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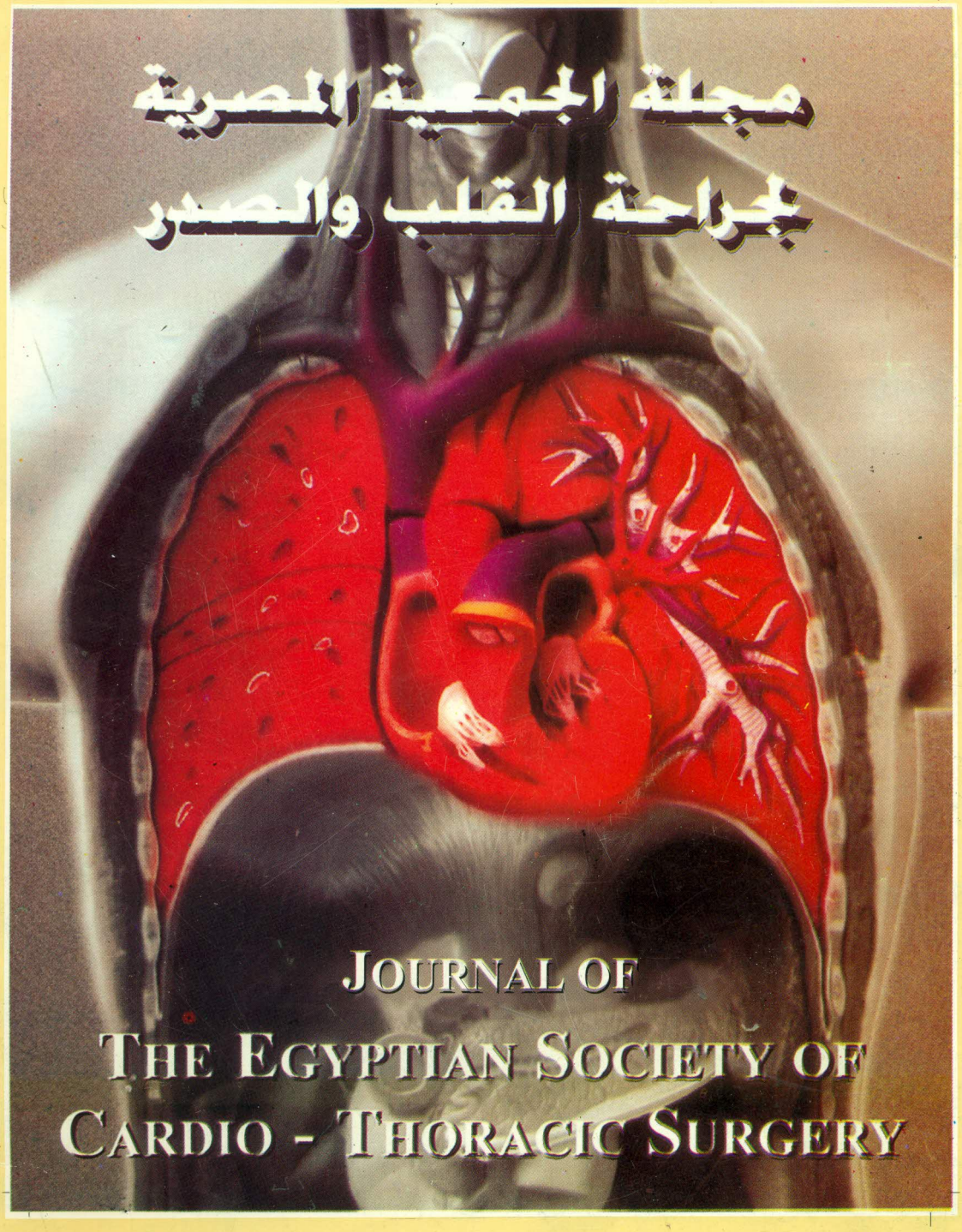

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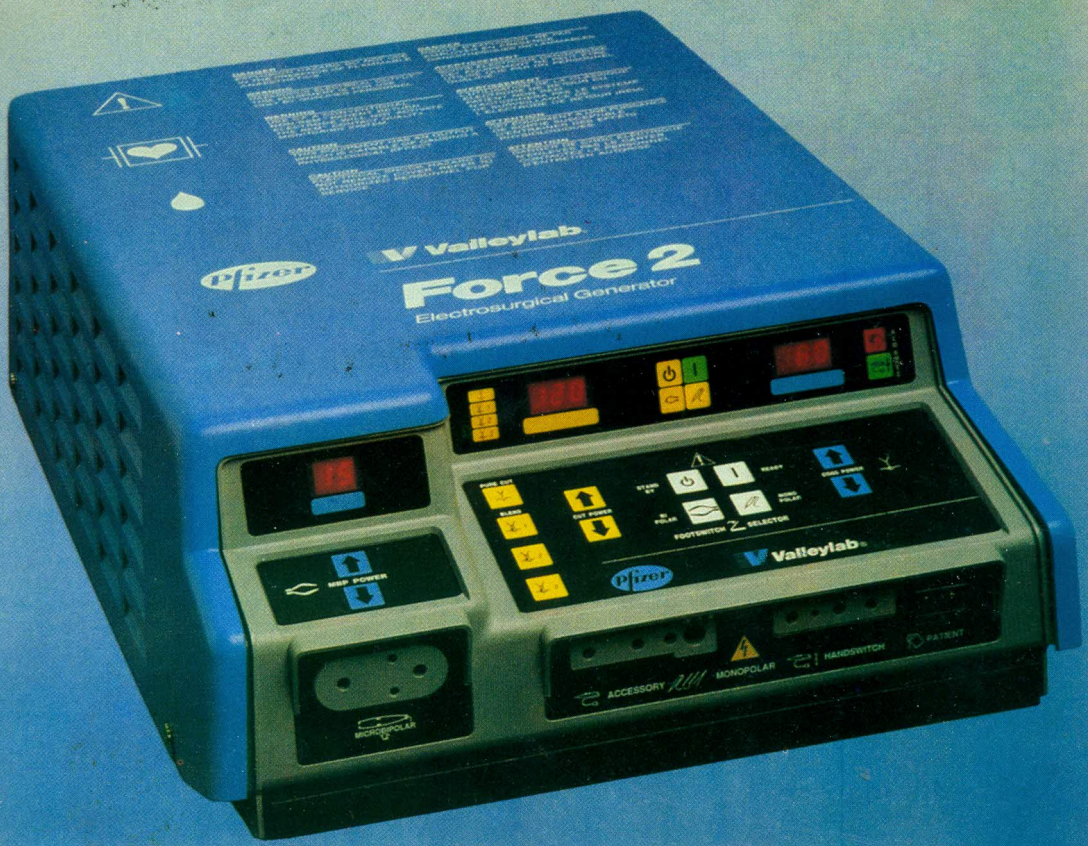

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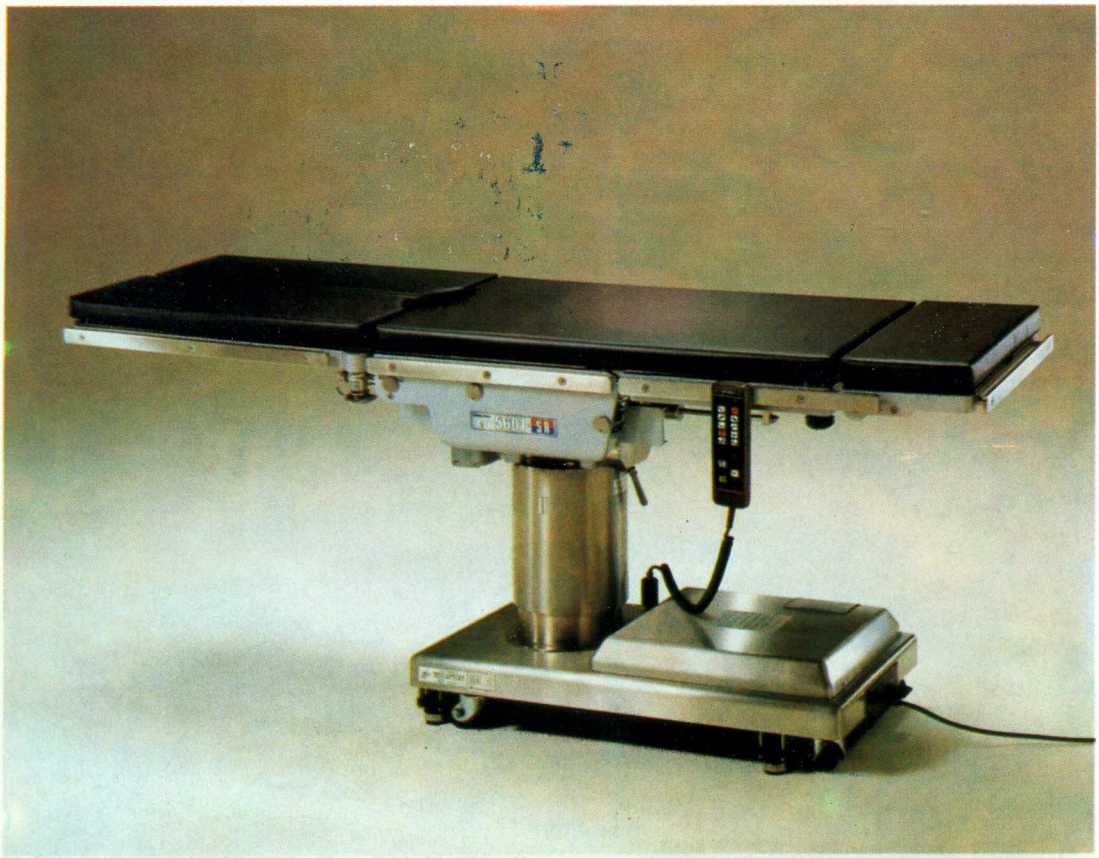

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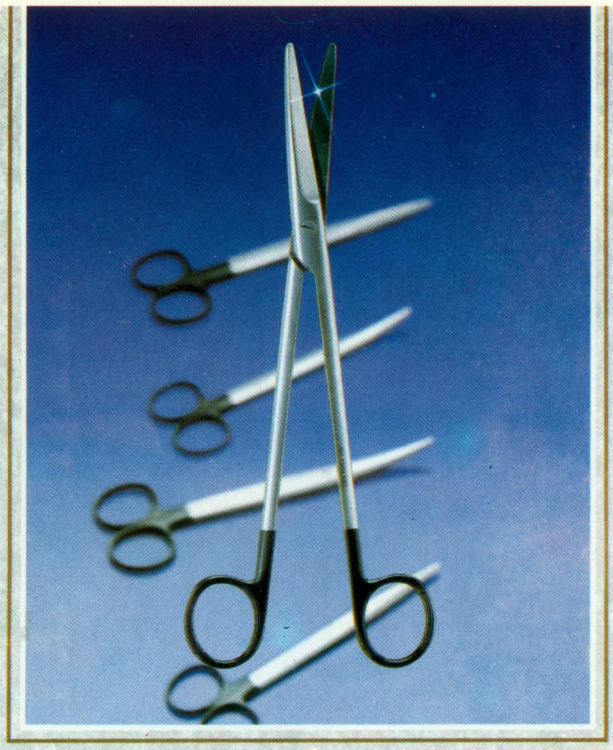

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Information for authors

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ANTERIOR PATCH ENLARGEMENT (AORTOVENTRICULOPLASTY) OF SMALL AORTIC ANNULUS IN REDO DOUBLE VALVE REPLACEMENT

ABSRTACT

The well known correlation between prosthetic valve orifice area and transvalvular gradient has raised the concern about the presence of significant residual gradients when the size of the prosthesis that can be used is limited by a small aortic annulus. This problem is more obvious in re-replacement of the aortic valve particularly in patients with large body surface area. Material and Methods: From November, 1997 to October, 1999, 30 patients underwent aortic and mitral valve re-replacement (Redo double valve replacement), 17 of them (group I) with enlargement of the aortic annulus while the other 13 patients (group II) did not had this procedure. In group I, male to female ratio was 3/14 while in group II it was 5/8. The ages of patients in group I and II ranged from 20 to 48 years (mean 34) and from 18 to 55 years (mean 36.5) respectively. Preoperative peak gradient across the aortic valve ranged from 75 to 135mmHg with a mean of 105mmHg in group I and from 65 to 118mmHg with a mean of 91.5mmHg in group II. The preoperative aortic annulus ranged from 17 to 21 mm in diameter in both groups. In the present study, patients of group I underwent double valve replacement with enlargement of the aortic annulus using the anterior approach (aortoventriculoplasty) technique. We modified the technique by adding 2 reinforcing mattress sutures with teflon pledgets at the meeting angles of the two Dacron patches which are the usual sites of bleeding. The postoperative evaluation (follow up ranged from 2 to 2 1 months) included clinical examination and echocardiographic studies. The postoperative peak gradient in group I ranged form 11 to 24mmHg with a mean of 17.5mmHg and ranged form 25 to 42mmHg with a mean of 33mmHg in group II. All patients are doing well with good haemodynamics. Conclusion: Aortic annular enlargement using the anterior approach (aortoventriculoplasty) technique is the method of choice for enlargement of small aortic annulus in redo double valve replacement, because we can not do this enlargement posteriorly as the mitral valve was also replaced by a prosthetic valve. Although this technique is demanding yet it is the best solution for such patients. It is safe procedure with good hemodynamic results.

Said Abdel Aziz, MD.

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INTRODUCTION

Residual postoperative gradients are often present after aortic valve replacement with prosthetic valve. The gradients are progressively increasing as the size of the prosthetic valve decreases. Therefore small prosthetic valves might become relatively stenotic, specially when implanted in patients with a large body surface area. The

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presence of a significant postoperative gradient has been thought to be responsible for adverse long term mortality and morbidity. In fact, the residual postoperative gradient might influence the extent of regression of left ventricular hypertrophy that in turn, is responsible for a higher incidence of arrhythmias and impaired ventricular function (1). A number of studies, mostly of patients with systemic arterial hypertension, have confirmed the adverse effect of left ventricular on life expectancy (2). Also it is reported that, the implantation of small, prosthetic valve in patients with a large body surface area increased the risk of late sudden death (3). The surgical management of patients with small aortic ring is nevertheless controversial became of the sub-optimal hemodynamics of small sizes of even the most advanced types of prostheses. For patients having a small aortic ring, the usual alternative to small valve implantation is to reduce the valve-prostheses mismatch by implanting a larger valve after enlargement of the aortic ring (4). In this study we describe the detailed operative technique and results of anterior patch enlargement (aortoventriculoplasty) of small aortic annulus in redo double valve replacement with a practical modification that lessens postoperative bleeding.

Patients and methods

From November, 1997 to October, 1999, 17 patients (group I) underwent aortic and mitral valve re-replacement (redo double valve replacement) with enlargement of the aortic annulus and during the same period, another 13 patients done by other surgeons (group H) underwent the same procedure but without enlargement of the aortic annulus. In group I, 14 patients (82%) were females and their ages ranged from 20 to 48 years with a mean of 34 years while in group II, there were 5 females (38%) and 8 males (62%) and their ages ranged from 18 to 55 years with a mean of 36.5 years. Those patients had been operated upon before for single or double valve surgery. All our cases were redo and the mitral valve would be replaced by a prosthetic valve, therefore, the aortic annulus enlarging procedure should only be through the anterior approach. The preoperative clinical data were summarized in table (1).

Inclusion Criteria:

* Aortic lesion either regurge or stenosis in patients with previous mitral valve repair or replacement.

* Malfunctioning prosthetic aortic valve in patients with previous double valve replacement.

* Malfunctioning prosthetic aortic valve in patients with previous aortic valve replacement in association with mitral valve disease.

Exclusion Criteria:

- Patients for double valve replacement for the first time.

- Patients with single aortic valve disease because there is another simple operative solution which is the Manouguian technique.

* Associated coronary artery disease requiring coronary artery bypass surgery.

* Patients with aortic annulus more than 21mm measured by echocardiography.

Table 1. Preoperative Clinical Data:

No. of patients	Group I (17)	Group II (13)
Age(y)	20-48 (mean 34)	18-55 (mean 36.5)
M/F	3/14	5/8
Previous operations		
MVR	13 (76%) MVR	5 (38%) MVR
MVRep	2 (12%) MVRep	4 (31%) MVRep
DVR	2 (12%) DVR	4 (31%) DVR
NYHA		
III	7 (41%)	4 (31%)
IV	10 (58%)	9 (69%)

***M** = male. **F** = female. **MVR** = mitral valve replacement. **MVRep** = mitral valve repair. **DVR** = double valve replacement. **NYHA** = New York Heart Association.*

Preoperative investigations:

Beside preoperative laboratory investigations, all patients were subjected to M-mode, two-dimensional, and Doppler echocardiography that was performed using the Hewlett-Packard series (Hewlett-Packard, in., Andover, Mass). Standard apical, parasternal, and subcostal views were obtained. The following parameters were measured and calculated: left ventricular end-diastolic and end-systolic diameters; the posterior and septal wall thickness; the aortic annulus and the peak gradients across the aortic valve. As concerning group I patients, the preoperative peak systolic gradient across the aortic valve ranged from 75 to 135 mmHg with a mean of 105 mmHg and the posterior wall thickness ranged from 1.4 to 1.8 cm with a mean of 1.6 cm while the septal wall thickness ranged from 1.3 to 1.8 cm with a range of 1.55 cm. The preoperative aortic annulus ranged from 17 mm to 21 mm. On the other hand, patients of group II showed that the preoperative peak systolic gradient across the aortic valve ranged from 65 to 118 mmHg with a mean of 91.5 mmHg and the posterior wall thickness ranged from 1.3 to 1.8 cm with a mean of 1.55 cm while the septal wall thickness ranged from 1.4 to 1.8 cm with a range of 1.6 cm. The preoperative aortic annulus ranged from 17mm to 21mm. Electrocardiograph (ECG) was done for each patient m both groups and showed evidence of left ventricular hypertrophy and strain for all patients.

The preoperative echocardiographic and ECG data were summarized in table (2).

Table 2. Preoperative echocardiographic and ECG data:

No. of patients	Group I (17)	Group II (13)
LVESD	2.5 - 4.3 (3.25)	2.7 - 4.8 (3.75)
LVEDD	5.2 - 6.9 (5.99)	5.5 - 6.8 (6.15)
PWT	1.4 - 1.8 (1.6)	1.3 - 1.8 (1.55)
SWT	1.3 - 1.8 (1.55)	1.4 - 1.8 (1.6)
Aortic annulus	17 – 21	17 - 21
PG across aortic valve(mmHg)	75-135 (105)	65-118 (91.5)
ECG		
Sinus	12 (70%)	6 (46.1%)
AF	5 (30%)	7 (53.8%)
LV hypertrophy	17 (100%)	13 (100%)

***LVESD** = left ventricular end systolic diameter **LVEDD** = left ventricular end diastolic diameter. **PWT** = posterior wall thickness. **LV** = left ventricle. **SWT** = septal wall thickness. **PG** = peak pressure gradient. **ECG** = electrocardiograph. **Af** = atrial fibrillation.*

Operative Technique:

All operations for both groups were performed through median sternotomy incision. Two millions KIU of aprotinin (Trasylol) were given before establishing the cardiopulmonary bypass. After cardiopulmonary bypass was established and aorta cross-clamped, cold blood cardioplegic solution was instilled into the aortic root. If aortic insufficiency was present, the aorta was opened longitudinally and the cardioplegic solution was given into the left and right coronary ostia selectively. First, the left atrium was opened and the mitral valve was replaced in all cases of both groups, then the left atriotomy was closed by running suture using 3-0 prolene (Ethicon, Somerville, NJ). All patients of group II received size 19 prosthetic valve in the aortic position without doing any of the enlargement procedures. The types of valve inserted m group II m aortic position were standard St Jude Medical (10 cases) and standard Carbomedics (3 cases).

As regard group I patients in whom aortic annular enlargement was done, a longitudinal incision was made on the anterior aspect of the aorta (Fig. 1A) and then the aortic valve was inspected and then excised. The annulus was then estimated. If size 21 or more prosthetic valve could not be inserted, the aortotomy incision was

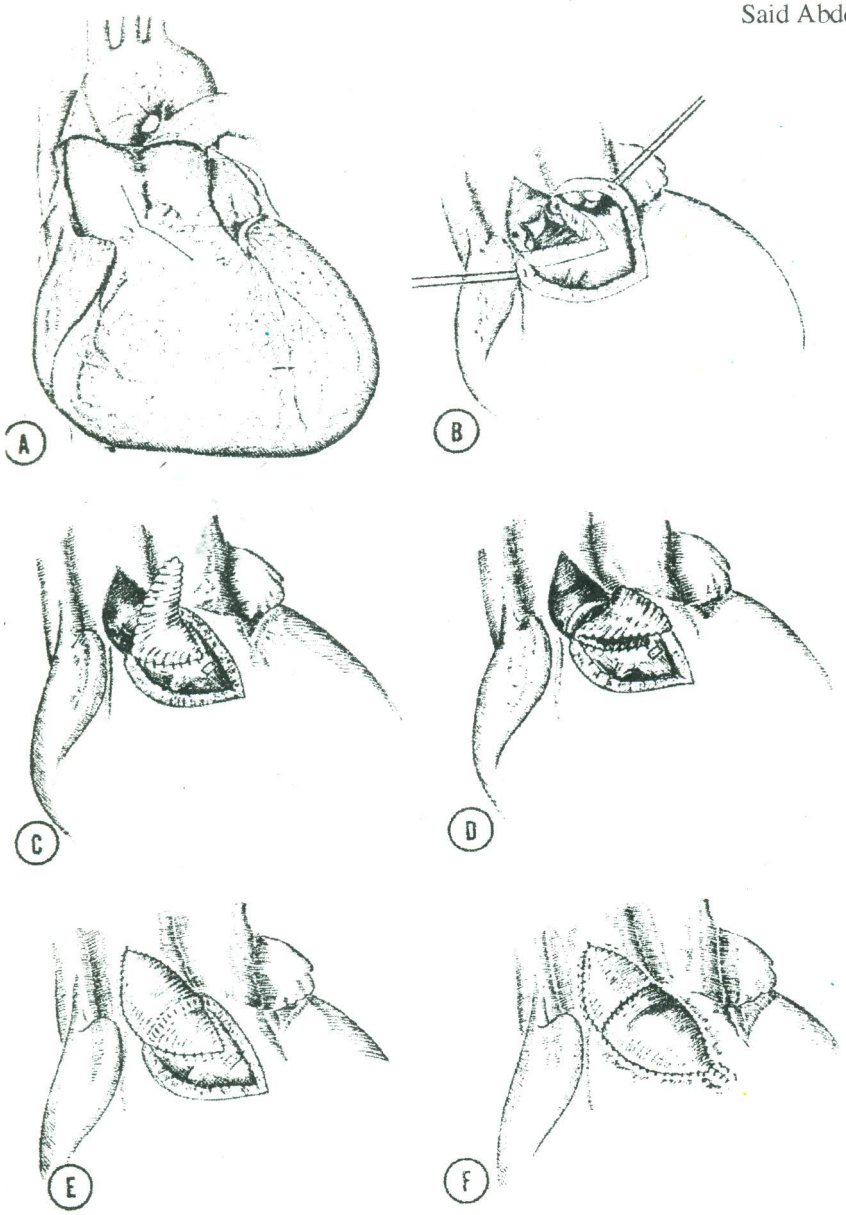

Fig. 1: *Operative technique of Konno procedure.* ***A,*** *Anterior longtudinal incision in the aorta.* ***B,*** *Opening the aorta, right ventricle and interventricular septum.* ***C,*** *Patching the septal incision.* ***D,*** *Replacement of the aortic valve.* ***E,*** *Closure of the aortic incision by the same Dacron patch.* ***F,*** *Closure of the right ventricular outflow tract by another Dacron patch.*

continued slightly to the left of the right coronary ostium and extended across the aortic annulus into the right ventricular free wall just below the level of the pulmonary valve and down into the inter-ventricular septum as described by Konno and associates (5). The incision was then continued down into the septum according to the width we need (Fig. 1B).

For closure, a woven Dacron prosthetic vascular graft was incised longitudinally, cut into an appropriately sized ellipse for the septal patch that closed the septal defect, and brought up onto the aorta (Fig. 1C). The Dacron patch was sutured (using 4-0 prolene, Ethicon, Somerville, NJ) on the right ventricular side of the septal defect so that it does not interfere with the leaflets of the prosthetic valve and prevent any subvalvular obstruction. Three reinforcement interrupted transverse mattress sutures (3-0 prolene, Ethicon, Somerville, NJ) were placed through the interventricular septum on Teflon pledget and were tied on the left ventricular side. These 3 sutures were placed one at the apex and one on either side of the septal defect. This reduces the possibility of postoperative interventricular septal defect with left to right shunt. After then, the patch was sutured to the level of the aortic annulus, and the valve sizers were used to estimate the new enlarged aortic annulus.

Valve sutures (2-0 Ethibond without Teflon pledget, Ethicon, Somerville, NJ) were first placed through the native portions of the annulus. Interlocking transverse matters sutures with Teflon pledgets were then used to secure the remainder of the prosthetic valve sewing ring to the Dacron patch. After all the valve sutures on the native portion of the annulus and on the Dacron patch were tied and cut, a running suture (4-0 prolene, Ethicon, Somerville, NJ) was used in over- and-over fashion to secure the upper portion of the patch to the edge of the resulting defect in the anterior aspect of the ascending aorta. The Dacron patch could be extended as far cephalad on the ascendmg aorta as was necessary to enlarge any narrowing of the proximal aorta. After this, the aortic crossclamp was released and rewarming was started. The remaining defect in the right ventricular outflow tract was patched with a separate Dacron patch. The patch was sutured to the right ventricular wall with a running over-and-over 4-0 prolene suture. We modified the technique by adding 2 reinforcing mattress sutures with teflon pledgets at the meeting angles of the two Dacron patches winch are the usual sites of bleeding (Figure 1D,E,,F). The types of valve inserted in group I in aortic position were standard St Jude Medical (10 cases), St Jude Medical BP (5 cases) and Carbomedics R (2 cases).

Results

Clinical and Echocardiocraphic Data:

Table 1 and 2 list the preoperative clinical and echocardiographic As regard the postoperative period, the New York Heart Association (NYHA) functional class improved in all patients in both groups. The majority of patients in group I and II (15/17 , 88%) (1 / 13, 84%) were in NYHA class 1 respectively (Fig. 2&3). In group I the postoperative peak gradient across -the aortic valve ranged from 11 to 24 mmHg with a mean of 17.5 mmHg (Fig.4). while in group 11 the postoperative peak gradient across the aortic valve ranged from 25 to 42

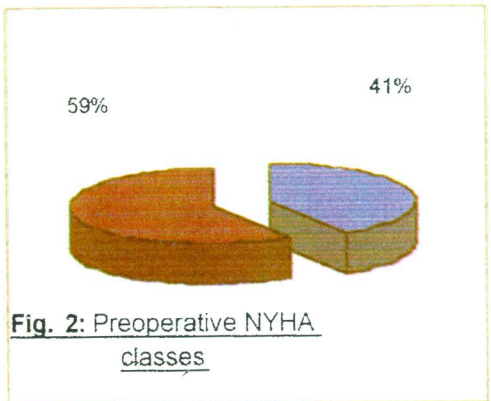

Fig. 2: Preoperative NYHA classes

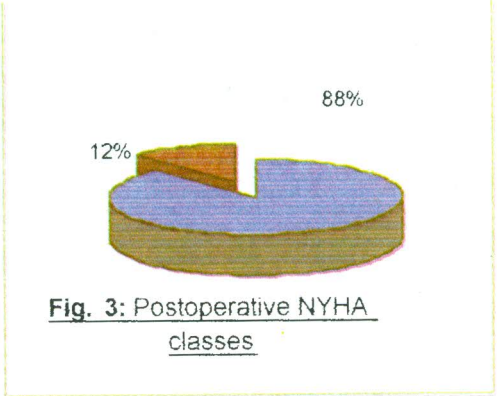

Fig. 3: Postoperative NYHA classes

(59%=NYHA IV) (41%=NYHA III) (12%=NYHA II)(88%=NYHA I)

Fig. 2&3:Pre and postoperative NYHA functional classes for group I patients

Table 3. Postoperative clinical and echocardiographic data:

No. of patients	Group I (17)	Group II (13)
LVESD	2.4 - 4.5 (3.41)	2.5 - 4.7 (3.6)
LVEDD	5.4 - 6.1 (5.75)	5.3 - 6.3 (5.8)
PWT	1.1 - 1.5 (1.3)	1.2 - 1.6 (1.4)
SWT	1.1 - 1.4 (1.25)	1.1 - 1.5 (1.3)
PG across aortic valve (mmHg)	11 - 24 (17.5)	25 – 42 (33.5)
NYHA I II	 15 (88%) 2 (12%)	 11 (84%) 2 (16%)

***LVESD** = left ventricular end systolic diameter. **LVEDD** = left ventricular end diastolic diameter. **PG** = peak pressure gradient. **PWT** = posterior wall thickness. **SWT** = septal wall thickness. **NYHA** = New York Heart Association.*

mmHg with a mean of 33.5 mmHg. In all patients of group I, the Konno procedure resulted in sufficient augmentation of the aortic annulus to allow placement of a prostheses at least 2 I mm. in external diameter. For both groups there were no significant change in the postoperative left ventricular dimensions, however, the

posterior and septal wall thickness was reduced markedly over the follow up period. ECG was done for each patient in the early postoperative period and it was the same as the preoperative. All 30 patients had satisfactory hemodynamic results. The postoperative clinical and echocardiographic data are summarized in table (3).

Operative data.

All patients had satisfactory hemodynamics results at the end of the operation. As regard group 1, The aortic cross-clamp time averaged 115 minutes (range 88 to 143 minutes) and the cardiopulmonary bypass time averaged 146 minutes (range 108 to 185 minutes). On the other hand, in group II, the aortic cross-clamp time averaged 95

Fig. 4: Pre&Postoperative PG across aortic valve for group I patients

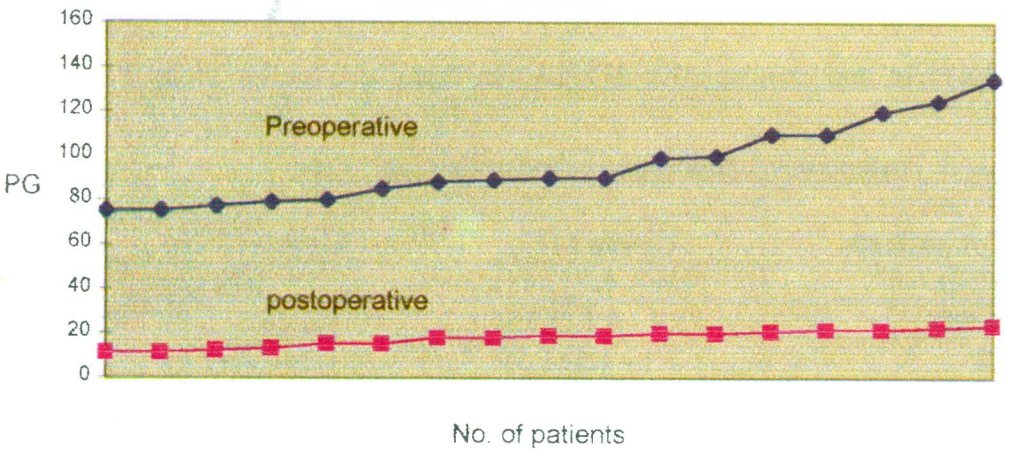

Table 4. Operative data:

No. of patients	Group I (17)	Group II (13)
Cross-clamp time (min)	88 - 143 (115)	70 – 120 (95)
Total pump time (min)	108 - 185 (146)	88 - 155 (121)
Prosthetic valve size		
19	0%	13 patients (100%)
21	2 Patients (12%)	0%
23	14 patients (82%)	0%
25	1 patients (6%)	0%

minutes (range 70 to 120 minutes) and the cardiopulmonary bypass time averaged 121 minutes (range 88 to 155 minutes). There was no abnormal rhythm after coming off bypass and all patients had the same preoperative rhythm. The sizes of the prosthetic valves used m the aortic position, as concerning group I, were 23 in 14 patients (82%), 21 in 2 patients (12%), and 25 in one patient (6%) table(4). In each patient the valve prostheses inserted was at least two or three sizes larger than that which could have been inserted with the standard aortic valve replacement. There was one re-operation for bleeding. In group II, all patients received size 19 prosthetic valve in the aortic position.

Discussion

Management of small aortic annulus is a challenge to the surgeon with regard the operative technique and selection of valve prosthesis. Many techniques have been described to accommodate a larger prosthesis to solve this problem (5,6).

It is possible to enlarge the aortic annulus by a few millimeters, especially during aortic valve replacement by incising the base of the non-coronary cusp and inserting a Dacron patch as described by Nicks and associates (7,8). On the other hand, Manouguian and associates (6) reported another technique in which the aortotomy incision is directed precisely toward the center of the fibrous origin of the anterior mitral leaflet and then inserting a patch to enlarge the aortic annulus. However, those previous two techniques are not applicable in our cases because the mitral valve was already replaced by a prosthetic valve due to the associated mitral valve disease and therefore we could not enlarge the aortic annulus through this posterior approach.. Accordingly, the only way to enlarge the aortic annulus in our cases was the anterior approach through the Konno-Rastan (aortoventriculoplasty) procedure.

In 1975 and 1976, Konno and associates (5) and Rastan and Konez (9) respectively reported the clinical use of the aortoventriculplasty technique to enlarge tunnel-like subaortic stenosis. In 1978 Rastan and colleagues (10) reported a more extensive experience with this technique.

In our study we used two woven Dacron patches; one to patch the incised septum and then completed to close the aortotomy; and the other patch to reconstruct the right ventricular outflow tract. Konno (5) originally described placing a pericardial patch over each of the Dacron patches to control bleeding through the Dacron grafts. He also suggested the use of pericardial patch to reconstruct the right (low-pressure chamber) ventricular outflow tract. Other investigators (11) extended the concept of using the pericardium for control of bleeding and simplified the procedure by continuing the pericardial patch used on the right ventricular outflow tract onto the aorta to completely cover the Dacron patch of the septum and the aorta.

In our cases bleeding through the Dacron patches was minimized by using woven Dacron and by giving 2millions KIU of aprotinin (Trasylol) before cardiopulmonary bypass. Also we added two stitches of prolene 3/0 with teflon bledget as a mattress stitch at the meeting angles of the two Dacron patches because these angles are usual sites of bleeding. In our technique we placed the Dacron patch on the right ventricular side of the septum to obtain the largest possible left ventricular

outflow tract. As described before, three interrupted horizontal mattress sutures were used to reinforce the Dacron patch over the septum. Rastan and associates (10) reported the same procedure while Misbach and associates (11) reported the placement of the Dacron patch on the left ventricular side of the septum to reduce the possible leak- which would be manifested as ventricular septal defect with left to right shunt. However, we did not face any postoperative residual ventricular septal defect in our cases.

The use of this technique in our cases showed significant relief of the pressure over load on the left ventricle in both groups as the transvalvular pressure gradient decreased markedly as shown in the postoperative echocardiography. However, in patients of group II the residual transvalvular pressure gradient is still higher than that of group I patients. The left ventricular hypertrophy is also improved as proved by the decrease of the septal wall and posterior wall thickness. The results published by Gonzales-Juanatey and co-workers(4) in 1996 strongly support the results obtained in our study. They concluded that, 19mm aortic prostheses continue to create a significant obstruction of the left ventricular outflow tract and possibly as a consequence of this, fail to bring about significant reduction in left ventricular hypertrophy. Aortic prostheses of this size should probably not be implanted in young or physically active patients or in patients with body surface area greater than 1.7 m^2. Instead, aortic valve replacement in these groups of patients should probably be effected by means of a homograft or by implantation of a 21 mm or larger valve after aortic root enlargement. Another study was published by Sim and colleagues (12) reported that, despite the high technology in artificial valve designs, the 19mm size valves may not provide comparable reduction in the left ventricular mass following aortic valve replacement for aortic stenosis, and the aortic root enlargement permits a larger prosthetic implantation and greater potential for reduction in left ventricular mass without an increase in the operative time or postoperative complications. Also left ventricular hypertrophy is a well known risk factor for sudden death and cardiovascular morbidity (13) and valve size as a risk factor for long term survival has been demonstrated by Jones and associates (14).

On the contrary, other investigators (15)(16)emphasize that the long term performance of 19mm prosthetic vain the small aortic root is satisfactory irrespective of the body surface area, and it is an alternative for such patients. However, patients who underwent enlargement of a small aortic annulus had long term survival and freedom from cardiac and valve related death comparable to those of patients who received larger aortic prostheses (17).

Two patients had a special problem that was the small aortic annulus of the previously implanted aortic valvular prostheses. Once the prostheses is implanted, no further growth of the annulus is possible and a larger prostheses can not be implanted without an annulus enlarging procedure. The Konno procedure allowed replacement of these valves with a valve larger enough for an adult. Although the

cardiopulmonary bypass time is prolonged than usual, yet this does not affect the outcome of the operation.

In summary, aortic annular enlargement using the anterior approach (aortoventriculoplasty) technique is the method of choice for enlargement of the small aortic annulus in redo double valve replacement, because we £m not do this enlargement posteriorly as the mitral valve was also replaced by a prosthetic valve. Although this technique is demanding, yet it is the best solution for such patients without higher operative risk. It is safe procedure with good hemodynamic results.

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INTRAOPERATIVE TRANS ESOPHAGEAL ECHOCARDIOGRAPHY GUIDED CANNULATION OF CORONARY SINUS.

ABSRTACT

Retrograde cardioplegia offers several distinctive advantages during different open-heart procedures. We adopted a technique of retrograde cannulation of the coronary sinus guided by intraoperative trans esophageal echocardiography (TEE) without touching the heart to avoid haemodynamic derangement (no-touch technique) in 194 consecutive patients. There were 189 males and 5 females. The patients' age ranged from 34 to 75 years with mean of 50 years. Coronary bypass procedure performed in 182 patients, redo coronary bypass operation in 5 patients, double valve replacement in 2 patients aortic valve replacement in 3 patients and redo aortic valve replacement in 2 patients. TEE 5.0MHZ omniplane probe, is inserted in the mid-esophagus and then connected to the echocardiography machine (Hewlett Packard, Sonos 2500, Andover, Massachusetts, USA). From the modified 4-chamber view at mid esophageal probe position, obtained by slight advancement of the probe and /or by retroflexion of the TEE probe, a view of the coronary sinus is obtained and real time assessment of retrograde cannula insertion is noted until a satisfactory position is obtained inside the coronary sinus All coronary sinuses were successfully cannulated by means of this technique. All hearts arrested easily with only retrograde cardioplegia. All procedures were accomplished without significant incident. No patient had evidence of CS injury or perforation and no other cardiac structures were perforated. There were no episodes of significant arrhythmia, but 4 patients (2%) developed intraoperative heart block. Two patients (1%) died of hospitalacquired septicemia and multisystem organ failure during their third postoperative week. Based on this experience, we conclude that the coronary sinus can be easily intubated transatrially guided by TEE using a catheter with a flexible stylet. Our technique of retrograde cannulation of the coronary sinus guided by intraoperative TEE without touching the heart, is simple, reproducible and quite easy even after going on-bypass for any reason.

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INTRODUCTION

Retrograde delivery of blood cardioplegia provides excellent myocardial protection when delivered by right atrial infusion (1) or by direct cannulation of the coronary sinus (2). In mitral valve procedures, one advantage of retrograde cardioplegia is the ability to infuse cardioplegic solutions with prolonged maintenance of hypothermia and cardiac arrest without interrupting the continuity of

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the procedure. Also during aortic valve procedures coronary ostial cannulation with its attendant risks of. selective cannulation, coronary artery dissection, and post cannulation ostial stenosis is avoided (3). For coronary bypass surgery, retrograde cardioplegia provides uniform distribution of cooling throughout both ventricles despite coronary lesions (4). In redo coronary bypass procedures, retrograde cardioplegia delivery has the distinctive advantage of creating reversal of flow in diseased grafts, which can be cut or ligated at an early stage, reducing the possibility of embolization of graft wall material (5). Finally, myocardial protection in acute aortic dissection is equally enhanced (6).

The availability of balloon-tipped canulae designed for closed atrial placement has eliminated the need for bicaval cannulation and opening of the right atrium. However, the most commonly described techniques for retrograde catheter placement involve palpation of the right atrioventricular groove-inferior vena cava junction to guide the catheter into the coronary sinus (6,7). These techniques might be time consuming and causing haemodynamic derangement especially in dilated hearts. In redo coronary bypass operations this requires considerable dissection and unavoidable handling of any patent grafts supplying the right or circumflex coronary artery system. This dissection can be merely time consuming in the case of redo aortic or mitral valve procedures, where dissection of the entire cardiac structure may not be desired or advantageous.

Intraoperative trans esophageal echocardiography (TEE) is a technique that allows for the direct visualization of the heart. Assessment of important factors for intraoperative management like hemodynamic parameters, determination of global myocardial function, and detection of ischemia, may be immediately and noninvasively assessed by this technique (8).

We adopted a technique of retrograde cannulation of the coronary sinus guided by intraoperative trans esophageal echocardiography (TEE) without touching the heart to avoid haemodynamic derangement (no-touch technique).

This is a retrospective study done to evaluate the technique of placement of the retrograde cardiopiegia cannula that allows for precise positioning of the retroplegia cannula at any desired location in the coronary sinus using TEE.

Patients and Methods

From September 1997 to February 1999, In Dubai Hospital, one hundred ninty four (194) consecutive patients underwent open-heart surgery using the technique of retrograde blood cardioplegia as the technique of myocardial protection. There were 189 males and 5 females. The patients' age ranged from 34 to 75 years with mean of 50 years. Operations performed are listed in table (1).

Surgical technique. Standardized techniques of anesthesia and operative procedures were used in all patients. Monitoring for the patients include: ECG, continuous 12 leads S-T segment analysis, and other monitoring lines (radial artery cannula, CVP line, urinary catheter). Thereafter, a 5.0-MHZ TEE omniplane probe, is inserted in the mid-esophagus and then connected to the echocardiography

Table 1: Operations list

Number of patients	Operations
182	coronary bypass
5	redo coronary bypass
2	double valve replacement
3	aortic valve replacement
2	redo aortic valve replacement
194	total number of patients

machine (Hewlett Packard, Sonos 2500, Andover, Massachusetts, USA). The mid-esophageal 4 chamber view was monitored.

The chest was entered through a median sternotomy incision. The left internal mammary artery (LIMA) was harvested in bypass patients whenever possible, simultaneously with the saphenous vein of the right leg. In bypass cases, doublestage single venous cannula was used, while in mitral and double valve replacements, two separate venous cannulae are used to cannulate both vena cavae. All operations were performed using standard cardiopulmonary bypass, systemic hypothermia to 28 - 30 CO and topical cold saline slush. All the distal anastomosis were performed first during a single period of aortic cross clamping, and the proximal anastomosis were performed after decamping, with a partial occluding clamp.

For redo cases, the sternum was divided with the oscillating saw after removal of the previously placed sternal wires. The ascending aorta is dissected for aortic cannulation and the high right atrium is freed from surrounding adhsions enough to place cannulation sutures. When vein grafts are present, no attempt's were made to dissect the junction of the inferior vena cava and atrioventricular groove or the diaphragmatic surface of the heart. The

Table 2: Operative data. CC: cross clamp, CPB: cardipulmpnary bypass. Data are expressed as mean ± standard of mean (SEM).

Variable		Operative data
CC time (minutes)	:	72± 1
CPB time (minutes)	:	127± 2
Cardioplegia volume (ml)	:	2350 ± 50

aortic cross-clamping time, the cardiopulmonary bypass time (CPB) and cardioplegia volume is mentioned in table (2).

Cardioplegia protocol: Blood cardioplegia was prepared by mixing four parts of the patient's oxygenated blood with one part of crystalloid solution (St. Thomas Hospital solution number 1 was used) and was delivered using the Medtronic blood cardioplegia system (Medtronic Bio-Medicus lnc, Eden Prairie, MN, USA). Two different concentrations were prepared according to the potassium content.. high potassium solution (containing 30 mEq/L of potassium), and low potassium solution (containing 15 m Eq/L of potassium). Induction of cardiac arrest was achieved with an infusion of the high potassium, cold blood cardioplegia solution (temperature 12- 14 °), in a dose of 15 ml/kg body weight. The maintenance was achieved with the low potassium cold solution in a dose of 5 ml/kg body weight repeated every 15 minutes. Reperfusion was achieved with infusion of 500 ml of the low potassium, warm cardioplegia solution (temperature 35 - 37 C°) over period of 3 to 5 minutes prior to aortic decamping (hot shot).

Cannulation of the CS:

For retrograde cardioplegia cannulation we have used the Buckberg retroplegia cannula with self-inflating balloon and a semi-rigid stylet and a handle (RMI code RC-014 from Research Medical Incorporation, Midvale, Utah, USA). Pressure monitoring during cardioplegic infusion in the coronary sinus was done routinely and was kept between 30 to 50 mm Hg.

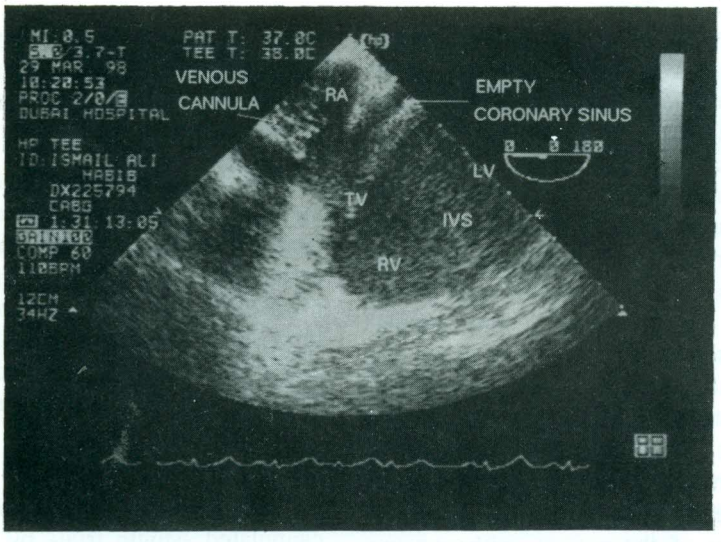

Fig. 1

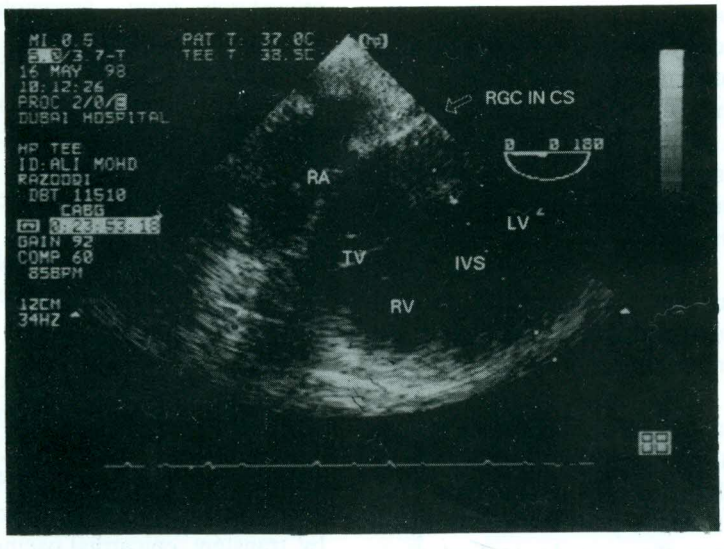

Fig. 2

Coronary sinus cannulation was accomplished before cardiopulmonary bypass in all patients. A 4-0 prolene purse string suture is placed high in the right atrium, anterior to the venous cannula, and is withdrawn through a rubber tourniquet.

A small puncture is made within the boundaries of the purse string suture and the site is enlarged minimally by inserting a curved clamp and opening its jaws. Advancement of the cannula into the coronary sinus can be accomplished easily from the surgeon side of the operating table using the right hand. The stylet and the cannula are introduced into the right atrium anterior to the two stage venous cannula, and are inserted far enough to advance the balloon into an intra-atrial position. The mattress suture and tourniquet are snugged to prevent bleeding. The cannula is advanced in a direction that extends at an approximate 45° angle directly toward the left shoulder of the patient without using any force. The TEE will guide its entrance into the coronary sinus, and verify its correct placement position. From the modified 4-chamber view at mid esophageal probe position, obtained by slight advancement of the probe and /or by retroflexion of the TEE probe, a view of the coronary sinus is obtained Figure (1) and real time assessment of retrograde cannula insertion is noted until a satisfactory position is obtained inside the coronary sinus Figure (2). The technique requires good communication between the echographer and the surgeon, and appropriate appreciation of the relation between spatial orientation and the display on the echocardiography screen. The stylet is then withdrawn while the coronary sinus cannula is held in position. Blood is then aspirated from the cannula to displace air and the cannula is clamped proximal to the exit of the pressure line. Pressure tracing and wave form verified and compared to central venous pressure. Also the exact position is checked and adjusted during aortic cross clamping and subsequent cardioplegia infusions or after manipulating the heart to verify that the cannula is still in proper position.

Data used for intraoperative evaluation include: the aortic cross-clamping time, the cardiopulmonary bypass time (CPB) and cardioplegia volume. The need of myocardial inotropic support, the use of intra aortic balloon pump (IABP), the use of a pacemaker or the need of repeat bypass to support the myocardium was recorded.

Results

All coronary sinuses were successfully cannulated -single trial- by means of this technique. All hearts arrested easily with only retrograde cardioplegia. All procedures were accomplished without significant incident. Intra aortic balloon pump (IABP) was required for weaning off bypass in 12 patients (6%) and only 23 patients (12%) were given inotropic support (Dopamine > 5 microgram / Kg / min or adrenaline). Eighteen patients (9%) had perioperative myocardial infarction as indicated by the presence of new Q waves and rise in creatine kinase MB fraction above 100 U/L.

No patient had evidence of CS injury or perforation and no other cardiac structures were perforated. There were no episodes of significant arrhythmia, but 4 patients (2%) developed intraoperative heart block treated by transient epicardial pacing for 48 hours. Two patients (1%) died of hospital-acquired septicemia and multisystem organ failure during their third postoperative week. The Postoperative morbidity and mortality are listed in table (3).

Table 3: Postoperative morbidity and mortality

Variable	Number of patients
Low cardiac output	:23 (12%)
IABP support	:12 (6%)
Heart block	:4 (2%)
Coronary sinus injury	:0
Perioperative myocardial infarction	:18 (9%)
Prolonged intensive care stay (> 48 hours)	:33 (17%)
Prolonged ventilation (> 24 hours)	:20 (10%)
Pulmonary complications	:23 (12%)
Infection	:9 (5%)
Hospital mortality	:2 (1%)

Discussion

Retrograde cardioplegic protection of the myocardium has entered a period of rapidly increasing interest by researchers and clinicians. Its appeal stems from the known limitations of antegrade delivery of cardioplegia, namely, inadequate distribution of cardiopiegia distal to coronary artery lesions (9), damage to coronary ostia, difficulty in ostial cannulation (10), and distal emboli from previous vein grafts (11).

In contrast, retrograde cardioplegia provides uniform distribution of cooling throughout both ventricles despite coronary lesions (4). Coronary ostia are neither sought nor injured with retrograde methods. Old vein grafts can be cut and any distal embolic material flushed retrogradely out of the coronary arteries and old grafts. Moreover, reoperations with patent internal mammary arteries are possible as all parts of the heart receive adequate myocardial protection. Mitral and aortic valve operations are accomplished more expeditiously; the operation can proceed without the interruption of cannulating coronary arteries or putting retractors down to restore aortic valve competence before giving more antegrade cardioplegia (12).

Despite these obvious benefits, the initial application of retrograde cardioplegia with open intubation of the CS necessitated a more complicated steps required to cannulate the coronary sinus, ie, bicavai cannulation, caval snares, and an atriotomy. Not only are these time consuming, but valuable cross-clamp time can be expanded while searching for and then cannulating the coronary sinus through a small atriotomy.

The introduction of transatrial intubation of the CS in 1988 did much to add retrograde cardioplegia into the armamentarium of the practicing cardiac surgeon, but for the most part palpation of the cannula within the atrioventricular groove was necessary to ensure its proper placement in the CS (6). In the case of redo operations, such dissection and manipulation would not be optimal.

It is our belief -as well as others- (1,6), that retrograde cardioplegia must be as facile to administer as antegrade cardioplegia for it to become more widely used. It has been demonstrated that the coronary sinus can be easily intubated transatrially by a variety of surgeons and used with good results on a variety of cardiac lesions. In our experience, we have become convinced that in certain lesions, transatrial coronary sinus cardioplegia is more facile than antegrade cardioplegia. These lesions include all valve replacements, valve and coronary combination operations; redo operations, aortic root surgery and revascularizations for acute myocardial ischemia. With practice, intubating the coronary sinus could be as easy as putting a cardioplegia needle into the ascending aorta.

Intraoperative trans esophageal echocardiography (TEE) is indicated as a valuable adjunct in the evaluation of many surgical procedures. Primary valvular surgery including valve repair and/or prosthetic valve replacement, are the most important indications for TEE. Intraoperative TEE is also indicated for the evaluation of surgical procedures for hypertrophic obstructive cardiomyopathy, congenital heart disease, thoracic aortic disease, and a variety of other indications, such as neoplastic or traumatic cardiac disease (13). TEE is also used for intraoperative monitoring of global left ventricular function and monitoring of segmental left ventricle (LV) regional wall motion abnormalities (RWMA) during coronary artery bypass graft surgery (14)

Another no-touch technique for coronary sinus cannulation was described by Gundry and colleagues, depending upon detection of specific coronary sinus waveforms, which is best described as a dampened pulmonary artery tracing (15). It is sometimes quite difficult to detect and interpret the specific coronary sinus waveforms especially with any haemodynamic derangements or going on bypass. Othe contrary, our technique of retrograde cannulation of the coronary sinus guided by intraoperative trans esophageal echocardiography without touching the heart, is simple, reproducible and quite easy even after going on-bypass for any reason.

Conclusion

Based on this experience, we conclude that the coronary sinus can be easily intubated transatrially guided by TEE using a catheter with a flexible stylet. Placement

of the balloon and catheter well into the great cardiac vein -usually past the posterior interventricular vein or even more distally- will avoid dislodgement during cardiac manipulation without coronary sinus or myocardial injury. Transatrial coronary sinus cardioplegia may be the cardioplegia method of choice for all operations, but at the very least it offers a superb alternative method of cardioplegia delivery for valve operations, coronary revascularizations, redo valve operations and redo coronary bypass operations.

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CHANGES IN PULMONARY ARTERY PRESSURE FOLLOWING REPAIR OF VENTRICULAR SEPTAL DEFECT. EARLY AND LATE POSTOPERATIVE RESULTS

ABSRTACT

Thirty patients underwent open-heart surgery for closure of ventricular septal defect (VSD). Age ranged from 6 months up to 28 years (mean 7.4 ± 1 years). The mean weight was 22.4 ± 2.9 kg. Six patients (53.4%) were in NYHA functional class 1, 7 patients (23.3%) were in NYHA 11, and 7 patients (23.3%) were in NYHA Ill. Twenty-eight patients had perimembranous VSD, one patient had subarterial VSD and one patient had muscular VSD. The preoperative systolic pulmonary artery pressure ranged from 35 to 130 mmHg (mean 68.6 ± 4.2 mmHg). It dropped immediately after closure of the VSD to a mean of 45.8 ± 3.9 mmHg (P < 0.01) and continued to drop in the early post op. study to a mean of 42.7 ± 4.6 mmHg (P < 0.001). In the late post op study it returned to nearly normal value with a mean of 27 ± 1 mmHg (P < 0.0001). The preoperative diastolic pulmonary artery pressure ranged from 8 to 70 mmHg (mean 32.2 ± 2.5mmHg). This dropped immediately to a mean of 22.5 ± 2.2 mmHg (P < 0.01) and continued to drop in the early postoperative study to a mean of 19.1 ± 2.3 mmHg (P < 0.001), and in the late postoperative study to a mean of 11.8 ± 0.8 mmHg (P < 0.0001). The mean preoperative right ventricular ejection fraction was 48 ± 2%. It improved in the early postoperative study to a mean of 51 ± 1% (P < 0.05) and in the late postoperative study to a mean of 55 ± 2% (P < 0.01). The preoperative cardiothoracic ratio ranged from 56 to 67% with a mean of 60.8 ± 2%. It was significantly reduced after repair of VSD in the late postoperative study to a mean of 55 ± 0.5% (P < 0.002). Four patients died (13.3%), all were below 6 years of age and ail were having systolic pulmonary artery pressure > 55 mmHg.

In conclusion, this study shows those patients with hypertensive VSD benefit from surgical repair with significant drop of pulmonary artery pressure.

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INTRODUCTION

Isolated ventricular septal defect (VSD) is the most common congenital heart defect, accounting for 20% to 25% of all forms of congenital cardiac lesions (1). It is present in over half of all congenital anomalies of the heart as either an isolated or a combined lesion (2). VSD may be either perimembranous, muscular or subarterial defects (3). The functional disturbance

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caused by a VSD depends primarily on its size and the status of the pulmonary vascular bed rather than on the location of the defect (4). A wide spectrum exists in the natural history of VSD ranging from spontaneous closure to congestive cardiac failure and death early in infancy. Within this spectrum are possible development of pulmonary vascular obstruction, right ventricular outflow tract obstruction, aortic regurgitation and infective endocarditis (5).

It is of utmost importance to identify patients who may develop irreversible pulmonary vascular obstructive disease. Patients with pulmonary hypertension are especially at risk and must be subjected to prompt closure of their VSD (6).

Choosing the proper time for operative intervention is not easy because preoperative hemodynamic findings alone do not necessarily predict the reversibility of pulmonary vascular disease (7).

Early operative intervention in patients with large VSDs with careful postoperative management will protect them from the development of irreversible pulmonary vascular changes and ensures normal pulmonary artery pressure postoperatively.

The aim of this study is to find out the effect of closure of VSD in patients having high pulmonary artery pressure.

Patients and methods

Thirty consecutive patients underwent open-heart surgery for closure of VSD at the department of cardiothoracic surgery Ain Shams University Hospitals, Cairo. Their age ranged from 6 months up to 28 years with a mean of 7.4 ± 1 year. Twenty-four patients were less than 8 years old and 6 patients only were above 8 years old. There were 13 female and 17 male patients. The weight ranged from 6.5 kilograms up to 81 kilograms with a mean of 22.4 ± 2.9 kilograms. Twenty four patients were less than 20 kilograms body weight and six were above 20 kilograms body weight. Age and weight correlated well with each other in the analysis, that age was used as the parameter for analysing the results. The patients were classified according to New York Heart Association (NYHA) functional classification (8). Sixteen patients (53.4%) were in NYHA class 1,7 patients (23.3%) were in NYHA II, and 7 patients (23.3%) were in NYHA Ill (Table 1).

Patients are subjected to preoperative, operative, and postoperative studies. Preoperative evaluation includes history and clinical examination, routine laboratory investigations, chest X-ray, ECG, echocardiography, and cardiac catheterisation. Operative studies include measurement of pressure gradient across pulmonary valve to detect any significant pulmonary stenosis, and blood gases examination from right atrium and pulmonary artery at the end of bypass on 50% oxygen for 5 minutes to detect any oxygen saturation difference.

Postoperative studies done at 3 months (early) and at 6 months (late); which include clinical examination, chest X-ray, ECG, and echocardiography.

Surgical Technique:

All patients were subjected to open heart technique for closure of the ventricular septal defect. Sternotomy, aortic cannulation, both venae cavae were cannulated and snared. Left atrium was

Table 1: Preoperative patients data. NYHA: New York Heart Association, SEM: Standard Error of Mean.

Number of patients	30
Male / Female	17 / 13
Age (Years) (Mean ± SEM)	7.4 ± 1
Weight (Kilograms) (Mean ± SEM)	22.4 ± 2.9
NYHA:	
I	16 (53.4%)
II	7 (23.3%)
III	7 (23.3%)

vented. Topical cooling was used in all patients together with cold crystalloid antegrade cardioplegic solution with systemic hypothermia down to 25°C to – 28°C to establish total cardiopulmonary bypass. Repair of the defect was carried out. Twenty-eight patients had perimembranous VSD, of them 25 patients were closed through a transatrial approach (right atrium), 2 through transventricular approach. (Right ventricle) and one patient through a combined approach (right atrium and right ventricle). One subarterial VSD was closed through the transventricular approach and one muscular VSD was closed through transventricuiar approach (Table 2).

In all patients patches were used except in one patient where the VSD was closed directly (muscular VSD) using Ethibond 3/0 supported by Teflon pledgets. Pericardial patches were used in 18 patients and Dacron patches were used in 11 patients. Suturing of the patch was done to avoid damaging the bundle of His and the conductive system. Interrupted sutures with Ethibond 3/0 was used in 26 patients and continuous Prolene sutures were used in 3 patients (Table 2). Closure of the atriotomy or ventriculotomy incision is carried out with gradual rise of temperature with routine de-airing techniques. Gradual weaning off bypass, decannulation, closure in layers after homeostasis leaving 2 mediastinal drainage tubes and 2 right ventricular pacing wires.

Statistical Analysis:

Data are expressed as mean value ± standard error of mean (mean SEM).

SITE	no.	Size (cm^2)			Approach			Closure		
		<1	1-1.5	>1.5	A	B	C	I	II	III
Perimembranous.	28	17	7	4	25	2	1	0	17	11
Subarterial	1	1	0	0	0	1	0	0	1	0
Muscular	1	1	0	0	0	1	0	1	0	0
Total	30	19	7	4	25	4	1	1	18	11

Table (2): Site, size approach and type of closure of VSD. A: Transatrial approach, B: Transventricular approach, C: Combined approach. I: Direct closure, II: Closure with pericardial patch, III: Closure with Dacron patch.

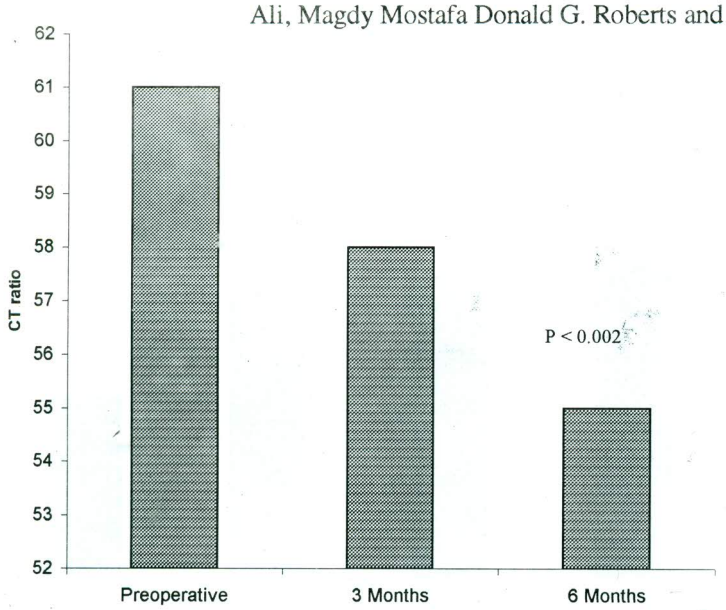

Fig. 1: Cardio-thoracic (CT) ratio

Quantitative data were analysed using student t-test and simple regression analysis test. P value < 0.05 denotes statistical significance. The software used is Statview SE + Graphics for Apple Macintosh.

Results

Clinical Findings: Sixteen (53.4%) patients were in class I according to NYHA classification and were discovered on routine medical examination. Seven (23.3%) patients presented with dyspnoea on exertion (NYHA class II). Seven (23.3%) patients presented with dyspnoea, on mild to moderate exertion (NYHA class III), 3 of them presented with recurrent chest infection. Postoperatively, all patients were symptom free (NYHA class I) in the postoperative period.

Typical murmur of VSD on the left border was heard in all the patients. Postoperatively, Residual VSD murmur was heard in the first 10 days in 50% of patients (15 patients), 9 of them were closed by Dacron patch. Echocardiography follow up of these patients detected that residual VSD remained in the early postoperative study in 7 patients; all are closed with Dacron patches. Late follow up after 6 months showed that the number decreased to 4 patients with mild residual VSD that do not need surgical intervention (Qp/Qs < 1.5).

Aortic cross-clamping time ranged from 26 to 60 minutes with a mean of 40.1 ± 1.6 minutes. Operative blood gases samples obtained after the end of bypass on F102 of 50% for 5 minutes from right atrium and pulmonary artery showed no significant difference in the oxygen saturation in ail patients. DC shock was used in 18 patients to regain sinus rhythm.

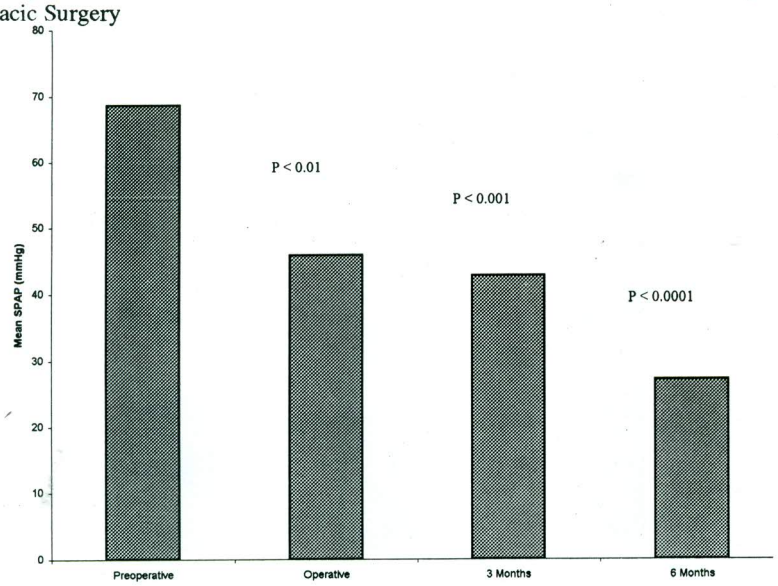

Fig. 2: Mean systolic pulmonary artery pressure (SPAP).

Twenty-six patients needed inotropic support after surgery (Dopamine 5 to 10 mcg/Kg/min) and continued in the intensive care unit. Period of mechanical ventilation ranged from 6 hours up to 72 hours for all patients

Preoperative chest x-ray showed increased cardiothoracic ratio in all patients (mean 60.8 ± 2%), plethoric lung fields in 26 patients, pulmonary artery dilatation in 4 patients and right ventricular enlargement in 25 patients. The cardiothoracic ratio decreased in the first postoperative study to mean of (58.8 2%), and reduced further in the late postoperative study to mean of (55 ± 0.5%) The difference was significant (P < 0.002) (Figure 1). The lung fields became normal with no plethora and the signs of pulmonary artery dilatation as well as right ventricular enlargement disappeared.

ECG revealed the presence of right ventricular hypertrophy in 18 patients, biventricular hypertrophy in 9 patients and 2 patients with right bundle branch block. Right axis deviation was found in 5 patients and the remaining patients were of normal axis. Late Postoperative finding showed that 15 out of 18 patients with right ventricular hypertrophy showed improved ECG pattern in the form of disappearance of right ventricular strain and decrease in R wave amplitude in V1 and V2. No postoperative conduction defects were noticed in all patients Echocardiographic studies revealed perimembranous VSD in 28 patients, subarterial VSD in one patient and muscular VSD in one patient. No patients of multiple VSD were encountered. Nineteen patients were having VSD size <1 x 1 cm2, seven were having VSD size from 1 x 1 to 1.5 x 1.5 cm2, and four were having VSD size >1.5 x 1.5 cm2 (Table 2). Ten patients presented with right ventricular dilatation (end diastolic diameter >26), three patients presented with

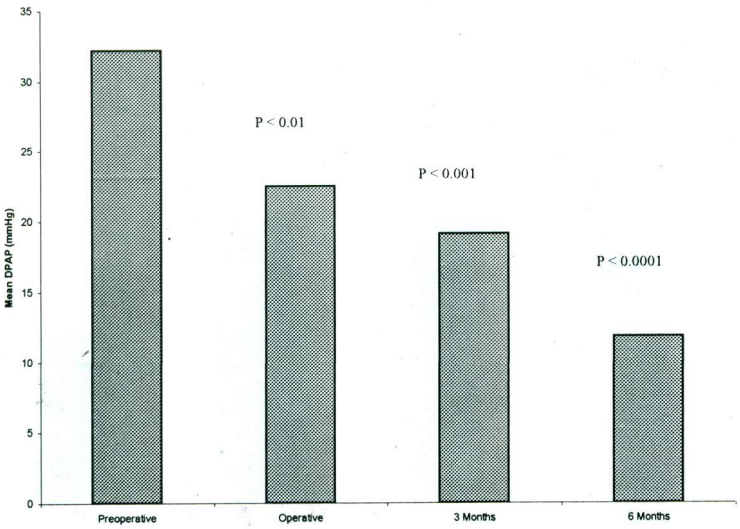

Fig. 3: Mean diastolic pulmonary artery pressure changes (DPAP)

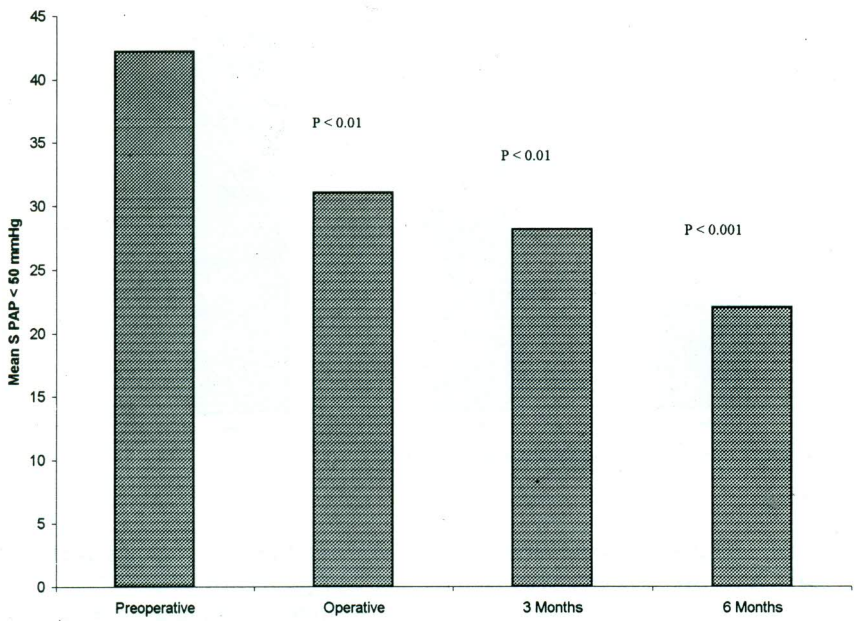

Fig. 4: Mean systolic pulmonary artery pressure (SPAP) <50 mmHg.

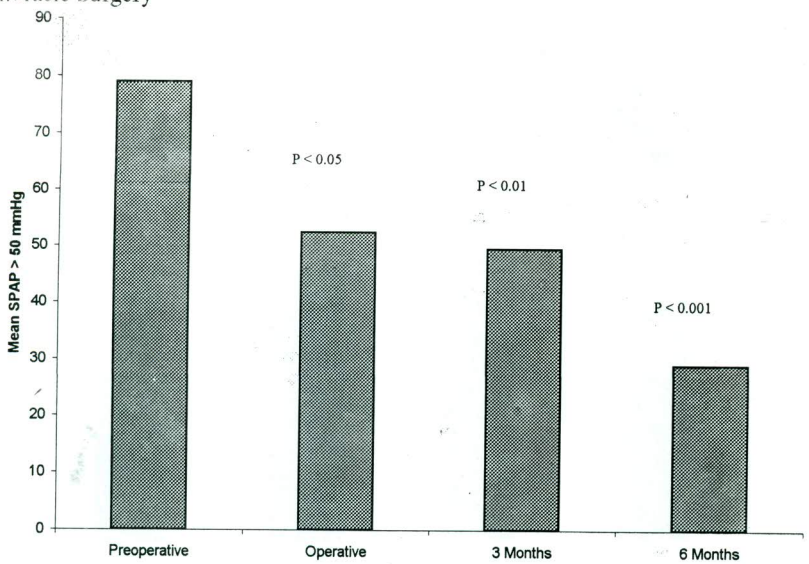

Fig. 5: Changes in systolic pulmonary artery pressure (SPAP) >50 mmHg.

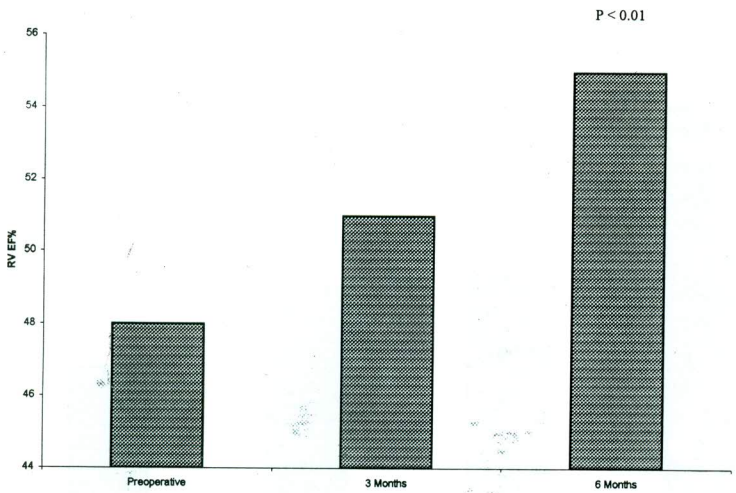

Fig. 6: Right Ventricular Ejection Fraction (RV EF%).

left ventricular dilatation (end diastolic diameter >57) and two patients presented with biventricular dilatation, the rest of the patients (15) were having normal ventricular dimensions. Operative findings confirmed the echo findings as regards type, size and number of VSD.

Systolic pulmonary artery pressure (SPAP): The preoperative peak systolic pulmonary artery pressure ranged from 35

to 130 mmHg (mean of 68.6 ± 4.2 mmHg). The SPAP dropped immediately after closure of the VSD to a mean of 45.8 ± 3.9 mmHg ($P < 0.01$), and continued to drop in the early post op. study to a mean of 42.7 ± 4.6 ($P < 0.001$). In the late postoperative study, SPAP had returned to nearly normal value with a mean of 27 ± 1 ($P < 0.0001$) (Figure 2).

Diastolic pulmonary artery pressure (DPAP): The preoperative diastolic pulmonary artery pressure ranged from 8 to 70 mmHg with a mean of 32.2 ± 2.5 mmHg. It dropped immediately to a mean of 22.5 ± 2.2 mmHg. ($P < 0.01$). It continued to drop in the early postoperative study to a mean of 19.1 ± 2.3($P < 0.001$), and in the late postoperative study to a mean of 11.8 ± 0.8 mmHg ($P < 0.0001$) (Figure 3).

In eight patients the preoperative SPAP was < 50 mm Hg (mean of 42 ± 2 mmHg). The SPAP dropped significantly in the operative study to a mean of 31 ± 2 mmHg ($P < 0.05$), early postoperative to a mean of 28 ± 1.8 mmHg ($P < 0.01$), and late postoperative to a mean of 22 ± 0.5 mmHg ($P < 0.001$) (Figure 4). Twenty two patients had SPAP > 50 mmHg (mean of 79 ± 3 mmHg). The SPAP dropped in the operative study to a mean of 52 + 3.5 mmHg ($P < 0.05$), early postoperative to a mean of 49 ± 4.1 mmHg ($P < 0.01$), and late study to a mean of 29 + 2 mmHg ($P < 0.001$) (Figure 5).

Right ventricular ejection fraction (RV EF%): Preoperative value ranged from 27 to 68% with a mean of 48 ± 2%. It improved in the early postoperative study to a mean of 51 ± 1 % ($P < 0.05$). It is more improved in the late postoperative study to a mean of 55 ± 1 0%. ($P < 0.01$) (Figure 6).

Intraoperative oxygen saturation: No statistical significant difference was found between samples taken from right atrium and pulmonary artery at the end of cardiopulmonary bypass in all patients.

Mortalities

Four patients out of thirty patients died (13.3%). All the patients were below 6 years of age, and 3 were below 3 years. All patients were in NYHA class Ill. All were having preoperative high peak systolic pulmonary artery pressure >55 mm Hg. Three patients were closed with Dacron patches, one patient with pericardial patch, and all were closed via transatrial root. None of them was having residual shunt as evidenced by intraoperative oxygen saturation in blood gases analysis. All the patients needed big dose of inotropic support in ICU. First patient died after 6 hours postoperatively of low cardiac output. Second patient after 24 hours, third patient after 4 days, both died of pulmonary hypertensive crisis, and the fourth patient died after 17 days postoperatively from septicaemia and mediastinitis due to open cardiac massage in the ICU secondary to low cardiac output state.

Discussion

Closure of a ventricular septal defect has become a routine open-heart surgery, which are done, even in newly born infants. However, the decision for early correction of a large ventricular septal defect is based upon the poor prognosis with regard to physical development, incidence of irreversible pulmonary vascular changes, and complications resulting from primary palliation. In view of the spontaneous closure or the diminution of the size of their VSD, noted in a certain number of infants correction at an early age should be

undertaken only if congestive heart failure and its consequences persisted despite maximal medical treatment. It should be done if there is evidence of a rapidly rising pulmonary vascular resistance in otherwise well and thriving patients.

Young age is considered a major risk factor affecting the surgical outcome especially when there is a major associated cardiac anomaly beside the VSD. Some investigators do not recommend delay of closure of VSD beyond the age of 2 years (9,10). In this study, age is still an eminent risk factor especially on hospital mortality, and this finding is confirmed by other studies (11,12,13,14). Huth suggested that correction of VSD could begin from the start of the second year in babyhood, provided that recurrent heart failure or growth disorders do not urge for earlier operation (15). Arcinegas, recommended closure of medium sized VSDs at 8 to 10 years of age as reported that no pulmonary vascular-occlusive disease develops before that age (16). With the recent improvement in preoperative diagnosis, intraoperative techniques, and the postoperative care, young age should no more be considered as a risk factor for surgical outcome (17).

In this study young age together with high systolic pulmonary artery pressure more than 50% of the systemic systolic pressure are the main two incremental risk factors leading to the early postoperative mortality (13.3%). In a previous study by the same group, the mortality rate in patients with VSD and severe pulmonary hypertension was 17% (18). John and colleagues reported 22% hospital mortality in patients with VSD and severe pulmonary hypertension (19).

A flow from left to right through the patch or the suture line is expected when Dacron or Teflon patches are used to the VSD due to their porous nature. This flow stops when complete epithelialization of the patch takes place in the early postoperative period (17). This goes with the data obtained from this study, where the use of Dacron patch to close the VSD was accompanied by residual murmur auscultated in the first few postoperative days. These murmurs disappeared in the first postoperative follow up study after 3 months. Residual VSD was detected in the late postoperative study in 4 patients (13.33%) with insignificant shunt ($Qp/Qs < 1.5$). Kirklin reported 20% incidence of small residual VSD (17), while Otterstad reported incidence of 34% (20). In our study as well as other studies (20,21,22) residual VSDs did not interfere with the drop of pulmonary artery pressure in the postoperative period.

Arcinegas stated that the indications of re-operation to close residual VSD are: symptomatic patients, cardiomegaly, significant increase in pulmonary blood flow ($Qp/Qs > 1.5$), deterioration of ventricular function and progressive elevation of systolic pulmonary artery pressure (16). In our study there were no indications for re-operation in those patients.

In this study both systolic and diastolic pulmonary artery pressure at 6 months were significantly reduced compared to the operative pulmonary pressure, which means that it take up to 6 months postoperatively before the pulmonary artery pressure reduces significantly to the normal levels. Using a simple regression test the same

findings was confirmed, where at immediate operative and 3 months postoperatively, the SPAP was significantly correlating with the preoperative SPAP i.e., patients with high SPAP continued to have high SPAP postoperatively and those with low SPAP continued to have a low SPAP postoperatively. While at 6 months no correlation was seen to the preoperative SPAP. The same applies for the DPAP. In our study, a significant drop of pulmonary artery pressure occurs after closure of the VSD regardless of the preoperative pulmonary artery pressure. This data correlates with other studies (23).

In our study patients having preoperative SPAP < 50 mmHg, a significant reduction in the pulmonary artery pressure -to near normal values- was observed in the immediate operative study compared to the preoperative value. (Figure 4). Patients with SPAP > 50 mmHg benefit from the surgery, but it takes up to 6 months postoperatively for the pulmonary artery pressure to reach near normal values. (Figure 5). Meanwhile, no correlation was found between the level of pulmonary hypertension preoperatively and the expected fall in the pulmonary artery pressure late postoperatively, where patients with high pulmonary artery pressure preoperatively showed significant drop to near normal values in the late postoperative period. This finding was confirmed by other studies (19).

In our study, significant improvement of right ventricular function was observed in all patients in both early and late postoperative study. Transatrial approach of closure of VSD is preferred by many surgeons rather than the transventricular approach to preserve the ventricular function (24), while other investigators reported that neither transatrial nor transventricular approach of VSD repair has any effect on the ventricular function provided that no conductive tissue injury had occurred during surgery (17,19). This is confined with the results of this study where the route of VSD closure has no correlation with the postoperative ventricular function.

Kirklin and Barratt-Boyes stated that the incidence of complete heart block after isolated VSD repair approaches zero (25). While it approaches 10% in cases of multiple VSDs (26). Right bundle branch block was reported in different series to occur in a good percentage of cases between 34% to 44% after VSD repair (27,28). However the incidence is less prevalent when transatrial approach is used for VSD repair (29). In our study no new conductive disturbance (right bundle branch block or complete heart block) were detected after VSD repair. Meticulous placement of sutures and identification of the anatomy of the conductive system is of utmost importance to avoid this postoperative complication.

Conclusion

The results of this study demonstrates that patients with isolated VSD and pulmonary hypertension could benefit from closure of the defect -provided that no reversal of shunt occurs- with drop of pulmonary artery pressure in the late postoperative period to near normal values. Mild residual shunts do not affect the postoperative drop of systolic pulmonary artery pressure or right ventricular function.

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URGENT CORONARY REVASCULARIZATION: ANALYSIS OF EARLY RESULTS

ABSRTACT

From September 1996 till September 1999, we have operated on 122 patients for surgical coronary revascularization on urgent basis. The indications for urgent coronary revascularization in our group included unstable angina in 92 patients (75.4%). Yet, in 40 of these cases (43.2%), surgery could be deferred for 24-48 hours of surgical consultation because of satisfactory medical control of ischemia. The great majority of these cases were delayed to allow for control of platelet dysfunction resulting from the use of potent antiplatelet agents as Ticlid and Agristat. The rest of these cases (52 cases = 56.8%), were operated upon within the first 12 hours after surgical consultation, because medical treatment achieved only transient regression of unrelenting ischemic pattern.

In the remaining 30 cases (24.6%), the indication was acute evolving, myocardial infarction, 2 cases of failed PTCA belong to this group, in 15 cases belonging to this group (50%), cardiopulmonary bypass had to be instituted emergently because of hemodynamic collapse, ventricular fibrillation, or cardiac standstill. There were 8 mortalities (6.6%), the causes of death were intractable ventricular arrhythmias in 2 cases, and low cardiac output in the remaining 6 cases. The incremental risk factors for early in-hospital mortality included: lower ejection fraction, left main disease, preoperative myocardial infarction, preoperative myocardial ischemia longer than 6 hours duration, and longer cross clamp time. Out of the 114 survivors, intra-aortic balloon pump was needed for a mean time of (28±10 hours) in 23 patients (20.3%). In one of these patients, acute lower limb ischemia necessitating urgent aorto-femoral bypass grafting, and ending in below knee amputation occurred. Re-exploration for bleeding occurred in 3 of our survivors (2.7%), mediastinitis in 2 (1.8%), perioperative myocardial infaretion which did not affect hemodynamics in 2 (1.8%), and embolic left sided hemiparesis in one patient (0.9%). Wound sepsis affecting the leg necessitating debridement, frequent dressing over 3 months, and secondary closure occurred in one patient (0.9%). Follow-up period for 6-30 month duration revealed that 109 of our patients (95.6%) were in NYIIA FUNCTIONAL class I-II. Also, 106 patients (93%) were in CCSC angina] class I-II. Patients who suffered anginal pains during the follow-up period (8CASES=7%) belonged to the group who underwent incomplete revascularization due to bad target vessels.

Urgent myocardial revascularization needs rapid intervention with optimal myocardial protection with the shortest possible ischaemic time and blood cardioplegia. Complete myocardial revascularization, whenever possible, offers

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an additional benefit to the patients. Whenever possible, we tried to harvest LIMA and/or radial artery for better long term results, if otherwise, haemodynamic instability is overwhelming, urgent cardiopulmonary bypass and the use of saphenous vein grafts is the surgical technique of choice.

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INTRODUCTION

The acute coronary syndromes represent a gradation of severity of coronary artery disease, from unstable angina through acute myocardial infarction All share an underlying pathophysiology of acute plaque rupture, with various degrees of platelet and thrombotic vessel occlusion (1). Several investigators have suggested that coronary artery thrombus formation, most likely secondary to plaque rupture, may precipitate unstable angina (2-6). Another study on 76 patients with unstable angina demonstrated an association of intracoronary thrombi detected by angiography with a higher frequency of in-hospital cardiac events including death myocardial infarction and urgent revascularization (7).

Materials And Methods

Definitions:

In 1994, the Agency for Health Care Policy and Research and the National Heart, Lung, and Blood Institute published a practice guideline (Unstable Angina: Diagnosis and Management). This guideline defined unstable angina as follows, as having three possible presentations: symptoms, of angina at rest [usually prolonged > 20 minutes], new onset [<2months] exertional angina of at least Canadian cardiovascular Society Classification [CCSC] class III in severity,or recent [< 2months] acceleration of angina as reflected by an increase in severity of at least one CCSC class to at least CCSC class III . In most, but not all, of these patients, symptoms will be caused by significant coronary artery disease (8). Preoperative ischemic interval was defined as the interval between the onset of the clinical or the electrocardiographic signs or both of acute coronary insufficiency and the institution of cardiopulmonary bypass (9). Recent myocardial infarction was considered as one occurring within 3weeks prior to revascularization. Cardiogenic shock was defined as the clinical state of hypoperfusion characterized by systolic pressure lower than 80 mm Hg and central filling pressure greater than 20 mm Hg or cardiac index of less than 1.8 L. min. m2. Low cardiac output was considered present when clinical signs of hypoperfusion were associated with elevated central venous and pulmonary capillary pressures, mean systemic pressure of less than 70 mm Hg.,

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Table (1) Pre-operative profile of our Patients (Total number 122)

Variable	Value
Age (year)	60.8 ± 18.2
Sex:	
Male	105 (86.1%)
Female	17 (13.9%)
History of acute M.I.	65 (53.3%)
Risk factor for I.H.D.:	
DM	57 (46.7%)
Smoking	91 (74.6%)
Hyperlipidemia	27 (22.1%)
Hypertension	49 (40.2%)
Ejection Fraction (%)	52 ± 13
Coronary Angio:	
Lt main disease	33 (27%)
Two vessel disease	39 (32%)
Three vessel disease	83 (68%)
Preoperative ischemic interval (H)	5.5 ± 4.5
Cardiogenic shock	5 (4.1%)
Serious ventricular arrhythmia	9 (7.4%)
Cardiac arrest	2 (1.8%)

Table (2) Operative data of our patients:

Variable	Value
Complete revascularization	93 (76.2%)
Endarterectomy	21 (17.2%)
Use of LIMA and/or Radial	69 (56.6%)
Blood cardioplegia	122 (100%)
Cross clamp time (min.)	53.5 ± 17.8
By pass time (min.)	72.8 ± 29.1
Need of IABP	23 (20.3%)

cardiac index lower than 2.0 L. min. m2., and metabolic acidosis .

The diagnosis of perioperative myocardial infarction was based on the basis of the presence of at least two of the following: new Q waves in the electrocardiogram, values of the MB fraction greater than 10 total creatine kinase levels, and new left ventricular akinetic areas in the postoperative echocardiogram. Full medical treatment included intravenous administration of nitroglycerine, calcium antagonist, and heparin. (10).

Patient population:

Between September 1996, and September 1999, 122 patients underwent urgent surgical coronary revascularization. The indications included unstable angina in 92 patients (75.4 %), and acute myocardial infarction in 30 cases (24.6 %).

Out of the cases of unstable angina, surgery could be deferred for 24 – 48 hours in 40 cases (43.2%), due to satisfactory medical control of angina. The purpose of the delay was mainly to control platelet dysfunction resulting from the use of potent antiplatelet agents as Ticlid and Agristat. In the remaining 52 cases (56.5%), surgery had to be performed within the first 12 hours of surgical consultation, because maximum efforts of medical control achieved only transient regression of unrelenting ischemic pattern. In 15 out of the 30 cases of acute myocardial infarction (including 2 cases of failed PTCA), emergent cardiopulmonary bypass had to be instituted because of acute hemodynamic collapse, ventricular fibrillation, or cardiac standstill.

The preoperative data of our patients are summarized in table No. 1.

Surgical techniques:

In all of our patients, modified Allen test was done to asses the suitability to use the radial artery as a conduit (in most of our cases preoperative duplex scan on the fore arm arteries was done for the same purpose). If hemodynamics were reasonable, LIMA was harvested, together with left radial artery, if otherwise. hemodynamics were unstable, emergent cardiopulmonary bypass and the use of saphenous vein grafts was the preferred technique. In all cases, cardiopulmonary bypass was instituted using ascending aortic cannula, and a two stage venous cannula, moderate hemodilution (hematocrit 20-25%), moderate systemic hypothermia, and a flow of 2.5 L. m2. min. Aortic cross-clamping and aortic root infusion of cold blood cardioplegia were used in all our cases. Distal anastomoses were performed under cardioplegic arrest, and proximal anastomoses were fashioned after removal of the cross-clamp. Complete revascularization, whenever possible, was the rule, but we did not waste time on grafting bad target vessels.

The operative data of our patients are summarized in table 2

Results

Hospital morbidities and mortalities are shown in table No. 3 Out of the 8 (6.6%) in-hospital mortalities, 6 were due to low cardiac output, and the % of the remaining 2 were due to intractable ventricular arrhythmias. Logistic statistical analysis of preoperative and operative variables to

Table (3) Operative morbidity and mortality:

Variable	Value
Mortality:	8 (6.6%)
L.C.O.P.	6 (4.9%)
Ventricular arrhythmias	2 (1.7%)
Acute lower limb ischaemia	1 (0.9%)
Bleeding (necessitating exploration)	3 (2.7%)
Mediastinitis	2 (1.8%)
Peri operative M.I.	2 (1.8%)
Lt. Sided Hemiparesis	1 (0.9%)
Sepsis affecting the leg wound	1 (0.9%)

detect preoperative & operative predictors of in-hospital mortality revealed that; lower ejection fraction (0.3 & less), left main disease, preoperative myocardial infarction, preoperative ischemic time longer than 6 hours duration, and longer cross-clamp time were the most significant incremental risk factors for early in-hospital mortality.

Intra-aortic balloon pump was needed to enable 23 out of the 114 survivors (20.3%) to come off cardiopulmonary bypass and for a mean time of 28±10 hours, yet in one of these cases, lower limb ischemia necessitating urgent aorto-femoral bypass grafting & unfortunately ending in below knee amputation occurred

Other morbidities included: re-exploration for post-operative bleeding in 3 cases (2.7%), mediastinitis in 2 cases (1.8%), perioperative myocardial infarction (which did not affect the hemodynamics) in 2 cases (1.8%), left sided hemiparesis in 1 patient (0.9%), and wound sepsis affecting the leg wound that necessitated debridement, frequent dressing, and secondary closure occurred in 1 patient (0.9%).

Our patients were followed up for variable periods of time ranging from 6-30 months. During the follow-up period, 109 of our patients (95.6%) were in NYHA class I-II. Also, 106 of our hospital survivors (93%) were in CCSC anginal class I-II. Patients who suffered anginal pains during the follow- up period (8 cases=7%) belonged to the group who underwent incomplete revascularization due to bad target vessels.

Discussion

Mortality rates for urgent surgical myocardial revascularization differ widely, at the Cleveland clinic, Golding and associates had a mortality rate of 2.5 % for emergency operations after failure of PTCA, a considerable number of these procedures were performed within 24 hours after the onset of ischemia (11). On the other hand, Athanasuleas et al, reported a mortality rate of 15.6% for cases undergoing urgent surgical revascularization for acute myocardial infarction (12). Fremes and associates reported an operative mortality rate of 9.2 % for patients with unstable

angina who needed urgent surgical myocardial revascularization (13). Philips and his colleagues had an operative mortality of 5.7% Included in their study are patients with myocardial revascularization within 36 hours of the onset of acute coronary ischemic syndrome (14). Edwards and colleagues reported a markedly high operative mortality of 14.5%. This was explained by them on the basis of inclusion of only the patients who needed emergent surgical revascularization (15). Toeh and co-workers reported an operative mortality rate of 8.5% for urgent surgical revascularization. Classified as urgent were all patients with unstable angina operated on within 72 hours of catheterization (16). In our study, we could delay surgical intervention for 24-48 hours in 43.2% of cases of unstable angina as a consequence of satisfactory (though incomplete) medical control of ischemia. In the rest of these cases (56.5%), surgery had to be instituted as soon as possible, as maximum efforts of medical control failed to achieve or achieved only periods of transient regression of unrelenting ischemic pattern.

In half of our cases with acute myocardial infarction, cardiopulmonary bypass had to be instituted emergently because of acute hemodynamic instability. So, according to our study, we could stratify cases of acute coronary syndromes into 3 grades, only in the mildest grade we could delay surgery to allow for adequate medical stabilization of ischemia or any other medical problems that could affect the surgical outcome.

Unjustified delay of surgery is hazardous, as we had noted that one of the most important risk factors for early postoperative mortality was preoperative ischemic time longer than 6 hours.

Others shared this opinion with us (10, 12, 14).

We have also found that prolongation of the cross clamp time is one of the incremental risk factors for early postoperative mortality. This result supported our policy of limiting cross clamp time as much as we could, and avoidance of wasting time on grafting unsuitable targets.

We have used blood cardioplegia as the only method of myocardial protection during the period of ischemic cardiopulmonary bypass, and we believe that blood cardioplegia, by improving the metabolic conditions of the ischemic myocardium, leads to improvement of the surgical outcome in this subset of high risk patients. This opinion was shared with us by Tomasco et al. (10), Braunwald and Kroner (17), and Buckberg (18).

We had always tried to use LIMA and/or radial conduits in order to enhance long-term patency of the conduits. However, when hemodynamics were too unstable to permit this, we always use saphenous vein grafts to allow for rapid cardiopulmonary bypass, rapid revascularization, and to ensure immediate good flow in the conduits.

In conclusion, in order to obtain good results in cases of acute coronary syndromes, urgent myocardial revascularization should be undertaken as soon as possible with the shortest possible preoperative ischemic interval. Optimal myocardial preservation, with the shortest possible ischemic time, and the use of blood cardioplegia is essential. Complete

revascularization, whenever possible, offers an additional benefit for the patients. However, cross clamp time should not be unduly prolonged by trials to graft bad target vessels. Whenever possible, we tried to use LIMA and / or radial artery conduits for better long term results, if otherwise, hemodynamic instability is overwhelming, emergent cardiopulmonary bypass and the use of saphenous vein grafts is the surgical technique of choice.

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Gamal Sami, Bakir M. Bakir, Wael AbdelAziz, Ashraf A. EL-Sebaie and Moustafa A. Abdel Gawad

EARLY EXPERIENCE WITH THE USE OF THE RADIAL ARTERY AS A CORONARY ARTERY BYPASS GRAFT

ABSRTACT

The radial artery was first used as a coronary graft by Carpentier in 1971 but was abandoned due to the disappointing results. Several surgeons started to use the radial artery again on a wide scale after the widespread use of calcium-channel blockers on the assumption that they could prevent spasm.

We operated on 100 patients undergoing coronary revascularization using the radial artery and we did not use calcium-channel blockers in any of our patients. Doppler study of the vascular system of the upper limb was performed preoperatively.

At a mean of 7 months follow up, all patients are alive with no perioperative myocardial infarction. One patient had vague chest pains 4 month later and catheterization showed string sign in radial artery due to competitive blood flow in the native grafted vessel. No ischemia of the hands occurred in any of patients.

The radial artery seems to be an excellent arterial conduit for myocardial revascularization. It should be used as adjunct to the left internal thoracic artery.

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INTRODUCTION

More than 3 decades have elapsed since the advent of coronary artery bypass grafting (CABG). In the beginning, the saphenous vein served as the principal conduit although it has been preceded by the use of the internal thoracic artery (ITA).(1,2) By the mid 1980s, however, accumulating data showed the clinical advantage of an 85% 90% 10-year patency for the ITA, compared with a 50% patency rate of the saphenous vein.(3)

In 1986, Loop and colleagues (4) clearly documented that the use of left ITA grafted to left anterior descending (LAD) coronary artery resulted in greater survival and patency rates at 10 years compared to conventional saphenous vein revascularization. More recently, Fiore and associates (5) suggested even better results after 15-17 years follow up. Since then, increasing interest in arterial conduits has led to the expanded use of the ITA, and also has led to the use of the so called "alternative arterial conduits": Right gastro-epiploic artery,(6) inferior epigastric artery(7) and radial artery (8,9) primarily as supplements to both ITAs.

The radial artery is a muscular artery with a media rich in lieomyocytes. It lies under the antebrachial fascia between the brachioradialis and flexor carpi radialis

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muscles, and is surrounded by 2 satellite veins.(10)

Coronary artery bypass grafting using the radial artery (RA) was first proposed and performed by Carpentier in 1971.(8) Two years later, Carpentier himself recommended that this technique should be abandoned because of a 35% incidence of narrowing or occlusion of this conduit at control angiography.(11) He suggested that the graft failure was due to spasm of the denervated artery. In 1987, he received from a referring; cardiologist the recent angiogram of a patient in whom the RA was examined immediately after the operation and thought to be occluded. 15 years later, this artery was actually fully patent with no visible atherosclerotic lesions. Other patients belonging to the same series and having shown some degree of obstruction at the control examination after operation were reinvestigated and showed a patent RA conduit. This encouraged Acar and associates to revive the use of RA in CABG. (12)

In this study, we reported our early experience and results with the use of RA in CABG, describing our technique in harvesting and preparation of the artery not using calcium channel blockers in any of our patients.

Patients

In this study, the RA was harvested in one hundred patients scheduled for isolated CABG with no other associated procedures to achieve a homogenous population study during the period from April 1999 to March 2000.

At the beginning, the indications for the use of the RA were lack of suitable vein graft due to venous stasis or varicosities, or previous vein stripping. Subsequently, after the first encouraging results, age and more arterial revascularization became more relevant in the decision-making process. Non of the patients included in this series underwent operation on an emergency basis.

Previous trauma to the arm, presence of A-V fistula in cases of hemodialysis, poor compensation of the ulnar artery as shown by doppler evaluation were considered as contraindications to the use of the RA as a coronary artery bypass graft. Two diabetic patients were excluded from the study after exposing the artery because its wall was found to be calcified with atheromatous changes.

Age and sex:

There were 90 males and 10 females in this study. The mean age of the patients was 5 1. 5 ± 6.25 years with a range from 3 8 to 65 years.

The radial artery was used usually as the second arterial conduit after the ITA except in six diabetic obese female patients where we preferred not to take down the LITA and used the RA as the arterial graft to the LAD. Coronary revascularization was completed with vein grafts as needed.

Among one hundred patients: The RA was harvested from the right forearm in two and from the left forearm in 95 patients. After becoming more confident in its use, we harvested the radial artery bilaterally in three patients to achieve more arterial revascularization.

Pre-operative data: (Table I)

Angina	Number
CCS I	12
CCS II	49
CCS III	33
CCS VI	6
Risk factors	
Diabetes mellitus	36
Smoking	73
Hypertension	76
Dyslipidemia	21
Coronary study	
Previous MI	8
Ejection fraction >50%	29
Ejection fraction 40-50%	59
Ejection fraction <40%	12
2-vessel disease	32
3-vessel disease	49
Left main disease	19
Reoperation	1

CCS= Canadian Cardiovascular Society

Methods

Pre-operative evaluation:

In addition to the routine pre-operative evaluation performed to all patients undergoing CABG, peripheral doppler arterial evaluation was done to all patients for assessment of the forearm main blood supply before the use of the RA as a bypass graft. The anatomy of the upper limb arteries were noted, in addition to the caliber of the RA. The pulsatile flow of the ulnar artery was also noted, in addition to the effect of the RA distal compression on the palmar arterial doppler flow. According to the result of the doppler evaluation, it was decided whether to use the RA or not. If the palmar arterial circulation shows increased or retrograde flow, this means that the RA could be safely harvested. (Fig. 1) If the flow in the palm was damped, the RA was not used as this means that the hand is dependent on it. (Fig. 2)

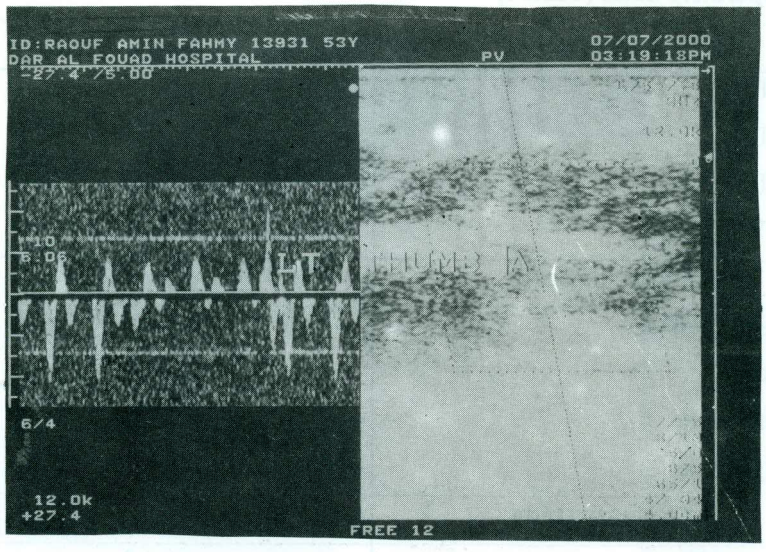


Fig. 1: The left thumb artery showing retrograde flow after distal compression of the radial artery.

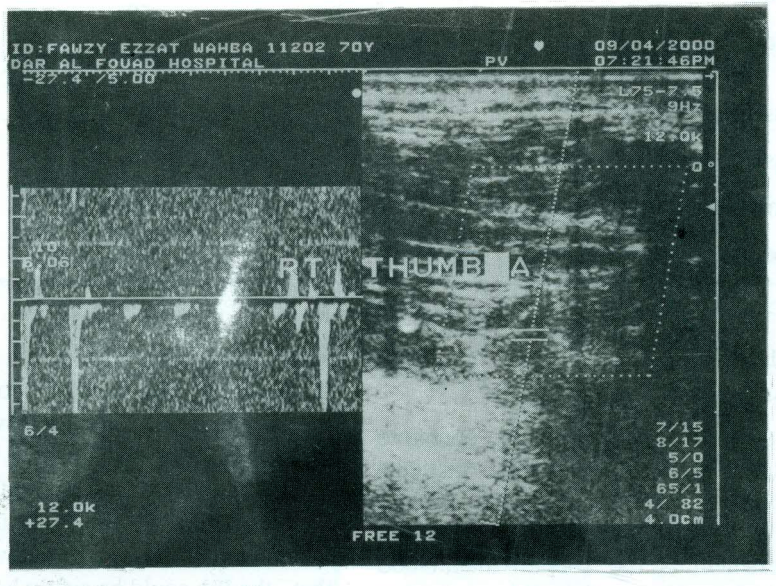


Fig. 2: The right thumb artery showing damped flow after distal compression of the right radial artery.

Preparation and draping of the patient:

All patients were prepped and draped in the routine way for CABG. in addition, the forearm from which the RA was going to be harvested was prepped circumferentially, extended and supinated on a standard operative arm board and positioned at approximately 70° - 80° to the operating table. The extremity was secured in position with two towel clips fixed to the hand towel and the arm-board wrap. The arm was left in position for the duration of CABG. Harvesting of the RA was performed in conjunction with preparation of the ITA. A pulse oximeter probe was placed on the thumb of the chosen hand for intra-operative monitoring of oxygen saturation. The numerical values and the magnitude of the trace oximetry were noticed before and after occlusion of the radial and ulnar arteries simultaneously and then alternatively.

Technique of harvesting the radial artery:

The incision for RA harvesting extends from 1 em medial and distal to the biceps tendon and continues distally to join another incision done over, the radial artery pulse. The incision follows the medial border of the brachioradialis muscle and care is taken not to cross over the joints to avoid limitation of movement. Low-voltage diathermy was used to divide the tissues down to the deep fascia. Care was taken to avoid the lateral antebrachial cutaneous nerve of the forearm (LABCN) - a branch of the musclulocutaneous nerve that provides sensory innervation to the radial aspect of the forearm - and the superficial branch the radial nerve supplying the radial aspect of the thumb and dorsum of the hand and lying under cover of the brachioradialis. The deep fascia was divided medial to the edge of the brachioradialis which was then retracted laterally before dissection of the RA. Deep to the brachioradialis, lies a well-defined fascia surrounding the RA and its satellite veins. This fascia was divided which made the harvesting technique proceed easily after that. The artery was harvested together with its two satellite veins and surrounding adipose tissue. The artery was not allowed to be touched during the procedure, however, manipulation of the pedicle was through grasping of the two satellite veins. Small metal clips were used close to the RA and the branches then divided using low-voltage diathermy. It is to be noticed that branches of the RA arise dorsally and laterally but not anteriorly, a point that makes the harvesting an easy technique after entering into the correct plane.

Preparation of the radial artery:

Before division of the RA, it was occluded distally using a bulldog and the trace and numerical value of the pulse oximetry were noticed once more. The RA is now ready for distal and proximal division. The RA is divided distally proximal to the wrist joint to preserve the collateral supply around this joint and also discarding the last 2 cm of the artery which is prone to spasm. Both cut ends were secured with silk tie and metal clips. To avoid intimal trauma to the artery, no metal probes were used at all. Gentle hydrostatic dilatation with heparinized blood containing papaverine after cannulating its proximal end using a standard vein cannula was performed. This maneuver was done to relieve any spasm and check for side-branch leakage. The artery was trimmed at the

distal end to be ready for distal anastomosis and kept in solution of heparinized blood and papaverine. Clipping of the venae commitantes of the RA should be stressed upon to avoid postoperative bleeding.

Wound closure:

The forearm was inspected for adequate hemostasis. A hemovac drain was inserted. The subcutaneous tissue and skin were closed without closing the deep fascia. Sterile dressings were applied without bandaging the forearm.

The time required to harvest the RA was 24 ± 2.3 minutes which didn't increase the total operating time as the RA was harvested at the same time of the sternotomy and preparing the LITA.

Operative procedures:

Cardiopulmonary bypass was conducted at 32°C. Myocardial protection was achieved by cold antegrade blood-enriched cardioplegia. The heart was vented through the aortic root. All distal anastomoses were performed after aortic cross clamping. A side-occlusion clamp was used during performing the proximal anastomoses.

Distal anastomosis:

Sequence of distal anastomosis was: right coronary artery, obtuse marginal, ramus, diagonal and lastly the left anterior descending coronary artery. The distal anastomosis of the radial artery to the target coronary artery was performed using 7/0 polypropylene continuous suture.

Proximal anastomosis:

The proximal anastomosis was performed using a side-occlusion clamp. At the beginning, we preferred to perform the proximal anastomosis to a saphenous vein graft using 6/0 polypropylene suture, but after gaining more confidence, we found no technical difficulty of performing it to the ascending aorta using 5/0 polypropylene suture and a 4 mm aortic punch except in patients with thickened and calcified aorta. We didn't perform the proximal anastomosis to the ITA because of size mismatch between the RA and ITA and fear of occurrence of steal phenomenon with preferential flow of blood from ITA to RA instead of the distal LAD.

Perioperative evaluation:

Perioperative evidence of myocardial ischemia was monitored by continuous ECG and echocardiography. The patients were monitored for postoperative bleeding and any evidence of low output syndrome, in addition to observation of any complications related to the forearm as regards ischemia, sensory or motor function abnormalities.

Follow up:

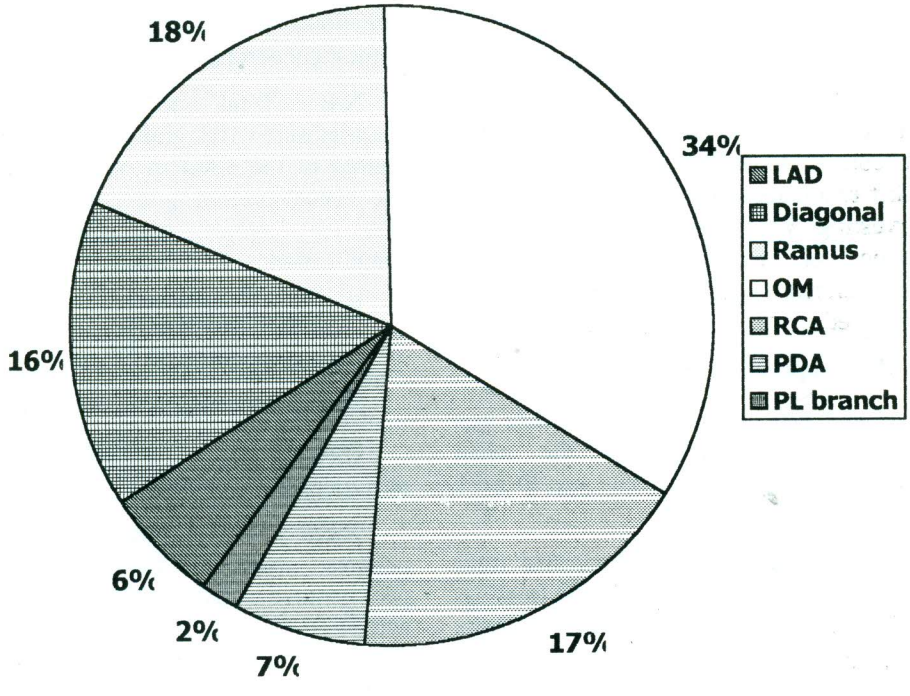
Patients were followed up clinically as regards recurrence of chest pain, ECG changes, and hand complications. The follow up period ranged from 1-12 months with a mean of 7 months. Coronary angiography was performed only in recurrence of angina.

Results

In this study we report our early experience with the use of RA as a coronary artery bypass graft. One hundred patients were operated upon using the radial artery as one of the conduits in bypass surgery. Ninety patients were males and ten were females having 103 RA harvested. Their

Table II, Chart 1: Implantation sites of RA grafts

Site	No. of anastomoses
Left coronary artery	**76**
LAD	6
Diagonal	16
Ramus	19
Obtuse marginal	35
Right coronary artery	**27**
Main RCA	18
P.D.A.	7
Posterolateral branch	2



ages ranged from 38 to 65 years with a mean of 5 1. 5 ± 6.25 years. Pre-operative data are illustrated in Table 1. None of the patients were operated upon on an emergency basis.

Intraoperative evaluation of the RA using the pulse oximetry method confirmed the preoperative arterial doppler evaluation and no patient who has been scheduled for RA harvesting on the basis of preoperative doppler was excluded except two diabetic patients where the RA was found to be calcified with atheromatous changes and were excluded from the study.

Radial artery graft characteristics:

The caliber of the RA proximally was about 2.9 mm and 2.3 mm distally. This led us to anastomose the proximal artery to the ascending aorta or a saphenous vein graft and the distal end to the coronary artery for better size matching. The length of the harvested RA ranged from 16 - 22 cm with a mean of 19.4 ± 1.4 cm- We stressed on meticulous dissection of the artery and didn't encounter spasm in the artery after its harvesting which usually occurs in the setting of rough dissection. No intraoperative prophylactic vasodilators were used.

Intra-operative data:

The mean aortic cross clamp time was 39 ± 3.6 minutes and, the mean cardiopulmonary bypass time was 80 ± 6.1 minutes.

The radial artery was harvested from the left forearm in 95 patients and from the right forearm in two patients. Three patients had bilateral harvesting of the radial artery to achieve total arterial revascularization. The average number of grafts was 2.9 per patient (2-5 grafts per patient). We didn't perform sequential anastomoses, and we preferred to anastomose the radial artery proximally to a vein graft at the beginning of the series but after that it was anastomosed to the ascending aorta except in patients with thickened and calcified aorta. The radial artery was not anastomosed to LITA for fear of steal phenomenon with preferential blood flow from ITA to RA instead of distal to LAD.

Implantation sites of the radial artery graft: (Table II, Chart I)

The most common target vessel for the radial artery was the obtuse marginal coronary artery followed by the ramus, main right coronary artery, diagonal, posterior descending artery and lastly the left anterior descending artery and posterolateral branch of the right coronary artery.

N.B. Total no. of distal RA anastomoses: 103 grafts. The artery was grafted to the LAD in 6 females (diabetic and obese) preferring not to take down the ITA to avoid postoperative sternal complications.

Proximal anastomotic site:

Ascending aorta: 80 (77.67%).

Saphenous vein graft: 23 (22.33%)

Operative mortality and perioperative morbidity:

There was no operative mortality in our patients. None of the patients had a perioperative myocardial infarction as evidenced by daily monitoring of the ECG. There was no need for mechanical support as there was no evidence of low cardiac

output postoperatively. Blood loss in the postoperative period ranged from 300 cc to 950 cc. Three patients were re-explored for excessive bleeding but none of them had the cause of bleeding related to the RA anastomosis or one of its branches.

Forearm and hand complications:

Only one patient required re-exploration of the forearm intraoperatively because of excessive drainage into the hemovac drain after closure of the forearm. Otherwise, no patient required re-exploration of the forearm and the mean amount of drainage was 40 ± 6.7 cc into the drain pump which was removed after 48 hours. Three patients developed seroma after removal of the drain which wmanaged by aspiration. There was no infection in any of the patients and no signs of hand ischemia and all the skin incisions healed adequately. The most common finding was parasthesia related to the forearm incision and dorsum of the hand related trauma to the LABCN and superficial branch of the radial nerve during harvesting the RA. This was observed in 33 patients (33%) and resolved in 2 weeks. All patients were able to use their upper extremity normally on the 1st postoperative day with no motor deficit.

Clinical outcome and follow up:

At a mean follow up of 7 months (range 1-12 months), all patients are alive with no recurrence of symptoms, except in one patient who had vague chest symptoms and was catheterized (4 months postoperatively) and his coronary angiography showed patent LITA but his radial artery showed string sign. The native vessel (ramus) to which the RA was grafted had good flow with only 40% stenosis suggesting the possibility of competitive flow. Otherwise, all other patients were clinically free of symptoms.

Discussion

With the present operative techniques and methods of myocardial protection, coronary revascularization can be performed with low morbidity and mortality rates. The goal now is to achieve better long-term results by improved selection of grafts.(13)

Compared with standard saphenous vein grafts, use of the ITA as a coronary artery bypass graft resulted in superior long-term results. (3,4) Studies have demonstrated that there are differences between venous and arterial grafts as follows:

(1) The venous wall is supplied by the vasavasorum, whereas the arterial wall may be supplied by diffusion through the lumen in addition to the vasavasorum. (14)

(2) The endothelium of arteries may secrete more endothelium-derived relaxing factors. (15)

(3) The structure of the vein is subjected to low pressure, whereas the artery is subjected to high pressure. (16)

The differences may account for the difference in the long-term patency rate. On the basis of the superior long-term results of the use of the ITA, other arteries have been used in CABG. Some studies, however, showed that arterial grafts are not uniform in either anatomy or function.

He and Young (17) proposed a functional classification of arterial grafts on the basis of experimental studies on vasoreactivity together with physiologic and embryologic considerations:

Arterial grafts		
Type I	**Type II**	**Type III**
Somatic arteries Less spastic e.g. internal thoracic artery, inferior epigastric artery.	Splanchnic arteries Spastic e.g. gastroepiploic artery.	Limb arteries Spastic e.g. Radial artery.

For the RA, the major concern is its spastic characteristics because of thicker media and fenestrated internal elastic lamina which led to the early abandonment of this graft. However, harvesting of a RA that is free of spasm and preservation of the endothelium is vitally important. Vascular endothelium secretes a number of EDRFs that play an important role in vasorelaxation and inhibition of platelet aggregation. (15,18)

The reported methods to avoid spasm during and after harvesting the RA include:

1) Systemic use of calcium channel blockers. (12,19)

2) Use of papaverine alone (20) or mixed with blood (12) for gentle hydrostatic dilatation of the artery to achieve antispastic effect and to check leaking.

3) Use of VG solution (verapamil hydrochloride, nitroglycerine, heparin and sodium bicarbonate in Ringer's solution).(21)

Some surgeons attempted to treat the spasm by gentle hydrostatic dilatation. Others, used to pass a probe through the lumen to dilate it. However, probing, a common maneuver in the early era of RA use would injure the endothelium leading to loss of its biological activities. We used gentle hydrostatic dilatation with a mixture of blood and papaverine primarily to check for any side branches and to relieve any segmental spasm if present. This maneuver was also adopted by Acar and associates(12) and Royse et al.(22) This procedure when undertaken at a low pressure is not harmful to the endothelium of the artery which is already accustomed to systemic pressure. On the other hand, He (21) preferred to flush the artery only with other end open for maximal preservation of the vascular endothelium.

It has been proposed by several authors that the current success is related to the use of calcium-channel blockers both perioperatively as an intravenous infusion and subsequently as an oral medication up to 12 months postoperatively. Several of these agents were used as: Diltiazem,(12) Verapamil (21) and Nifedipine.(23) However, we have chosen not to use any of these medications either perioperatively or postoperatively. In our opinion, these drugs may lead to vasodilatation, hypotension and reduced cardiac output if not well tolerated by the patient. We agree with Barrier (24) that there is no benefit of dilating the whole body to avoid spasm to the RA and that the preservation of vascular endothelium by

avoiding probing and the meticulous non-touch technique during harvesting and anastomosing will result in an appropriate artery that is free of any spasm.

The RA should be removed en bloc together with its pedicle which allows safe manipulation of the artery. It should be noted, that even the ITA is not free of spasm especially in its distal part as reported by Saraba (25) and Blanche(26). This stresses once more on meticulous dissection of arterial grafts to harvest the artery free of any spasm.

It was postulated by Van Son et al (14) that the RA when used as a free graft has a tendency to intimal hyperplasia because the thick medial layer is more vulnerable to ischemia due to interruption of the vasavasorum. In addition, the internal elastic fenestrations facilitate the migration of myocytes into the intima. The histological studies by these authors however show that the vasavasorum of the RA don't penetrate the media, thereby implying that they have little role, if any, in arterial nourishment which thus comes mainly through diffusion from the lumen which would make it ideal to be used as a free graft. Thus, major concern regarding intimal hyperplasia as a cause of early graft failure could be avoided as this phenomenon which is induced by injury to the intima during harvesting occurs in the setting of rough dissection leading to prolonged spasm causing a reduced flow into the graft. (12)

We have relied upon doppler evaluation to determine the adequacy of palmar collateral flow after occlusion of the RA confirmed by observing the pulse oximetry trace after occluding the RA intra-operatively. No patient with an adequate preoperative doppler study has been denied the use of RA intraoperatively (except only 2 diabetic patients where the RA was found to be calcified with atherosclerotic changes and were excluded from the study). This supports the adequacy and importance of doppler study pre-operatively. On the other hand, about 5% of the patients who were scheduled for CABG using the RA were excluded depending on the preoperative doppler study.

Royse et al (22) and Acar et al (12) used to do Allen's test preoperatively and performed doppler study only in case of a positive test. Tatoulis et al (27) and Bhan et al (23) relied totally on doing Allen's test. Others, like Manasse et al (19) performed both Allen's test and doppler study to verify the collateral circulation in the hand.

Both methods seem to be reliable as hand ischemia was not encountered in any of the studies and the only common finding among all studies was dysthesia of the thumb or the forearm incision due to traumatic injury of the nerves related to the RA with a mechanism similar to the lesions of the saphenous nerve responsible for dysthesia of the superior aspect of the foot after removal of the saphenous vein in the leg.

Another point of concern is the site of proximal anastomosis; we performed the proximal anastomoses in the beginning of our use of the RA onto a saphenous vein graft, but after gaining more experience we used to perform the proximal anastomoses on the ascending aorta using 5/0 polypropylene suture except in patients with calcified and ascending aorta. We used the distal end of the RA for the distal anastomosis for better size matching with the target coronary artery.

Acar et al (12) mentioned that there is no problem from performing proximal anastomosis to the ascending aorta. Others, (28) also used the ascending aorta for proximal anastomosis except where a radial artery was used as part of composite arterial revascularization anastomosing it to the LITA. (29) We preferred not to anastomose the RA to the ITA for fear of steal phenomenon due to size mismatch between ITA and RA and to avoid making the entire revascularization dependent on the proximal ITA. Dietl (20) anastomosed the proximal end of the RA to a patch of autologous pericardium sutured to the aortic wall when the aortic wall was thicker than the internal diameter of the RA. Calafiore (29) avoided performing the proximal anastomosis to the aorta suggesting that free arterial grafts are normally third or fourth-order branches of the aorta, so they usually are submitted to a pattern of flow that is quite different and can't tolerate the flow of the ascending aorta. When those conduits are anastomosed to the aorta, the abrupt increase in pressure wave can result in wall stretching with intimal tearing and subsequent development of premature hyperplasia. The other reason is the mismatch between the aorta and the conduit wall in terms of thickness and diameter which implies technical difficulties in performing the anastomosis leading to impairment of flow. However, the RA measured proximally about 2.9 mm in diameter and could be adequately anastomosed to the aorta except in those with calcified and thickened aorta.

Acar (12) published his 5-year results of using the RA and showed a patency rate of 83%, Bhan and associates (23) reported 97% patency at a mean of 16.2 months.

In these reports, the RA was anastomosed proximally to the aorta while that by Calafiore (29) where the RA was anastomosed proximally to the in-situ LITA, the patency rate was 94% at a mean of 21 months follow up.

Studies by Kaufer et al (30) showed a low correlation between the degree of RA pathology and known coronary artery disease risk factors as smoking, hypertension, hypercholesterolemia and obesity and that the RA may be relatively resistant to atheroselerotic development in such patients, although somewhat less than the ITA.

The RA has several advantages over other conduits: It can be dissected simultaneously with the LITA, its length allows grafting to all target vessels, its diameter matches with that of most coronary arteries with no valves along its whole length, and is easy to handle. Bilateral harvesting of RAs allows total arterial revascularization to be achieved and avoids leg incision leading to early ambulation of the patient.

Although patients were not catheterized postoperatively, however, the good clinical outcome suggests that the grafts are functioning well. Catheterizing the patient postoperatively is not practical in the era of cost containment and also the difficulty of convincing patients who are not complaining to undergo cardiac catheterization.

In conclusion

The RA could be used safely without increase in morbidity or mortality. It is important to perform doppler study of the

upper limb before going to surgery. Spasm in the RA could be overcome by meticulous dissection following the non-touch technique, entering into the correct plane of dissection and avoiding probing of the RA. We have chosen not to use any calcium-channel blocker. Good long-term patency rates could also be achieved by anastomosing the RA to coronary arteries with good run-off and tight proximal stenosis to avoid competitive flow.

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IS IT POSSIBLE TO LIMIT POST-CABG NEUROLOGICAL COMPLICATIONS?

ABSRTACT

Neurological deficits occur after coronary artery bypass grafting with an incidence ranging between 0.8% and 5.2%. To identify risk factors associated with this neurological deficits, we retrospectively studied pre-, intra-, and postoperative variables in 971 patients undergoing coronary artery bypass grafting (CABG) operations over the period from 1994 - 1999.

Neurological deficits were detected postoperatively by the study team and confirmed by neurologic consultation and completed tomographic scan4ing. Neurological deficits were defined as: coma > 24 hours, new deficits on comprehensive examination at 7 days or 1 month, and death before 1 month if associated with neurological deficits.

Results: 17 patients out of 971 patients deveoped various neurological deficits. Six preoperative risk factors were correlated with stroke: age (mean 58.± 11 years), female gender (in 5 patients), systemic hypertension (in 13 patients), diabetes mellitus (in 12 patients), and non-symptomatic carotid stenosis > 70% documented by carotid duplex in 6 out of 8 patients who had the test). By statistical comparison, all these factors showed significant risk (P < 0. 05).

Intraoperative risk factors included only: long bypass time (> 90 minutes in 17 patients and > 120 minutes in 9 patients) and lowest detected mean arterial blood pressure < 45 mmHg (in 5 patients); that showed significant risk (P < 0. 05). Surgery that included double cross-clamp (in 15 patients) showed significant risk (P < 0. 05) as well Mortality within 1 month showed significant difference (12.4% in patients with neurological deficits compared to 1.2% overall mortality rate, P < 0. 05).

Conclusion: All the six preoperative risk factors taken together can identify the risk of stroke in patients having coronary bypass grafting. Recognition of the high risk group will aid prevention of stroke by modification of surgical procedures, hemodynamic or pharmacologic intervention.

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INTRODUCTION

Coronary artery bypass grafting (CABG) has become a routine surgical procedure for patients with coronary artery disease (1). Although of great benefit, CABG is associated with adverse neurologic and/or neuropsychological complications in a subgroup of patients. Identification of these factors is of particular concern because the procedure is being performed in older patients as well as those with more complicated medical histories (2). New sensitive methods to measure subtle changes in brain function postoperatively and to scan the ascending aorta to determine the incidence and location of aortic atheroma have recently been developed (3). Discussion of alternative methods of dealing with ascending aortic atherosclerosis and myocardial protection techniques to avoid cerebral microembolism are now the focus of many surgeons and anesthesiologists around the world (4)

With these factors in mind, we report on an extensive 6-year evaluation of a large number of patients undergoing CABG surgery with accurate assessment of postoperative neurological and/or neuropsychological changes and the results of surgical, anesthetic or extracorporeal modifications designed to reduce cerebral injury.

Patients and Methods

In the period from December 1994 to January 1999, a total number of 971 patients operated upon with isolated coronary artery bypass grafting using cardiopulmonary bypass were evaluated. The group included 61 females (6.3%) and 910 males (93.7%).

Each patient underwent a comprehensive neurologic history and physical examination, including a visual examination. A previous history of transient ischemic attacks (TIAs), known asymptomatic bruits, previous endarterectomy, or other neurologic deicits were recorded and analyzed separately as a risk factor. During clinical examination, the presence of carotid bruit was enrolled followed by carotid Doppler examination (in the last 2 years) for these patients (106 patients). Exclusion criteria were patients with history of previous stroke, neurodegenerative disease, major depressive disorder, class IV congestive heart failure, cirrhosis, renal failure, or other serious life-threatening diseases.

On the day of operation, patients were given their cardiac medications and premedicated with diazepam (2.5 to 5 mg orally) and morphine (0.1 mg/kg intramuscularly). A standard anesthetic technique including the cannulation of a peripheral vein, radial artery and the internal jugular vein under local analgesia. A moderate dose of fentanyl 5 - 15 µg/kg and thiopentone 2 mg/kg used for induction of anesthesia and pancuronium 0.1 mg/kg was used to facilitate endotracheal intubation. The anesthesia was maintained using O2 / N2O supplemented as necessary with isoflurane and incremental fentanyl 2 - 5 µg/kg sufficient to maintain stable hemodynamics. Controlled mechanical ventilation was used keeping end-tidal carbon dioxide at 30 - 35 mmHg.

Each patient was then subjected to coronary artery bypass grafting in which cardiopulmonary bypass was conducted using a membrane oxygenator (Meditronic,

Table (1): Demographic data of patients from 1994 - 1999.

	Normal	Neurologic Deficits
Age (years)		
Mean ± SD	51 ± 9	58 ± 11
Range	40 - 75	38 - 73
Male / Female (number)	893 / 61	12 / 5
Weight (kg)	68 ± 19	65 ± 13

Values are mean ± SD, range, or patient number.

CA or Baxter Univox - CY, Baxter Healthcare Corp, Bentley Division, CA) and an arterial line filter (in the last two years). CPB with non-pulsatile perfusion flow (2.2 - 2.4 L/min/M2) using a circuit primed with crystalloids. Moderate hyothermia down to 32°C was implemented in all patients. Heparin doses were given according to the hourly measurement of the activated clotting time (ACT). Blood glucose levels were measured repeatedly and kept below 200 mg/dL, using insulin infusion (1 IU/mL) in all patients regardless of being diabetic or not. The highest and lowest MAP during operation were detected.

Aorto-coronary bypass was done according to the recommendations of the referring cardiologist after reviewing the results of cardiac catheterization and coronary angiography. Left internal mammary artery (LIMA), saphenous vein grafts (SVGS) and right internal mammary artery (RIMA) were used as bypass grafts in all the cases. Radial artery was used over the last year. The technique of myocardial preservation was the same in all cases (cold, crystalloid high-potassium, blood enriched cardloplegia) usually administered as a single dose of 750 mL - 1000 mL. As soon as the distal anastomoses were done, the aortic cross-clamp was removed and partial occlusion clamp was applied. The proximal anastomoses were done to the ascending aorta (In 3 cases out of 971, large part of the ascending aorta had to be replaced for gross calcification). The time of cardiopulmonary bypass, highest MAP and lowest MAP during bypass were recorded.

During postoperative period, the patient's arterial blood pressure, coagulation profile, and blood sugar level were recorded in the intensive care unit till the complete recovery of the patients.

Patients had standard postoperative care with the exception that all patients received a full neurologic testing up to 7 days postoperatively before discharge. All patients returned at one month for a standard postoperative visit when examinations were repeated. Patients were classified as having a postoperative neurological deficit if one of the following criteria were recorded: (1) coma lasting > 24 hours, (2) neurologic deficit on comprehensive examination at 7 days or 1 month confirmed by a neurologist and computed tomographic scanning, or (3) death before 1 month, if associated with a neurologic deficit.

Table (2): Preoperative clinical characteristics of the 17 cases who developed neurological deficits.

Pt. No.	Age (years)	Sex	Hypertension	DM	Hyperchol-esterolemia	Carotid stenosis > 70% by duplex
1	65	F	+	+	+	Not done
2	38	M	+	-	-	Not done
3	60	M	+	+	+	Not done
4	65	M	+	+	+	Not done
5	60	M	-	+	+	Not done
6	62	M	-	+	+	Not done
7	55	F	+	-	+	Not done
8	58	M	-	+	+	Not done
9	68	M	+	+	-	Not done
10	57	F	+	+	+	+
11	67	M	+	+	-	-
12	57	M	-	-	+	+
13	52	M	+	-	-	-
14	52	M	+	+	+	+
15	55	F	+	+	+	+
16	73	F	+	+	+	+
17	58	M	+	-	-	+

DM = diabetes mellitus, + = positive, - = negative, M = male, F = female

Statistical Analysis:

Quantitative data were represented as mean ± standard deviation and were analyzed when necessary by unpaired t-test while qualitative data were represented as percentage (%) of the total and were anusing Chi-square test for comparison between the two groups.

Results

This study was enrolled for 971 cases; only 17 cases developed different types of postoperative neurological complications.

From table (3) of these 17 cases in whom neurological complications were reported: (1) delayed recovery was in 11 cases, (2) paralysis or paresis involving one

Table (3): Intra- and postoperative characteristics of the 17 cases who developed neurological deficits.

Pt. No.	CPB time (min.)	Lowest MAP (mmHg)	Highest MAP (mmHg)	Coag.	Neurologic deficit	Outcome	Mortality
1	93	50	80	Normal	Delayed recovery	Complete recovery (3 days)	
2	99	42	90	Normal	Delayed recovery	Complete recovery (7 days)	
3	120	56	95	Normal	Delayed recovery	Complete recovery (3 days)	
4	117	44	90	Normal	Delayed recovery	Complete recovery (1 day)	
5	112	56	95	Normal	Delayed recovery	Complete recovery (3 days)	
6	115	48	90	Normal	Delayed recovery	No recovery	+
7	110	52	90	Bleeding tendency	Delayed recovery	No recovery	+
8	125	56	95	Normal	Delayed recovery	Partial recovery (hemiparesis)	
9	128	30	90	Bleeding tendency	Delayed recovery	Partial recovery (amnesia)	
10	125	58	80	Normal	Delayed recovery	No recovery	
11	125	50	70	Bleeding tendency	Delayed recovery	Complete recovery	
12	100	52	75	Bleeding tendency	Peroneal N. injury	Complete recovery	
13	100	50	65	Bleeding tendency	Monoparesis	Partial	
14	125	39	67	Bleeding tendency	Hemiparesis	Partial	
15	125	52	65	Normal	Hemiparesis	Partial	
16	130	40	75	Normal	Hemiparesis	Partial	
17	125	50	75	Bleeding tendency	Delayed recovery	Complete recovery (4 days)	

MAP = mean arterial blood pressure on cardiopulmonary bypass; coag. = coagulation profile; comp. recovery = complete recovery (no deficits); partial = partial recovery with neurological deficits; Mortality = death within 1 month associated with neurologic deficits.

Table (4): Analysis of the study data.

Variable	No Deficit	Deficit	P value (Significance)
Preop. Demographics			
No. of patients	954	17	
Age in yrs (mean ± SD)	51 ± 3	58 ± 11	< 0.05 (Sig)
Female gender (No., %)	61 (6.39%)	5 (29.41%)	< 0.05 (Sig)
Medical history			
Hypertension	207 (21.69%)	13 (76.47%)	< 0.05 (Sig)
Diabetes mellitus	158 (16.56%)	12 (70.58%)	< 0.05 (Sig)
Hypercholesterolemia	520 (54.50%)	12 (70.58%)	< 0.05 (Sig)
Physical examination			
Carotid bruit (stenosis)	315 (33.01%)	14 (82.35%)	< 0.05 (Sig)
Carotid duplex (> 70% occlusion of carotid)	27 / 98 (27.1%)	6 / 8 (75%)	< 0.05 (Sig)
Intraoperative			
CPB time (min.)			
> 90 min.	305 (31.97%)	17 (100%)	< 0.05 (Sig)
> 120 min.	117 (12.2%)	9 (57%)	< 0.05 (Sig)
Aortic atherosclerosis (palpation by surgeon)	210 (22.01%)	14 (82.35%)	< 0.05 (Sig)
Lowest MAP < 45 mmHg	79 (8.2%)	5 (29.4%)	< 0.05 (Sig)
Highest MAP > 90 mmHg	91 (9.6%)	3 (16.7%)	> 0.05 (NS)
Double cross clamping	95 (9.95%)	15 (88.23%)	< 0.05 (Sig)
Postoperative coagulopathy	388 (40.7%)	7 (43.4%)	> 0.05 (NS)
Mortality rate within 1 mo.	12 (1.2%)	2 (12.4%)	< 0.05 (Sig)

Deficit = neurologic deficit; Sig = significant; NS = non-significant

or more limb(s) in 6 cases, (3) two mortalities (one male and one female).

From table (2), summarizing preoperative data of these cases (medical history): 5 patients out of 17 were females, 12 patients out of 17 were diabetics, 13 patients out of 17 were hypertensive, 12 patients out of 17 were hypercholesterolemic, 6 patients out of 8 were complaining of > 70% carotid occlusion confirmed by carotid duplex.

Of these 17 patients with neurologic deficits, 16 had a diagnosed stroke and the last one had a peroneal nerve injury.

Factors that were significantly associated with stroke at univariate level ($P < 0.05$) are shown in table (4).

Discussion

Coronary artery bypass grafting (CABG) has become a routine surgical procedure for patients with coronary artery disease. Although of great benefit, CABG is associated with adverse neurologic complications including stroke. Cardiopulmonary bypass (CPB) itself induces a variety of pathophysiological processes that can exert a profound influence on cerebral physiology. Shaw (1987)(5) summarized potential mechanisms for post-CABG neurologic deficits, including macroembolization of air or particulate matter originating from aorthic atheroma (particularly with aortic manibulation); microembolization of gas, fat, aggregates of blood cells, platelets or fibrin, or particles of silicone or polyvinylchloride tubing; and inadequate cerebral perfusion pressure resulting from reduced flow and low arterial blood pressure.

Much of the researches regarding cerebral complications following CPB are descriptive, relating patient risk factors to the incidence of postoperative stroke.

In this study, the incidence of neurologic deficits following CABG operation was about 1.6%, nearly as Redmond et al. study in 1996, (6) while the mortality rate as a sequel of neurologic problem was about 0.3%, nearly as Faggioli et al. study in 1990 (7).

In our study, increased age has been identified as a significant risk for new postoperative neurological deficits ($P < 0.05$), possibly for the potential increased number of emboli and the presence of more extensive atheroselerosis. (8)

C. W. Hogue et al. (in 1998) (9) studied female gender as a risk factor for neurologic complications after cardiac surgery (3.8% vs. 2.4% in males) and he diagnosed it as a factor independently associated with risk for new neurological deficit. The overall 30-day mortality rate following neurologic insults for females was higher than in males. In our study, we noticed that the global number of females represented 61out of 954 patients who had CABG without a neurological deficit, while 5 out of 17 patients having deficit were females, i.e., while having an overall incidence of neurological problems following CABG of 1.6% we have 8.1% incidence among female population. C. W. Hogue claimed that this higher risk cannot be explained by other known risk factors (9). A possible explanation is that because of the normal hormonal protective mechanisms for females, whenever we have symptomatic patient, e.g. coronary artery

disease, there must be an aggressive arterial pathology increasing cerebral risk.

Like other studies, history of hypertension, diabetes mellitus, hypercholesterolemia, presence of carotid bruit, or critical carotid stenosis (> 70%) diagnosed by preoperative carotid duplex remained significant predictors of stroke risk in CABG patients.

CPB time was found in our study a predictor of stroke risk. All the patients who had stroke (17 patients) had a CPB time > 90 minutes and 57% of them (9 patients) had a CPB time > 2 hours. Guy et al. in 1996 (10) demonstrated that patients who had long bypass time (> 120 minutes) to be 6.6 times as likely to have stroke.

Mean arterial blood pressure on CPB was found to be a significant risk factor for postoperative neurological deficits. In a study employing a hypothermic CPB model, Schwartz et al. (11) demonstrated that changes in MAP below the apparent cerebral autoregulatory range influenced cerebral blood flow. One trial in 248 CABG patients showed decreases in mortality (1.6% vs. 4%) and stroke rate (2.4% vs. 7.2%) in a group of patients in whom MAP was maintained at 80 to 100 mmHg. In our study, we found that the incidence of exposing patients to a mean arterial blood pressure less than 45 mmHg was 2 patients (9.4%) in patients who got neurological deficits vs. 8.2% incidence in the rest of the patients ($P < 0.05$) while having mean pressure > 90 mmHg proved no significant difference ($P > 0.05$).

Lastly, surgical technique remained an important factor to minimize the incidence of neurological deficits following CABG. Longer bypass time (indicating longer manipulation titne) as well as the number of cross clamps (manipulating atherosclerotic aorta) were found significant factors ($P < 0,05$) indicating risk. To reduce the surgical risk of breaking atheromatus plaques in the ascending aorta, the proximal anastomoses are being done over the recent period, with the application of single aortic cross clamp. We are confident that this modification will reduce the incidence of neurological complications even further, though this needs to be studied over longer period of time.

In our study, postoperative coagulopathy did not show statistical significance. as a risk factor for post-CABG neurological deficits. However, this may be because majority of neurological deficits following CABG are due to embolic phenomena.

In this retrospective study of 971 patients undergoing CABG, we identified six preoperative factors associated significantly with stroke: increasing age, female gender, history of hypertension, diabetes mellitus, hypercholesterolemia, and presence of carotid bruit. The major implication of this study compared with previous studies 7,13, is that individual risk factors should not be viewed in isolation; as an example, a 70-year-old patient without other risk factors is at low risk for stroke; hence age taken in isolation should not be used to determine stroke risk. When preoperative variables were combined with intra- and postoperative variables, cardiopulmonary bypass time, mean arterial blood pressure (lowest and highest) values could significantly affect outcome.

Finally, we suggest that the prevention of stroke in CABG patients can be considered in stepwise fashion. First, individuals identified by the preoperative risk factors as having higher probability of stroke should be evaluated more closely. The predictive factors identified in this study are all associated with or are consequences of atherosclerotic disease and potentially undiagnosed extracranial or intracranial disease.

Atherosclerotic involvement of the carotid arteries as detected by carotid bruit can be further defined with respect to degree of stenosis by duplex ultrasound techniques Atherosclerotic involvement of ascending aorta can be determined intraoperatively, and a calcified aorta may lead to more embolic phenomena during cross-clamping (15). So, we suggest that high risk patients be targeted for carotid duplex scanning, epicardial echocardiography or both. Identification of this high-risk population makes this approach both logistically and economically feasible. Second, there are patients for whom modification of surgical management such as perfusion flow rate, blood pressure and time of cardiopulmonary bypass may be important. The addition of arterial filter to the perfusion circuit, though not universally accepted in all centers, seems to be the last line of defense against microemboli. Another studies correlating physiologic intraoperative changes with neurologic outcome have used methods as quantitative electroencephalography and transcranial Doppler study (16). These methods show promise for evaluating the short-term and long-term of intraoperative physiologic variables. Third, postoperative period, the stability of all hemodynamics and coagulation profile have the potential to minimize neuronal damage and decrease the occurrence of stroke (17).

Finally, we suggest that the strategy used ill this study to predict factors that can affect the neurologic outcome during CABG, the optimization of these factors can protect and limit the brain from injury.

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Boseila A, Abd AlSadek M*, Balbaa Y, Abu Senna G

DOES SEQUENTIAL CORONARY ARTERY BYPASS GRAFTING HAVE ADVANTAGES OVER SINGLE CORONARY ARTERY BYPASS GRAFTING?

ABSRTACT

Background: Sequential coronary bypass grafting (CABG) is claimed to allow more complete revascularization, decrease the bypass time on the heart lung machine, and increase the blood flow through the graft.

Material and Methods: Fifty adult patients underwent surgical coronary revascularization in the department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University. The patients were divided randomly into two groups: Group I: 25 patients, submitted to sequential CABG, and Group II: 25 patients submitted to single CABG. They were evaluated preoperatively, perioperatively, and 6 months after surgery clinically, by ECG, echocardiography, and myocardial stress perfusion imaging, followed by myocardial perfusion scanning.

Results: There were 44 males and 6 females who had an age range from 42 - 62 years (mean 50.2 ± 12.6 years). The 2 groups were comparable in their preoperative characteristics. Intraoperative and postoperative data were also equal, except for a significantly increased bypass time in group II, coinciding with a statistically significant increase in proximal anastomoses in the same group. The distal anastomoses were however significantly more in the sequential group. As regards the postoperative extra cardiac complications a statistically significant increase in lower limb wound infection at the site of saphenous vein harvesting in group II was evident.

Conclusions: The results indicate that sequential coronary bypass grafting decreases the bypass time through decreasing the number of proximal anastomoses required, increases the number of distal anastomoses possible thus allowing a more complete revascularization, and saves bypass conduits, which also decreases the length of the limb wound and its infectious complications.

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INTRODUCTION

Techniques of coronary artery bypass surgery have evolved over the past 35 years in response to the changing technical problems presented to the surgeon, as well as the changing patient base. Constant refinements of technique are required to minimize morbidity and mortality for the patient. Sequential coronary artery bypass grafting is a surgical technique, advocated to deal with many technical problems presented to the surgeon (Brian and Alexander, 1996) (1). In 1971 in a report by Flemma and associates, the technique of using side-to-side anastomosis as a

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sequential technique during the course of triple aorto-coronary vein bypass for coronary insufficiency was first mentioned (Flemma, et al., 1971) (2).

The sequential grafts were advocated initially because it shortened the operative procedure and made a more complete revascularization possible, decreased the bypass time on the heart lung machine, and increased the blood flow through the graft (Kondo et al., 1994) (3). Later, an improved patency rate was reported, while Grondin and coworkers (1978) (4) pointed out that with the proper technique the anastomoses to very small coronary arteries could be successful. (Meeter, et al., 1991) (5).

Kieser and associates in 1986 (6) reported after long term follow up of sequential CABG versus single CABG, that sequential CABG has presented problems mainly because of commonly reported differences between the patency of side-to-side anastomosis and end-to-side vein to coronary anastomoses. Consequently they recommended that a single venous bypass graft to each coronary artery is to be preferred unless shortage of venous conduit or local aortic conditions are found.

The aim of this work is the evaluation of advantages and disadvantages of sequential and single coronary artery bypass grafting using the saphenous vein as a conduit, on the immediate postoperative period and on the short term after 6 months.

Material and Methods

A total of 50 consecutive patients proven to have multivessel coronary artery disease were included in our study and were submitted to CABG. They were selected according to the following criteria:

Inclusion criteria:

I- Multivessel coronary artery disease

2- No age or sex limitation

3- Accepted risk factors were: hypertension, diabetes, hyperlipidemia and smoking.

Exclusion criteria:

I- Poor left ventricular function (ejection fraction less than 40%).

2- Post PTCA complications

3- Patients having associated valve lesions

4- C.O.P.D patients

5- Patients submitted to CABG previously.

6- Patients with varicose veins

The patients were divided randomly into two groups: Group I: 25 patients, submitted to sequential CABG, and Group II: 25 patients submitted to single CABG. Data of the patients were collected for preoperative, operative and postoperative assessment. All patients were operated upon using standard cardio-pulmonary bypass with normothermia, and myocardial protection was performed using intermittent antegrade warm blood cardioplegia.

For all patients, lesions of the left anterior descending coronary artery (LAD) were bypassed using the left internal mammary artery (LIMA).

The distal anastomosis in all cases of single CABG was end to side anastomosis, while in cases of sequential CABG the most distal anastomosis was end to side anastomosis and the following distal

	Sequential CABG (N = 25)	*Single CABG (N = 25)*	*Total (N = 50)*	*P*
Age (years) Mean ± SD Range	50 ± 13.7 42-60	50.4 ± 15.1 45 – 62	50.2 ± 12.6 42 – 62	>0.05
Male: Female (%)	22:3 88%: 12%	22:3 88%: 12%	44:6 88%: 12%	>0.05

CABG=Coronary artery bypass grafting

Table 1: Age and Sex distribution of 50 patients with coronary heart disease for sequential CABG or single CABG

Angina Effort Grading	*Sequential CABG* (N = 25)	*Single CABG* (N = 25)	*Total* (N = 50)	*P*
II	14 (56%)	16 (56%)	30 (60%)	>0.05
III	6 (24%)	4 (26%)	10 (20%)	>0.05
Unstable angina	5 (20%)	5 (20%)	10 (20%)	>0.05

CABG=Coronary artery bypass grafting

CCS=Canadian Cardiovascular Society

Table 2: Distribution of 50 patients with coronary heart disease undergoing sequential CABG or single CABG according to angina effort grading by the CCS.

anastomoses were Diamond "cross" side to side anastomoses. Sequential grafts were fashioned in two techniques: The first: the sequential graft bypassed both the right and the left coronary systems: The second. the right system received one separate graft, and the branches of the left system were taken in one or two sequential grafts.

Follow up:

Six months postoperatively all patients were evaluated clinically, by ECG, echocardiography, and myocardial stress perfusion imaging, followed by myocardial perfusion scanning using Tc99.

Statistical Analysis:

The statistical analysis of the results was computed on IBM PC microprocessor. The computing was done by means of a statistical software package "Microstat".

Echocardiographic findings	Sequential CABG (N=25)	Single CABG (N=25)	Total (N=50)	P
E.F.(%) Mean ± SD Range	44.8 ± 17.1 30-55	43.8 ± 16.7 30-53	44.3 ± 16.9 30-55	>0.05
WMA (Number of patients)	10 (40%)	4 (16%)	14 (28%)	**<0.05**
Overall contractility: (Number of patients)				
Fair	14 (56%)	11 (44%)	25 (50%)	>0.05
Good	11 (44%)	14 (56%)	25 (50%)	>0.05

EF = Ejection fraction.

WMA = wall motion abnormalities.

CABG=Coronary artery bypass grafting

Table 3: Echocardiographic findings in 50 patients with coronary heart disease undergoing sequential CABG or single CABG.

	Sequential CABG (N = 25)	*Single CABG (N = 25)*	Total (N = 50)	P
Cardioplegia dose Mean ± SD	2.7 ± 0.9	3.5 ± 1.1	3.1 ± 1	>0.05
Ischemic time *(min)* *Mean ± SD*	51.4 ± 11.7	53.8 ± 13.3	52 ± 12.4	>0.05
Bypass time *(min)* *Mean ± SD*	68.7 ± 18.8	96.4 ± 37.1	81 ± 24.5	**<0.05**
Length of vein graft *Range (cm)* *Mean ± SD*	40-55 46.4±5.8	65-90 77±7.5	40-90 61.9±17.0	**<0.005**

min = minutes

CABG=Coronary artery bypass grafting

Table 4: Perioperative Data in 50 patients with coronary heart disease undergoing sequential CABG or single CABG

The statistical analyses were performed using the arithmetic mean, standard deviation, hypothesis t-test, paired t test, chi-square test, test of proportion, correlation test and analysis of variance using one way Anova test. The P-value less than 0.05 (P<0.05) was considered significant.

Results

There were no statistically significant differences between both groups as regarding age and sex distribution (Table 1).

All risk factors including hypertension, diabetes mellitus, hyperlipidemia, cigarette

	Sequential CABG (N = 25)	*Single CABG (N = 25)*	**Total (N = 50)**	**P**
Number of distal anastomoses/patient Mean ± SD	3.04 ± 0.2	2.68 ± 0.4	2.86 ± 0.4	**<0.005**
Number of proximal anastomoses/patient *Mean ± SD*	1.6 ± 0.5	2.68 ± 0.4	2.1 ± 0.75	**<0.05**
Number of grafts *Mean ± SD*	1.6 ± 0.5	2.68 ± 0.4	2.1 ± 0.75	**<0.05**

CABG=Coronary artery bypass grafting

Table 5: Bypass grafts performed in 50 patients with coronary heart disease undergoing sequential CABG or single CABG

	Sequential CABG (N = 25)	*Single CABG (N = 25)*	**Total (N = 50)**	*P*
	Mean±SD Range	*Mean±SD Range*	*Mean±SD Range*	
Duration of ventilation (hours)	7.78±4.9 5 – 14	6.52±5.00 4 - 18	7.1±4.9 4-18	>0.05
Total days in ICU	2.92±1.2 2 – 4	2.92±1.1 2 - 3	2.9±1.1 2-4	>0.05
Total days in hospital	7.8± 1.1 7 – 10	8±1.2 7 - 11	7.9±1.1 7-11	>0.05

CABG=Coronary artery bypass grafting

Table 6: Postoperative data of 50 patients with coronary heart disease who had sequential CABG or single CABG.

smoking and presence or absence of positive family history of cardiac disease are distributed between both groups with no statistically significant differences.

Both groups were also comparable as regards the preoperative angina functional class and echocardiographic findings (Table 2 & 3), except for an increased incidence of wall motion abnormalities (WMA) in the sequential CABG group.

Table 4 revealed insignificant differences in the operative data concerning the number of doses of antegrade warm blood cardioplegia (2.7±0.9 doses and 3.5±1.1 doses in group (I) and (II) respectively), and ischemic time (51.4±11.7 minutes in group I versus 53.8±13.3 minutes in group II).It shows however, that the bypass time is significantly longer in group 11 with 96.4+37.1 minutes than in group I with 68.7±18.8 minutes. Table 5

Table (7): Distribution of of 50 patients with coronary heart disease undergoing sequential CABG or single CABG with postoperative assessment using resting and stress ECG and stress myocardial perfusion scanning.

	Sequential CABG (N = 25)	*Single CABG* (N = 25)	*Total* (N = 50)	*P*
Resting ECG new infarction	0 (0%)	1 (4%)	1(2%)	>0.05
Positive stress ECG	0 (0%)	1 (4%)	1(2%)	>0.05
Positive stress myocardial perfusion scanning	4 (16%)	3 (12%)	7(14%)	>0.05

CABG=Coronary artery bypass grafting

Table (8): Postoperative extracardiac complications in 50 patients with coronary heart disease who had sequential CABG or single CABG

	Sequential CABG (N = 25)	**Single CABG** (N = 25)	**Total** (N = 50)	**P**
Bleeding:				
Medical	2 (8%)	3 (12%)	5 (10%)	>0.05
Surgical	2 (8%)	1 (4%)	3 (6%)	>0.05
Superficial Wound infection:				
Sternotomy	1 (4%)	1 (4%)	2 (4%)	>0.05
Lower limb	2 (12%)	8 (32%)	10 (20%)	**<0.05**
Chest infection	4 (16%)	3 (12%)	7 (14%)	>0.05
Pleural collection :				
* Chylothorax	1 (4%)	0	1 (2%)	>0.05
* Hemothorax	0	1 (4%)	1 (2%)	>0.05
* Pleural effusion	3 (12%)	1 (4%)	4 (8%)	>0.05

CABG=Coronary artery bypass grafting

shows a significantly higher number of proximal anastomoses in group II, and it shows a significantly increase in the number of distal anastomoses in group 1 compared to group II.

Table 6 shows the duration of ventilation, and total days of stay in the ICU and hospital for both groups with no significant differences between both groups.

The results of postoperative resting ECG, stress ECG and stress myocardial perfusion scanning, for both groups are shown in table 7 and were comparable.

Table 8 lists the postoperative extra cardiac complications showing a statistically significant increase in lower limb would infection at the site of saphenous vein harvesting in group II.

Discussion

Sequential CABG has been used with increasing frequency for coronary artery revascularization. This is mainly due to its advantages which include saving bypass conduits, decrease the number of proximal anastomoses and increasing the total graft flow, furthermore the operating time can be shortened and the revascularization can be made on small arteries (Bartley, et al., 1972) (7) (Grondin et al., 1989) (8) (Christenson and Schmuziger, 1997) (9).

Goldman and associates in 1997 (10) reported that the operative technique, including cross clamp time less than 80 minutes, bypass time less than 2 hours, and number of proximal anastomoses less than 2 are the positive predictors for the clinical outcome of CABG, represented by postoperative improvement of anginal functional class, ejection fraction, and the presence or absence of postoperative new ischemic events. Meeter and associates in 1991 (5) reported that for the sequential CABG the operating time and cross clamp time can be shorter than single CABG. Brussel and associates in 1997 (11) gave similar results, they reported that the mean cross clamp time for a mean number of 3.5 vessels was 61 minutes for sequential CABG versus 75.1 minutes for single CABG for the same number of vessels, while the mean total bypass time for sequential CABG was 70 minutes versus 94 minutes for single CABG.

These results coincide with the results of the current study, as we have a mean total bypass time of 68.7 minutes for sequential CABG versus 96.4 minutes for single CABG. So there is a definite significant difference concerning the total bypass time of both groups. This is attributable to the smaller number of proximal anastomoses in the sequential CABG group with a mean number of 1.6 per patient, which consumes less total bypass time than the single CABG technique with a statistically significant higher number of proximal anastomoses of 2.7 per patient.

Several authors consider the sequential technique more advantageous than the single CABG technique for patients with poor coronary run off, as the revascularization can be more complete, because anastomoses can be made on smaller coronary arteries (Pietrabissa et al, 1996 (12); Christenson and Schmuziger, 1997 (9); Quigley et al, 1998) (13). This is manifested in our study by the increased mean number of distal anastomoses in the sequential group, which was 3.4 anastomoses per patient versus 2.7 anastomoses per patient in the single CABG

group. This shows that more coronary vessels could be anastomosed in the sequential group leading to a more complete revascularization.

Another advantage for sequential bypass grafting is saving bypass conduits, which is reflected on the incidence of postoperative wound infection of the lower limb after harvesting of the saphenous vein (Hendrick et al, 1997) (14). Tavaerai and associates in 1997 (15) and David and associates in 1998 (16), in their studies of minimally invasive techniques of saphenous vein harvesting, reported that the shorter the lower limb incision, the less is the risk for wound infection. In the current study there is a statistically significant difference between both sequential and single CABG groups concerning lower limb wound infection. The sequential coronary bypass graft group showed only 2 cases (12%) of lower limb wound infection while the single coronary bypass graft group showed 8 cases (32%). This is due to a significantly shorter lower limb incision in the sequential CABG group, which had a mean length of 46.4 cm, as this technique needs a shorter vein segment than the single CABG group in which the incision had a mean length of 77 cm.

Mills in 1990 (17), Meeter and associates in 1991 (5), Yamagashi and associates in 1993 (18), and Christenson and Schmuziger in 1997 (9), in their studies for the evaluation of the clinical outcome of sequential and single CABG, reported no significant differences between both groups concerning the period of mechanical ventilation or the haemodynamic parameters, including myocardial support by inotropic drugs or IAB. These results coincide with the results of the current study, as there were no significant differences between both groups of sequential and single CABG concerning the mechanical ventilation period, and non-significant differences between the haemodynamics of both groups including the inotropic myocardial support and the use of IAB. The similarity between both groups concerning the haemodynamic status and myocardial support is attributable to the absence of significant differences between the preoperative ejection fraction, using the same myocardial protective techniques, and the proper surgical techniques which was associated with no significant differences between the cross clamp time of both groups.

Kondo and associates in 1994 (3) reported that early results of follow up revealed no significant differences between patency rates of sequential CABG (92%) and single CABG (90%). In other studies concerning the long term follow up there were two dominant directions. The first is that there are no significant differences between patency rates of both types as reported by Yamagashi and associates in 1993 (18). The second is that sequential CABG has better long term patency rates, as reported by Christenson and Schmuziger in 1997 (9), who explained these results by the fact that sequential graft patency depends on where the terminal ESA is placed, so they always place the ESA to the largest possible system with the highest flow.

In the current study, follow up of both groups of sequential and single CABG 6 months postoperatively by stress radioisotopic myocardial perfusion

scanning, revealed no significant difference between both groups. Among the patients in the sequential group 84% did not develop any new ischemic areas versus 88% of the single CABG group. These results are coinciding with the previously reported results, which suggested that on short term follow up, there is no significant difference between both groups of sequential and single CABG.

In conclusion, this study indicates that sequential coronary artery bypass grafting decreases the bypass time through decreasing the number of proximal anastomoses required, increases the number of distal anastomoses possible thus allowing a more complete revascularization, and saves bypass conduits, which also decreases the length of the limb wound and its infectious complications.

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BRONCHIAL STUMP CLOSURE AFTER LUNG RESECTION: ABSORBABLE OR NONABSORBABLE SUTURE MATERIAL?

ABSRTACT

A total of 47 patients underwent lung resection surgery and were followed up postoperatively for 1 year in the Cardio-Thoracic Surgery Department of the Cairo University. The patients were 0.2-67 years old (mean 30.7 years), and they were 31 males and 16 females In 24 patients the bronchial stump was closed using absorbable braided suture material, and in the other 23 patients using nonabsorbable braided suture material.

There were no statistically significant differences between both groups as regarding age, weight, and sex.

The groups were comparable regarding pre-operative status und operative diagnosis. Suppurative lung syndrome comprised about 44%, malignant tumors comprised about 17%, infected lung cysts about 10%, benign and locally malignant tumors 8.5%, and hydatid disease 8.5%, of the cases in both series. Congenital lobar emphysema accounted for 6%. while tuberculosis and trauma made up the remainder. As regards the operative procedures done for both groups of patients, pneumonectomies were performed in only 6.5% of all patients, a few lingulectomies were done, but the majority with 91.5% were lobectomies. ,

Non-fatal complications were comparable among both groups with 12.4% in the absorbable suture group, and 17.3% in the nonabsorbable suture group.

During the postoperative follow-up period new respiratory symptoms developed in three patients (6.3%) due to granulation tissue around loosened nonabsorbable sutures detected by bronchoscopy. The bronchial stumps in all three patients had been closed with synthetic nonabsorbable braided polyester suture material.

So we conclude that manual closure of the bronchial stump using synthetic absorbable braided suture material has the same results as synthetic nonabsorbable braided polyester suture material in the immediate postoperative period, but has the advantage of being free of late complications related to nonabsorbable suture granuloma 'in the late postoperative course.

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INTRODUCTION

It is generally accepted that bronchopleural fistula is the most dreaded bronchial complication associated with pulmonary resection. This postoperative problem is related in part to the mode of healing of the bronchial stump. Minor complications as cough, expectoration, wheezing, and hemoptysis are also

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attributed to impaired bronchial stump healing due to reactive nonabsorbable suture material causing increased inflammation. The resulting granulation tissue formed leads to the emergence of new symptoms suggestive of recurrence of the primary disease process. To avoid complications related to reactive nonabsorbable suture material, staple closure for bronchial closure or interrupted polyglycolic suture material for bronchial closure or anastomosis are recommended (Baumgartner and Mark, 1981) (1).

Synthetic braided absorbable sutures, as polyglycolic acid (Dexon R) and polyglactin 910 (Vicryl R), have lactic acid, glycolic acid or a combination of the two as the basic ingredients of these polymers and as their eventual breakdown products. These sutures are degraded by hydrolysis and introduction of water, and do not require cellular activity. The independence from cellular reaction for their degradation accounts for less tissue reaction around the suture (Artandi, 1980) (2).

The aim of this study is to compare two suture materials, the synthetic absorbable braided suture (polyglycolic acid or polyglactin 910) with the synthetic nonabsorbable braided polyester sutures, used for manual closure of the bronchial stump after pulmonary resection. Through a prospective randormised comparative study, the early results and the results 1 year postoperatively of using either suture material will be compared, to define the optimum suture material as regards closure strength and inflammatory reaction for manual bronchial stump closure.

Patients and Methods

During a 2 year period, 47 patients underwent lung resection at the Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University,

Non-anatomical pulmonary resections (wedge resection) and bronchoplastic procedures which did not include closure of the bronchial stump were excluded from this study. Also sputum positive tuberculous patients were excluded from the study.

All other patients indicated and scheduled for lung resection were randomly allocated to bronchial closure with one of two suture materials, according to which the patients were divided into two groups: One group included patients. in whom the bronchial stump suture had been performed with a synthetic absorbable braided suture (polyglycolic acid or polyglactin 910). The other group of patients had the bronchial suture made with synthetic nonabsorbable polyester braided suture material, using the manual sewing procedure with interrupted single stitches for stump closure.

Patients who did not show up for follow-up 1 year postoperatively were excluded from the study.

Surgical procedure:

Standard posterolateral thoracotomy was performed. Pulmonary resection was performed by dissection, double ligation, and division of the vascular pedicles; depending on local possibilities, the pulmonary veins and/or arteries were controlled in an extrapericardial or intrapericardial position. In all cases, mediastinal dissection of all draining lymph

Table 1: Variables of 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures

Preoperative Patient Data	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)	P-value
Age range (year) **Mean ±SD**	0.2-67 30.7±21.0	0.3-67 30.2±22.4	0.2-60 31.3±19.9	P>0.05
Weight range (kg) **Mean ± SD**	3-95 45.4±28.2	6-80 41.0±25.3	3-95 50.1±31.4	P>0.05
Sex (Male:Female)	31:16 66%:34%	16:8 66.7%:33.3%	15:8 65,2%:34.8%	P>0.05

node chains was performed; infracarinal lymph node dissection was completed after resection of the operative specimen by avoiding major devitalisation of the bronchial stump. Control of the bronchus was performed and 2 bronchial clamps were positioned and bronchial section was performed between the two clamps. Closure of the bronchial stump was performed with exclusion of air, by using interrupted sutures of 3/0 or 4/0 braided synthetic absorbable or nonabsorbable suture material according to which group the patient was categorized in.

Tissue adhesive was never used. The bronchial stump was inspected with bronchial hyperinflation under water for the presence of possible air leakage that can be controlled by single sutures.

Data collection and patient follow-up

The main assessment criterion of reliability of the surgical technique described was the incidence of BPF, defined as any disruption, regardless of the size, situated on the bronchial stump suture line and visualised by endoscopic examination. Postoperative empyema without BPF demonstrated on endoscopy was excluded. The other assessment criteria were the usual criteria of morbidity associated with the surgical procedure.

Statistical Analysis:

Data were recorded as mean ± standard deviation. Statistical analysis of the data was performed using the paired student's test. The P-value less than 0.05 ($P<0.05$) was considered significant. All quantitative data were presented as the mean ± SD.

Results

There were no statistically significant differences between both groups as regarding age, height, and sex (Table 1).

The groups were comparable regarding pre-operative status und operative diagnosis. Suppurative lung syndrome comprised about 44%, malignant tumors comprised about 17%, infected lung cysts about 10%, benign and locally malignant tumors 8,5%, and hydatid disease 8,5%, of the cases in both series. Congenital lobar emphysema accounted for 6%, while tuberculosis and trauma made up the remainder (Table 2).

Table 2: Preoperative Diagnosis in 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures

Preoperative Diagnosis	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)	P-value
Suppurative Lung Syndrome	21 (44.7%)	10 (41.7%)	11 (47.8%)	P=0.0713
Bronchogenic Carcinoma	8 (17%)	4 (16.7%)	4 (17.4%)	
Infected Lung Cysts	5 (10.6%)	3 (12.5%)	2 (8.7%)	
Hydatid Disease	4 (8.7%)	1 (4.2%)	3 (13%)	
Benign & Locally Malignant tumors	4 (8.7%)	3 (12.5%)	1 (4.3%)	
Congenital Lobar Emphysema	3 (6.4%)	2 (8.3%)	1 (4.3%)	
Tuberculosis	1 (2.1%)	1 (4.2%)	0	
Trauma	1 (2.1%)	0	1 (4.3%)	
Total	47 (100%)	24 (100%)	23 (100%)	

Table 3: Operative Procedure in 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures

Operative Procedure	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)	P-value
Pneumonectomy	3 (6.4%)	2 (8.3%)	1 (4.3%)	
Lobectomy, upper	14 (29.9%)	9 (37.6%)	5 (21.7%)	
Lobectomy, middle & upper	5 (10.6%)	3 (12.5%)	2 (8.7%)	
Lobectomy, middle & lower	3 (6.4%)	1 (4.2%)	2 (8.7%)	
Lobectomy, middle	5 (10.6%)	2 (8.3%)	3 (13%)	P=0.8
Lingulectomy & lower lobectomy	3 (6.4%)	2 (8.3%)	1 (4.3%)	
Lingulectomy	1 (2.1%)	0	1 (4.3%)	
Lobectomy, lower	13 (27.6%)	5 (20.8%)	8 (35%)	
Total	47 (100%)	24 (100%)	23 (100%)	

Table 4: Postoperative data in 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures

Postoperative Data	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)	P-value
Mechanical Ventilation (Number of Patients)	1	1	0	
Mean duration of Mechanical Ventilation (hours)	32	32	0	
ICU stay Range (days) Mean±SD	1-5 1.34±0.7	1-2 1.29±0.46	1-5 1.39±0.89	P = 0.2
Hospital stay Range (days) Mean±SD	7-14 10.3±1.8	7-13 10.4±1.7	7-14 10.2±1.8	P = 0.7

Table 3 shows the operative procedures done for both groups of patients. Pneumonectomies were performed in only 6.5% of all patients, a few lingulectomies were done, but the majority with 91.5% were lobectomies.

The postoperative data of the patients were not significantly different among both groups as regards the incidence of mechanical ventilation and its duration, duration of the stay in the intensive care, and duration of hospital stay are shown in table 4.

Non-fatal complications were comparable among both groups with 12.4% in the absorbable suture group, and 17.3% in the nonabsorbable suture group. They are prin detail in table 5. Following suture closure of the bronchus bronchopleural fistula developed in one (2.1%) of the 47 patients, which was small and closed in response to conservative treatment five months postoperatively. There were no significant differences in the incidence of complications among both groups.

New respiratory symptoms developed in three patients (6.3%) following pulmonary resection out of the 47 patients of this study. The bronchial stumps in all three patients been closed with synthetic nonabsorbable braided polyester suture material (Ethibond). No patient had empyema or bronchopleural fistula. Symptoms included nonproductive cough (three patients), hemoptysis (two patients), wheezing (one patient), and coughing up suture material (one patient). More than one symptom was observed per patient. The underlying disease necessitating pulmonary resection was carcinoid adenoma in one patient, tuberculosis in one patient, and bronchiectasis in one patient. The median time interval between resection and development of respiratory symptoms was 9.3 months, occurring seven, ten and eleven months postoperatively. The chest roentgenograms showed no change from earlier postoperative films. Bronchoscopy under general anesthesia was performed in all three patients. Granulation tissue around loosened Ethibond sutures was present in all patients so examined.

Table 5: Number of patients with postoperative complications among 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures 1 year after surgery

Number of Patients	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)
Pleuropulmonary complications:			
Bronchial fistula	1 (2.1%)	0 (0%)	1 (4.3%)
Empyema without fistula	2 (4.2%)	1 (4.2%)	1 (4.3%)
Residual pouch for drainage	2 (4.2%)	1 (4.2%)	1 (4.3%)
Air leak (more than 10 days)	4 (8.7%)	2 (8.3%)	2 (8.7%)
Acute respiratory failure	1 (2.1%)	1 (4.2%)	0
Pneumonia or atelectasis	1 (2.1%)	0	1 (4.3%)
Other complications:			
Bleeding	1 (2.1%)	0	1 (4.3%)
Atrial fibrillation	1 (2.1%)	0	1 (4.3%)
Wound dehiscence	3 (6.4%)	2 (8.3%)	1 (4.3%)
Total Number of Patients:	7* (14.8%)	3** (12.4%)	4*** (17.3%)

* 7 patients with 16 complications
** 3 patients with 7 complications
***4 patients with 9 complications
(One patient might have more than one complication)

Table 6: New respiratory symptoms in 47 patients undergoing lung resection surgery with bronchial stump closure using absorbable or nonabsorbable sutures 1 year after surgery

New Respiratory symptoms	All (N = 47)	Absorbable Sutures (N=24)	Nonabsorbable Sutures (N=23)
Hemoptysis	2	0	2
Cough	3	0	3
Coughing of suture material	1	0	1
Wheezing	1	0	1

Immediate and sustained relief of symptoms was obtained in all three patients by removal of the loosened sutures, and cautery of the granulomatous tissue with silver nitrate. One patient had recurrence of minor hemoptysis 5 months following suture removal but has refused further endoscopy. In the 24 pulmonary resections in which synthetic absorbable braided suture (polyglycolic acid or polyglactin 910) has been used for bronchial stump closure no such complications have been seen.

Discussion

One of the direct complications of a major pulmonary resection is disruption of the bronchial stump with bronchopleural fistula which often results in empyema, may lead to sepsis and death and is exceedingly difficult to treat. Secondary closure of the bronchial stump is difficult and hazardous and failure is common (Barker et al, 1971) (3). The method of closing the stump is almost certainly one of the factors influencing the development of this complication. Accordingly, in attempts to prevent fistula formation various methods of closing the bronchial stump have been devised (Dahlbaeck and Schüller, 1971 (4); Monod and Weyl, 1956 (5); Maier and Loumanen, 1949 (6)).This postoperative problem is related in part to the mode of healing of the bronchial stump (Baumgartner and Mark, 1981) (1). In their study, of the role of inflammation in bronchial stump healing, Scott et al. (1975) (7) observed that in canine bronchi closed with silk there was a dense inflammatory infiltrate after 14 days while in stumps closed with catgut there was a moderate infiltrate with disintegration of the suture material, but that in bronchi closed with stainless steel staples the best healing and the minimal degree of inflammation were observed.

In this study there were no significant differences in the incidence of bronchopleural fistula between the two groups operated upon using either absorbable or nonabsorbable suture material. In fact there was only 1 patient who had a bronchopleural fistula, which corresponds to a total incidence of 2. 1%, so that we feel that both suture materials can be used safely in bronchial stump closure, as the incidence in the literature is between 1 and 4% (Asamura et al, 2000 (8); Hubaut, 1999 (9). Shields, 1994 (10)).

Other early postoperative pleuropulmonary complications noted in this study comprised: empyema without fistula, residual pouches necessitating its drainage, air leak for more than 10 days, and acute respiratory failure, which amounted to 16 complications in 7 patients (14.8%). There were no significant differences in the incidence of these complications in relation to the type of suture material used. The incidence of these complications was quite small when compared with the 28.7% postoperative morbidity reported by Hubaut and associates in 1999 (9) (60 patients with 71 complications out of 209 pulmonary resections).

Asamura and associates in 1992 (11) recommended manual closure of the bronchial stump in lung resection surgery for cancer. Wright and associates (1996) (12) and Hubaut and coworkers (1999) (9) believe that manual closure of the bronchial stump after pneumonectomy is at least as good if not better than closure by stapling. Mechanical suture is certainly a simple and rapid technique (Peterffy and Calabrese,

1979) (13), but they consider manual suture to be the technique of choice. It is a reliable technique, which can be used regardless of the quality of the bronchus and regardless of the disease. it is easily reproducible and can be taught to trainee surgeons (Alkattan et al, 1995) (14). Its low cost (10 times less expensive than mechanical suture) makes it a widely used universal technique.

Cough and hemoptysis due to endobronchial sutures are usually caused by the inflammation and granulation tissue (Albertini, 1981 (15); Baumgartner and Mark, 1981 (1)). An additional mechanism of cough is that of direct mechanical irritation of the airway by the end of a stiff suture (Shure D, 1991) (16).

Endobronchial sutures occur by the migration of a suture placed over the stump during healing of the surgical site. Suture commonly cuts through the stump and may be found in either peribronchial or, endobronchial locations (Shure D, 1991) (16). When the suture migrates to an endobronchial site, granulation tissue may form around the suture as a response to inflammation (Baumgartner and Mark, 1981) (1).

The inflammatory response appears to vary with the composition of the suture. Bacteria adhere most to catgut and least to nylon, with silk and polyglycolic acid suture being intermediate in reactivity. Braiding increases bacterial adherence over monofilaments. Suture material retrieved from suture granulomas consisted of wire, a monofilament (polypropylene), and braided silk and braided Teflon-coated nylon (Baumgartner and Mark, 1981 (1); Shure, 1991 (16)). In the series of Baumgartner and Mark (1981) (1), suture granulomas were all associated with braided Teflon-coated nylon suture.

In our study the difference between absorbable and nonabsorbable suture material in the incidence of late new pulmonary symptoms was quite evident, as all these symptoms in the form of cough, expectoration, wheezing and hemoptysis occurred only in the group in which nonabsorbable suture material was used for bronchial stump closure.

So we conclude that manual closure of the bronchial stump using synthetic absorbable braided suture material has the same results as synthetic nonabsorbable braided polyester suture material in the immediate postoperative period, but has the advantage of being free of late complications related to nonabsorbable suture granuloma in the late postoperative course. New types of suture material are produced continuously and the optimum suture material should have maximal breaking strength retention, and minimal inflammatory reaction for manual bronchial stump closure, in combination with having superior handling and knotting qualities.

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NODULAR PULMONARY AMYLOIDOSIS OF THE LOWER RESPIRATORY TRACT : CASE REPORT

ABSRTACT

Amyloidosis limited to the respiratory tract is uncommon. Nodular Pulmonary amyloidosis is usually found incidentally on chest radiographs in symptomatic older adults. We describe a patient presenting with chest pain and treated by resection who has remained well with no recurrence of symptoms for 3 years. The progression of the chest radiograph and CT appearances of this rare neoplasm are described, and current views regarding the origin of the disease, its clinical and radiological presentation are discussed.

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J. of Egypt. Society of Cardiothorac. Surg. 1998, Vol. VI July No. 3

INTRODUCTION

A 76-year-old male, smoker and chronic bronchitic with a 2 year history of right sided chest pain with cough and breathlessness. He had been followed up for 8 years with opacities in the right.mid zone and the left apex on chest x-ray which had increased in size over this period (Fig 1). CT scan confirmed the right-sided lesion with no malignant features (Fig 2). CT guided fine needle biopsy failed in two occasions to give a definite histological diagnosis. Bronchoscopic examination was also negative. PET scan showed uptake only in the right-sided lesion. The lesion at the apex was diagnosed by oesophogoscopy and barium swallow as pharyngeal pouch. FBC, ESR, liver function and calcium level were all normal, as were serum protein and antibody screen. In view of failed needle biopsy and continuing chest pain, it was decided to attempt **an** open biopsy. This was performed via right thoracotomy. Multiple lesions of different sizes were found in the right upper lobe. These were enucleated and the lung was closed with a combination of staples and sutures. Macroscopic examination of the specimen showed the main mass to consist of a disc of friable tissue measuring 5x5xl.5 cm, partially covered by thickened pleura with other 2 smaller masses. Histologically, the specimen consisted of well-circumscribed masses of hyaline esinophilic material that has replaced the lung parenchyma (Fig 3). The hyaline material stained strongly with Congo red and showed marked green birefringence under polarized light. When stained by the immunoperoxidase technique, it was positive for the P component of amyloid. Examination of the hyaline material with electron microscope showed randomly oriented non-branching fibrils. The patient remained well with no recurrence after 3 years.

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Discussion

Pulmonary infiltration occurs frequently in patients with systemic amyloidosis, particularly in those with cardiac involvement (1, 2, and 3). Amyloidosis

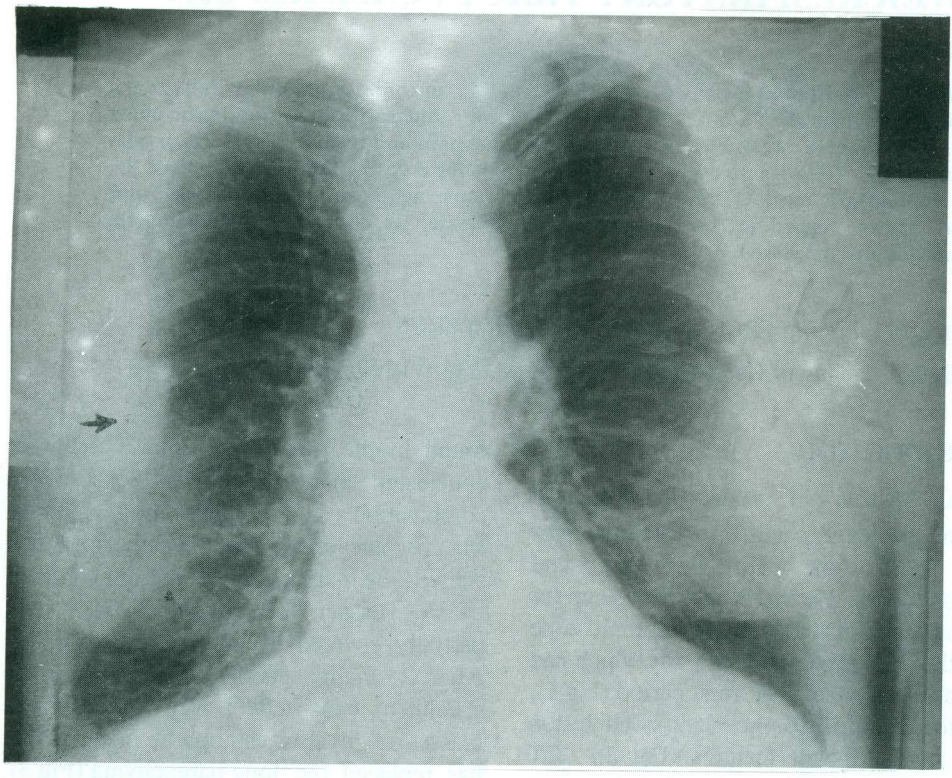

Figure 1: Chest X-ray demonstrating 2 opacities one in the right mid zone and the second in the left apex.

limited to the lower respiratory tract is a rare disorder.

Three types of pulmonary amyloidosis have been described (2), I- focal deposits of amyloid within the mucosa and adventitia of the major airways; 2- single or multiple parenchymal nodules (as in our patient); 3- diffuse parenchymal infiltrates involving the alveolar septa and the walls of small vessels.

The radiological appearance cannot be distinguished from malignant or benign neoplasms and chronic inflammatory or granulomatous lesions. The nodules vary in size and may be single or multiple. Calcification, bone formation and cavitation may occur (4). Clinical presentation is usually asymptomatic during routine check-up as happened in our case. Hemoptysis, cough and dyspnoea are uncommon. The prognosis in the nodular variety is usually good in contrary to other types of pulmonary amyloidosis. Trans-thoracic fine needle biopsy and trans-bronchial biopsy are the standard ways to get tissue

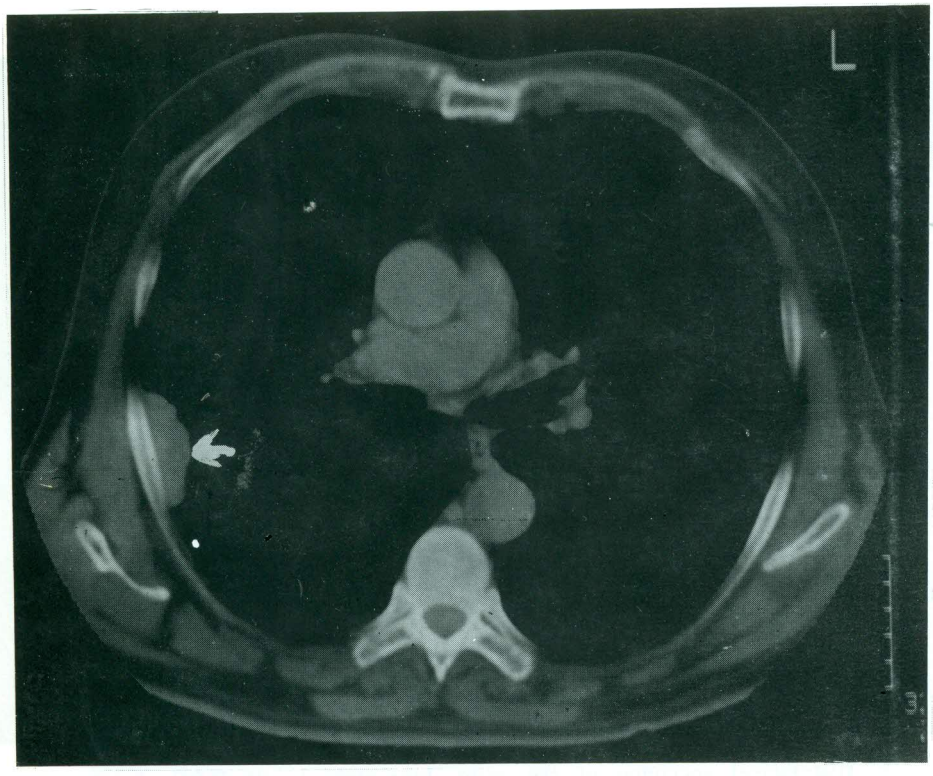

Figure 2: Computed Tomogram of the chest at the level of the carina, showing the peripheral right mid zone lung mass.

diagnosis. The first is preferred. Most authors agree that thoracotomy is needed when biopsy is not feasible by the previous two methods. In our case thoracotomy was performed in view of repeated failures of needle biopsy and because of continuing chest pain. Nodular parenchymal amyloidosis generally produces few symptoms, but is often confused with cancer or tuberculosis, especially when nodules are cavitating. Once such lesions are diagnosed, some authors believe that resection is not recommended unless they cause symptoms as the case of our patient.

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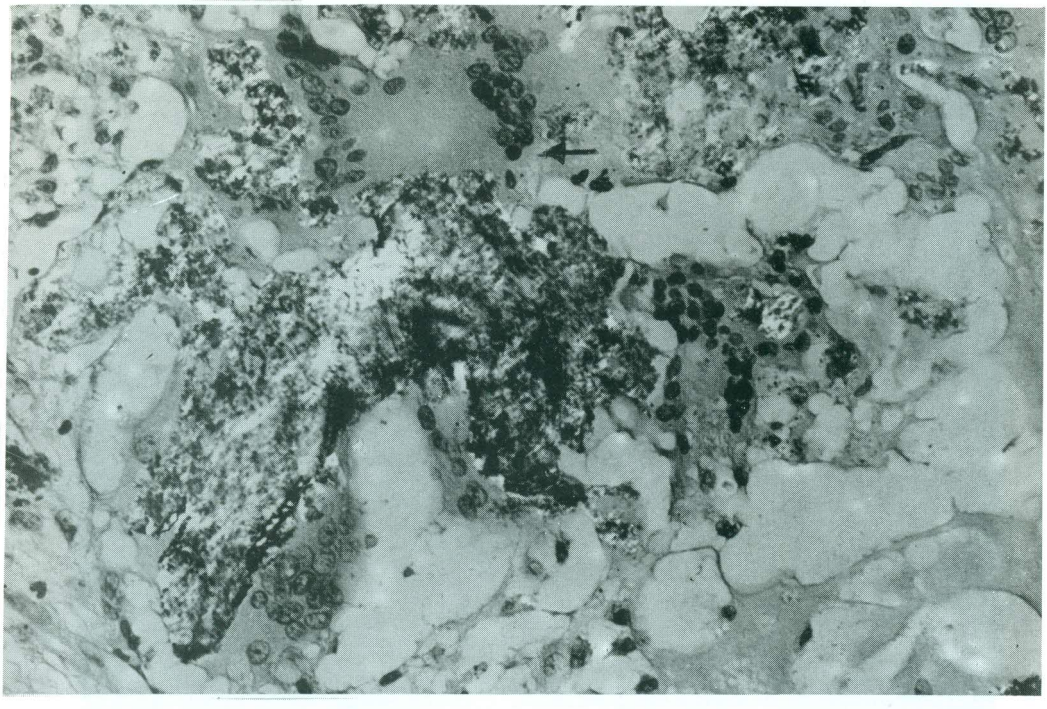

Figure 3: Histological specimen of the right lung stained with H&E, showing a well-circumscribe mass of hyaline esinophilic material that has replaced the lung parenchyma.

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GRANULAR CELL TUMOUR OF THE LUNG: CASE REPORT

ABSRTACT

Granular cell tumour (GCT) is a benign neoplasm that has generated considerable controversy. It can occur at any age, most often in young to middle aged adults with no sex preponderance. The granular cell tumour was first described by Abrikossoff (1) in 1926, but it wasn't until the late 1930s when Kramel (2) first observed a GCT in the bronchus. When GCT occurs in the tracheo-bronchial tree, it may cause pulmonary complications due to obstruction of the airways.

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INTRODUCTION

A 35-year-old Caucasian woman who smoked 10 cigarettes per day, presented with a 5 month history of cough, productive of creamy colored sputum with episodic left sided chest pain and a 5 kg weight loss over a period of two months. She had two episodes of mild hemopltysis and no fever. She felt wheezy when lying down.

On examination, she had scattered crackles in the left side of the chest. Renal and liver function, calcium, plasma viscosity and immunoglobulins were all normal Her lung function was good with a FEV 1 of 2.73 liters. Chest x-ray showed a minor degree of bulkiness on the left hilum with little consolidation peripheral to this mass. CT scan confirmed the left hilar mass with no enlargement of hilar or mediastinal lymph nodes. Bronchoscopy showed a white exophitic tumour mass in the left upper division of the left upper lobe partially occluding the lumen. Biopsy of this tumour was consistent with granular cell tumour of the bronchus.

A left thoracotomy was performed through the fifth intercostals space. A hilar mass was present, 3 cm in diameter surrounding the left upper lobe bronchus with some other hilar lymphadenopathy. Left upper lobectomy was done. Macroscopic examination of the resected specimen showed a nodular mass at the left hilum with the cut surface showing well circumscribed white hard tumour arising from the wall of the upper bronchus and partially occluding the lumen. Microscopically, the tumour was arising from the submucosa of the left main bronchus and infiltrating between the bronchial cartilages around the mucous glands to form a tumour nodule behind the bronchus.

Discussion

After the oesophagus, the tracheo-bronchial tree is the next most common site of intrathoracic GCT. They may present

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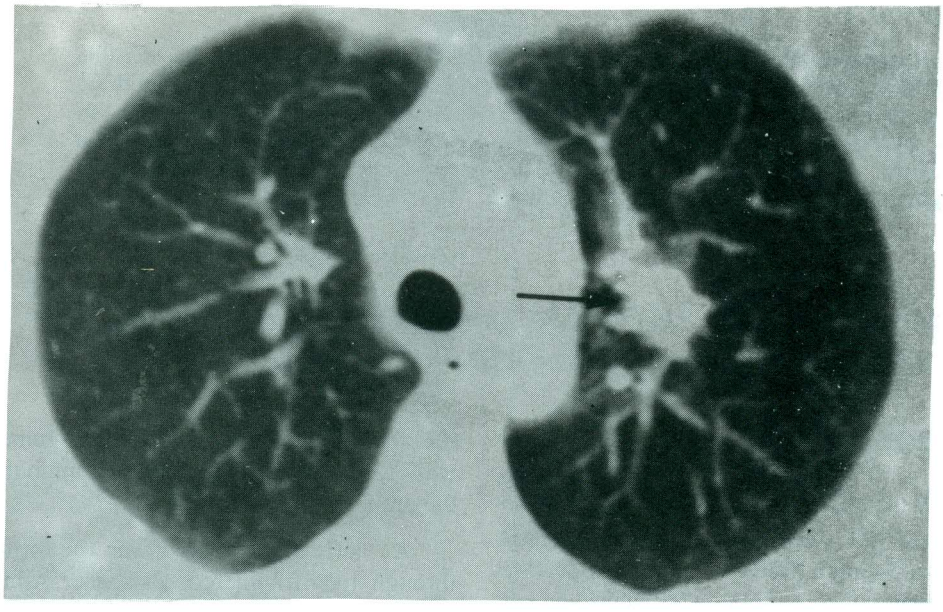

Fig. 1: Computed tomogram at the upper hilar level of the lungs demonstrating a mass involving the left upper lobe bronchus with minimal peribronchial consolidation.

as an asymptomatic, incidental finding during bronchoscopy. Most commonly, however they manifest with cough, hemoptysis, localized wheezing and chest pain (as in this case) or with recurrent pulmonary infections because of obstruction.

Deavers et al (3) in a clinic a pathological study of 20 cases found that twenty-one tumours were endobronchial and two were peripherally located. Most of the endobronchial lesions were pedunculated or sessile. Of the nineteen-endobronchial tumours he studied, neoplastic cells infiltrated submucosal glands in eleven cases (58%) and peribronchial tissue in eight cases (42%). In our case, the tumour arose from the submucosa of the left main bronchus and infiltrated between the bronchial cartilages around the mucous glands to form a nodule behind the bronchus.

Tracheo-bronchial GCT has a high rate of recurrence when removed endoscopically (4), and the use of laser is controversial (2). Daniel et al (5) reviewed 55 cases in the literature, 32 of which had surgical resection and 13 underwent bronchoscopic removal. There were no recurrence in any of the patients who had surgical resection, and five recurrences in endoscopically removed group. In view of the present

literature and our current experience, we favor surgical resection as the treatment of choice for GCT greater than 8 mm in diameter or which are locally infiltrating the tracheo-bronchial tree.

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ECHOCARDIOGRAPHIC ASSESSMENT OF BILEAFLET VERSUS MONOLEAFLET MITRAL PROSTHESIS

ABSRTACT

Background: Ever since the invention of mechanical valve prosthesis, there have been continuous attempts to improve the hemodynamic performance of these devices. The current concept among most cardiologists is that bileaflet prostheses are hemodynamically superior to the rest. However this is mainly based on in vitro studies. Objective: This study was designed to evaluate and compare the hemodynamics of bileaflet versus monoleaflet valve prosthesis in the mitral position using transthoracic echocardiography

Methods: Our study included 40 patients categorized into two groups: Group I included 20 patients with monoleaflet mitral prosthesis and Group II included 20 patients with bileaflet mitral prosthesis. Each group consisted of 10 males and 10 females. There was no statistically significant difference between the age or the preoperative NYHA functional class in both groups.

The patients were subjected to a full clinical examination, ECG, echocardiography and a chest X-ray.

Results: Doppler studies showed no significant difference in the prosthetic valve effective area (2.2 ± 0.4 cm2 in group I versus 2.4 ± 0.43 cm2 in group II, p= 0.1), mean gradient (4.5 ± 1.5 mmHg in group I versus 4.7± 1.4 mmHg in group II, p= 0.2)and cardiac dimensions in both groups. NYHA functional class improvement was also similar in both groups and showed no statistically significant difference

Conclusion: This study suggests that there is no difference between the mono- and bileaflet prostheses with respect to the hemodynamic or clinical results. Therefore does not support the preferential selection of either prosthesis.

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INTRODUCTION

In developing countries, rheumatic fever, a sequel of group A streptococcal upper respiratory infection, is responsible for almost half of cardiovascular diseases in all age groups, and is the leading cause of death in the 1st five decades of life. (1). Mitral valve disease is the most common rheumatic valvular disease (2) . The surgical implantation of artificial cardiac valves has dramatically improved the quality of life and life expectancy in patients with valvular heart disease. (1,4) Worldwide figures indicate that approximately 210 000 patients undergo valve replacement annually, two thirds of which receive mechanical valves (5). Accordingly there is much ongoing investigation related to improving

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Prosthetic valve construction. The changes in design aim at enhancing safety and efficiency, whilst minimizing deleterious complications (5). Mechanical cardiac valve prosthesis generally fall into one of three categories: The ball and cage valve, with excellent durability but sub-optimal flow dynamics, the monoleaflet tilting disc, with improved flow dynamics and the bileaflet model, with almost streamline flow (3) . This feature has emerged it as today's prosthesis of preference in many centers, despite its higher cost. (5)

In this study we compared the performance by the monoleaflet to the bileaflet tilting disc prosthesis in patients who had a Mitral valve replacement; clinically and by echocardiography.

Patient population

A total of forty subjects who had undergone Mitral valve replacement for isolated Mitral valve disease were evaluated clinically and echocardiographically.

Group I consisted of 10 males and 10 females with monoleafllet prosthesis. Their ages ranged from 22 to 62 years with a mean of 35. 4 ± 10.5 years.

Group II consisted of 10 males and 10 females with bileaflet prosthesis. Their ages ranged from 1 5 to 48 years with a mean of 30.5 ± 9 years.

All Patients were subjected to a detailed history taking and clinical examination. The data recorded included age, gender, type of preoperative valve lesion, type of prosthesis, valve size, and date of operation. From the history given by each patient, a NYHA functional classification was determined for that particular subject before and after surgery. In addition to and ECG and a chest X-ray, a full transthoracic echocardiographic examination was performed using Hewlett Packard sonos 1000 and sonos 2500 machines with 2.5 - 3.5 MHz transducers. This included M-mode, two dimensional and Doppler echocardiography with special emphasis on the Doppler measurements of the trans Mitral gradients and effective valve area.

Results

Preoperative Mitral valve disease

Eleven patients in group 1 had suffered from Mitral stenosis, seven from Mitral. incompetence, and two from a double lesion. In group II, fifteen patients had suffered from Mitral stenosis, four from Mitral incompetence, and only one from a double lesion. (see table 1)

Size of the prosthesis

The majority of patients had a size of 27 and 29 mm valve prosthesis with no statistical difference between both groups. The size of the prosthetic valve ranged between 25 and 31 nun (mean 28.5 + 1.6), while in group II it ranged between 25 and 31 mm (mean 28.1 + 2.5), p value was 0. 5 3.

Hemodynamic results

- Improvement of functional class:

Preoperatively 3 patients in group 1 were in NYHA functional class II, 15 were in functional class III and 2 were in functional class IV. The functional class remained unchanged in two patients all others improved after surgery.

In group II, preoperatively 3 patients were in NYHA functional class II, 16 were

Table 1 : Clinical data

	Group I	Group II	p value
Age in years	35.4 + 10.5	30.5 + 9.0	0.12
Male/ Female ratio	10/10	10/10	
Sinus rhythm	6	11	
Atrial fibrillation	14	9	
Underlying Mitral valve disease			
- Mitral stenosis	11	15	
- Mitral incompetence	7	4	
- Double lesion	2	1	
Prosthesis size	28.5 + 1.6	28.1 + 2.5	p=0.53

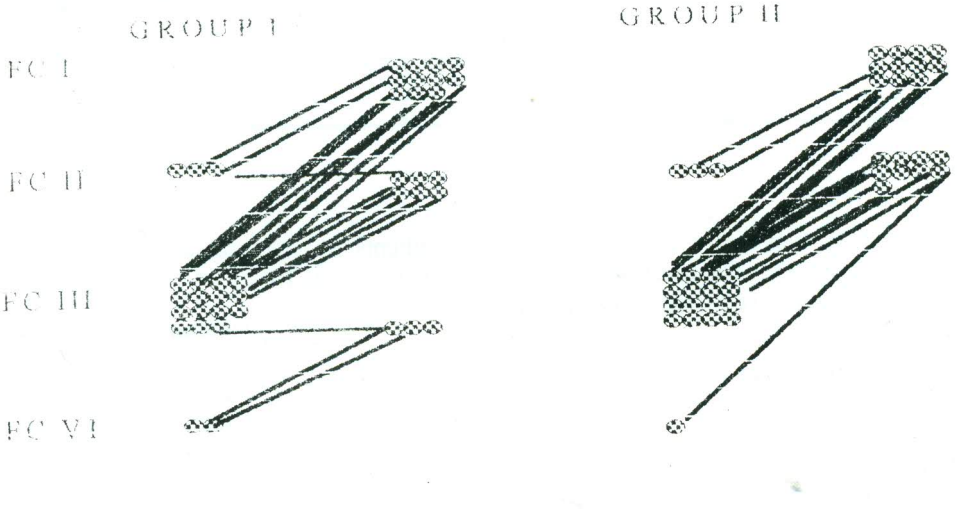

Fig. 1: Improvement of Functional class

Table II

Dimensions measured in cm	Group I	Group II
Left atrium	5.2±1.2	4.5±1.0
Aorta	3.01±0.5	2.8±0.4
LVEDD	5.4±0.7	5.2±0.5
LVESD	3.7±0.7	3.5±0.7
RV	1.8±0.6	1.7±0.5
Fractional shortening in percent	33.7±7.8	33.2±7.5

Table III

	Group I		Group II		
	Mean + SD	Range	Mean + SD	Range	p value
Peak gradient in mmHG	12.6 ± 3.1	5.9-16.4	13.6 ±2.9	7.7-20.2	0.3
Mean gradient in mmHG	4.5 ± 1.5	2.7-10.1	4.7±1.4	2.8-7.2	0.2
Effective orifice area in cm2	2.2 ±0.4	1.03-2.7	2.4 ± 0.43	1.4 -3.3	0.1

in functional class III and one was in functional class IV. The functional class of all patients improved after surgery. (see Figure 1)

The difference between both groups was statistically not significant

- Echocardiographic parameters

Cardiac dimensions were similar in both groups except for the left atrial size which was smaller in group II (see table II)

There was no statistically significant difference between both groups as concerns the peak or mean transvalvular pressure gradients or the calculated effective orifice area (see table III)

It was noticed that although patients in group II had a slightly higher effective orifice area, they had slightly higher peak and mean gradients as well, so the correlation between the mean gradient and the effective orifice area was calculated for both groups. (See Figures II and III)

Discussion

Rheumatic fever is still a major problem in developing countries, where it accounts for almost half of cardiovascular

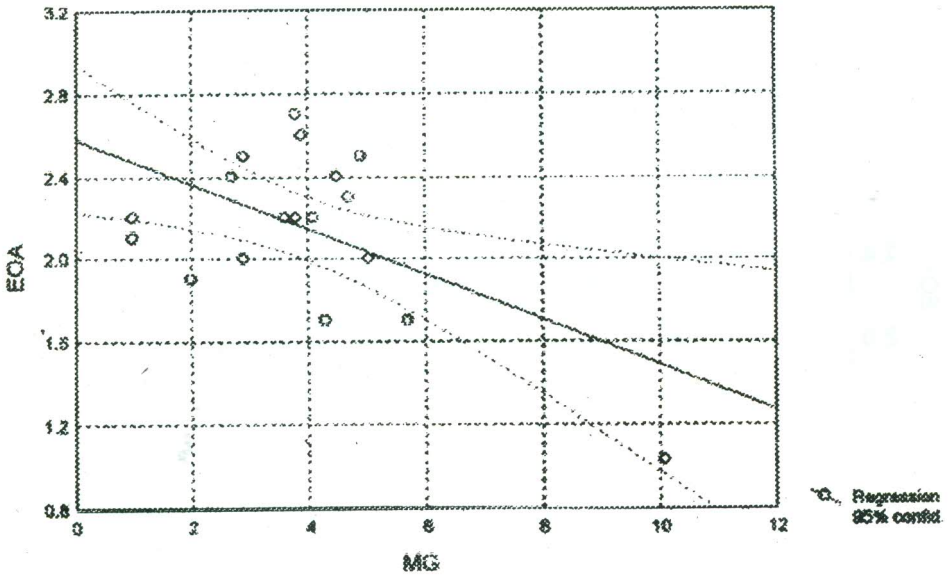

Fig. 2: Shows correlation study between the MG and the EOA in group I (n=number; r= correlation; p=P value)

diseases in all age groups. Mitral valve disease is the most common rheumatic heart disease with Mitral stenosis occurring in about 40 %. (2). The development of artificial cardiac valves has dramatically improved the surgical outcome by improving cardiac function and alleviating symptoms of heart failure 11,4) In the cardiothoracic surgery department at Kasr El Aini University hospital, about 308 cardiac surgeries were performed in the period from January 1998 to January 1999, one hundred and sixty two of which were valve replacements (53%). Of the latter, eighty patients had Mitral valve replacements, fifty had Aortic valve replacement and thirty two had both Aortic and mitral valve replacement.

One hundred and thirty two of the one hundred and sixty two valve prosthesis used were of the St. Jude type (82%), twenty three carbomedics (14%) and seven Sorin (4%), It seems that although expensive, bileaflet valve prosthesis was routinely used in comparison to the monoleaflet prosthesis which is cheaper.

Although many advances have been made in the design, construction and materials used in the production of prosthetic heart valves, prosthesis related complications are currently reported in up to 50% of heart valve recipients 10 years after operation (6) As a result, surgical treatment of valvular heart disease remains a field of constant clinical and experimental research. To be a good substitute for a

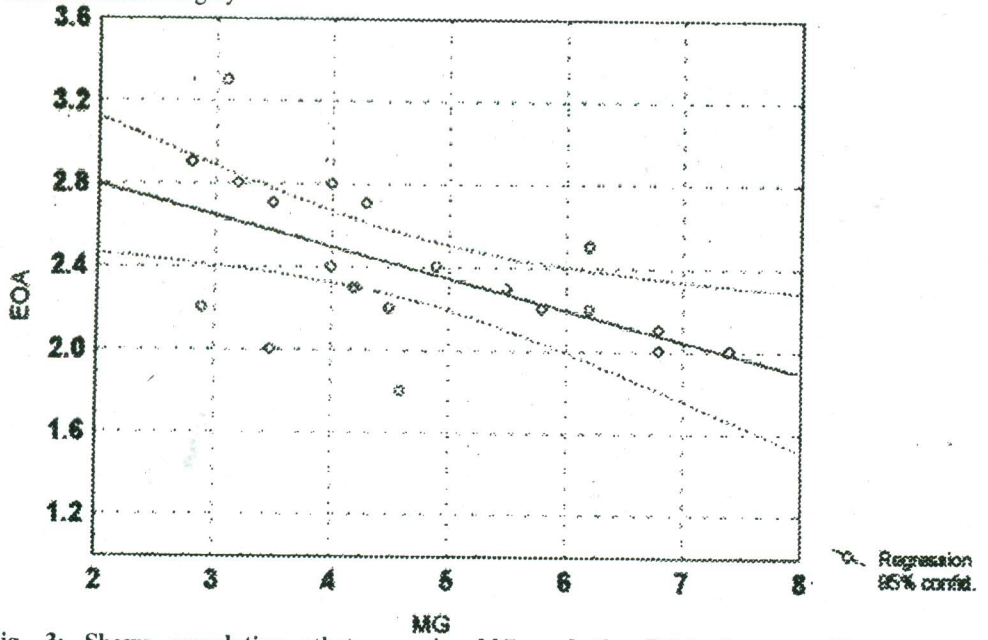

Fig. 3: Shows correlation stbetween the MG and the EOA in group II (n=number; r=correlation; p=P value.

native valve, the prosthesis should have favorable hemodynamics in form of total competence as well as being non obstructive to blood flow. (5)

The bileaflet ST. Jude and the pivoting disc Medtronic Hall valves have retained widespread popularity for more than twenty years. These devices have undergone virtually no alteration in design since their development in 1997 and 1998. (8) Although a number of investigators have reported their clinical and hemodynamic results with these valves, there has been only one prospective randomized trial comparing these prosthesis in the mitral position throughout a ten years period of observation at a single institution (8)

In our work, mono - and bileaflet tilting disc prosthesis were studied and compared postoperatively in patients who had received these implants

The clinicl evaluation of the forty patients was mainly devoted to the patients degree of dyspnea according to NYHA functional classification. The post operative improvement was equally good in both groups, where the majority of patients was in functional class III preoperatively and improved to functional class I postoperatively. These results are in accordance with those of Fiore et al, who studied 80 patients with St. Jude and 76 patients with Medtronic Hall prosthesis in the mitral postion. They reported a statistically significant improvement in both groups without a statistically significant difference between them. (8)

We compared the hemodynamic performance of the monoleaflet and bileaflet tilting disc prostheses in our two study groups. We chose patients with comparable valve sizes, and this resulted in a more or

less equal mean valve size for both groups (28.5 ±1.6 in group I versus 27.6±1.6 in group II). Owing to the small number of each valve size in our study, and because the mean valve size was similar in both groups, we compared the mean pressure gradient and the mean effective orifice area of the of group I and group II as a whole. The mean transvalvular pressure gradient across the prosthesis was 4.5 ± 1.5 mmHg and 4.7± 1.4 mmHg in group I and group II respectively. The mean orifice area was 2.2±0.4 cm2and 2.4 ± 0.6 cm2 in group I and group II respectively. There was no statistically significant difference between both groups as concerns either the mean gradient or effective orifice area. Although the mean valve size in group II was slightly smaller, the effective orifice area was slightly larger, which may be explained by the valve design. This however was not reflected on the mean transvalvular gradient which was slightly lower in group I. Correlation studies revealed a significant negative correlation between the mean gradient and effective orifice area in both groups which differed slightly (r= 0.5 5 , p=0.011 for group I and r= 0.57 , p=0.009 for group II). Similar results were reported by other investigators (8,9)

Limitations of the study

As this was a cross sectional study, it was not possible to determine the incidence of valve related complications. Although no difference was detected in the mean orifice area and mean transvalvular gradients at rest, it is advisable to examine for these parameters during and at peak exercise.

Summary

The postoperative hemodynamic studies in our patients indicate that both types of prosthetic valves serve as an effective substitute for the diseased human valves. From the hemodynamic data, the monoleaflet tilting disc prosthesis appears to compare favorably with the bileaflet valve design. Despite minor differences in valve area and hemodymamic flow patterns, clinical results with both types of prosthesis were nearly identical in our population, where the majority of patients in both groups experienced a sharp decrease in their symptoms postoperatively. Thus none of the two types appeared to be superior to the other. This finding is of extreme importance for centers with limited budget due to the substantially lesser cost of the mono leaflet valve

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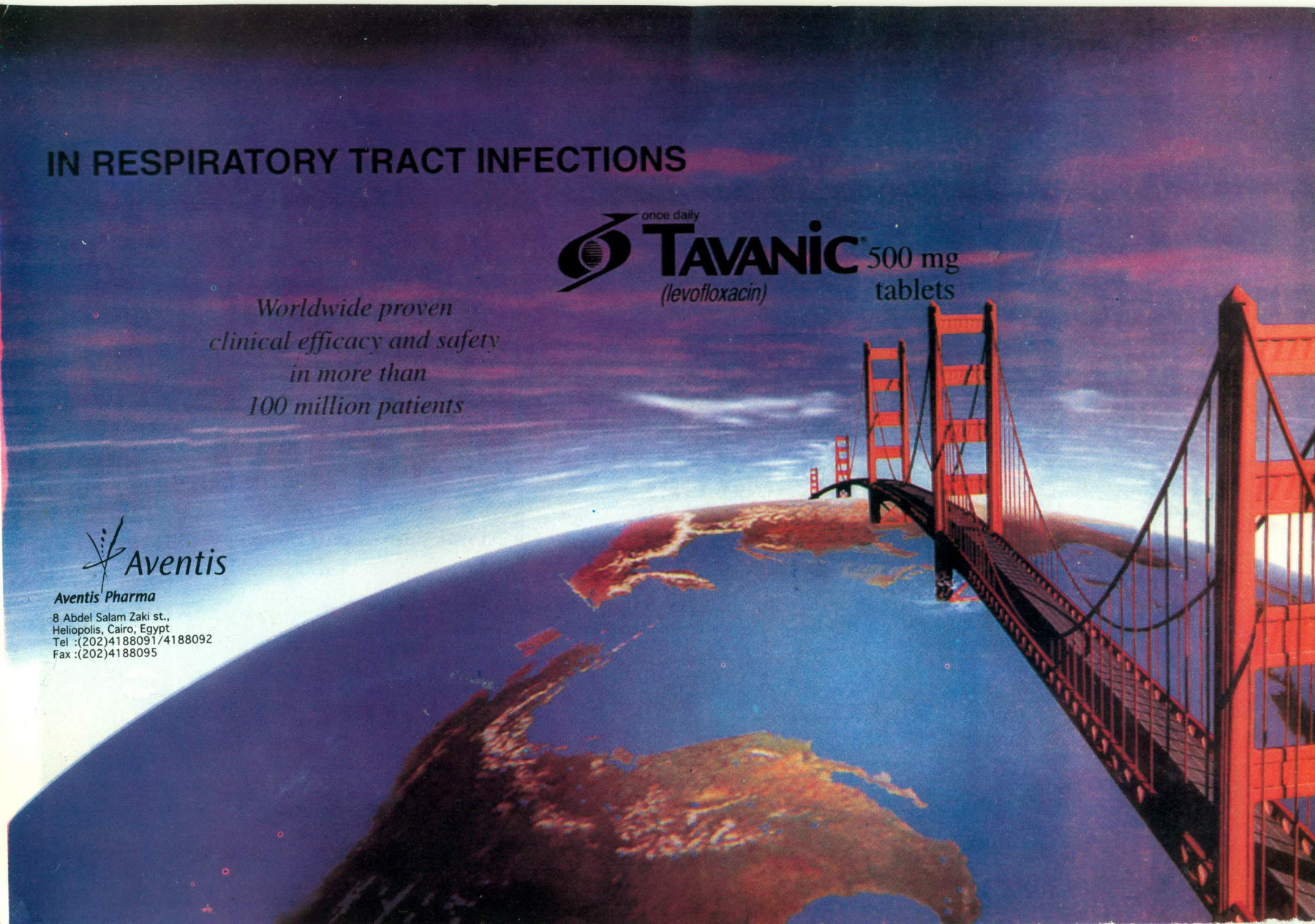
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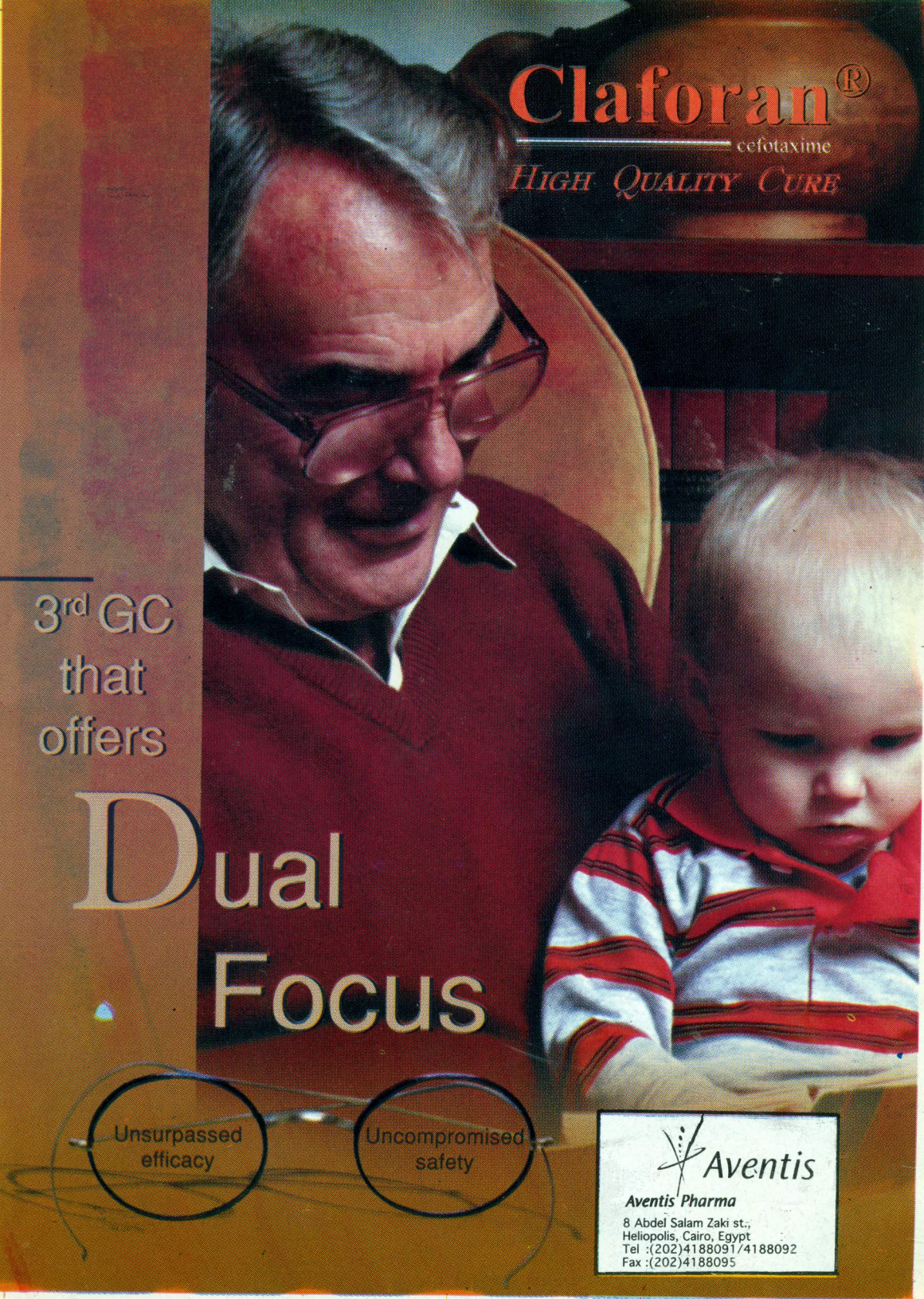
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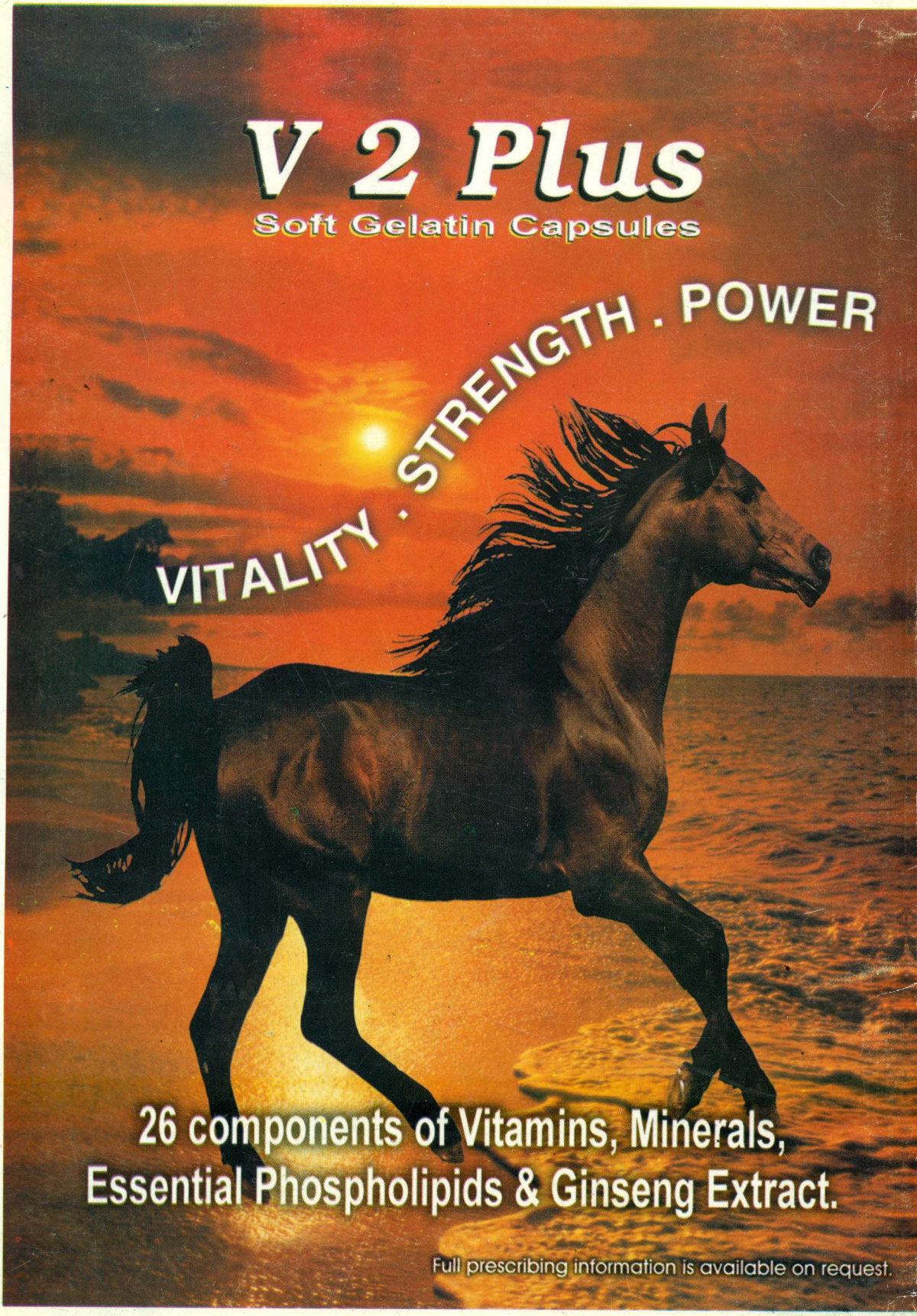
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