Senbeta Guteta, Dejuma Yadeta, Aklilu Azazh, Dufera Mekonnen. *Ethiop Med J, 2016, Vol. 54, No.* 2

ORIGINAL ARTICLE

CARDIAC SURGERY FOR VALVULAR HEART DISEASE AT A REFERRAL HOSPITAL IN ETHIOPIA: A REVIEW OF CASES OPERATED IN THE LAST 30 YEARS

Senbeta Guteta, MD[1*], Dejuma Yadeta, MD[1], Aklilu Azazh, MD[1], Dufera Mekonnen, MD[1]

ABSTRACT

Background*: Valvular heart disease has been a significant cause of heart disease worldwide. In Ethiopia, it particularly affects young individuals and constitutes the major cause of cardiovascular disease. Factors associated with choice of treatment for advanced valvular heart disease are variable. The objective of this study is to review surgery done for Ethiopian patients with valvular heart disease.*

Methods*: We analyzed data on patients who had valve surgery and follow-up at the Tikur Anbessa Specialized Hospital cardiology unit. We collected data on sociodemographic characteristics, the pre-operative status of effected valves and co-morbidities, and assessed their associations with patient management options.*

Results*: A total of 157 valve surgeries were done from 1983 to 2013. Mean age at time of surgery was 26.7 years and females constituted 66% of the cases. Patients with rheumatic heart disease were younger, more likely to be female and have atrial fibrillation, but less likely to have impaired left ventricular systolic function when compared to patients with non-rheumatic heart disease. More than 75% of the surgical procedures done were mechanical valve replacement. Mechanical valves, compared with bioprosthetic valves, were more likely to be used in patients with rheumatic heart disease. The median age of those receiving mechanical valves, 24 (IQR 22 – 28) years, was lower than those receiving bioprosthetic valves, 31.5 (IQR 29.9 – 37.9) years. Mechanical valve replacement was significantly higher in those under the age of 20 years (Adjusted Odds Ratio 41.0, 95% CI: 3.0-557.2) and in those between 20 and 29 years of age (Adjusted Odds Ratio 14.3, 95% CI: 2.3-88.6).*

Conclusions*: Valve surgery for valvular heart diseases has been more common performed for young and female patients. A great majority of the replacements done have been with mechanical valves. As many of the patients have been younger and female, the choice of valve surgery and the need for anticoagulation impacts subsequent management of rheumatic heart disease and associated morbidities, lifestyle plans and pregnancy.*

Keywords*: Rheumatic heart disease, valve surgery, valve choice, Ethiopia*

INTRODUCTION

Valvular heart disease (VHD), affecting close to 20 million people, is a condition of global health importance. About 80% of those patients with VHD are residents in low and middle-income countries (1,2). Unlike in high income countries (3), it remains an important cause of preventable heart disease in Sub-Saharan countries, including Ethiopia. This could be explained by a combination of educational, economic and environmental disadvantages and reduced access to health care (4).

In 2014, a study on the spectrum of cardiovascular diseases at the largest referral hospital in Ethiopia, Guteta et al. reported that rheumatic heart disease (RHD) accounted for 62% of overall cardiovascular disease (5). In a screening study among school children aged 13–15 years, Oli et al. reported a prevalence of RHD of 6.4 per 1000 (6). The most common valves affected by RHD and non-RHD are the mitral and aortic valves, while less commonly the tricuspid and rarely the pulmonary valves are affected. Rheumatic valve disease most commonly leads to regurgitation (7,8) and less commonly to valve stenosis or mixed regurgitation and stenosis (9). Although the majority of cases with rheumatic valve disease are only mildly affected initially (1), most of them ultimately progress to more severe disease requiring valve surgery (10).

In some population groups at risk of RHD, outcomes of cardiac surgery can be inferior (11,12) despite that they are of younger age at the time of surgery (8). This is likely to be related to factors including comorbidities(4,11,12), barriers to primary and specialist health care and the ability to achieve safe anticoagulation during long-term follow-up (13). The options for surgical management of rheumatic valve disease are valve repair or replacement with either a bioprosthetic or mechanical prosthesis. In patients with mitral stenosis an additional option is non-surgical percutaneous mitral balloon valvuloplasty (9,14). There are limited data available about factors which might affect the choice of surgery in patients

Department of Internal Medicine, Addis Ababa University, School of Medicine, Collage of health Sciences.
*Corresponding author: drsenbetag@yahoo.com

with rheumatic valve disease. The decision is likely to be influenced by patient's residence, medication access and use, timing and place of referral, gender and access to ongoing care and follow-up. There have been no published studies of heart valve surgery as well as factors that influence surgical management from Ethiopia. Therefore, the aim of this study was to describe Ethiopian patients who had surgery for VHD and assess the pre-operative factors that are associated with the choice of surgical management of VHD.

MATERIALS AND METHODS

Study setting: Tikur Anbessa Specialized Hospital (TASH) is a tertiary, national general referral and university teaching hospital located in Addis Ababa, Ethiopia. The adult cardiology clinic at TASH is the only public hospital cardiology clinic in the country that provides specialist cardiac care to patients coming from different regions of the country. According to registries from the medical intensive care unit, the hospital started to provide surgical management for patients with VHD in 2003.

Study design: Records of patients at TASH cardiology clinic who underwent cardiac valve surgery over a 30 year period (1983 to 2013) were retrieved. Data was collected from the medical records and medical intensive care registry.

Data collection and instrument: Data was collected using a structured checklist by physicians. A total of 112 records of patients' who underwent cardiac surgery for VHD were included in the study. The data included patient sociodemographic characteristics, comorbidities, pre-operative cardiac status, and the type of surgery conducted. Demographic data consisted of age, gender and residential area, and comorbidities considered included stroke, a pre-existing clinicical diagnosis of diabetes mellitus and hypertension, seizure disorder and hypothyroidism. The pre-operative status relating to underlying heart disease included symptomatic status based on the New York Heart Association (NYHA) classes I to IV (15), preoperative atrial fibrillation, and echocardiographic assessment of left ventricular ejection fraction (LVEF) stratified to 50% and more, 40-49%, 30%-39% and less than 30%. Valvular lesions were analyzed according to the valve(s) affected, the valvular lesion (regurgitation, or stenosis, the number of valves affected, and the place and year of surgery. Valve-related surgical procedure data included valve repair or replacement and in the case of replacement, whether this was a mechanical or bioprosthetic valve.

Data entry, processing and analysis: Data were analyzed using IBM SPSS Statistics 21 (IBM, New York, USA) and Excel 2013. Descriptive data were summarized using standard univariate techniques and reported as proportions with Odds Ratios (OR) with 95 Confidence Interval (CI), means with standard deviation (SD) or medians with interquartile range (IQR) depending on the variables type and probability distribution. Categorical data were analyzed using the Chi-square test or Fisher's exact test. All tests were two-sided and a p-valve less than 0.05 was taken to indicate statistical significance. Logistic regression models were developed to identify independent factors associated with the type of surgical procedure done for VHD.

RESULTS

Data on 157 cardiac surgical procedures performed in 112 patients were analyzed. Two thirds (66.1%) of the patients were female. The mean age was 26.9 (SD 8.54) years. Males were older (mean age 29.4 years) than females (mean age 25.3 years). More than 60% of the patients were under 30 years of age. Over 90% were from cities or big towns of the country (Table 1). A breakdown of valve surgery procedures in our series of patients is summarized in Figure 1.

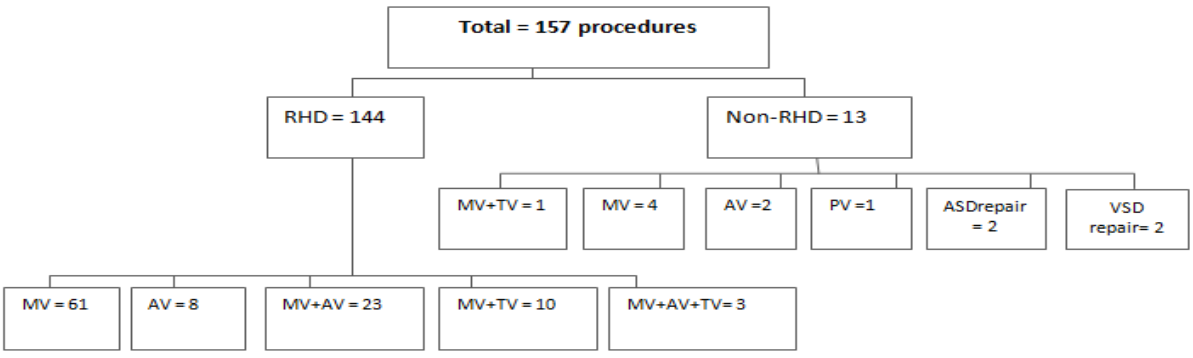

Figure 1: Cardiac valve procedures collected from Adult cardiology clinic, 1983 to 2013. Abbreviations: RHD, rheumatic heart disease; MV, mitral valve; TV, tricuspid value; AV, atrioventricular valve; PV, pulmonic valve; ASD, atrial septal defect; VSD, ventricular septal defect

Table 1: Sociodemographic characteristics of patients November 2014 (n=112)

Variables	Frequency	Percent
Sex		
Male	38	33.9
Female	74	66.1
Age		
< 20	24	21.4
20-29	48	42.9
30-39	28	25.0
40-49	11	9.8
50-59	1	0.9
Residential area		
City or big town	101	90.2
Small town or rural	11	9.8

Of the total number of procedures done, 144 (91.7%) were valve procedures on rheumatic heart disease, while the rest were on congenital heart diseases including mitral valve prolapse, bicuspid aortic valve, atrial septal defect (ASD) and ventricular septal defect (VSD) repair and pulmonary valve dilatation. The surgical centers where the procedures were done include Tikur Anbessa Hospital (TAH), Cardiac Center for Ethiopia (CCE) and 11 other different countries. A description of the characteristics the patients of who had valve surgery are given in Table 2. RHD patients were younger, more likely to be females, residing in cities/big towns, more likely to have atrial fibrillation, but less likely to have impaired left ventricular systolic function (LVEF 40-49%) than patients who had surgery for non-RHD.

Table 2: Characteristics of patients who had valve surgery for rheumatic and non-rheumatic heart diseases, TASH, January 2015

	All patients n = 112	**Rheumatic heart disease n = 105**	**Non-rheumatic heart disease n = 7**	**p value**
Age in years (+/- SD)	26.68 (8.54)	26.3 (8.1)	32.4 (13.0)	0.065
Sex (percentage female)	74 (66.1)	72 (64.3)	2 (1.8)	0.043
Residence (% city or big town)	101 (90.2)	96 (85.7)	5 (4.5)	0.14
Preoperative comorbidities (%)*	14 (12.5)	13 (11.6)	1 (0.9)	0.014
Preoperative status				
New York Heart Association Functional class II heart failure (%)	52 (46.4)	49 (43.8)	3 (2.7)	
New York Heart Association Functional class III heart failure (%)	60 (53.6)	56 (50.0)	4 (3.6)	1.0
Atrial fibrillation (%) OR (95% CI)	23 (20.5)	23 (20.5) 1.085 (1.021-1.153)		
Left Ventricular Ejection Fraction, 50 & above (%) (95% CI)	96 (85.7)	92 (86.8) 1.38 (0.78-2.44)	4 (3.8)	0.1
Left Ventricular Ejection Fraction, 40-49 (%) (95% CI)	10	8 (7.5) 0.24 (0.07-0.89)	2 1.8)	0.039
Postop cardiac events	24 (21.4)	22 (19.6)	2 (1.8)	0.64
Heart failure (%)	15 (13.4)	13 (11.6)	2 (1.8)	0.24
Stroke (%)	8 (7.1)	8 (7.1)		
Atrial fibrillation	1 (0.9)	1 (0.9)		

*Stroke(7), Hypertension (2), Diabetes Mellitus (1), Generalized Tonic Clonic Seizure (2), Hypothyroidism (2)

The nature of the underlying RHD-related mitral and aortic valve lesions stratified by age group is outlined in Figure 2.

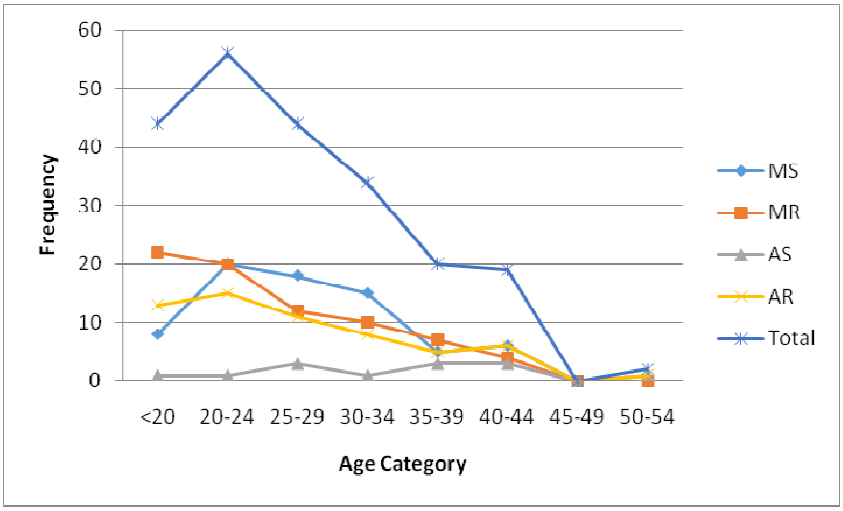

Figure 2: Age distribution of specific valve lesions for which surgery was done

The peak age of patients with mitral regurgitation was under the age of 20 years for mitral stenosis and 20-24 years of age for aortic regurgitation, and that for aortic stenosis greater than 25 years. Among patients who had RHD valve surgery, 69 (65.7%) required surgery on one valve only, 33 (31.4%) on two valves and 3(2.9) on three valves. The details of the valve procedures are outlined in Table 3.

The choice of surgical valve procedure for specific valve diseases is outlined in Table 4. Temporal trends in the surgical management of RHD related mitral and aortic valve disease are outlined in Table 4.

Table 3: Rheumatic valvular heart disease in patient who had surgical management, TASH, 1983 to

Valve involved	Frequency (%)
1 valve	
Mitral valve only	61 (58.1)
Aortic valve only	8 (7.6)
2 valves	
Mitral and aortic	23 (21.9)
Mitral and tricuspid	10 (9.5)
3 valves	
Mitral, aortic and tricuspid	3 (2.9)
Total	**105 (100.0)**

Table 4: Surgical management of the patients stratified by the valves involved

Procedure done	Mechanical valve, n (%)	Bioprosthetic valve, n (%)	Valve repair n (%)	**Total** n (%)
Mitral	86 (54.8)	11 (7.0)	5 (3.2)	102 (65.0)
Aortic	28 (17.8)	6 (3.8)	2 (1.3)	36 (22.9)
Tricuspid valve			14 (8.9)	14 (8.9)
Pulmonary valve dilatation			1 (0.6)	1 (0.6)
ASD repair			2 (1.3)	2 (1.3)
VSD repair			2 (1.3)	2 (1.3)
Total	**114 (72.6)**	**17(10.8)**	**26 (16.6)**	**157 (100%)**

Looking at the overall trend, most of the valve surgeries at TASH were done in the period 2004 to 2011 and 60% of the procedures were done on mitral valves. For both mitral and aortic valves, mechanical valve replacements contributed to about 73% of the total surgical procedures. Multivariate logistic regression modeling was undertaken to identify independent predictors of mechanical versus bioprosthetic valve replacement or repair. When compared to those 40 years of age and above, there was a significantly higher use of mechanical valve replacement among subjects under the age of 20 years (AOR 41.0; 95% CI: 3.0-557.2) and those aged 20-29 years (AOR 14.3 (95% CI: 2.3-88.6). Mechanical valves, compared with only using bioprosthetic valves, were more likely to be used in those with RHD (AOR 13.5;95% CI 1.2-148.7).

The median age of those receiving mechanical valves was lower (24 years; IQR 22–28) than for those receiving bioprosthetic valves (31.5 years; IQR 29.9– 37.9). Gender, residential place and type of valve lesion were not significant predictors of choice of type of valve procedure. Patients having valve repair, compared to those who had valve replacement were more likely to be younger, and less likely to have associated atrial fibrillation (AF), although these were not significant predictors.

DISCUSSION

This study is the first to provide a description of valve surgery for patients with VHD from Ethiopia. We analyzed a total of 157 valve procedures in 112 patients who had surgical valve procedures performed between 1983 and 2013. From the total procedures done, more than 90% of the valve lesions were due to rheumatic heart disease. Advanced RHD affects people at a younger age compared with non-RHD-related valve disease (16,17). Several studies reported that patients with RHD would require valve surgery at a younger age (12,18,19).

The finding that RHD surgery patients were both younger and more likely to be female has implications for treatment choice, particularly given the potential hazards of anticoagulation associated with future pregnancies (20). AF was more common in those having RHD-related compared to non-RHD-related valve surgery. Undertaking RHD mitral valve surgery prior to the onset of AF appears to provide greater therapeutic choice as both bioprosthetic valve replacement and valve repair do not typically require ongoing anticoagulation in the presence of sinus rhythm and no embolic history. This can be particularly useful when managing younger and female patients for the reasons outlined above and for patients from rural areas of the country who are more likely to reside in remote communities where anticoagulation monitoring and ongoing specialist review is not possible. Nonetheless the associated increased risk of surgical reoperation in valve repair and bioprosthetic valve replacement must also be considered in the decision-making process.

Despite the risk of restenosis, Percutaneous Balloon Valvuloplasty (PBV) can provide a non-invasive approach to mitral stenosis management that does not necessarily require ongoing anticoagulation and which has excellent overall survival rates ranging from 96.5% at three years (21) to 99.2% at 16 years (22). Stroke was the commonest preoperative comorbidity in patient with RHD. The valves involved in RHD valve surgery were similar with earlier studies, most commonly the mitral and aortic valves, less commonly the tricuspid and rarely the pulmonary valve. Isolated RHD-related tricuspid valve disease did not exist in our study which is more or less similar to the other studies that found it to be relatively uncommon (23). Thirty one percent of patients having RHD-related surgery required management of multiple valves, highlighting the increased complexity of surgery in RHD-related valve disease.

About three fourth of the patients had mechanical valve replacement. Those with RHD and younger in age were more likely to get mechanical valve replacement. The choice of valve procedure in our patients was also likely to be informed by what was available at time of surgery as the valve surgeries where done by collaboration of TASH and people coming from Europe and North America. This is unlike the other settings where the choice of valve procedure is likely to be informed by a combination of patient's and health practitioner's choice and demographic and disease factors. A mechanical valve has long term durability compared to a bioprosthetic valve which is likely to degenerate over time (1,20-25).

Mechanical valves may therefore be preferred in younger patients, particularly in the settings like sub -Saharan Africa so as to avoid later reoperation provided therapeutic anticoagulation can be achieved. Nonetheless this must be balanced against the inconvenience and risk of anticoagulation in a younger patient who may wish to become pregnant or to participate in recreational or employment activities that entail a greater risk of trauma.

The balancing of these factors means there is no universally correct approach to treatment choice in the individual patient. Our data would suggest that

mechanical valves are preferred in younger patients irrespective of their residential place. This is particularly the case when there is co-existent AF, and is, therefore, an additional indication for anticoagulation. While such an approach can be argued as potentially reasonable for patients living in rural areas of Ethiopia, it would suggest that decisions regarding the use of mechanical valves, particularly in younger people should be undertaken cautiously and in consultation with the patients, their families, the community and local health care providers. The difficulty of maintaining long-term anticoagulation, particularly in a remote setting, should not be underestimated.

The timing of surgical referral and the lack of regularly serving surgical center practices and expertise are the most likely reasons influencing the timing and type of surgery performed in our case. Earlier referral to and availability of a surgical center with a specific interest in valve repairs thus increase the possibility of repair. Mitral valve repair compared to replacement has previously been associated with higher survival rates (26-28) in young RHD patients, with Remenyi et al. (26) reporting actuarial survival at 10 and 14 years for patients with mitral replacement of 79% and 44%, compared to 90% and 90% for those who underwent mitral repair. Similarly Wang et al. (28), in a systematic review of mitral valve repair and replacement, found a survival benefit associated with mitral repair over replacement.

Not all valves, however, are suitable for repair (29) and repaired valves have an increased risk of early reoperation (29,30). Key factors of successful mitral valve repair are likely to be early referral prior to the onset of valvular fibrosis and calcification which may reduce the chance of successful repair (31), and concentrating RHD surgical management in centers with greater experience in this area.

The proportion of mitral valve procedures that were repairs rather than replacements were few and did not significantly change over time. This is likely to reflect an understanding of the difficulties associated with anticoagulation. Residents in cities and major towns of Ethiopia are more likely to be able to achieve safe anticoagulant use and monitoring. In such a setting mechanical valve replacement with attendant long-term anticoagulation is likely to be preferable.

The main limitation of this study is that it was restricted to adult RHD patients from Ethiopia and does not reflect management of pediatric patients. However overall this study is likely to provide an accurate representation of surgical management of RHD in Ethiopia as it addressed all patients with follow-up at TASH. There may be only a few patients having follow-up at other cardiac centers in the country. It is unlikely the inclusion of these centers would have significantly altered our findings.

In conclusion, mitral and aortic valve disease remains the focus of most surgery but tricuspid valve procedures are not uncommon. The predominant factors associated with type of valve surgery were age, underlying cause of VHD and the facility availabilty at times of surgical campaigns. Earlier surgery, prior to the onset of AF, and more aggressive management of AF if it does occur, may allow a broader choice of intervention and, correspondingly, less requirement for life-long anticoagulation. Mechanical valves were more likely to be used in younger patients, but other risk factors require consideration. The greater use of bioprosthetic valves, valve repair and PBV, may be more suitable in patient with other risk factors. Establishing and strengthening local facilities with expertise in managing VHD patients provides greater opportunity for valve repair and PBV.

REFERENCES

1. Carapetis J, Steer A, Mulholland E, Weber M. The global burden of group A streptococcal diseases. Lancet Infect Dis. 2005; 5:685-94.
2. Zühlke L, Watkins D, Engel ME. Incidence, prevalence and outcomes of rheumatic heart disease in South Africa: a systematic review protocol. BMJ Open. 2014 Jun 10; 4(6):e004844.
3. Remenyi B, Carapetis J, Wyber R, Taubert K, Mayosi BM. Position statement of the World Heart Federation on the prevention and control of rheumatic heart disease. Nat Rev Cardiol. 2013; 10:284-92.
4. RHDAustralia (ARF/RHD writing group), National Heart Foundation of Australia and the Cardiac Society of Australia and New Zealand. Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (2nd edition). 2012.
5. Guteta S, Oli K, Feleke Y, Yadeta D, Makonnen D, Tafese A. Spectrum of cardiovascular diseases among Ethiopian patients. Ethiop Med J. 2014; 52(1):9-17.
6. Oli K, Porteous J. Prevalence of rheumatic heart disease among school children in Addis Ababa. East Afr Med J. 1999; 76:601-5.

7. Remenyi B, Wilson N, Steer A, Ferreira B, Kado J, Kumar K, et al. World Heart Federation criteria for echocardiographic diagnosis ofrheumatic heart disease-an evidence-based guideline. Nature reviews Cardiology. 2012;9:297-309.
8. Enriquez-Sarano M, Akins CW, Vahanian A. Mitral regurgitation. Lancet Infect Dis. 2009; 373:1382-94.
9. Bhandari S, Subramanyam K, Trehan N. Valvular heart disease: diagnosis and management. J Assoc Physicians India. 2007; 55:575-84.
10. Baskerville CA, Hanrahan BB, Burke AJ, Holwell AJ, Remond MG, Maguire GP. Infective endocarditis and rheumatic heart disease in the north of Australia. Heart Lung Circ. 2012; 21:36-41.
11. Lehman SJ, Baker RA, Aylward PE, Knight JL, Chew DP. Outcomes of cardiac surgery in Indigenous Australians. Med J Aust. 2009; 190:588-93.
12. Alizzi AM, Knight JL, Tully PJ. Surgical challenges in rheumatic heart disease in the Australian indigenous population. Heart Lung Circ 2010; 19:295-8.
13. Maguire GP, Carapetis JR, Walsh WF, Brown AD. The future of acute rheumatic fever and rheumatic heart disease in Australia. Med J Aust. 2012; 197:133-4.
14. Zakkar M, Amirak E, Chan KMJ, Punjabi PP. Rheumatic Mitral Valve Disease: Current Surgical Status. Prog Cardiovasc Dis. 2009; 51:478-81.
15. Dolgin M, editor. Nomenclature and criteria for diagnosis of diseases of the heart and great vessels / the criteria committee of the New York Heart Association. Boston: Little, Brown, 1994.
16. Bernal JM, Ponton A, Diaz B, Llorca J, Garcia I, Sarralde A, et al. Surgery for rheumatic tricuspid valve disease: a 30-year experience. J Thorac Cardiovasc Surg. 2008; 136:476-81.
17. Choudhary SK, Talwar S, Dubey B, Chopra A, Saxena A, Kumar AS. Mitral valve repair in a predominantly rheumatic population. Long-term results. Tex Heart Inst J. 2001; 28:8-15.
18. Russell EA, Tran L, Baker RA, Bennetts JS, Brown A, Reid CM, et al. A review of valve surgery for rheumatic heart disease in Australia. BMC Cardiovascular Disorders. 2014; 14:134.
19. Wiemers P, Marney L, Muller R, Brandon M, Kuchu P, Kuhlar K, et al. Cardiac surgery in Indigenous Australians-how wide is 'the gap'? Heart Lung Circ. 2014; 23:265-72.
20. Essop MR, Nkomo VT. Rheumatic and Nonrheumatic Valvular Heart Disease: Epidemiology, Management, and Prevention in Africa. Circulation. 2005; 112:3584-91.
21. Wang A, Krasuski R, Warner J, Pieper K, Kisslo K, Bashore T, et al. Serial echocardiographic evaluation of restenosis after successful percutaneous mitral commissurotomy. J Am Coll Cardiol 2002; 39:328-34.
22. Fawzy ME, Fadel B, Al-Sergani H, Al Amri M, Hassan W, Abdulbaki K, et al. Long-Term Results (Up to 16.5 Years) of Mitral Balloon Valvuloplasty in a Series of 518 Patients and Predictors of Long-Term Outcome. J Interv Cardiol. 2007; 20:66-72.
23. Blaustein AS, Ramanathan A. Tricuspid valve disease. Clinical evaluation, physiopathology, and management. Cardiol Clin. 1998; 16:551-72.
24. Edwin F, Aniteye E, Tettey M, Tamatey M, Frimpong-Boateng K. Outcome of left heart mechanical valve replacement in West African children - A 15-year retrospective study. J Cardiothorac Surg. 2011; 6:57.
25. Yau TM, El-Ghoneimi YA, Armstrong S, Ivanov J, David TE. Mitral valve repair and replacement for rheumatic disease. J Thorac Cardiovasc Surg. 2000; 119:53-60.
26. Remenyi B, Webb R, Gentles T, Russell P, Finucane K, Lee M, et al. Improved Long-Term Survival for Rheumatic Mitral Valve Repair Compared to Replacement in the Young. World Journal for Pediatric and Congenital Heart Surgery. 2013; 4:155-64.
27. De Santo LS, Romano G, Della Corte A, Tizzano F, Petraio A, Amarelli C, et al. Mitral mechanical replacement in young rheumatic women: analysis of long-term survival, valve-related complications, and pregnancy outcomes over a 3707-patient-year follow-up. J Thorac Cardiovasc Surg. 2005; 130:13-9.
28. Wang Z, Zhou C, Gu H, Zheng Z, Hu S. Mitral valve repair versus replacement in patients with rheumatic heart disease. J Heart Valve Dis. 2013; 22:333-9.
29. Bakir I, Onan B, Onan IS, Gul M, Uslu N. Is rheumatic mitral valve repair still a feasible alternative?: indications, technique, and results. Tex Heart Inst J. 2013; 40:163-9.
30. Sarralde J, Bernal J, Llorca J, Ponton A, Diez-Solorzano L, Gimenez-Rico JR, et al. Repair of rheumatic tricuspid valve disease: predictors of very long-term mortality and reoperation. Ann Thorac Surg. 2010; 90:503 -8.
31. Chaudhry F, Upadya S, Singh V, Cusik D, Izrailtyan I, Sanders J, et al. Identifying patients with degenerative mitral regurgitation for mitral valve repair and replacement: a transesophageal echocardiographic study. J Am Soc Echocardiogr. 2004; 17:988-94.