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WHICH METHOD SHOULD BE PREFERRED IN NARROW AORTIC ROOTS? RISKS AND PROGNOSES OF MANOUGUIAN AND NICKS PROCEDURES

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Contribution

UV concieved the idea ,designed and wrote manuscript. Data collection was done by AAA while final review was done by MK All authors contributed equally to the submitted manuscript.

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ABSTRACT

Objective: To analyze the superiority, feasibility and problems of Nicks and Manougian procedures in the light of literature data, independent of valve type and BSA values.

Methodology: The study was a cross-sectional study from June 2009 and September 2017 conducted at Health Sciences University Haydarpaşa Numune Hospital. The study included patients who underwent Manougian and Nicks procedures between 2009-2017. The effects of the procedures on left ventricular functions at the postoperative 0-12th months, postoperative complications and mortality were evaluated. Cases with (I) isolated aortic stenosis without additional valve pathology who undergone ARE, with (II) BSA index between 1,40-1,70 m^2, and cases undergone (III) standard mechanical aortic valve (Carbomedics) replacement with Manougian and Nicks methods were included. Echocardiographical data of the cases were evaluated.

Results: The study included 104 patients who underwent Manougian (n=40;46,5%) and Nicks(n=46;53,5%) procedures between 2009-2017. Postoperative effective orifice area index was higher in the Manougian procedure (1,28Vs1,17cm/m^2;p=0,001). NYHA functional capacity was decreased by 1.58±0.7 postoperatively (inter-procedures p=0,809). Early and late mortality rates for Manougian and Nicks procedures were 0% , 2,2% and 2,5%, 2,2%, respectively (p=0,641). Reoperation rate due to bleeding, thrombosis, infection and the paravalvular leak was 15% at the end of the first year (inter-procedures p=0,565).The changes of echocardiographic parameters were significant in all cases against time. On the other hand, fractional shortening and gradient changes were significantly higher for Manougian procedure compared to Nicks, while ejection fraction and septum thickness change were not significant.

Conclusion: Although both methods had a positive effect on left ventricular function, Manougian procedure was more effective because it provided a larger valve area and near-normal left ventricular function. Considering risk factors for the optimal size valve implant, the choice of root dilatation method instead of alternative prostheses doesn't affect morbidity and mortality.

Key Words: Effective orifice area index, Manougian procedure, Nicks procedure, Aortic root enlargement, Patient-prosthesis mismatch, Septum thickness

INTRODUCTION

The main goal of the surgical treatment for advanced aortic stenosis is to achieve quality long-term survival by relieving pressure and volume load of the left ventricle and improving symptoms but patient-prosthesis mismatch (PPM) is frequently encountered after undersized valve replacement. Particularly in younger patients, it has been demonstrated by survival analyses that PPM leads to late mortality and morbidity by delaying the regression of the ventricular hypertrophy due to increased left ventricular workload after exertion. PPM was first described by Rahimtoola in 1978.[1] In the following years, the PPM was gradedhemodynamically as severe, moderate and mild according to effective orifice area index (EOAI) being less than 0,65 cm^2/m^2,between0,65-0,85 cm^2/m^2, and more than 0,85 cm^2/m^2, respectively.[2,3] Studies suggest that the prevalence of moderate PPM after valve replacement is between 20-70% whereas the prevalence of severe PPM is between 2-11%. In addition, it has been shown that moderate PPM increases mortality by 2 fold while severe PPM increases it by 11 fold. [2,3]

Today, despite the publication of many reports that sutureless and stentless valves provide effective orifice area in the elderly patients with narrow aortic annuli, the advantage on mortality and morbidity is not detected in young patients and long-term follow-up.[3-5] In addition, the general opinion is that these prostheses may be the first choice in patients undergone coronary artery bypass grafting who have patent grafts and heavily calcified aortic root. Furthermore, comparisons made are based early results of aortic root enlargement (ARE) procedures with high mortality. The pulmonary auto graft use or sutureless homograft use or ARE, whichever the procedure the goal is to provide a minimal gradient on the valve to increase effort capacity and regression of ventricular hypertrophy. On the other hand, this problem also triggers competition among producers for the production and trade of prosthetic valves with superior effective orifice area. In the cost-benefit analysis, it has been shown in many studies that the ARE is favored.

In 1975, Konno et al. described anterior ARE in congenital aortic stenosis after Nicks et al. described ARE through the middle of non-coronary sinus. [6,7] However, there was a need for an ARE that offered a larger valve area for surgeons but had a low risk. Furthermore, surgical strategies were required to allowregression of ventricular hypertrophy with minimal gradient in the valve. Manougian and Seybold-Epting described a method in 1978 that was asserted to be an alternativeto the Nicks procedure with the provision of wider valve area by an incision done between the left coronary sinus and non-coronary sinus to the anteriormitral leaflet.[8-10] However, the increase in postoperative mitral regurgitation complication led Nunez et al to develop annuloplasty technique by expanding this region with a Dacron patch without entering into the mitral anterior leaflet between the non-coronary sinus and the left coronary sinus.[10] The choice amongthese procedures is determined by the inherent complexity of these procedures, experience of the surgeon and the need for ARE. In addition, the prejudices caused by the surgeons' belief that they will increase morbidity and mortality are also effective.

In our study, we analyzed the effect of Nicks and Manougian procedures on left ventricular functions and NYHA functional capacity in the cases with small aortic root and similar BSA values. In addition, in one year, we tried to present the effect of these procedures, on postoperative complications, early and late mortalityin the light of alternative studies

METHODOLOGY

The study was planned as a retrospective randomized controlled cross-sectional study.Between June 2009 and September 2017, 1 cases were evaluated retrospectively.The study was approved by the Health Sciences University Haydarpaşa Numune Hospital Ethics Committee. Informed consent was waived by the Institutional Review Board owing to the study's retrospective nature. Cases with (I) isolated aortic stenosis without additional valve pathology (except mild mitral and tricuspid regurgitation)who undergone ARE, with (II) BSA index between 1,40-1,70 m^2, and cases undergone (III) standard mechanical aortic valve (Carbomedics) replacement with Manougian and Nicks methodswere included. Patients with congestive heart failure or renal insufficiency requiring dialysis or those who had undergone additional cardiac intervention and/or anterior ARE were not included in the study. Case files, polyclinic controls, and telephone records were used in the evaluations. Preoperative demographic characteristics, NYHA functional capacities, andechocardiographical data[(peak systolic gradient (PSG),mean gradient (MG), effective orifice area (EOA), left ventricular ejection fraction (LVEF), fractional shortening (FS), left ventricular end-diastolic diameter (LVEDD) and septum thickness (ST)] of thecases were evaluated(Table-2). Cross-clamp time (CCT) and total cardiopulmonary bypass time (CPBT), length of intensive care unitand hospital stay, early postoperative (0-1 months) complications, as well as late period (1-12 months) morbidity, mortality and echocardiographic data at the postoperative 6th and 12th months, were evaluated. BSA values were calculated with 'The Mosteller formula' [BSA(m^2) = [Height(cm) x Weight(kg)/3600)½].

Echocardiography: Standard left parasternal, apical, subcostal and suprasternal images were obtained. Two-dimensional echocardiography and parasternal long and short axial and apical images of the aortic valve morphology and valve opening were evaluated. Those cases whose mechanical valves could not be visualized by transthoracic echocardiography due to artifact and reverberation were evaluated by transesophageal echocardiography. The aortic valve area was calculated with the Gorlin formula. In apical four-chamber images, in CW Doppler, the maximum and average gradients of the valvular implants were calculated using Bernoulli's equation. Aortic insufficiency was evaluated by color Doppler. In M-mode echocardiogram measurements, septum thickness, LVEDD, and LVESD values were measured at the level of chordaetendinea. Left ventricular EF [(LVED volume-LVES volume / LVED volume) X (100%)] was determined by modified Simpson method and fractional shortening [FS = (LVEDD-LVESD / LVEDD) X (100%)] formula.

Surgical Technique: The operations were performed under general anesthesia with median sternotomy. Myocardial protection was achieved with antegrade cold-blood cardioplegia given every 20 minutes and moderate systemic hypothermia (28-32°C). Left ventricular decompression was achieved through the right superior pulmonary vein.

The aortotomy incision was done between the non-coronary and the left coronary sinus, extended to the middle of the mitral anterior leaflet along the fibrosis trigone (10-15 mm), opening the roof of the left atrium in cases in which Manougian technique was applied. Then, with the dacron patch, starting from the incision line of the mitral anterior leaflet, it was sutured over and over using 4,0 propylenesuturewith the double patch technique. In the Nicks procedure, aortotomy was extended from the middle of the non-coronary sinus to the mitral valve anterior leaflet approximately 10 mm without opening roof of the left atrium. Native valve was resected and the calcifications on it were cleared by leaving a 1 mm suture area in the annulus. After the valve size taken, the mechanical valve was inserted into the annulus [2,0 Ethibond (Ethicon Ltd. UK) suture] by sub-annularly placed pledged suture technique. The sutures in the patch area were first passed from the valve in shape of U, then through the roof of the left atrium which was opened outside the patch and the stripfelt, and the valve was placed. The aortotomy was then closed by continuing the suture of the dacron patch or by using another dacron patch, in accordance with the newly formed aortic root.

The difference between the targeted EOA (BSAX0,85 cm2 /m2) and the EOA measured during surgery was helpful in the root enlargement preference. The surgeon's preferencealso influenced the determination of the ARE procedure. NYHA functional capacities, CCT and CPBT values, complications, length of the intensive care unit and hospital stay of the cases were analyzed. Missing information in records of the cases was obtained by communicating with them.

Continuous variables were expressed as mean ± SD. Categorical variables were expressed as percentages. Mean values were compared by using independent-samples T-test or its non-parametric alternative, the Mann–Whitney U test for continuous variables and Pearson's Chi-squared test for categorical variables. Inter-procedure echocardiographic data(at thepostoperative 6th and 12th months)were analyzed with repeated measure ANOVA. According to EOAI, the correlation between postoperative events and echocardiographic data was analyzed by the Pearson correlation test. Linear regression was used to determine the level of relationship of the data detected in the continuous variables, and the logistic regression was used to determine the predictors of the nominal data (mortality and reoperation). Kaplan Meier (Mantel-Cox) test was used in the analysis of the effect of mortality and reoperation on survival. Statistically significant differences were established at $p<0.05$.All calculations were performed using a commercially available statistical package (SPSS 19.0; SPSS Inc., Chicago). Power analysis was calculated with G power 3*1.9.2. When the effect size was 0,50 and the alpha error was 0,05, power was 80%.

RESULTS

The mean age of the patients was 55.1 ± 11.4 (58 female; 67%). The mean preoperative EOAI value was 0.6 (0.58-0.72) cm^2/m^2 and the mean BSA value was 1.59 (1.4-1.70) m^2. The number of female cases was higher than that of males but the quantitative difference in terms of the gender was not significant between the procedures (p=0.351; Table-1).Preoperatively,55% of the cases undergone Manougian procedure and 59% of the cases undergone Nicks procedure were in the NYHA Class-III (Table-1). Postoperatively, 86% of the cases were observed in NYHA class-I and the change was significant (p = 0,01; Table-1).In the NYHA functional capacity class, an average decrease of 1.58 ± 0.7 was achieved after the procedure (Manougian = 1.60 ± 0.7; Nicks = 1.56 ± 0.7; Figure-2C; p = 0.818). There was no difference between procedures in terms of length of hospitalstay (p = 0.274; Table-1). In the Manougian procedure, the cross-clamp time was 3 minutes longer (p = 0.029; Table-1).

Early mortality (0-1 month) was not observed in Manougian procedure; for the other was 2.2%. Late mortality (1-12 months) was 2.5% for Manougian procedure and 2.2% for Nicks procedure. The difference in the type of the procedure was found to have no effect on mortality (p=0.641; Table-1). In both procedures, mortality was directly related to reoperation (p=0.011), thrombosis (p=0.001), paravalvular leak (p=0.001), but slightly correlated with infection (p=0.065) and septum thickness (p=0.164). Moreover, mortal cases were found to have two times longer length of hospital stay(r=0.524; p=0.001; Figure-3). The rate of predicting the mortality of these mortality-related parameters was 61% (Figure-3). There was no difference, in 1-year survivalanalysis, between the effects of the procedures on mortality and reoperation status (p=0.643; p=0.530; Figure 2A -2B).

Figure 1: Consort Diagram

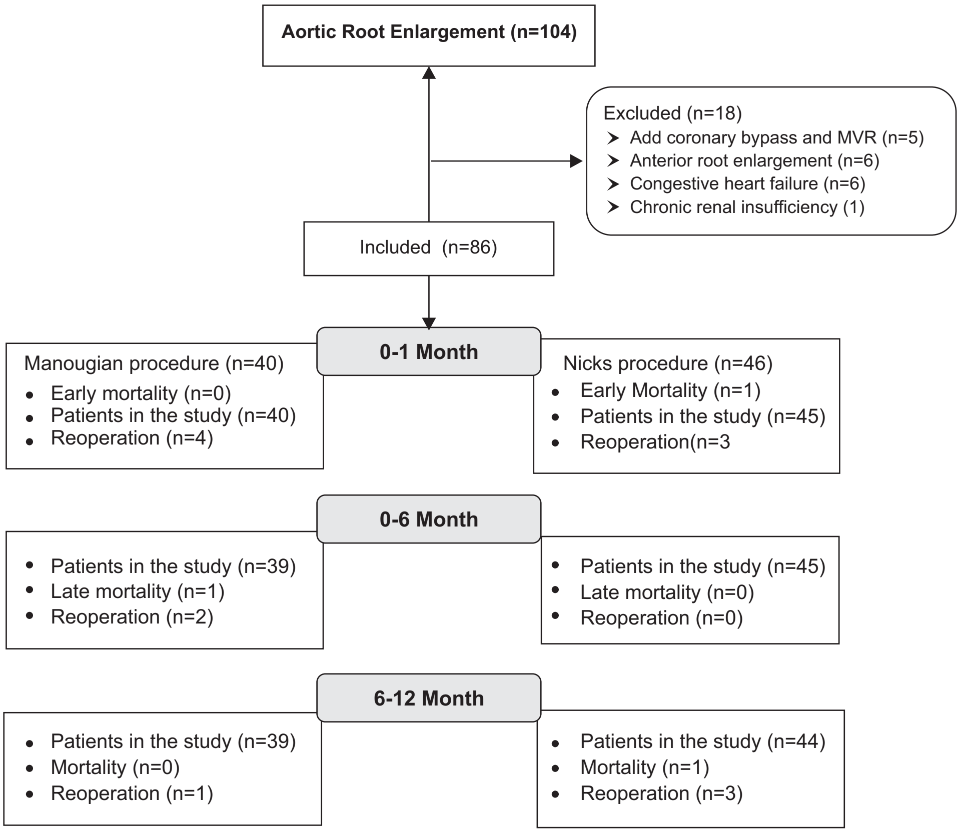


Figure 2: A)Surveys of Procedure Cases in one Year (Log Rank(Mentel-cox)=0,643) B) Analysis of Reoperations in one Year According to Procedures C) NYHA Functional Capacity Change and Statistical Analysis

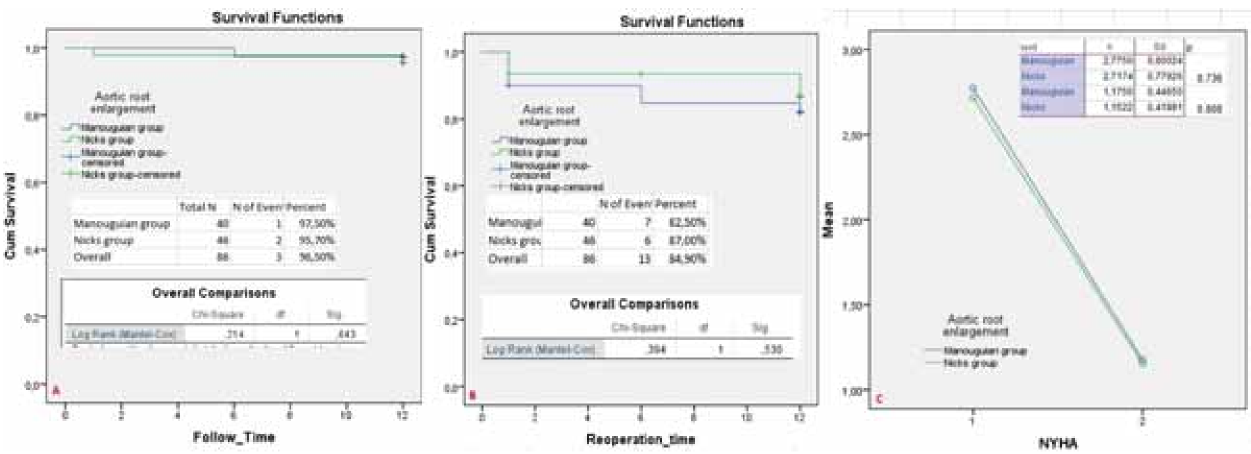
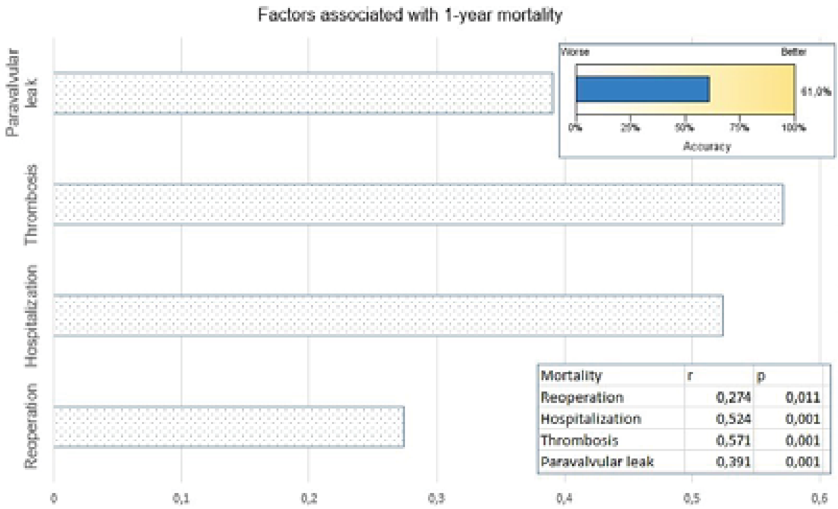


Figure 3: A Graphical View of the Relationship Rate and Direction of Parameters, which are Found to be Significantly Correlated with Mortality (r = Correlation Coefficient) Related data Explains the Mortality 61.0%. (Pearson Correlation Analysis)



Reoperations dueto bleeding, thrombosis, infection and paravalvular leak were seen at a rate of 15% in 1 year and no significant difference was found between the procedures (p = 0,565; Figure-4 and 5). These cases had longer lengths of the hospital stay(r = 0,227; p = 0,062) but no significant correlation was found. A significant positive correlation was observed between reoperation and bleeding (p = 0,001), infection (p = 0,001), mortality (0,011), and paravalvular leak (p = 0,001) (Figure-6). The rate of predicting the reoperations of the parameters with significant correlation was found to be 100% (Figure-6).

Figure 4: Echocardiographic Image of the Paravalvular Leakage of the Patient who Underwent Posterior Root Enlargement in the First Operation

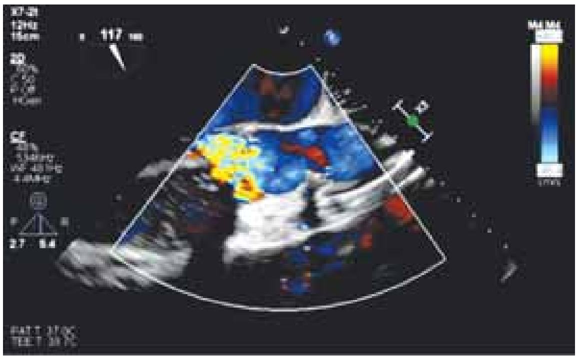


Figure 5: After Nicks procedure, between the valve and the noncoronary sinus, the view of paravalvular leak after resection of the valve.

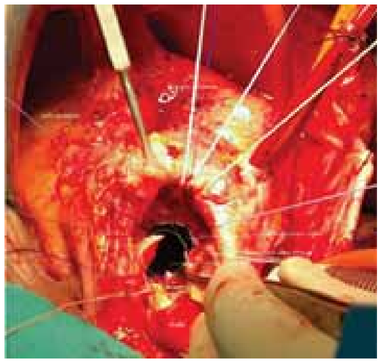
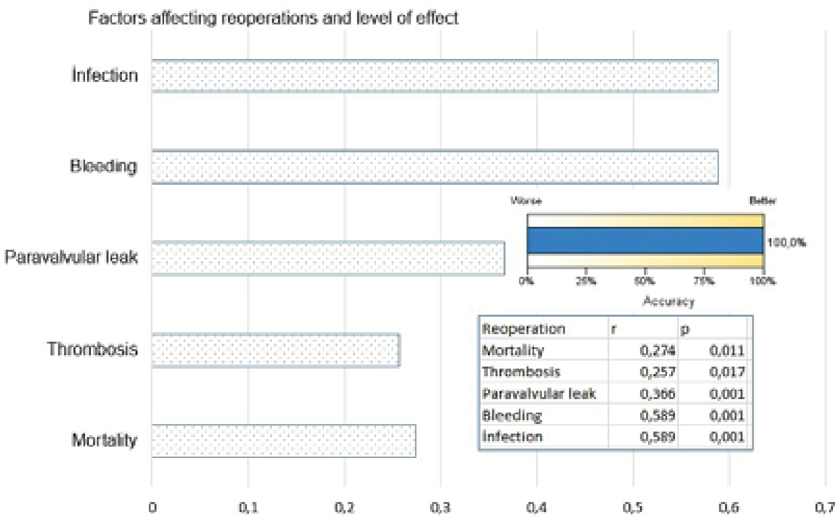


Figure 6: The Effect of Reoperation on Factors Affecting Reoperation. (r=Correlation Coefficient; Pearson Correlation Analysis)



When the factors associated with the change in EOAI at the postoperative 6th month were examined, the procedure followed (in Manougian's favor; p=0,001), presence of hypertension (p=0,019), and preoperative NYHA (p=0,033) class and FS (p=0,002), LVEF (p=0,001), septum thickness (p=0,004) and NYHA (p=0,022) class values at the postoperative 6th month andLVEF at the postoperative 12th month (p=0,035) were found to be related in the positive direction (Figure-7). In our series, in patients with higher EOAI, more improvement in ventricular function was achieved. The rate of predictingtheimprovement in EOAI of therelatedfactorswas 53,1%(Figure-7). In both procedures, improvement in left ventricular functions was significant until the postoperative 6th month. Improvement in ventricular functions in betweenpostoperative 6-12thmonths was also significant but less compared to thatseen in postoperative 1-6 months (Figure-8). There was 14,6% correlation in negativedirectionbetween early mortality and postoperative EOAI. However, it was not significant (p = 0,180). Considering all cases, changes in all echocardiographic parameters betweenpostoperative 6-12th months were found to be significant (p<0,05; Table-2; Figure-8). However, comparing the two procedures, while FS, LVEDD,andgradient-based changes were found to be significant in favor of the Manougian procedure (p <0,05; Table-2; Figure-8), the changes between two procedure in LVEF and ST were not significant (p>0,05; 2; Figure-8).

Figure-7: Graphical View of the Linear Correlated Parameters, Relation Rate and Direction with Effective Orifice Area Index. In the 6th Year, the Data of Significant Association Revealed 53.1% of EOAI. (Pearson Correlation Analysis)

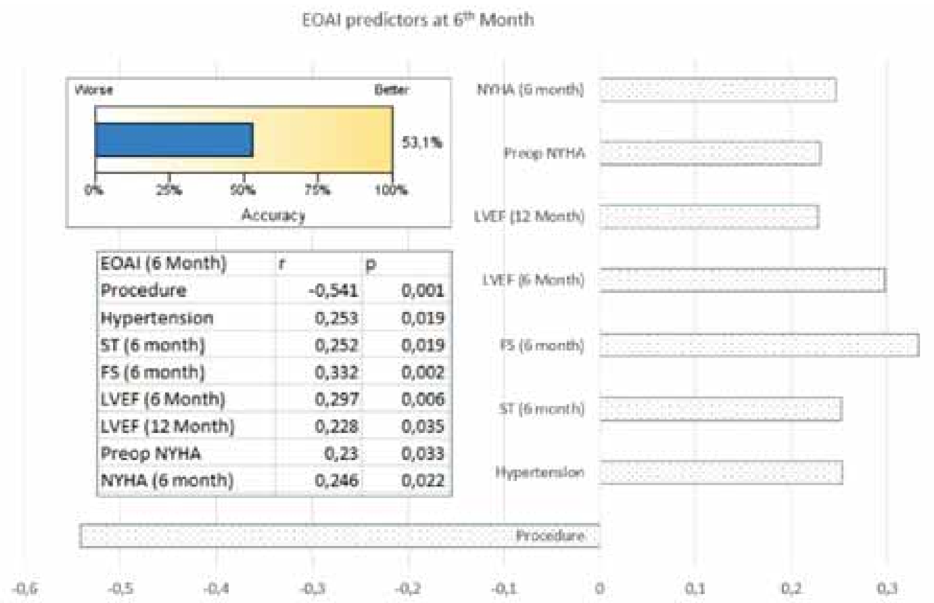
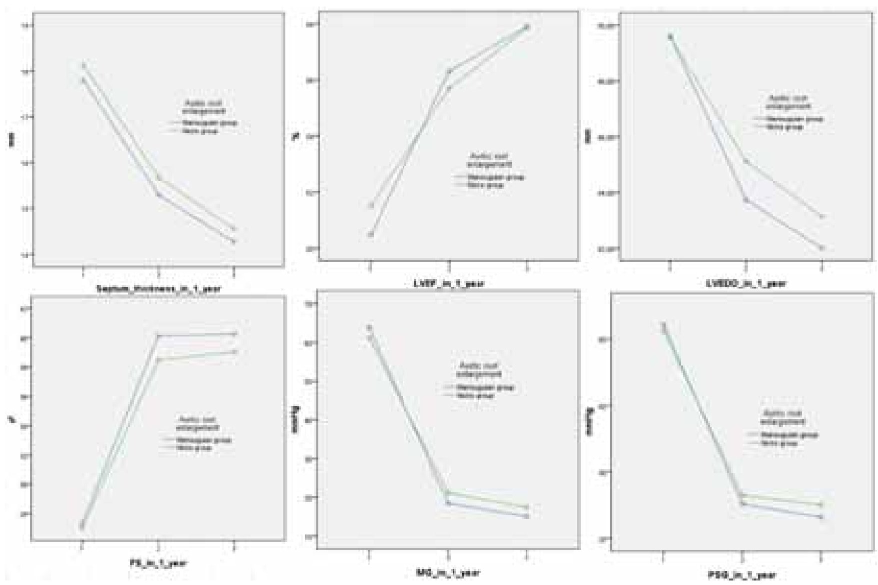


Figure-8: Graphical Analysis of the Change in Septum Thickness, Left Ventricular Ejection Fraction and End-Diastolic Diameter, Fractional Shortening, Mean and Peak Systolic Gradient in a One Year Period.



There was no difference between the stroke rates of the procedures (p=0.920). In our series,in two (5%) cases who undergoneManougian procedure, postoperative mitral regurgitation was detected at thepostoperative6th month (2nd-degreemitral insufficiency). Second-degree mitral regurgitation was detected to be evolved into 3rd degree MR in one case (2,5%) at the postoperative 12 th month and mitral annuloplasty was performed for this case 2 years later. In the other case, mitral insufficiency was regress edtotrivial mitral regurgitation. Mitral regurgitation in echocardiography was found to be caused by the dysfunction of the patch leading to anterior movement of the mitral anterior leaflet in the systole. First-degree mitral regurgitation detected preoper atively in 4 (9%) patients were found to be improved post operatively.

Table 1: Inter-Proceduredistribution of Preoperative, Operative and Postoperative Characteristics of Cases and their Statistic Alana lysis

		Aorticrootenlargement					Total	
		Manouguian		Nicks				
		n	%	n	%	p^a value	n	%
Gender	Female	29	73	29	63	0,351	58	67
	Male	11	27	17	37		28	33
Hypertension	(-)	31	78	35	76	0,877	66	77
	(+)	9	22	11	24		20	23
Cigaret	(-)	26	65	30	65	0,983	56	65
	(+)	14	35	16	35		30	35
COPD	(-)	28	70	37	80	0,261	65	76
	(+)	12	30	9	20		21	24
Diabetes mellitus	(-)	32	80	33	72	0,374	65	76
	(+)	8	20	13	28		21	24
Mortalite	(-)	39	98	44	96	0,641	83	97
	Early	0	0	1	2,2		1	1,2
	Late	1	2,5	1	2,2		2	2,3
Reoperation	(-)	33	83	40	87	0,565	73	84,9
	Bleeding	3	7,5	2	4,3		5	5,8
	?nfection	3	7,5	2	4,3		5	5,8
	Thrombosis	0	0	1	2,2		1	1,2
	p. leakage	1	2,5	1	2,2		2	2,3
Strok&TIA	(-)	39	98	45	98	0,920	84	98
	(+)	1	2	1	2		2	2
Preoperative NYHA	I	3	7	4	9	0,732	7	8
	II	9	23	10	22		19	22
	III	22	55	27	59		49	57
	IV	6	15	5	11		11	13
Postop 6th Month NYHA	I	34	85	40	87	0,809	74	86
	II	5	12	5	11		10	12
	III	1	3	1	2		2	2
	IV	40	0	0	0		0	0
		Mean	Sd	Mean	Sd	p^b Value	Mean	Sd
Age		55,1	10,4	55,0	12,3	0,969	55	11,4
Cross-clamp time		70,4	6,4	67,5	5,2	0,029	68,9	5,9
Total CPB duration		96,4	6,9	95,7	5,7	0,635	96	6,3
Body surfacearea		1,59	0,1	1,58	0,1	0,845	1,59	0,1
Hospitalization		8,6	2,7	8,1	1,3	0,274	8,3	2,1
ICU Stay		1,2	0,4	1,4	0,5	0,149	1,3	0,5

p^a=PearsonChi -Square -test and Fisher's Exact test, p^b=undependentsample t-test

Table 2: Statistical analysis of change in echocardiographicparametersaccordingtotheproceduresandmonths.

		Aortic Root Enlargement						
		Manouguian		Nicks		P^b Value	average	
		Mean	Sd	Mean	Sd		Mean	Sd
Effectiveorificeareaindex	Preoperative	0,58	0,04	0,61	0,03	0,007	0,60	0,0
	6th ay	1,28	0,07	1,17	0,007	0,001	1,22	0,1
P value		0,001		0,007			0,001	
LeftVentricular EjectionFraction	Preoperative	50,5	3,9	51,3	4,9	0,293	51,0	4,5
	6th Month	56,3	3,1	55,7	0,293	0,376	56,0	3,1
	12th Month	57,9	2,3	57,8	0,376	0,921	57,9	2,4
P^a value		0,001		0,001			0,001	
Fractional Shortening	Preoperative	27,3	3,0	27	3,2	0,655	27,1	3,1
	6th Month	40,1	2,7	38,5	0,655	0,002	39,2	2,5
	12th Month	40,2	3,0	39,0	0,002	0,069	39,6	3,1
P^a value		0,001		0,001			0,001	
LeftVentricular End -Diastolic Diameter	Preoperative	49,6	3,3	49,6	2,4	0,956	49,6	2,8
	6th Month	43,7	2,6	45,1	0,956	0,017	44,5	2,7
	12th Month	42,0	2,6	43,1	0,017	0,037	42,6	2,5
P^a value		0,001		0,001			0,001	
SeptumThickness	Preoperative	17,8	2,1	18,1	2,1	0,462	18,0	2,1
	6th Month	15,3	1,5	15,7	0,462	0,299	15,5	1,7
	12th Month	14,3	2	14,6	0,299	0,459	14,4	1,8
P^avalue		0,001		0,001			0,001	
MeanGradient	Preoperative	63,7	5,9	61,1	4,4	0,024	62,4	5,3
	6th Month	18,4	4,1	21,0	0,024	0,004	20,0	4,5
	12th Month	15,0	4,2	17,4	0,004	0,017	16,3	4,6
P^a value		0,001		0,001			0,001	
PeakSystolic Gradient	Preoperative	84,3	6,6	82,4	7,9	0,219	83,3	7,4
	6th Month	30,3	5,4	33,0	0,219	0,055	31,7	6,3
	12th Month	26,4	5,3	30,0	0,055	0,008	28,3	6,4
P^a value		0,001		0,001			0,001	

P^a =Repeatedmeasurmentanova test andPairedsample t_test wereused in the 6th and 12th monthcomparisons. P^b = Independentsample t -test

DISCUSSION

The most important clinical condition caused by narrow aortic annulus is increased mortality in the long-term after a decrease in left ventricular function. Therefore, if the effective orifice area calculated is smaller than the measured effective orifice area, the surgeon has several options. The first option is to install a non-conforming mechanical prosthesis, which may be an acceptable option for a weak and elderly patient. The second option is to use a wider valve (new generation mechanical prosthesis, stentless or suture less bioprosthesis, aortic homograft).[11,12] In cases where these are inadequate, anterior or posterior ARE procedures are performed. Even though it offers the largest ARE area, the Konno-Rastan procedure, which is performed from the anterior of the aortic root, is not routinely used because of the need for exploration of the right and left ventricles, such risks as damage to septal arteries and conduction system, the development of inter cameral fistula.[13] Our data suggest that operative procedures (Manougian and Nicks) do not increase the surgical mortality rate, significantly. Moreover, it shows that it corrects left ventricular functions in direct proportion with EOAI, especially in young individuals, and it can be safely applied when larger valve replacement is needed.

The relationship between undersized valve replacement and late mortality was demonstrated by Kitamura et al. who compared their cases undergone ARE with those undergone aortic valve replacement with 19 mm mechanical prosthesis (45 cases). They reported that, among the two groups, early mortality rates(3,6% and 5,9%) were similar but 10-year survival rate was 85,7% in the ARE group while it was 62,7% in the other.[14] On the other hand, there are articles reporting well toleration of the PPM even with an under sized mechanical prosthesis in societies with small BSA values like Asian societies.[15] Our findings also confirm that if effective EOAI is provided, left ventricular function improves and late mortality is reasonable.

In cases of AVR + ARE, at least three-fold and significant increase in perioperative morbidity and mortality have been reported as a result of increased CCT.[1,2] Similarly, Sommers et al (AVR n=530 cases) reportedthat 11-minute prolongation in CCT leads to a significant increase in reoperation and bleeding rates in cases (ARE n = 98).[16] In an AVR series of 712 patients 172 of which also undergone ARE, it was reported that 10 min. shortening in CCT, which is one of the advantages of suture less valves, did not affect the peri- and postoperative complication rates. Moreover, fewer patients had PPM and congestive heart failure after ARE.[17] Kendra et al also reported that there was no association between CCT and mortality and morbidity, but ARE increased the survival by reducing the incidence of PPM in the longterm. [18]

Mean cross-clamp time of our cases was only 14 min longer than the mean CCT of mechanical AVR cases of Çakıcı et al while was 8 min shorter than the mean CCT of stentless biological AVR cases of the same group.[19] Moreover, there was only 3 min CCT difference between the two procedures. It is understood that CCT duration does not affect the rates of early mortality (1,2%) and reoperation (5,8% bleeding) since our mortality rates are same as the standard AVR mortality rates (1-7%) in the literature.[20,14]

The effective orifice area refers to the functional area rather than the geometric valve area. Studies indicate that EOAI has a sensitivity of 73% and a specificity of 80% for showing moderate and severe PPM.[3] Since the cardiac output is proportional to body size, it is inevitable for the patient to have PPM if a prosthesis smallto the patient's body sizeis implanted. Tasca et al reported that 55% of patients with 21 mm bioprosthetic aorticvalve replacement and 90% of patients with 19 mm aorticvalve replacement had moderate or severe PPM. [21] The EOA values in prostheses with the same label size and geometric valve area may also vary depending on the model of the prosthesis.[22] On the other hand, prosthetic valves with the same EOA values are known to lead to different results depending on the size of the body in different individuals. In addition, reasons such as the continuation of the growth process, low estimation of EOAI, and the use of stentedbioprostheses may also cause PPM.[13] The relationship of the effective orifice area index with postoperative gradient and undesirable clinical results was also shown. In our cases, we used the EOAI parameter for measurement and evaluation. We found that in both procedures, postoperative EOAI values were significantly higher than the preoperative values and that greater EOAI increases were achieved in patients who underwent Manougian procedure compared but left ventricular functions and mortality were not significantly affected by the difference in procedure type. The relationship with left ventricular functions is shown in Figure-7.

Although posterior ARE methods had been reported to be reliable and effective methods in their early reports, there has been a general consensus, in the following years, among surgeonsthat these increase the risk of the operation. Therefore, large-EOA valves (stentless and suturelesshomo grafts, St Juderegent, etc.) have been more preferred. Beck mann et al reported that suture less valve replacement was superior to Nicks procedure in terms of early mortality, possibly due to the shortened CCT values.[9] The same study reported 5-year survival rate of 92% in the ARE group and 76% in the sutureless group. Although Beck mann et al have drawn attention to the older age of the sutureless AVR group, the EOAI value of 0,8 cm^2/m^2 in sutureless cases is consistent with mild PPM and this may have contributed to mortality.[9] In other studies, they reported that ARE had increased early mortality but this increase was not statistically significant.[20,14,23] Despite the high mortality rates reported in the initial reports, mortality was lower with increased experience (from 7.2% to 0-1%).[20,14,24] Early mortality was reported to be mostly due to low cardiac out put while the late mortality was due to cerebral embolism, sudden cardiac death, arrhythmias and congestive heart failure.[25] In the early period, bleeding, pericardial effusion, embolism, andmesenteric ischemia are the most common complications.[25] Our early mortality was due to ventricular fibrillation in 1 patient (1,7%). Late mortality was due to valve thrombosis and cerebral embolism (1-12 months) (Table-1). The fact that warfarin use and reoperation principles were not followed adequately were considered to be effective on late mortality.The difference between the two procedures was not significant (p=0,921). However, moresignificant results can be obtained in a larger series.

Kuhl et al. reported, based on the echocardiographic and clinical data, that the meanpreoperativeNYHA functional capacity class of 30 patients who underwent aortic valve replacementwas 2.9 ± 0.5 while it was 1.4 ± 0.5 postoperatively, and thedifferencewassignificant.26 When all of our cases were taken into consideration, it was observed that 57% of the patients were in NYHA Class III preoperatively, while 86% were in NYHA Class I postoperatively and the change(preoperative mean=2,7; postoperative mean=1,2) was significant (p = 0,001; Figure-2C; Table-1).

Mohty et al. divided the PPM cases into three groups as mild, moderate and severe to analyze the effects of age, obesity and left ventricular function on long-term survival[27]. Among the three groups, in patients with severe PPM, if the body mass index (BMI) was ≥ 30 kg/m^2 and age ≥ 70, the effect on survival was not significant, but in patients with age $\leq$ 70 and BMI ≤ 30 kg/m^2, there was a decrease in left ventricular function-independent late survival. In the subgroup analysis of PPM studies that did not involve ARE procedures, the prognosis was worse in under 70 years of age and in patients with preoperative left ventricular dysfunction.[23,27] In our series, since the number of cases with advanced age and large BSA was low and the effective orifice area provided with ARE was sufficient, the relationship between left ventricular function, mortality, and complications with age and obesity was not detected (p> 0,05).

There are also studies showing no increase in postoperative LVEF values as well as studies suggesting an increase in LVEF values by an average of 6-8% after aortic valve replacement for narrow annulus.[25] Rammos et al reportedinsignificant changes in LVEF despite a significant decrease in cardiac mass and 1,4 cm^2 average increase in EOA.[10] Studies reporting that LVEF hadn't changed reported that preoperative LVEF was determinative in the mortality [long life in normal LVEF, LVEF (<50%) survival reduced].[26] In our study, considering all cases, increase in LVEF, FS and EOAI values and decrease in LVEDD and septum thickness values were found to be significant (Table-2). In our series, the mean preoperative LVEF was over 50% but 5-7% average increase in LVEF was achieved postoperatively. We think that the differences in the studies are due to the difference in evaluating the effect of moderate PPM on mortality.

One of the most frequently reported complications of the Manougian procedure is mitral regurgitation (0-14%). In the literature, there are those who suggest that the incision should be terminated at the aortomitral junction to avoid mitral regurgitation as well as those suggesting that a 15-mm incision made in the mitral anterior leaflet will not cause functional problems in the valve.[18,28] However, there are reports of mitral insufficiency from mild to severe degrees after ARE operations.[29] Three reasons for the increase in the degree of mitral insufficiency are (I) the change in ventricular geometry, (II) the anterior motion of the mitral anterior leaflet due to the pull of the patch caused by anterior displacement of the ascending aorta during systole, and (III) the possibility of another asymptomatic disease. Insomer are studies, it has been reported that there a sons such as retraction, shrink age and aneurysmatic dilatation and hardening of the autogenous tissue cause mitral regurgitation.[30] However, in the long-term follow-up, Ghavidel et al. (103 cases) reported that they did not have an aneurysm and mitral regurgitation in cases in which they used pericardial patches.[25] The absence of mitral valve insufficiency in autologous patch series suggests that this condition is related to the use of the synthetic patch. In our series, preoperative mild mitral insufficiency was detected in 4 cases but the insufficiency was disappeared at the postoperative sixth month. In these cases, mitral regurgitation was thought to be the result of an increase in left ventricular systolic pressure and change in ventricular geometry. In our series, 2 patients who underwent Manougian procedure had 2nd-degree mitral regurgitation at postoperative 6th month. In one of these asymptomatic cases, at the post operative 12th month, 3rd-degree mitral regurgitation detected. In our case where we applied double patch technique with Dacron patch on the mitral anterior leaflet with 15-mm incision, we detected that the mitral insufficiency resulted from the anterior motion of the mitral anterior leaflet triggered by the patch.

LIMITATIONS

In our study, it was not possible to create a separate group with small valve replacement and similar EOAI and BSA values. If we wanted to create such a group in similar BSA values, we would not be able to reach sufficient number of cases. For this reason, we have evaluated the postoperative results of AVR cases done with under size dpros theses in the literature. Since our goal was not to evaluate patient-prosthesismismatch but was to determine the effect of posterior ARE methods on the change in ventricular functions, such a grouping was not performed.

We believe that the difference in each surgeon's personal decision in the selection of prosthetic valve size is effective on postoperative results but this does not weaken empirical observations.

If longer follow-up is achieved with larger series, we believe that between two ARE procedures, the effect on complications and mortality within 1-5 years will be more accurately determined.

CONCLUSION

The use of stentless and sutureless homografts as an alternative treatment for narrow aortic annulus, especially in young patients, is limited due to their early degeneration, uncertainty in long-term results and their high cost. If the patient's age, activity level, LVEF, risk factors are taken into consideration, and the most appropriate size valve replacement is envisaged after calculating the preoperative estimated EOAI, rather than an alternative prosthesis, ARE preference does not affect morbidity and mortality. Although both ARE methods had a positive effect on left ventricular function, the Manougian procedure was found to be more effective in 1 year because of the larger valve area and near-normal left ventricular functions observed besides similar morbidity and mortality rates. However, studies with longer follow-up periods are needed. In the few cases with mitral insufficiency, we believe that the problem will be circumvented with a suitable autogenous patch that does not cause pulling of the mitral anterior leaflet.

REFERENCES

1. Rahimtoola SH. The problem of valve prosthesis-patient mismatch. Circulation. 1978 Jul;58(1):20-4. PMID: 348341
2. Pibarot P, Dumesnil JG. Hemodynamic and clinical impact of prosthesis-patient mismatch in the aortic valve position and its prevention. J Am Coll Cardiol. 2000 Oct; 36(4): 1131-41 Doi: https://doi.org/10.1016/S0735-1097(00)00859-7
3. Blais C, Dumesnil JG, Baillot R et al. Impact of valve prosthesis-patient mismatch on short-term mortality after aortic valve replacement. Circulation 2003; 108:983-8Doi:10.1161/01.CIR.0000085167.67105.32
4. Coutinho GF, Correia PM, Paupério Get al. Aortic root enlargement does not increase the surgical risk and short-term patient outcome? Eur J Cardiothorac Surg. 2011;40(2):441-7. Doi: 10.1016/j.ejcts.2010.11.064
5. Beckmann E, Martens A, Alhadi Fet al. Aortic valve replacement with sutureless prosthesis: better than root enlargement to avoid patient-prosthesis mismatch? Interact Cardiovasc Thorac Surg. 2016 Jun; 22(6): 744–749. Doi: 10.1093/icvts/ivw041
6. Konno S, Imai Y, Iida Yet al.A new method for prosthetic valve replacement in congenital aortic stenosis associated with hypoplasia of the aortic valve ring. J Thorac Cardiovasc Surg. 1975 Nov;70(5):909-17. PMID: 127094
7. Nicks R, Cartmill T, Bernstein L. Hypoplasia of the aortic root. The problem of aortic valve replacement. Thorax. 1970 May;25(3):339-46 Doi: http://dx.doi.org/10.1136/thx.25.3.339
8. Manougian S, Seybold-Epting W. Patch enlargement of the aortic valve ring by extending the aortic incision into the anterior mitral leaflet. New operative technique. J Thorac Cardiovasc Surg 1979; 78: 402–12. PMID: 470420
9. Losenno KL, Gelinas JJ, Johnson Met al. Defining the efficacy of aortic root enlargement procedures: a comparative analysis of surgical techniques. Can J Cardiol. 2013 Apr;29(4):434-40. Doi: 10.1016/j.cjca.2012.04.012

10. Rammos SK, Ketikoglou DG, Koullias GJet al.T The Nicks-Nunez posterior enlargement in the small aortic annulus: immediate-intermediate results. Interact Cardiovasc Thorac Surg. 2006 Dec;5(6):749-53 Doi:10.1510/icvts.2006.136457

11. Fischlein T, Meuris B, Hakim-Meibodi Ket al. The sutureless aortic valve at 1 year: A large multicenter cohort study. J Thorac Cardiovasc Surg. 2016 Jun;151(6):1617-1626. Doi: 10.1016/j.jtcvs.2015.12.064

12. Shrestha M, Maeding I, Höffler Ket al. Aortic valve replacement in geriatric patients with small aortic roots: are sutureless valves the future? Interact Cardiovasc Thorac Surg. 2013 Nov;17(5):778-82 Doi: 10.1093/icvts/ivt291

13. Yeşilay AB, Kaya Z, Demirbağ R. Current approach for the prosthesis-patientmismatch. Arch Turk Soc Cardiol 2013;41(4):354-363.Doi:10.5543/tkda.2013.35219

14. Kitamura M, Satoh M, Hachida Met al. Aortic valve replacement in small aortic annulus with or without annular enlargement. J Heart Valve Dis 1996; 5(3): 289 –93. PMID: 8953456

15. Tsutsumi K, Nagumo M, Nishikawa K, et al. Effect of prosthesis-patient mismatch on survival after aortic valve replacement using mechanical prostheses in patients with aortic stenosis Gen Thorac Cardiovasc Surg. 2008 Dec;56(12):577-83. doi: 10.1007/s11748-008-0317-9.

16. Sommers KE, David TE. Aortic valve replacement with patch enlargement of the aortic annulus. Ann Thorac Surg. 1997 Jun;63(6):1608-12. Doi: https://doi.org/10.1016/S0003-4975(97)00127-6

17. Kulik A, Al-Saigh M, Chan Vet al.Enlargement of the Small Aortic Root During Aortic Valve Replacement: Is There a Benefit? Ann Thorac Surg. 2008 Jan; 85(1): 94-100. Doi: 10.1016/j.athoracsur.2007.07.058

18. Kendra JG, Aortic Root Enlargement During Aortic Valve Replacement: Nicks and Manouguian Techniques. Operative Techniques in Thoracic and Cardiovascular Surgery 2016;20:206-218 Doi: https://doi.org/10.1053/j.optechstcvs.2016.02.004

19. Çakıcı M, Durdu S, Uçanok Ket al. Changes in leftventricularfunctionandgeometryafteraorticvalvereplacement in patientswith severe aorticstenosisTurcishJ Thorac CardiovascSurg 2013;21(2):284-293 Doi: 10.5606/tgkdc.dergisi.2013.6999

20. Manougian S, Seybold-Epting W. Patch enlargement of the aortic valve ring by extending the aortic incision into the anterior mitral leaflet. New operative technique. J Thorac Cardiovasc Surg 1979; 78: 402–12. PMID: 470420

21. Tasca G, Brunelli F, Cirillo Met al. Impact of valve prosthesis-patient mismatch on left ventricular mass regression following aortic valve replacement. Ann Thorac Surg. 2005 Feb; 79(2):505-10. Doi: 10.1016/j.athoracsur.2004.04.042

22. Pibarot P, Dumesnil JG. Valve prosthesis-patient mismatch, 1978 to 2011: from original concept to compelling evidence. J Am Coll Cardiol. 2012 Sep 25;60(13):1136-9. Doi: 10.1016/j.jacc.2012.07.005.

23. Coutinho GF, Correia PM, Paupério Get al. Aortic root enlargement does not increase the surgical risk and short-term patient outcome? Eur J Cardiothorac Surg 2011;40(2): 441-447. Doi: 10.1016/j.ejcts.2010.11.064

24. Krayenbuehl HP, Hess OM, Monrad ESet al. Left ventricular myocardial structure in aortic valve disease before, intermediate, and late after aortic valve replacement. Circulation 1989;79: 744-55. PMID: 2522356

25. Ghavidel AA, Omrani G, Chitsazan Met al. Long-term results of aortic valve replacement with posterior root enlargement Asian Cardiovasc Thorac Ann.2014;22(9) 1059–1065. Doi: 10.1177/0218492314528923

26. Kuhl HP, Franke A, Puschmann Det al. Regression of left ventricular mass one year after aortic valve replacement for pure severe aortic stenosis. Am J Cardiol. 2002 Feb 15;89(4):408-13. Doi: https://doi.org/10.1016/S0002-9149(01)02262-7

27. Mohty D, Dumesnil JG, Echahidi Net al. Impact of prosthesis-patient mismatch on long-term survival after aortic valve replacement: influence of age, obesity, and left ventricular dysfunction. J Am Coll Cardiol. 2009;53(1):39-47. Doi: 10.1016/j.jacc.2008.09.022

28. Eghtesady P, Hanley F Posterior Aortic Annular Enlargement for Mechanical Aortic Valve Replacement Operative Techniques in Thoracic and Cardiovascular Surgery 2002;7(4):181-187Doi: https://doi.org/10.1053/otct.2003.36319

29. Imanaka K, Takamoto S, Furuse A. Mitral regurgitation late after Manouguian's annulus enlargement and aortic valve replacement. J Thorac Cardiovasc Surg. 1998;115(3):727-9. Doi: 10.1016/S0022-5223(98)70342-3

30. Mayumi H, Toshima Y, Kawachi Yet al. Simplified Manouguian's aortic annular enlargement for aortic valve replacement Ann Thorac Surg 1995; 60(3):701–704.Doi: 10.1016/0003-4975(95)00335-I