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# Crossed papillopexy with graft in mitral valve replacement: case report

## *Papilopexia cruzada com enxerto na substituição da valva mitral: relato de caso*

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***Abstract***

**The aim of this study is to present the crossed papillopexy technique using bovine pericardial graft in mitral replacement caused by intense valvar and subvalvar fibrosis and calcification. This technique allows the functional preservation of the mitral subvalvar apparatus and was successfully applied, by the first time as far as we known, in a patient with calcified rheumatic mitral stenosis, who underwent mitral valve replacement surgery. The patient had an uneventful recovery and was discharged home on postoperative day 6. Echocardiography controls showed normal left ventricular function without any interference on the mitral prosthesis dynamics.**

***Descriptors:*** **Mitral valve/surgery. Papillary muscles/ surgery. Heart valve prosthesis.**

***Resumo***

**O objetivo deste artigo é mostrar a técnica da papilopexia cruzada com o uso de enxerto de pericárdio bovino na substituição mitral por fibrose e calcificação intensa valvar e subvalvar. Esta técnica permite a preservação funcional do aparelho subvalvar mitral e foi aplicada pela primeira vez, na literatura alcançada, em paciente portador de estenose mitral reumática calcificada, submetido a troca valvar mitral. O paciente evoluiu sem complicações, com alta hospitalar em seis dias. Controles ecocardiográficos mostraram função ventricular esquerda preservada sem interferência na dinâmica da prótese mitral.**

***Descritores:*** **Valva mitral/cirurgia. Músculos papilares/ cirurgia. Próteses valvulares cardíacas.**

## INTRODUCTION

The mitral subvalvar apparatus (MSVA) consists of the papillary muscles and two sets of tendinous cords. MSVA performs a double function to maintain valve competence and to strength left ventricular systolic function. The importance of the papillary-annular continuity to a better overall systolic performance with valvular-ventricular interaction has been shown in clinical trials with improvement of results and left ventricle performance. These studies support the preservation of all chordate tendinae in mitral valve replacements [1]. Experimental studies have documented the overall dysfunction of the left ventricle contractility (Fig. 1A) when all the chordate tendinae are severed [1,2]. Mitral valve repair is associated with a higher survival and better left ventricular function compared to prostheses implantation in part due to the preservation of MSVA [3]. However, mitral valve repair techniques are not always feasible or indicated, leading to mitral valve replacement, mainly in the cases of impairment due to fibrosis or calcification.

Lillehei et al. [4] in the pioneer years of mitral valve replacement surgeries, over the early 1960s, concluded that

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This study was carried out at the Cordis - Clinica de Doenças do Coração Ltda, Vitória, ES, Brazil.

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the preservation of mitral chordate tendinae resulted in a lower operative mortality rate in comparison to the resection techniques of MSVA. These procedures were improved by Carpentier and stimulated with the successive studies by Deloche et al. [5], which supported the preservation of MSVA.

Frater et al. [6], in 1983, were the first ones to use bovine pericardial (BP) strips to replace the chordate tendinae. Advances against the calcification of the bovine pericardium largely used in biological prostheses made from the studies by Braile et al. [7], in 1983, in Brazil, stimulated their use as supportive material. In 1987, Gomes [8] reported surgeries preserving the supportive framework of the anterior papillary complex with the subvalvar intersection of chordae. Also, Gomes et al. [9], in 1990, reported a technique to preserve the subvalvar apparatus with the homolateral interposition of the segment of glutaraldehyde-fixed bovine pericardium (Fig. 1B) in order to maintain the connection between the papillary muscles and the mitral valve ring. It was evidenced that this reconstitution is made necessary along with the ventricular-annular continuity, especially when the subvalvar structures are compromised. Posteriorly, Gomes et al. [10] presented a new conception to increase the structural support with the intersection of the chordate tendinae, attaining satisfactory results (Fig.1C).

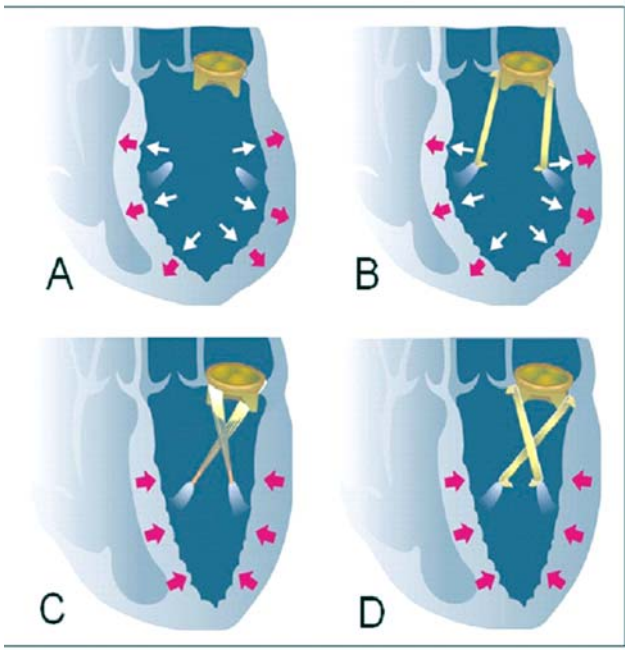


*Fig. 1 (A) Pathological left ventricular remodeling after removal of mitral SVA; (B) functional dynamic of mitral SVA with BP graft "in parallel"; (C) crossed papillopexy with native SVA; (D) crossed papillopexy with BP strips*

The current report aims, based on the abovementioned researches, to describe the procedure of mitral subvalvar left ventricle remodeling, replacing the chordae tendinae by a graft (BP stripe) interposed in a cross fashion (Fig. 1D) between the mitral valve ring and the papillary muscles when the use of a native MSVA is not feasible. We chose to use a 0.5% glutaraldehyde solution to fix bovine pericardium, considering the well-known fact of its large use in cardiovascular surgery [11] as the biological valve prostheses the most used material, assuring to the stripe used in the crossed papillopexy the same shelf life of its use in other cardiovascular applications.

## CASE REPORT

We report a case of a 52-year-old female patient admitted to the Centro Integrado de Assistência à Saúde (CIAS - Unimed - Vitória - ES) on September 16th 2007, with clinical, echocardiographic, and cinecoronariographic diagnosis of rheumatic mitral and aortic valve double disease. In the mitral valve, severe stenosis was predominant, and in the aortic valve, light insufficiency was predominant. Echocardiographic assessment showed the following measurements: LA = 44 mm, LVDD = 47 mm, LVSD = 28 mm, and EF = 71%.

A clinical referral recommended mitral valve replacement. Knowing the development of aortic valve insufficiency with progressive volume and pressure overload over the left ventricle, which characterizes it further dilation, it was recommended the MSVA preservation.

The patient underwent surgery, on September 17th 2007, using median sternotomy; normothermic cardiopulmonary bypass support and aortic cross-clamping with intermittent antegrade normothermic blood cardioplegic protection were established.

After left atriotomy, visualization of mitral valve confirmed the clinical diagnosis. On surgical examination, a marked calcification of valve leaflets and shortening of subvalvar apparatus were evidenced, corroborating the need of completely removing the leaflets and chordate tendinae. As a result, the fixation of the native subvalvar apparatus close to the mitral annulus was not feasible due to the intense rheumatic involvement.

As an immediate surgical strategy to mitral valve replacement with preservation of a functional subvalvar apparatus, an interposition of the bovine pericardium segments, measuring 5 mm wide as a surrogate of chordate tendinae was the surgeon's choice (Figure 1). The distal extremity of the grafts was fixed, at the apex of each papillary muscle at its fibrotic portion, by three stitches using 4-0 polypropylene suture anchored with Teflon cushion, in the transition zone between the muscular plan and the thickened chordate tendinae. Based on the article by Gomes

et al. [10], published in 2005, which recommended crossed papillopexy using the native subvalvar apparatus, a fixation of the proximal bovine pericardium extremities in a cross fashion to the mitral annulus was chosen. The proximal fixations were set close to the areas of the removed native valve commissures. Next, a biological bovine mitral prosthesis was implanted by means of individual sutures in a "U" format, anchored by cushion, according to the conventional technique.

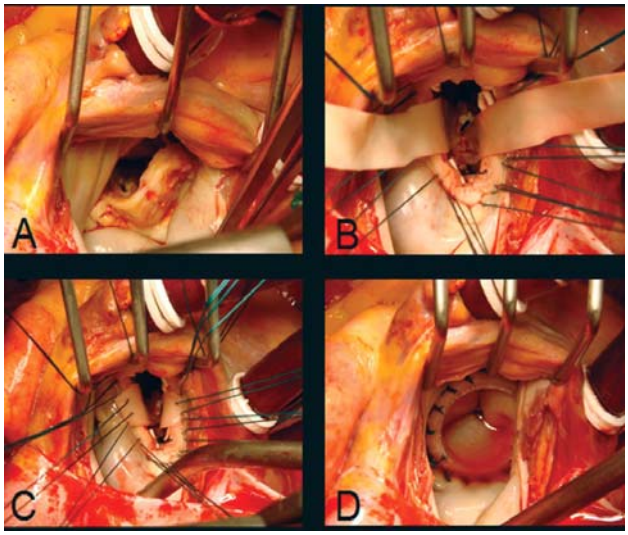


*Fig. 2 (A) Severe mitral valve calcification, (B) crossed BP strips fixed to the edge of papillary muscles; (C) Suturing of BP strips on the mitral annulus; (D) Implanted mitral bioprosthesis*

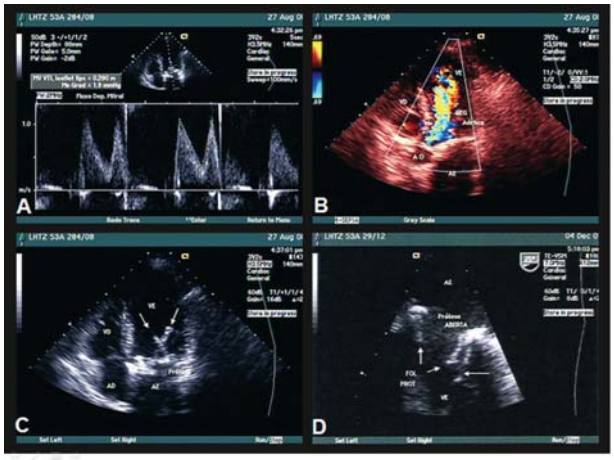


*Fig. 3 – (A) Mitral bioprosthesis with normal gradient; (B) Slight aortic valve regurgitation; (C) Crossing of subvalvar grafts; (D) Normal opening of mitral bioprosthesis*

Patient's immediate and hospital postoperative periods were uneventful, and she was discharged on day 6 after admission. Echocardiographic study performed 6 months after surgery showed the following measurements: LA = 36.6 mm; LVDD = 45.3 mm, LVSD = 30.0 mm; LVEDV = 93.9 mL; LVESV = 35.0 mL; and EF = 62%; normofunctioning mitral bioprosthesis; mean pressure gradient = 3.9 mmHg; and mitral area of 2.70 $cm^2$. Left ventricular function was shown to be preserved without interference on the mitral valve prosthesis dynamics. There was no flow obstruction in the LF resulting from the decussation of subvalvar grafts (Figure 3A to 3D).

At 6-month postoperative follow-up, the patient is asymptomatic and in NYHA functional class I.

## DISCUSSION

Current scientific evidences suggest that the mitral valve repair surgery is superior to mitral valve replacement, as evidence by the recent published meta-analysis [12]. In cases where the replacement is recommended, the preservation of the MSVA maintains left ventricular function, thus increasing survival. Mitral surgical repair is not always feasible or successfully performed, especially in children with rheumatic mitral valve disease and in valves severely compromised by calcification and fibrotic distortion.

Such patients need valve replacement. In these cases, survival can be increased by preserving the native MSVA, avoiding the pathologic remodeling of the LV (Fig. 1A). When it is not feasible to use native MSVA, graftings to replace the chordate tendinae can be used. Up to that time, these techniques were not being routinely used, despite the studies showing better outcomes with repair surgeries and in prostheses implantation preserving MSVA. Their real values were darkened by the limited number of comparative studies. Recently, a meta-analysis has confirmed the evidences of mitral valve repair superiority over the mitral valve replacement.

The major mitral valve anatomicopathologic alterations are the result of rheumatic disease and fibroelastic degeneration which interfere in the dynamics of mitral valve apparatus. The cusps may be excessively retracted or redundant and the chordate tendinae, in their turn, can present themselves retracted, elongated or ruptured. Commissural fusion with or without calcification can be associated in some cases. In cases where the valve impairment makes the surgical repair unfeasible due to the high degree of tissue involvement, it is recommended mitral replacement by preserving MSVA. Polytetrafluoroethylene sutures can also be used to replace rupture chordate tendinae with reoperation indexes of 94.3% and 81%, respectively for five and ten years, thus validating the proposal of its use as recommended by David et al [13], in 1991.

Frater et al. [6], in 1983, was the first one to use bovine pericardium strips to successfully replace chordae tendinae.

The acceptance of using glutaraldehyde-fixed bovine pericardium to maintain the interaction between the ventricle and the mitral valve annulus in the present case report, is due to its large use to manufacture bioprostheses, to correct congenital heart diseases, to reconstruct ventricle walls and great vessels with a low indexes of rupture and calcification in the long-term. A 5% glutaraldehyde solution was used to fix the bovine pericardium, which was submitted to anti-calcifying treatment using glutamic acid in alkaline pH. This improves its mechanical properties and minimizes the calcification process [11].

Gomes et al. [10] clearly comment that, when analyzing the potential negative ventricular remodeling postoperative, the crossed papillopexy (Fig. 1C) offers optimized geometrical support reducing the side-to-side displacement of the bases of each papillary muscle and of the respective ventricular wall. In a healthy heart, at the end of the diastole, the subvalvar apparatus works out as a restrainer of the ventricular sphericity. At the beginning of the isovolumetric contraction, the mitral valve cuspids close, causing the traction at the most of the tendineae chordae, what allows the perfect union of the mitral cuspids. This movement causes a radial displacement of the papillary muscles into de the left ventricular cavity. When the resultant of the forces, considered as the axis, is transferred from its natural oblique position toward a parallel position to the ventricular wall, with no angulation, the auxiliary effect of the restraint (diastole) or of the traction (systole) exerted by the whole structure is lost. This force works out to protect against the extreme sphericity besides its contribution to the ventricular contraction.

Respected the inherent limitations to the rarity of the present case report, it can confirm that the crossed papilloplexy is also technically feasible successfully with the use of bovine pericardium segments (Fig. 1D). It is also evident in the present study the echocardiographic study findings, evidencing that the decussation of the papillary structure with bovine pericardium graft did not interfere with the functional dynamics of the implanted mitral valve prosthesis.

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