

Aortic Annulus Enlargement: Early and Long-Terms Results

Selman Dumani^{1*}, Ermal Likaj¹, Laureta Dibra¹, Vera Beca², Saimir Kuci¹, Ali Refatllari¹

¹University Hospital Centre "Mother Theresa", Service of Cardiac Surgery, Tirana, Albania; ²Obstetric Gynaecologic Hospital "Queen Geraldine", Tirana, Albania

Abstract

Citation: Dumani S, Likaj E, Dibra L, Beca V, Kuci S, Refatllari A. Aortic Annulus Enlargement: Early and Long-Terms Results. Open Access Maced J Med Sci. <https://doi.org/10.3889/oamjms.2017.006>

Keywords: Aortic valve; heart valve prosthesis; aortic valve replacement; aortic annulus enlargement; patient prosthesis mismatch.

***Correspondence:** Selman Dumani MD, PhD, UHC "Mother Theresa", Service of Cardiac Surgery, Dibra Street 372, Tirana, Albania. E-mail: selmandumani@yahoo.co.uk

Received: 07-Dec-2016; **Revised:** 24-Dec-2016; **Accepted:** 11-Jan-2017; **Online first:** 31-Jan-2017

Copyright: © 2017 Selman Dumani, Ermal Likaj, Laureta Dibra, Vera Beca, Saimir Kuci, Ali Refatllari. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0).

Funding: This research did not receive any financial support.

Competing Interests: The authors have declared that no competing interests exist.

AIM: Patient-prosthesis mismatch (PPM) is a common occurrence in aortic valve surgery. Even the discussions about the impact of this phenomenon on the results of aortic valve surgery, the management of this problem remain one of the main topics in this kind of surgery. One of the ways of a solution is aortic annulus enlargement. The main topic of this study is to evaluate the early and longterm results of this technique in our country.

METHODS: During the period January 2010 –January 2015, 641 patients performed aortic valve surgery. In ten patients we performed aortic annulus enlargement according to Manouguian technique to avoid severe patient-prosthesis mismatch. Operative mortality and perioperative complications (low cardiac output, pulmonary complications, etc..) were considered the indicators of the early results. Survival, clinical presentation according to NYHA, quality of life were the indicators to evaluate long-term results. Preoperative and postoperative echocardiographic data were also used to evaluate our results. We collected the data from hospital registrations and periodical clinical visit and echographic examination after hospital discharge.

RESULTS: In our group, 6 of 10 patients were diagnosed with stenotic aortic valve, two patients had aortic valve regurgitation and two mixed valve pathology. Four patients had concomitant cardiac surgery procedure, mitral or CABG. In all cases, aortic valve pathology was the primary diagnose. In the preoperative echocardiographic examination mean transvalvular gradient was 54.3 ± 6.42 . We had no death during early or late postoperative period. Only one patient had pulmonary complications and long time of respiratory assistance because of his pulmonary pathology. The same patient had low cardiac output and wound infection. Early after surgery mean transprosthetic gradient was 16.2 ± 3.44 and late postoperative was 15.9 ± 4.3 . No patient had the severe patient-prosthesis mismatch. Mean follow-up was 49 ± 20.26 months. During follow-up, we had no death, and all patients had very good quality of life.

CONCLUSIONS: Aortic valve annulus enlargement can be used with very good early and late results with the final goal to increase the potential benefit of the patient from surgery of aortic valve.

Introduction

Prosthesis - patient mismatch is the common occurrence in aortic valve surgery. Despite the discussions about the impact of this phenomenon on the results of aortic valve surgery, the management of this issue remains one of the major objectives of this type of surgery. One way of solutions for this phenomenon is the use of aortic annulus enlargement technique.

Objectives of this work are to present the early and late results of this technique in our experience.

Patients and Methods

During the period January 2010 - January 2015, 641 patients performed aortic valve surgery isolated or combined with other surgical procedures. We realised aortic annulus enlargement in 10 patients according to Manouguian technique [1] to avoid the occurrence of patient- prosthesis mismatch. The mean age of the group was 49 ± 17.7 . There were three males and seven females in all cases; the primary pathology was aortic valve disease. Indications for operation are made according to the European or American associations of Cardiology guidelines [2, 3]. The main diagnostic tool examination

was echocardiography. Six patients were with aortic valve stenosis, two with aortic valve regurgitation and two others with mixed pathology.

Table 1: General data

General Data	
Nr Patients	10
Mean Age	49 ± 17.7
Gender	3M/7F
BSA	1.69 ± 0.14
Pathology	AVS 6 Pt
	AVR 2 Pt
	Mixed 2 Pt
CABG	3 Pt
Mitral	1 Pt
Esc Stand	4.7 ± 1.36
Esc Log	4.35 ± 1.35

The aortic annulus size ranged from 18-23 mm with an average of 20.1 ± average 1.42. The thickness of left ventricle septum and posterior wall were respectively 13.1 ± 0.9 and 12.2 ± 1.24 mm. Body surface of patients ranged from 1.5-2m² (mean 1.69 ± 12.14), hospital mortality and perioperative complications (low cardiac debit, pulmonary complications, renal complications, reexploration for bleeding, ventricular arrhythmias, conductions disturbances, wound infections) are considered indicators of early results evaluation.

Table 2: Echocardiographic data

Echocardiographic Data	
EF%	63.3 ± 3.53
Annulus	20.1 ± 1.42
ThPW	12.2 ± 1.24
ThS	13.1 ± 0.9
EDD	52.7 ± 5.7
ESD	30.8 ± 3.2
Mean Grad	54.3 ± 6.4

EF-ejection fraction, ThPW-thickness posterior wall, Ths-the knees septum, EDD-end diastolic diameter, ESD-end systolic diameter, Grd-gradient. BSA-body surface area, Esc stand -Log-euro store standard and logistic.

The mean follow-up time was 49 ± 20.26 months. Survival, clinical condition according to NYHA class and quality of life were indicators of long-term results evaluation. Follow-up was complete. The data were collected from hospital records and periodic clinical and laboratory examinations after hospital discharge. The data are presented in average value and standard deviation (Table 1 and Table 2).

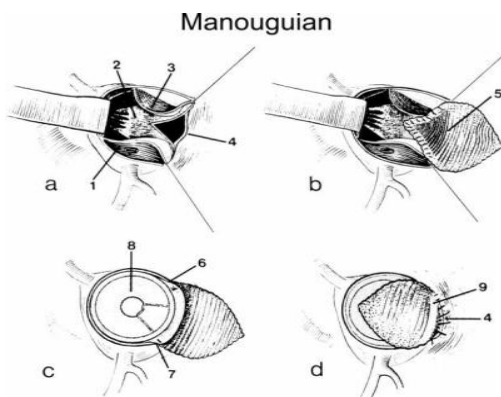
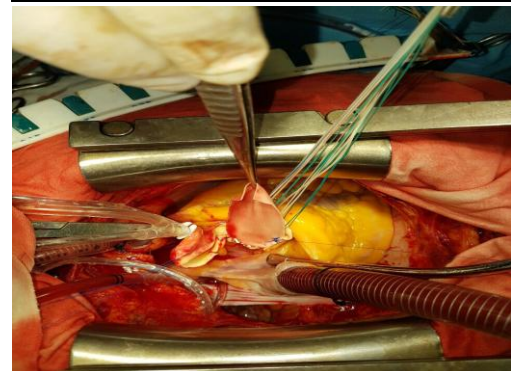
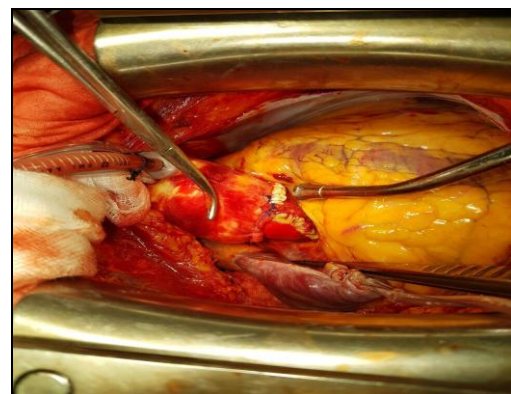
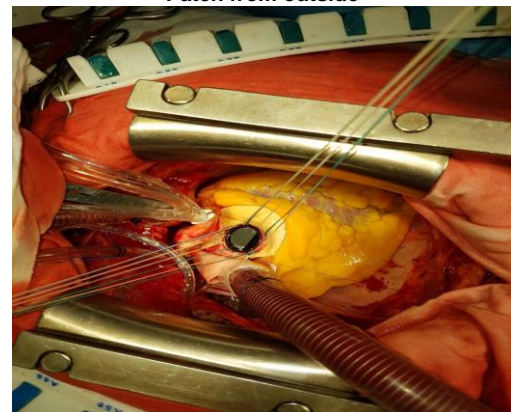


Figure 1: Schematic figure of Manouguian technique

Interventions were performed through the median sternotomy with standard cardiopulmonary bypass and systemic hypothermia to 32°C. An oblique osteotomy was performed, and myocardial protection was provided by intermittent antegrade crystalloid (first dose), and cold blood cardioplegia delivered directly into the coronary ostium. After excision of the native aortic valve and meticulous decalcification, the aortic annulus was sized. The decision to enlarge the aortic was taken when the 19-mm sizer could not be implanted and according to the body surface area of the patient and the type of prosthesis available. Aortic Annulus enlargement was done using the Manouguian technique. Aortotomy was extended through annulus into the fibrous trigone between the noncoronary cusp and the left coronary cusp to the subaortic curtain and anterior mitral valve leaflet. This defect was closed using a synthetic Teflon patch.



Patch from outside



Patch from inside

Figure 2: Photos during intervention

Results

We had no hospital death in our series. One patient had post-operative pulmonary complications because of his pulmonary preoperative illness. The same patient had low cardiac output and wound infection. All these complications were treated with intensive therapy.

Operative and postoperative data are presented in Table 3. Average prosthesis number used was 20.8 ± 1.75 and ranged from 19-25. The types of the prosthesis implanted were SJM: one SJM Regent, one biological prosthesis SJM Epic Supra and others SJM Standard. The average trans-prosthetic gradient was 16.2 ± 3.44 and ranged from 12-25 mmHg. Indexed effective prosthesis surface mean value was $0.86 \pm 0.14 \text{ cm}^2/\text{m}^2$. Based on the reference values of effective orifice area we used, no patient come out with severe MPP.

We see that there were long intervention times. This fact can be explained considering that four patients (40 % of the group) have undergone simultaneous surgical procedures (three cases CABG and one case mitral valve repair). Long respiratory assistance and intensive therapy stay time-related to the situation in which one patient (10 % of the group) is treated for a long time in intensive care unit.

Table 3: Operative and postoperative data

Operative and postoperative data	
CPBt	150.3± 19.7
XCt	118.2 ± 15.6
Prot Nr	20.8 ± 1.75
Resp As time	25 ± 21.4
ICU time	102.3 ± 94.7
Hosp time	13.3 ± 7.08
Prot Grad	16.2 ± 3.44
EOAi	0.86 ± 0.14

CPBt = cardiopulmonary bypass time, XCt = cross-clamp time, Prot nr = prosthesis number, Resp As time = respiratory assistance time, ICU = intensive care unit, hosp = hospital, Prot grad = prosthesis gradient, EOAI = effective orifice area indexed.

All patients survived during a follow-up period. They were in NYHA 1 clinical status four patients and asymptomatic the other part. The quality of life was very good. One patient had gastrointestinal bleeding from anticoagulation two years after the intervention.

Discussion

Patient-prosthesis mismatch is a common phenomenon in the aortic valve surgery. This problem that has been presented by Rahimtola since 1978 [4] is present also in our series of patients who has performed aortic valve surgery. The incidence resulted from 10.3 % and 67.8 % respectively for severe PPM and moderate PPM [5]. To achieve the

maximum of patient benefit from the replacement of the aortic valve, to avoid the phenomenon of patient - prosthesis mismatch, we have followed the strategy of aortic valve annulus enlargement according to Manouguian [1]. The technique is an additional surgical procedure in standard aortic valve, therefore, increases the complexity of the surgery. This is the reason why the discussion about the impact of this procedure in the early and late results of aortic valve surgery is still opened.

Annulus aortic valve enlargement is a safe procedure. In a study where 172 patients have performed aortic annulus enlargement Kulik et al. report mortality 7% while in 540 patients who realised standard aortic valve replacement mortality resulted from 6.5%. Major post-operative complications were no differences between groups with or without annulus enlargement. The PPM incidence and trans-prosthetic gradients were significant lower in the group with AAE ($p < 0.01$, $p < 0.0001$) [6]. Hospital mortality in groups of patients who realised aortic valve replacement with annulus enlargement varies 0.9-7%. Perioperative morbidity has no significant differences compared with standard valve replacement surgery. These results are presented in some separated studies. All studies refer that the occurrence of PPM is always minimised [6-9].

We see that the early results of aortic valve surgery results referred are not influenced by the additional annulus enlargement. This procedure is related strongly to the benefit of diminution of patient – prosthesis mismatch incidence and lower trans-prosthetic gradients. In our group of patients, we had no hospital deaths. The times of intervention, intensive therapy stay and respiratory assistance resulted longer in comparison with a series of our patients with isolated standard aortic valve surgery [5]. These results can be explained by considering the small group of patients (10 patients) among which four patients (40%) have performed simultaneous procedures and one patient who had a preoperative pulmonary disease for which was treated for a long time in intensive therapy unit. No patient was in severe PPM postoperatively.

There are authors by analysing their results refer that small aortic valve prosthesis is not an independent risk factor for the early results and find aortic annulus enlargement among strong predictors of hospital mortality. Aortic annulus enlargement should be used carefully [10].

Urso et al. in a review made regarding the impact of PPM in the early and intermediate the results aortic valve surgery conclude that severe PPM is an independent risk factor for early and intermediate outcomes. This phenomenon should be avoided. Moderate PPM has the impact on patients with severe impairment function of a left ventricle. PPM should be managed because has direct negative impact on early results of aortic valve surgery [11].

Kitamura et al. studied the impact of AAE on long-term results. Ten years survival was 85.7 % in the group that have performed AAE and 62.7 % in the group with small prosthetic but have not realised at the same time AAE. The independence from events related to the prosthesis referred respectively 81% and 58.8%. The difference of survival is not statistically significant, but the difference in absolute value is clear while for events related to the prosthesis is the very important difference [9].

In the contingent of patients named LGAS (low gradient aortic stenosis), PPM should avoid. PPM affects importantly adversely long-term results. In this special group of patients, PPM is related strongly to lower survival and independence from heart failure [12].

In this context in a study where were involved 805 patients and from them 548 patients had VM low function with (EF < 50%) Kulik et al refer that the patients with low EF and with PPM survival and independence from clinical death from heart failure is importantly lower in the long term in comparison with patients without PPM ($p = 0.03$, $p = 0.009$) [13].

The last two works take as point reference moderate PPM ($SEPi \leq 0.85 \text{ cm}^2/\text{m}^2$). To avoid the negative consequences of MPP in aortic valve surgery results we should include the avoidance strategy of this phenomenon at the time of surgical procedure.

There are studies that denied negative effects of PPM in the early or late results of aortic valve surgery [14, 15], but in a meta-analyses where are selected 34 works and involved 27,186 patients to give response to the question of how long-term results are influenced by PPM realizing AVR was concluded that PPM is associated with increased cardiac or other reasons mortality in long term. The efforts to prevent PPM should be highlighted and disseminated to improve the results of aortic valve surgery [16].

In conclusion, aortic valve annulus enlargement can be used with very good early and late results with the final goal to increase the potential benefit of the patient from surgery of aortic valve.

References

- Manouguian S, Seybold-Epting W. Patch enlargement of the aortic valve ring by extending the aortic incision to the anterior mitral leaflet. *J Thorac Cardiovasc Surg.* 1979;78:402–12. PMID:470420
- Bonow RO, Carabello BA, Chatterjee K, De Leon AC Jr, Faxon DP, et al. 2008 Focused Update Incorporated Into the ACC/AHA 2006 Guidelines 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 (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease) Endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *J Am Coll Cardiol.* 2008;52:e1–e142. <https://doi.org/10.1016/j.jacc.2008.05.007> PMID:18848134
- Vahanian A, Baumgartner H, Bax J, Butchart E, Dion R, et al. Guidelines on the management of valvular heart disease: The Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology. *European Heart Journal.* 2007;28:230–268. PMID:17259184
- Rahimtoola SH. The Problem of Valve Prosthesis-Patient Mismatch. *Circulation.* 1978;58:20-24. <https://doi.org/10.1161/01.CIR.58.1.20>
- Dumani S, Likaj E, Kacani A, Dibra L, Petrela E, Beca V, Refatllari A. Incidence and Impact of Patient-Prosthesis Mismatch in Isolated Aortic Valve Surgery. *Open Access Maced J Med Sci.* 2015; 3(4):624-629. <https://doi.org/10.3889/oamjms.2015.108> PMID:27275298 PMID:PMC4877898
- Kulik A, Al-Saigh M, Chan V, Masters RG, Bédard P, Lam BK, Rubens FD, Hendry PJ, Mesana TG, Ruel M. Enlargement of the Small Aortic Root During Aortic Valve Replacement: Is There a Benefit? *Ann Thorac Surg.* 2008;85:94–101. <https://doi.org/10.1016/j.athoracsur.2007.07.058> PMID:18154789
- Castro LJ, Arcidi MJ, Fisher AL, Gaudiani VA. Routine enlargement of the small aortic root: a preventive strategy to minimize mismatch. *Ann Thorac Surg.* 2002;74:31–6. [https://doi.org/10.1016/S0003-4975\(02\)03680-9](https://doi.org/10.1016/S0003-4975(02)03680-9)
- Coutinho GF, Correia PM, Paupério G, De Oliveira F, Antunes MJ. Aortic root enlargement does not increase the surgical risk and short-term patient outcome? *European Journal of Cardio-thoracic Surgery.* 2011;40:441–447. <https://doi.org/10.1016/j.ejcts.2010.11.064>
- Kitamura M, Satoh M, Hachida M, Endo M, Hashimoto A, Koyanagi H. Aortic valve replacement in small aortic annulus with or without annular enlargement. *J Heart Valve Dis.* 1996;5(Suppl 3):289–93.
- LaPar DJ, Ailawadi G, Bhamidipati CM, Stukenborg G, Crosby IK, Kern JA, Kron IL. Small Prosthesis Size in Aortic Valve Replacement Does Not Affect Mortality. *Ann Thorac Surg.* 2011;92:880-888. <https://doi.org/10.1016/j.athoracsur.2011.04.105> PMID:21871273 PMID:PMC3260881
- Urso Sa Sadaba R, Aldamiz-Echevarria G. Is patient-prosthesis mismatch an independent risk factor for early and mid-term overall mortality in adult patients undergoing aortic valve replacement? *Interactive Cardio Vascular and Thoracic Surgery.* 2009;9:510–519. <https://doi.org/10.1510/icvts.2009.207597> PMID:19497953
- Kulik A, Burwash IG, Kapila V, Mesana TG, Ruel M. Long-term outcomes after valve replacement for low-gradient aortic stenosis: impact of prosthesis-patient mismatch. *Circulation.* 2006 Jul 4;114(1 Suppl):I553-8. <https://doi.org/10.1161/circulationaha.105.001180>
- Ruel M, Al-Faleh H, Kulik A, Chan KL, Mesana TG, Burwash IG. 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. *J Thorac Cardiovasc Surg.* 2006;131:1036-44. <https://doi.org/10.1016/j.jtcvs.2005.10.028> PMID:16678587
- Eric Jamieson WR, Ye J, Higgins J, Cheung A, Fradet GJ, Skarsgard P, Germann E, Chan F, Lichtenstein S. Effect of Prosthesis-Patient Mismatch on Long-Term Survival With Aortic Valve Replacement: Assessment to 15 Years. *Ann Thorac Surg.* 2010;89:51–9. <https://doi.org/10.1016/j.athoracsur.2009.08.070> PMID:20103205
- Howell NJ, Keogh BE, Ray D, Bonser RS, Graham TR, Mascaro J, Rooney SJ, Wilson IC, Pagano D. Patient-Prosthesis Mismatch in Patients With Aortic Stenosis Undergoing Isolated Aortic Valve Replacement Does Not Affect Survival. *Ann Thorac Surg.* 2010;89:60–4. <https://doi.org/10.1016/j.athoracsur.2009.07.037> PMID:20103206
- Head SJ, Mokhles MM, Osnabrugge RL, Pibarot P, Mack MJ, Takkenberg JJ, Bogers AJ, Kappetein AP. The impact of prosthesis-patient mismatch on long-term survival after aortic valve replacement: a systematic review and meta-analysis of 34 observational studies comprising 27 186 patients with 133 141 patient-years. *European heart journal.* 2012;33(12):1518-29. <https://doi.org/10.1093/eurheartj/ehs003> PMID:22408037