JMSR
Journal of Medical and Surgical Research

Research Article

ISSN: 2351-8200

JMSR 2019, Vol V; N°3: 592- 598

OUTCOMES OF AORTIC VALVE REPLACEMENT IN AORTIC STENOSIS WITH IMPAIRED LEFT VENTRICULAR FUNCTION: HAS THE TRANSVALVULAR GRADIENT A DETERMINANT VALUE IN THESE RESULTS?

A. Bakkali [1, 2], S. Lyazidi [3], R.Sayah [3], M. Ait Houssa [4], M. Laaroussi [2].
[1] Faculty of Medicine and Pharmacy, Ibn Zohr University; Agadir, Morocco.
[2] Cardiovascular surgery department, Ibn Sina University Hospital; Rabat, Morocco
[3] Cardiovascular surgery department, Ibn Rochd University Hospital; Casablanca, Morocco.
[4] Cardiovascular surgery department, Military Hospital; Rabat, Morocco.

ABSTRACT

Background: Left ventricular dysfunction remains a major prognostic indicator of the outcome of patients undergoing surgery for aortic valve stenosis (AS). These groups of patients are heterogeneous; they include patients with low and high transvalvular gradient. The aim of this study was to compare the results of aortic valve replacement (AVR) for AS and severe left ventricular (LV) systolic dysfunction in patients with low and high transvalvular gradient and to identify whether the transvalvular gradient has a determinant value in these results.
Methods: In this retrospective bicentric study, 61 patients who underwent isolated AVR for severe AS associated to reduced LV function (LVEF < 40%) were enrolled. The patients were divided into two groups according to the mean transvalvular gradient: group 1 with mean gradient <40 mmHg (n=16) and Group 2 which mean gradient was ≥40 mmHg (n=45). The two groups were similar from demographic characteristics, symptoms, comorbidites and the pathological causes of AS.
Results: The hospital mortality was 12.50% in the group 1 Vs 11% in the group 2 (p=1). Postoperative morbidities were without significant statistical difference between the two groups. In the early postoperative stage, both the groups have improved their LV function.
The post-operative follow-up data in the 2 groups shows no significant statistical difference, in terms of improvement of clinical symptoms and left ventricular features.
Conclusion: The mean transvalvular gradient has a limited prognostic value in the surgical results. Aortic valve replacement may be performed in cases with low transvalvular gradient and is associated with better outcome compared to those with a high gradient.

Keywords: severe aortic stenosis, aortic valve replacement, low transvalvular gradient, left ventricular dysfunction.

Corresponding Author:
Prof. Abderrahmane Bakkali, **MD, PhD.**
Address: Faculty of Medicine and Pharmacy, Ibn Zohr University ; Agadir, Morocco..
E-mail: drbakkaliabd@yahoo.fr
Phone: 00212661291450

Copyright © 2012- 2019 Dr **Abderrahmane Bakkali** and al. This is an open access article published under **Creative Commons Attribution -Non Commercial- No Derives 4.0 International Public License (CC BY-NC-ND)**. This license allows others to download the articles and share them with others as long as they credit you, but they can't change them in any way or use them commercially.

INTRODUCTION

Although left ventricular dysfunction remains a major prognostic indicator of the outcome of patients undergoing surgery for aortic valve stenosis (AS), surgical aortic valve replacement (AVR) still represents the gold standard among the therapeutic options [1].

Dysfunction of the left ventricle (LV) increases the risk of surgery failure significantly but does not constitute a reason to reject these patients [2].
In fact, these groups of patients are heterogeneous; they include patients with low and high transvalvular gradient. The aim of this study was to compare the results of aortic valve replacement for AS and severe left ventricular (LV) systolic dysfunction in patients with low and high transvalvular gradient and to

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2019, Vol V; N°3: 592- 598

identify whether the transvalvular gradient has a determinant value in these results.

PATIENTS AND METHODS

Patients:

This retrospective bicentric study, from January 2000 to April 2016, was done at Cardiovascular Surgery Departments of the Avicenna University Hospital and the Military Hospital, both in Rabat (Morocco). It includes 61 patients who underwent isolated AVR for severe AS associated to reduced LV function (LVEF < 40%).

Inclusion criteria were**:**

- Severe native aortic stenosis with an area < 1 cm2 or < 0.6 cm 2 / m 2
- Systolic left ventricular ejection fraction (LVEF) <40%

Exclusion criteria were**:**

- Previous aortic valve replacement
- Aortic insufficiency over grade I
- Associated valve disease requiring surgical correction
- Coronary artery disease
- History or clinical evidence of previous acute myocardial infraction
- Less than 18 years old age

The baseline operative risk of the patients was estimated using the logistic EuroSCORE.

Methods:

Patients' data were obtained from the individual patient hospital records.
All patients in our series underwent transthoracic echocardiography (TEE) by an experienced cardiologist
Dobutamine stress echocardiography (DSE) has been performed in 3 cases.
All but one patient underwent coronary angiography —the exceptional patient was operated in extreme emergency after cardiac arrest.

Surgical Management:

Classical aortic valve replacement was performed under general anesthesia and cardiopulmonary bypass (CPB) with moderate systemic temperature, through median sternotomy. Until 2002, myocardial protection was achieved via the administration of intermittent antegrade cold crystalloid cardioplegia (Saint Thomas II) but since 2003, intermittent hyperkalemia cold blood cardioplegia has been employed.

Follow- up:

Early postoperative stage was defined as 6 months after surgery and the late operative stage was defined as the period beyond 1year after AVR.
Hospital mortality was defined as death at any time before discharge from hospital.
All surviving patients underwent TTE before hospital discharge. During follow-up, patients were contacted directly and were individually requested to make an appointment with the primary surgeon and referring cardiologist. They were investigated by a visit, including physical examination, chest X radiogram, ECG and echocardiogram.
Occasionally, the follow-up data was obtained by telephone contact with their cardiologist.

Statistical analysis:

Standard descriptive statistical methods were used in the analysis. Continuous variables were expressed as means (M) with standard deviation (SD) or medians (MD) with interquartile range (IQR). Student's t-test was used to compare and study the relationships between the continuous variables whenever the data was normally distributed and Non-parametric Mann-Whitney test was used in the others cases. Categorical variables were described as numbers and percentages (%) and analyzed using the $\chi 2$ test or Fisher's exact test, as appropriate. One-way analysis of variance with the post hoc Bonferroni test (for normal distribution with equal variance between the groups) or Friedman test (for non-normally distributed data) was applied to compare quantitative variables between paired samples.
A p-value < 0.05 was considered to be significant.
All the analyses were performed with the Statistical Package for the Social Sciences (SPSS version 11.5, Chicago, Illinois, USA).

RESULTS:

Baseline Clinical Characteristics

Between January 2000 and April 2016, 61 patients, whom 83.60 % were men, underwent isolated AVR for severe AS associated to reduced LV function (LVEF < 40%) in the Cardiovascular Surgery Departments of the Avicenna University Hospital and the Military Hospital, both in Rabat (Morocco). Sixteen patients (26.2%) had a transvalvular gradient<40 mmHg (Group 1: low gradient) and forty five patients (73.8%) had a transvalvular gradient ≥40 mmHg (Group 2: high gradient).
The two groups were similar from demographic characteristics including age, gender, body surface area (BSA), presenting symptoms, comorbidities

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2019, Vol V; N°3: 592- 598

and the pathological causes of AS. Clinically, there was no significant statistical difference between the 2 groups: the mean NYHA was 2.82 ± 0.80 in group 1 and 3.05 ± 0.72 in group 2 (p= 0.263).The patients' demographic characteristics appear in Table I.

The preoperative echocardiographic patients' data were with significant statistical difference concerning the mean transvalvular gradient and the mean left ventricular end systolic diameter (LVESD).

The mean transvalvular gradient was 30.37 ± 5.80 mmHg in the group1 and 55.80 ± 16.60 mmHg in the group 2 who had a low mean LVESD than the low gradient group.

There was no significant statistical difference concerning the mean calculated logistic EuroScore in the two groups. The preoperative echocardiographic patients' data appear in Table I.

Table I: Comparison of preoperative data between low and high transvalvular gradient groups.

Variables	Group 1 Low gradient (n=16)	Group 2 High gradient (n=45)	p Value (n=61)
Age[1] (years)	57.20± 10.4	58.60 ± 13.20	0.70
Sexe[3] Male/Female	14/2 (87.50 %)	37/8 (82.20)	1
BSA[1]	1.80 ± 0.14	1.74 ± 0.16	0.16
NYHA[1]	2.82 ± 0.80	3.05 ± 0.72	0.263
- NYHA[3]II	5 (31.30%)	13 (2.90 %)	
- NYHA[3]III	6 (37.50 %)	21 (46.70 %)	
- NYHA[3]IV	5 (31.10 %)	11 (24.40 %)	
Angina pectoris[3]	4 (25 %)	16 (35.60 %)	0.44
Syncope[3]	1 (6.30 %)	4 (9 %)	1
Congestive heart failure[3]	4 (25 %)	6 (13.30%)	0.43
Etiologies[3]			0.14
-Degenerative	7 (43.80 %)	32 (71 %)	
-Rhuematic	8 (50 %)	12 (27 %)	
-Congenital	1 (6.30 %)	1 (2 %)	
Comorbidites[3]			
-Hypertension	3 (18.80 %)	15 (33.30 %)	0.35
-Diabetes	3 (18.80 %)	5 (11 %)	0.42
-Renal failure	4 (25 %)	7 (15.60 %)	0.45
-AIS	0 (0%)	1 (2.20%)	1
CT index[2]	0.6 [0.58 ; 0.60]	0.60 [3 ; 40]	0.42
Aortic valve area[1]	0.60 ± 0.20	0.63 ± 0.17	0.60
Mean transvalvular gradient	30.37 ± 5.80	55.80 ± 16.60	**<0.001**
Preoperative LVEF [1] (%)	29.60 ± 9.60	34 ± 6.60	0.09
Preoperative LVEDD (mm)[1]	66,80 ± 10	62.50 ± 8.70	0.10
Preoperative LVESD **(mm)[1]**	55 ± 10	48.50 ± 7.7	**0,009***
SPAP [1] (mmHg)	46.30 ± 27,70	48 ± 20	0.78
Logistic regression Euroscore [1]	11.60 ± 4	8.20 ± 2.60	0.37

1: expressed as means standard deviation (SD); 2: expressed as medians with interquartile range (IQR); 3: described as numbers and percentages (%).BSA: body surface area; AIS: Acute ischemic stroke; CT: cardio-thoracic; LVEDD: left ventricular end diastolic diameter; LVESD: left ventricular end systolic diameter; LVEF: left ventricular ejection fraction; SPAP: systolic pulmonary arterial pressure.

Operative and early postoperative results

The mean prosthesis size was 21.70 ± 1.60 mm in the group 1 and 22.60 ± 1.70 mm in the group 2. The mean aortic cross-clamp time was 61.70 ± 15 minutes in the group 1 and 69.30 ± 22.30 min in the group 2 (p= 0.20), whereas the average duration of cardiopulmonary bypass (CPB) was 98.30 ± 49.40 min in the group 1 and 104.60 ± 39.80 min in the group 2 (p=0.60).

There was no significant statistical difference concerning the early postoperative outcomes. The hospital mortality was 12.50% (2/16) in the group 1 Vs 11% (5/45) in the group 2 (p=1)

In the two groups, the causes of deaths were low output syndrome. The mean length of stay in the intensive care unit was 90.40 ± 31.80 hours in the group 1 and 66.4 ± 30.40 hours in the group 2 (p=0.29). Postoperative morbidities were without significant statistical difference between the two groups. The inotropic drug support was needed in 93.80% of Group 1 versus 91% of group 2. The use of hemodynamic support by intra-aortic balloon pump (IABP) was necessary in 2 patients (2.50%) of the group 1.

In the early postoperative stage, both the groups have improved their LV function.

Perioperative data are shown in Table II.

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2019, Vol V; N°3: 592- 598

Tableau II: Comparison of perioperative data between low and high tansvaular gradient.

Variables	Group 1 Low gradient (n=16)	Group 2 High gradient (n=45)	p Value (n=61)
X clamp time1	61.70 ± 15	69.30 ± 22.30	0.20
CPB time (mn) 1	98.30 ± 49.40	104.60 ± 39.80	0.60
Biological prothesis	3(18.70%)	8 (17.80 %)	1
Mechanical prosthesis	13(81.25 %)	37(82.22 %)	1
Prosthesis size (mm) 1	22.60 ± 1.70	21.70 ± 1.60	0.06
Use of positive inotropic agents3	15 (93.80 %)	41 (91 %)	1
IABP3	2 (2.50 %)	-	0.06
Mechanical ventilation time2 (h)	8.50 [5.70 ; 19.20]	10 [8 ; 17]	0.29
IUC stay1 (h)	90.40 ± 31.80	66.4 ± 30.40	0.29
Early postoperative LVEDD1 (mm)	64 ± 11.40	60.50 ± 7.70	0.29
Early postoperative LVESD1 (mm)	49 ± 11.30	46 ± 7.60	0.33
Early postoperative LVEF1	38.20 ± 11.30	38.20 ± 8.60	0.98
Mean transprosthesis gradient1 (mmHg)	12.40 ± 4	12 ± 3.40	0.76
Complications			
-Bleeding[1] (ml)	364.70 ± 216.40	452.45 ± 269	
-Low output syndrome[3]	9(56.20 %)	16 (35.50 %)	0.26
-Acute renal failure [3]	1 (6.30 %)	1 (2.30 %)	0.44
-Third degree AV block[3]	-	2 (4.70 %)	0.40
-Reoperation for bleeding[3]	-	1 (2.30 %)	
Mortality[3]	2 (12.50 %)	5 (11%)	1

1: Expressed as means standard deviation (SD); 2: Expressed as medians with interquartile range (IQR); 3: Described as numbers and percentages (%). X clamp: cross clamping; CPB: cardiopulmonary bypass; IABP: intra-aortic balloon pump; ICU: intensive care unit; LVEDD: left ventricular end diastolic diameter; LVESD: left ventricular end systolic diameter; LVEF: left ventricular ejection fraction; AV: atrioventicular.

Long-term outcomes

After a median follow-up of 40 months (IQR [29; 79.50]) in the group 1 and 36 months (IQR 36 [17; 115] in the group 2, incidence of late death and complications were similar in the 2 groups. We have recorded 3 deaths, one in the group 1 and two in the group 2 (due to hemorrhagic stroke in one case of the group 1 and due to cancer in the two cases of the group 2).

Among the 52 survivors, 38 patients were audited. The post-operative follow-up data in the 2 groups shows no significant statistical difference, in terms of improvement of clinical symptoms and left ventricular features.

The NYHA class improved from 2.82 ± 0.80 to 1.10 ± 0.30 in the group 1 and from 3.05 ± 0.72 to 1.20 ± 0.40 in group 2.

Recovery of LV systolic function was also apparent in the 2 groups. The group 1 had recovered 25.40 ± 0.40 points of EF. In Group 2, the gain was 15.40 ± 2 points.

Decrease of LV diameters was also apparent in the 2 groups. Table III shows the long-term outcomes of the two groups.

JMSR
Journal of Medical and Surgical Research
ISSN: 2351-8200
Research Article
JMSR 2019, Vol V; N°3: 592- 598

Table III: Comparison of long-term outcomes between low and high transvalvular gradient.

Variables	Group 1 Low gradient (n=16)	Group 2 High gradient (n=45)	p Value (n=61)
Controlled patients[3]	8 (57%)	31 (77.50 %)	0.17
Follow up time [2] **(months)**	40 [29 ; 79.50]	36 [17 ; 115]	
NYHA[1]	1.10 ± 0.30	1.20 ± 0.40	0.81
Use of digitalo-diuretic tretement[3]	1 (14.30 %)	11 (36.70 %)	0.38
Late complications[3]			
- Cerebrovascular accident	-	2 (6.50 %)	0.29
- Congestive heart failure	-	2 (6.50 %)	
Late postoperative LVEDD (mm)[1]	52 ± 12.11	54.60± 7	0.626
Late postoperative LVESD (mm) [1]	38.85 ± 11.70	39.43 ± 6.50	0.904
Late postoperative LVEF [1]**(%)**	55 ± 10	49.20 ± 9.30	0.154
Late death[3]	1 (12.50 %)	2 (6.50 %)	0.50

1: expressed as means standard deviation (SD); 2: expressed as medians with interquartile range (IQR); 3: described as numbers and percentages (%). LVEDD: left ventricular end diastolic diameter; LVESD: left ventricular end systolic diameter; LVEF: left ventricular ejection fraction.

DISCUSSION

This study showed that the results of AVR in patients with severe AS, severe LV dysfunction, and low transvalvular gradient were beneficial and comparable to those of patients with a higher transvalvular gradient.

Patients with LV dysfunction represent up to 26% of patients with AS and their spontaneous prognosis is severe [3,4].Currently, the only effective therapy is the removal of the mechanical obstruction by aortic valve replacement (AVR) or by percutaneous aortic valve replacement (PAVR) as a therapeutic option [5].

Despite the operative risk remains significantly higher, the postoperative prognosis of these patients remains better, compared to those treated medically [6,7].In our study, the rate of hospital mortality reached the margin of 8-21% reported in the literature [6,8]. (12.50% in the group of low gradient and 11% in the group of high gradient) .It was mainly due to low cardiac output.

Literature reports several factors which are considered as associated with unacceptable risk of operative mortality. They include: age, female gender, class III-IV of NYHA, renal failure, congestive heart failure, LVESD> 54mm, severe pulmonary hypertension, absence of contractile reserve (CR) and low trans-aortic valvular gradient [1,8-12]. However most of those series are heterogeneous, including patients with other associated lesions, especially, coronary or valvular disease other than aortic stenosis.

In fact, prior acute myocardial infarction, concomitant coronary artery bypass graft surgery and untreated coronary lesions are considered as significant risk factors of hospital mortality as far as mitral valve regurgitation (MR) [1, 7, 13].

To avoid biases of the association with others disease lesions, our study has been focused on isolated AS with severe left ventricular dysfunction.

Clavel et al reported that patients with low transaortic gradient were a high-risk population with an operative mortality rate of 18%.The risk was even higher when transvalvular gradient was ≤ 20 mmHg [14].

Our study did not show any significant differences in hospital mortality between patients with low and those with high transaortic gradient. This finding is consistent with those of Borowski et al. they showed a comparable postoperative mortality rate in a low gradient group and a high gradient one [15].

LV contractile reserve (CR), accessed by dobutamine stress echocardiography, can be useful to assess anatomic severity and prognosis. Indeed , the lack of CR increase the hospital mortality and yet should not be considered by itself as surgical contraindication since the potential of myocardial recovery after surgery are not excluded [16-18].

Since 2012, we have begun to study the CR of LV by echocardiography with low-dose of dobutamine. Only three of our patients underwent this test. All of them had a contractile reserve.

In our series, late mortality rate was similar in the two groups. All deaths were related to non-cardiac origin.

Several risk factors of late death have been reported, they include: male gender, advanced age, diabetes mellitus, severe pulmonary hypertension, preoperative class III and IV NYHA, preoperative use of high doses of diuretic, preoperative circulatory assistance by intra-aortic balloon pump and prosthesis–patient mismatch [19-22].

In our study, LVEF, LVEDD and LVESD evolved favorably during early and late postoperative periods in both groups. Recovery of the ventricular function displayed no statistically significant between the two

groups and improvement of clinical symptoms was real in both groups. Some studies have retained ours finding; Thus, Vaquette et al confirmed that early postoperative recovery of LV function was associated with significantly greater relief of symptoms and longer survival. They concluded that patients who improve their LVEF more than 10 units in the early postoperative course had a better long-term survival than patients who did not [23- 25]. In our study, LVEF increased in the early postoperative stage but did not reach the threshold of 10 units (8.6 ± 1.7 units in group 1 and 4.2 ± 2 units in group 2) and seemed to be associated with improved survival rate.

CONCLUSION

Despite severe left ventricular dysfunction, aortic valve replacement in aortic stenosis can be tenable with excellent results.
The mean transvalvular gradient has a limited prognostic value in the surgical results. Aortic valve replacement may be performed in cases with low transvalvular gradient and is associated with better outcome compared to those with a high gradient.
The long term outcome of AVR for severe and isolated AS with left ventricular dysfunction and low transvalvular gradient is excellent as evidenced by: Better survival (although the rate of hospital mortality is still for further improving), decreased left ventricular diameters and improvement in left ventricular function and functional class.

Conflicts of interest

The authors declare having no conflicts of interest related to this article

REFERENCES

1. Connolly HM, Oh JK, Orszulak TA, Osborn SL, Roger VL, Hodge DO, Bailey KR, Seward JB and Tajik AJ. Aortic Valve Replacement for Aortic Stenosis with Severe Left Ventricular Dysfunction Prognostic Indicators. Circulation. 1997; 95: 2395-2400.
2. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ and Sorajja P. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Journal of the American College of Cardiology. 2014; 63:e57-e185.
3. Pai RG, Varadarajan P and Razzouk A. Survival benefit of aortic valve replacement in patients with severe aortic stenosis with low ejection fraction and low gradient with normal ejection fraction. The Annals of thoracic surgery. 2008; 86:1781-1789.
4. Varadarajan P, Kapoor N, Bansal RC and Pai RG. Clinical profile and natural history of 453 non-surgically managed patients with severe aortic stenosis. The Annals of thoracic surgery. 2006; 82: 2111-2115.
5. Caballero-Borrego J, Gómez-Doblas JJ, Valencia-Serrano F, Cabrera-Bueno F, Rodríguez-Bailón I, Sánchez-Espín G, etal. Influencia del género en el pronóstico perioperatorio de pacientes sometidos a sustitución valvular por estenosis aórtica severa. Rev Esp Cardiol 2009; 62:31-8.
6. Cannolly HM, Oh JK, Schaff HV, Roger VL, Osborn SL, Hodge DO, et al. Severe aortic stenosis with low transvalvular gradient and severe left ventricular dysfunction. Results of aortic valve replacement in 52 patients. Circulation 2000; 101: 1940-1946.
7. Flores-Martin A, Gomez-Doblas JJ, Caballero-Borrego J, Cabera-Bueno F, Rodriguez-Bailon I, Melero J, et al. Long-term predictor of mortality and functional recovery after aortic valve replacement for severe aortic stenosis with left ventricular dysfunction. Revista Española de Cardiologia 2010; 63: 36-45.
8. Sharony R, Grossi EQ, Saunders P, Schwartz CF, Ciuffo GB, Baumann FG, et al. Aortic valve replacement in patients with impaired ventricular function. Ann Thorac surg 2003; 75: 1808-1814.
9. Silver K, Aurigemma G, Krendel S, Barry N, Ockene I, Alpert J. pulmonary artery hypertension in severe aortic stenosis: Incidence and mechanism. Am Heart J 1993; 125: 146-150.
10. Pereira JJ, Lauer MS, Bashir M, Afridi I, Blackstone EH, Stewart WJ, et al. Survival after Aortic Valve Replacement for Severe Aortic Stenosis with Low Transvalvular Gradients and Severe Left Ventricular Dysfunction. J Am Coll Cardiol 2002; 39 (8): 1356–63.
11. Tribouilloy C, Levy F, RusinaruD, Guéret P, Petit-Eisenmann H, Baleynaud S, et al. Outcome after aortic valve replacement for low-flow/low-gradient aortic stenosis without contractile reserve on dobutamine stress echocardiography. J Am Coll Cardiol 2009; 53: 1865-73.
12. Bakkali. A, Koulekey. D, Sayah R, Jaabari.I, Ait Houssa.M, Laaroussi.M. Aortic Valve Replacement for Patients with Severe Aortic Stenosis and Severe Left Ventricular Dysfunction: Mortality Risk Factors. Int J Med Surg, 2017. (4):1-5. DOI: 10.15342/ijms.v4.129.
13. Powell DE, Tunick PA, Rosenzweig BP, Freedberg RS, Katz ES, Applebaum RM, Perez JL and Kronzon I. Aortic valve replacement in patients with aortic stenosis and severe left ventricular dysfunction. Archives of internal medicine. 2000; 160: 1337-1341.
14. Clavel MA, Fuchs C, Burwash IG, Mundigler G, Dumesnil JG, Baumgarter H, et al. Predictors of outcomes in low-flow, low-gradient aortic stenosis. Results of the multicenter TOPAS Study. Circulation. 2008; 118 (Suppl 1):234–242.
15. Borowski A, Ghodsizad A, Vchivkov I, Gams E. Surgery for severe aortic stenosis with low transvalvular gradient and poor left ventricular

function-a single centre experience and review of the literature. J Cardiothorac Surg 2007; 2:9-13.
16. Tribouilloy C, Levy F, RusinaruD, Guéret P, Petit-Eisenmann H, Baleynaud S, et al. Outcome after aortic valve replacement for low-flow/low-gradient aortic stenosis without contractile reserve on dobutamine stress echocardiography. J Am Coll Cardiol 2009; 53: 1865-73.
17. Monin JL, Monchi M, Gest V, Duval-Moulin AM, Dubois-Rande JL, Gue¬ret P. Aortic stenosis with severe left ventricular dysfunction and low transvalvular pressure gradients, Risk stratification by low-dose dobutamine echocardiography. J Am Coll Cardiol 2001; 37: 2101-7.
18. Subramanian H, Kunadian B, Dunning J.Is it ever worth contemplating an aortic valve replacement on patients with low gradient severe aortic stenosis but poor left ventricular function with no contractile reserve? Interactive CardioVascular and Thoracic Surgery April 2008; 7:301-305.
19. Duarte IG, Murphy CO, Kosinski AS, Jones EL, Craver JM, Gott JP and Guyton RA. Late survival after valve operation in patients with left ventricular dysfunction. The Annals of thoracic surgery. 1997; 64: 1089-1095.
20. Morris JJ, Schaff HV, Mullany CJ, Rastogi A, McGregor CG, Daly RC, Frye RL, Orszulak TA. Determinants of survival and recovery of left ventricular function after aortic valve replacement. Ann Thorac Surg 1993; 56:22–29.
21. Rabus, M. B., Kirali, K., Kayalar, N., Yayla-Tuncer, E., Toker, M. E., Yakut, C. Aortic valve replacement in isolated severe aortic stenosis with left ventricular dysfunction: long-term survival and ventricular recovery/Sol ventrikul disfonksiyonunun eslik ettigi izole ileri aort darliginda aort kapagi replasmani: uzun donem sagkalim ve ventrikuler duzelme. The Anatolian Journal of Cardiology 2009; 9(1):41-47.
22. Ruel, M., Al-Faleh, H., Kulik, A., Chan, K. L., Mesana, T. G., Burwash, I. G. Prosthesis–patient mismatch after aortic valve replacement predominantly affects patients with preexisting left ventricular dysfunction: effect on survival, freedom from heart failure, and left ventricular mass regression. The Journal of Thoracic and Cardiovascular Surgery, 2006; 131 (5):1036-1044.
23. Vaquette B, Corbineau H, Laurent M, Lelong B, Langanay T, De Place C and all. Valve replacement in patients with critical aortic stenosis and depressed left ventricular function: predictors of operative risk, left ventricular function recovery, and long term outcome. Heart. 2005; 91: 1324-1329.
24. Bakkali A, Harrag JE, Belkhadir A, BenlafqihC, Mansouri F, Laroussi M. Cardiac Valvular Papillary Fibroelastoma: an Usual Cause of Acute Ischemic Stroke. Journal of Medical and Surgical Research (JMSR), 2014 : I (2) : 60-62
25. Bakkali A, Jaabari I, Sayah R, Dadji K, Ait Houssa M, Laaroussi M. Impact of Aortic Valve Replacement on Left Ventricular Remodeling In Patients with Severe Aortic Stenosis and Severe Left Ventricular Dysfunction. Journal of Medical and Surgical Research (JMSR) 2016: III (2): 267-274.