Section A-Research paper
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Predictors of failure of aortic valve repair

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Abstract:

Background: Aortic valve repair is the preferred procedure for the treatment of cases of severe aortic regurge with suitable morphology of the diseased valve and thus avoiding the prosthesis related complications. However, the major complication of this operation is AR recurrence. Enhanced understanding of predictors of failure of repair helps in the improvement of outcome.

Methods: 100 patients underwent aortic valve repair surgery in the period between Janaury 2020 and March 2022 in Kasr Alainy hospitals. Preoperative assessment included echocardiographic findings, CT aortograpghy and coronary angiography or MSCT on coronaries. Aortic valve repair was performed with different techniques. Follow up was 6 months for postoperative assessment of degree of regurge, contractility and LV dimensions.

Results: There was significant improvement in the left ventricular dimensions and contractility. Seven patients had moderate degree of regurge and one patient had severe degree of regurge in the follow up period. One patient died as a result of profound low cardiac output syndrome

Conclusion: dilated aortic annulus, mild residual cusp prolapse, mild residual cusp retraction are among the significant predictors of failure of aortic valve repair, while bicuspid aortic valve and degree of preoperative aortic valve regurge are not.

Keywords: Bicuspid aortic valve, ascending aortic aneurysm, outcome, repair, predictors of failure

Introduction:

Repair of the aortic valve is a favorable procedure in patients with aortic insufficiency (AI) especially with suitable valve morphology. It offers the opportunity for the patients to keep their native aortic valve and thus avoiding the prosthesis related complications and making the avoidance of using anticoagulation medications is feasible. [1]

Despite of good long term outcome results of aortic valve repair, which have been documented through many studies, AI recurrence remains a possible complication of such operation. [2]

In our study we share our experience with factors leading to failure of aortic valve repair such as annular diameter dilatation, residual leaflet prolapse or retraction and orientation of the commissures, for the purpose of improving the aortic valve repair techniques and eventually the patients' outcome.

Patients and Methods:

Study population

During the period between Jaunary 2020 and March 2022, 100 patients with severe aortic regurge (AR) underwent surgery in Kasr Alainy hospitals. Patients underwent previous cardiac operations or had concomitant cardiac disease were not included in our study. Surgeries for aortic stenosis or infective endocarditis were excluded. Our study was approved by the institutional ethical committee

Definitions

Operative mortality was defined as all deaths occurring within 30 days during hospitalization or after discharge from the hospital. Patients were followed up through outpatient clinics and telephone calls.

Postoperative bleeding was defined as a blood drainge more than 1.5 ml/kg/h for 6 consecutive hours within the first postoperative day.

Preoperative preparation

All patients received preoperative transthoracic Echocardiography to assess the severity of aortic regurge, aortic annulus diameter, ejection fraction (EF), CT aortography to assess the aortic aneurysm measurements, exclusion of dissecting flap occurrence and exclusion of coarctation and Coronary angiography or MSCT on coronaries to exclude any coronary lesions in patients (male patients over 40 years old and postmenopausal females).

Surgical Techniques

The Anesthetic protocol in open heart surgery was followed in all cases. TEE probe was placed to assess the morphology of aortic cusps, annulus diameter, degree of regurge and diameter of ascending aortic.

The surgery was done through a median sternotomy. Then cannulation and establishment of cardiopulmonary bypass (CPB) was done. Subsequently, the aorta was cross clamped and direct visualization of the aortic valve and coronary ostia for cold cardioplegia administration was done.

Visual assessment of the aortic valve and root was very important to decide the repair procedure to do. Each patient get a tailored surgical technique for repair including: David procedure, supra coronary conduit with non-coronary sinus replacement or supra coronary conduit with external annular ring.

There was also a wide variation in techniques of leaflet repair as leaflet augmentation, plication and /or shaving. The aim was to restore the aortic valve competence and coaptation through coaptation distance above 9 mm and leaflet height above 20 mm with coaptation level above the annular level.

TEE evaluation was done after weaning from cardiopulmonary bypass to assess the competence of the aortic valve, coaptation level and coaptation distance.

Statistical Analysis:

The statistical analysis of the data was by using IBM Statistical Package for Social Sciences version 22.0 (IBM Corporation, Chicago, USA, 2013). Quantitative data were represented as (mean ± SD), while qualitative data were represented as percentage and number. The significance of the difference between two study group means were assessed statistically by the Student's t-test, while the relationship between two or more qualitative variables was compared by the Chi square test. A p-value less than 0.05 was considered significant.

Results:

Preoperative Data

The mean age was 44.73 ± 9.48 years. Males represented 76% while females represented 24%. Table (1) summarizes the preoperative patient data.

Table (1) Summary of preoperative patient characteristics

Preoperative parameter	**Value**
Age (years)	44.73 ± 9.48
Gender	
Male	76 (76%)
Female	24 (24%)
Diabetes mellitus	42 (42%)
Systemic hypertension	64 (64%)
Previous cerebrovascular stroke	6 (6%)
Chronic obstructive pulmonary disease	51 (51%)
Timing of Surgery:	
Emergency: Acute aortic dissection (Stanford type A)	23 (23%)
Elective:	
Chronic aortic dissection (Stanford type A)	13 (13%)
Ascending aortic aneurysm	64 (64%)
Echocardiographic data:	
LVED (cm)	6.1 ± 0.45
LVES (cm)	4.09 ± 0.39
EF %	59.47 ± 5.19
Aortic annulus (mm)	2.5 ± 0.5
BAV	19 (19%)
Degree of AR :	
Mild	11 (11%)
Moderate	38 (38%)
Severe	51 (51%)

Operative Data

The mean cardiopulmonary bypass time (CPB), cross clamp time (CCT), intraoperative TEE data and type of surgical technique were summarized in table (2).

Intraoperative TEE was done and revealed that there was mild aortic regurge in 12 patients, three had dilated annulus and underwent emergency surgery with supra

coronary conduit replacement without annuloplasty, five had residual mild cusp prolapse while the remaining four patients had residual mild leaflet retraction. There was no aortic regurge in the rest of the patients.

Table (2) summary of intraoperative data

Operative data	**Value**
Intraoperative time parameters (minutes)	
CPB time (minutes)	130.28 ± 8.57
CCT time (minutes)	109.02 ± 7.11
Intra operative TEE	
EF %	46.95 ± 5.64
Mean PG (mmHg)	10.10 ± 1.22
Peak PG (mmHg)	19.58 ± 1.75
Leaflet height (mm)	22.2 ± 2.1
Coaptation distance (mm)	11.6 ± 2
Aortic regurge (post repair)	
No	88 (88%)
Mild	12 (12%)
Need for inotropes	63 (63%)
Surgical technique	
-Valve sparing procedure (Tiron David procedure)	67 (67%)
-Supra coronary conduit	12 (12%)
-Supra coronary conduit with external aortic annuloplasty ring	16 (16%)
-Supra coronary conduit with non-coronary sinus replacement	5 (5%)

Postoperative Data

The mean time of postoperative mechanical ventilation for the patients was 8.28±2.31 hours. One patient had postoperative complete heart block that needed implantation of permanent pacemaker, two patients had significant postoperative bleeding which required transfusion of blood units and re-exploration for control of bleeding. One patient died as a result of profound low cardiac output syndrome resistant to maximum doses of pharmacological inotropic support. Table (3) shows postoperative results.

Table (3) summary of postoperative data

Postoperative data	**Value**
Mechanical ventilation (hours)	8.28 ± 2.31
ICU stay (days)	3.3 ± 1.4
Need for blood transfusion (units)	2.1 ± 0.9
Postoperative complications	
Re-exploration for bleeding control	2 (2%)
Need for permenant pacemaker insertion	1 (1%)
Cerebrovascular stroke	2 (2%)
Need for renal dialysis	1 (1%)

Postoperative mortality	1 (1%)

Follow-Up Data

Follow up after six months was done and follow up echo revealed that LVED was 5.65 ±0.44 cm, LVES 3.71 ± 0.4 cm and EF 61.68 ± 6.73. Echo also revealed that there was moderate aortic regurge (AR) in 7 patients that could be summarized as following: 2 out of the 3 patients with dilated annulus, 3 out of the 5 patients with mild cusp prolapse, 2 out of the 4 patients with mild residual cusp retraction .All the 7 patients had mild AR immediate postoperatively and were asymptomatic on follow up with no need for surgical reintervention. Only one patient, who had mild AR due to mild residual cusp retraction immediate postoperatively, developed severe AR and the patient was symptomatic and in need for surgical reintervention by aortic valve replacement 5 months after the initial surgical intervention. Table (4) shows that there was statistically significant improvement regarding left ventricular dimensions and contractility in 6 months postoperative follow up Echo compared with preoperative Echo.

Table (4) Comparison between preoperative and 6 months postoperative follow up Echo

Parameter	**Preoperative Echo**	**Follow up Echo**	**P value**
LVED (cm)	6.1 ± 0.45	5.65 ± 0.44	**<0.001**
LVES (cm)	4.09 ± 0.39	3.71 ± 0.4	**<0.001**
EF %	59.47 ± 5.19	61.68 ± 6.73	**0.01**

Discussion:

Many studies have documented good outcome of repair of the aortic valve in the treatment of cases of severe aortic regurge through keeping the native aortic valve and thus reducing the risk of complications of using prosthetic valves. [3] The mechanisms of recurrence of the regurge after repair have been considered as predictors of failure of valve repair which include diltation of the annulus, cusp prolapse or retraction and orientation of the commissures. [4]

Preoperative comorbidities such as atrial fibrillation or previous myocardial infarction might have their negative impact on the outcome of the study. [5] In our study, there were 23 patients that needed emergent intervention due to acute aortic dissection (Stanford type A), unlike other studies which had much less number of patients who needed an emergency intervention. [6]

Surgical techniques performed in our study were valve sparing procedure (Tiron David procedure) in 67 patients (67%), supra coronary conduit in 12 patients (12%), supra coronary conduit with external aortic annuloplasty ring in 16 patients (16%) and supra coronary conduit with non-coronary sinus replacement in 5 patients (5%). Other studies revealed other surgical techniques in aortic valve repair such as Yacoub procedure and subcommissural annuloplasty. [7] According to our unit's experience, Tiron David procedure is preferred than Yacoub procedure in aortic valve repair, also

external aortic annuloplasty ring should be added to supracoronay procedures for elective cases only and not in urgent situations.

Our study shows similar results to other studies regarding the significant improvement in echo findings such as EF, LVED and LVES in the postoperative follow up compared to preoperative echo data. [8][9]

Follow up of our study revealed that there were seven patients developed moderate aortic regurge and they were asymptomatic for follow up with no need for surgical reintervention. There was one patient who developed severe aortic regurge. In this patient, the condition progressed from mild aortic regurge due to mild residual cusp retraction immediate postoperatively to severe aortic regurge and the patient was symptomatic and in need for surgical reintervention by aortic valve replacement 5 months after the initial surgical intervention. Our study shows nearly similar results to other studies regarding the rate of failure of aortic valve repair and the need for surgical reintervention [5][10][11]. However some studies revealed that transcatheter aortic valve implantation (TAVI) could be a successful alternative to surgery for reintervention in high surgical risk patients with failure of aortic valve repair.[12]

According to our study, regardless of degree of AR, we believe that the durability of aortic valve repair could be improved by stabilization and reduction of dilated aortic annulus, total correction of cusp prolapse by central plication and repair of cusp retraction. Also, there were no significant differences in results in cases with bicuspid aortic valve when compared with trileaflet aortic valve.

Limitations:

Our search has some limitations due to its retrospective nature with single center experience. Aortic valve repair techniques were always performed by the same group of surgeons. Therefore, we recommend more multicenteric studies in the future.

Conclusion:

Aortic valve repair offers the patients to live with their native valves, so avoiding the complications associated with the prosthetic valve surgeries including the anticoagulation medications. However, there are number of factors should be managed intraoperatively properly to improve the durability of aortic valve repair. These factors, which have been considered as predictors of failure of aortic valve repair, are: dilated aortic annulus, residual cusp prolapse and residual cusp retraction.

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