UNIVERSIDADE FEDERAL DE MINAS GERAIS
Faculdade de Medicina
Programa de Pós-graduação em Cirurgia e Oftalmologia

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NOVEL SEMI-RIGID RING ANNULOPLASTY FOR CONCOMITANT TRICUSPID VALVE REPAIR DURING RHEUMATIC MITRAL VALVE PROCEDURES

Belo Horizonte
2024

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Dissertação apresentada ao Programa de Pós-Graduação em Cirurgia e Oftalmologia da Faculdade de Medicina da Universidade Federal de Minas Gerais como requisito parcial à obtenção do título de Mestre.

Orientador: Prof. Doutor Claudio Leo Gelape

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MEDICINA - CENTRO DE PÓS-GRADUAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS APLICADAS À CIRURGIA E À OFTALMOLOGIA

ATA DE DEFESA DE DISSERTAÇÃO

Às 08:00 horas do dia primeiro de dezembro de dois mil e vinte e três, através da Plataforma LifeSize realizou-se a sessão pública para a defesa da Dissertação de **BERNARDO PARREIRAS GUIMARÃES TARABAL**. A presidência da sessão coube ao professor Cláudio Léo Gelape (orientador). Inicialmente, o presidente fez a apresentação da Comissão Examinadora assim constituída: Cláudio Léo Gelape, Universidade Federal de Minas Gerais, Gustavo Bernardes de Figueiredo Oliveira, Instituto Dante Pazzanese de Cardiologia, Renato Tambellini Arnoni, Instituto Dante Pazzanese de Cardiologia. Em seguida, o candidato fez a apresentação do trabalho que constitui sua Dissertação de Mestrado, intitulada: **NOVEL SEMI-RIGID RING ANNULOPLASTY FOR CONCOMITANT TRICUSPID VALVE REPAIR DURING RHEUMATIC MITRAL VALVE PROCEDURES**. Seguiu-se a arguição pelos examinadores e logo após, a Comissão reuniu-se, sem a presença do candidato e do público e decidiu considerar aprovada a Dissertação de Mestrado. O resultado final foi comunicado publicamente ao candidato pelo presidente da Comissão. Conforme os arts. 76 e 77 das Normas Gerais de Pós-Graduação da UFMG, as defesas de dissertação e tese são públicas. O aluno e os membros da banca estão cientes e autorizaram a gravação desta defesa, que ficará disponibilizada em acervo da Universidade. Nada mais havendo a tratar, o presidente encerrou a sessão e lavrou a presente ata que, depois de lida, se aprovada, será assinada pela Comissão Examinadora.

Belo Horizonte, 01 de dezembro de 2023.

Assinatura dos membros da banca examinadora:

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RESUMO

A regurgitação da válvula tricúspide é extremamente prevalente na população em geral. (31-38) Devido à falta de dados consistentes sobre o acompanhamento e tratamento adequado de pacientes reumáticos com regurgitação tricúspide secundária, 20 pacientes foram acompanhados por 2 anos após a cirurgia no serviço de cardiologia da Universidade Federal de Minas Gerais. Os pacientes foram tratados cirurgicamente com o anel semirrígido Star Ring®. Conseguimos mostrar que o tratamento com o anel é eficiente e que os pacientes tiveram redução significativa da regurgitação valvar.

Palavras-chave: Válvula tricúspide; Star Ring®; regurgitação tricúspide; doença reumática; doença valvar; reparo da válvula tricúspide; reparo da válvula; doença da válvula mitral.

ABSTRACT

Tricuspid valve regurgitation is extremely prevalent in the general population. (31-38) Due to the lack of consistent data regarding adequate follow-up and treatment of rheumatic patients with secondary tricuspid regurgitation, 20 patients were followed up for 2 years after surgery at the cardiology department of the Federal University of Minas Gerais. Patients were surgically treated with the semi-rigid Star Ring®. We were able to show that the treatment with the ring is efficient and that the patients had a significant reduction in valve regurgitation.

Keywords: Tricuspid valve; Star Ring®; tricuspid regurgitation; rheumatic disease; valve disease; tricuspid valve repair; valve repair; mitral valve disease.

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LIST OF ABBREVIATIONS

ACC	American College of Cardiology
AHA	American Heart Association
EACTS	European Association for Cardio-Thoracic Surgery
ECT	Extracorporeal Circulation Technique
ESC	European Society of Cardiology
FAC	Fractional Area Change
FTR	Functional Tricuspid Regurgitation
HC-UFMG	Hospital das Clínicas of Federal University of Minas Gerais
NYHA	New York Heart Association
TR	Tricuspid Regurgitation
TV	Tricuspid Valve

SUMMARY

1. INTRODUCTION

Once nicknamed the “forgotten valve”, the tricuspid valve (TV) has finally garnered the attention of all surgery and cardiology societies. (39) At least 1.6 million Americans are affected by severe tricuspid regurgitation (TR), and this number is likely underrepresented (1). More than 80% of TR arises from a functional mechanism but TR can also arise from organic/primary valve disease, commonly from pacer leads affecting leaflet motion (2,27).

Functional Tricuspid Regurgitation (FTR) is defined as an acquired, nonorganic tricuspid valve pathology and can result from advanced left side disease, pulmonary hypertension, right ventricular dilation or right atrial dilation, all of which can lead to tricuspid annular dilation. (3,25).

In patients with mitral stenosis, the incidence of moderate or greater FTR has been shown to be as high as 33% to 38%. (7,8,27).

FTR was first noted in the 1950s when resolution of FTR was believed to occur as a result of the correction of the left-side disease (4,40-43). Later in the 1960s, Braunwald et al. demonstrated, in a study of patients with severe FTR undergoing mitral valve replacement, that the FTR resolved after correction of the mitral pathology (5). However, as time passed by, an increase in the prevalence of residual FTR was seen in patients who originally had correction of left-side lesions without concomitant right-side surgery (6). Furthermore, many additional studies have demonstrated high rates of TR during late postoperative follow-up (9,10,11,12) and increased long-term morbidity and mortality from moderate-to-severe FTR in cohorts of patients undergoing isolated mitral valve surgery (13).

The FTR can increase risk of morbidity and mortality as time goes by. Thus, the central dogma behind the treatment of FTR began to be called into question by the community of cardiologists and surgeons. (44-51)

The cause of the valve disease, on both left and right sides, the rheumatic disease is strongly associated with mitral valve disease and secondary tricuspid regurgitation (functional) *(Image 1)*. Serious and prevalent disease in Brazil, caused by an autoimmune reaction after *Group A Streptococcus beta-hemolytic* infection, rheumatic fever affects mostly women, young and economically vulnerable people, causing, among other symptoms, a pancarditis that can affect pericardium, epicardium, myocardium and

endocardium. For this last one, the inflammation can extend up to the cardiac valves, progressing to valvulitis (mostly mitral or aortic) and cause significant deterioration of the structures affected by it. The disease varies in intensity, however, in the most severe cases, it can lead to acute cardiac insufficiency and death. (20,21,22,23)

RF remains a significant contributor to morbidity, particularly in developing countries. The annual incidence varies widely from 0.5 per 100,000 people in the USA, escalating to 8 per 100,000 to 51 per 100,000 in children and young adults in developing countries. (28,29,30) Therefore, the research and guidelines that guide the conduct of valve heart disease, lack data regarding rheumatic patients, commonly perceived in third world countries.

Figure 1 – Anatomy of the Tricuspid Valve

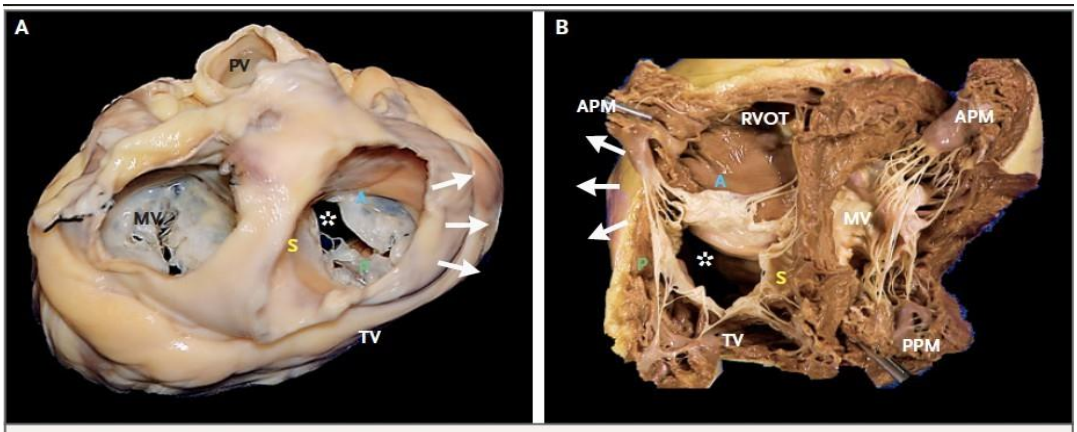


Figure 1. Anatomy of the Tricuspid Valve (TV).

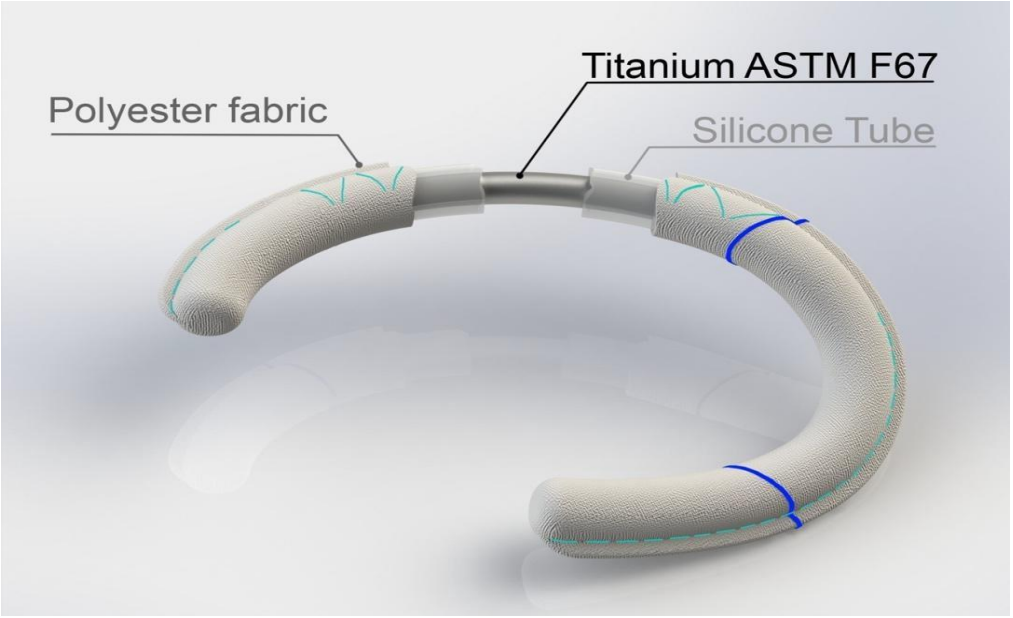
As seen from the atrial aspect (Panel A), the valve has a D-shaped annulus, with the septal leaflet (S) adjacent to the interatrial and interventricular septum, the anterior leaflet (A) posterior to the aorta and pulmonic valve (PV), and the posterior leaflet (P) closest to the diaphragm. In this pathological specimen, the lateral annulus is dilated (arrows), resulting in a large leaflet coaptation gap (asterisk). The subvalvular complex is seen from the ventricular aspect (Panel B), with direct chordae from the septum to the septal and anterior leaflets and a large anterior papillary muscle (APM) supplying chordae to both the anterior and posterior leaflets. Displacement of the APM, caused by dilatation of the mid-to-apical right ventricular free wall (arrows) or a change in the position of the septum, will result in tethering of TV leaflets and a coaptation gap. MV denotes mitral valve, PPM posterior papillary muscle, and RVOT right ventricular outflow tract. Photographs courtesy of Dmitry Levin.

Source: N Engl J Med 2023;388:1876-91. DOI: 10.1056/NEJMra2216709

2. OBJECTIVES

This study presents the mid-term results (two years) of a novel tricuspid valve (TV) repair strategy with a semi-rigid ring (Star Ring®, made by LABCOR®) with no adjunctive procedures applied for the correction of functional tricuspid regurgitation (FTR), associated with mitral intervention in rheumatic mitral disease patients.

Figure 2 - Star Ring®



The Star Ring® *(Figure 2)* was created by Dr. Anas Sarraj Asil, from the Cardiovascular Surgery Department of the University Hospital of Marqués de Valdecilla, in Santander, Spain, and it is manufactured with a rigid titanium core as a basis, covered by a silicone tube and a polyester fabric. It has a tridimensional shape, is anatomically configured to treat tricuspid functional regurgitation and presents an open side that prevents interference in the cardiac conduction system. Besides its rigid core, the tip is flexible to easily adapt to its corresponding area. The ring is produced in Brazil by LABCOR® and it is available in sizes from 26 to 36.

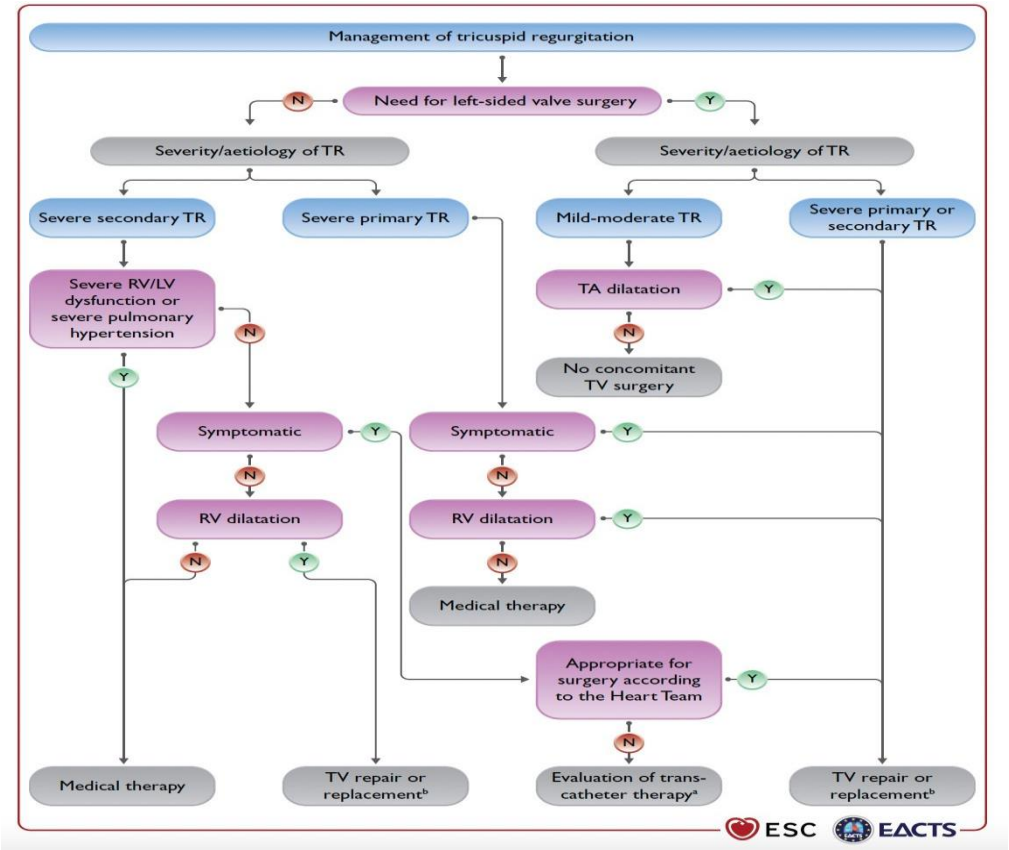
2.1 Guidelines

Both, the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for the management of patients with valvular heart disease (14) and the Joint European Society of Cardiology (ESC)/European Association for Cardio-Thoracic Surgery (EACTS) guidelines (15) take a more assertive approach to both identifying the stages of tricuspid regurgitation and treating FTR in patients undergoing cardiac surgery.

The 2020 ACC/AHA guidelines classify >40 mm (or >21 mm/m2 of body surface) as significant annular dilation measured in the apical 4-chamber view using transthoracic echocardiography. In patients undergoing left-side valve surgery, tricuspid valve surgery should be performed for severe tricuspid regurgitation.

The 2021 joint ESC/European Association for Cardio-Thoracic Surgery guidelines also recommend valve repair over valve replacement if technically possible and state that a repair does not add appreciative risk to the primary surgery.

Figure 3 – Management of tricuspid regurgitation



Source: *2021 ESC/European Association for Cardio-Thoracic Surgery guidelines*

A meta-analysis of 10 studies including 2,488 mild-to-moderate FTR patients undergoing mitral valve surgery demonstrated that patients who underwent concomitant tricuspid valve annuloplasty were less likely to experience progression to moderate-to-severe TR (16). The authors concluded that although not everyone may benefit from concomitant tricuspid surgery, a more aggressive approach in treating tricuspid disease is in order to prevent severe FTR at follow-up.

3. MATERIALS AND METHODS

For this research, 20 patients from 31 to 69 years old were involved, 18 of them female, from 2018 to 2022, affected by the rheumatic disease, with a mitral valve disease associated with a secondary tricuspid valve regurgitation, from the cardiological ambulatory of the *Hospital das Clínicas* of Federal University of Minas Gerais (HC-UFMG), that would be submitted to combined valve surgery. After hospital discharge, these 20 patients were followed during 2 years to evaluate the effectiveness of the tricuspid repair to which they were been submitted. From this group, 18 were submitted to a tricuspid repair with LABCOR® number 26 ring plus mitral replacement; one was submitted to aortic valve replacement plus mitral replacement plus tricuspid repair with LABCOR® number 26 ring; and one to mitral repair plus tricuspid repair with LABCOR® number 26 ring. From the group that was submitted to a mitral replacement, 8 patients received biological valve prosthesis.

The echocardiograms were made using the equipment Vivid Q®, GE® with patients in left lateral decubitus position, using conventional parasternal and apical planes, according to standards created by the American Society of Echocardiography (1,2). The following techniques were used: bidimensional echocardiography (2D), pulsing and continuous Doppler-guided by color flow mapping and tissue Doppler. (52-61)

All patients were operated and cared by the same team from HC-UFMG.

Exclusion criteria: patients under 18 years old, with valve endocarditis, patient refusal or use of artificial heart pacing device.

Inclusion criteria: patients with rheumatic mitral valve disease and FTR, with indication to surgical approach of both valves.

Anesthetic technique: continuous electrocardiographic monitoring, arterial blood pressure at the radial artery, pulse oximetry, and central venous pressure. The body temperature was measured at the nasopharynx. Anesthetic induction with midazolam (0.005-0.1 mg/kg), etomidate (0.,3 mg/kg) ou propofol (2mg/kg), fentanyl citrate (5-10 mcg/kg) e pancuronium (0.1 mg/kg). After orotracheal intubation, the anesthetic maintenance was made with sevoflurane (0.5 at 1%) and oxygen (50 to 100%) in

controlled mechanical ventilation. Prophylactic antibiotic: cefazolin 2g every 2 hours during operation procedures and every 8 hours on postoperative for 48 hours.

Surgical technique: Median sternotomy. Systemic heparinization with 4mg/kg of weight, custom cold blood cardioplegia (400mL of intravenous sugar solution at 5%, 40mL of potassium chloride solution at 10%, 30mL of sodium bicarbonate solution at 8.4%, 3mL of magnesium sulfate at 50%, 20 UI of regular insulin) every 20 minutes, performed at the aortic root, associated with systemic mild hypothermia from 32 to 34 degrees Celsius. Oblique right atriotomy, with atrial septostomy, left chamber access, mitral valve surgical correction, left atrial appendage internally closure, using polypropylene suture material (Cox-Maze surgery was not performed). Septorrhaphy with polypropylene suture material, tricuspid valve measurements, followed by Labcor® tricuspid ring implant using ethibond 2-0 without Teflon suture material, *(figure 3, 4, 5 and 6)* interrupted. Maneuvers for deaeration of cardiac chambers, an increase of temperature up to
36.6 degrees Celsius, the opening of the aorta clamp, removal of cardiopulmonary bypass, removal of cannula, reversion of systemic heparin with protamine in a proportion of 1:1 (1 ampule of protamine for each 1 mL of heparin), hemostasis revision, temporary epicardial pacemaker implant, mediastinal drainage, closing by plans.

Extracorporeal Circulation Technique (ECT): All patients were operated using the same ECT equipment. The oxygenator used was the membrane one (Braile®), with cardiotomy and cardioplegia reservoirs. The tubes for arterial and venous lines were made with siliconized polyvinyl uncoated with heparin. The extracorporeal circuit was washed with 2 liters of a physiological solution that was discarded before the placement of the perfusate. The perfusate is composed of 1500 mL of Ringer Lactate solution. The blood addition to the perfusate was made when necessary, to keep the hematocrit between 25 and 30%. Cannulations of the ascending aorta and superior and inferior cava veins were made for venous drainage. The Activated Clotting Time (ACT) was held up to 400 seconds. Perfusion with a non-pulsatile roller pump. Arterial pressure held up between 60mmHg and 70mmHg with the application of arterial flow of 2.4 L/min/m^2 of the body surface.

The customized cardioplegia at 8 degrees was used for cardioplegic arrest.

Postoperative treatment: In patients with arterial hypotension (Mean

Blood Pressure <50mmHg), individualized maneuvers were made to keep the arterial pressure. For the treatment of arterial hypertension observed immediately after surgery, sodium nitroprusside was used at 25mg/mL, also observing each patient's necessities.

The patients were observed and evaluated clinically and echocardiographically at the preoperative and after two years of surgery.

The following are the physical data of the patients:

Table 1 - Descriptive analysis related to the clinical variable of nterest, in general

Study variables	Frequency	
	n	%
Age (in years)	**(n=20)**	
Mean ± s.d	52.8 ± 10.3	
C.I of mean (95%)	(47.9; 57.6)	
Median (Q1 - Q3)	54.5 (45.0 - 60.8)	
Minimum - Maximum	31.0 - 69.0	
Sex		
Male	2	10
Female	18	90
Total	**20**	**100**
Weight (kg)	**(n=20)**	
Mean ± s.d	59.5 ± 9.1	
C.I of mean (95%)	(55.2; 63.7)	
Median (Q1 - Q3)	59.5 (53.5 - 65.3)	
Minimum - Maximum	40.0 - 78.8	
Heigh (m)	**(n=20)**	
Mean ± s.d	1.60 ± 0.07	
C.I of mean (95%)	(1.57; 1.63)	
Median (Q1 - Q3)	1.60 (1.55 - 1.65)	
Minimum - Maximum	1.46 - 1.73	
Body Mass Index	**(n=20)**	
Mean ± s.d	23.3 ± 4.1	
C.I of mean (95%)	(21.4; 25.3)	
Median (Q1 - Q3)	23.0 (20.4 - 26.8)	
Minimum - Maximum	14.9 - 29.7	

Body Surface Area (m2)	**(n=20)**
Mean ± s.d	1.62 ± 0.13
C.I of mean (95%)	(1.56; 1.68)
Median (Q1 - Q3)	1.64 (1.53 - 1.69)
Minimum - Maximum	1.30 - 1.83

Atrial Fibrilation	**n**	**%**
Yes	16	80,0
No	4	20,0
TOTAL	**20**	**100,0**
Systemic Hypertension		
Yes	6	30,0
No	14	70,0
TOTAL	**20**	**100,0**
Diabetes		
Yes	3	15,0
No	17	85,0
TOTAL	**20**	**100,0**
Dyslipidemia		
Yes	1	5,0
No	19	95,0
TOTAL	**20**	**100,0**
Smoking		
Yes	7	35,0
No	13	65,0
TOTAL	**20**	**100,0**

Pulmonary Hypertension (mmHg)	**(n = 18)**	
Mean ± s.d	53,2 ± 19,5	
C.I of mean (95%)	(43,5; 62,8)	
Median (Q1 – Q3)	43,5 (37,8 – 71,5)	
Minimum - Maximum	29,0 – 93,0	
Chronic Kidney Disease		
Yes	1	5,0
No	19	95,0
TOTAL	**20**	**100,0**

Source: prepared by the author; *data base - 20 patients*

4. RESULTS

The following tables show the results in the preoperative and postoperative (two years after the surgical procedure) phases:

Table 2 - Descriptive and comparative analysis between pre and postoperative based on the clinical/echocardiographic variable of interest

Study variables	Study phase				p
	Pre		Post		
	n	%	n	%	
Left Atrium (mm)	(n = 20)		(n = 20)		
Mean ± s.d	57.7 ± 8.4		51.1 ± 8.7		
C.I of mean (95%)	(50.7: 58.6)		(47.0; 55.2)		0,025
Median (Q1 – Q3)	53.0 (50.0 – 57.8)		51.5 (46.3 – 58.5)		Z = 2.247
Minimum – Maximum	31.0 – 75.0		28.0 – 63.0		r = 0.50
Left Atrium Volume (mL)	(n = 16)		(n = 16)		
Mean ± s.d	89.7 ± 41		71.1 ± 25.6		
C.I of mean (95%)	(67.8; 111.6)		(57.4: 84.7)		0,003
Median (Q1 – Q3)	80.0 (66.5 – 95.8)		63.5 (57.5 – 76.8)		Z = 3.013
Minimum – Maximum	41.0 – 208.0		41.0 – 139.0		r = 0.75
Tricuspid Ring (mm)	(n = 11)		(n = 11)		
Mean ± s.d	33.0 ± 6.7		25.9 ± 3.8		
C.I of mean (95%)	(28.5; 37.5)		(23.4: 28.4)		0,019
Median (Q1 – Q3)	32.0 (27.7 – 38.0)		27.0 (22.0 – 29.0)		Z = 2.347
Minimum – Maximum	24.0 – 45.0		20.0 – 31.0		r = 0.67

Source: prepared by the author

Table 3 - Descriptive and comparative analysis between pre and postoperative based on the clinical/echocardiographic variable of interest

Tricuspid regurgitation	Study phase				p
	Pre		Post		
	n	%	n	%	
Mild	0	0	15	75	< 0.001
Moderate	7	35	5	25	Z = 4.043
Severe	13	65	0	0	r = 0.91
Total	20	100	100	100	
NYHA Heart Failure Classification	**Study phase**				**p**
	Pre		**Post**		
	n	**%**	**n**	**%**	
I	0	0	15	75	
II	8	40	4	20	< 0.001
III	9	45	1	5	Z = 3.573
IV	3	15	0	0	r = 0.80
Total	20	100	20	100	

Source: prepared by the author

Table 4 - Descriptive analysis related to the clinical variable of interest, in general

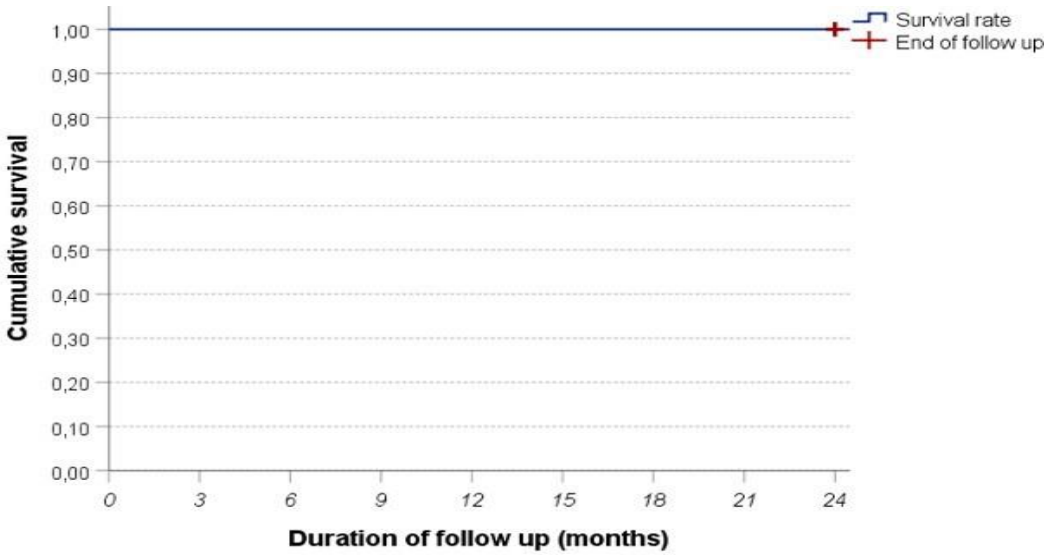
Study variables	Frequency
	n
Post-operative length of ICU stay (days)	**(n = 20)**
Mean ± s.d	3,9 ± 0,8
C.I of mean (95%)	(3,5; 4,2)
Median (Q1 – Q3)	4,0 (3,0 – 4,8)
Minimum - Maximum	3,0 – 5,0
Duration of mechanical ventilation (hours)	**(n = 20)**
Mean ± s.d	9,3 ± 3,1
C.I of mean (95%)	(7,8; 10,8)
Median (Q1 – Q3)	8,5 (7,0 – 11,0)
Minimum - Maximum	5,0 – 16,0
Post-operative length of hospital stay (days)	**(n = 20)**
Mean ± s.d	8,9 ± 2,2
C.I of mean (95%)	(7,8; 9,9)
Median (Q1 – Q3)	9,0 (7,0 – 10,0)
Minimum - Maximum	6,0 – 14,0

Table 5 - Descriptive analysis related to the clinical variable of interest, in general

Characteristics	Frequency
	n %
Nonelective surgery	0 (0%)
Right anterolateral minithoracotomy	0 (0%)
Isolated TV repair	0 (0%)
Concomitantly performed procedures:	
Left-sided valve surgery	20 (100%)
Mitral valve surgery	19 (95%)
Aortic valve and mitral valve surgery	1 (5%)
Coronary artery bypass grafting	0 (0%)
Aorta surgery	0 (0%)
Maze procedure	0 (0%
New renal replacement therapy	0 (0%)
Reoperation with cardiopulmonary bypass (all causes)	0 (0%)
Reexploration for bleeding	0 (0%)
Pericardial puncture/pericardiotomy	0 (0%)
Stroke during hospital stay	0 (0%)

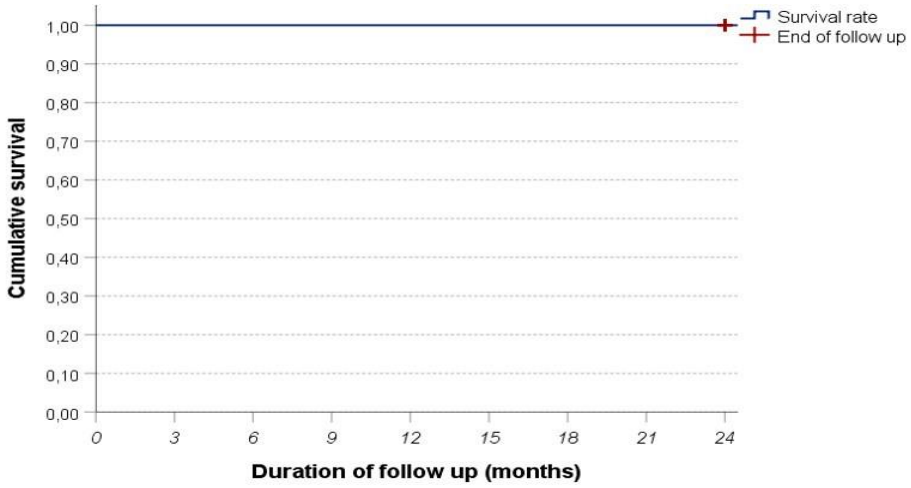
Source: prepared by the author

Figure 4 – Kaplan Meier survival curve for death



Source: data base - 20 patients

Figure 5 – Kaplan Meier survival curve for reoperation



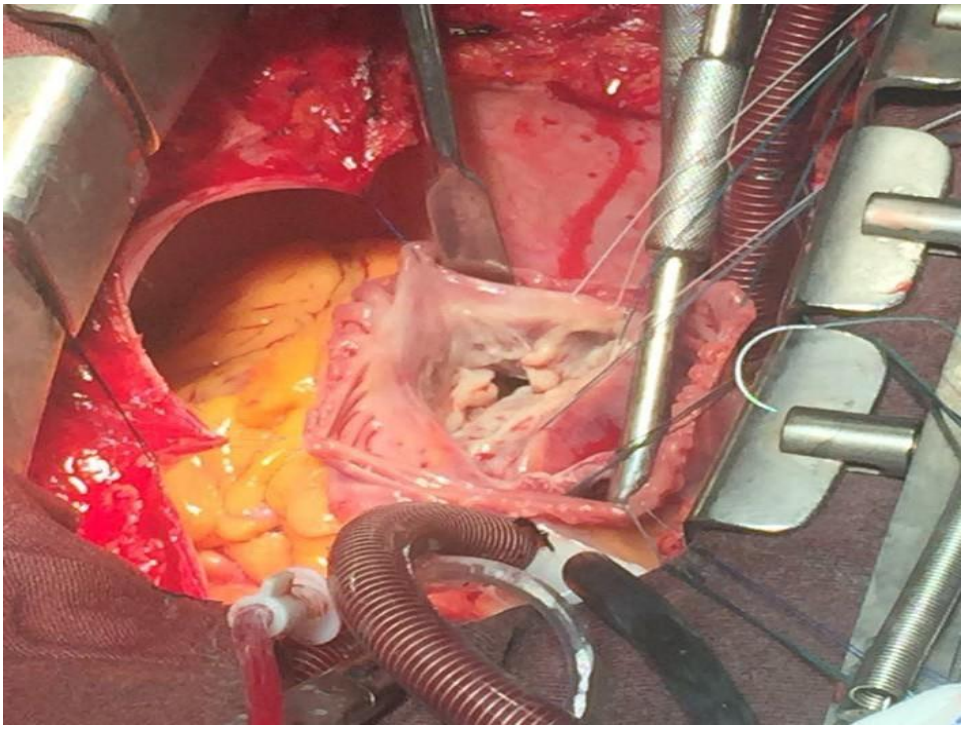
Source: data base - 20 patients

Table 6 - Descriptive analysis related to the clinical variable of interest, in general

Study variables	Frequency	
	n	%
Euroscore II (%)	**(n = 20)**	
Mean ± s.d	4,4 ± 4,0	
C.I of mean (95%)	(2,4; 6,3)	
Median (Q1 – Q3)	3,5 (1,6 – 6,3)	
Minimum - Maximum	0,9 – 16,5	
Cardiopulmonary by-pass (minutes)	**(n = 20)**	
Mean ± s.d	115 ± 29	
C.I of mean (95%)	(101; 129)	
Median (Q1 – Q3)	110 (90 – 140)	
Minimum - Maximum	80 – 178	
Aortic Clamp Time (minutes)	**(n = 20)**	
Mean ± s.d	98 ± 30	
C.I of mean (95%)	(84; 112)	
Median (Q1 – Q3)	81 (76 – 112)	
Minimum - Maximum	54 – 172	
Blood Transfusion		
Yes	11	55,0
No	9	45,0
TOTAL	**20**	**100,0**

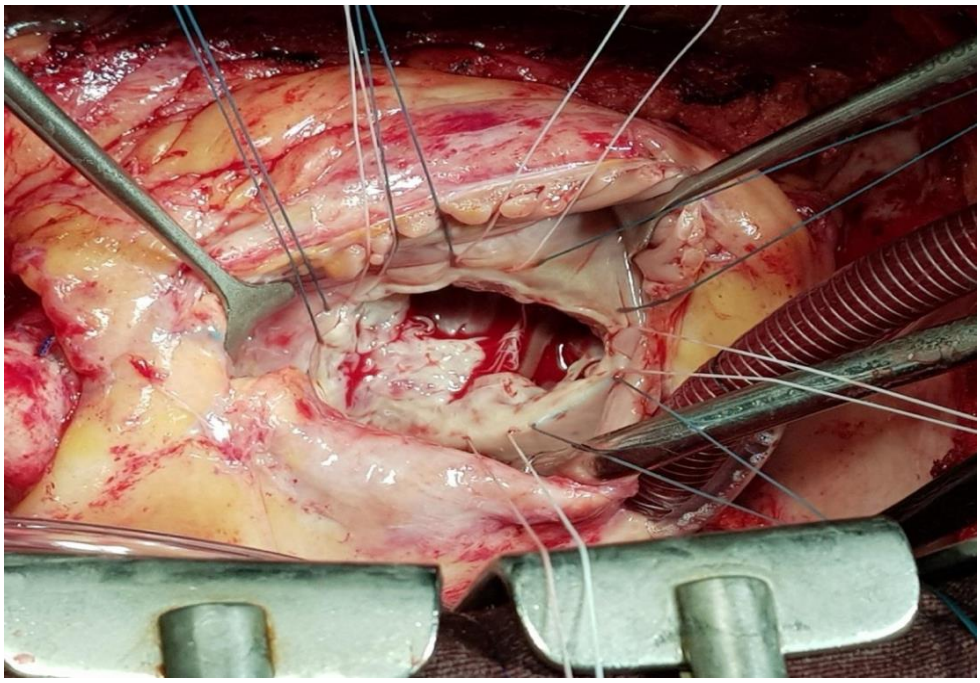
Data base: 20 patients
S.d - standard deviation
C.I of mean - confidence interval of the mean
P - Wilcoxon test significance probability
Z - test statistics
r - size of the effectic for non-parametric test

Figure 6 - Exposure of tricuspid valve



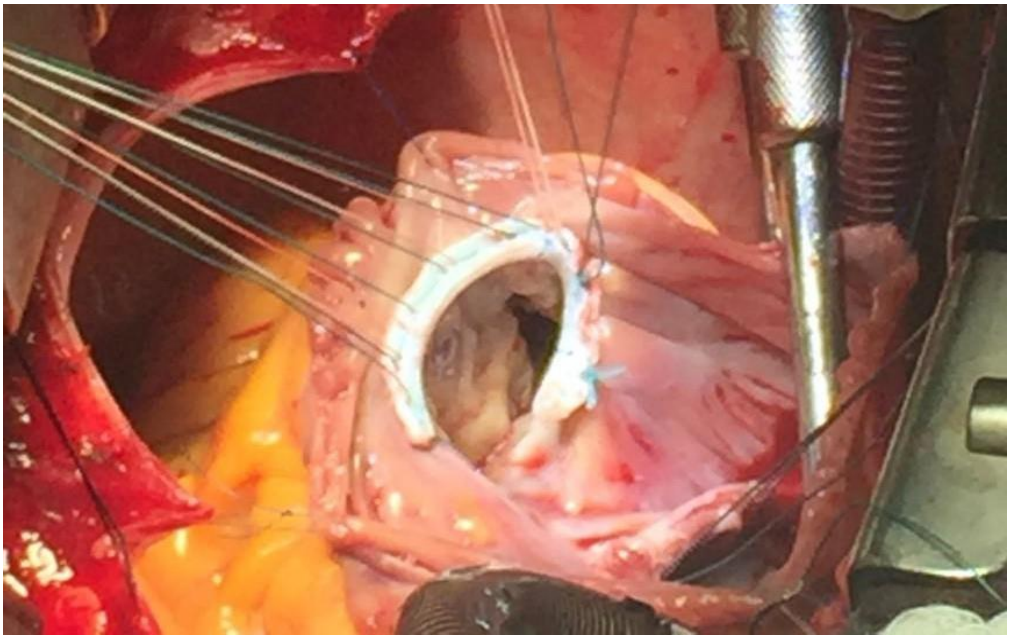
Source: Author's image

Figure 7 - Sutures on tricuspid valve ring



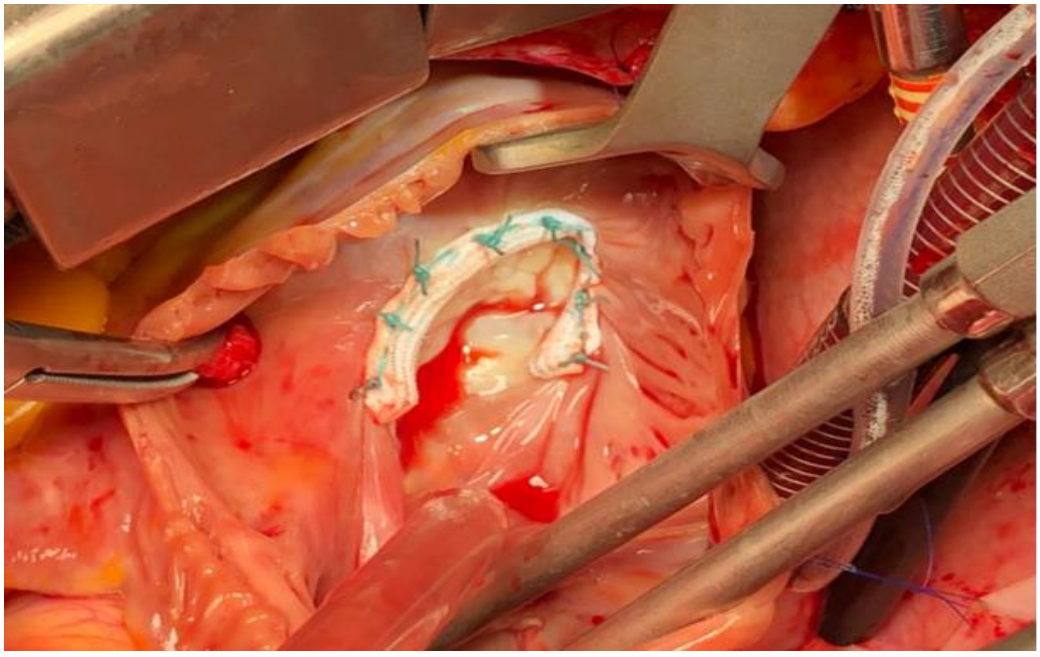
Source: Author`s image

Figure 8 - Suturing Star Ring®



Source: Author's image

Figure 9 - Final aspect of repaired tricuspid valve



Source: Author's image

5. DISCUSSION

The tricuspid repair with Star Ring® in patients with rheumatic valvular disease associated with mitral involvement presented as a safe and effective option *(figure 6 and figure 7)*, since after two years of surgical procedure, it shows measurements reduction, such as diameter reduction of the left atrium and reduction of the volume of the same chamber; tricuspid ring size reduction; tricuspid regurgitation degree reduction; in addition to significant improvement of functional capacity of the patient on a clinical evaluation, as described on Table 3.

It is important to highlight, as well, that none of the patients who were submitted to this surgical procedure needed a definitive cardiac pacemaker, either uni or dual chamber. An eventual complication that can occur in 5 to 15% of the patients submitted to surgery is the fact that they can predispose to several complications, such as higher rates of endocarditis and future recurrence of tricuspid regurgitation. (25,26)

In a vast revisional article published in 2023 by The New England Journal of Medicine (27) written by Dr. Rebecca T. Hahn, from Columbia University, the most common causes for secondary tricuspid regurgitation, in cases with normal valve leaflets, are listed, but in any part of the article is mentioned the Rheumatic Disease as one of the causes. The author mentions atrial fibrillation, pulmonary hypertension, and ventricular and atrial dilation, but the autoimmune disease caused by *Streptococcus beta-hemolytic from group A* infection did not get any attention in their study. (27)

If we take as an example the 2021 study that took place in New York, USA, we can understand that the patients in our study are, in general, shorter, thinner, female, and from Latin ethnicity, besides carrying the rheumatic disease, a fact that is not observed, commonly, in the most important research carried out Europe and North America. (19)

It is also observed that patients have access to the quaternary health service at an advanced point of their lives in our healthcare context, since at the time of surgery they had clinical and echocardiographic parameters outside the normal range, already, many times, in a certain clinical deterioration. Some measures were pointed out, like the Average Diameter of the Left Atrium at 54.7mm; Average Left Atrium Volume at 89.7 mL/m2 of body surface; Average FAC (Fractional Area Change) at 29.8%, and we can observe 12 patients, which means 60% total, in functional class NYHA (New York Heart Association) III or IV.

5.1 - Surgical Annuloplasty Procedures

In functional TR, there is a clear trend favoring repair, now performed in up to 89% of TV surgeries in the USA (17). It has demonstrated a rate of persistent severe TR (grade 3/4) after TV repair of 13% compared to 2% after replacement. Nevertheless, TV repair is preferred over replacement when a high likelihood of postoperative patent valve function can be expected (18).

Because concomitant tricuspid valve repair is being used increasingly in more patients at earlier stages, the question then turns to what is the best and most durable way to fix the tricuspid valve while imparting minimal risk (5).

The principles of tricuspid valve annuloplasty regardless of the technique are to (1) expose the valve and perform a thorough valve analysis, (2) ensure leaflet coaptation and mobility, (3) stabilize the tricuspid valve annulus and (4) avoid conduction system injury. Annuloplasty rings better distribute the tension over the suture line and result in decreased rates of recurrent or progressive FTR over time. It is very safe relating to injury of the cardiac conduction system which is protected in its anatomic zone. One of the disadvantages of partial annuloplasty rings is that may result in future recurrence of FTR because of a lack of stabilization of the posterior portion of the septal annulus.

Dr Andrew W. Siefert, PhD wrote that the “results suggest the 3D shape of annuloplasty rings, and not ring size, may be the contributing factor to the prohibition of recurrent tricuspid regurgitation in the studied patients” and probably their better prognosis after tricuspid valve repair. (62)

We choose to correct the FTR with a semi-rigid ring (LABCOR®) fixed with separate stiches, avoiding injury to the conduction system. It is recognized that this kind of material is more likely to stabilize and fix the annulus in the systole. As we treated patients with severe annular dilation and right ventricular dysfunction, the rigid ring can decrease annular motion during cardiac cycle avoiding FTR residual for a long time. In this number of patients, there were no necessary adjunctive procedures during tricuspid repair.

Considering that rheumatic fever and rheumatic heart disease are extremely prevalent in developing countries and probably underdiagnosed in the developed ones (63), it is necessary that the world cardiological community knows how and when is the right time to treat a patient with rheumatic valve injury. Over the past decade, an

important advocacy movement by the World Health Organization has raised awareness about rheumatic heart disease. Besides this, studies from the United States and Israel have highlighted that rheumatic heart disease is still an important public health problem even in high-income countries. (64) While the international community waits for a *Group A Streptococcus* vaccine or a medication that treats better rheumatic disease, all of us must know what is the best to offer to our patients when the possibility of a surgical treatment comes up. (64,65)

6. CONCLUSIONS

Beyond the fact that the Star Ring® proved to be extremely safe, once any patient had atrioventricular disjunction or needed pacemaker implant, tricuspid repair concomitant with rheumatic mitral valve procedures with this novel semi-rigid ring is a safe and effective treatment modality in terms of its mid-term results (as patients will continue to be monitored at HC-UFMG to better assess long-term data). This new technique provides an innovative perspective for the treatment of TR, especially in a very dilated tricuspid annulus and right ventricle dysfunction.

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