ORIGINAL ARTICLE

Mitral Valve Replacement in Patients with Mitral Annulus Calcification

Reemplazo valvular mitral en pacientes con anillo calcificado

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ABSTRACT

Background: Mitral annulus calcification is a degenerative process which poses a challenging technical problem in patients undergoing surgical treatment of the mitral valve, increasing the probability of severe complications as stroke, perivalvular leaks, bleeding and death.
Objective: The aim of this study was to describe our experience in mitral valve surgery with severe mitral annulus calcification.
Methods: Between July 2010 and July 2020, 28 patients underwent surgery due to mitral valve disease with severe mitral annulus calcification. Median age was 77 years and 68% of patients were female. Mitral valve replacement was performed in all patients, associated with aortic valve replacement in 36%, tricuspid valve repair in 11% and coronary artery bypass graft surgery in 21% of cases.
Results: Two patients died during hospitalization. The most frequent postoperative complications were atrial fibrillation and acute kidney failure. No perivalvular leaks or prosthesis-associated complications were observed.
Conclusions: Mitral valve surgery in the presence of mitral annulus calcification can be performed with acceptable results for the risk profile of the population with the disease and according to international publications.

Key words: Mitral Valve / surgery - Heart Valve Prosthesis Implantation - Mitral Valve Annuloplasty - Calcinosis

RESUMEN

Introducción: El anillo mitral calcificado es un proceso degenerativo que, de encontrarse presente en pacientes con indicación de tratamiento quirúrgico de la válvula mitral, implica un problema técnico de difícil resolución, que genera un aumento de probabilidad de complicaciones graves como accidente cerebrovascular, fugas perivalvulares, sangrado y muerte.
Objetivo: El propósito del estudio es describir nuestra experiencia con cirugía valvular mitral en el contexto de calcificación grave del anillo mitral.
Material y métodos: entre julio de 2010 y julio de 2020, 28 pacientes fueron intervenidos por patología valvular mitral en presencia de anillo mitral gravemente calcificado. La mediana de edad de la población fue de 77 años y el 68% fue de sexo femenino. Se realizó reemplazo valvular mitral en todos los casos asociado con reemplazo valvular aórtico en el 36%, con plástica tricuspídea en el 11% y con cirugía de revascularización miocárdica en el 21% de los casos.
Resultados: Dos pacientes fallecieron en el hospital. Las complicaciones posoperatorias más frecuentes fueron la fibrilación auricular y la insuficiencia renal aguda. No se observaron fugas perivalvulares ni complicaciones asociadas con la prótesis.
Conclusiones: La cirugía valvular mitral en presencia de anillo mitral calcificado puede realizarse con resultados aceptables para el perfil de riesgo de la población con la patología y de acuerdo con lo informado en publicaciones internacionales.

Palabras clave: Válvula Mitral / Cirugía -Implantación de Prótesis de Válvulas Cardíacas - Anuloplastia de la Válvula Mitral - Calcinosis

Abbreviations

AVG	Atrioventricular groove	**MAC**	Mitral annulus calcification
AVR	Aortic valve replacement	**MVR**	Mitral valve replacement

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INTRODUCTION

Mitral annulus calcification (MAC) is a degenerative process affecting 10% of the total population, although its incidence may affect up to 40% of people >70 years of age. (1)

Different from rheumatic mitral disease, this process mainly alters the posterior aspect of the mitral annulus, while the leaflets, commissures and the subvalvular apparatus are generally preserved.

Its etiology has not been completely clarified. It is associated with old age, female sex, diabetes, aortic stenosis, hypertrophic cardiomyopathy, general atherosclerosis, chronic kidney disease and thoracic irradiation among other factors.

In most cases, MAC does not cause valve dysfunction. When it is associated with valve disease, the etiology of the valvular disorder will depend on other causes and MAC is a problem that will encumber the surgical resolution, if this were deemed necessary. Approximately 20% of patients requiring mitral valve surgery have some degree of MAC. (2) This situation poses an important technical problem, as the presence of annular calcium increases the probability of severe complications in terms of stroke, atrioventricular groove (AVG) rupture, perivalvular leaks, etc.

Three different approaches are used to deal with this situation. They can be grouped as:

a) Techniques that eliminate annular calcium (AVG decalcification), allowing the implantation of a larger size prosthesis with scarce probability of periprosthetic leaks, but which is exposed to severe complications, as AVG dehiscence with posterior bleeding. After decalcification, the grove can be repaired with a pericardial patch (3, 4) or without prosthetic material, fixing the atrial tissue to the ventricular muscle (5) for later mitral prosthesis implantation or valve repair.
b) Conservative techniques that do not remove MAC and avoid the problem of severe bleeding, but have the potential risk of perivalvular leaks (6, 7) and
c) Alternative procedures as endovascular or surgical transcatheter valve implantation. (8)

Mitral valve disease associated with MAC has become more frequent due to the increasing age of the population undergoing mitral valve surgical procedures.

However, to our knowledge, there are no local reports about surgical results in this particular context.

Thus, with the purpose of reporting our experience with mitral valve surgery in the presence of severe MAC, a retrospective review of the Department of Cardiovascular Surgery database was performed identifying patients suffering from this condition.

METHODS

All patients undergoing mitral valve surgery in the context of MAC from January 2010 to July 2010 were included in the study. Patients with endocarditis were excluded, because surgical morbidity and mortality is strongly influenced by the septic process.

Demographic data, risk factors and preoperative comorbidities, procedures performed, as well as surgical morbidity and mortality are described.

Continuous variables are expressed as median and interquartile range, and categorical variables are reported as absolute and relative frequency (percentage).

Follow-up was carried out for 6 months after the procedure.

Ethical considerations

The study was conducted following the recommendations on research in human beings and current legal regulations. No informed consent was requested as a review of clinical records was performed with anonymized data. The study investigators implemented measures to protect the privacy and confidentiality of patient data according to the current legislation (Personal Data Protection Law 25,326) and the institutional confidentiality policy.

RESULTS

A total of 40 patients were operated-on for mitral valve disease associated with severe MAC during the study period. In 12 cases the indication for surgery was endocarditis, and these patients were excluded from the study, so the results of the remaining 28 patients are reported. The population here described represents 1% of the total number of mitral valve surgeries registered in the Department of Cardiovascular Surgery database since 1957 (n=2,562).

Median age was 77 years (IQR 67.5-79.5) and 68% of patients were female. Table 1 shows risk factors and comorbidities.

Mitral regurgitation was the disease that generated the surgical indication in 16 patients (57%), in 6 cases associated with moderate or severe aortic stenosis and, in one case, with tricuspid regurgitation; 11 cases (39%) presented mitral stenosis associated with aortic stenosis in 4 cases and severe tricuspid regurgitation in one case. In one case (4%), treatment indication was for prosthetic mitral valve dysfunction.

In all cases, mitral valve disease was resolved by means of mitral valve replacement (MVR) and concomitant procedures were required on other valves in 13 cases (46%).

Moreover, 13 patients (46%) required non-valvular associated procedures (Table 2).

Extensive mitral annulus decalcification was performed in all cases to implant the valvular prosthesis. Endovascular procedures were not indicated nor were conservative techniques used.

The surgical procedures, the AVG repair techniques after decalcification, as well as the associated procedures are detailed in Table 2.

Mechanical prostheses were used in 7 patients (25% of cases).

In all cases, myocardial protection was done by anterograde or retrograde blood cardioplegia, administered through the coronary ostia or the coronary sinus, respectively, with an induction dose followed by intermittent infusions every 20 min.

Median cardiopulmonary bypass time was 221.5

min (IQR 184-281.5), while mean clamping time was 190.5 min (IQR 154.5-225).

In-hospital mortality comprised 2 cases (7%). The cause of death was bleeding associated with AVG disruption. Both events occurred in the second postoperative day.

The most frequent postoperative complications are described in Table 3. There were 4 cerebrovascular events, 2 ischemic and 2 hemorrhagic strokes (one case required decompressive craniectomy).

Median hospital stay was 12 days (IQR 7-20).

Echocardiographic control at discharge revealed normal functioning prostheses in all cases, except one, which showed mild mitral mismatch. No periprosthetic leaks were observed.

No loss to follow-up and no deaths outside the perioperative period were observed at 6 months. During this follow-up period, the following events occurred: a patient was readmitted due to heart failure 15 days after hospital discharge and another patient presented early prosthetic endocarditis, which was reoperated without major complications or mortality.

No other clinical events or events associated with the implanted prostheses in mitral position were encountered. A patient presented mild aortic perivalvular leak without clinical involvement.

Table 1. Risk factors and comorbidities

Hypertension	18	64%
Diabetes	8	29%
COPD	5	18%
Atrial fibrillation	10	36%
Stroke	5	18%
Myocardial infarction	2	7%
Chronic kidney disease	6	21%
Neoplasias	5	18%
Hypertrophic cardiomyopathy	1	4%
Previous cardiac surgery	3	11%
Ejection fraction <40%	5	18%

COPD: Chronic obstructive pulmonary disease

Table 2. Surgical procedures, mitral annulus treatment technique, and associated procedures

Valvular surgical procedures		
Mitral valve replacement	15	54%
MVR plus tricuspid repair	3	11%
MVR plus aortic valve replacement	10	35%
Atrioventricular groove repair		
Pericardial patch	25	89%
Atrial sliding	3	11%
Associated procedures		
Coronary artery bypass graft surgery	6	21%
Mitroaortic fibrosa replacement	6	21%
Extended septal myectomy	1	4%

MVR: Mitral valve replacement

Table 3. Risk factors and comorbidities

Death	2	7%
Low cardiac output	5	18%
Acute kidney failure	7	25%
Atrial fibrillation	7	25%
Permanent pacemaker	5	18%
Stroke	4	14%
Reoperation for bleeding	2	7%
Mediastinal infection	1	4%

DISCUSSION

This study reports results from an institutional series of patients with severe MAC undergoing isolated mitral valve surgery or combined with either aortic or coronary artery procedures.

In this context, MAC implies a relevant technical problem due to the difficulty or impossibility of prosthetic valve implantation or valve repair. The population in this series presents with factors classically cited in the literature, with mean age of 72 years, slightly higher than that reported in historical and recent series on this disease. (2, 3-9) The rest of the predisposing factors are in similar proportions to those reported, which obviously exceed the incidence observed in populations undergoing mitral valve surgery without calcified annulus involvement. (9)

As recently published, the presence of mitral stenosis in a high percentage of cases is not an infrequent finding. (9, 10)

Although the surgical technique used is technically challenging, annular decalcification with subsequent AVG repair allows more efficient resolution of the disease. The procedure tolerates the elimination of all the annular calcium and, then, the performance of mitral valve repair (in case the leaflets are not affected by the calcification) or valve replacement.

Anatomically, calcium is, in general, limited to the annulus and in a high percentage of cases it is surrounded by a fibrous sheath, (5) but there are cases in which the degenerative process and the calcification exceed the annulus border affecting the myocardium and, even, the papillary muscles. In this last situation, annulus decalcification will become extremely complex and dangerous. Rarely applied alternative techniques have been described for these patients, with unknown long-term results. (11)

Annular decalcification exposes the fatty tissue in which the vessels coursing along the AVG are embedded (circumflex coronary artery and coronary sinus). After removing the calcium band, the ensuing groove disruption must be repaired with a pericardial patch (3, 4) or sliding the atrial tissue onto the ventricular muscle to restore the AVG before prosthesis implantation. (5)

In this group of patients, the AVG was repaired in 90% of cases with a pericardial patch, and atrial slid-

ing and suture on the ventricular muscle was used in only 3 patients.

Associated valvular heart disease was often encountered; in fact, 46% of cases required a procedure on another valve, with aortic valve replacement (AVR) being the most frequently associated valve surgery (36%). Perhaps, this is a surrogate of study patient characteristics.

In 6 patients, due to the limited diameter of the valve annulus and weakened perivalvular structures upon decalcification, it was necessary to replace the mitroaortic fibrous membrane to widen both aortic and mitral annuli and generate an adequate support for both prostheses. (12)

Twenty-one percent of patients required associated coronary artery bypass graft surgery.

The high frequency of mitral stenosis, the need for associated procedures and a technically complex intervention influenced the decision to perform MVR in all cases without resorting to the mitral valve repair strategy in this group of patients.

Observed operative mortality was 2/28 (7%). These patients died in the postoperative period due to bleeding caused by AVG dehiscence. This complication is inherent to the surgical strategy. We have mentioned that to elude this severe problem, different techniques which avoid decalcification have been proposed. However, none of them is very effective and, even, predispose to other complications, such as perivalvular leaks, reoperations due to non-structural dysfunction and, most important, they are nor free from bleeding, many times fatal. (6, 7)

Even though mortality in similar reports is close to 10% and ranges between 9% and 28% according to different studies, (3, 12, 14) there are currently institutional series (9, 10), some of them limited in the number of cases, which report perioperative mortality values of 1% and 5%, respectively.

The authors of these trials attribute the advantage of decreased mortality to technical modifications, so they propose more limited or more conservative decalcifications and suggest prosthesis implantation from annex cavities. (9) or generating an additional support using patches fixed to the atrial walls. (10) We have not performed these procedures in our series.

Transcatheter valve implantation has emerged as an option for the treatment of this complex situation, but, unfortunately, results are not encouraging in the context of MAC. A recent multicenter registry, evaluating percutaneous prosthesis results for the treatment of mitral bioprosthesis dysfunction, or valve dysfunction after mitral valve repair, or mitral valve disease in the presence of MAC, revealed that it is precisely in this scenario where the worst results of the procedure are observed. (15)

In this registry, a transcatheter mitral valve implant performed in 58 patients with MAC resulted in periprocedural mortality of 34%, technical success of 62% and severe complications, as left ventricular outflow tract obstruction due to prosthesis support stent in 39% of cases. We have no experience with this type of procedure.

Regarding postoperative complications, reoperation for bleeding, requiring pacemaker, and mitral paravalvular leak are described more frequently among patients with MAC than in cases without annular calcification. (16) The need for permanent pacemaker ranges between 8% and 25%; in our experience it was 17%. It has been described that a pacemaker is required mainly in patients with involvement of the anterior section of the annulus and commissural calcification. Among our patients, the requirement for postoperative pacemaker could be explained by the frequency of double valve replacement and the need for mitroaortic fibrous membrane replacement.

Four patients suffered from stroke. This was hemorrhagic in 2 cases, associated with the anticoagulation therapy indicated for baseline atrial fibrillation, and embolic in the remaining two. The presence of hemorrhagic events increased the frequency of stroke among our patients, though it is a phenomenon scarcely mentioned in the literature on the subject.

All approaches avoiding mitral annulus decalcification have periprosthetic leak as potential complication. In the series treating the disease with AVG decalcification (3) and in our experience, no such problem was observed, which is very relevant due to the clinical relationship of perivalvular leak with anemia, hemolysis and need for reintervention. This is one of the reasons we believe annular decalcification has advantages over techniques seeking to avoid it.

Currently, the therapeutic alternative for perivalvular leaks is percutaneous or transcatheter closure. (17)

This strategy, though less invasive, is not free from complications or mortality, and two concepts should also be reminded: the procedure has anatomical requirements, so not all patients are candidates for percutaneous treatment and, in the second place, those treated with this method may remain with residual leaks of different severity. (18, 19) Therefore, offering a conservative approach for annular disease, based on a potential endovascular treatment after an eventual paravalvular leak, suggests a suboptimal therapeutic proposal.

Concerning the long-term outcome, survival and rate of events during follow-up is the one expected for the population characteristics, and it should be pointed out that a postoperative follow-up limited to 6 months is presented. It has been reported that survival in these patients, ranging between 61% and 73% (3-9) at 5 years is lower than that of patients without MAC.

The limitation of this study is its retrospective and single center nature, so the experience here reported might not be extrapolated to other centers' practice.

CONCLUSIONS

Mitral valve surgery in the presence of MAC, although challenging, can be performed with acceptable results

for the risk profile of the affected population, and agrees with reports from international publications.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material)

REFERENCES

1. Bedeir K, Kaneko T, Aranki S. Current and evolving strategies in the management of severe mitral annular calcification. J Thorac Cardiovasc Surg 2019;157: 555-66. https://doi.org/10.1016/j.jtcvs.2018.05.099

2. Fusini L, Ghulam Ali S, Tamborini G, Muratori M, Gripari P, Maffessanti F, et al. Prevalence of calcification of the mitral valve annulus in patients undergoing surgical repair for mitral valve prolapse. Am J Cardiol 2014;113:1867-73. https://doi.org/10.1016/j.amjcard.2014.03.013

3. Feindel C, Tufail Z, David T, Ivanov J, Armstrong S. Mitral valve surgery in patients with extensive calcification of the mitral annulus. J Thorac Cardiovasc Surg 2003;126: 777-81. https://doi.org/10.1016/S0022-5223(03)00081-3

4. Smedira N. Mitral Valve Replacement with a Calcified Annulus. Op Tech Thorac Cardiovasc Surg 2003; 8:2-13. https://doi.org/10.1016/S1522-2942(03)70030-0

5. Carpentier A, Pellerin M, Fuzellier J, Relland J. Extensive Calcification of the Mitral Annulus: Pathology and Surgical Management. J Thorac Cardiovasc Surg 1996;111: 718-30. https://doi.org/10.1016/S0022-5223(96)70332-X

6. Nataf P, Pavie A, Jault F, Borst V, Cabrol C, Gandjbakhch I. Intraatrial Insertion of a Mitral Prosthesis in a Destroyed or Calcified Mitral Annulus. Ann Thorac Surg 1994;58:163-7. https://doi.org/10.1016/0003-4975(94)91092-8

7. Mills N, McIntosh CH, Mills L. Techniques for Management of the Calcified Mitral Annulus. J Card Surg 1986; 1:347-55. https://doi.org/10.1111/j.1540-8191.1986.tb00722.x

8. Guerrero M, Dvir D, Himbert D, Urena M, Eleid M, Wang D, et al. Transcatheter Mitral Valve Replacement in Native Mitral Valve Disease with Severe Mitral Annular Calcification. JACC Cardiovasc Interv 2016; 9: 1361-71. https://doi.org/10.1016/j.jcin.2016.04.022

9. Saran N, Greason K, Schaff H, Cisek S, Daly R, Maltais S et al. Does Mitral Valve Calcium in Patients Undergoing Mitral Valve Replacement Portrend worse Survival? Ann Thorac Surg 2019; 107: 444-52 https://doi.org/10.1016/j.athoracsur.2018.07.098

10. Hussein ST, Idress J, Brozzi N, Blackston E, Petterson G. Use of annulus washer after debridement: A new mitral valve replacement technique for patient with severe mitral annular calcification. J Thorac Cardiovasc Surg 2013; 145:1672-74. https://doi.org/10.1016/j.jtcvs.2012.12.049

11. Said S, Schaff H. An alternative approach to valve replacement in patients with valve stenosis and severely calcified annulus. J Thorac Cardiovasc Surg 2014;147: e76-8. https://doi.org/10.1016/j.jtcvs.2014.02.039

12. David T, Kou J, Armstrong S. Aortic and Mitral Valve Replacement with Reconstruction of the Intervalvular Fibrous Body. J Thorac Cardiovasc Surg 1997; 114:766-72. https://doi.org/10.1016/S0022-5223(97)70080-1

13. Cammack P, Edie R, Edmunds H. Bar calcification of the mitral annulus. A risk factor in mitral valve operations. J Thorac Cardiovasc Surg 1987;94:399-404. https://doi.org/10.1016/S0022-5223(19)36254-3

14. d'Alessandro C, Vistarini N, Aubert S, Acar C, Pavie A, Gandjbakhch I. Mitral annulus calcification: determinants of repair feasibility, early and late surgical outcome. Eur J Cardiothorac Surg 2007;32:596-603. https://doi.org/10.1016/j.ejcts.2007.06.044

15. Yoon S, Whisenant B, Bleiziffer S, Delgado V, Dhobler A, Schofer N, et al. Outcomes of Transcatheter mitral valve replacement for degenerated bioprostheses, failed annuloplasty rings and mitral annular calcification. Eur Heart J 2019;40:441-51. https://doi.org/10.1093/eurheartj/ehy590

16. Ribeiro R, Yanagawa B, Légaré JF, Azan A, Ozounian M, Verma S, et al. Clinical Outcomes of mitral valve interventions in patients with mitral annular calcification: a systematic review and meta analysis. J Card Surg 2020; 35: 66-74. https://doi.org/10.1111/jocs.14325

17. Nishimura R, Otto C, Bonow R, Carabello B, Erwin J, Fleisher L. et al. 2017 AHA/ACC Focused Update of 2014 AHA/ACC Guidelines of Management of Patients with Valvular Heart Disease. J Am Coll Cardiol 2017;70:252-89. https://doi.org/10.1016/j.jacc.2017.03.011

18. Busu T, Alqathani F, Badhwar B, Cook C, Rihal Ch, et al. Meta-analysis comparing Transcatheter with Surgical Treatments of Paravalvular Leaks. Am J Cardiol 2018;122: 302-9. https://doi.org/10.1016/j.amjcard.2018.03.360

19. Ruiz C, Jelnin V, Kronzon I, Dudiy Y, Del Valle Fernandez R, Einhorn B, et al. Clinical Outcomes in Patients Undergoing Percutaneous Closure of Periprosthetic Paravalvular Leaks. J Am Coll Cardiol 2011;58: 2210-7. https://doi.org/10.1016/j.jacc.2011.03.074