

Initial Single-center Experience with Premeasured Chordal Loops for Mitral Valve Repair

Experiencia inicial en un centro único del uso de neocuerdas preformadas en reparación mitral

GUILLERMO N. VACCARINO, GUILLERMO GUTIÉRREZ, CHRISTIAN GIL, GUSTAVO BASTIANELLI, RENZO MELCHIORI, SERGIO BARATTA

ABSTRACT

Background: Mitral valve repair has demonstrated better outcomes compared with valve replacement for the treatment of degenerative mitral regurgitation.

Objective: The aim of this study was to show the experience with premeasured expanded polytetrafluoroethylene chordal loops for successful mitral valve repair.

Methods: Between May and December 2018, 13 patients with severe mitral regurgitation caused by degenerative disease and indication for surgery underwent mitral valve repair at Hospital Universitario Austral.

Results: The procedure was successful in the 13 patients. Chordal loops were applied to the anterior leaflet in 4 patients, to the posterior leaflet in 6 patients and to both anterior and posterior leaflets in 3 patients.

Conclusions: Polytetrafluoroethylene chordal loops allowed the satisfactory, safe and reproducible repair of mitral regurgitation due to prolapse of any mitral leaflet segment.

Key words: Mitral valve insufficiency - Chordae tendineae/surgery - Mitral valve/surgery

RESUMEN

Introducción: La reparación de la válvula mitral ha demostrado superioridad por sobre el reemplazo valvular en el tratamiento de la insuficiencia mitral degenerativa.

Objetivo: El propósito de este trabajo es demostrar la utilización de neocuerdas de politetrafluoroetileno expandido preformadas para la realización de una plástica mitral exitosa.

Material y métodos: Entre marzo y diciembre del 2018 se intervinieron 13 pacientes con insuficiencia mitral grave quirúrgica por enfermedad degenerativa con criterios quirúrgicos a los cuales se les implantó cuerdas nuevas preformadas para la reparación mitral en el Hospital Universitario Austral.

Resultados: Se repararon en forma exitosa la insuficiencia mitral grave a los 13 pacientes colocando neocuerdas preformadas en la valva posterior en 6 pacientes; en la valva anterior, en 4 pacientes; y, en ambas valvas, en 3 pacientes.

Conclusiones: Las neocuerdas de politetrafluoroetileno permitieron realizar la plástica reparadora de la insuficiencia mitral en forma satisfactoria, segura y reproducible para el prolapso de cualquier segmento valvular mitral.

Palabras clave: Insuficiencia de la válvula mitral - Cuerdas tendinosas/ cirugía - Válvula mitral

INTRODUCTION

Mitral valve repair is the preferred surgical strategy in patients with mitral regurgitation caused by mitral valve prolapse. (1) There are different techniques for mitral valve repair depending on the leaflet involved. While leaflet resection for posterior prolapse and chordal transfer for anterior prolapse have good results, there is recent enthusiasm for the application of artificial chords to correct prolapse. Among the

various techniques using artificial chords for mitral valve repair, Frater et al. have introduced the use of polytetrafluoroethylene (PTFE) sutures. (2) Chordal replacement has proved to be highly versatile with excellent short- and long-term results. (3, 4) To facilitate the creation of artificial chords, Von Oppell and Mohr developed the concept of PTFE chordal loops facilitating mitral valve repair due to leaflet prolapse. (5) These loops, with different lengths according to the

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Address for reprints: Av. Juan Domingo Perón 1500 (B1629ODT) Pilar, Provincia de Buenos Aires, Argentina

Tel: +54230 448, extension 2467. E-mail: gvaccari@cas.austral.edu.ar

Hospital Universitario Austral

characteristics of each patient, are prepared intra-operatively using a reusable special metallic caliper. Once these neochords are created, they are sutured to the body of the corresponding papillary muscle and the free ends are then distributed along the free margin of the prolapsed segment using an additional suture for each loop.

Premeasured PTFE chordal loops are nowadays available. The surgeon only has to measure the length of the neochords, which can be considered a prefabricated prosthesis. These premeasured loops facilitate mitral valve repair by potentially reducing operative time, increasing the chance of successful repair and facilitating surgeons with a more reproducible technique. (3)

METHODS

Between May and December 2018, 13 patients with severe mitral regurgitation caused by degenerative disease and indication for surgery underwent mitral valve repair. Intra-operative transesophageal color-Doppler echocardiography was performed in all the patients for correct evaluation of the mechanism and severity of mitral regurgitation. In 6 patients, severe mitral regurgitation was due to posterior leaflet prolapse, 4 patients presented anterior leaflet prolapse and both leaflets were prolapsed in 3 patients.

The anterior leaflet with its segments (A1-A2-A3) and the posterior leaflet with its segments (P1-P2-P3) were analyzed. The presence of elongation or chordal rupture in each leaflet segment was also evaluated. Left ventricular ejection fraction (LVEF) was >60% in 7 patients and between 45% and 60% in the remaining 4 patients. Left ventricular diastolic diameters (LVDD) ranged between 43 mm and 80 mm (mean 60 mm), left ventricular systolic diameters (LVSD) between 31 mm and 47 mm (mean 38 mm), left atrial area (LAA) between 28 cm² and 60 cm² (mean 39 cm²), and the effective regurgitating orifice area (EROA) between 50 mm² and 70 mm² (mean 60 mm²) (Table 1).

Surgical technique

A complete median sternotomy was performed with cardiopulmonary bypass (CPB) and cardiac arrest, and the mitral

valve was accessed through a left atrial incision. After exposure of the mitral valve, a systematic inspection of all valve components was done. The prolapsing segment and elongated or ruptured chords were identified and chordal length was determined with a caliper. The single-use caliper measures the exact distance between the tip of the corresponding papillary muscle (where the patient's chordae tendineae emerge) and the free edge of the valve to be repaired, taking as reference either the length of a normal adjacent chordae or the distance between that portion of the papillary muscle and the plane of the mitral annulus with the heart relaxed and without anatomical distortion (Figure 1).

Three premeasured PTFE chordal loops with different standardized lengths were individually sutured to the leaflet free edge at the site of prolapse, and a fourth suture was used for fixation of the neochords to the corresponding papillary muscle (Figure 2).

Additional repair maneuvers (as quadrangular or triangular leaflet resection) including a prosthetic annuloplasty with complete semi-flexible ring were performed as necessary. (4)

Ethical considerations

The study was approved by the institutional Ethics Committee

RESULTS

Cardiopulmonary bypass (CPB) time ranged between 51 and 122 min (mean 69 min) and aortic-cross clamp (ACC) time between 31 and 95 min (mean 89 min). Premeasured chordal loops with different sizes according to the leaflet affected were used in all the patients. The anterior leaflet was repaired with chordal loops between 20 mm and 24 mm, and the posterior leaflet with chordal loops between 16 mm and 20 mm (Table 2). Two sets of premeasured neochords were used in all the patients with anterior leaflet prolapse, with successful repair in all the cases. For posterior leaflet prolapse, mitral valve repair with chordal loops required triangular resection to correct mitral valve prolapse in all the patients.

Table 1. Patients' symptoms and echocardiographic characteristics

Patients	Symptoms	LVEF %	LVSD mm	LVDD mm	EROA cm ²	LA cm ²	Leaflet affected	Segment affected	Ruptured chords
1	Dyspnea III-IV	65	40	60	0.7	60	Anterior	A1-A2	YES
2	Dyspnea III-IV	60	41	63	0.6	45	Anterior	A2	YES
3	Dyspnea I-II	65	42	73	0.6	56	Posterior	P2	YES
4	Dyspnea III-IV	55	46	80	0.7	55	Posterior	P1-P2	YES
5	Dyspnea III-IV	45	47	65	0.6	38	Anterior and posterior	A1-A2/P1-P2	NO
6	Dyspnea III-IV	57	37	60	0.7	55	Anterior and posterior	A1-A2/P1-P2	YES
7	Dyspnea III-IV	65	40	60	0.5	35	Posterior	P1-P2	NO
8	Dyspnea III-IV	48	34	54	0.5	27	Anterior	A2	YES
9	Dyspnea I-II	65	34	64	0.7	29	Posterior	P2-P3	YES
10	Dyspnea III-IV	72	40	64	0.7	37	Anterior and posterior	A2-P2	YES
11	Dyspnea III-IV	67	23	43	0.7	24	Posterior	P2	YES
12	Asymptomatic	60	35	58	0.5	24	Anterior and posterior	A2-A3 / P2	YES
13	Dyspnea III-IV	65	31	55	0.7	28	Posterior	P2	YES

LVEF: Left ventricular ejection fraction. LVSD: Left ventricular systolic diameter. LVDD: Left ventricular diastolic diameter. EROA: Effective regurgitant orifice area. LA: Left atrial area.

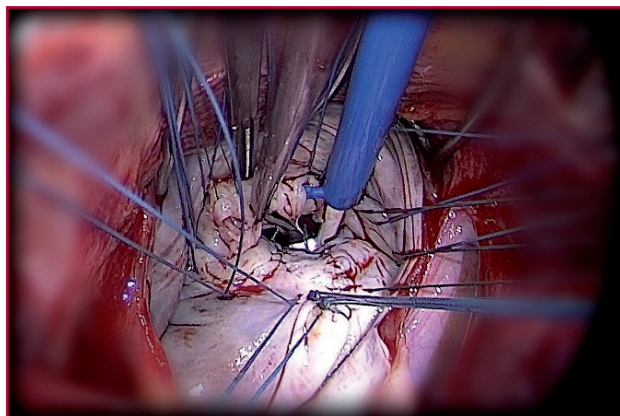


Fig. 1. Measurement of chordal length

Following the “respect rather than resect” approach, triangular resection of P2 was performed in 11 patients. All the patients underwent implantation of a semiflexible ring with a size between 28 and 34 mm. Intraoperative color-Doppler echocardiog-

raphy showed adequate coaptation of both leaflets without mitral regurgitation in 10 patients and minimal mitral regurgitation in the remaining 3 patients. None of the patients presented transmitral gradients or systolic anterior movement of the anterior mitral leaflet.

During the postoperative period, one patient with a history of chronic obstructive lung disease developed minor respiratory complications, and another patient presented severe biventricular dysfunction with complete recovery before discharge. There were no deaths in this consecutive series. The results of the Doppler echocardiography before discharge were the same as those obtained during surgery.

DISCUSSION

Mitral valve repair has demonstrated better outcomes compared with valve replacement in multiple studies, and is therefore considered to be the treatment of choice for this condition. There are many techniques for valve repair, including resection of the prolapsing segment, chordal transposition, the Alfieri technique

Fig. 2. Intraoperative view of the premeasured neochords. A. Anterior leaflet. B. Posterior leaflet.

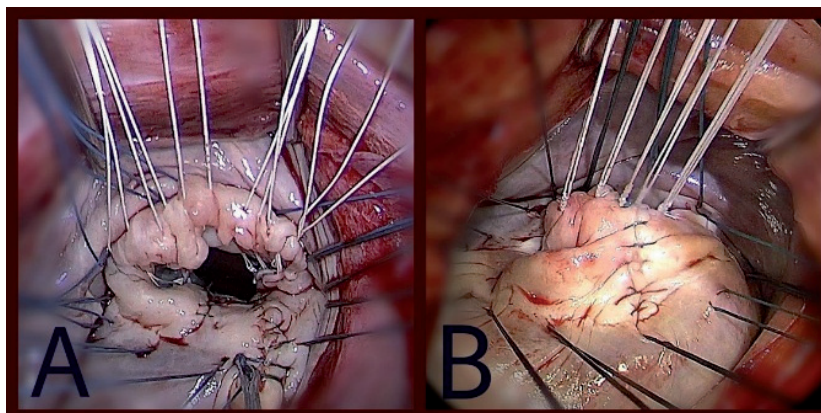
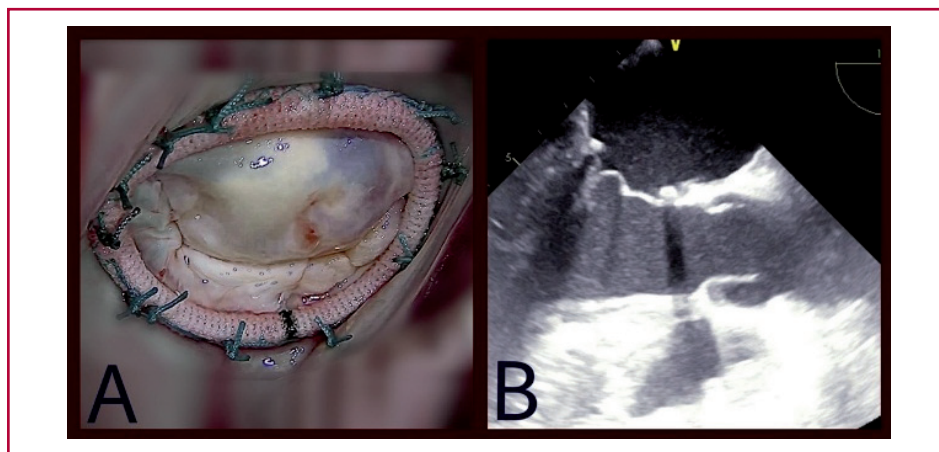


Table 1. Results of operative times, concomitant surgical technique, chordal length and number of loops per patient

Patients	ACC min	CPB min	annuloplasty ring	Chordal length	Number of loops	Posterior leaflet resection	MAZE
1	79	94	32	20 mm	6	NO	NO
2	68	101	32	24 mm	6	Triangular	NO
3	57	70	32	20 mm	6	Triangular	NO
4	86	106	34	20 mm	3	Triangular	NO
5	75	105	34	20 mm y 16 mm	6	Triangular	YES
6	95	122	32	24 mm	6	Triangular	YES
7	67	75	28	16 mm	3	Triangular	NO
8	75	120	28	24 mm	6	Triangular	NO
9	60	70	32	20 mm	6	Triangular	NO
10	60	75	32	20 y 24 mm	6	Triangular	NO
11	70	82	32	16 mm	6	Triangular	YES
12	70	85	34	24 mm	6	Triangular	NO
13	38	51	34	16 mm	3	NO	NO

ACC: Aortic cross-clamp. CPB: Cardiopulmonary bypass.

Fig. 3. A. Intraoperative view. Direct vision of mitral valve repair with good coaptation and no evidence of residual mitral regurgitation. **B.** Intraoperative transesophageal echocardiography with good mitral valve coaptation.



and annuloplasty, among others. There are also several reports about the use of artificial neochords, which is a widely used technique in many centers of excellence and is sometimes the first option when choosing the surgical approach for patients with this condition.

We present the initial experience of 13 patients presenting with severe myxomatous mitral regurgitation with elongated or ruptured chords undergoing mitral valve repair with replacement of the damaged chords by premeasured PTFE chordal loops. In all the patients, valve repair was feasible; thus we believe that this technique facilitates and enables the repair of the prolapsed posterior leaflet, anterior leaflet or both.

The possibility of accurately measuring the chordal length with a specific instrument allowed the successful repair of prolapse in all the patients that was confirmed by the visualization of good leaflet coaptation during intraoperative and postoperative Doppler echocardiography. The caliper used for measuring chordal length is simple, convenient and versatile to know the correct anatomy of the valve.

We believe that the availability of premeasured chordal loops decreases the operative time and that the high interest observed in this technique among surgeons encourages an evaluation of mid- and long-term outcomes. (6, 7) Vrancic et al. have demonstrated that the use of neochords has expanded the indications of mitral valve repair. (8)

CONCLUSION

Despite the small sample size, the good results in all the cases lead us to conclude that complex mitral valve repair using premeasured PTFE chordal loops is a valid option in addition to the traditional repair

techniques, as it is effective, safe and highly reproducible even under adverse conditions. We consider that the use of this type of neochords would increase the likelihood of performing mitral valve repair.

As this is the initial experience of our surgical team, we need more patients to draw significant conclusions.

Conflicts of interest

None declared. (See authors' conflicts of interest forms on the website/Supplementary material).

REFERENCES

1. Suri RM, Schaff HV, Dearani JA, Sundt TM 3rd, Daly RC, Mullany CJ, et al. Survival advantage and improved durability of mitral repair for leaflet prolapse subsets in the current era. *Ann Thorac Surg* 2006;82:819-26. <http://doi.org/cb75v7>
2. Frater RW, Vetter HO, Zussa C, Dahm M. Chordal replacement in mitral valvulopathy. *Circulation* 1990;82:IV125-30.
3. Perier P, Hohenberger W, Lakew F, Batz G, Urbanski P, Zacher M, et al. Toward a new paradigm for the reconstruction of posterior leaflet prolapse: mid-term results of the 'respect rather than resect' approach. *Ann Thorac Surg* 2008;86:718-25. <http://doi.org/dgwq59>
4. David TE, Armstrong S, Ivanov J. Chordal replacement with polytetrafluoroethylene sutures for mitral valve repair: a 25-year experience. *J Thorac Cardiovasc Surg* 2013;145:1563-9. <http://doi.org/tt9>
5. Von Oppell UO, Mohr FW. Chordal replacement for both minimally invasive and conventional mitral valve surgery using premeasured gore-tex loops. *Ann Thorac Surg* 2000;70:2166-8. <http://doi.org/fppdk6>
6. Gillinov AM, Banbury MK. Pre-measured artificial chordae for mitral valve repair. *Ann Thorac Surg* 2007;84:2127-9. <http://doi.org/fjsf7g>
7. Falk V, Seeburger J, Czesla M, Borger MA, Willige J, Kuntze T, et al. How does the use of polytetrafluoroethylene neochordae for posterior mitral valve prolapse (loop technique) compare with leaflet resection? A prospective randomized trial. *J Thorac Cardiovasc Surg* 2008;136:1200-6. <http://doi.org/fw49ms>