were predictors for early postoperative mortality.(tab. 2,5)

Variables	Alive	Died	Z	p
Cardio-pulmonary bypass time:			3.145	0.002*
Range	56-291	101-296		
Mean±SD	125.14±58.62	195.8±64.29		
ischemic time :			1.523	0.128
Range	28-127	22-187		
Mean±SD	58.93±27.60	79.33±42.86		
HCA :			0.899	0.369
Range	22-62	19-180		
Mean±SD	42.54±10.94	58.54±41.85		

Table 3. Comparison of mean cardiopulmonary bypass time, ischemic time and HCA among studied patients in relation to mortality.

Operative variables	Alive		Died		p
	n	%	n	%	
Cardiolpegia:					0.195
St. Thomas	17	58.6	12	41.4	
Custodial	12	80.0	3	20.0	
Need for HCA					0.010*
Absent	16	88.9	2	11.1	
Present	13	50	13	50.0	
Approach:					1.000
Intra- cardiac	18	66.7	9	33.3	
Extra- cardiac	11	64.7	6	35.3	
Suture:					0.695
Prolene	22	62.9	13	37.1	
PDS	7	77.8	2	22.2	
Vertical vein:					0.469
Absent	10	55.6	8	44.4	
Present	11	73.3	4	26.7	
Sternum:					0.057
Closed	15	83.3	3	16.7	
Opened	14	53.8	12	46.2	
Rhythm:					0.091
Sinus	25	73.5	9	26.5	
Junctional	2	28.6	5	71.4	
Heart block	2	66.7	1	33.3	

Table 4. Comparison of operative variables in relation to mortality

Post-operative variables	Alive		Died		p
	n	%	n	%	
Rhythm early postoperative:					0.364
Sinus	23	74.2	8	25.8	
Junctional	3	100.0	0	0.0	
Heart block	2	40.0	3	60.0	
Atrial fibrillation	1	100.0	0	0.0	
Stenosis early post operative					0.007*
Absent	26	83.9	5	16.1	
Present	3	33.3	6	66.7	

Table 5. Comparison of post-operative variables in relation to mortality

Variables	Wald	P
Body surface area	1.325	0.245
Associated diseases	1.917	0.166
Cardio pulmonary bypass time	0.885	0.347
Need for HCA	1.726	0.189
Early post operative stensosis	3.325	0.068

Table 6. Binary logistic regression for variables affecting mortality among studied patients

Discussion

Early surgical repair for TAPVC is currently recommended, even before the onset of clinical symptoms and irrespective of anatomic subtype [2,8]. Results of TAPVC repair in infancy have markedly improved in recent years, with an operative mortality of 5% or less in some institutions [2,9,10] . This improvement is probably multi-factorial, mainly due to early non-invasive diagnosis and aggressive preoperative, intraoperative and postoperative management.

Routine use of echocardiography as the gold-standard diagnostic tool, improvements in myocardial protection with specific attention to protection of the right ventricle, creation of a large and tension-free anastomosis with maximal use of the venous confluence and atrial tissue, careful geometric alignment of the pulmonary vein (PV) sinus with the body of the left atrium avoiding torsion and rotation of the pulmonary veins, monitoring and prevention of pulmonary hypertensive events and delayed sternal closure have probably played a major role in reducing operative mortality (11).

Early in our series we had a high operative and postoperative mortality 11/21(52.3%) however late in our series there was a great improvement in operative and early postoperative mortality 3/23(13%), this is in accordance with the series of many other authers (12-15).Early postoperative pulmonary stenosis was a dependant risk factor for operative and early postoperative mortality in our series .also, Hancock et al (5) in their series of 123 patients with early mortality of 23%. And Seale et al(17) found that early postoperative pulmonary stenosis was a significant risk factor for early postoperative mortality. Late in our series we changed our protocol for extracardiac approach that allowed a generous wide anastomosis also, we used absorbable suture material(polydioxanone) instead of polyprolene suture type,these factors in our results were not dependent risk factors for mortality, however they affect the incidence of early postoperative stenosis which indirectly affect the early mortality.

On the other hand, preoperative pulmonary venous obstruction was not a risk factor for mortality in our series which is the same in the series of Hancok and collegues(5). This is may be due to early intervention in those patients once echocardiographic evidence of obstruction was noticed and not waiting for the appearance of clinical sings of obstruction. However, in a study by Chun-Min Fu and collegues (16) they found that preoperative pulmonary venous obstruction is not only a risk factor for mortality but also a risk factor for early postoperative pulmonary venous stenosis.

The need for deep hypothermia and circulatory arrest which was associated with Long time of cardiopulmonary bypass, both were dependent risk factors for operative and early postoperative mortality in our study. However, since we changed our protocol for continuous cardiopulmonary bypass with moderate hypothermic technique and just brief periods of low flow bypass with the use of Custodiol as a cardioplegic solution for myocardial protection instead of the use of the commonly used St. Thomas solution, our results have significantly improved. Similarly , Karamlou and colleagues(18) found that moving closer to the end of their study was associated with younger age at repair , decreased use of deep hypothermic circulatory arrest , and use of specific drugs postoperatively like nitic oxide all contributing to better surgical outcome in their series.

The presence of associated anomalies is a common risk factor for early mortality in patients operated for TAPVC is it like that (5,15,17,18) which is consistent with our results. Like most of other authors, we excluded from our series patients with TAPVC with associated anomalies that contraindicate a biventricular repair.

Unlike other authers who found age and body weight to be risk factors for early mortality after repair in our study, we found them statistically non significant factors may be for the statistical reasons due to small number of patients. Despite patient's weight being a non-significant factor our results revealed that body surface area is a determinant factor for early mortality after repair.

The type of TAPVC and the type of surgical approach either transatrial or extracardiac approach did not affect the early mortality of our patients like many other authors. Early in our series there was a tendency to leave the sternum open to be closed at a later date postoperatively, however with the improvement in cardiopulmonary bypass techniques, the use of hemofiltration during bypass and better myocardial preservation, we speculate that myocardial oedema rates have improved making primary sternal closure the rule in repair of TAPVC at the moment. Obviuosly, leaving the sternum open for hemodynamic instability postoperatively may expose the patient to postoperative risks as regard to wound healing or infection. Conversely leaving an open sternum postoperatively did not affect the mortality in our series in our results. The rule of thumb is that it takes 10 events / deaths to identify each predictive variable, and the total number of deaths in the entire group is only less than 20 patients which is enough to pick up only 2 predictors

We confess that the limitation of our study is being retrospective study and the limited number of patients may affect the statistical results, so we believe that these factors should be retested with a large number of patients for accurate assessment of the results.

Conclusion

Surgery for TAPVC can be carried out nowadays with accepted operative and early postoperative mortality. With advancement of preoperative work up, operative techniques, perfusion techniques, anaesthetic management and the level of postoperative care, many of the previously known risk factors for early mortality could be neutralized for better outcome. . Early postoperative pulmonary stenosis, the presence of associated anomalies and body surface area are among the common risk factors for early mortality after repair of TAPVC. We recommend a multicentre prospective study so we can recruit an ample number of patients for a big study.

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Early and Midterm Results of Surgical Repair of Discrete Supravalvular Aortic Stenosis

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Background: **Congenital supravalvular aortic stenosis (SVAS) is one of the rare forms of LVOTO usually associated with the Williams–Beuren syndrome (WBS).**

Objective**: Our objective was to review the mid-term outcomes of surgical repair of SVAS.**

Methods**: this is a retrospective review of 16 patients who were operated on for surgical repair of SVAS from March 2011 to December 2013 in Misr Children Hospital and private hospitals.**

Results**: sixteen patients (9 males and 7 female) underwent surgical repair of SVAS by either single, two or three patches aortoplasty using autologous pre-treated pericardium,. The mean age was (5.13±1.78)years. Thirteen patients was diagnosed to have WBS. There was no early or midterm mortality. At the latest follow-up ,median of follow up 21.5 months (range from 9 to 34 months), echo-cardiograms revealed a peak Doppler gradient across the aortic outflow tract of 17.8±6.04 mmhg. No reoperation or re-intervention was required.**

Conclusions**: The early and midterm results of surgical repair of supravalvular aortic stenosis is excellent as regard to mortality and morbidity, howevere, a longer time of follow up for those patients is required.**

KEYWARDS: **SVAS, Congenital supravalvular aortic stenosis,Williams-Beuren syndrome, WBS.**

Congenital supravalvular aortic stenosis is a rare congenital anomalies in which there is exaggerated narrowing at the sinotubular junction (1). It is the least common form of left ventricular outflow tract (LVOT) obstruction. It is caused by elastin arteriopathy and occurs in three defined populations: Williams-Beuren syndrome (WBS), familial elastin arteriopathy, and "sporadic" elastin arteriopathy(2).All three populations have a microdeletion involving the elastin precursor gene on chromosome 7(7q11.23).(3-4)

Clinical reports divide SVAS into two categories based on the degree of involvement of the ascending aorta: 1) "discrete" disease, and 2) "diffuse" disease.(5-12)

Patients and methods:

From March 2011 through December 2013, 16 (9 male and 7 female) patients with discrete supravalvular aortic stenosis underwent repair in Misr Children Hospital and private hospitals. The mean age was (5.13±1.78) years, with a range of (3 to 8 years). A bicuspid aortic valve was present in 3 patients, Most patients had some degree of dilatation of the aortic sinuses. Three patients had significant fibrous tag over the right coronary ostium and one patient had a fibrous tag over the ostium of the left coronary artery. The total gradient across the left ventricular outflow tract ranged from (75 to 115) mm Hg (mean 90.9±11.8 mm Hg).

Williams syndrome was present in 13 patients, all of them had some degree of pulmonary stenosis 12 of whom had, mild and one had moderate pulmonary stenosis beside one patient who is non Williams but had moderate pulmonary stenosis.

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We reviewed the clinical sheets of all patients, all 13 williams patients were diagnosed by pediatricians to have the syndrome from the clinical stigmata of the disease and 4 of them had chromosomal assay confirming the diagnosis. All patients had all the routine investigations preoperatively. Thirteen patients had cardiac multislice tomography and 3 patients had cardiac catheterization for evaluation of the lesion. The postoperative follow up was by ehocardiography as no patient has significant postoperative gradient mandating cardiac multislice tomography or aortography.

Operative technique

Through median sternotomy, thymectomy was done. A pericardial sheet was taken and treated with gleutaraldehyde. High aortic and right atrial or bicaval cannulation was done. A vent was inserted either through the right superior pulmonary vein or in some cases retrograde venting through the pulmonary artery. Dissection and mobilization of the ascending aorta. Aortic cross clamping and cold blood cardioplegia was given. Longitudinal aortotomy ,starting from above the stenotic area and extended downward toward the non coronary sinus. Evaluation of the coronary ostia and the aortic valve. Excision of the fibrous tags over the coronary ostia and aortic repair were done when needed. In the cases where single patch aortoplasty was done, a pericardial patch was used to enlarge the non coronary sinus. In the cases where two patch technique was used, the incision is extended into the right coronary sinus to the right of the commissure between the left and right cusps and a pantallon shaped pericardial patch was used to enlarge both the right and coronary sinuses. In 3 cases we used the 3 patch technique, where the aorta is completely transected and the stenotic segment was resected, 3 almost equal pieces of pericardium were used to enlarge the 3 sinuses and then the aorta is re-anstomosed using prolene 5\0. If it is nedded additional doses of cold blood cardioplegia were given directly in the coronary ostia. After completion of the anastomosis, rewarming and deairing was done and the aortic clamp was removed.

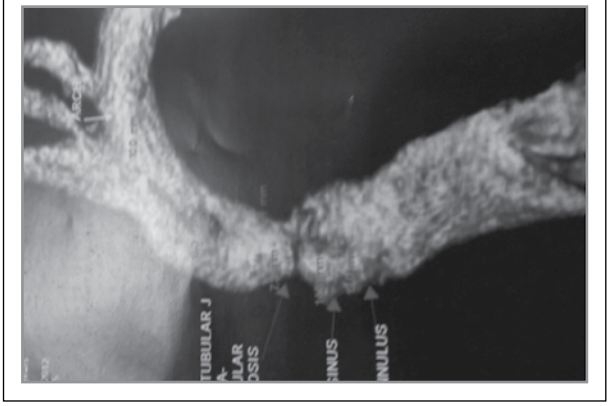

Fig 1. Preoperative multislice tomography showing discrete supravalvular aortic stenosis.

Results

A total of 16 patients underwent repair for SVAS at Misr Children Hospital and private hospitals from March 2011 to December 2013. The mean age of the patients was (5.13±1.78) years (median: 5 years); about 56% were male, and 44% were female.

The mean weight was 19.6 ± 4.3 kg. Eleven patients had 2 patch repair, 3 patients had 3 patch repair and 2 patients had single patch repair. Out of the 16 patients, 13 had Williams–Beuren syndrome. Three patients had aortic valve repair and another 3 patients has fibrous tags over the coronary ostia to be excised.

Out of the 16 patients, 2 patients had no peripheral PS, 12 had PS that was graded to be mild ,while 2 patients had moderate RPA stenosis. The mean aortic cross-clamp time was 46.87 ± 10.3 min, and the mean bypass time was 69.69 ± 9.57 min. No early death was observed. There were no major complications or mediastinitis during the postoperative period. The peak aortic systolic gradient on echocardiogram at hospital discharge was 16.25 ± 5.91 mmHg. This value was significantly reduced from the preoperative peak gradient of 90.9 4± 11.86 mmHg.

At hospital discharge, only one patient had mild aortic regurgitation, 5 patients had trivial AR while 10 patients had competent aortic valve. Thirteen patients had mild peripheral PS, one patient had moderate RPA stenosis and 2 patients had no PS. The mean postoperative supravalvular pressure gradient was 16.25±5.9 mmhg at the time of hospital discharge which is significantly reduced than the mean preoperative gradient (90.9±11.8 mm Hg) .

After a median duration of follow up 21.5 months (range from 9 to 34 months), which was completed for all 16 patient. No mortality was reported through this period of follow up. On the last echocardiography, 6 patients had mild aortic regurgitation while 10 patients had no AR. One patient had moderate RPA stenosis while 13 patients had mild peripheral PS. The mean pressure gradient across the supravalvular aortic area was 17.8±6.04 mmhg (10 to 30 mmhg) which is significantly reduced than the preoperative value while no significant changes between the early and late postoperative pressure gradients (16.25±5.9 and 17.8±6.04 mmhg respectively). No reoperations or re-interventions.

	Preoperative PG Early postop PG	Preoperative PG Midterm PG	Early postop PG Midterm PG
PG in mmhg	90.9 16.25	90.9 17.8	16.25 17.8
P value	0.0001*	0.859	0.0001*

*= significant

Table 1. Preoprative ,early and midterm post-operative pressure gradient across the supravalvular area

Disscussion

Surgical procedures to treat SVAS have evolved from technically simple early operations to complicated reconstructions of the aortic root in more recent years. The first reported repair was McGoon's single-sinus diamond-shaped patch aortoplasty(13). In 1977, the Doty 2-sinus inverted bifurcated patch aortoplasty technique was described (14). Doty's repair was widely adopted, and it remains commonly in use in the current era. In 1988, Brom reported the first 3-sinus repair (15). The Brom repair uses three separate patches to reconstruct each aortic sinus. In 1993, Chard and Cartmill (16) and Meyers et al(17) separately introduced similar all- autologous 3-sinus repairs.

In our series and in other reports, the majority of SVAS patients had WBS, which is an underlying elastin arteriopathy involving the aorta and the pulmonary arteries [2]. In surgical series, significant involvement of the aortic valve, including stenosis or an abnormal number of leaflets, has been reported in 34% to 47% of patients, and was present in 24% of cases reviewed by Petersen and coworkers [18] in our series we have about 18% of our patients with bicuspid aortic valve.

In our series we have no early postoperative or late mortality . Nunn et al (1) in 41 year experience on 75 patients who underwent repair of supravalvular aortic stenosis reported 7 (9.3%) early mortality, this could be explained by the early era of their work and also some of their series had diffuse form of the disease while all our patients had the discrete form of the disease.

The aim of repair of supravalvular aortic stenosis should include the complete augmentation of the supravalvular narrowing, a reshaping of the physical and symmetrical geometry of the aortic root, and the prevention of growth limitations by patch augmentation of the right coronary and noncoronary sinuses [14]. In our series and like other authors (1,14,15) we achieved the goal of repair as evidenced by the marked reduction in the pressure gradient across the supravalvular area with preservation of a competent aortic valve both in the early and midterm results.

Still there are some points that should be followed up for a long period like the fate of the aortic valve specially in patients who had bicuspid aortic valve, the recurrence of supravalvular stenosis due to the progressive nature of the disease specially in patients with WBS. supravalvular pulmonary stenosis, however, some authors (2,8,11,19) believe that it has a regressive course after repair of the supravalvular aortic stenosis, should be followed for a longer time for the need of interventional or surgical procedures.

We used three techniques for repair, single patch(2), two patch technique (11) and three patch technique (3) patients. The number of patients was not sufficient to have significant data for the superiority of one technique over the others and this issue should be studied on a large scale of patients repaird by each technique.

Conclusion

Supravalvular aortic stenosis is not just a simple disease, it is a complex involving the supravalvular area, the aortic valve, the aortic root and sometimes with affection of the subvalvular area. The problem become more complex when combined with syndromic state like WBS and associated with generalized artioropathy especially in large vessels like the pulmonary artery and its branches. The early and midterm results of surgical repair of supravalvular aortic stenosis is excellent however, those patients should have a longer time of follow up.

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Right Antrolateral Minithoracotomy Versus Median Sternotomy In Mitral Valve Surgery

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Objectives: **To determine the potential benefits of minimally invasive mitral valve surgery via right antrolateral minithoracotomy versus median sternotomy.**

Methods: **In that study, forty patients with isolated mitral valve disease requiring mitral valve surgery were included. The patients were divided into two groups:**

Group «A»: **Included twenty patients who underwent mitral valve surgery through right antrolateral minithoracotomy.**

Group "B": **Included twenty patients who underwent mitral valve surgery through standard median sternotomy.**

Results: **The length of incision was smaller in minithoracotomy group compared with sternotomy group by 11.5 cm. The postoperative mechanical ventilation time was less in minithoracotomy group versus sternotomy group by 2.5 hours. The amount of blood drainage in the first 24 hours was less in minithoracotomy group than sternotomy group by 324 ml. The blood units transfused to minithoracotomy group patients was less than sternotomy group patients by 1.6 U and the number of patients who received blood transfusion in minithoracotomy group versus sternotomy group was (11 VS 18 patients). The mean hospital stay was less in minithoracotomy group versus sternotomy group (6.75 ± 0.7 days VS 11.4 ± 4.69 days). Wound satisfaction was much better in minithoracotomy group versus sternotomy group (95% Vs 15%). Time from skin incision to full cannulation was increased in minithoracotomy group than sternotomy group by 13 min while cross-clamp time and total bypass time was of no statistical significance.**

***Conclusion*:** **Mitral valve surgery through antrolateral minithoracotomy is a good alternative to conventional surgical access. Excellent cosmetic results and avoidance of the sternal complications are major advantages, also it is intended to minimize harm to patients by reducing blood loss, reducing amount of blood transfusion, reducing the danger of infection by minimizing wound dimensions, thereby shortening the patient's hospital stay and decreasing costs.**

Median sternotomy has been a standard method of approach for open heart surgeries for many decades, since it provides a definitive view of the surgical field. However, as the patients social life improves, and as the competition among medical institutions become intensive, lesser postoperative pain, shorter hospital stay and better cosmetic results are being considered, and many minimally invasive surgical methods are being developed to satisfy the patient's variable demands .[1]

The field of minimally invasive (MI) cardiothoracic surgery continues to grow in popularity owing to improvements in technology, and surgical technique. Although MI approaches have been integrated into many areas of cardiac surgery, MI mitral valve surgery has been particularly influenced by MI techniques. [2]

Although minithoracotomy mitral valve surgery requires complex technical skills, it's implemented because it only requires a 4 to 8cm incision in the skin (less than half of that of conventional surgery), and no incisions are made in the sternum. The surgery is also done with the assistance of an endoscope inserted beside the small

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incision to enable good visualization of the valve. Even when dealing with complex mitral valve lesions, mitral valve repair can be performed more reliably using the minithoracotomy method than with a sternotomy-based procedure. [3]

Today, both replacing and repairing of Mitral valve through small minithoracotomy incision have become a standard practice for many surgeons as patients have become more aware of its increasing availability. [4]

Aim of work

That study was designed to determine the potential benefits of minimally invasive mitral valve surgery via right anterolateral minithoracotomy versus median sternotomy.

Patients and methods

In that study, forty patients with isolated mitral valve disease requiring mitral valve surgery were included. The study was done at the Cardiothoracic Surgery Department, Kasr EL-Aini Hospital, Cairo University, Nasr City Insurance Hospital and Zayied specialized hospital in the period between June 2012, and July 2013.

Patients were divided into two groups:

- *Group "A":* Included twenty patients who underwent mitral valve surgery through right anterolateral minithoracotomy.
- *Group "B":* Included twenty patients who underwent mitral valve surgery through standard median sternotomy.

Patients with valve lesions other than Mitral Valve requiring surgical interference, Patients with previous open-heart surgery, Patients with previous closed mitral commissurotomy , Patients with mitral valve disease and ischemic heart disease requiring coronary bypass surgery as well, and Patients exhibiting significant pulmonary, renal, hematologic, hepatic, endocrine, metabolic or neurologic pathology were excluded from that study.

Preoperative preparation

All the patients were subjected to preoperative evaluation in the form of full history taking, clinical examination, routine laboratory investigations, chest x-ray, Echocardiography and coronary angiography in patients older than 40 years.

During the preoperative counseling the visual analogue scale for pain assessment in the post-operative period was instructed to the patients in the preoperative visit (Fig.1). The pain VAS is a continuous scale comprised of a horizontal or vertical line, usually 10 cm in length, anchored by 2 verbal descriptors. For pain intensity, the scale is most commonly anchored by "no pain" (score of 0) and or "worst possible pain" (score of 10).

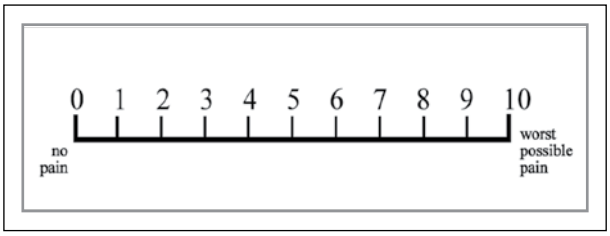

Fig 1. Visual Analogue Scale (VAS)

Operative procedure

A) Anaesthetic Technique:

The routine anaesthetic technique for open heart surgery was the same for all patients except for double lumen endotracheal tubes were used in group "A" patients, and single lumen endotracheal tubes were used for patients in group "B". Also external adhesive DC pads were placed at the back and Lt Side of the chest in patients of the minithoracotomy group.TEE probe was inserted into the patients of both groups whenever available.

B) Positioning:

In group "A", The patient was in a supine position and a sand bag was placed under the right scapulae, to allow the patient's right chest to be elevated slightly for a better working field exposure. Patient's right arm should be deviated slightly from the body; that permits having enough space for the thoracotomy incision. Afterwards, the patient was prepared with iodine solution. The patient was draped exposing the anterior and right lateral chest wall and bilateral groin areas. An adhesive aseptic strip was then applied to the exposed areas, thus minimising the possible risk of contamination. (Fig 2)

In group "B", the patient was in classic supine position and a sand bag was placed under both shoulders. The patient was prepared with iodine solution and draped in the usual pattern for conventional open heart surgery.

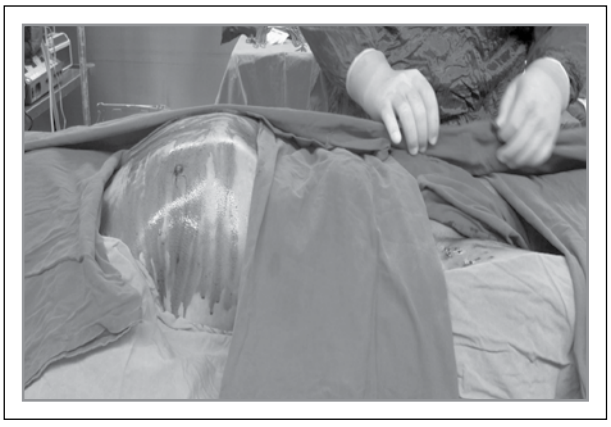

Fig 2. Draping of the Patient in group "A"

C) Cardiopulmonary Bypass (CPB):-

The membranes oxygenators were used in all patients in both groups. Myocardial protection was carried out through systemic cooling to 28°C, and most important by ante grade cold blood Cardioplegia infused into the ascending aorta at 4°C. Cardioplegia was given in a dose of 15.20 ml/Kg every 30-40 minutes.

D) Surgical Technique:-

GROUP "A" (MINITHORACOTOMY):

Specially developed telescopic instruments for minimally invasive cardiac surgery procedures were used (Fig.3).

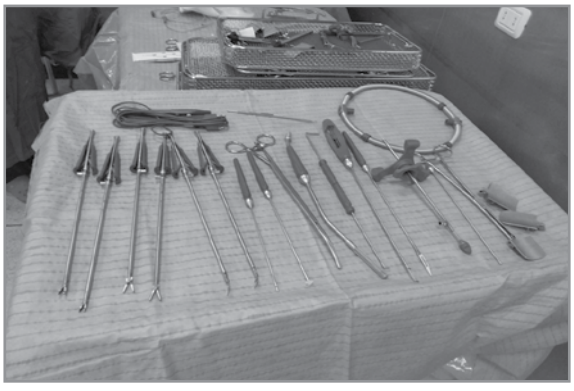

Fig 3. Instruments Used Specially in Minithoracotomy group

We started by Transverse Rt femoral incision to expose Rt femoral artery and vein. Purse 4/0 prolene for femoral artery and 5/0 prolene purse for femoral vein were done for femoral cannulation. Then we shifted to the chest: Rt antrolateral sub mammary incision 6-8 cm, to enter the chest through the 4th Intercostal space (around ant axillary line). The Rt lung was collapsed by using the double lumen endotracheal tube and applying suction to the lung by the anaethiologist.

Diaphragmatic retraction was done using 2/0 silk suture at the Membranous part of the diaphragm (and not the muscular part) to retract the diaphragm downwards away from the operative field. That stitch was pulled out through separate stab lower to the Thoracotomy incision.

Then we shifted to the femoral incision: femoral vein cannulation was done first using the seldinger technique (double stage femoral venous cannula size 24 F) through the purse in the femoral vein. (The venous cannula was not fixed in order to reposition it anytime when we palpate it from the Thoracotomy incision later on). Then the femoral artery was cannulated after that by seldinger technique (Femoral arterial cannula size 16, 18 F). A nylon tape was passed proximal to the cannula and snared, and then the cannula was tied to the snare. (Fig. 4)

Fig. 4. Femoral artery and vein cannulation

Then we shifted to the Thoracotomy incision, the soft tissue retractor was placed. We tried to avoid using the chest retractor in most of our cases, but sometimes it was used with the 2 crossing arms anterior. The camera(10 mm width, ZERO angled 30 cm long camera lens) was inserted at the 4th Intercostal space posterior to the Thoracotomy incision at the midaxillary line or midway between the anterior and mid axillary line (same space as the Thoracotomy incision, or sometimes above by one space. Our landmark was the Rt superior pulmonary vein). The idea of the camera in addition to visualization was to light the operative field. The camera was applied through thoracoport (10 cm long ,11 or 12 mm width). The CO2 insufflations was connected to a side port at the thoracoport of the camera, and started at 3L/ min at pressure 3 bars.

We started the bypass, and we opened the pericardium by transverse incision 2 to 3 cm above and parallel to the phrenic nerve. (The upper and lower ends of the pericardial incision must be extended upwards towards the sternum for better exposure.) Pericardial suspension sutures were applied using 2/0 ethibond sutures, one suture at the middle of the upper pericardial edge and was pulled out through the upper border of the wound (or may be through the stab for the Atrial retractor). Then 3 pericardial suspension stitches were applied at the lower edge of the pericardium. These sutures were brought out through the same stab of the camera or another stab lower to the stab of the camera.

The position of the venous cannula was checked, (the tip of the cannula should be at the entrance of the SVC into the Rt atrium). The purse of the Cardioplegia was done by 2/0 ethibond suture, as low as possible in the aorta (to leave enough space to the aortic clamp). It should be done at the Rt lateral surface of the aorta to be easier to control in case of bleeding later on. (The Rt Atrial appendage may be needed to be retracted in order to expose the aorta). A LONG Cardioplegia cannula was inserted and it was passed from the upper end of the wound with the snare below the chest retractor crossing arms.

Then the CHITWOOD CLAMP was applied at the 2nd Intercostal space , anterior to the anterior axillary line , first it was applied with its concave downwards then inside the chest it was turned to make the concave part upwards. The inferior limb of the clamp passed through the transverse sinus. The sucker was used to check the Lt Atrial appendage, and the pulmonary artery while applying the clamp. The CBP was stopped during applying the Clamp, then the Cardioplegia was delivered. (Fig. 5)

The Lt Atrium was opened classically by the curved scissors, and the angles were extended towards the SVC &the IVC. The anterior wall of the Lt Atrium was retracted by prolene 3/0 suture at its middle and pulled outside from the anterior end of the wound. We used a special designed atrial retractor which was pulled out through a separate stab incision anterior to the Thoracotomy wound. The LA vent or bullet sucker was put in the atrium for continuous suction.

After that, Classic MV replacement or repair was done using the special long instruments. The camera and Monitor were used for better assessment of the Mitral valve. (Fig. 6)

Classic closure of Lt Atrium was done by 2 prolene 4/0 stitches, and LA vent was used at the Lt atriotomy incision closure for better Dearing of the heart. The pacemaker wires were inserted while the heart is flaccid and before removing the aortic clamp. Then the Aorta was unclamped after filling the heart. Debubbling through the aortic root and the Lt atrial vent was done .Then the Lt Atrial vent was removed while the heart was filled. The perfusinest was asked to Empty the heart again, and the Cardioplegia cannula was removed on bypass (to ensure low pressure) in order to control the Cardioplegia purse site in case of bleeding. The atriotomy was checked again for bleeding and then gradual weaning off bypass was achieved after restoration of mechanical ventilation.

Decannulation at the groin incision was done starting by removing the venous cannula first and controlling its site. Then removal of the arterial femoral cannula, and controlling its site. Vascular clamps were used at the femoral artery site in some cases in order to take extra sutures at the femoral artery in case of excessive bleeding.

The chest drains were put in the following pattern: Upper drain at the site of the CHITWOOD CLAMP, and the lower drain at the site of the retraction suture of the diaphragm. The pericardium was approximated by interrupted sutures, and then routine closure of the Thoracotomy incision (Fig.7), followed by routine closure of the femoral incision.

• Group "B" (Sternotomy):

Routine Mitral valve surgery was done in patients of group "B", through Conventional Median sternotomy.

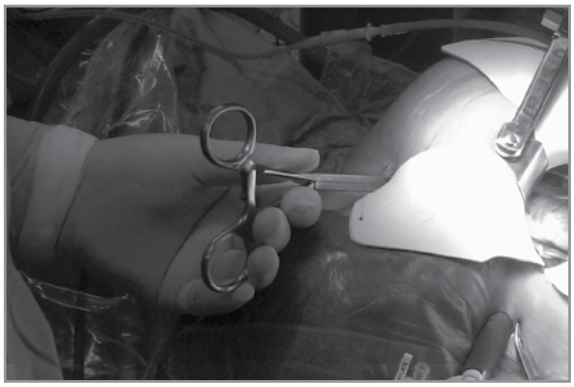

Fig. 5. Chitwood clamp applied and the Cardioplegia delivered

Fig. 6. Video Assistance Shows Placement of the Mitral valve replacement sutures

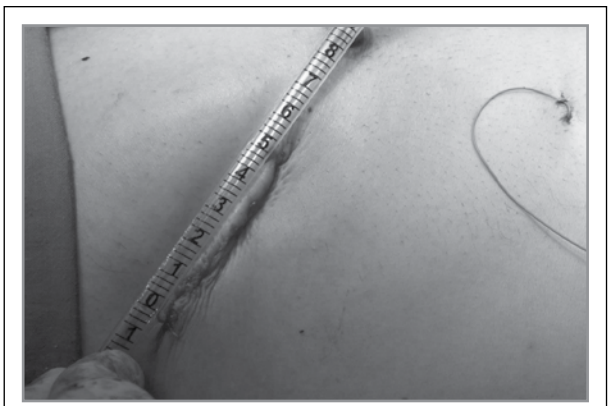

Fig. 7. Thoracotomy incision wound

Operative Parameters:

The following data were recorded for statistical analysis:

1. Cannulation time.
2. Aortic Cross Clamp Time and Total Bypass Time.

3. Total operative time.
4. Procedure done: Whether repair or replacement of the mitral valve.
5. Length of skin incison at closure of the wound.

Post-Operative parameters:

All patients were evaluated thoroughly during their intensive care unit stay and during their hospital stay.

A. Intensive Care Unit Evaluation:

1. Post-Operative mechanical Ventilation time:-
2- Post-Operative Blood Loss, Blood Transfusion and Re-exploration .
3- Total Intensive Care Unit Stay.
4- Post-Operative Pain Score.

B. Hospital stay Evaluation:

1. Chest X-ray and Echocardiography:
3. Pain score, and wound satisfaction.
4. Complications: Wound infection, phrenic nerve injury, and neurological complications.
5. Total hospital stay.

Results

Preoperative results

The demographic data of the patients in both groups were shown in table (1).

	Group "A"	Group "B"	P value	Sig.
Number	20	20	-	-
Age (years)				
mean ±SD	31.25 ± 10.07	32.65 ± 9.58	>0.05	NS
Range	15-46	17-50		
Male/female	8/12	9/11	>0.05	NS
Weight (kg)				
Mean ± SD	64.85±18.21	66.7±16.92	>0.05	NS
Range	32-97	35-100		

Table 1. Demographic Data (Mean ± SD).

The mean NYHA classification was 2.35 ± 0.67 in group "A", while it was 2.20 ± 0.85 in group "B" with no statistical significance as shown in table (2).

	Group "A"	Group "B"	P value	Sig.
I	1(5%)	2(10%)		-
II	8(40%)	9(45%)		-
III	9(45%)	8(40%)		-
IV	2(10%)	1(5%)		-
Mean ± SD	2.35 ± 0.67	2.20 ± 0.85	> 0.05	NS

Table 2. Preoperative NYHA Classification (Number & %).

The preoperative echocardiographic data as regards mitral Valve pathology of the patients in both groups were shown in Table (3)

	Group "A"	Group "B"	P value	Sig.
Mitral Regurge	8 (40%)	7 (35%)	>0.05	NS
Mitral Stenosis	7 (35%)	7 (35%)	>0.05	NS
Double Mitral	5 (25 %)	6 (30%)	>0.05	NS

Table 3. Preoperative Mitral Valve Pathology.

Intra-Operative Results

The time from the beginning of skin incision till full cannulation was much more in group "A" than in group "B", with a P value less than 0.01 denoting high statistical significance with no statistical difference between both groups as regards cross clamp and total bypass time as shown in table (4) and figure (8).

	Group "A"	Group "B"	P value	Sig.
Cannulation (min)	39.7 ± 2.8	26.7 ± 3.2	< 0.01	HS
Cross clamp (min)	49.8 ± 7.3	51.5 ± 5.9	> 0.05	NS
Total bypass time	64.15 ± 7.16	64.1 ± 6.46	> 0.05	NS

Table 4. Cannulation, Cross Clamp & Total Bypass Time in Both Groups.

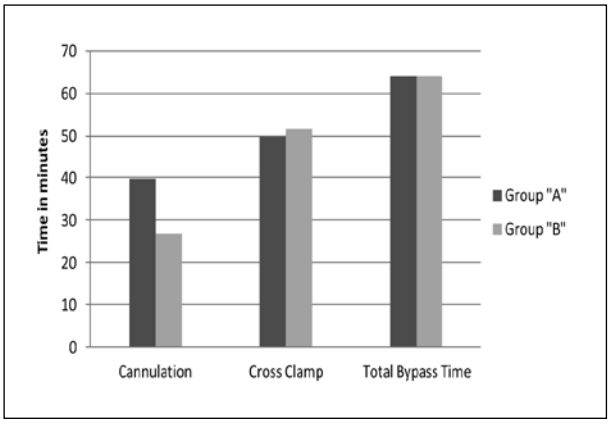

Fig. 8. Cannulation, Cross Clamp & Total Bypass Time in Both Groups.

The surgical procedures in group "A" included 15 cases (75%) of mitral valve replacement and 5 cases (25%) of mitral valve repair using rigid annuloplasty ring. In group "B", there were 17 cases (85%) of mitral valve replacement and 3 cases (15%) of mitral valve repair using rigid annuloplasty ring. There was no statistical significance as regards the surgical procedure done.

The length of the incision was comparable in the two groups. The mean length of incision in group "A" was 8.15 ± 1.13 cm. While in group "B" the mean length was 19.65 ± 2.7 which is statistically higher than that of group "A" as shown in table (5), figure (9).

	Group "A"	Group "B"	P Value	Sig.
Range (cm)	5-10 cm	16-24		
Mean ± SD (cm)	8.15 ± 1.13	19.65 ± 2.7	< 0.01	HS

Table 5. Length of Skin Incision in Both Groups.

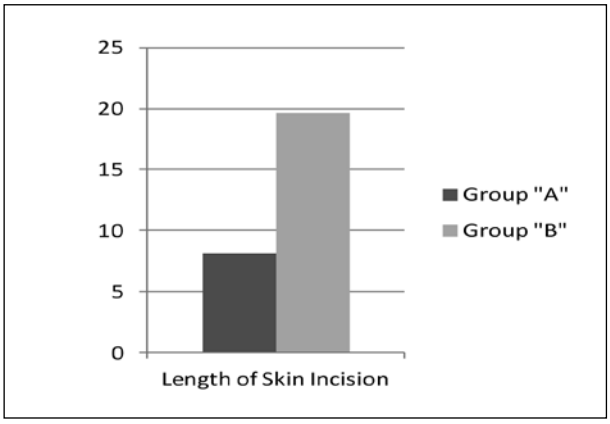

Fig. 9. Length of Skin Incision in Both Groups.

The total operative time showed no statistical difference between both groups, as shown in table (6).

	Group "A"	Group "B"	P value	Sig.
Range (min)	130-175	125-180		
Mean ± SD (min)	149.5 ± 13.9	153.2 ± 16.08	> 0.05	NS

Table 6. Total Operative Time in Both Groups.

Post-Operative Results

During ICU stay

There were statistical significant difference between both groups as regards Mechanical ventilation time, amount of blood loss during first 24 hrs, and number of blood transfusion units. But there was no statistical significant difference between both groups as regards Total ICU stay, although the ICU stay in the minithoracotomy group was less than the sternotomy group, Table (7).

	Group "A"	Group "B"	P value	Sig.
Duration of Mechanical Ventilation (hours):				
Range	2-6	2.5-12	< 0.01	HS
Mean ± SD	4 ± 1.3	6.45 ± 2.8		
Blood loss (ml)				
Range	120-400	180-1300	< 0.01	HS
Mean ± SD	241.5 ± 89.16	565 ± 344.3		
Blood transfusion (unit)				
Range	0-3	0-6	< 0.01	HS
Mean ± SD	1 ± 1.1	2.6 ± 1.6		
ICU stay (Hours)				
Range	24-48	24-72	> 0.05	NS
Mean ± SD	34.8 ± 12.25	43.2 ± 16.7		

Table 7. Mechanical Ventilation, Blood Loss, Blood Transfusion and ICU Stay.

No patients required re-exploration for bleeding in group «A», while two patients (10%) required re-exploration for bleeding in group «B» due to excessive blood drainage (>5 ml/Kg/hour). During re-exploration, no significant surgical cause was found and only evacuation of retrosternal hematomas and re-closure was done.

Post-operative pain score using the visual analogue scale was compared in the two groups. In group "A", the mean pain

score in the first post-operative day was 6.3 ± 0.7. This score decreased in the second post-operative day to 4.4 ± 0.75, while pre-discharge, it was 2.7 ± 1.34. Pain score in group "B" during the first 24 hours was 5.45 ± 0.88 which decreased to 3.4 ± 0.75 in the second post-operative day, pre-discharge the mean pain score was 2 ± 0.97. This data shows that pain was less in group "B", but of no statistically significant difference except for the 1st and 2nd post-operative days as shown in table (8) .

	Group "A"	Group "B"	P value	Sig.
1st post-operative day	6.3 ± 0.7	5.45 ± 0.88	< 0.05	Sig.
2nd post-operative day	4.4 ± 0.75	3.4 ± 0.75	< 0.05	Sig.
Pre-discharge	2.7 ± 1.34	2 ± 0.97	> 0.05	NS

Table 8. Pain Score among the Two Groups (Mean±SD)

There was no statistical significant difference as regards postoperative complications in both groups as shown in table (9).

	Group "A"	Group "B"	P value	Sig.
No Complication	16 (80%)	14 (70%)	> 0.05	NS
Phrenic Nerve Injury	1 (5%)	-	> 0.05	NS
Brachial Plexus Injury	-	2 (10%)	> 0.05	NS
Lower Lobe Collapse	1 (5%)	-	> 0.05	NS
Mild Pleural Collection	1 (5%)	1 (5%)	> 0.05	NS
Superficial Wound Infection	1 (5%)	1 (5%)	> 0.05	NS
Sternal Wound Complication	-	2 (10%)	> 0.05	NS

Table 9. Post-Operative Complications of Both Approaches

The total hospital stay in the minithoracotomy group was less than sternotomy group, and this difference has high statistical significance as shown in table (10).

	Group "A"	Group "B"	"P" value	Sig.
Range (days)	6-8	6-21		
Mean ± SD (days)	6.75 ± 0.7	11.4 ± 4.69	< 0.01	HS

Table 10. Total Hospital Stay of Both Groups.

Wound Satisfaction was comparable in the two groups; it's obtained through conducting a questionnaire which showed that 19 cases (95%) of group "A" were satisfied about their wound after minithoracotomy, while only 1 case (5%) wasn't satisfied about her wound. But in group "B" there were 17 cases (85%) not satisfied about their wound and only 3 cases (15%) were satisfied about their wound. The P value was < 0.01 denoting that there was statistically significant difference between two groups as shown in figure (10).

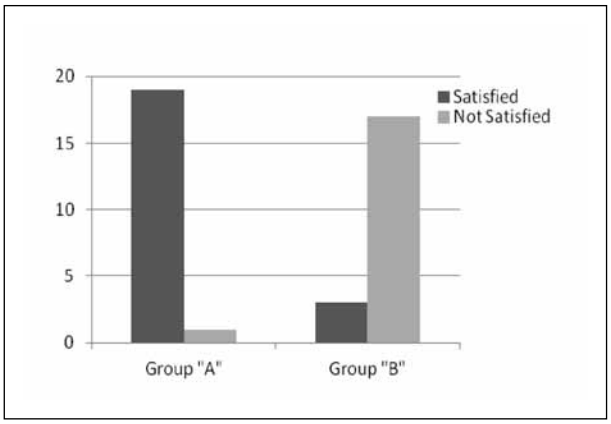

Fig. 10. Wound Satisfaction in Both Groups.

Discussion

Conventional median sternotomy as a surgical approach to the mitral valve yields excellent short- and long-term results and has set an extremely high standard. More recently, less invasive approaches have been introduced, including the right anterolateral minithoracotomy (4-6 cm), with or without robotic assistance, in order to reduce the surgical trauma and hasten recovery. Compared to a sternotomy, it has been shown to be associated with comparable short-and long-term mortality, with reduced pain, transfusions and post-operative atrial fibrillation. Duration of ventilation, ICU and hospital stay are also shortened, and there are obviously fewer sternal complications. However, perhaps the greatest benefit is one that is most difficult to measure and that is speed of recovery ,once the patient leaves hospital, with return to normal activity in 3 weeks rather than 2½ to 3 months with a sternotomy.[5]

Minimally invasive techniques had evolved in steps up through levels. According to Carpenter/Loulmet Classification of degrees of surgical invasiveness, there are four levels.[6]

Level I	Mini-incision (10-12 cm)	Direct vision
Level II	Micro-incision (4-6 cm)	Video-assisted
Level III	Micro or port incision (1-2 cm)	Video-directed
Level IV	Port incision with robotic instrument	Video-directed

Table 11. Levels of Degrees of Surgical Invasiveness

The first truly minimally invasive valve surgeries performed in 1996 by Cosgrove and associate .At that time surgeons became aware of potential benefits when using minimized incisions for corrections of valvular heart diseases. Mitral valve operations during that time were performed under direct vision using a lateral minithoracotomy with longer instruments, concomitant with Simultaneous advances in CPB.[7]

Thus, the next step in the development of MIMVS was the improvement of valve visualization. Two-dimensional endoscopes were introduced leading to successful MIMVS performed by Carpenter and Chitwood and co-workers.[8]

In 1998 Mohr and colleagues reported using a three-dimensional videoscope. This was positioned automatically using voice-activated robot assistance (Aesop 3000) leading to solo surgery .Mohr and Chitwood have the largest experiences in this area and independently have determined this approach effective for performing complex mitral valve repairs.[9]

The indications for MIMVS are quite similar to those for conventional isolated mitral valve operations. An attempt to repair the mitral valve is always indicated. In experienced centres the probability of successful mitral valve repair is well above 70% at present. When using a minimally invasive approach, all conventional mitral valve repair techniques can be applied with similar precision as with the conventional surgical technique.[6]

In our study, in group"A", 75% of patients had Mitral valve replacement versus 85 % of patients in group "B" who had Mitral valve replacement. We had more replacement in our study due to the rheumatic pathology of the mitral valve of our patients, and also due to the beginning of our learning curve for MIMVS.

One of the most important advantages of anterolateral minithoracotomy is the lesser incidence of postoperative bleeding and lesser requirement for exploration. In our study, the mean amount of blood drainage in the first 24 hours in group "A" was 241.5 ± 89.16 ml, while in group "B" the mean amount was 565 ± 344.3 ml with statistically significant difference between both groups. Cosgrove et al., 1998 ;[10] reported that this may be the result of smaller incision which lessens the potential for bleeding. It is possible to stop bleeding from minimally invasive incision during entry, whereas sternal bleeding form standard sternotomy continues throughout the operative procedure. It is suspected that a sternotomy will continue to bleed into the mediastinum after it has been re-approximated. As the incidence of bleeding and the amount of blood loss postoperatively is less, the amount of blood transfusion required in group "A" is less. In our study, the blood units transfused to groups "A" ranged from 0-3 units with a mean of 1 ± 1.1 units, while in group "B" it ranged from 0-6 units with a mean of 2.6 ± 1.6 units with statistical significant difference between both groups. With decreasing the demands for blood transfusion, the hazards of blood transfusion are lessened, and the patient's costs are decreased. The mean amount of blood units transfused reported by US M et al., 2000;[11] was 1.3 ± 0.4 units in the thoracotomy group, and 2 ± 0.5 units in the sternotomy group which is nearly the same amount used in our study groups.

Pain level after cardiac operations is relatively low in most patients as such postoperative pain is bearable, and the patients receive sufficient pain medication on request. As anticipated, thoracic pain is of tolerable intensities, if the sternum and the ribs are stable postoperatively. All patients suffered from pain during mobilization and coughing; this can be directly related to the thoracic incision and friction of the split sternum during this maneuver.[12]

Evaluation of pain by visual analogue pain scale was used in our study; in group "A", the mean pain score in the first 24 hours was 6.3 ± 0.7, this decreased to 4.4 ± 0.75 on the second day, and 2.7 ± 1.34 pre-discharge. In group "B" the mean pain score in the first 24 hours was 5.45 ± 0.88 which decreased to 3.4 ± 0.75 on the second day. Pre-discharge, the pain score was 2 ± 0.97. There was statistically significant difference in both groups only in the first 2 days. Walther et al., 1999; [12] reported that Pain levels from the visual analog scale was in the range of 4 to 6.5 for all groups postoperatively. Patients having a left anterolateral minithoracotomy suffered from the most pain during the first 2 postoperative days. From the third postoperative day onward an improvement was observed for all patients having a lateral minithoracotomy. This is an important finding that may be explained by the fact that mobilization of patients with a lateral mini-thoracotomy is painless as compared with median sternotomy, in which strain caused mobilization causes bony friction.[12]

In our study, the mean hospital stay was 6.75 ± 0.7 days in group "A" and 11.4 ± 4.69 days in group "B" this difference is highly statistically significant with P value < 0.01. The mean hospital stay in the minithoracotomy group in other studies ranged from 5.5 to 10.7 days. All the studies reported that hospital stay is significantly less in patients with minithoracotomy than those with sternotomy. In 2011; Cheng et al., [13] reported that the length of hospital stay was significantly reduced with minimally invasive mitral valve surgery versus conventional open mitral valve surgery (mean 6.9 vs 8.9 days). In 2010; Iribarne et al.,[2] reported that there was a significant difference in mean length of stay by incision type and this is similar to our result. El-Fiky et al., 2000; [14] reported that the mean hospital stay was similar for both groups (7 ± 2 days). In our study, we did not discharge the patients before the 6th day, before removal of any non-absorbable stitches, and for proper control of anticoagulation, of these patients.

Regarding wound satisfaction, in our study, 95% of group "A" was satisfied about their wound after minithoracotomy. But in group "B" there was only 15% satisfied about their wound. This difference is highly statistically significant with P value < 0.01. In *2010;* Schmitto et al.,[15] stated that improved cosmoses

is an undisputed benefit of MIMVS. In a study of patients having a right Thoracotomy, Casselman et al., 2003; [16]reported that approximately 99% of patients thought that their scar was esthetically pleasing. Mariscalco and Musumeci et al., 2014; [17] reported that minithoracotomy incisions improve cosmoses and patient satisfaction. Approximately 99% of patients appreciated the final minithoracotomy cosmetic results. Vida et al., 2013; [18] reported that the overall satisfaction rate for the cosmetic results of right antrolateral minithoracotomy was 97.8% (138/141 patients). In 2011; Cheng et al.,[13] reported that there were significantly fewer patients dissatisfied with their scar with minimally invasive mitral valve surgery versus conventional open mitral valve surgery (0% vs. 19.2%).

Minimally invasive cardiac surgery has evolved during recent years to a point where it might be more beneficial than conventional procedures. For these approaches must meet the goals of being less invasive, better comfort, more desirable cosmetic results, and a more rapid and complete rehabilitation, maintaining safety, efficacy and outcome equivalent to those of more established techniques, such as median sternotomy.[19]

Today, both replacing and repairing cardiac valves through small incisions have become a standard practice for many surgeons as patients have become more aware of its increasing availability. [4]

Our experience with mitral valve repair and replacement through right antrolateral minithoracotomy as well as the literature showed encouraging results regarding the feasibility, safety and the efficacy of MIMVS but larger sample size studies and long term follow-up are needed for better recommendations about MIMVS.

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Pleural Effusion Post CABG; A Prospective Case-Control Study

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Objective; **To identify risk factors, prophylaxis and management of pleural effusion in patients undergoing coronary artery bypass graft.**

Background; Pleural effusion following coronary artery bypass grafting (CABG) is a common occurrence with some patients developing significant effusion during their initial hospitalization or after hospital discharge. The reported incidence varies in the literature from 42 to 89%.

Methods; **This is a prospective case-control study included eighty patients all of them underwent CABG. Case group patients (40 cases who underwent CABG with symptomatic pleural effusion (SPE) developed in the postoperative period) who were managed according to lines of management, and control group (40 patients underwent CABG with no pleural effusion in the post-operative period). All cases of SPE underwent diagnostic thoracocentesis.**

Results; **Univariate analysis showed a higher risk profile in the pleural effusion group who had pre-operative hypertension, longer cardiopulmonary bypass time, longer intensive care unit (ICU) stay, and low post operative serum albumin (P>0.005). The pleural fluid analysis findings of all 40 patients showed criteria of an exudative effusion. The mean time of occurrence of pleural effusion was by the seventh post operative day. All cases in our study are classified to have early postoperative effusion. According to lines of management; twenty patients underwent tube thoracostomy (50%). Therapeutic thoracocentesis was performed in 8 patients with symptomatic pleural effusion (SPE) either once or repeated. All patients underwent medical treatment even after invasive management in the form of diuretics and non-steroidal anti-inflammatory drugs (NSAIDs e.g. diclofenac Sodium I.M injection and indomethacin oral tablets)and chemotrypsine tablets.**

Conclusions: **The exact etiology of post-CABG pleural effusion and why some effusions persist while others resolve remains unknown. Most effusions occur in the early postoperative period. Pleural effusion post CABG should be treated conservatively and should include management of congestive heart failure if appropriate and periodic thoracocentesis is indicated.**

Pleural effusion following coronary artery bypass grafting (CABG) is a common occurrence with some patients developing significant effusion during their initial hospitalization or shortly after hospital discharge. The reported incidence varies in the literature from 42 to 89% [1, 2, 3].

The incidence of post CABG effusion is higher in patients who receive internal mammary artery (IMA) grafts than those who receive only saphenous vein grafts (SVG). This difference is attributed to the performance of pleurotomy to take down the IMA. Most effusions due to CABG surgery are left sided or larger on the left side, if the effusions are bilateral [2,3,4].

Most effusions occur in the early postoperative period .They are small, regress with time, and of no clinical significance .Occasionally, a patient may develop a moderate to large effusion that requires drainage to relieve respiratory symptoms [5,6]. The incidence of symptomatic pleural effusion (SPE) is around 10%. The effusions usually resolve with one or two thoracocentesis but occasionally several thoracocentesis are required [7,8].

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Patients and Methods

This study was carried out from December 2011 to December 2012. It included 40 patients who had symptomatic pleural effusion (SPE) post CABG as case group patients and another 40 patients who underwent CABG without post operative pleural effusion as control group, in a prospective case-control study. Exclusion criteria included patients who have minimal to mild (asymptomatic) effusion and those who undergoing combined CABG and valve surgery.

Data collection

Data were collected regarding the demographic data(age, sex, weight, height and body mass index), type of surgery (whether on or off-pump CABG), perioperative data, time of occurrence of the effusion after CABG, criteria of pleural fluid, left ventricular ejection fraction (EF) by echocardiography, list of associated medical problems and methods of management.

Operative technique and postoperative care

Patients in this study had CABG either cardiopulmonary assisted or off pump. All patients underwent IMA grafting. Each patient had the mediastinum and left pleural cavity drained with two chest tubes (size 40 F). The chest tubes were removed routinely after 48 hours.

Patients' evaluation and management

Patients who had symptomatic pleural effusion had their post-operative chest radiographs analyzed. Pleural effusions were classified as early if the initial thoracocentesis was performed within three weeks of surgery, and as late if the initial thoracocentesis was performed three weeks or more after surgery. All patients having symptomatic pleural effusion underwent diagnostic thoracocentesis and pleural fluid was analyzed for albumin, glucose, lactate dehydrogenase (LDH) and hematocrit.

Patients with pleural effusion post CABG were treated by one or more of the following lines:

a. Medical treatment.

b. Therapeutic thoracocentesis.

c. Chest tube insertion.

d. Pleurectomy.

Follow up with clinical examination, chest X-ray and laboratory investigation was done for all cases for at least six months. There were no recurrent cases in the follow up period.

Statistical Analysis

This is a prospective case-control study. The results for continuous and categorical variables were presented as mean ± SD and percentages, respectively. Categorical variables were compared between patients with and without pleural effusion using contingency tables and χ^2 tests, and t- tests were used to compare continuous variables between the two groups. Variables that were associated with occurrence of pleural effusion with a p value < 0.05 were considered statistically significant between case and control groups. Pleural fluid findings were examined separately using only univariate analysis.

Results

During the 12-month study period, the total number of patients who underwent CABG was 220. Forty patients presented with symptomatic pleural effusion (SPE) within 12 months of undergoing CABG. The overall incidence of symptomatic post-CABG pleural effusion was 18.2%. Another forty patients were selected randomly as control group.

The demographic data in relation to age, sex, weight, height and body mass index (BMI) showed no significant difference between both groups [Table1]. The results as regards preoperative risk factors including diabetes mellitus (DM), smoking, previous myocardial infarction (MI), preoperative anticoagulant therapy and EF showed no significant difference between both groups except hypertension (HTN) that showed a significant increase in case group (P-value 0.004). [Table 2]

The results regarding operative data including type of grafts, number of grafts per patient and cross clamp time showed no significant difference between both groups. On contrary, the results with respect to technique of CABG "*whether CPB assisted or off-pump*" showed a significant difference between case and control groups. For case group patients, there was no patient underwent off-pump CABG (all done using cardiopulmonary bypass) and for control group patients, 36 patients underwent CPB assisted CABG and 4 underwent off pump CABG (P-value 0.04). [Table 3]

Regarding cardiopulmonary bypass time, the results showed that the mean *CPB* time for case group (77.6 ± 23.8 minutes) was significantly higher than that for control group (61.9 ± 29.6 minutes) (P-value 0.009). [Table 4]

The results regarding postoperative data including ICU stay period and serum albumen showed significant difference between both case and control groups; the ICU stay period was 3.7±0.9 days and 2.3±0.7 days respectively (P-value 0.004). As regards the postoperative serum albumin, the mean serum albumin was 3.1±0.3 gm/dl and 3.5±0.2 gm/dl respectively (P-value < 0.001) [Table 5].

All the forty patients underwent thoracocentesis as a diagnostic procedure which showed that the pleural fluid analysis was in favor of exudative effusion [Table 6]. Twenty patients underwent tube thoracostomy (50%), 16 males and 4 females. Therapeutic thoracocentesis was enough in 8 patients with SPE (20%), seven of them were males and one was female while medical treatment alone was enough in 14 patients (35%), 9 males and 5 females [Table 7].

	The studied groups		Test of significance	P value
	Cases No = 40	Controls No = 40		
Age	55.6 ± 6.4	55.5 ± 8.9	t-test 0.06	0.95 NS
Weight	89.1 ± 15.7	84.3 ± 12.2	t-test 1.52	0.13 NS
Height	166.8 ± 7.3	164.1 ± 6	t-test 1.77	0.08 NS
BMI	31.951 ±4.834	31.403 ± 4.514	t-test 0.52	0.6 NS
Sex	**No** **%**	**No** **%**	χ^2	
Male	31 77.5	26 65.0	1.5	0.22
Female	9 22.5	14 35.0		NS

Table 1. Demographic data in both groups

	The studied groups				Test of significance	P value
	patients No = 40		Controls No = 40			
	No	%	No	%	X^2	
HTN						
Yes	28	70.0	15	37.5	8.5	0.004
No	12	30.0	25	62.5		S
DM						
Yes	20	50.0	14	35.0	1.8	0.18
No	20	50.0	26	65.0		NS
Smoking						
Yes	16	40.0	21	52.5	1.3	0.26
No	24	60.0	19	47.5		NS
Previous MI						
Yes	10	25.0	7	17.5	0.67	0.41
No	30	75.0	33	82.5		NS
Anticoagulant						
Yes	3	7.5	0	0.0	3.1	0.077
No	37	92.5	40	100		NS
EF%					**t-test**	0.67
Mean ± SD	57.3 ± 4.5		57.7 ± 4.9		0.42	NS

Table 2. Incidence of preoperative risk factors in both groups

	The studied groups				Test of significance	P value
	Patients No = 40		Controls No = 40			
	No	%	No	%	χ^2	
Number of grafts						
One	7	17.5	7	17.5		0.22
Two	10	25.0	16	40.0	4.4	
Three	20	50.0	11	27.5		NS
Four	3	7.5	6	15.0		
Type of grafts						
LIMA+SVG	33	82.5	33	82.5		1.0
LIMA	7	17.5	7	17.5	0	NS
Technique of surgery						
Conventional CABG	40	100.0	36	90.0	4.21	0.004
Off pump CABG	0	0.0	4	10.0		S

Table 3. Comparison between cases & controls regarding operative data

Variable	The studied groups		Manne Whitney U-test	P value
	Patients No = 40	Controls No = 40		
Cross clamp time/minutes Mean ± SD	48.9 ± 14.9	41.1 ± 19.4	1.8	0.07 NS
By pass time/minutes Mean ± SD	77.6 ± 23.8	61.9 ± 29.6	2.6	0.009 S

Table 4. Comparison between cases & controls regarding operative data

Variable	Patients *No* = 40	Controls *No* = 40	Man Whitney U-Test	P Value
ICU stay/day Mean ± SD	3.7 ± 0.9	2.3± 0.7	2.9	0.004 S
Post-op. Serum albumen	3.1±0.3	3.5±0.2	2.9	0.001 S
Total blood loss/1st24 Hs	578.5± 468.6	419.5±150.7	1.7	0.09 NS

Table 5. Comparison between cases & controls regarding postoperative data

Variable	*Mean*	*SD*
Hct %	3.175	3.637
Albumin(gm/dl)	2.213	0.2534
Glucose (mg/dl)	182.78	105.94
LDH (IU/l)	658.73	184.76

Hct: hematocrit. *LDH: lactate dehydrogenase.*

Table 6. Criteria of pleural fluid analysis

The studied groups						
Medical treatment		**Chest tube insertion**		**Therapeutic thoracocentesis**		**Pleurectomy**
14 patients (35%)		20 patients (50%)		8 patients (20%)		1 (2.5%)
Male 9	female 5	male 16	female 4	Male 7	female 1	male 1

Table 7. Lines of management of case group patients

Discussion

Pleural effusion following coronary artery bypass grafting (CABG) is a common occurrence with some patients developing significant effusion during their initial hospitalization or shortly after hospital discharge. The reported incidence varies in the literature from 42 to 89% [1,2,3]. The majority of pleural effusions are small and usually left sided, however, large and bilateral effusions have been reported [6]. Most effusions occur in the early postoperative period.

The early phase effusions peak in size within the first three weeks after surgery while late phase effusions occur after three weeks [1]. The etiology of post-CABG effusions and why some effusions persist while others resolve remains unknown[1]. There are several potential reasons to expect an increase in frequency or severity of pleural effusions after CABG using IMA grafts as opposed to saphenous grafts [7]. There is no difference between bilateral mammary artery and left internal mammary artery grafting in the incidence or severity of postoperative pleural effusions [8].

The univariate analysis of perioperative data in our study revealed that there was significant difference between both groups as regard hypertension and this was in agreement with the results of Moujahed Labidi *et al* [9] (P-value 0.004). However, this disagreed with the results of Faraz Kerendi *et al* [10] that showed no significant difference between hypertensive and normotensive patients undergoing CABG as regards the incidence of post-operative pleural effusion.

In our study, the mean time of occurrence of pleural effusion post CABG was 7.2 days; this was in agreement with Vargas FS *et al* [11]. Hurlbut *et al* [12], in his study on 200 patients underwent CABG, 4% of patients receiving IMA grafts required thoracocentesis or tube thoracotomy by 6th postoperative day and this agree also with our study. However, our results disagree with Aarnio *et al* [13], who studied the postoperative course in 200 patients receiving IMA grafts and reported that 8.5% required thoracocentesis immediately after surgery.

As regards the technique of CABG performed "*either on-pump or off-pump*", there was a significant difference between case and control groups (P-value 0.04) in favor of on-pump CABG. These results agree with Moujahed Labidi *et al* [9]. Gerald W. *et al* [14] showed no significant difference between on and off-pump surgery as regards the incidence of post-operative pleural effusion.

As regards the bypass time and ICU stay in our study, it was significantly higher in case group (P-value 0.009), this was similar to the results of Adel K Ayed et al [15], but was against the results of Maryaan Payne et al [5], that in their results, there was no significant difference regarding bypass time only.

The post operative serum albumin was significantly lower in the case group (P-value < 0.001), and these results disagree with that of Adel K Ayed *et al* [15], as their results showed no significant difference between both groups regarding post operative serum albumin.

Biochemical analysis of pleural fluid showed criteria of exudative effusion in all cases. This was in agreement with Landymore *et al* [16], Vargas FS *et al* [11] and others.

As regards the lines of management, all the forty patients underwent thoracocentesis as a diagnostic procedure. Eight patients underwent therapeutic thoracocentesis (20%), seven were males and one female. Twenty patients underwent tube thoracostomy (50%), 16 males and 4 females, three of them needed injection of sclerosing agent into the pleural space (doxycyclin) for long standing effusion. Medical treatment alone was enough in 14 patients with SPE. All patients received medical treatment even after invasive management in the form of diuretics and non steroidal anti-inflammatory drugs, (NSAIDs e.g. diclofenac Sodium I.M injection, indomethacin oral tablets or suppository) and chemotrypsin tablets. Our results disagree with Jeffery T. Rogers et al [17], as in their study on 19 patients with SPE post CABG, 15 patients had a therapeutic thoracocentesis for shortness of breath (79%) , 5 patients were treated with anti-inflammatory agents (26%) , and 5 patients were treated with tube thoracostomy (26%) (more than line of treatment were used in the same patient).

Pleural effusion post CABG should be treated conservatively and should include management of congestive heart failure if appropriate and periodic thoracocentesis was indicated [18]. Other causes should be sought only if the effusion is large or if it fails to resolve in an appropriate time frame or if the patient is febrile "e.g. pleurisy or empyema". These effusions tend to resolve within eight weeks but long-term effusions have persisted for three to 20 months. Some long-term effusions result from prolonged oozing of blood and serum into the pleural space at the site of the harvested IMA while others are the result of trapped lung [18]. More aggressive therapy including thoracostomy tube placement with or without chemical pleurodesis may be necessary in some cases. Surgical interventions in the form of decortication by thoracoscopy or thoracotomy may be needed in some cases with trapped lung and for preventing re-accumulation of the effusions [19]. Use of supplemental soft tissue drain in a non-randomized study was pointed out by Payne et al [5] which showed a significant reduction (3.5%) in the incidence of pleural effusion as compared to routine chest drain (11.9%). Some patients develop respiratory insufficiency and may require more aggressive surgical intervention including thoracoscopic decortication if the pleural fluid continues to re-accumulate or becomes loculated [20]. Thoracoscopy is also recommended for an effusion after CABG that continues to recur for several months despite several therapeutic thoracocenteses. At thoracoscopy, any fibrous tissue that coating the visceral pleura should be removed and the parietal pleura should be abraded to create pleurodesis [21].

Conclusion

Most effusions occur in the early postoperative period. The exact etiology of post CABG effusions and why some effusions persist while others resolve remains unknown. Pleural effusion post CABG should be treated conservatively and should include management of congestive heart failure if appropriate and periodic thoracocentesis was indicated. More aggressive therapy including thoracostomy tube placement or pleurectomy may be necessary in some cases. Early ambulation and physiotherapy may reduce the incidence of postoperative pleural effusion as it has a role in reducing lung atelectasis.

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Fate of Right Ventricle Outflow Gradient After Fallot Repair

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Objective: **With more long-term survivors after Fallot repair the pulmonary valve regurgitation and right ventricular function, started to play a major role in the surgery of Fallot. Preserving the pulmonary valve offers a better long-term prognosis despite the risk of residual stenosis. This study was done to evaluate the effect of residual gradient on early mortality and follow up the fate of this gradient.**

Methods: **Between December 2011 and 2013, 43 patients with Fallot tetralogy operated upon in Cardiothoracic Surgery Department, Alexandria University were reviewed, direct intraoperative measured gradient and the echo-gradient were recorded and pressure ratio between right and left ventricle (p RV/LV) . The residual gradient was considered significant if it exceeds 40 mmHg or p RV/LV exceeds 0.85, transannular patch was used in 17 patients. Clinical and echo data were assessed over the study and time and every 3 months after discharge.**

Results: **Median age was 4.2 years (8 months – 37 years), there was 6 early deaths (13.95%) all of them not related to high outflow gradient 23 patients (53.48%) had gradient higher than 40 mmHg, one of them with fixed obstruction and gradient of 60 mmHg and is scheduled for revision. On follow-up echo. There was a significant fall in RVOT gradients on predischarge echocardiograms (47 ± 16.8 to 31.5 ± 14.7 mmHg $p < 0.005$). A further significant fall in gradients was noticed at a mean follow-up of 5 ± 3 months (20 ± 9 mmHg, $p < 0.05$).**

Conclusions: **This study showed that in patients with dynamic obstruction, there was a significant reduction in residual outflow gradient, and immediate revision was not needed. Echo is essential in identifying dynamic from fixed obstruction in addition to the surgeon belief of the adequacy of the outflow.**

KEY WORDS: **Fallot, gradient, RVOT, transannular patch.**

The classic components of the "tetrad" are a ventricular septal defect (VSD), right ventricular outflow tract obstruction (RVOT), overriding of the aorta and right ventricular hypertrophy. All of these individual components result from one basic morphological abnormality: anterior and left-ward displacement of the infundibular septum (Van-Praagh 1970).[1] Since the first successful repair using a pump oxygenator by Kirklin at the Mayo clinic,[2] it is appreciated that success of the repair of Tetralogy of Fallot (TOF) depends on adequate relief of right ventricular outflow tract obstruction (RVOTO), and secure closure of the ventricular septal defect (VSD).

Risk factors for early and late death include older age at repair, high peak right/left ventricular pressure immediately after repair (more than 0.85) and the presence of Potts shunt. The use of a transannular patch was not found to be a risk factor for premature late death.[3]

Over years, several modifications of the technique or repair evolved to improve both short term as well as long-term outcome. The most common indications for reoperation after repair are complications related to the RVOT, such as severe pulmonary regurgitation or residual outflow tract obstruction.[4] The exact amount of residual outflow tract obstruction required for reoperation is controversial, but when right ventricular pressure exceeds 60 mmHg relief of residual obstruction is generally indicated.[4]

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There is general agreement that postoperative pRV/LV more than 0.85 is not acceptable, and revision is needed,[5] however we think that this criteria may lead to unnecessary intervention. Many published reports, confirm that fact that a high intraoperative gradient falls significantly in many patients.[6-8] However, it remain high or become higher in some patients, necessitating reoperation. It is possible that in these patients the amount of resection of infundibular obstruction was inadequate, but this could not be confirmed.[5]

Transesophageal echo (TEE) may help clarify this issue with high gradient and may reveal the cause of obstruction and help the surgeon to better assess the adequacy of the repair and the need for re-intervention, in addition the combined use of epicardial and TEE may be helpful in some cases .[9]

Although the effect of pulmonary insufficiency on early and late mortality has been neutralized in recent series, long-standing pulmonary insufficiency appears to have deleterious effects on ventricular function and exercise capacity. This is particularly true when additional residual lesions are present, such as VSD or peripheral pulmonary stenosis.[10] In one study pulmonary insufficiency showed significant lower right and left ejection fractions when compared with a group of patients with competent pulmonary valves.[11] This was found despite the fact that all the patients analysed in this study were asymptomatic and had excellent hemodynamic repairs. Thus it is likely that some patients with pulmonary insufficiency will develop symptoms many years after repair, even in the absence of other significant residual defects.[10,11]

Bacha et al,[12] reported in 2001 the late results of early primary repair of tetralogy of fallot performed at children's Hospital Boston between 1972 and 1977 in 57 patients who were less than 24 months of age at the time of surgery. The major indication for reintervention in his follow up was for residual right ventricular outflow tract obstruction in 8 patients. Lomg-term follow-up studies from other centers have suggested that residual or recurrent right ventricular outflow tract obstruction is a more serious late problem and a more common cause for reoperation than pulmonary regurgitation.[12-14] Chen and Moller followed 144 patients for 10 years and found that patients with right ventricular outflow tract obstruction had the worst late results. A large right ventricular to pulmonary artery pressure gradient was noted in three patients who died suddenly.[13]

Aim of the Study

This study conducted in Cardiothoracic Department, Alexandria University, to review results after repair of TOF, and follow the residual gradient in patients with high gradients.

Patients and Methods

Between the period of December 2011 and December 2013, Total repair of TOF was performed in 43 patients. Mean age was 4.2 years (range 8 months to 37 years). Twenty patients (46.5%) were below 2 years, 9 (20.9%) 2-5 years, seven (16.27%) 5-12 years, 2 patients (4.65%) 12-18 years and five patients (11.6%) were over 18 years. The median weight was 17 kg (range 8-76 kg). Previous Blalock Taussig shunt was performed in 3 patients. One patient had previous repair of Tetralogy of Fallot performed in other Center and required revision for residual VSD and residual gradient of 110 mmHg. Associated malformations were atrial septal defect or patent foramen ovale in 34 patients, persistent left superior vena cava in 6 patients, right sided aortic arch in 4 patients, atrioventricular septal defect in one patient.

Operative Procedure

Surgery was performed utilizing standard techniques of cardiopulmonary bypass (CPB), moderate hypothermia, and antegrade cold crystalloid cardioplagia. We applied the transatrial + transpulmonary approach in all patients.

First, right atrium (RA) was opened and anatomy examined. The VSD was closed with a bovine pericardial patch (Edwards Heart Care) using a combination of interrupted pledgetted and continuous sutures transatrially in all the cases. Infundibular resection was then performed transatrially, and if required, it was completed through a pulmonary arteriotomy which is opened in all the cases. Adequacy of RVOTO resection was determined by Sizing the RVOT with Hegar dilators to appropriate diameters according to the tables done by Rowlatt's table for acceptable pulmonary artery size. If the annulus was found to be inadequate, the pulmonary arteriotomy was extended into the RVOT for a short distance 5 – 10 mm (n=17) and transannular patch was utilized. Atrial communication was closed. Direct intracardiac pressures were taken after discontinuation of CPB.

After repair Echo was done in the majority of patients (TEE in 30 patients), epicardial echo in 9 patients and 4 patients in the ICU after transfer depending on the availability of the Echo machine and the operator.

The following parameters were evaluated and graded in the manner described by Stumper and their colleagues:[16] 1- Presence of any residual VSD; 2- Presence of residual RVOT obstruction; 3- Right and left ventricular function and 4- presence of tricuspid or aortic regurgitation. Residual RVOT obstruction was graded as 1- none: no anatomic narrowing, minimal turbulence by color flow; RVOT gradient less than 20 mmHg; 2- Mild to moderate: anatomic narrowing, turbulent flow; RVOT gradient less than 40 mmHg, and 3- severe or significant; discrete narrowing, severe turbulence and gradient more than 40 mmHg.

The RVOTO was considered "fixed" if it appeared to be discrete and did not change in dimensions during the cardiac cycle. The presence of localized muscle band or increased echogenicity suggestive of residual fibrous tissue also favored a "fixed" obstruction. The RVOTO was considered to be "dynamic" variety if it appeared to be diffuse and if there was a definite increase in dimensions during diastole. Ventricular

dysfunction was graded visually as none, mild to moderate, or severe, the presence of RV dysfunction prompted exclusion of a fixed RVOTO.[5]

Postoperative Course

All patients remained in the intensive care unit until ventilator and inotropic support was withdrawn. The following parameters were recorded: dosage and duration of inotropes, duration of mechanical ventilation, central venous pressure, Intensive care and total hospital stay, presence of pleural effusion and/or ascites, arrhythmias, and need for re-exploration, pulse oximetry saturation was recorded or room air before ICU discharge.

Routine echo was performed in all patients at discharge and every 3 months after discharge and the findings compared with the immediate post-CPB echo.

Statistical analysis

The statistical analysis was performed using version 5 of JMP Software (SAS Institute Inc.). The continuous variables are expressed as mean ± SD and categorical variables were expressed as proportions. Continuous variables were compared using Student´s *t* test. The categorical variables were compared using the X^2 test or Fisher´s exact test.

Results

There was 6 (13.9%) early deaths, two mortalities from low cardiac output and multiorgan failure, one patient died from aspiration and sudden arrest one day after extubation with excellent hemodynamics, developed sudden arrest and was reopened and resuscitated to die later from a second arrest, another patient developed tamponade as a result of blocked drainage tube that was unrecognized and also with good hemodynamics, she was also opened and huge hematoma evacuated but the time to opening and resuscitation was long and the heart did not return, one patient suddenly developed ventricular fibrillation and the last mortality was from massive cerebral air hemorrhage. All the patients who died did not have a high gradient and their echo showed residual gradient less than 40 mmHg.

Junctional tachycardia occurred in 4 (9.3%) patients, and it was generally controlled by lowering the patient's core temperature to 35°C and/or by atrial pacemaker overriding In all patients, the median Prv/Plv ratio as measured in the operating room was 0.54 ± 0.18 (range 0.3-0.9) with a mean pressure gradient in RVOT of 47 mmHg (range 16-60).

Postoperative echo was performed in all cases whether in the operating room or in the intensive care unit, in 23 patients, RVOT gradient was found to be equal or more than 40 mmHg, although adequate muscle resection and easy passage of the corresponding hegar dilator, and the obstruction was considered to be dynamic as long as the patients are hemodynamic stable. Patients with higher gradients when compared with those with lower gradients, there was no difference as regards mechanical ventilation, ICU stay and inotropic requirement between those with high and low gradients.

Pleural effusion affected four patients (9.3%) and one of them needed drainage for 11 day, three of them had a transannular patch. Increased postoperative morbidity was not found to be related to higher intraoperative gradients. Three patients (6.9%) underwent reexploration for excessive postoperative bleeding.

Variable	Value
Number of patients	43
Age (years)	4.2 (8 months-37 years)
< 2	20 (46.5%)
2-5	9 (20.9%)
5-12	7 (16.27%)
12-18	2 (4.65%)
>18	5 (11.6%)
Sex (male/female)	21/22
Body weight (kg)	17 (8-76)
Previous shunt	3
Previous surgical repair	1
Pulse oximetry saturation	84%
McGoon ratio	1.7
Preoperative RVOT gradient (mmHg)	84

RVOT: right ventricular outflow tract

Table 1. Demographic data

Variable	Value
CPB (min)	80.5 ± 21.3
Ischemic time (min)	47.8 ± 15.3
pRV/LV	0.54 ± 0.18
Measured direct gradient	48.2 ± 19.6
Echo gradient (mmHg)	47 ± 16.8
Transannular patch	17 (39.53%)
Mechanical ventilation (days)	1.3 ± 1.1
Inotropic infusion (days)	1.9 + 0.8
ICU stay (days)	3.1 ± 2.6
Hospital stay (days)	9.76 ± 4.4
Pleural effusions	4 (9.3%)
Discharge saturation on room air	93%
Mortality	6 (13.95%)

CPB: Cardiopulmonary bypass
p RV/LV: pressure right ventricle/left ventricle ratio
ICU: Intensive care unit

Table 2. Operative and postoperative data

Echo was repeated before discharge and after 3 months in all survivors and the details in table 3. Mean follow-up was 12.5 ± 8 months. There were no reoperations and no late deaths.

RVOT gradient	Echo day 0	Predischarge	After 6 months	p mmHg
All patients Surgical approach	47 ± 16.8	31.5 ± 14.7	20 ± 9	<0.05
Without transannular Patch (n = 25)	55 ± 14.5	28 ± 16.6	17.7 ± 9.8	<0.05
With transannular Patch (n = 17)	40 ± 21.1	35 ± 12.9	22.43 ± 10.7	<0.05
Fixed RVOT Obstruction (one patient)	60	60	68	

Table 3. Fate of redisual RVOT gradients on followup echo

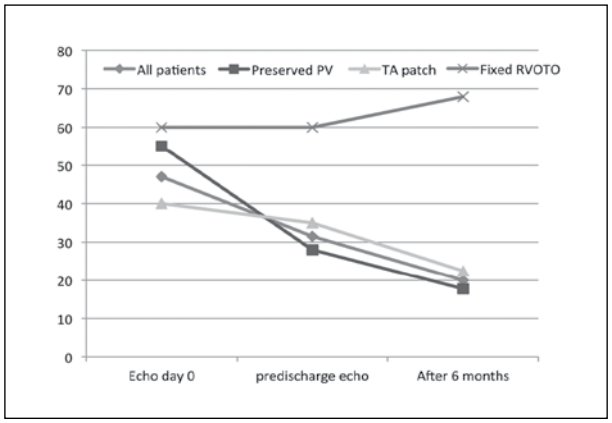

Fig. 1. Echo gradient
All patients: not including the one with fixed obstruction
PV: Pulmonary valve
TA: Transannular patch
RVOTO: Right ventricle outflow tract obstruction

The gradient measured directly intraoperatively correlated well with that measured by echo and for sake of comparison we utilized the echo gradient. There was a significant fall in RVOT gradients on predischarge echocardiograms (47 ± 16.8 to 31.5 ± 14.7 mmHg $p < 0.005$). A further significant fall in gradients was noticed at a mean follow-up of 5 ± 3 months (20 ± 9mmHg, $p < 0.05$). The fall was more in patients with gradients greater than 40 mmHg as compared with patients with gradients less than 40 mmHg. So patients with preserved pulmonary valves and dynamic gradient showed a greater decrease then patients with transannular patch.

One patients with high gradient on discharge remained with the same gradient on follow up one year after surgery, the gradient remained 60 mmHg, and he will be scheduled for reintervention. Moderate pulmonary regurgitation occurred in 11 patients and severe pulmonary regurgitation in 3 patients and they are closely followed up.

It should also be noted that one of our patients that was operated in another center and presented with recurrent symptoms and echo gradient of 110 and residual VSD, when operated upon, we found that she had a double chamber just under the pulmonary valve with its opening resembling the leaflets of the pulmonary valve which when excised the gradient dropped from 110 to 30 mmHg, and it was also noted that the previous repair was done solely trans-atrially.

Discussion

This study reviews a single center experience with repair of Fallot tetralogy over the past 2 years. Although the morphology of the RVOTO did not change over time, but the advance in the time of surgery and the trend to perform the repair earlier in life to avoid the damaging effect of hypoxia on normal development and to preserve the right ventricle function and to avoid problem associated with palliative procedure. The advantage of preserving the right ventricular function led many groups to avoid if possible the usage of trans-annular patch and preserving a competent pulmonary valve even accepting a higher gradient as long as the gradient is not fixed in the hope that it will decrease overtime.[10,14,17,18]

A side effect of the adoption of a RVOT – sparing policy is a higher re-operation rate for residual or recurrent RVOTO. Many reports have already pointed to the higher residual outflow gradients after trans-atrial correction.[17,18] Therefore, in the pursuit of the optimal balance between adequate relief of RVOTO and the harmful long term results of pulmonary regurgitation related volume load, this study was taken to assess our results and to assess the fate of residual gradient and the incidence of reoperation.

It is well known since the beginning that the most important determinants of the adequacy of repair,[2-4] is minimal degree of residual RVOTO and secure VSD closure. Residual lesions of any kind would lead to higher morbidity and impaired ventricular function, higher reoperation rate, and increased risk

of sudden arrhythmias and sudden death. Postoperative right ventricular pressure is still the most frequently used method to assess the repair,[3] but it does not clarify the nature and site of the obstruction.

In older patients with Fallot with right ventricular hypertrophy, and less compliance, the hypercontractile state, which exists in the immediate period after surgery, and inotropes may exaggerate this effect of systolic obstruction of the RVOT,[6,7] significant systolic gradients may thus be present despite adequate relief. Echo can help in identifying this type of dynamic obstruction, that will fall over time. We belief that over time and remodeling of the RVOT occurs and the gradient falls which is not the case when a transannular patch is used which cause progressive increase in pulmonary incompetence and right ventricular dysfunction.[5] The chances of leaving considerate obstruction are higher in older patients because the hypertrophied muscle bands increases with age. Since a significant number of our patients belong to the older age group the adequacy of RVOT relief was of concern and the majority of them needed a transannular patch.

It is recommended by many authors,[2-5] that immediate surgical revision is required if RV pressure is systemic or suprasystemic or p RV/LV ratio > 0.85, irrespective of the method of repair used. In our study we feel that this can cause to unnecessary surgical revisions which may increase the morbidity and predispose to long term ventricular dysfunction due to aggressive myocardial resection and extension of right ventriculotomy. Four factors should be considered, the surgeon impression of the adequacy of relief, the passage of adequate sized Hegar, the postoperative RV/LV pressure ratio and the data gathered from the echo as to whether the increased gradient are fixed or dynamic and more important is the degree of hemodynamic stability. We found that 23 patients had significant residual gradient, > 40 mmHg all of them did not require revision because the nature of obstruction was judged to be of dynamic origin even with a high RV/LV pressure ratio. All of these patients had a smooth postoperative course, and on follow up echo, their gradients showed a significant fall to near 20 mmHg. This agrees with the findings of many authors.[10,14,17,18,19] The presence of significant dynamic obstruction did not increase morbidity or mortality in our cases, these gradients may be safely accepted and avoiding unnecessary surgical revision.

We have 6 mortalities, 2 patients died from low cardiac output, one of them his echo showed undiagnosed subaortic membrane and significant left ventricle outflow obstruction which necessitated surgical revision, and the second one was the combined Fallot and AV canal, both of them needed high inotropic support, and suffered multiorgan failure. Another mortality was caused by aspiration in a perfectly stable and extubated 8 months old baby and was off all inotropes, the fourth mortality was caused by undiagnosed tamponade because of blocked drainage tube, the last 2 mortalities were caused by arrhythmia (sudden ventricular fibrillation) and massive cerebral hemorrhage , all those patients had gradient below 40 mmHg except the adult 30 years old patient with cerebral hemorrhage, his RV/LV ratio was 0.7 and had a gradient of 55 mmHg.

We therefore feel that surgical revision is indicated only when fixed obstruction is the cause, we had one patient whose obstruction remained constant and the gradient on follow up did not decrease, on the contrary it increased from 60 to 68 mmHg on follow up and he is scheduled for redo surgery. It should be stressed that turbulent flow in the RVOT[9,16] is not an indication for revision as long as the patient had acceptable right and left ventricular function and is doing well in the postoperative period, we did not find any difference in the immediate postoperative period between patients who had transannular patch (17 patients) and those without as regard ICU and hospital stay, duration of inotropic support, however pleural effusion drainage was more prolonged in the transannular patients.

In conclusion, after tetralogy repair, two types of RVOT obstruction can be identified fixed and dynamic. The fixed obstruction if not diagnosed and treated immediately will tend to worsen over time and cause repeated surgical revision. High gradient with dynamic obstruction will decrease over time and does not need immediate surgical revision, and does not affect early outcome. Intraoperative echocardiography is essential in identifying the type of obstruction and helps avoiding unnecessary surgical interference.

Limitation: This is a short term study, Long term follow-up is needed to further assess the gradient and the degree of incompetence of the pulmonary valve and any late mortality and morbidity.

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Risk Factors and Outcomes of Re-exploration for Bleeding after Coronary Artery Bypass Grafts

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Background: **Re-exploration for bleeding after coronary artery bypass graft surgery (CABG) is an important source of morbidity and mortality in many cardiac centres. The proportion of patients that requires reexploration for bleeding after CABG has been reported to be between 2% and 6%. The risk factors for reexploration after CABG are not well established..**

Objectives: **This retrospective study was conducted to ascertain the risk factors and to study the outcome, that are associated with increased rates of reexploration for bleeding after CABG.**

Methods**: A retrospective study of data collected in the systematic database of Morriston Hospital in Swansea, Wales, UK of patients who underwent coronary artery bypass grafting (CABG) operations from January 2005 to January 2012.**

Results**: 943 patients underwent isolated coronary artery bypass grafts (CABG) from January 2005 to January 2012. 52 patients (5.5%) required re-exploration for bleeding. Univariate analysis showed that only BMI was significantly associated with the need for re-exploration for bleeding. The duration of mechanical ventilation, intensive care unit (ICU) stay and the hospital stay were all longer in the re-exploration group than the no re-exploration group and the differences were statistically significant (*p* value: <0.001, 0.014 and 0.023 respectively). The average total blood transfusion was higher in the re-exploration group than the no re-exploration and the difference was statistically highly significant. The difference between the two groups regarding mortality and post operative complications was not statistically significant.The results of the multivariate logistic regression analysis showed that the independent predictors of re-exploration for bleeding were BMI more than 25 kg/m^2 and emergency surgery.**

Conclusion: **The risk factors for re-exploration after CABG, include BMI<25, and emergency surgery. Re-exploration for bleeding does not seem to add to the mortality and morbidity after CABG, although it increase the length of ICU and hospital stay.**

KEYWORDS: **Re-exploration; Bleeding; Coronary Artery Bypass Grafts.**

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Reexploration for bleeding after coronary artery bypass graft surgery (CABG) is an important source of morbidity and mortality in many cardiac centres. It has been associated with case-fatality rates as high as 22% [1]. It is also associated with deep and superficial wound infections [2]. Such patients are often haemodynamically unstable and require urgent or emergent re-exploration and are also at greater risk from the various hazards of blood and blood products [3].

Patients undergoing re-exploration for bleeding also consume considerable resources, including blood products and those related to prolonged intensive care and overall hospital stays [1,4–6]. The proportion of patients that requires re-exploration for bleeding after CABG has been reported to be between 2% and 6% [1,3,7].

The risk factors for re-exploration after CABG are not well established. Older age, smaller body mass index (BMI), longer cardiopulmonary bypass (CPB) times, greater number of distal anastomoses, and the use of internal mammary artery have been associated with greater risk of reexploration for bleeding [3,4,7,8].

There have been several changes in the practices associated with cardiac surgery over the last decade, and many of these are quite likely to have some impact on the rates of reexploration after CABG. Among the many changes that are likely to affect the haematological profile of the patient after cardiac surgery are the preoperative use of aspirin and clopidogrel, an increased number of unstable patients undergoing surgery, many of whom are receiving heparin infusions, off-pump CABG, a greater number of older and sicker patients having surgery, and varying practices with regard to the use of anti-fibrinolytic drugs [9].

This retrospective study was conducted to ascertain the risk factors and to study the outcome, that are associated with increased rates of reexploration for bleeding after CABG.

Patients and Methods

This was a retrospective study of data collected in the systematic database of Morriston Hospital in Swansea, Wales, UK. Permission was obtained from the institutional review board to perform this study. Data of patients operated on from January 2005 to January 2012 were analysed. Patients who underwent coronary artery bypass grafting (CABG) operations were included in the study. There were 943 patients included in the study (757 males and 185 females). The operations were performed by different surgical teams, all using cardiopulmonary bypass.

All patients undergoing CABG in our study are fully heparinised, that is, 300 U per kilogram body weight of heparin. Patients undergoing CABG along with heart valve repair or replacement, resection of a ventricular aneurysm or other surgical procedure were not included in the study.

The primary outcome measure for our study was re-exploration for bleeding, which was defined as bleeding that required surgical re-exploration after leaving the operating theatre. The decision to perform re-exploration for bleeding was made by the consultant surgeon responsible based mostly on the protocol stated by Kirklin and Barratt-Boyes [10]. Although these criteria were followed for a majority of the cases, it was not so for all of them. The criteria are as follows: (1) drainage of more than 500 mL during the first hour, more than 400 mL during each of the first 2 hours, more than 300 mL during each of the first 3 hours, or more than 1000 mL in total in the first 4 hours (2) sudden massive bleeding; (3) obvious signs of cardiac tamponade; (4) excess bleeding despite correction of coagulopathies; and (5) cardiac arrest in a patient who continues to bleed [10].

Outcomes collected, after re-exploration, are listed in Table 4. The early clinical outcomes were defined as any morbidity or mortality in the first 30 postoperative days or during hospitalisation regardless of cause. Preoperative aspirin or heparin use was defined as continuing the medications until the day of surgery.

Data were collected and analyzed using SPSS version 17 software (SPSS, Inc., Chicago, IL, USA). Quantitative data are shown as mean and standard deviation, and qualitative data are expressed as frequency and percentage. The chi-square test was used to assess associations between qualitative variables. A stepwise logistic regression model was used to give adjusted odds ratios (OR) and 95% confidence intervals (CI) for the effects of the various risk factors on early clinical outcomes. The model included all variables hypothesised to be possible confounders. A *p* value was considered statistically significant when it was less than 0.05.

Results

In our study 52 patients (5.5%) required re-exploration out of 943 patients who underwent isolated coronary artery bypass grafts (CABG). Patient demographic data are shown in tables 1. Only BMI (*p:* <0.001) was significantly associated with the need for re-exploration for bleeding. There was no statistically significant difference between the re-exploration and no re-exploration groups regarding sex or age (table 1).

	No re-exploration	Re-exploration	*p* value
	891 (94.5%)	52 (5.5%)	
Sex			0.663
Male *	714 (80.2%)	43 (82.7%)	
Female *	176 (19.8%)	9 (17.3%)	
Age (years) ^	65.8 ± 0.6	64.0 ± 2.6	0.180
BMI			<0.001
Underweight*	40 (6.40%)	5 (17.24%)	
Normal weight*	195 (31.20%)	13 (44.83%)	
Over weight*	223 (35.68%)	4 (13.79%)	
Obese*	167 (26.72%)	7 (24.14%)	

**: Number (%)*
^: Mean ± SD
BMI: Body Mass Index

Table 1. Demographic data:

There was no statistically significant difference between the no re-exploration and the re-exploration groups regarding

the pre-operative intake of aspirin, clopidogrel, warfarin or heparin. Of the no re-exploration group 27 patients (3.0%) had previous cardiac surgery, 317 patients (35.6%) had previous myocardial infarction and 66 patients (7.4%) had previous PCI. Of the re-exploration group one patient (1.9%) had previous cardiac surgery, 18 patients (34.6%) had previous myocardial infarction and 5 patients (9.6%) had previous PCI. There was no statistically significant difference between both groups regrading previous cardiac surgery, previous myocardial infarction or previous PCI (table 2).

There was no statistically significant difference between the no re-exploration and the re-exploration groups regarding presence of diabetes, hypertension, hyperlipidaemia, renal disease, pulmonary disease or peripheral vascular disease (table 2). Also there is no statistically significant difference between the 2 groups regarding history of cigarette smoking or family history of ischaemic heart disease (table 2). There was no statistically significant difference between both groups regarding the pre-operative ejection fraction or pre-operative heart rhythm (table 2).

Univariate analysis of the operative data (table 3) showed no statistically significant difference between the no re-exploration and the re-exploration group regarding the extent of coronary vessel disease (*p*: 0.408), the presence of left main stem disease more than 50% (*p*: 0.165), the timing of surgery (*p*: 0.821), the minimum intra-operative temperature (*p*: 0.557), the number of coronary grafts (*p*: 0.231), aortic cross clamp time (*p*: 0.799) or cardiopulmonary bypass time (*p*: 0.827) (table 3)

Table 4 shows the post operative outcome of the no re-exploration and the re-exploration groups. The duration of mechanical ventilation, intensive care unit (ICU) stay and the hospital stay were all longer in the re-exploration group than the no re-exploration group and the differences were statistically significant (*p* value: <0.001, 0.014 and 0.023 respectively). The average total blood transfusion was higher in the re-exploration group than the no re-exploration and the difference was statistically highly significant (*p*: <0.001) (table 4). The difference between the two groups regarding mortality and post operative complications was not statistically significant (table 4).

The results of the multivariate logistic regression analysis (table 5) showed that the independent predictors of re-exploration for bleeding were BMI less than 25 kg/m2 (p: 0.002) and emergency surgery (p: 0.031).

	No re-exploration 891 (94.5%)	Re-exploration 52 (5.5%)	*p* value
Pre-operative Medications			
Aspirin*	636 (71.4%)	39 (75%)	0.333
Clopidogrel*	215 (24.1%)	20 (38.5%)	0.056
Warfarin*	20 (2.9%)	2 (3.8%)	0.543
Heparin*	6 (0.2%)	0	0.533
Previous cardiac surgery*	27 (3.0%)	1 (1.9%)	0.650
Previous MI*	317 (35.6%)	18 (34.6%)	0.120
Previous PCI*	66 (7.4%)	5 (9.6%)	0.235
Past History			
Diabetes*	154 (17.3%)	5 (9.8%)	0.165
Smoking			0.515
Current smoker*	96 (10.9%)	8 (15.7%)	
Ex-smoker*	538 (61.1%)	31 (60.8%)	
Never smoked*	246 (28.0%)	12 (23.5%)	
Family history of IHD*	525 (62.8%)	32 (64.0%)	0.864
Hypertension*	654 (73.8)	36 (70.6%)	0.621
Hyperlipidaemia*	669 (80%)	38 (76%)	0.491
Renal disease*	17 (2.0%)	0	0.322
Pulmonary disease*	113 (12.9%)	10 (19.6%)	0.168
Peripheral vascular disease*	131 (14.7%)	10 (19.2%)	0.377

**: Number (%)*
MI: Myocardial infarction
PCI: Percutaneous coronary intervention
IHD: Ischaemic heart disease

Table 2. Pre-operative data:

	No re-exploration 891 (94.5%)	Re-exploration 52 (5.5%)	*p* value
Extent of coronary vessel disease			0.408
One vessel disease	13 (1.6%)	2 (4.2%)	
Two vessels disease	83 (10.1%)	5 (10.4%)	
Three vessels disease	724 (88.3%)	41 (85.4%)	
Left main stem >50%	164 (19.5%)	14 (27.5%)	0.165
Timing of surgery			0.821
Elective	858 (96.7%)	50 (96.2%)	
Emergency	29 (3.3%)	2 (3.9%)	
Minimum intra-operative temperature			0.557
<32°C	292 (32.8%)	15 (28.9%)	
≥32°C	599 (67.2%)	37 (71.2%)	
Number of distal grafts			0.231
Single graft	18 (2%)	2 (3.9%)	
2 grafts	105 (11.8%)	4 (7.7%)	
3 grafts	422 (47.4%)	31 (59.6%)	
4+ grafts	346 (38.8%)	15 (28.9%)	
CPB time (minutes) ^	99.8 ± 1.9	98.9 ± 7.5	0.827
Aortic cross clamp time (minutes) ^	64.5 ± 1.9	63.1 ± 12.6	0.799

**: Number (%)* *^: Mean ± SD* *CPB: Cardio-pulmonary bypass*

Table 3. Operative data:

	No re-exploration 891 (94.5%)	Re-exploration 52 (5.5%)	*p* value
Ventilation time (hours) ^			<0.001
< 6 hours	181 (22%)	6 (12.5%)	
6 - 12 hours	543 (65.9%)	23 (47.9%)	
12 - 24 hours	81 (9.8%)	13 (27.1%)	
> 24 hours	19 (2.3%)	6 (12.5%)	
ICU stay (hours) ^	2.5 ± 0.6	5.3 ± 4.3	0.014
Hospital stay (days)	11.9 ± 0.6	15.4 ± 4.6	0.023
Total blood transfusion (ml)	170.6 ± 25.5	688.9 ± 265.5	<0.001
Mortality	7 (0.8%)	1 (1.9%)	0.385
Previous PCI*	66 (7.4%)	5 (9.6%)	0.235
Post operative complications			
Pulmonary complications*	194 (21.8%)	12 (23.1%)	0.529
GI complications*	10 (1.1%)	1 (1.9%)	0.327
Renal complications*	47 (5.3%)	4 (7.7%)	0.144
Neurological complications*	36 (4.0%)	2 (3.8%)	0.254

**: Number (%)* *^: mean ± SD* *ICU: Intensive Care Unit*

Table 4. Post operative data:

Variable	Odds Ratio	Standard Error	95% Confidence Interval	*p* value
Age at operation	0.975	0.021	(0.934 , 1.017)	0.233
Female Sex	0.131	0.140	(0.016 , 1.055)	0.056
Pre-op Clopidogrel	2.146	0.918	(0.928 , 4.964)	0.074
Pre-op Aspirin	0.448	0.273	(0.135 , 1.481)	0.188
Previous cardiac surgery	0.669	0.779	(0.068 , 6.555)	0.730
BMI less than 25 kg/m^2	4.371	2.085	(1.716 , 11.134)	0.002
Emergency operation	6.426	5.545	(1.184 , 34.875)	0.031

Table 5. Multivariate Risk Factors for Re-exploration for Bleeding

Discussion

In our Study, 52 patients (5.5%) of 943 patients who underwent CABG required re-exploration for bleeding. This figure compares quite well with incidence of 2% to 6% mentioned in the literature [1,3,7].

Univariate analysis of patient characteristics revealed patients with smaller BMI to have a significantly higher risk of re-exploration for bleeding ($p<0.001$). On multivariate analysis, BMI less than 25 kg/m^2 (*p*: 0.002) and emergency surgery (*p*: 0.031) were at a greater risk of needing re-exploration for bleeding. Most studies looking at risk factors for bleeding after cardiac surgery have found increased risk in older patients, smaller body surface area, longer CPB times, greater number of distal anastomosis, dialysis dependant renal failure, and the use of the internal mammary artery [3,4,7,8].

Our finding of an association between BMI less than 25 kg/m^2 and increased reexploration for bleeding is similar to the findings from Dacey and colleagues [3] from the Northern New England Cardiovascular Disease Study Group. Those investigators demonstrated that re-explorations increased as body surface area decreased. The reasons behind this relationship are unclear but may be due to dilution of coagulation factors [3]. also our findings were similar to those by KARTHIK et al who found a BMI less than 25 kg/m^2 (*p:* 0.003), nonelective surgery (*p:* 0.022), patients requiring 5 or more grafts (*p:* 0.035), and elderly patients were at a greater risk of needing reexploration for bleeding [9].

It is likely that both the mediastinal and pericardial fat have a tamponading effect on the small bleeders in the mediastinum. We also think that, patients with smaller BMI are less likely to tolerate major blood losses. Hence, the threshold for re-exploration is usually lower in these patients.

In our study there was no statistically significant effect of cardiopulmonary bypass (CPB) time, aortic cross clamp time, minimal intra-operative temperature or number of distal anastomosis on re-explorations for bleeding after CABG, as demonstrated by univariate analysis. Dacey and coworkers [3] found that both CPB duration and number of grafts were associated with re-exploration for bleeding. This difference between both studies may be due to sample size, with the Dacey study having more than 8,000 patients.

In our study there was no statistically significant difference between the re-exploration and the no re-exploration groups regarding the pre-operative intake of aspirin, clopidogrel, warfarin or heparin. Aspirin (in a dose of 75 mg to 300 mg daily) is a strong inhibitor of the platelet cycloxygenase, thus inhibiting the production of thromboxane A2. Thromboxane A2 is essential for the initiation of clot formation by platelets. This loss of function due to aspirin is permanent for the lifetime of the platelet. Because the average lifespan of platelets is about 7 days, the usual practice of stopping aspirin a week before surgery was considered appropriate. The association between bleeding and clotting ab- normalities and various components of CPB and heparinization are very well known and documented. Cardiopulmonary bypass also tends to affect platelet function quite severely. These could be the reasons for the increased risk of bleeding seen in many studies of patients undergoing on-pump CABG [11,12].

Srinivasan and coworkers [13], showed that continued aspirin does not increase postoperative blood loss, re-sternotomy rates, and blood or blood product requirements in patients who undergo off-pump CABG. The debate around aspirin use in conventional on-pump CABG is still undecided. Dacey and colleagues [14], in a study by the Northern New England Cardiovascular Disease Study Group, showed that preoperative aspirin significantly reduced mortality without increasing bleeding-related morbidity. However, the Veterans Administration Cooperative Study found higher rates of reoperation and bleeding when using preoperative aspirin [11].

Karthik et al [9] found that the preoperative use of aspirin and heparin were more common in patients re-explored for bleeding compared with a propensity-matched group who were not re-explored [9].

Although there was statistically significant difference in the ventilation time, ICU stay and hospital stay between the re-exploration and the no re-exploration groups, in our study, we did not find any significant difference in the mortality rates and major morbidity between the re-exploration and the no re-exploration groups, including pulmonary, gastrointestinal, renal or neurological complications. our results were similar to those found by Karthik et al [9] who did not find any significant difference in the mortality rates and major morbidity, including sternal wound infection, stroke, renal failure, and need for intra-aortic balloon pump support, between the re-exploration and the no re-exploration groups.

Moulton and coworkers [4] found a significantly higher mortality rate and increased risk of renal failure, sepsis, and need for prolonged ventilation in the group needing reexploration. They concluded that reexploration is a significant multivariate indicator of increased morbidity and mortality in all patients, but more so in a selected low-risk subgroup of patients. They also felt that the amount of bleeding is a significant risk factor rather than the act of reexploration. Unsworth-White and coworkers [1] also found an association between reexploration and increased mortality and morbidity.

Limitations of our study include the fact that it was a retrospective and nonrandomized, and it was a single-institutional study on patients undergoing operations by different surgical teams. We concluded that the risk factors for re-exploration after CABG, include BMI<25, and emergency surgery. Re-exploration for bleeding does not seem to add to the mortality and morbidity after CABG, although it increase the length of ICU and hospital stay.

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Cavopulmonary connections: comparisons between different techniques (with or without cardiopulmonary bypass)

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BACKGROUND: **The bidirectional cavopulmonary connection (BCPC) is a commonly performed procedure for a variety of complex cyanotic congenital heart diseases as one of staged palliation. Most often, it is performed using cardiopulmonary bypass (CPB), with its associated complications. The advantages of a BCPC procedure without the use of cardiopulmonary bypass (CPB) remain mixed within many reported series. The purpose of this study was to compere the early outcomes of cavopulmonary connections techniques performed off-pump versus conventional using cardiopulmonary bypass**

METHODS: **From December 2011 through February 2014, 150patients underwent CPC procedure. patients were classified into 2 main groups group (A) CPB (n=50, mean age 23months) and group (B) non- CPB (n=100 mean age =22 months) and non-CPB group further classified into group BI (n=50) in which venoatrial shunt used and group B2 (n=50) without use any decompressing shunt. Primary outcomes included operative mortality, postoperative complications as well as ICU stay and hospital stay.**

RESULTS: **Preoperative patient characteristics were similar among patients despite the use of CPB. The most frequent indications for a BDG procedure were functionally single ventricle (60%)(mostly TA 21%) and Complex DTGA was present in (36%). Mean perfusion time was 34.6 minutes for CPB patients. Overall mortality was 4% , 2% deaths occurred among non-CPB patients in group B2,0% in B1 group, 8% in CPB patients (2% versus 8%; p > 0.077), . Similarly, no significant differences existed between non-CPB patients and CPB patients with respect to overall complication rates (5% versus 8%; p 0.466) or postoperative length of stay (6.34±0.8days (5-7)for group B versus 7.66±2.56,(5-15) days for group A ; p 0.129).**

CONCLUSIONS: **The BDG procedure without CPB has no significant risk in operative mortality, morbidity when compared to the same procedure with the use of CPB support. The off pump technique with venoatrial shunt showed the best postoperative results in terms of shortest duration of ventilator support, less incidence of complications , no neurological complication least ICU stay and least hospital stay .**

KEY WORDS: **Cavopulmonary connection, cardiopulmonary bypass.**

In Current surgical approaches in congenital heart disease that is characterized functionally as single ventricle are based on diverting systemic venous return to the lungs (30)

The first clinical use of a unidirectional cavopulmonary anastomosis occurred in 1951 by Carlon [1] at the University of Padua. Subsequent revisions resulted in the classic approach described by William Glenn [2] in 1958. The bidirectional Glenn shunt (BDG) is an operation to divert systemic venous return from the superior vena cava (SVC) directly to both lungs through the right pulmonary artery (RPA), bypassing a hypoplastic or absent right ventricle.(31)

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BCPC is most frequently used as staged palliation for patients with functionally univentricular hearts in preparation for a later Fontan operation. However it may also be used in patients with hypoplastic right ventricles and selected other lesions, such as Ebstein's anomaly (6)

Most often, it is performed under cardiopulmonary bypass (CPB), with its associated complications and costs. (10).

Since CPB is known to activate inflammatory mediators, increase lung water, and decrease right ventricular compliance, off-pump surgery offers the advantage of reducing postoperative complications in these patients, (19) but performance of this operation without CPB is associated with significant temporary elevation of the proximal superior vena cava (SVC) pressure that may lead to neurological injury. (19).

The technique of doing BCPC without CPB has been reported by many authors. Most of these authors have reported this procedure using various techniques to drain the SVC blood during clamping. (10). Lal and Mahant (4) reported that BCPC could be done without using cardiopulmonary bypass (CPB). They used different techniques to drain the superior vena cava (SVC) blood during clamping for BCPC anastomosis. (23)

Thus the optimal operative approach for performance of a BDG procedure with respect to the use of CPB remains unsettled, and the comparative effectiveness of a BCPC procedure with or without CPB remains ill defined. The purpose of the our study was to compare the early outcomes for patients undergoing a BCPC procedure with and without the use of CPB

Patients and methods

Approval for this study was obtained by the Ethical Committee of Scientific Research of Ain Shams University Faculty of Medicine including the acceptance of the patient's parents to participate in the study in the form of a written consent. The study was conducted in Ain Shams university Hospital, Misr children hospital and in National heart institute.

All (150) patients underwent performance of bidirectional superior cavopulmonary anastomoses. They were done from 2011 to 2014. Patients were classified based on the use of CPB into 2 study groups: CPB (A) and non-CPB (B). The non-CPB group further divided based on use venoatrial shunt or not into 2 sub group: Group BI with use of venoatrial shunt. And group BII without use veno- atrial shunt The patient selection for each group was depended on surgeon choice for the performance of a BDG procedure with or without CPB and using venoatrial shunt or not.

Primary outcomes of interest included operative mortality, postoperative complications as well as ICU stay, ventilation time and hospital stay. Secondary outcomes included observed differences in patient characteristics, and postoperative events.

Patient's characteristics:

All patients underwent cavopulmonary shunt were ≥6 months, with univentricular heart physiology or complex anatomy not candid for biventricular repair ,Mean pulmonary artery pressure ≤15 mmHg, unless the mean pulmonary artery pressure is adjusted intraoperative to ≤ 15 mmHg .All Patients with hypoplastic left heart syndrome, LVOT obstruction, and coarctation, absent one of pulmonary artery or anomalous origin of one pulmonary artery from aorta or from the other pulmonary artery branch, anomalous pulmonary or systemic venous connection, with other intracardiac defects requiring correction, Patients with more than mild AV valve regurgitation, Patients with preoperative neurological problems And those originally intended to undergo non-CPB BDG procedures then underwent intraoperative conversion to CPB procedures were excluded from the study.

Preoperative assessment:

Patient assessment Preoperatively included Full history taking (age, sex, weight, and height, prematurity) General and cardiac examination, Oxygen saturation by pulse oximetry in room air at admission, Full laboratory investigation (CBC, liver function, kidney function, coagulation profile),Chest x-ray, and Echocardiographic examination with full study: Full anatomical description , Estimation of: pulmonary artery pressure, Degree of AV valve regurgitation, Pressure gradient on the pulmonary artery either it originally has stenosis or has been banded previously.

Operative procedure

Anesthesia

All patients underwent the same anesthesia protocol. After oral intubation, general anesthesia was maintained with inhalation. The intraoperative management included monitoring the electrocardiogram, O2 saturation, and invasive blood pressure measurement. A nasopharyngeal temperature probe was used to record core temperature .A single-lumen central venous neck line was placed to monitor the BDG shunt pressure, and a separate multiport femoral venous line was placed to infuse drugs and measure left atrial pressure.

Patient assessment Intraoperative included Measurement of SVC pressure pre-anastomosis, during anastomosis, and after completeness the shunt, Measurement of oxygen saturation before, during and after completeness of shunt, Time of cardiopulmonary bypass in CPB group Time of clamping of SVC, and SVC decompressing technique when used ,Hemodynamic status (arterial blood pressure, heart rate, body temperature) ,Measurement of the difference between the systolic blood pressure and the mean jugular venous pressure (transcranial pressure) as indicative for cerebral perfusion ,using of inotropic agents (type and its dose).After operation,

patients received intravenous nitroglycerin (2 to 3 μg · kg–1 · min–1), inotropic support when needed.

Operations

The procedure was performed through a standard median sternotomy.

BDG PROCEDURE WITH CARDIOPULMONARY BYPASS.(Group A):

1-The entire length of the SVC dissected. The azygos vein was ligated. The entire length of the right pulmonary artery and proximal left pulmonary artery was dissected, and circumferential control was gained around the right main pulmonary artery as well as the hilar branches. The patient was systemically heparinized with 300 units/kg heparin.

2-A right-angle cannula was placed high on the SVC or innominate vein and another straight cannula was placed in the right atrium, whereas an aortic cannula was placed in the ascending aorta. Each patient was then placed on standard CPB. All operations in this group were performed with a beating heart .Once on bypass; the B-T shunt, PDA was snared . Subsequent end-to-side Glenn Glenn anastomoses were then performed in the same manner as already described. After weaning and MUF had been done if needed The systemic-pulmonary shunt (modified B-T shunt, or patent ductus arteriosus [PDA]) was then doubly ligated and divided if needed and the main pulmonary artery was either left, banded, or totally ligation.

Bdg Procedure Without Cardiopulmonary Bypass. (Group B)

In group BI:

The same dissection and hiparinization a right-angle cannula was placed high on the SVC or innominate vein and another straight cannula was placed in the right atrium. After the air had been removed the two cannula were hooked together to create a venoatrial shunt and allow drainage of the upper body while the proximal SVC was occluded. The pulmonary artery was temporarily occluded to ensure acceptable oxygen saturations and hemodynamic stability. The mid portion of the SVC was occluded with a clamp and the SVC was divided from the right atrium then closure of the right atrium end with 5/o polypropylene. The right pulmonary artery was occluded partially with C shape colly clamp, and a superior pulmonary arteriotomy was made and extended with Potts scissors. A standard end-to-side BDG anastomosis was then anastomoses were performed using a continuous suture technique with 6/0 polypropylene. At the conclusion of the anastomoses, the clamps were released after air was removed from the anastomosis, all cannulas were removed, and the previously placed purse-string sutures were tied down. The systemic-pulmonary shunt (modified B-T shunt, or patent ductus arteriosus [PDA]) was then doubly ligated and divided if needed and the main pulmonary artery was either left, banded, or totally ligation.

In group BII:

As the previous with the head-end elevated, and no insertion of canula, or hiparinization.

RESULTS

-Patient Characteristics, Operative Details, and Surgical Diagnoses

A total of 150 consecutive patients were included in this study, including50 underwent BCPC procedure with assistance of CPB, group A, and 100 patients underwent a non-CPB BCPC procedure, group B, [50 with venoatrial shunt (group B1), and 50 without venoatrial shunt (groupB2)].

Regarding the Patient Characteristics and Perioperative events as shown in table 1and 2, No differences were observed in sex distribution among the groups, nor in mean patient age, nor in mean patient weight or height.

Overall, performance of operations was more common among males 59%in all study groups.

Regarding primary surgical diagnoses (Functionally single ventricle in form of DTGA-HRV-ASD-PS , TA-ASD-PS , HRV-ASD-VSD-PS , HRV-CA-PA-Large PDA , HRV-DTGA-VSD-PS-ASD , DORV-ASD-MA-PS , DORV-HLV-ASD-PS ,DILV-TA-DTGA-Moderate size .VSD-PS , DILV-HRV-ASD-PS , LTGA-TA-ASD-PS , LTGA-SA-HRV-PS, UBCAVC-PS and PAVC-Single .RV) was the most common indication for a BCPC procedure in both study cohorts (60%) , It was present in (56%) of non-CPB patients and in (68%) of CPB patients. Complex DTGA was present in (36%) of over all patients, (24%) in non-CPB patients and in a lower proportion of CPB patients (16%).

Operative details

- mean CPB time for those undergoing a BDG procedure with CPB was 34.6±1.23minutes.Clamping of SVC associated with significant increase in central venous pressure in group B2 (P<0.001*). Group B1 had the best trans -cranial pressure as There was statistical significance in trans-cranial pressure in favors of group B1 (P0.005 <). Group A had significantly highest O2 (P < 0.001) ,but There was no statistical significance in oxygen saturation between group B1and group B2 , Group A had significantly highest O2 during clamping (P 0.001<) Group B1 better than group B2 significantly (P < 0.001) .Group B2 had significantly the longest clamp time (p=<0.001)

115patients had additional pulmonary blood flow from main PA (76.67%), 31patients had additional pulmonary blood flow from main PA plus PDA (20.67%), and 4 patients had NO additional pulmonary blood (2.67%). Pulmonary artery didn't need banding in 109 (72.67%) patients and in 24 patients (37%) had PA banding and in 4(2.67) patients totally occluded. All patients were hemodynamically stable with acceptable arterial

blood gas analyses on transfer to the pediatric intensive care unit postoperatively.

Postoperative Events

There was no statistical significance in ventilation time between the three groups. SVC pressure change significantly post extubation as There was statistical significance in SVC pressure before and after extubation in all groups (after extubation less than before extubation), there were no differences in oxygen saturation neither before nor after extubation between the three groups, but oxygen saturation was significantly higher before than after extubation in all groups .

ICU stay didn't differ significantly in 3 groups , Overall, the composite incidence of complication was 6 % (9 patients). The most common complication after BCPC procedure was chylothorax four (4) patients (3%), tow (2) patient in group A (4%) ,one patient in group B1(2%) and 1 in group B 2 (2%) Other noteworthy events included nuro-problem 3 patients (2%) all of them in group B2 , 2 patients (1.33%) were re explored for bleeding all in group A and those patient made a good recovery. There is a significant difference was found between CBP group and non CPB group in reoperation for bleeding p=0.044. High prevalence (6%) of occurrence of neurological events in group B2and it has statistically significance (P0.035), the occurrence of neurological events was associated with increased SVC pressure during the clamping (P 0.047), The occurrence of neurological events was associated with decreased trans-cranial pressure during the clamping, The occurrence of Chylothorax was associated with high pulmonary artery pressure during the clamping (P <0.001), The occurrence of chylothorax had no association with doing pulmonary artery banding nor leaving additional pulmonary artery

Hospital mortality is about 4% (6 patients), there were no deaths in group B1 (0%), the highest mortality rate 8 % (4 patients) in group A, and mortality rate in group B1was 4%, Mod of death in group A most probably due low cardiac output and heart failure but in group B1due to neurological events,

- Incremental risk factors for death

Gender wasn't a risk factor as there was no statistical significance in relation between mortality and sex of patients. Pulmonary artery wasn't a risk factor as there was no statistical significance in relation between mortality and doing pulmonary artery banding. Additional pulmonary blood flow wasn't a risk factor for death as there was no statistical significance in relation between mortality and leaving additional pulmonary blood flow. Occurrence of neurological events was a risk factor for death as there was statistical significance in relation between the mortality and occurrence neurological problems. Post-operative bleeding wasn't a risk factor for death as there was no statistical significance in relation between the mortality and occurrence of bleeding. Importantly no significant differences in postoperative events were observed between patients in either study group.

There was no statistical significance in hospital stay between the 3 groups

The postoperative course was uneventful in all other children after extubation. Post-procedure echocardiography demonstrated a functional Cavopulmonary anastomosis with no significant gradient across the anastomosis.

Before discharge all patients were assessed by echocardiography, O2 saturation, in all cases, the BCPC was widely open with laminar flow, good O2 saturation. Antiplatelet agent aspirin (25 to 50 mg days) was described for 3 months or longer after the operation , afterload reducing drugs according to post-operative ECHO and antiepileptic drugs was described to one patient from group B2.

Limitations:

In present study Performing CPC off pump or with pump technique was related to surgeon preference, also using venoatrial shunt or not.

The present study has select limitations and important clinical implications must be considered in any retrospective study design. First, the influence of patient selection bias as there is not randomization, and choice for the performance of a BDG procedure with or without CPB was according to preference of each surgeon and also uses of decompression shunt or not.

		Range			Mean	±	SD	ANOVA F	ANOVA P-value	TUKEY'S Test	
Age months	Group A	6.000	-	120.000	23.240	±	21.040			A&B1	0.972
	Group B1	7.000	-	126.000	24.060	±	20.017	0.424	0.655	A&B2	0.787
	Group B2	6.000	-	60.000	20.860	±	11.572			B1&B2	0.649
Wight Kg	Group A	6.000	-	30.000	10.700	±	5.936			A&B1	0.692
	Group B1	5.000	-	50.000	11.640	±	6.524	0.404	0.669	A&B2	0.745
	Group B2	5.000	-	23.000	11.540	±	4.612			B1&B2	0.996
Height Cm	Group A	60.000	-	107.000	78.080	±	9.812			A&B1	0.778
	Group B1	64.000	-	110.000	79.320	±	9.471	0.409	0.665	A&B2	0.981
	Group B2	65.000	-	98.000	77.740	±	8.223			B1&B2	0.666
SO2%	Group A	50.000	-	80.000	64.740	±	8.214			A&B1	0.648
	Group B1	50.000	-	80.000	63.440	±	6.917	3.032	0.051	A&B2	0.270
	Group B2	50.000	-	78.000	67.000	±	6.728			B1&B2	0.040

Table 1: Patient Characteristics and Perioperative Events among the sub groups

Perioperative variable		Overall (no=150)		Non CPB(B) [n=100]		CPB(A) [n=50]		
		NO. mean	% / SD	NO. mean	% / SD	NO. mean	% / SD	p
Sex	Male	89	59%	59	59%	30	60%	0.906
	Female	61	41%	41	41%	20	40%	
Age (months)		22.72	17.98	22.46	16.35	23.24	21.04	0.819
Weight(kg)		11.27	5.73	11.59	5.62	10.62	5.94	0.340
Height(cm)		78.38	9.16	78.53	8.86	78.08	9.81	0.785
Cardiopulmonary bypass time(min)		34.6	8.68	—	—	34.6	8.68	

Table 2: Patient Characteristics and Perioperative Events among the main groups

Age	Average	Normal average weight for age	Relation to normal percentile values weight (in Kg)at different age
7 Months	6.13	7.5 kg	Less than 5th percentile (underweight)
9 Months	7.50	8.250Kg	Less than 25th percentile (low normal)
10 Months	7.89	8.5Kg	Less than 10th percentile (low normal)
12 Months	8.20	9 Kg	Less than 25th percentile (low normal)

Table 3: Patients study population average weight at different age

Second the impact of changing practice patterns in three different places as they are differ in surgical and ICU protocols,

Changes in CPB pump and surgical technology as well as advances in anesthesia and postoperative management over time are also unable to be accounted for in these analyses.

Discussion

This study provides a recent analysis of early outcomes after BDG procedures for staged palliation of functional single-ventricle congenital heart defects and demonstrates the effect of performance of a BDG procedure without the use of CPB.

In present study although the youngest age of perform BCPC was 6 months [6-120 months in group A,7-126 months in group B1 , and 6-60 months in group B2] we are unable to assess the effect of young age on BCPC outcomes as the number of patients who had underwent BCPC at age 6 months is limited to only 2 children ,and only 8 patients at 7 months age.

But Young age at time of BCPC was found to be associated with increased morbidity following BCPC and with diminished survival in few series. (3)

Although In 1997, Reddy and colleagues reported operative mortality of 4.8%, a reoperation rate of 17%in 42 infants less than 6 months of age (19) , Jaquiss and coworkers laterin 2004 documented 0.0% operative morality, and median hospitalizations of 8.0day. (9)

In present study the weight of patients was less than average normal weight for age, e.g. The average weight in patients with 7 months age was 6.31Kg (range 5- 7Kg), and this is less than the normal average weight 7.5kg. The average normal weight for age is shown in table 3 and figure 1and 2

As Bahaaldin Alsoufia and colleague documented that Lower weight at time of BCPC reflects poor nutritional status and reduced growth at the interval between first palliation stage and BCPC(6), we need to pay attention to nutrition prior to BCPC to assure that those children are meeting their nutritional needs and achieving proper weight gain. For that purpose, preoperative hospital admission and feeding chart warranted and use feeding with nasogastric tube (Ryle) if needed

On the other hand, in report from Cincinnati, lower weight-for-age Z-score was an independent factor for longer hospital stay for BCPC. (1)

Patients' weight more than 10– kg was associated with good outcomes in the present study.

In general the results of the present study are comparable to the published series as the documented overall operative mortality of 4% which is high compared to Kogon and colleagues in 2008 who reported a 0.7% mortality rate (66) ,and in 2012

Damien and colleagues reported on their experience overall operative mortality of 0.9% (5) .

On the other hand composite complication rate was 6% in our study which is less than that reported by Kogon and colleagues in 2008 (27%) and that reported by Damien and colleagues in 2012 (16%).

Reoperation for bleeding rate was 1.3 %, less than the rate reported by Damien and colleagues in 2012 (1.9 %)

The median postoperative hospital length of stay 7 days, which is the same as reported by Damien and colleagues in2012 but more than that reported by Kogon and colleagues in 2008

Performance of a BCPC procedure with CPB has a well-established risk profile, including increased lung injury and consequent prolonged mechanical ventilation requirements, hemolysis, and increased costs. Prolonged CPB has been recently identified as an independent predictor of adverse outcomes after a BDG procedure. (5)

A number of adverse effects are associated with the use of cardiopulmonary bypass in children. (66) ,as There is an increase in capillary permeability that leads to an overall increase in total body water and edema formation.

Haemodilution occurs due to the large priming volumes of the cardiopulmonary bypass circuit as a result pulmonary compliance and gas transfer are decreased, and edema of myocardium which may result in diastolic dysfunction.

So efforts have to done to reduce the deleterious effects of post bypass capillary leak syndrome. (22)

This including optimizing bypass by reducing circuit volumes, perioperative anti-inflammatory and diuretic therapies, and the use of postoperative peritoneal dialysis. (22)

In present study 50 patients were done using CPB, with operative mortality 4 patients (8%), composite complication rate (8%), reoperation for bleeding 2 patients (4%) and they were due to accumulation of clots most probably due to effects of CPB on coagulation factors, 2 patients with chylothorax, this most probably due to elevated venous pressure but no neurological problems .

Performing MUF after cardiopulmonary bypass was related to surgeon preference, MUF was done in patient weight ≤ 8 Kg (22 patients of 50 patients in group A), (44 %) to eliminate the effects of CPB.

When we compare the results of those patients whom weight ≤ 8 Kg in group A (with MUF after CPB) and those in group B1 and group B2 .

We found that The least duration of postoperative ventilation was in group B1 (6.64±2.74 hours), then group Awas ((7.64 ±0.53 hours)and the longest was in the group B2(22.67±15.53 hours),

Intensive care unit length of stay was the least in group B1 (31.36±1.36 hours) then group A was (35.36±1.36 hours), and the longest in group B2which was (38.4±1.83 hours) and this confirms that doing the operation with temporary shunt is better .

In 1991, Naik and associates introduced the technique of modified ultrafiltration (MUF) as an alternative method to reduce the adverse effects of cardiopulmonary bypass in pediatric patients. (17)

The technique of MUF is performed after cardiopulmonary bypass is completed and allows ultrafiltration of both the patient and the remaining contents of the venous reservoir. In addition to plasma water, solutes less than 50 kilodaltons in size are removed, including a number of inflammatory mediators. (23)

Children after the repair of single-ventricle anomalies are particularly sensitive to elevations in pulmonary vascular resistance and decreases in pulmonary and ventricular compliance. (22)

Early studies with modified ultrafiltration reported decreases in the accumulation of total body water that occurs after cardiopulmonary bypass, reduced perioperative blood loss, and decreased blood use.(2) Later studies demonstrated improvements in myocardial function. (16) Post bypass pulmonary vascular resistance also appears to be reduced by using MUF. (6)

The outcomes after performance of a BCPC procedure without CPB are underreported.

In the present cohort of 100 patients who underwent non-CPB BDG procedures, 2 patients (2%) operative mortalities which is more than that documented by Hussain ST in 2007 (0%) .(7) .

Comparing the complications of non CPB group to that reported by Hussain ST in 2007 which was 0%complications, we had higher morbidity (5%)

Mean intensive care unit length of stay was (32.84±21.58 hour) which is less than that reported by Hussain ST 1.27 0.45 days.(49).

The performance of the BCPC without the use of CPB has been described using several different approaches. Jahangiri and colleagues have described a non-CPB approach without the use of temporary shunts. (8)

A fundamental problem with this technique is that it puts the brain at risk, and yet the safety of the method in adequately protecting the brain is not documented. (18)

Off-pump BDG shunts done without a proximal decompressing shunt can cause significant elevation of the proximal SVC pressure, decreased cerebral blood flow, and neurological damage. (14) Off-pump BDG shunt without a proximal decompressing shunt was done in50 patients and

this group operative mortality was (2 patients) (4%) due to neurological neurological problems.

Neurological problems were occur in (3 patients)(6%) mostly due to elevated SVC pressure as mean SVC pressure during construction of the anastomosis was 49 ±5.75mm Hg (range 35–60mm Hg). Comparing the three groups of patients included in this study we found that there was statistical significance in occurrence of neurological problems in patients of group B2 (P0.035)

In attempts to find the cause we used multivariable analysis of the results and we found that there was statistical significance in relation of the occurrence of neurological complications and increased SVC pressure during clamping of SVC (P 0.047) ,and There was statistical significance in relation of occurrence of neurological complications and decreased transcranial pressure (P0.047)

Occurrence neurological problems was the cause of mortality in group B2 as there was statistical significance in relation between it and the mortality and (P 0.002)

Although transcranial pressure in this group of patients was (51.9±13.2mmHg) which is higher than the minimum that recommended by Jahangiri and colleagues neurological problems occurred.

Jahangiri and colleagues reported the feasibility of an unassisted off pump BDG operation without any neurologic deficits, by maintaining cerebral perfusion (trans-cranial pressure), defined as the difference between the systolic arterial pressure and the mean jugular venous pressure, at a minimum of 30mmHg. Whether such a strategy protects the cerebrum is still debated. With increasing SVC pressure on clamping, one study showed significantly decreased oxyhemoglobin in brain tissue by near infrared spectroscopy, and others showed a 50% reduction in blood flow velocity in the middle cerebral artery with significant electroencephalogram changes (14)

In a series of 7 patients undergoing non-CPB BDG procedures without decompression shunts, Jahangiri and associates argued that a temporary shunt may not be needed with cerebral perfusion pressures maintained at greater than or equal to 30 mm Hg through augmentation of systemic blood pressure using dopamine or alpha-agonist infusions, or both. Such reports have documented no significant differences in neurologic sequelae after clamping the SVC without the use of a proximal shunt.(8)

Also it has been shown to result in significant electroencephalographic changes during SVC clamping. (21)

Jinfen Liuand and coworker, using near-infrared spectroscopy, observed that the oxyhemoglobin in brain tissue decreased significantly as SVC pressure increased during clamping of the SVC. (10) The oxyhemoglobin in brain tissue recovers to the preclamping level soon after the SVC was opened, and it improved continually as the So2 increased. (10)

BCPC without CPB is reasonable if SVC pressure is less than 30 mm Hg and clamping time less than 30 minutes. (10)

In this study in group B2 SVC pressure was (35-60 mmHg) and clamping time was (15- 35 minutes)

The temporary use of a venoatrial shunt between the SVC and right atrium allowed for the avoidance of CPB support, it originally described by Lamberti and colleagues in 1990. (13)

A suitable size cannula is needed to avoid higher SVC pressure, and the clamping time should be kept as brief as possible. (10)

In present study venoatrial shunts were used in 50 patients underwent non-CPB BDG procedures in an attempt to protect the brain from high upper body venous pressures, resulting in the absence of any persistent neurologic deficits (0.0%), no operative mortality (0%), the same as reported by Damien and colleagues in 2012 and there is no phernic nerve injury (0.0 %) nor reoperation for bleeding (0.0%) which are better than what reported by the same author 8.8%phernic nerve injury ,2.9% reoperation for bleeding.

The median total hospital stay 6.34 days which is less than what reported by Damien and colleagues in 2012 (9 days).

Comparing the three groups of the study this group (group B1) has the shortest time of ventilation (6.26±0.24 hour (range 3-10 hour), the shortest ICU stay 28.78±0.64 hour (range 20–30hour),), and shortest hospital stay 6.34±0.8days (range 5-7days).

In the present series, the presence of a preexisting of adequate forward pulmonary artery flow (58%) was the most common surgical condition allowing the performance of non-CPB BDG procedures, followed by the presence of adequate forward pulmonary artery flow and large PDA (40%) followed by the presence of large PDA(2%).

Additional pulmonary blood flow was left in 146 patients (97%) in our series: antegrade from the main PA in 115 patients (77%) and antegrade from the main PA plus retrograde through an open large PDA in 31 patients (21%). No Additional pulmonary blood flow was left in 4 patients (3%), main pulmonary artery ligated to adjust the pulmonary artery pressure ≤18 mmHg.

In those 4 patients we simply ligate the main pulmonary artery and we have not seen any residual antegrade blood flow through the pulmonary artery or thrombus formation after simple ligation of the main pulmonary artery although division of the pulmonary artery and over sewing of the stump is recommended.

According to the results, additional pulmonary blood flow was not found to affect early outcome as there was no difference detected in occurrence of chylothorax nor mortality.

It is important to note that in the present study, the pulmonary trunk and PDA were the main source of antegrade blood flow.

In present study the decision whether to leave antegrade flow was based on intraoperative pressure measurements and was considered favorably when the pulmonary artery pressure was ≤18 mm and SO280%-90% Hg with inspired oxygen fraction of 0.5 , and we continue monitoring of the pulmonary artery pressure in the intensive care unit during the mechanical ventilation and after extubation .

Leaving additional source of pulmonary blood flow at time of BCPC may have the advantage of allowing more PA growth, supplying hepatic factor to the lungs and thus preventing arteriovenous fistula formation, facilitating future catheterization by providing access to the PA, and finally allowing a delay of Fontan by providing better oxygenation. (15)

On the other hand, disadvantages include the potential increase in volume load on SV, higher central venous pressure with subsequent facial swelling and pleural effusions, ineffective increase in oxygenation due to the high O2 concentration in the blood coming from SV, complicating future Fontan surgery and possibly increasing mortality in some reports .(15)

Using a different criterion, Chang and colleagues based their decision to leave antegrade pulmonary blood flow when arterial blood saturation was lower than 70%. (4)

The potential for growth of the pulmonary arteries after BCPA still remains controversial. (11)

Although Mendelsohn and colleagues questioned the adequacy of pulmonary artery growth after BCPA, (86)Reddy and associates demonstrated that pulmonary artery growth was not reduced after BCPA. (20)

A significant increase in the size of the pulmonary arteries in patients with antegrade blood flow, based on angiographic indexes obtained before and after surgery, without adverse increase in the pulmonary artery pressure or pulmonary vascular resistance. (11)

The pulsatile flow may promote development of the pulmonary arteries especially when they are small. (11)

The exclusion of all other sources of pulmonary blood flow at the time of BCPA is aimed to volume unload the single ventricle, improve function of the ventricle, and reduce the degree of atrioventricular regurgitation. (4)

Conclusion

Comparing the results from the present study , the off pump group with venoatrial shunt showed the best postoperative results in terms of shortest duration of ventilator support, less incidence of complications , no neurological complication shortest ICU stay and shortest hospital stay.

Performing the CPC with off-pump technique offers more benefits than with CPB as Cost saving is increasingly become important in global medicine. Constructing of CPC with off pump technique with venoatrial shunt method reduces operative costs by avoiding CPB disposables and blood products.

Doing non-CPB BCPC procedures without decompression shunts associated with increase in neurological complications and mortality.

The venoatrial shunt-assisted off-pump bidirectional cavopulmonary shunt operation can be performed in selected patients safely by optimizing intraoperative management strategies, and keeping clamping time as brief as possible. This avoids CPB and related complications, also avoid complications of increase intracranial pressure associated with off –pump and no venoatrial shunt and economically this technique is reproducible and has the best results.

The present study has select limitations and important clinical implications must be considered in any retrospective study design. First, the influence of patient selection bias as there is not randomization , and choice for the performance of a BDG procedure with or without CPB was according to preference of each surgeon and also uses of decompression shunt or not .

Second the impact of changing practice patterns in three different places as they are differ in surgical and ICU protocols, most NHI sturgeon prefer doing CPB assisted CPC and doing MUF in patients weighting ≤8 Kg and in few selected cases doing off pump without venoatrial shunt and ICU protocol in favor early extubation(3 hours in heamodynamicaly stable patients), in EL-demerdash hospital CPC mostly done without CPB as long as no need for opening of the heart and this trend also in Misir children hospital and ICU protocol in favor late extubation (6 hours in heamodynamicaly stable patients).

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Repair of Aortic Coarctation With Hypoplastic Distal Aortic Arch in Neonates and Infants

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Background: **The surgical repair of aortic coarctation with hypoplastic distal aortic arch has evolved over time. Some changes came from technique refinements and anatomical variations while other changes came from high rate of residual, recurrence or other complications. In this study, we report & compare our experience with two types of repair of simple aortic coarctation with hypoplastic distal aortic arch without prosthetic material to enlarge all areas of distal aortic arch in neonates and infants.**

Methods: **From March 2011 to March 2014, 34 patients with simple aortic coarctation and hypoplastic distal aortic arch underwent repair using one of two types of repair; 18 patients underwent radically extended end-to-end anastomosis & 16 patients underwent combined reversed subclavian flap and extended end-to-end anastomosis. The study was done at Abu El-Rish children hospital. All patients were consented for the purpose of the study. We assessed both groups preoperatively to make sure that they were comparable groups. Operative and postoperative data were collected to evaluate & compare between these two types of repair with emphasis on mortality, residual gradients & postoperative morbidities & complications.**

Results: **There was no statistically significant difference in preoperatively demographic data and clinical characteristics of the patients in both groups. All the patients completed the study. There was no operative mortality difference between the two types of repair. Residual gradients were as follows: 14 patients had no residual gradient, 16 patients had low residual gradient (< 20 mmHg) and 4 patients had gradients between 20 and 30 mmHg. Residual gradients between 2 types of repair didn't reach statistical significance. However morbidity incidence of left lung collapse requiring intensive chest physiotherapy, reintubation and prolonged I.C.U. and hospital stay were more common in patients treated with radically extended end-to-end anastomosis than combined reversed subclavian flap and extended end-to-end anastomosis. There was no paraplegia, recurrent laryngeal nerve injury, Horner's syndrome, phrenic nerve injury or stroke. There were no left arm ischemia, hemorrhage, aneurysm, chylothorax or paradoxical hypertension.**

Conclusion: **Combined reversed subclavian flap and extended end-to-end anastomosis is preferable over radically extended end-to-end anastomosis to reduce pulmonary complication incidence in repair of simple aortic coarctation with hypoplastic distal aortic arch in neonates and infants. Both techniques have comparable mortality rates & residual gradients but radically extended end-to-end anastomosis had higher incidence of pulmonary complications than combined reversed subclavian flap and extended end-to-end anastomosis. Other complications were equal.**

Keywords: **Hypoplastic aortic arch repair, Coarctation of aorta repair.**

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Surgical repair of aortic coarctation has been available since 1944, but the surgical approach has changed over time (1-4). Some changes came from technique refinements and anatomical variations while other changes came from high rate of residual, recurrence or other complications (5-7). Overtime there has been a move toward repair in infancy which has decreased the

risk of long term hypertension and its associated cardiovascular risks but increased the risk of recoarctation and reintervention (8-13).

The incidence of simple coarctation with distal aortic arch hypoplasia is high especially in neonates and infants. Repair of coarctation with distal aortic arch hypoplasia is technically more difficult.

Currently at our institution, the approach to repair of such lesion is through a lateral thoracotomy and entails either radically extended end to end anastomosis or combined reversed subclavian flap and extended end to end anastomosis.

The purpose of this study is to compare the outcome of radically extended end to end anastomosis and combined reversed subclavian flap & extended end to end anastomosis in repair of simple coarctation with distal aortic arch hypoplasia in neonates & infants.

We hypothesized that both these surgical technique in neonates and infants

1) Has low & comparable mortality,

2) Has low & comparable residual gradients,

3) Has low & comparable other complication rates.

Patients & Methods

This was a comparative prospective clinical trial of 34 neonates and infants with simple aortic coarctation with hypoplastic distal aortic arch who underwent repair **at** Abu El-Rish Children Hospital Aff./ Kasr El-Aini Hospital during 3 year period from March, 2011 to March, 2014. Patients were randomly divided into two groups according to type of repair used by surgeons into Group "A", included 18 patients underwent radically extended end-to-end anastomosis and Group "B", included 16 patients underwent combined reversed subclavian flap and extended end-to-end anastomosis. All patients were consented for the purpose of the study and underwent repair operation. This study compared between outcome of two types of repair with emphasis on mortality, residual gradients & postoperative morbidities & complications.

Inclusion criteria for the study included neonates or infants with simple aortic coarctation with aortic arch hypoplasia distal to left common carotid artery and isthmus hypoplasia (long segment coarctation). Patients older than 1 year, with simple aortic coarctation without distal aortic arch hypoplasia, with complex coarctation with associated cardiac anomalies, with aortic arch hypoplasia proximal to left common carotid artery (proximal arch hypoplasia) or with simultaneous repair of other significant associated lesions were all excluded from the study.

Demographic, echocardiogram, multislice computerized tomography, operative note, perioperative hemodynamics and complications data were extracted from patient's charts. There was no dropouts and the collected data was statistically applied & entered to MedCalc software programs to get the final results.

All patients presented with history of congestive heart failure or failure to thrive preoperatively. Patients were put on antifailure medications before being taken to the operating room. The operation was usually performed within days after establishment of the diagnosis regardless of the patient's age.

All patients were investigated preoperatively using routine labs (complete blood count, kidney function test, liver function test & coagulation profile), chest X-ray, echocardiography & multislice computerized tomography. All patients were investigated postoperatively using echocardiography before hospital discharge.

Anaesthesia technique :- Anesthesia was conducted using Mindray A5 anesthesia machine, (Mindray, Shenzhen, China) and GE monitor (Dash 5000), (GE healthcare, Little Chalfont, UK). All monitors were applied including ECG, pulse oximetry, and noninvasive BP. Following induction and after obtaining muscle relaxation, ETT was inserted and properly fixed with an adhesive tape. Single lung ventilation was not undertaken. A central venous catheter was inserted and fixed. Invasive arterial lines were inserted in right upper limb in all patients except 2 who had noninvasive blood pressure cuff & pulse oximetry on right upper limb and 10 patients had femoral arteries in addition. Nasopharyngeal temperature probe was inserted. The patients were positioned in the lateral decubitus with the left side up with an axillary roll underneath the right axilla and after positioning, the ETT position was rechecked for equal breath sounds and all monitors were secured again. During anesthesia induction and the dissection of the aorta, the patients were allowed to passively surface cool to approximately 35°C to lessen the risk of postoperative paralysis. A heparin dose of 100 units/kg was given before clamping aorta. During aortic cross - clamp time, high proximal aortic pressure and distal aortic pressure >30 mmHg were maintained using volume expanders and inotropes. Nitroglycrin or sodium nitroprusside were used to control excessively high pressures.

Surgical Technique:- The coarctation repair was approached through a serratus-sparing, left posterolateral thoracotomy through the third or fourth interspace. The lung was retracted anteriorly and inferiorly. The dissection was begun by incising the pleura overlying the aorta in the region of the coarctation. The pleural opening was extended up the left subclavian and down to the mid-descending aorta. Care was taken to identify and preserve the vagus and phrenic nerves. The aorta was then mobilized from the mid-transverse aortic arch to the mid-descending aorta, as were the left subclavian and common carotid arteries. Collaterals and other branches from the aorta were preserved as were feasible. Heparin given.

Radically extended end to end anastomosis:- Division of the ductus or ligamentum with preservation of the recurrent

laryngeal nerve can facilitate the exposure. Control of the proximal aorta was accomplished tangentially (using a Castenida side bitting clamp) just proximal to the left carotid artery, thereby maximizing exposure to the underside of the arch. The left carotid artery can either be controlled in the same clamp or a clip was applied with a handheld instrument to temporarily clamp it separately. The descending aorta was controlled distal to the coarctation (using a right angle vascular clamp) usually at the level of T4. If an intercostal artery was not included in the clamp, it was temporarily occluded by gently applying a clip. The coarctation was resected including all ductal tissue. (The entire area from the left subclavian artery to an area of normal proximal descending aorta was resected). The incision was prolonged underneath the aortic arch up to the proximal clamp (the incision usually reached the aorta underneath the left common carotid artery). The descending aorta was fashioned to fit the aortic arch opening, with an incision on the lateral part of the aorta. Extended end-to-end anastomosis using a beveled tension-free anastomosis of the proximal descending aorta to the underside of the arch was accomplished without prosthetic material. The anastomosis was accomplished using continous running 6/0 or 7/0 prolene suture and suture ends were tied. The anastomosis was flushed by declamping distal clamp and circulation was gradually restored by declamping proximal clamp but leaving clamps in place. Protamine given and haemostasis was ensured.

Reversed subclavian flap & extended end to end anastomosis: Control of the proximal aorta was accomplished tangentially (using a Castenida side bitting clamp) just proximal to the left carotid artery. The left carotid artery can either be controlled in the same clamp or a clip was applied with a handheld instrument to temporarily clamp it separately. The descending aorta was controlled proximal to the coarctation leaving patent ductus arteriosus supplying lower body. The left subclavian artery controlled distally at vertebral branch site occluding it separately to avoid subclavian steel and divided. The left subclavian artery incised longitudinally continous with roof of aortic arch to left common carotid artery ostium & patch enlarging distal aortic arch using continous running 6/0 or 7/0 prolene suture. Distal aortic control released, haemostasis ensured then proximal clamp released. Reperfusion allowed for 5 min. then clamps reapplied. Division of the ductus or ligamentum with preservation of the recurrent laryngeal nerve can facilitate the exposure. Control of the proximal aorta was accomplished tangentially (using a Castenida side bitting clamp) just distal to the left carotid artery, thereby maximizing exposure to the underside of the arch. The descending aorta was controlled distal to the coarctation (using a right angle vascular clamp) usually at the level of T4. If an intercostal artery was not included in the clamp, it was temporarily occluded by gently applying a clip. The coarctation was resected including all ductal tissue. The incision was prolonged underneath the aortic arch up to the proximal clamp (the incision usually reached the aorta underneath the left subclavian artery). The descending aorta was fashioned to fit the aortic arch opening, with an incision on the lateral part of the aorta. Extended end-to-end anastomosis using a beveled tension-free anastomosis of the proximal descending aorta to the underside of the arch was accomplished without prosthetic material. The anastomosis was accomplished using continous running 6/0 or 7/0 prolene suture and suture ends were tied. The anastomosis was flushed by declamping distal clamp and circulation was gradually restored by declamping proximal clamp but leaving clamps in place. Protamine given.and haemostasis was ensured.

The anatomy of the aortic arch and descending thoracic aorta was inspected for any residual narrow segment. Pressure gradient between radial and femoral arterial lines assessed in10 patients with femoral arterial lines.

Statistical analysis :- Data was collected, verified and edited on a personal computer, then analyzed by MedCalc software program to get the final results. These results will be presented in tables & chart accordingly. The following tests were used:

Quantitative uniform and Qualitative ordinal data were presented as means ± standard deviation.

Quantitative nonuniform data were presented as median ± range.

Qualitative nominal data were presented in terms frequencies and relative frequencies.

Quantitative uniform and Qualitative ordinal data were analysed by student's t test or the Mann–Whitney U test.

Quantitative nonuniform data were analysed by Wilcoxon test.

Qualitative nominal data were analysed by Yates corrected Chi square (c^2) test or Fisher exact test.

A probability value less than 0.05 was considered statistically significant.

Results

The study was conducted on 34 patients with isolated coarctation of the aorta and distal aortic arch hypoplasia who underwent repair at less than 1 year of age. Patients were divided into two groups according to type of repair they underwent; group A & group B. (Table 1).

Group A	Group B
18/34 (52.9%)	16/34 (47.1%)

Table 1: Groups data: expressed as number (percentage).

Group A: Underwent radically extended end-to-end anastomosis;

Group B: Underwent reversed subclavian flap and extended end-to-end anastomosis.

Preoperative data

All demographic data were comparable between both groups. (Table2).

	Group A N = 18	Group B N = 16
Age (in days)	22.1 ± 31.43	23.2 ± 38.74
Weight (in kilograms)	3.5± 2.61	3.7±2.66
Gender male/female	10/8	8/8

Table 2: Demographic data: expressed as mean ± S.D., ratio.

Group A: Underwent radically extended end-to-end anastomosis;

Group B: Underwent reversed subclavian flap and extended end-to-end anastomosis.

Routine labs were all normal for age in all patients. All patients had pulmonary congestion & mild cardiomegally on chest X-ray and left ventricle strain pattern on electrocardiogram. Echocardiography was diagnostic in 32 out 34 patients with mean pressure gradient 55mmHg (range 40-65 mmHg) with no statistical significant difference between 2 groups.

Operative data :

Preoperative arm leg pressure gradient correlated well with echo gradient +/- 10 mmHg. in 10 patients who had femoral arterial line. All operative data were comparable between both groups. (Table 3).

	Group A N = 18	Group B N = 16
First aortic cross clamp time (minutes).	17 (10 to 25).	15 (7 to 20).
Second aortic cross clamp time (minutes).		15 (10-20)

Table 3: Operative data: expressed as mean (range).

Group A: Underwent radically extended end-to-end anastomosis;

Group B: Underwent reversed subclavian flap and extended end-to-end anastomosis.

Postoperative, all patients who had femoral arterial lines had arm leg pressure gradient < 20 mm Hg.

Postoperative data :

There was no perioperative death, and thus 0% early mortality. One patient underwent exploration for postoperative bleeding. There were no paraplegia, recurrent laryngeal nerve injury, Horner's syndrome, phrenic nerve injury or stroke. No patients had chylothorax, mesenteric arteritis or persistent or paradoxical hypertension. No left arm ischemia was reported. There was no difference between the groups in the incidence of complications.

At the time of discharge, 14 patients (41%) had no residual coarctation gradients, 16 patients (47%) had low residual coarctation gradients < 20 mm Hg and 4 patients (12%) had residual coarctation gradients >20 mmHg on echocardiogram with no statistical significant difference between 2 groups.

All patients were extubated within 24 hours of the procedure with no statistically significant difference between groups. Median ventilation time in Group A was 16 hours and range from 4-24 hours and in Group B was 15 hours and range from 4-20 hours.

Group A had statistically significant higher incidence of left lung collapse (Group A 10 patients & Group B 2 patients) documented clinically by diminished air entry on left lung & by chest X-ray (P value < 0.05). Group A had also statistically significant higher incidence of reintubation (Group A 5 patients & Group B non) (P value < 0.05). Patient in group A stayed in ICU & hospital longer. Median ICU stay for Group A was 10 days and ranged from 6-20 days and for Group B was 5days and ranged from 3-10 days. Median hospital stay for Group A was 14 days and ranged from 10-25 days and for Group B 8 days and ranged from 6-15 days (P value < 0.05).

Comments (Discusion)

Our results add to the growing body of literature supporting resection and extended end-to-end anastomosis as the optimal surgical approach to isolated aortic coarctation in the neonates and infant. This technique allows for wide excision of ductal tissue, and the beveled anastomosis addresses tubular hypoplasia of isthmus of the arch and diminishes the likelihood of circumferential suture line scarring. The results presented here support a tailored approach in selected neonates and infants with distal arch hypoplasia (not just isthmus hypoplasia) that add s reversed subclavian flap to extended end to end anastomosis vs radically extended end to end anastomosis. Mortality & morbidity rates were equal between both groups except for incidence of left lung collapse with its associated morbidities of reintubation, and longer ICU and hospital stay which was higher in radically extended end to end anastomosis. This complication may be related to tension on left main bronchus under aortic arch which is more in radically extended end to end anastomosis compared to reversed subclavian flap and extended end to end anastomosis. This tension is due to shortening distance between ascending & descending aorta & lowering aortic arch more in radically extended end to

end anastomosis compared to reversed subclavian flap and extended end to end anastomosis. Also reversed subclavian flap also add diameter to roof of aortic arch not just floor.

During these 3 years, 34 patients with isolated coarctation of the aorta with distal aortic arch hypoplasia underwent repair at less than 1 year of age through radically extended end-to-end anastomosis or reversed subclavian flap & extended end-to-end anastomosis procedures at our institution. Patients with other associated lesions that would requireadditional procedures were excluded, since the intent of the study was to focus solely on isolated aortic coarctation. All patients were repaired through a lateral thoracotomy. Mortality and morbidity were low, as they are with all techniques in patients with isolated coarctation. Note, 4 of these 34 patients had residual arch gradients of 20 mmHg or greater at hospital discharge.

The presence of a residual aortic arch gradient of 20 mmHg or greater at hospital discharge warrants particular attention. Although these numbers are too small for valid statistical analyses, a similar finding was noted in another recent study of extended arch aortoplasty in infants [14]. In that report, all 4 patients who required reintervention had some residual gradient at discharge. When reintervention was needed it occurred within the first 7 months after initial repair.

For patients with isolated aortic coarctation, the move toward repair in infancy has been driven by the finding that patients repaired at earlier ages had lower risk of long-term hypertension [8–10]. Our findings appear consistent with this goal in that no patient was on antihypertensive medication at discharge. However, it remains to be seen whether this will be the case as these children age. In a study of long-term complications in patients who underwent coarctation surgery at later ages, Toro-Salazar and colleagues [15] noted a correlation between elevations in right arm blood pressure at the 6-week postoperative follow-up visit and later development of hypertension. In our group of infants, all patients went home on no antihypertensive medications. Determining whether this subset of the patients is at increased risk of hypertension in adulthood will require further long-term investigation.

Our review demonstrates that surgical repair for aortic coarctation using resection and extended end-to-end anastomosis alone or combined with reversed subclavian flap has a low rate of residual and recurrent coarctation even in neonates and infants. There has been continued debate about the preferred technique of surgical repair in infants, particularly with respect to addressing aortic arch hypoplasia. Some institutions have had excellent results with the end-to-side anastomosis with a 4% reintervention rate at 2-year follow-up [16, 17]. Other authors have reported recurrence rates ranging from 2% to 24% with extended end-to-end anastomosis without prosthetic material [4, 14,18–27]. In 1993, Zannini and associates [21] described 32 patients less than 3 months old repaired by this technique with a recurrence rate of 13%. Van Heurn and colleagues [22] reported a 17% recurrence rate at 4 years using resection and extended end-to-end anastomosis in 77 infants. In 1995, Conte and coworkers [23] reported a 9.8% recurrence rate at 5-year follow-up in neonates, including 95 patients with isolated coarctation. Recently, Wood and colleagues [14] and Pearl and colleagues [27] reported recurrence rates of 2% in infants repaired through lateral thoracotomy.

Like other contemporary studies, this study is limited by the duration of follow-up available thus far. Based on the history of surgical repair of aortic coarctation, caution is warranted until this approach has stood the test of time. Although these short term results are very promising, it will be important to compare recurrence rates at 15 years or longer. A small number of adverse outcomes within this group would significantly alter these results. Because we focused solely on neonates & infants with isolated aortic coarctation, the findings of this study may not be generalizable to those with associated lesions. This narrow focus was intentionally selected, however, as there is continued debate about the optimal management of even this most straightforward group of patients.

In summary, both these surgical technique (radically extended end-to-end anastomosis vs reversed subclavian flap and extended end to end anastomosis) in neonates and infants with isolated aortic coarctation and hypoplastic distal aortic arch has low & comparable mortality, has low & comparable residual gradients and has low & comparable other complication rates except for left lung collapse with its associated morbidities which was higher in patients with radically extended end-to-end anastomosis than reversed subclavian flap and extended end to end anastomosis.

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Emergency Repair of Trahceo-Bronchial Injuries

Thoracic

Sameh Mostafa Amer

Background: **There is an increasing number of alive patients reaching emergency department with tracheobronchial injuries due to an increase incidence of motor car accidents and improvement of the techniques of transporting injured patients.**

Objectives: **We reviewed our experience to evaluate our results to determine how to give better attention that facilitates correct management aiming at decreasing surgical mortality and morbidity.**

Patients and methods: **We reviewed the data of (41) patients from January 2005 to December 2007 who were operated up on emergency basis on Cardiothoracic Surgery Department (Mansoura University Hospital) for acute tracheobronchial injuries.**

Results: **The mean age of the patients was (23.4±8.2) years ± SD, 29 (70.7%) were males and 12 (29.3%) were female .Of 41 cases, 38 (92.7%) had blunt trauma and 3 (7.3%) penetrating trauma. The most common initial manifestation was subcutaneous emphysema in (95%) and dyspnea in (93%) of the patients. Thoracic (34%) and orthopedic injuries (7.3%) were the most associated injuries and rigid bronchoscope was the corner stone in diagnosis and was made in 38 (92.3%) of the cases. Repair was done via a right thoracotomy in 28 (68.2%), through left thoracotomy in 10(24.4%) and cervical approach for tracheal injuries in 3 (7.3%) of the cases. Direct suturing was done in 38 (92.5%) patients including resection of destroyed 2 tracheal ring and reanastomosis, while lobectomy was carried out in 2 (4.8%) of the cases. Surgical morbidity was 14.5% while mortality was 7.3%, there were associated injuries in 100% of mortality cases who were presented after longer latent period following trauma compared with the survivors. On follow up bronchial granuloma developed in 3 out of 38 patients (7.8%) which was removed by bronchoscope, bronchial stenosis occurred in two cases (5.2%) which was successfully dilated with periodic bronchoscopy in one case (2.6%) and failed in the other one who was underwent for pulmonary resection.**

Conclusion: **In our study, we found that tracheobronchial injuries gave non specific clinical manifestations, bronchoscopy was the corner stone in the diagnosis. Repair could be done in the majority of the cases with accepted surgical outcome compared with other reports. Associated injuries and delayed intervention were important mortality factors.**

KEY WORD: **Tracheo-bronchial injuries, air way injuries, repair of tracheobronchial injuries.**

Tracheobronchial injuries (TBI) are rare but potentially fatal, resulting from blunt or penetrating chest or neck trauma [1]. During recent decades an increase in motor car accident has caused an increase in blunt TBI [2]. Although emergency service and transport techniques have improved yet between 30% to 80% of patients with such injuries die before arrival to hospital [3]. A high level of suspicion and liberal use of bronchoscopy are important in the diagnosis of TBI [4], early diagnosis is essential for proper life saving management [5].

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Patients and Methods

This retrospective study revised data of patients surgically treated in Mansoura Emergency Hospital of (Cardiothoracic Surgery Department) from January 2005 to December 2012. We dealt with 41 tracheobronchial injured patients who were presented to us at a delay time of 6.8±1.2 h following injuries. They presented to the emergency department and were in need for emergency repair (must be performed without delay and as soon as a surgeon is available [6]. On arrival at hospital with clinically suspected tracheobronchial injury by presence of one or more of clinical presentations as, subcutaneous emphysema, mediastinal emphysema, pneumothorax, haemptysis or dyspnea, a patent air way and vascular access were established quickly and the patients were clinically stabilized.

Chest x-ray was rapidly performed, when there was continuous air leak with failure of lung expansion, progressive surgical emphysema and increasing mediastinal emphysema on subsequent radiographic examination, the patient was transported to operating room and rigid bronchoscopy was carried out. The patient was immediately prepared for thoracotomy if there was: long tear more than 3 cm, avulsed of a bronchus or bleeding and/or blood clots obscuring the bronchoscopic view. In stable patients with acute presentation, computed tomography was done in addition, patients with penetrating cervical tracheal injuries were transported to operating theatre - after medical stabilization was carried out rapidly - and the repair was done without bronchoscopic evaluation as wound was in view.

5 (12.1%) patients arrived with severe respiratory distress and were intubated to control air way prior to intervention.

All patients underwent surgical repair at a mean time of (1.4±0.8) hour from arrival to the emergency department.

After endotracheal intubation, surgical approaches were done according to the location of the injury, when the tear became in field the surgeon guided the endotracheal tube into the healthy air way to prevent anesthetic gas leakage, we applied shunt ventilation technique using a sterile endotracheal tube passed via the surgical field to ventilate the distal segment when indicated.

After opening the mediastinal pleura with limited dissection to maintain adequate blood supply, direct suture closure was done using interrupted 3/0 or 4/0 polyglacin (vicryl) or polypropylene (prolene) sutures in 38 (92.5%) patients, 3 patients were in need for pulmonary resection due to severely damaged bronchus associated with destroyed lung parenchyma, had right upper lobectomy and 2 had left lower lobectomy.

Among the repaired group one (2.4 %) patient required resection of 2 tracheal rings followed by end to end anastomosis (fractured 2 tracheal rings due to blunt trauma). Cervical trachea was approached via cervical collar in 2 (%) patients and through the traumatic wound in one (2.4 %) patient. In the patient with transsection of the trachea due to knife injury there was a tear in the anterior wall of cervical oesophagus which was repaired followed by tracheal repair with separate stitches then interposing of the sternolyoid muscle flab between 2 suture lines .

After testing the suture line, the thoracotomy was closed leaving 2 inter costal tubes for drainage. Extubation on table was possible in 36 (87.9%) of the patients.

All patients were evaluated by chest x-ray and rigid bronchoscopy on early postoperative days to evaluation suture line and to remove secretions. Also re-evaluation was done at 1 and 6 months postoperatively to detect granuloma or stenotic scarring when indicated which were managed accordingly.

Results

The patients characteristics and mechanism of injury are illustrated in table (1)

Item	Finding (No. 41)
Mean age (year ± SD)	23.4±8.2
Gender:	
Male	29 (70.7%)
Female	12 (29.3%)
Mechanism of injury: ***Blunt*** *92.7% (38/41)*	All affected bronchi except one patient had thoracic tracheal injury with destroyed 2 tracheal rings
Motor car accident	25 (61.1%)
Falling from height	7 (17%)
Crush injury	6 (14.6%)
Penetrating *7.3% (3/41)*	All involved cervical trachea
Knife (1)	Anterior circumferencial cut with stab in the posterior tracheal wall reaching anterior oesophageal wall
Metal wire (1)	Anterior gap in anterior tracheal wall
Gun shot (1)	Tangential from right to left through anterior tracheal wall without associated injuries, the shot was seated in the left infraclavicular region.

Table 1. Patients characteristic and mechanism of injuries

Findings	No. (41)	%
Subcutaneous emphysema	39	95.1
Pneumothorax	20	49
Dyspnea	38	93
Mediastinal emphysema	8	20
Haemptysis	6	15
Haemothorax	5	12

N.B: *More than one finding may be present in the same patient.*

Table 2. Shows clinical presentation of all patients

injury	No. (41)	%
Thoracic:	16	34
Multiple fracture ribs	12	29
Lung injury	3	7.3
Esophageal injury	1	2.4
Extrathoracic:	8	19.5
Orthopedic	3	7.3
Head trauma	2	4.8
Maxillofacial	1	2.4
Abdominal	2	4.8

N.B: *more the one injury may be present in the same patient.*

Table 3. Shows associated injuries in all patients

Bronchoscopic finding	Surgical management		
	Approach	Finding	Procedure
Bronchial injuries: **37/41(90.2%)**			
RMB 21 (51.3%)	Right thoracotomy		All were repaired except 3 cases:
Longitudinal tear	9 (22.1%)	Longitudinal tear	2(4.8%) had LLL
Blood obscuring the field	12 (29.2%)	Avulsion	1(2.4%) had RUL
LMB 10 (24.4%)			
Longitudinal tear	7(17.1%)Lt.thoracotomy	Longitudinal tear	
Avulsion of bronchus	3(7.3%)Rt.thoracotomy	Avulsion	
LLLB 3 (7.3%)			
Blood obscuring the field	3(7.3%)Lt.thoracotomy	Avulsion	
RULB 3 (7.3%)	3(7.3%)Lt.thoracotomy	Avulsion	
Avulsion			
Tracheal injuries: 4/41(9.8%)			
Cervical trachea 3 (7.3%)	collar cervical incision 2 (4.8%)	Destroyed Two	Primary repair+ repair of
Bronchoscope was not done	Through the wound 1 (2.4%)	tracheal rings	concomitant esophageal tear
Thoracic trachea 1 (2.4%)			
Bronchoscope revealed hematoma and destroyed two rings	Right thoracotomy1 (2.4%)		Resection of the destroyed two tracheal rings then repair

N.B: *RMB= right main bronchus, LMB= left main bronchus, LLLB= left lower lobe bronchus, RULB= right upper lobe bronchus, LLL=left lower lobectomy, RUB= right upper lobectomy .*

Table 4. Shows the location of the lesion by bronchoscope and definite management :

Events	No. (41)	%
Ventilatory support	5	12
Morbidity:	6	14.5
Chest infection	3	7.3
Empyema	1	2.4
Wound infection	2	4.8
Mortality	3	7.3

Table 5. Shows the postoperative events

	Survivors (38)	Mortality cases (3)
Delay hours mean + SD	6.3±1.2 hours	12.6±2.1
Postoperative ventilation	2 (5.2%)	3 (100%)
Type of injury	Blunt 35 (92%)	Blunt 3 (100%)
Associated injuries	9 (23.6%)	3 (100%)

Table 6. Mortality cases compared with survivors

Finding	Total No. 38	Management
Normal tracheabronchial	33 (87%)	
Granuloma	3 (7.8%)	Removal of the granuloma (which was repeated every 2 weeks) (3 visits)
Stenosis	2 (5.2%)	Periodic bronchoscope dilatation 1 case success (2.6%) 1 case failure (2.6%) (resection)

Table 7. Follow up bronchoscopy at 6 month: after operation and management

Discussion

Trachobronchial injuries (RBI) were considered rare till the last 3 decades, now these lesions are becoming more or being recognized more because of the increasing incidence of motor vehicle accidents and rapid transport system that permits patients to reach emergency department alive [7].

We studied 41 patients with traumatic TBI (29.3%) were females and (70.7%) males, Alassal and colleague [8] reported a nearly similar percentage 27% female and 73% males [8], other authors found females predominated in their studies and explained this by the fact that female air ways are smaller in size so more susceptible to rupture [9] while Alassal and colleague [8] explained male prevalence by the fact that in some oriental countries females are not allowed to drive so injuries due to motor vehicle accident are more common in males .

TBI results from blunt or penetrating chest or neck trauma[9,10]. The position of the trachea relative to the mandible, sternum and vertebral column protects it from injuries and explains the rare tracheal injuries in blunt trauma [11], this fact was obvious in our study as we had one case (2.4%) intrathoracic tracheal injury due to blunt trauma and 3 (7.3%) cases with penetrating cervical tracheal injury due to easy access. Blunt chest injuries are most often due to motor vehicle accident, and the risk of serious injury increase by >300% if one is ejected from a vehicle [12, 13]. Bronchial rupture may be caused by crushing, twisting injuries or falling from a height [14].

In our study motor car accident presented (61%) of total causes of TBI which was near to the incidence of other reports 57% and 56% (5,8), late diagnosis of TBI is very common only 59% of the cases could be diagnosed early (within 3 days) [15].

TBI should be suspected in patients with subcutaneous emphysema, dyspnea, persistent peumothorax, multiple fractured ribs, haemptysis with or without air way difficulties [9]. 95% of our patients were presented with subcutaneous emphysema, 93% with dyspnea and 49% with intractable peumothorax this was in agreement with the study of Gwely [5]. However, Davies and Hopkins [5] recognized 2 groups of patients, in one group there was rupture of the mediastinal pleura which produced dyspnea and respiratory distress with continuous air leak and failure of lung to re-expand, these findings were in agreement with our study in the other group despite of complete bronchial transsection there was little or no communication between the injured segment and the pleural cavity and the peribronchial tissues were firm enough to maintain integral air way producing or little symptoms, in our study no patients were asymptomatic.

In our patients by chest radiography, subcutaneous emphysema, pneumomediastiunm and persistent pneumothorax (failure of lung to re-expand after proper insertion of chest tube) were the predominant findings in patients with major or more of these radiological findings as described by kuhlman and colleagues (17) Some authors advocated computed tomography (CT) in suspected cases specially when there was mediastinal emphysema [16, 17] in our study CT was limited for stable patients when the clue of diagnosis by chest x-ray was not obvious.

Proper management of TBI leads to good functional recovery, the most useful diagnostic tool in many studies was bronchoscopy as it was a reliable method for establishment of the site, nature and the extent of the injury [3, 18, 19].

If the bronchoscopy tends to underestimate the extent of the injury it still the most reliable method for diagnosis as the injury may be covered by blood clots or recognized as edema or erythema of the mucosa and when the findings were correlated with the patients history and clinical manifestations, the diagnosis and the decision for surgery became correct [20, 21], this opinion was true in our study as in some cases, bronchoscopy could not visualize the definite lesion, instead, blood clots, bleeding or erythema of the mucosa were the findings , on thoracotomy the suspicious sites were confirmed and were true, bronchoscopy was done for 39 (95%) patients in our study. Gwely ha done bronchoscopy for all studied cases, all had blunt trauma [5]. In contrast we had 3 (7.3%) patients with penetrating tracheal injuries and the wound was in view.

There is a controversy regarding the incidence of injury of the right and left main bronchi, some authors showed equal distribution [5], others indicated that right sided bronchial injuries predominate due to shorter length of the right main bronchus that carries a heavier right lung also due to less protection compared with trachea and left bronchus which are

encircled by aorta and other mediastinal structures [12, 13, 22] , we reported 51.3% injuries involved the right main bronchus.

Conservative treatment has been described as appropriate for iatrogenic injuries or when the diagnosis had been delayed (more than 3 days) [3, 23].

No iatrogenic injuries were found in our cases,.Our patients were presented at a mean delay time of 6.8+/- 1.2 h following trauma and were operated on an emergency basis (without delay and as soon as a surgeon is available [6]) due to massive surgical emphysema and/or continuous air leak associated with failure of lung re-expansion inspite of proper chest tube insertion. The decision of surgery was supported by bronchoscopic findings denoting that there was significant injury either by inspection of the tear which was more than 3 cm or by its sequale as blood clot or bleeding obscuring the bronchoscopic view. Our decision was in line with many authors who said that the size of the injury is not by itself an indication for surgery and conservative management presents greater risk when the lesion is longer than 4 cm so one must correlate clinical presentations with the bronchoscopic finding (23, 24, 26). Lampl postulated guidelines for conservative management which are small tears around 2 cm, delay in diagnosis more than 3 days, refusal of the surgery and bad physical condition in severely ill patients [27].

Induction of general anesthesia using volatile agent with spontaneous ventilation is the safest technique in patients with major air way injuries, trachea or bronchus may be intubated distal to the injured segment to ensure effective ventilation [12, 15], this was our anaesthetic protocol. The surgical approach to repair TBI can be dicated by the site of injury, exposure of mediastinal trachea, carina, right main bronchus and proximal left main bronchus can be achieved via right posterior thoracotomy, complete transsection of left main bronchus is best exposed through standard left thoracotomy [19, 22], transcervical approach was described by Angelillo for lesions limited to cervical trachea [3].

Our approaches was selected according to the site of injury as determined or suspected by broncoscope . The majority of our cases underwent direct suture repair as noted by many authors[5,15,20], in one case (2.4%) resection of destroyed 2 tracheal rings was necessary followed by end to end anastomosis as done by Peclet and colleague [13], lobectomy was done in 3(7.3%) patients due to extensive injury of the lobar bronchi and/or lung parenchyma as indicated by Laci and colleague[20]. Repair is usually performed using interrupted absorbable sutures that is less likely to cause granuloma also monofilament non absorbable suture tends to avoid suture line infection [28,29]. In our study we used both types of sutures and were tied on the outer side of the bronchial lumen as described by many authors [5,29] On follow up of the survivors, (38 patients) we found 3 (7.8%) patients with endobronchial granuloma and 2 (5.2%) patients with bronchial stenosis which was similar to many reports [5, 20].

Morbidity was 11.4-35% in the literature [20] and 14.6% in this study in the form of chest infection, empyema and wound infection.

Mortality varied from 4 to 30% in other studies [20, 30], surgical mortality was 7.3% in our study and all mortalities occurred among patients with blunt trauma whom were presented to us at a delayed time compared with the survivors. So we thought that delayed presentation and associated injuries were important mortality factors.

Conclusion

In our study, we found that tracheobronchial injuries gave non specific clinical manifestations, bronchoscopy was the corner stone in the diagnosis. Repair could be done in the majority of the cases with accepted surgical outcome compared with other reports , associated injuries and delayed intervention were important mortality factors.

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Role of Fibrinolytic Drugs In The Management of Empyema In Children

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Background; **The use of intrapleural injection of fibrinolytic agents through intercostal chest tube for lysis of pleural adhesions started in the late 1940s, when Tillett and Sherry reported the use of a mixture of streptokinase and streptodornase for intrapleural fibrinolysis[1]. Use of streptokinase for this purpose was limited until the availability of purified streptokinase in the 1960s resulted in an improved safety profile. Urokinase was introduced in 1987 and became the most frequently used agent for because of concerns about the antigenicity of streptokinase[2].**

Aim of the work: **The aim of this work was to evaluate the role of fibrinolytic agents in the treatment of complicated empyema in children.**

Patients and methods: **This work included 50 child (age less than 12 years) of either sex diagnosed as thoracic empyema admitted to Cardiothoracic Surgery department, Menofyia University, prospectively studied. Every patient was subjected to complete history taking, through clinical examination, routine laboratory investigations, and radiological studies including chest x-ray and CT chest. Analysis of pleural aspirate was done for all children. Chest tube was the primary treatment in all patients except two children in whom the pleural aspiration was negative and decortication was decided from the start. Streptokinase was used in patients who show non-inflation of the lung in follow up x-rays. Patients showed no response to streptokinase was converted to surgery. Patients was followed up for 6 months after discharge by serial chest x-ray and CT chest.**

Results: **fifty patients were included in this study. There were 22 males (44%) and 28 females (56%), their ages ranged from 1-142 months (43.3 ± 36.3). Chest tube was the definitive treatment in 40 (80%) cases, while more aggressive surgical management was done in 10 (20%) cases. Total lung inflation occurred in 22 (44%) cases while lung was not totally inflated postoperatively in 18 (36%) patients. Streptokinase (STK) was used in 16 cases (32%) with non-inflated lung. Streptokinase usage resulted in total lung inflation in 12 out of the 16 cases used it (75%), while 4 cases (25%) showed non inflated lung (treated by open drainage). Its use caused no complications in 13 cases (81.3%), but it caused remarkable bleeding in 2 cases (12.5%) and allergy in 1 case (6.2%). Open drainage was done in 5 cases (10%). Mortality occurred in one child one day after chest tube insertion.**

Conclusion: **Although the use of intrapleural fibrinolytics can decrease the incidence of need for more aggressive surgical interference, yet until controlled studies documenting their efficacy have been completed, they cannot be recommended as standard therapy. Until such studies are available, the use of intrapleural fibrinolytics should be recommended for patients in centers without access to VATS and for patients who are not surgical candidates.**

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The natural history of empyema thoracis was described by Hippocrates who realized that drainage could result in cure[3]. He observed that death was likely "*if pus that flows after opening was mixed with blood, muddy and foul smelling*." He also remarked that if the empyema was drained "*with knife or cautery*" and the pus was "*pale and white*" the patient would survive[4]. While the morbidity and mortality of this condition have undoubtedly

improved over recent years, debate continues regarding the nature and timing of surgical intervention[5]. The incidence of parapneumonic effusion and empyema is approximately 3.3 cases per 100,000 children. It has been estimated that 1 in every 150 children hospitalized with pneumonia will develop an empyema[6]. The majority of empyema in children follows acute bacterial lobar pneumonia[7]. During recovery from viral infections (such as chicken pox and measles) children are more susceptible to lower respiratory tract infections and therefore empyema[7]. Underlying conditions such as chronic pulmonary diseases, diabetes mellitus, long-term steroid therapy, organ transplantation with associated immune suppression, and recurrent aspiration could predispose the child to empyema[8]. Empyema may follow secondary infection of a traumatic hemothorax or lung contusion[9]. Occasionally a secondary empyema follows a penetrating injury of the chest or after infection in the pleural space following thoracotomy. More commonly secondary empyema invariably follows intrathoracic rupture of the esophagus[10]. Parapneumonic effusions are exudative and progress through three stages to an empyema; the first or exudative stage is characterized by relatively low lactate dehydrogenase enzyme (LDH), normal glucose, and normal pH, may be treated successfully by antibiotics. If untreated or inappropriately treated, the second or fibropurulent stage evolves with invasion of pleural fluid by bacteria, increased fibrin deposition, cellular debris, and white blood cells with the ultimate formation of limiting fibrin membranes producing loculations. The third or organization stage occurs as fibroblasts grow into the exudative fibrin sheet coating the visceral and parietal pleura with an inelastic membrane or pleural "peel" encasing the lung and rendering it functionless [11]. Almost all patients with an empyema will have hectic fever, tachycardia, and an increased respiratory rate. Some patients will be cyanosed. Clinical signs in the thorax include decreased chest expansion, stony dullness to percussion, reduced or absent breath sounds, and scoliosis[12]. Pleural fluid analysis is important to confirm an empyema rather than simple pleural effusion by glucose, lactate dehydrogenase enzyme (LDH), protein level and pH. Pleural biopsy can determine the staging of the disease accurately which will influence the management plan significantly. US and CT are helpful for characterizing the fluid density, detecting the presence of sepetations and loculations. They also facilitate optimal needle and catheter placement and differentiate consolidated lung from pleural fluid[13]. The goals of empyema treatment as expressed by Mayo and associates are: save the life of the patient, eliminate the empyema, re-expand the lung, restore mobility of the chest wall/diaphragm, return normal respiratory function, eliminate complications or recurrence and reduce length of hospital stay[14]. The appropriate management of complicated Para-pneumonic effusion or empyema remains controversial. Most cases are treated initially using antibiotics with or without repeated thoracentesis, closed thoracostomy with or without fibrinolytics. Surgical approaches such as open thoracotomy and decortication, and thoracoplasty are generally reserved for these patients with deteriorated clinical conditions after conservative treatment. Video-assisted thoracoscopic surgery (VATS), which plays a bridging role between medical and aggressive surgical management has assumed greater importance in the treatment of complicated Para-pneumonic effusion and empyema[15].

Intrapleural fibrinolytic drugs

When an infected pleural space progresses to the fibropurulent phase, fibrin creates intrapleural locules that impede proper chest tube drainage. Intrapleural instillation of fibrinolytic drugs offers a theoretical benefit for lysing fibrin adhesions, promoting pleural drainage, and avoiding surgery[16]. Three agents are commonly used for intrapleural instillation: streptokinase, urokinase, and Alteplase (tissue-type plasminogen activator) [2,17]. Small studies had reported the beneficial effects of therapy with these agents. Based on early reports of efficacy, the BTS (British Thoracic Society)[18,19] and the ACCP (American College of Chest Physicians) guidelines recommend fibrinolytic drugs as management options[20].

1- Streptokinase (STK):

Streptokinase (STK), a protein secreted by several species of streptococci can bind and activate human plasminogen. STK is used as an effective and inexpensive clot dissolving in cases of myocardial infarction and pulmonary embolism[21,22]. Till now, the use of STK has been mostly restricted to patients with empyema in the early phase of the disease where the loculations have just formed and fibrin peel is being laid on pleural surface. At this stage maximum breakdown of loculations and dissolution of fibrin peel is expected to occur. Almost complete preservation of lung function can be expected[23]. One cycle of intrapleural STK (IP-STK) instillation comprised of three doses, each of 250,000 IU given every 12 hours, so that three doses of IP-STK were instilled by the next morning (at 0, 12, and 24 hours). Depending on the response and need, another cycle of three doses of 250,000 IU was initiated the next morning, thereby providing an interval of at least 24 hours between the two cycles[24]. In one study, 40 child with Light's class 5, 6, or 7 parapneumonic effusions were randomized to receive streptokinase 15,000 IU/kg/dose intrapleurally for 3 consecutive days[25]. After instillation of the fibrinolytic agent through thoracostomy tube, it was clamped for 1 hour then standard under-water seal suction at 20 cm H2O was resumed[26].

The complications of fibrinolysis include chest pain, fever, haemothorax, hematuria, and allergic reactions to streptokinase[27,28]. There have also been reports of nose bleeds, pleural pain, and transient disorientation (without evidence of intra-cerebral bleeding on CT brain scan)[29].

In the most important study ever published on the use of intrapleural fibrinolytics for the treatment of complicated parapneumonic effusion, the administration of streptokinase had no effect on the need for surgery or the duration of

hospitalization[27]. Diacon et al. in a single-center, randomized, double-blind study, assigned 44 patients to receive daily pleural washes with streptokinase or saline for four or five days. After 3 days, there was no significant difference in the groups, but after 7 days, streptokinase treated patients had a higher clinical success rate and fewer referrals for surgery[30].

2- Urokinase (UK):

Urokinase (UK), a naturally occurring human enzyme which acts on the endogenous fibrinolytic system by converting plasminogen to plasmin, appears to be a valid alternative to STK. So far, several children have been treated with UK with a success rate ranging from 62% to 100%. Excellent results have been reported with daily doses of 80,000 to 100,000 IU/day or 4,000 IU/kg/day[31]**.** Urokinase was introduced in 1987 and became the most frequently used agent for fibrinolysis because of concerns about the antigenicity of streptokinase. Several studies have confirmed the efficacy of Urokinase for intrapleural fibrinolysis[32], including a few small case series that have evaluated its use in children[33]**.** Streptokinase is now rarely used for intrapleural fibrinolysis because of the risk of severe allergic reactions. Urokinase is both non-pyrogenic and non-allergenic and has become the enzyme of the choice for fibrinolysis[12]. However, the optimal dosage, timing and method of intrapleural administration of UK still remain to be defined[34].

Urokinase Treatment Schedule (UK Pediatric study)[35]:

- Forty-thousand units in 40 ml of normal saline instilled twice daily for 3 days for children >10-kg weight.
- Ten-thousand units in 10 ml of saline instilled twice daily for 3 days for children <10 kg weight.
- Intercostal tube clamped for 4 h after instillation.
- Response to treatment is assessed after six doses (3 days) using clinical, CRP, and radiological parameters.

Intrapleural bupivacaine can be given with the Urokinase if the instillation is uncomfortable. Significant bleeding has been mentioned in case reports after the use of Urokinase[36,37] . Urokinase is non-antigenic but may still cause acute reactions (due to immediate hypersensitivity and histamine release) with fever and cardiac arrhythmia[18].

3-Tissue plasminogen activator (t-PA):

Some centers now use t-PA for fibrinolysis. Walker et.al first reported the apparent benefits of t-PA in a patient with empyema[38]. Subsequently, Skeete et.al. installed t-PA through surgical chest tubes into 42 patients with a variety of pleural conditions, of which 12 were empyema[28]. They reported accelerated radiographic improvement and clinical benefit. Levinson and Pennington used fibrinolytic therapy for 30 patients with largely multiloculated pleural infections; 20 patients received t-PA through small-bore, image-guided chest tubes. The mean length of hospital stay was 11 days, and no patient required surgical drainage[39]. Method of usage is infusing 5 mg t-PA reconstituted in 20 to 30 mL saline into the pleural space and allowing it to remain there for 2-4 hours before draining. However, the optimal dose is not known and a dose of less than 5 mg may be equally effective.

Several issues remain unresolved in the study of fibrinolytics: no large-scale studies in children have been performed; few studies compare fibrinolysis directly with other treatment modalities; and dosing regimens for fibrinolytics in children have not been studied[14]. The results of clinical studies involving adults may not be directly comparable with children because co-morbidity is considerably less common and preillness lung function is generally normal[12]. However, until controlled studies documenting their efficacy have been completed, they cannot be recommended as standard therapy. Until such studies are available, the use of intrapleural fibrinolytics should be reserved for patients in centers without access to VATS and for patients who are not surgical candidates[40].

Patients and Methods

This work included fifty child of either sex suffering from thoracic empyema **admitted to the Cardiothoracic Surgery** Department, Faculty of Medicine, Menofiya University, from the period between January 2010 and January 2012. The diagnosis of empyema was established by pleural fluid analysis revealing one or more of the following criteria;

- Grossly purulent pleural fluid aspirate.
- Positive gram stain or culture.
- Pleural fluid glucose level less than 40 mg/dl, pleural fluid pH level less than 7.00, and\or pleural fluid lactic dehydrogenase (LDH) more than 1000 IU/l.

All patients of the study were subjected to:

1) History taking; including personal history, present history, and past History.

2) Clinical examination; including general examination and local chest examination.

3) Laboratory investigations; including routine laboratory examination (complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), serum LDH, serum glucose and serum protein) and pleural fluid sample analysis including; PH, LDH, total protein, glucose levels, culture and sensitivity analysis.

4) Radiological investigations: Chest x-ray, CT chest with IV contrast, and U.S when indicated.

5) Tube thoracostomy:

It was performed under general anesthesia in the operation room under complete aseptic precautions. The patient was put in the supine position with his arm on the side to be operated on was placed under his head to widen the intercostal spaces facilitating the procedure. The side to be operated on was sterilized by povidone-iodine solution and sterile towels were put. Before incising the chest wall, aspiration was done to assure the best site for chest tube insertion which will allow maximum drainage especially in case of encysted pleural effusion.

The chest tube caliber was selected according to age, intercostal space size and pus consistency (larger tube for thick pus). Tube sizes were ranging from 14-24 French. Chest tube connected to underwater seal bottle was inserted in a dependant position. Pus was allowed to pass freely to the underwater seal bottle.

If pus was very thick or discontinued to flow with persistent lung collapse in the chest x-ray, without air leak, pleural irrigation was tried first by warm saline to break down and dissolve any thick debris to help drainage.

If chest tube drainage stopped or became minimal with persistent lung border and no air leak for more than 4 days and the CT chest revealed pleural loculations, then intrapleural injection of streptokinase was done on the 5th day. The dose of streptokinase was 10.000 IU/kg with a maximum dose 250.000 IU/dose. The calculated dose was diluted in 30 ml normal saline and injected via the chest tube. The chest tube was clamped for 4 hours after instillation then opened to allow drainage. This was done once daily for three successive days, provided that no complications occurred, then chest x-ray was done to demonstrate the effect (Figure 1).

6) Thoracotomy and open decortication:

It was done in cases that did not improve clinically or radiologically despite of IV antibiotics, patent draining chest tube and pleural irrigation. Whether decortication or resection procedure was an intraoperative decision made in some cases according to the lung condition. Lung sparing was the main target but in some cases

when the lung was too damaged and its repair was not a satisfactory decision, lobectomy was done.

Follow-up for our cases in the outpatient clinic was done monthly for six months after discharge including:

- Serial chest x-ray every month.
- CT chest after 6 months.
- Overall morbidity and mortality.

Results

Fifty child (less than 12 years) included in this study, 22 (44%) were males and 28(56%) were females. Their ages ranged from 1-142 months (ranging from 1 month to 12 years 45.54 ± 38.24). Twenty one child (42%) had right sided empyema and 29 children (58%) had left sided empyema.

Regarding patients' complaints, fever was present in 39 patients (78%), while productive cough was present in 44 patients (88%) and dyspnea occurred in 37 patients (74%). Duration of complaint ranged from 3-30 days before hospital admission (10.80 ±4.86). Past history was negative in 21 cases (42%), repeated chest infection was present in 22 cases (44%) and miscellaneous in 7 cases (14%).

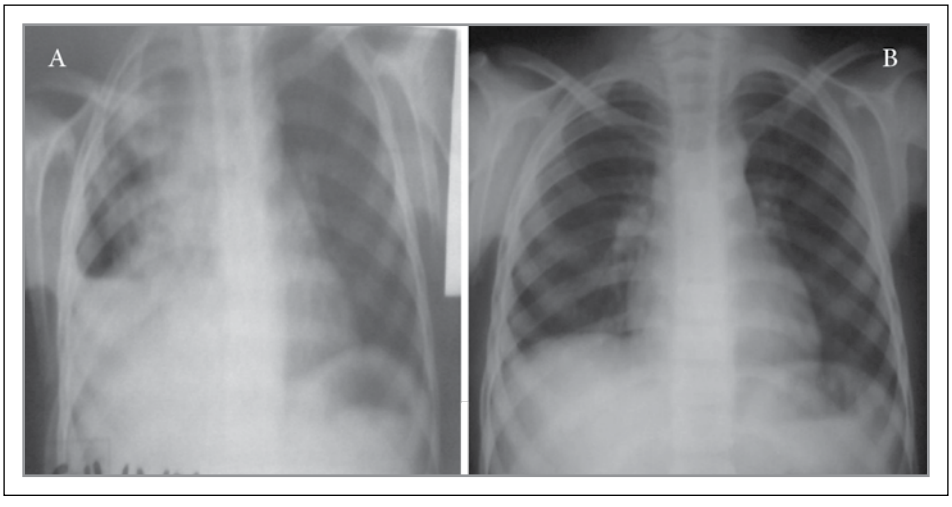

Figure 1; A. Chest x-ray of 11 years old child diagnosed to have right empyema showing lateral lung border with small air fluid level. B. The same child chest x-ray done after 6months from intrapleural injection of streptokinase. It showed total lung inflation.

The pre-operative imaging of the patients by x-ray revealed that 38 patients (76%) were having pleural effusions, while 12 patients their chest x-ray showed hydro-pneumothorax. While when CT chest was used there were 24 patients (48%) had pleural effusion, 16 patients (32%) had encysted pleural effusion and 10 patients (20%) had hydro-pneumothorax .

Regarding pre-operative pleural fluid sample analysis taken by thoracic aspiration; the studied group number was 48 (as thoracic aspiration was negative in two cases); PH ranged from 6.5 – 7.4 (6.87 ± 0.21), lactate dehydrogenase enzyme (LDH) level ranged from 7 – 24478 (4074.62 ± 5235.63), glucose level ranged from 10 – 55 (27.72 ± 9.0) and protein level ranged from 0.7 – 18.7 (5.40 ± 2.74) .

Culture of pleural fluid showed positive bacterial growth in 21 (42%) cases and no growth in 27 (54%) cases while bacterial culture couldn't be assessed in 2 (4%) cases as aspiration was negative. Infection was by single organism in 19 (90.5%) cases and mixed infection in 2 (9.5%) cases. The most identified organism was Streptococcus Pneumonia (28.6%), where Staphylococcus aureus was the second common cultured organism (23.8%).

Chest tube as a definitive treatment was done in 40 patients(while surgery was the definitive treatment in 10 cases; two cases with negative pleural aspiration went for surgery from the start, and eight cases showed no improvement after chest tube and was converted to surgery). There were 16 males (40%) and 24 females (60%). Their ages ranged from 1-142 months (43.3 ± 36.3). Duration of complaint ranged from 7-30 before hospital admission (10.10 ± 4.06). Sixteen (40%) patients were diagnosed to have right sided empyema while 24 (60%) patients had left sided empyema.

Chest x-ray post chest tube insertion(in 40 cases) showed total lung inflation in 22 (55%) cases while lung was not totally inflated postoperatively in 18 (45%) patients. Streptokinase (STK) was used in 16 cases (40%) out of the eighteen patients with non-inflated lung after chest tube (the remaining 2 patients went for open drainage). Its use caused no complications in 13 cases (81.3%) but it caused remarkable bleeding in 2 cases (12.5%) and allergy in one case (6.2%). Streptokinase usage resulted in total lung inflation in 12 out of 16 cases (75%), while 4 cases (25%) showed non inflated lung (treated by open drainage). Open drainage (chest tube replacement by malicot catheter connected to underwater seal or urine bag) was done in total 5 cases (12.5%).

Regarding hospital stay in these patients, the preoperative duration (either the patient was hospitalized or not) ranged from 0 – 7 days (1.32 ± 1.89), the postoperative duration ranged from 2 – 42 days (15.32 ± 8.30) and overall hospital stay ranged from 4 – 42 days (16.75 ± 8.81) (Table 1).

	Studied group No=40	
	No	%
Post operative chest x ray		
Inflated lung	22	55
Non inflated lung	18	45
Streptokinase usage		
Yes	16	40.0
Open drainage done or not		
Yes	5	12.5
No	35	87.5
Tube time		
X ± SD	16.62 ± 9.05	
Range	2 - 41	

Table 1. Operative data of patients treated by chest tube

As regard patients in whom surgical intervention was the definitive treatment; lobectomy was done in 6 cases (60%), initial decortication without chest tube insertion was done in 2 cases (20%) and decortications with repair of broncho-pleural fistula was done in 2 cases (20%) also.

The preoperative duration of hospital stay in these patients ranged from 0 – 16 days (5.30 ± 5.45), while the postoperative duration ranged from 4 - 35 days (22.70 ± 10.52), the overall hospital stay ranged from 12-38 days (29.0 ± 8.25).

	Studied group No = 50
Preoperative	
X ± SD	2.12 ± 3.30
Range	0 – 16
Postoperative	
X ± SD	16.80 ± 9.17
Range	2 - 42
Overall stay	
X ± SD	19.20 ± 9.94
Range	42 – 4

Table 2. The overall hospital stay of the studied patients

Follow-up CT chest with contrast done after six months of discharge showed complete lung inflation in all cases, 21 cases (42.85%) had non significant residual thickened pleura. As regard morbidity; 4 cases (8%) had wound infection, 1 case (2%) had wound dehiscence and 1 case (2%) had scoliosis. Mortality occurred in 1 (2%)case who was a child 14 days old admitted with septicemia and died after one day of chest tube insertion (Table 3).

	Studied group	
	No	%
Follow up CT chest done after 6 months of discharge	No=49	
No residual	28	59.18
Residual thick pleura (inner fibrosis in TDT group)	21	40.82
Morbidity	No=50	
No	44	88.0
Wound infection	4	8.0
Wound dehiscence	1	2.0
Scoliosis	1	2.0
Mortality	No=50	
Yes	1	2.0
No	49	98.0

Table 3: Follow up results of the studied patients

Discussion

The appropriate management of complicated Parapneumonic effusion or empyema remains controversial. Most cases are treated initially using antibiotics with or without repeated thoracentesis, closed thoracostomy with or without fibrinolytics. Surgical approaches such as open thoracotomy, decortication, and thoracoplasty are generally reserved for these patients with deteriorated clinical conditions after conservative treatment[15].

Parapneumonic effusions have been described to include three stages; Stage 1 or exudative stage (3–5 days) which is characterized by simple effusions that are considered sterile and are usually managed by intravenous antibiotics alone or with chest tube drainage if the effusion is large enough[40]; Stage 2 or fibrinopurulent stage (7–10 days) is characterized by deposition of fibrin on the visceral and parietal pleura while pleural fluid becomes colonized and loculated[41]. The management options for stage 2 include antibiotic treatment for the underlying pneumonia, fluid removal and debridement of the fibrinous layer of pleura to allow the underlying lung to fully expand with either VATS or intrapleural fibrinolytics[42]; Stage 3 or organization stage (2–3 weeks) is characterized by the development of thick peel or fibrosis with a potential for lung entrapment. The management options for stage 3 include VATS, mini-thoracotomy and thoracotomy with decortication[43].

Our study included 50 children (less than 12 years) who had thoracic empyema, they were 22 males (44%) and 28 females (56%). Our patient's ages ranged from 1-142 months (45.54 ± 38.24). The mean age for patients is very close to the figures reported by Ozel et. al. [44], as the mean age was 47.04 months in their study.

As regard preoperative radiological investigations, we have found that (76%) of cases had pleural effusion in their preoperative chest x-ray, while (24%) of cases had hydro-pneumothorax. These results are similar to that obtained by Grewal et. al.[45] as they recorded in their study that (72%) of cases had pleural effusion and (28%) had loculated effusion with air fluid level. When CT chest with contrast was used we found that (48%) of cases had pleural effusion, (32%) had encysted pleural effusion and (20%) of cases had hydro-pneumothorax, this coincides with Ozel et. al.[44] who recorded in their study that (53%) of cases had pleural effusion, (31%) had encysted pleural effusion and (14%) had hydro-pneumothorax.

Biochemical analysis of pleural fluid revealed that: mean pH = 6.87, mean glucose level = 27.72 mg/dl, mean LDH = 4074 IU/l and mean protein = 5.4 g/dl. These results coincide with the results obtained by Aydoğan et. al.[46] in their study which were: mean PH = 6.96, mean glucose = 30.9 mg/dl, mean LDH = 3282 IU/l and mean protein = 4.1 g/dl. In our study pH level was below 7.2 in (93.7%) which disagree with the results obtained by Gün et. al.[47] as they recorded that pH below 7.2 was in (49%) of cases only. But our results were similar as regard levels of LDH more than 900 IU/l and glucose level below 40 mg/dl as it occurred in (81%) of cases in our study, while in Gün et. al.[47] study these levels occurred in (77%) of cases.

In our study, chest tube was the definitive treatment in 40 (80%) cases and thoracotomy was the definitive treatment in10 (20%). These results are similar to the results recorded by Ozel et. al.[44] as in their study, chest tube was the definitive treatment in (78.5%) of the studied patients and thoracotomy was the definitive treatment in (21.5%). Our results were also close from those obtained by Çekirdekçi et. al.[48] as they reported on their study on 53 children that chest tube was the definitive treatment in 39 (73%) cases with progression to thoracotomy in (27%) of cases.

In chest tube treated patients, chest X-ray post chest tube insertion showed total lung inflation in 22 (55%) cases while lung was not totally inflated postoperatively in 18 (45%) cases. These results agree to those recorded by Rodriguez and Catalan[49] as they reported that postoperative chest x-ray revealed total lung inflation (52%) of cases while (48%) of cases showed non inflated lung in postoperative chest x-ray.

In chest tube treated patients, Streptokinase (STK) was used in 16 cases (40%). Its use resulted in total lung inflation in 12 (75%) cases, while 4 cases (25%) showed non inflated lung (failed). Its use caused complications in 3 cases (18.7%). These results coincide with those obtained by Çekirdekçi et. al.[48] as they reported that after STK was used on 17 children, 13 of

them (76%) showed lung inflation, while 4 cases (24%) failed. Our results are also similar to those obtained by Aydoğan et. al.[46] on their study on 14 children; 12 of them (84%) showed lung inflation after STK was used and 2 cases (16%) were failed to achieve lung inflation. They also reported that complication occurred in 1 case (7%).

The mean total length of hospital stay in chest tube treated patients was 16.75 days; this is close to the mean duration in Aydoğan et. al.[46] study that was 18.4 days. But our result was less than that that was reported by Avansino et. al.[50] as they reported that the mean duration of hospital stay in chest tube definitive treatment group in their study was 20 days.

On comparing the group of patients treated with chest tube and those treated with surgical interference in our study as regard streptokinase usage, there was a significant relationship between STK usage and the need for surgical intervention. This points towards importance and impact of STK usage on avoiding thoracotomy as STK wasn't used in surgically treated patients (not intended, but there were contraindications as air leak, bleeding tendency). These results coincide with those obtained by Çekirdekçi et. al.[48] as they reported that STK was used in 17 cases and it was effective in 13 (76%) of them while the remaining 4 cases (24%) underwent thoracotomy. But our results disagree to those obtained by Singh et. al.[51] who concluded that intrapleural STK instillation has no additional benefits in children with empyema.

The overall total hospital stay showed a highly significant difference between the group of patients treated by chest tube and those treated by surgery. It was longer in chest tube patients as empyema management occurs in a stepwise manner although this prolongs the period of hospital stay but avoid the need for aggressive surgical management unless there's no way else. This result coincides with Ozel et. al.[44] who reported that overall hospital stay was longer in children who were managed by thoracotomy.

Regarding overall data, we had 50 children in our study; chest tube was the definitive treatment in 40 (80%) cases, 6 cases (12%) underwent lobectomy, 2 cases (4%) underwent primary decortication without chest tube and 2 cases (4%) underwent decortication with repair of bronchopleural fistula. These results are similar to those obtained by Ozel et. al.[44] who worked on 102 children, chest tube was the definitive treatment in 90 children (88%) and 12 children (12%) underwent decortications.

As regard morbidity and mortality; morbidity occurred in 6 cases (12%) in the form of; wound infection in 4 cases (8%), wound dehiscence in 1 case (2%) and scoliosis in 1 case (2%). These results are similar to those obtained by Rodriguez and Catalan [49] as morbidity occurred in (10%) of cases in the form of recurrence and wound infection. But Avansino et. al.[50] reported that morbidity occurred in only (5.6%) of cases. Mortality occurred in 1 case (2%) from septicemia; he aged 24 days and was diagnosed to have congenital pneumonia and pleural effusion. He was put in the incubator with chest tube insertion after diagnosis but he died one day later from septicemia. Mortality rate was (3.3%) in Avansino et. al.[50] study. Rodriguez and Catalan[49] reported a mortality rate of (10%), while mortality occurred in 1 case (1.9%) in Çekirdekçi et. al.[48] study.

Conclusion

Although their use can decrease the incidence of need for more aggressive surgical interference, until controlled studies documenting their efficacy have been completed, intrapleural fibrinolytics cannot be recommended as standard therapy. Until such studies are available, the use of intrapleural fibrinolytics should be recommended for patients in centers without access to VATS and for patients who are not surgical candidates.

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Surgical Approach For Mediastinal Tumors

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This study was done on seventeen patients in the period from April 2009 to April 2012 at Al-Hussein University Hospital. The study was done to evaluate the incidence, investigations, the best surgical approach, the results and complications. Anterosuperior masses were found in 9 patients (52.94%), middle mediastinal masses were found in 2 patients (11.76%) and posterior mediastinal masses were found in 6 patients (35.29%). As regard the pathology; thyroid goiter was found in 3 patients (17.67%), teratoma was found in one patient (5.88), lipoma in 2 patients (11.76%), thymoma in 3 patients (17.64%), bronchogenic cyst in 1 patient (5.88%), inflammatory cyst in 1 patient (5.88%), neurofibroma in 3 patients (17.76%), ganglioneuroma in 1 patient (5.88), tuberculous cyst in 1 patient (5.88), and fibroid tumor in 1 patient (5.88). Surgical approach was via sternotomy, ministernotomy, thoracotomy, combined transcervical and thoracotomy. Complications included brachial palsy, hemorrhage due to subclavain injury.

Ministernotomy was done in 3 cases (17.64%) in which thyroid goiter was removed, full stermotomy was performed in 6 cases (35.28%) in which teratoma, lipomas thymomas were operated upon. Thoracotomy was done in 7 cases (41.16) for middle and posterior mediastinal masses. Combined transcervical and thoracotomy was done in 1 case (5.88%) with neurofibroma in which there was extension to the neck.

The mediastinum is the space between the two lungs. The space is protected by the rigid anterior and posterior chest walls. Much of the space is occupied by the heart and great vessels. The other components include lymph nodes and thoracic ducts. Any of these component organs can become enlarged thereby becoming symptomatic or even asymaptomatic. Mediastinal tumors, benign or malignant may be primary or secondary, congenital or acquired. Most benign tumors are primary to the mediastinum in location but cervico mediastinal tumors are also fairly common. They are mostly solid tumors but may be cystic or mixed **(Zany et al., 2003; Cheng, 2004; Adzik, 2003 and Kim, 2003).**

Benign masses present mostly with pressure symptoms. They also present with endocrine symptoms. Malignant masses may present with pressure or constitutional symptoms. **Ankermann and his colleagues (2004),** found three pediatric cases that presented like bronchial asthma. Critical mediastinal mass with propensity to cause respiratory symptoms in children is associated with the followings: anterior location of the mediastinal mass, histological diagnosis of lymphoma, presence of superior vena cava obstruction, radiological evidence of vessel compression or displacement, pericardial effusion and pleural effusion **(Lam et al., 2004 and Ankermann et al., 2004).**

The histological patterns also vary widely. The common benign masses of the antero-superior mediastinum include thyroid masses, thymomas and vascular tumors. The middle mediastinum is dominated by pericardial masses while the posterior mediastinum is dominated by neurogenic tumors like ganglio neuromas.

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Presurgical evaluation

Properative diagnosis may include:

CXR, CT scan of the chest or CT guided needle biopsy **(Marom et al., 2011)**, magnetic resonance imaging of the chest (MRI). The surgeon may determine if additional preoperative tests are needed based on the type of the procedure that will be performed.

Biopsy procedures may include percutaneous biopsy, mediastinoscopy with biopsy, thoracoscopic mediastinal biopsy and mediastinotomy (chamberlain procedure).

Surgical approaches to remove mediastinal tumors include sternotomy, thoracotomy, minimally invasive surgery **(Kasper et al., 2005; Kaledin et al., 2000 and Strollo et al., 1997).**

Patients and methods

This study was done to study the pathophysiological issues and management challenges of mediastinal masses.

Seventeen patients were operated upon for resection of mediastinal masses. Data included age, sex, presenting symptoms, report of investigations, starting the location of the mass, treatment modality and specific associated operative and postoperative complications.

The aim of the study was to evaluate, and discuss about the approach and difficulties during the operations.

The approach to the anterosuperior mediastinal masses was via median sternotomy as in cases of teratoma, pericardial lipoma. Partial or ministernotomy was done in cases with cervical goiter with mediastinal extension for safe dissectin of the mediastinal part of the goiter. This was done in association with the general surgeon. Nerve palsy was not encountered.

Middle mediastinal masses as pluro pericardial cysts, bronchogenic cysts were dealt with via thoracotomy. Dissection around the cyst to get it closed may be difficult because of the very thin plane of dissection. It may be easer to aspirate part of the content or to open the cyst to catch the wall of the cyst and proper dissection. Sometimes it may be safe to get part of the cyst wall adherent to adjacent structure such as the great vessels. Cytology and pathology were performed.

As regard to the posterior mediastinal structures difficulties were faced in cases neurogenic tumors because of their adherence to the vertebral bone and possibility of adherence to the neural canal. Complete dissection in the last situation as one mass may be very difficult, debulking of the mass and piece meal dissection to avoid injury of the great vessels at the apex of the thorax can be performed.

In one case of child 4 years old, posterior mediastinal cyst was found about 5x5 cm. Aspiration of the content revealed greenish fluid. The cyst was adherent to the azygos vein. Dissection and excision was done, pathology revealed tuberculosis and the child received medical treatment.

In one case of neurofibroma of the brachial plexus presented with swelling in the neck. Cervical approach combined with high thoracotomy was performed. Brachial palsy complicated this approach.

Fibroid tumor was removed from the posterior mediastinum about 10 x 10 cm in a female about 55 years old.

In cases of thymomas, although CT may reveal well defined masses it was found in one case to be unresectabile because of adherence and invasion of great vessels. Debulking of the tumor as possible as we can was done to be more favourable for radiotherapy. This was done via median sternotomy.

Results

Seventeen patients were operated upon table (1). Anterosuperior mediastinal masses were 9 patients (52.94%). Thyroid goiter presented in 3 patients (17.64%), all were females and their ages ranged from 33-48 years.

Site and pathology	No	Age/ys	Sex	%
Anterosuperior				
Thyroid goiter	1	40	F	5.88
	1	33	F	5.88
	1	48	F	5.88
	Total 3		3	17.64
Teratoma	1	19	F	5.88
Pericardial	1	20	F	5.88
Lipoma	1	35	M	5.88
Thymoma	1	33	F	5.88
	1	50	F	5.88
	1	45	M	5.88
	Total 3			17.64
Middle				
Bronchogenic cyst	1	35	M	5.88
Inflammatory cyst	1	37	F	5.88
Posterior neurogenic				
Neurofibroma	3	20	M	5.88
		32	M	5.88
		10	F	5.99
Ganglioneuroma	1	3	F	5.88
	Total 4			23.52
Tubrculous cyst	1	4	M	5.88
Fibroid tumor	1	55	F	5.88

Table 1. Site, incidence and pathology of mediastinal masses.

Teratoma was found in a female patient aged 19 years old (5.88%).

Lipoma presented in 2 patients, one male (35 y) an the other female (20 y) with a percentage of 11.76%.

Thymoma presented in 3 patients (17.64), 2 females and one male, their age ranged from 33-50 y.

Middle mediastinal masses were found in 2 patients, (11.76%), bronchogenic cyst in a male patient with the age of 35 y (5.88%) and inflammatory cyst (pleuro-pericardial) in a female patient with the age of 37 years (5.88%).

Posterior mediastinal masses comprised 6 patients (35.29%l). Neurogenic tumors were found in 4 patients (23.52%), three with neurofibroma (17.64%) and one with ganglioneuroma (5.88%). Two of them were children (10 years).

Surgical approach	No	%
Mini sternotomy	3	17.67
Full oternotomy	6	35.28
Thoracotomy	7	41.18
Combined cervical and thoracotomy	1	5.88

Table 2. ***Surgical approach to mediastinal masses.***

Tuberculous cyst was found in 1 patient aged 4 years old (5.88). Fibroid tumor was found in a female patient aged 55 years old (5.88%).

From the seventeen patients, 3 patients were children (17.76%) and found in the posterior mediastinum, 14 patients (82.35) were adults. Also 10 patients (58.82%) were females and 7 patients were males (41.18%). Children comprised 50% of the posterior neuregenic tumors and also 50% of all posterior mediastinal masses.

Complications

1. Injury to subclavian artery during dissection of posterior mediastinal mass at the apex of the thoracic cavity and repair was done.
2. Brachial palsy complicated dissection of neurogenic tumor transcervical.

Discussion

There are general agreement that medical treatment is ineffective for substernal goiters; thyroxin suppression and iodine-131 ablation are not particularly useful **(Chauhan and Serpeel, 2006; Pieracci Tahey, 2007, dePerrot et al., 2007).**

The incidence of cancer in substernal goiters is not higher than the incidence of cancer in cervical goiters. Risk factors for malignancy in substernal goiters may include a family history of thyroid pathology, a history of cervical radiation therapy, recurrent goiter, and the presence of cervical adenopathy.

Expert endocrine surgeons utilize an extracervical approach in approximately 2% of cases to remove substernal goiter safely; sternotomy or thoracotomy appears likely in cases of a primary substernal goiter or a mass larger than the thoracic inlet. There may be a higher rate of permanent hypoparathyroidism and unintentional permanent RLN injury when total thyroidectomy is performed to remove substernal goiter than to remove cervical goiter alone **(Pieracci and Fahey, 2007).**

The presence of a substernal goiter, especially being present more than 5 years and causing significant tracheal compression, is likely a risk factor for tracheomalacia and tracheostomy. However, many cases of tracheomalacia can be managed without tracheostomy **(Chen et al., 2004).** About 5% to 10% of operations for substernal goiters are due to recurrent or persistent disease. The most common initial operations appear to be subtotal thyroidectomy or hemithyroidectomy **(Matthew et al., 2008).**

Between January 2001 and January 2004, **Abdel Rhahman et al.**, performed 30 patients with posterior mediastinal tumors. CT scan and CT guided biopsy were done for all patients whereas MRI was done for tumors with intraspinal extension. Posterolateral thoracotomy was done in most of the patients. The Akwari approach was used in most of the patients with Dumbbel Tumors. Neurogenic tumors constituted 67% of cases being neuroblastoma in 60%. The non neurogenic tumors included a heterogenous group of rare tumors (n=10). Dumbbel tumors were found in 10 patients. Neuroblastoma was the commonest tumor to cause intraspinal extension (40%). Wide local excision was done in 13 patients; whereas extended resection was done in the remaining 17 patients. The size of the resected tumors ranged from 3x4 cm to 30x22 cm, 80% were malignant. Morbidity developed in 8 patients (atelectasis, meningitis, paraplegia, Horner' syndrome, wound sepsis). One postoperative mortality due to meningitis was recorded. The overall survival by the end of 3 years was 87.7% with a mean survival of 30.4 months. The overall disease free survival was 55.9% with a mean disease free survival of 26.2 months **(Abdel Ahaman et al., 2005).**

Davidescu et al. reported that from the posterior mediastinal tumors, the most commonly encountered are the neurogenic tumors (75%), the remaining 25% are presented by a heterogenous group of rare tumors including teratoma, lymphoma, sarcoma and other lesions arising outside the mediastinum and projecting into the posterior compartment. Surgical excision by thoracotomy or mini-invasive techniques is the first line of treatment in the posterior mediastinal tumors.

Tumors with extension into the spinal canal (Dumbbell tumors) accounting for nearly 10% of the posterior mediastinal tumors, require a multidisciplinary approach: thoracic surgeon and neurosurgeon **(Dadvidescu et al., 2011).**

Although surgical resection is the preferred treatment of thymomas, patient with clinically unresectable extrathoracic disease require radiation therapy, chemotherapy, or both. Radiation therapy is an essential part of the treatment of any thymoma with invasive characteristics. Controversy exists regarding the use or radiation therapy for patients with stage I tumors, however, it is recommended for those with tumors in more advanced stages, although a recent study demonstrated no advantage for stage II thymic tumors. Radiation therapy has also been used preoperatively to facilitate the resection of bulky tumors; however, this role is usually played by chemotherapy.

Cisplatin based chemotherapy regimens are often recommended for patients with unresectable stage III or with disseminated stage IV disease. Chemotherapy is also a useful induction agent for locally advanced thymomas to facilitate resection of bulky tumors. Cisplatin based regimens have shown promise for improving both resectability and long-term patient survival **(Berman et al., 2011).**

Surgical resection is the treatment of choice for most neoplasms that occur in the mediastinum. In cases of benign neoplasms, complete excision of the lesion itself is generally sufficient. Thymoma is one exception to this principle because, in addition to removal of the tumor, total thymecotomy is indicated for all thymomas. All benign neoplasms that are encapsulated should be resected without violating the capsule. In cases of malignant neoplasms, complete resection including local excision should be included as indicated. Pericardium, brachiocephalic vein, superior vena cava, lung, pleura, sternum, ribs, phrenic nerve and diaphragm have all been resected with extensive malignant thymomas **(Shields, 2000; Rios et al., 2002 and Berman et al., 2011).**

Conclusion

- Presentation of mediastinal tumors varies according to the site of the tumor.
- Posterior mediastinal masses may reach a large size before giving symptoms.
- The approach of surgery also varies according to the site of the tumor.
- Video-assisted thoracoscopy when possible decreases the degree of pain, avoid infection, decreases bleeding, early ambulation and hospital stay.
- Cooperation between the thoracic surgeon, general and neurosurgeons.
- Cooperation between surgery and oncology.

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