A new surgical technique for left atrial reduction in giant left atrium

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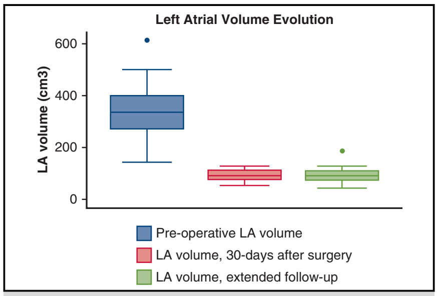
ABSTRACT

Objective: The study objective was to evaluate the safety and clinical and echocardiographic outcomes of a new surgical technique in adult patients diagnosed with a giant left atrium.

Methods: We analyzed a cohort of patients who underwent left atrium reduction surgery between January 2016 and June 2020 performed by a specialized surgical team in 2 national reference centers in Lima, Peru. We assessed the major adverse valvular-related events and the New York Heart Association functional class as primary clinical outcomes. Also, our primary echocardiographic endings were the diameter, area, and volume of the left atrium. We assessed these variables at 3 time periods: baseline (t0), perioperative period (t1), and extended follow-up (t2: 12 ± 3.4 months). We carried out descriptive and bivariate exploratory statistical analysis for dependent measures.

Results: We included 17 patients, 70.6% of whom were women. Rheumatic mitral valve disease (76.5%) was the main etiology. We performed 14 (82.4%) mitral valve replacements and 3 repairs. Major adverse valvular-related events occurred in 1 patient (5.9%) (hemorrhagic stroke) at t1. A significant reduction in the size of the left atrium was observed: diameter (77 mm vs 48 mm, $P < .001$), area (75 cm^2 vs 31 cm^2, $P < .001$), and volume (332 cm^3 vs 90 cm^3, $P < .001$). Compared with t0 and t1, these echocardiographic findings remained without significant changes during t2.

Conclusions: Our surgical left atrium reduction technique was associated with improved clinical functionality and reduced left atrium measures in patients with a giant left atrium undergoing mitral valve surgery. (JTCVS Techniques 2023;17:56-64)



We observed a significant decrease in LA volume after reduction surgery.

CENTRAL MESSAGE

We describe a technique that is safe and reduces LA echocardiographic measures in patients with a GLA undergoing MV surgery.

PERSPECTIVE

We describe an easily reproducible technique of LA reduction that would be particularly useful in countries with a high incidence of RHD.

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Video clip is available online.

Rheumatic heart disease (RHD), a preventable health condition, still prevails as a significant cause of morbidity and mortality in low- and middle-income countries.[1-3] Although there are new mechanisms proposed, the pathogenesis of RHD is not fully clarified.[4] Rheumatic mitral valve (MV) disease remains a frequent but neglected burden for the health systems, and it is the primary indication for MV surgery in developing countries.[2,5-7] Among the several repercussions, a relevant finding is left atrial (LA) enlargement (~19% of patients undergoing MV

Abbreviations and Acronyms

CPB = cardiopulmonary bypass
GLA = giant left atrium
IQR = interquartile range
LA = left atrium
MAVRE = major adverse valvular-related events
MV = mitral valve
NYHA = New York Heart Association
RHD = rheumatic heart disease
SR = sinus rhythm

surgery), where the giant left atrium (GLA) constitutes a significant concern.[8]

GLA is a challenging health condition characterized by a relatively low frequency, controversial pathophysiology, and complex therapeutic approaches. The GLA is a severe dilatation of the LA that produces various complications compromising hemodynamic stability.[9,10] There is no standardized definition of GLA throughout the literature, and it tends to differ across the published series.[2,9,11] The pathophysiology is still under debate, although GLA occurs mainly in patients with MV insufficiency and stenosis[11] and is more frequent in patients with rheumatic MV disease regurgitation than in nonrheumatic patients.[9,11,12] Also, GLA is a substrate for chronic atrial fibrillation (AF), thrombus formation, thromboembolic events, decreased cardiac output, and increased mortality.[12-14] Moreover, the compression of adjacent organs may cause dyspnea, severe respiratory dysfunction, dysphagia, or hoarseness.[8,14,15] Subsequently, the evaluation of therapeutic alternatives is highly pertinent.

In some instances, the treatment for GLA requires a surgical-based approach. Apostolakis and Shuhaiber[9] established the following conditions for potential candidates for this surgical intervention: (1) presence of intracardiac or extracardiac compressive symptoms from neighboring organs; (2) presence of thrombus and a history of thromboembolic events; and (3) to restore sinus rhythm (SR) in patients with AF, associated or not with the ablation process.[9] Complex atrial surgery merits close surveillance of outcomes in the short- and long term; during this follow-up, monitoring major adverse valve-related events (MAVRE) and echocardiographic evaluation is crucial.[16]

Thus, based on these constraints mentioned, our study aimed to describe the safety and clinical and echocardiographic outcomes of a new surgical technique in adult patients diagnosed with GLA.

PATIENTS AND METHODS

Study and Population

We carried out a retrospective study in 2016 to 2020 in patients diagnosed with GLA who underwent LA reduction surgery associated with MV surgery in 2 national reference centers in Lima, Peru: The National Cardiovascular Institute (Social Security) and Hipolito Unanue General Hospital (Ministry of Health). In our study, we used the GLA definition of Kawazoe and colleagues[17]: "diameter more than 65 mm by M-mode echocardiography, and left ventricular posterior-basal wall bent inward and lying between the dilated LA cavity and left ventricle cavity". We excluded all patients undergoing emergency or redo surgeries.

Surgical Technique

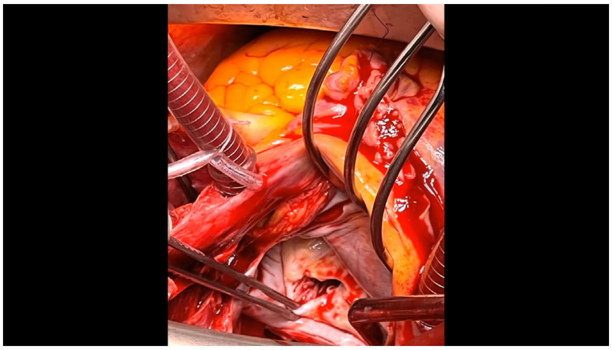
The same professional team performed the surgical technique in both healthcare centers (Video 1 and Figure 1, *A*). After a median sternotomy, we placed a patient on cardiopulmonary bypass (CPB) with bicaval cannulation and cooled at 32 °C. We executed the superior vena cava cannulation at the highest possible place and induced cardiac arrest through anterograde or retrograde cardioplegia. We used HTK Custodiol for myocardial protection. A standard left atriotomy was made parallel to the interatrial groove. After that, we performed MV surgery (repair or replacement) and excision and closure of the left appendage. Then, we extended the inferior edge of the left atriotomy across the oblique sinus in the LA inferior wall between the left and right pulmonary veins (Figure 1, *B* and *C*). We resected a 1- to 1.5-cm–wide band in the inferior wall and closed it with 4/0 polypropylene continuous sutures (Figure 1, *D*). The other side of the left atriotomy was extended superiorly below the superior vena cava across the LA roof (Figure 1, *E*); we also resected a 1- to 1.5-cm–wide band and closed with 4/0 continuous polypropylene sutures. Finally, standard left atriotomy was closed with 4/0 polypropylene. It is important to mention that pericardial reflections on the superior vena cava and ascending aorta were carefully released. In addition, the oblique sinus was mobilized to completely free the space between the pulmonary veins and thus avoid possible injuries to the esophagus with the suture. Suture lines typically included a 1-cm band of atrium wall. When we found a mural thrombus, it was meticulously removed, and in the case of LA wall calcifications, we try to carefully remove them or exclude them from the suture line.

Other Procedures and Measurements

Intraoperative monitoring involved transesophageal echocardiography, pulmonary artery catheter, and standard monitoring. The postoperative period included echocardiography, chest x-ray, electrocardiogram, cardiac enzymes, thoracic computed tomography, and other clinical parameters evaluation. At follow-up, a 24-hour Holter determined the heart rhythm in all patients. According to the American Society of Echocardiography Recommendations, an advanced trained imaging cardiologist assessed LA measures.[18]

Evaluation Stages

We define 3 time periods: (1) baseline (t0): from hospital admission to before the surgical procedure; (2) perioperative period (t1): until first 30



VIDEO 1. Surgical technique. Video available at: https://www.jtcvs.org/article/S2666-2507(22)00539-9/fulltext.

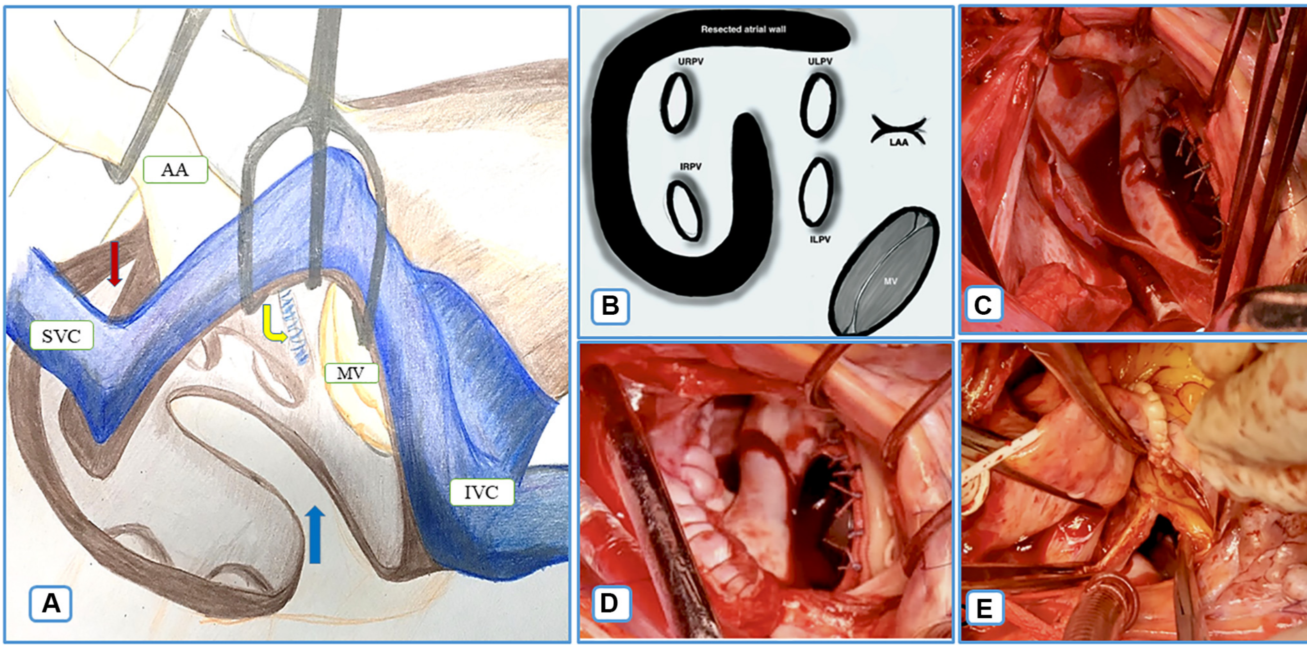


FIGURE 1. Surgical technique. A, Diagram showing our LA reduction technique, resection through the oblique sinus and between the pulmonary veins (*blue arrow*), LA roof resection (*red arrow*), and LA appendage excision and closure (*yellow arrow*). B, Sketch diagram showing the tissue resected. C, The inferior edge of left atriotomy extended across the obliquus sinus in the LA inferior wall between the left and right pulmonary veins. D, LA inferior wall sutured with 4/0 polypropylene. E, Left atriotomy extended superiorly below the superior vena cava across the LA roof. We resected a longitudinal segment 1- to 1.5-cm wide and closed it with 4/0 polypropylene continuous sutures. *AA*, Ascending aorta; *SVC*, superior vena cava; *MV*, mitral valve; *IVC*, inferior vena cava; *URPV*, upper right pulmonary vein; *ULPV*, upper left pulmonary vein; *LAA*, left auricular apendix; *ILPV*, inferior left pulmonary vein; *IRPV*, inferior right pulmonary vein.

postoperative days; and (3) extended follow-up (t2): after 30 postoperative days until 12 months.

Outcomes

The primary clinical outcomes were safety measured through MAVRE, defined according to guidelines for reporting mortality and morbidity after cardiac valve interventions and functional class.[19] The secondary clinical outcomes were atrial fibrillation (AF), oral anticoagulants use, and compressive symptoms. The primary echocardiographic outcomes were the diameter (mm), area (cm^2), and volume (cm^3) of the LA. We assessed all echocardiographic indicators in the 3 study periods.

Statistics

Descriptive analysis. We explored the distribution of variables using analytical and graphical methods, and reported numerical data as mean and standard deviation or as medians and interquartile ranges (IQRs). The categorical variables were presented as absolute and relative frequencies in all periods. For MAVRE, we estimate the cumulative incidence.

Comparative analysis. We used 2 approaches: (1) multinomial: one comparison among t0, t1, and t2; and (2) binary: 3 post hoc direct exploratory comparisons: t1 versus t0, t2 versus t0, and t2 versus t1. In a multinomial way, we used the Friedman test for dependent numerical measures and the nonasymptotic Cochran's Q test for dependent categorical measures for the multinomial comparison. In the binary analysis, we calculated the absolute differences in each of the direct comparisons: Δ(t1-t0), Δ(t1-t0), and Δ(t2-t1). We tested the differences with the Wilcoxon signed-rank test and the McNemar's exact test for dependent categorical measures. We did not observe normality and homoscedasticity in numerical data, so we opted for these nonparametric methods.

Ethics

The Institutional Research and Ethics committee of the National Cardiovascular Institute, approved the protocol of this study (certificate of approval 11/2021-CEI, May 5, 2021).

RESULTS

Baseline Characteristics

During the study period, 18 surgeries were performed; however, 1 patient was excluded due to reoperation and emergency surgery. We included 17 patients in our analysis. Preoperative baseline profiles are listed in Table 1. The median age of patients was 52 years (IQR, 30), and most were women (70.6%). Most were classified with New York Heart Association (NYHA) III (76.5%) and IV (11.8%). The main etiology was rheumatic (76.5%), and approximately 82% of patients had insufficiency or insufficiency and stenosis.

Compressive symptoms were present in 52.9% of patients; dysphagia was the most common symptom (52.9%). Also, 94% of patients had chronic atrial fibrillation and used oral anticoagulants.

Surgical Procedure Features

Table 2 shows the surgery-related variables. The medians of surgical, CPB, and aortic crossclamping times were 270 minutes (IQR, 60), 147 minutes (IQR, 37), and

TABLE 1. Baseline characteristics of patients (n = 17)

	n (%)
Age	52 [30]*
<40 y	6 (35.3)
40-59 y	5 (29.4)
≥60 y	6 (35.3)
Sex	
Male	5 (29.4)
Female	12 (70.6)
BMI (kg/m^2)	23 [7]*
Underweight (<19)	4 (25.3)
Normal (19-24.99)	6 (35.2)
Overweight (25-29.99)	4 (25.3)
Obesity (≥30)	3 (17.7)
Functional class (NYHA)	
II	2 (11.8)
III	13 (76.5)
IV	2 (11.8)
MV disease physiopathology	
Stenosis	3 (17.6)
Insufficiency	8 (47.1)
Stenosis/insufficiency	6 (35.3)
MV disease etiology	
Rheumatic	13 (76.5)
Myxomatous	4 (23.5)
Specific symptoms	
Dysphagia	9 (52.9)
Hoarseness	2 (11.8)
Hemoptysis	1 (5.9)
None	8 (47.1)
Other basal characteristics	
Chronic atrial fibrillation	16 (94.1)
Oral anticoagulation therapy	16 (94.1)
Mean PA pressure (mm Hg)	37.47 [10]*
SPAP ≥65 mm Hg	10 (58.8)
Mean PVR (Woods units)	3 [1.3]*

BMI, Body mass index; *NYHA*, New York Heart Association; *MV*, mitral valve; *PA*, pulmonary artery; *SPAP*, systolic pulmonary artery pressure; *PVR*, pulmonary vascular resistance. *Data are expressed as median and IQR.

TABLE 2. Surgical characteristics and intensive care unit evolution (n = 17)

	n (%)
Surgical time (h)	4.5 [1.0]*
CPB time (min)	147 [37]*
ACC time (min)	103 [29]*
euroSCORE II (%)	2 [1.5]*
euroSCORE II >5%	2 (11.8)
Mitral valve surgery	
Replacement	14 (82.4)
Repair	3 (17.6)
Associated procedures	
TV repair	12 (70.6)
AV replacement	2 (11.8)
AV repair	2 (11.8)
Atrioseptoplasty	1 (5.9)
ICU evolution	
ICU stay (d)	2 [1.0]*
Prolonged stay (>4 d)	2 (11.8)
Intubation time (h)	17 [12]*
Prolonged intubation (>48 h)	2 (11.8)
Postoperative bleeding (mL)	650 [470]*
Postoperative transfusion ratio	11 (64.7)
Other ICU complications	
Redo surgery for postoperative bleeding	1 (5.9)
Sternal dehiscence	1 (5.9)
Intra-aortic balloon pump	1 (5.9)
Dialysis	0 (0)

CPB, Cardiopulmonary bypass; *ACC*, aortic crossclamping; *euroSCORE*, European System for Cardiac Operative Risk Evaluation; *TV*, tricuspid valve; *AV*, aortic valve; *ICU*, intensive care unit. *Data are expressed as median and IQR.

103 minutes (IQR, 29), respectively. We mainly performed MV replacements due to RHD (82.4%), in all cases preserving the posterior leaflet. Only 3 patients underwent MV repair for myxomatous insufficiency (P2 resection with annuloplasty). The most frequent associated procedure was tricuspid valve repair (70.6%).

Perioperative Findings

MAVRE occurred in 1 patient (5.9%), and there was no in-hospital mortality without changes throughout follow-up. This patient had a hemorrhagic stroke in the third postoperative week and required decompressive craniotomy, resulting in hemiparesis as a sequel. Also, 2 patients (11.8%) needed redo surgery for excessive postoperative bleeding and sternal dehiscence, and 2 patients (11.8%) had prolonged intubation and intensive care unit stay (Table 2).

Comparative Analysis

We describe the evolution of the clinical outcomes during follow-up in Table 3. We evidenced a statistically significant reduction in the proportion of patients in levels III or IV of NHYA functional class at t1 (<.001) and t2 (<.001) compared with the preoperative period. Concerning specific symptoms, the frequency of dysphagia was significantly lower at t1 (0%) and t2 (0%) versus the baseline (52.9%). We observed a substantial reduction in chronic AF frequency in the perioperative period (52.9% vs 94.1% at baseline; $P = .0156$), but then the proportion increased in the extended follow-up (64.1%) without statistical differences from t0 ($P = .0625$). Also, there were no changes in the use of oral anticoagulants.

Regarding echocardiographic parameters, the main results are shown in Table 4. We found significant changes in the median LA diameter from baseline (77 mm) to t1 (48 mm) (median Δ: –31 mm, $P < .001$), and this variation was kept until t2 (45 mm) ($P < .001$). Also, we observed

TABLE 3. Clinical variables at the baseline, perioperative period, and extended follow-up (n = 17)

	Baseline (t0) n (%)	Perioperative period (t1) n (%)	Extended follow-up (t2) n (%)	*P* value*	*P* value†	*P* value‡
Primary outcomes						
MAVRE	NA	1 (5.9)	1 (5.9)			
Valve-related mortality	NA	0 (0)	0 (0)			
Valve-related morbidity	NA	1 (5.9)	1 (5.9)			
Stroke	NA	1 (5.9)	1 (5.9)			
Definitive pacemaker	NA	0 (0)	0 (0)			
Other	NA	0 (0)	0 (0)			
Functional class (NYHA)				**.0045**§	**.0001**§	**.0001**§
I	0 (0)	11 (64.7)	14 (82.4)			
II	2 (11.8)	5 (29.4)	3 (17.6)			
III	13 (76.5)	1 (5.88)	0 (0)			
IV	2 (11.8)	0 (0)	0 (0)			
Secondary outcomes						
Specific symptoms						
Dysphagia	9 (52.9)	0 (0)	0 (0)	**.0162**	**.0156**	**.0156**
Hoarseness	2 (11.8)	0 (0)	0 (0)	**.0150**	.1573	.1573
Hemoptysis	1 (5.9)	0 (0)	0 (0)	NA	.3173	.3173
None	8 (47.1)	17 (100)	17 (100)	**.0035**	**.0078**	**.0078**
Atrial fibrillation	16 (94.1)	9 (52.9)	11 (64.7)	**.0110**	**.0156**	.0625
OAT	16 (94.1)	15 (88.2)	16 (94.1)	.1082	.9999	.9999

MAVRE, Major adverse valvular-related event; *NA*, not applicable; *NYHA*, New York Heart Association; *OAT*, oral anticoagulation therapy. Bold values denotes statistically significant. *Cochran's Q nonasymptotic test for dependent categorical measures. †Exact McNemar test for dependent categorical measures (immediate follow-up vs baseline). ‡Exact McNemar test for dependent categorical measures (extended follow-up vs baseline). §Hypothesis test performed for binary collapsed data (III-IV vs I-II).

differences between the LA area at baseline (75 cm^2) and t1 (31 cm^2) (median Δ: –49 cm^2, $P < .001$) and t2 (–50 cm^2) ($P < .001$). Likewise, we observed a significant reduction in LA volume from baseline (332 cm^3) to t1 (90 cm^3) (median Δ: –259 cm^3, $P < .001$) without modification in t2 (90). The Figure 2 shows these differences using boxplots. Figure 3 shows the echocardiographic changes (*A* vs *C*) and x-ray variations (*B* vs *D*) from t0 to t1 in a randomly selected patient.

Anatomopathological Findings

We analyzed 7 atrial wall samples. In all cases, we found that moderate myocyte hypertrophy, myocyte vacuolization, and mild-to-moderate myocardial interstitial fibrosis represented the most frequent findings (Figure 3, *E* and *F*). All samples exhibited myocardial fatty infiltration, especially in the LA appendage. More than 50% (4/7) of the cases presented focal to multifocal lymphocytic infiltration. We did not identify neutrophils and granulomas.

TABLE 4. Echocardiographic parameters at the baseline, perioperative period, and extended follow-up (n = 17)

	Baseline (t0) Median (95% CI)	Perioperative period (t1) Median (95% CI)	Follow-up (t2) Median (95% CI)	Δ (t1-t0) Median (IQR)	Δ (t2-t0) Median (IQR)	Δ (t2-t1) Median (IQR)	*P* value*	*P* value†	*P* value‡
Primary outcomes									
LA diameter (mm)	77 (71.0-82.0)	48 (44.0-51.9)	45 (45.0-51.9)	–31 (14)	–29 (13)	0 (1)	**.007**	**<.001**	**<.001**
LA area (cm^2)	75 (55.1-89.9)	31 (29.01-32.9)	31 (24.0-32.0)	–49 (36)	–50 (31)	–1 (6)	**.035**	**<.001**	**<.001**
LA volume (cm^3)	332 (270.1-399.9)	90 (74.1-112.9)	90 (72.01-109.9)	–259 (185)	–258 (163)	0 (5)	.096	**<.001**	**<.001**
Secondary outcomes									
LVEF (%)	58 (52.01-61.9)	53 (50.0-56.9)	55 (53.0-64.9)	–4 (10)	1 (10)	5 (7)	**.039**	.131	.68
EDLVd (mm)	59 (50.0-65.9)	51 (48.0-52.9)	50 (46.0-51.9)	–2 (15)	–8 (14)	0 (2)	**.029**	.101	**.011**
ESLVd (mm)	37 (34.0-44.9)	36 (32.0-37.9)	33 (30.0-36.0)	–1 (10)	–4 (8)	–1 (6)	**.006**	.248	.025

CI, Confidence interval; *IQR*, interquartile range; *LA*, left atrium; *LVEF*, left ventricular ejection fraction; *EDLVd*, end-diastolic left ventricular diameter; *ESLVd*, end-systolic left ventricular diameter. Bold values denotes statistically significant. *Friedman test for dependent measures. †Wilcoxon signed-rank test for dependent measures (perioperative period vs baseline). ‡Wilcoxon signed-rank test for dependent measures (extended follow-up vs baseline).

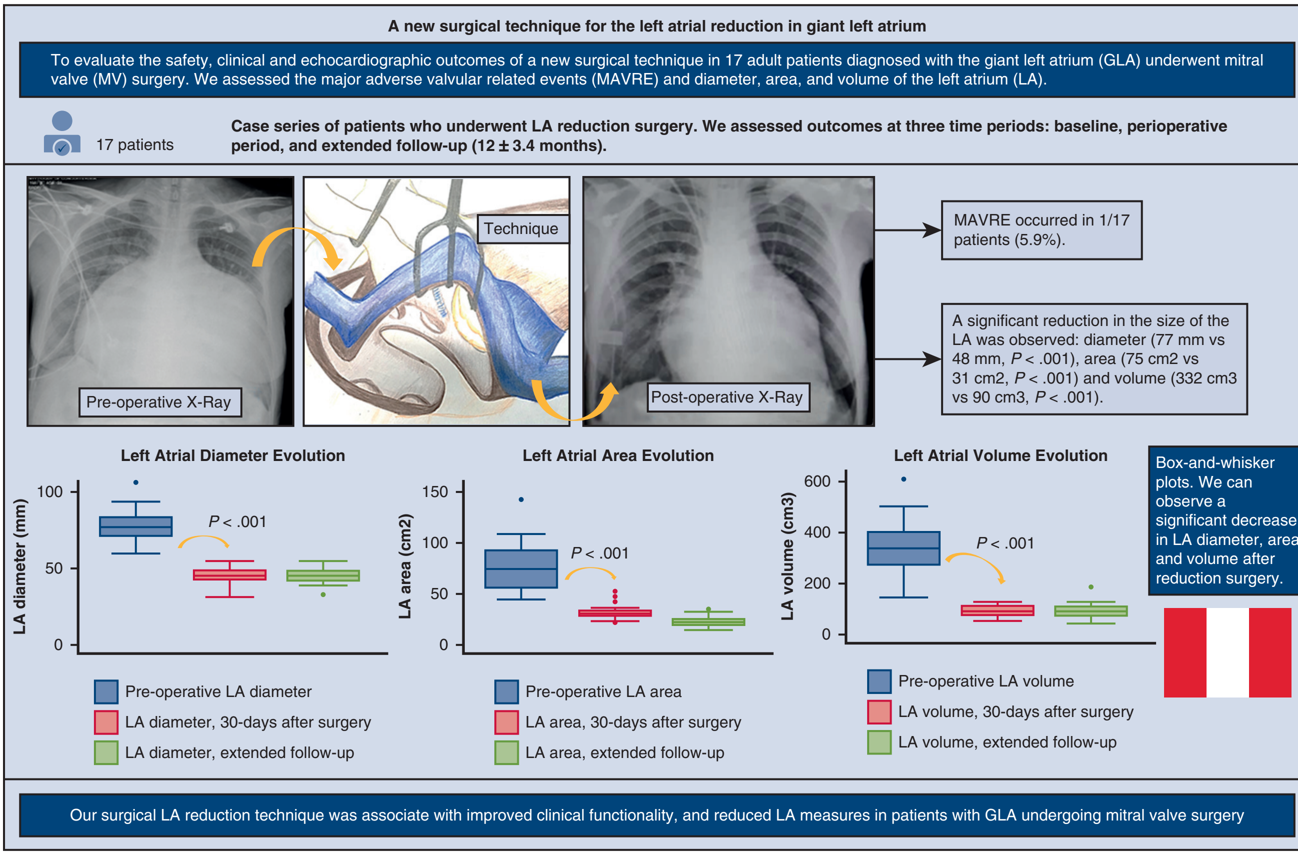


FIGURE 2. Postoperative results in 17 patients undergoing MV surgery and LA reduction with our technique.

DISCUSSION

Main Results

Our findings showed that the new novel surgical technique was safe and had favorable clinical and echocardiographic evolution in adults with GLA. Regarding MAVRE, only 1 patient had a hemorrhagic stroke episode, no patient experienced thromboembolic phenomena, and no patients died during the in-hospital stay. Most patients were rapidly extubated and discharged from the intensive care unit. Related clinical outcomes, NHYA functional class, and specific symptomatology improved after surgery within maintenance in the extended follow-up (this improvement in functional class may also be the effect of MV surgery). Also, echocardiographic findings unveiled positive structural changes during the immediate postoperative period and extended follow-up. Although the rate of conversion to SR in the immediate postoperative period was significant, recurrence of AF was important at follow-up. Consequently, this primary evidence supports the new surgical technique as a promising alternative for patients with GLA.

Surgical Technique

Several surgical techniques have been described to reduce GLA.[9] Some approaches use a partial or total autotransplantation, although in our opinion, these are technically difficult and could increase the possibility of surgical complications.[13,20] Our technique constitutes a variation of the procedure described by Sugiki and colleagues,[21] based on a combined superior trans-septal approach to the MV. However, unlike this, our method does not detach the superior vena cava, reducing surgical complexity. Also, CPB and aortic crossclamping times are acceptable and comparable to those in other series.[22,23] Atrial reduction could allow electrophysiological isolation of the posterior wall of the atrium and the pulmonary veins. Regarding this, previous works have shown excellent results when resecting the wall of the LA around the 4 pulmonary veins.[13,20,24] However, we believe that these techniques (mostly autologous transplant procedures) have greater technical complexity and are not easily reproducible. Our technique includes resections in the space between the pulmonary veins, which is easily accessible through a standard atriotomy; in addition, to "complete" the electrical isolation of the pulmonary veins, we could use cryoablation or radiofrequency. We consider that our technique is of low surgical complexity because most of the published techniques include partial or total autotransplantation, whereas ours does not; we also believe that our technique is safe, easily

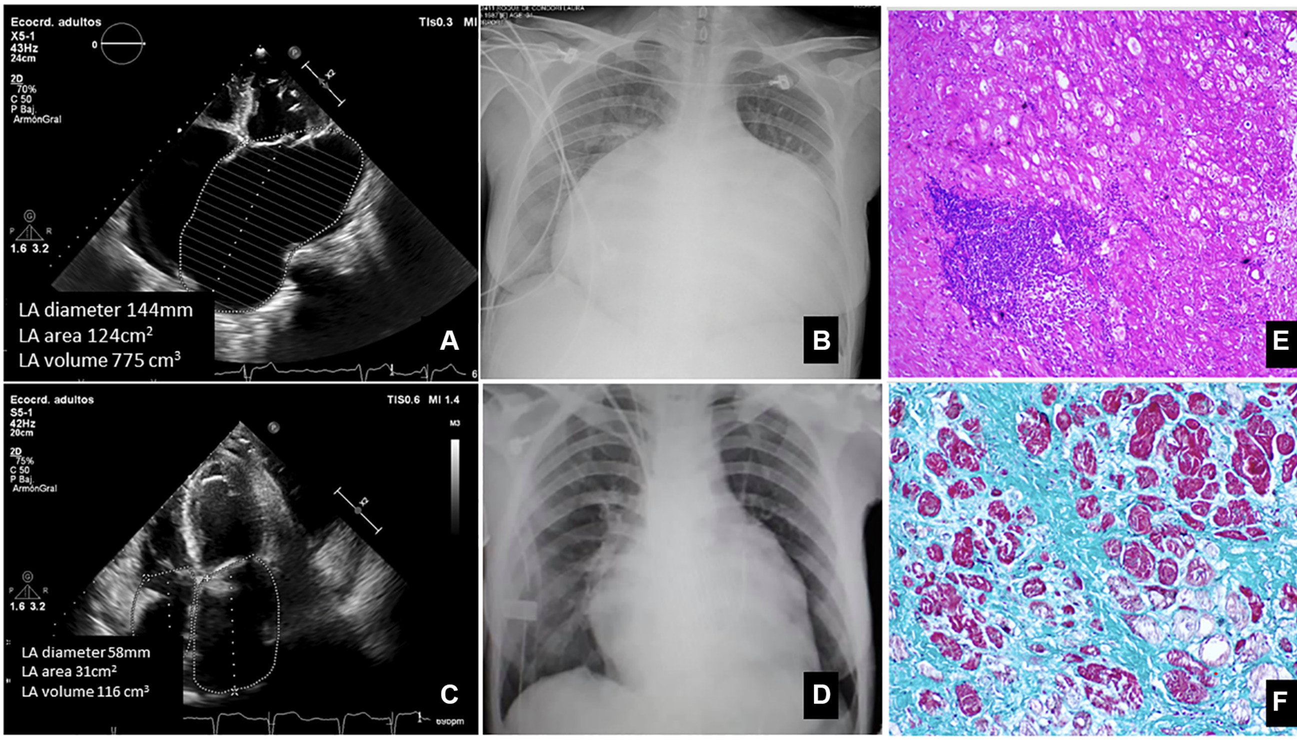


FIGURE 3. A and B, Preoperative transthoracic echocardiography and thoracic x-ray showing extreme LA dilatation. C and D, Significant postoperative LA reduction in the same patient. E, Hematoxylin–eosin stain: Low-power photomicrograph exhibiting myocyte vacuolization with myocardial lymphocytic inflammation. F, Masson's trichrome stain: moderate myocardial interstitial fibrosis (pericellular-type fibrosis). *LA*, Left atrium.

replicable, and effective in LA reduction because the resections include the inferior wall and roof. Thus, its implementation might be beneficial, especially in settings with limited resources.

Safety, Clinical, and Echocardiographic Effects

The principal indication for LA reduction surgery is the presence of compressive symptoms or a history of thromboembolic events.[8,15,17,21,24,25] As expected, most of our participants had this medical history at the preoperative stage, but we observed a significant reduction of these symptoms after surgery. Likewise, these results are linked to the substantial improvement in NYHA functional class observed during the follow-up, which is directly correlated to the patients' quality of life and mortality risk. However, LA dilation, although associated with mortality, is probably a marker for other factors such as pulmonary hypertension, and in the absence of a control group, we cannot definitively affirm that the important improvement in functional class could not also be due to MV surgery per se. In addition, we have noted a significant and sustained reduction in compressive symptoms and in the 3 most important echocardiographic LA measurements. Thus, this set of clinical outcomes, although exploratory, supports that our technique has positive effects on patients with GLA undergoing LA reduction surgery.

Restoring Sinus Rhythm

Regarding this, some surgical techniques have restored the SR in approximately 100% of cases. Certain authors argue that AF, a mortality predictor in patients with GLA, could be another indication for LA reduction surgery.[22,24] The dilatation of the LA is one of the predictors of the modified Maze procedure; in a cohort of patients undergoing operation for AF, Kawaguchi and colleagues[26] demonstrated that those remaining in AF (vs patients with restored SR) had a significantly higher incidence of GLA and larger cardiothoracic ratio and LA dimension; most patients with postoperative LA size less than 40 mm or cardiothoracic ratio less than 55% had restored SR. Kim and colleagues[25] found that LA volume reduction and cryoablation instead of radiofrequency were protective against AF recurrence during surgical ablation of AF. Kasemsarn and colleagues[27] reported that reducing the LA diameter to less than 50 mm increases the success of conversion to SR in patients undergoing radiofrequency ablation. In our series, only 35% of patients maintained SR during extended follow-up; afterward, we considered that our technique alone did not have enough effect over this end point. Despite these observations, we believe that our approach with the concomitant use of cryoablation or radiofrequency procedures could increase the conversion rate to SR and decrease the ensuing use of anticoagulants in patients undergoing MV repair or biological MV replacement. Other authors have supported this hypothesis.[25-28] Nevertheless, in the absence of empirical evidence, future studies are required.

Pathological Findings

In agreement with our results, the literature suggests that GLA occurs mainly in patients with long-standing MV regurgitation (with or without stenosis) and GLA is more common in RHD due to tissue weakness resulting from pancarditis[9,11,12,14,22,29]; however, our pathological study of atrial wall biopsies did not reveal Aschoff bodies (fibrinous necrotic center found in the myocardium surrounding blood vessels) in patients with RHD. As in other publications, intense fibrosis and chronic inflammation were our main histological findings, which are not exclusive to RHD and can be observed in myxomatous disease (23.5% in our series).[12,14] Therefore, beyond the high relative frequency of RHD in developing countries, we infer that the GLA is not exclusive to this etiology.

Limitations and Strengths

Our study must be interpreted in light of its limitations. First, we included a small number of patients, which may suppose a low statistical power and random error. But, our analysis constitutes the first report of a novel technique in cardiac surgery, the population sample is higher than in other series, and we applied only exploratory inferential statistics methods. Second, the extended follow-up time was not homogeneous in all participants; this reflects the administrative, logistic, and geographical restrictions dealing with the postoperative follow-up in patients with cardiac disease in a low-resource health system. Third, medical records were the primary data source, so we cannot guarantee data quality control; nonetheless, all patients were treated in national reference centers and underwent rigorous auditory processes. Fourth, although the study had a longitudinal design, we cannot estimate the causal effect of surgery because of the lack of a control group and the variables we did not assess, and there was a small number of patients; these factors did not allow us to control potential confounding variables or apply causal inference methods. However, our inferential analysis is exploratory, and we estimated the best possible parsimonious statistics. Fifth, in the anatomopathological study, we included only 7 samples in this report; in this sense, the report of these findings is merely descriptive without hypothesis tests involved.

On the other hand, our study also has several strengths. This is the first real-world evidence study describing a novel and reproducible surgical technique that may be straightforwardly implemented in developing countries where sanitary resources are limited but the GLA is relatively frequent.

Recommendations to Future Studies

Further studies are needed to evaluate the effect of LA reduction techniques (alone or with ablation procedures) to restore SR. It is also important to conduct studies with a larger number of patients. A new longer-term follow-up control of the patients should be performed, evaluating the same outcomes and incorporating quality of life measures. Some economic evaluations could assess the cost-effectiveness and cost-utility of the early detection of MV disease and the decentralized implementation of this new surgical technique.

CONCLUSIONS

Our surgical technique for LA reduction is safe and has positive effects on clinical and echocardiographic outcomes in patients with GLA undergoing LA reduction in MV surgery. This technique improves compressive symptoms and NYHA functional class, and significantly reduces the LA echocardiographic measures. Nevertheless, for restoring SR, we do not recommend this technique alone. The addition of ablation techniques should be evaluated.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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