

# INITIAL EXPERIENCE IMPLEMENTING A MITRAL PLASTY PROGRAM: IS IT A TECHNIQUE WITH REPRODUCIBLE RESULTS?

## Authors

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## ABSTRACT

**Background:** Repairing the mitral valve has demonstrated a significant advantage over managing severe mitral insufficiency over mitral valve replacement. Therefore, the clinical practice guidelines considered it the first therapeutic option for treating valvular pathologies. Consequently, it should be widely adopted as a standard procedure by cardiac surgeons worldwide.

**Objective:** To establish the reproducibility of mitral valve repair within our hospital in terms of techniques and outcomes, we aim to compare our performance with data published by leading international medical institutions. This comparative analysis will allow us to evaluate our proficiency and quality of care in the field of mitral valve surgery in line with global standards.

**Methods:** Between January 2018 and January 2022, 63 patients with severe mitral insufficiency due to degenerative or functional disease who met surgical criteria were operated at Luis Vernaza Hospital. Of these, 22 patients underwent mitral valve repair. We conducted a retrospective longitudinal study and assessed the postoperative progression, focusing on key outcomes, including valve patency, reintervention rates, and mortality. The patients' follow-up was made by telephone communication, and they underwent at least one annual echocardiogram as a part of the monitoring process.

**Results:** As a result, 22 patients (73% males) with an average age of 48 years (ranging from 36 to 72 years) were analyzed. All patients presented severe mitral insufficiency, with 91% of cases attributed to primary etiology. In our experience, severe primary mitral insufficiency was successfully repaired in 55% of cases, with the P2 segment involvement being the most common cause. On the other hand, only two patients required reoperation, one due to ring dehiscence and the other due to rupture of new chordae tendineae. In contrast, we had one case of hospital mortality associated with immediate reoperation due to repair failure, and three patients passed away later due to non-cardiovascular causes. Finally, the remaining patients are asymptomatic, maintain regular activities, have no residual mitral insufficiency, and maintain a left ventricular function with more than 45% ejection fraction.

**Conclusion:** Mitral valve repair with an annuloplasty ring is a technique that can be successfully replicated in our hospital and provided by cardiac surgeons with adequate training. This approach yields outcomes similar to those achieved in globally renowned centers with higher surgical volumes and extensive experience in mitral valve repairs.

**Keywords:** mitral valve insufficiency, cardiac surgery, mitral valve, resection.

## INTRODUCTION

Mitral repair surgery (mitral ring plasty) is a technique that seeks to preserve the patient's valve tissue, improve leaflet coaptation, and prevent the progression of mitral annulus dilatation with the implantation of a prosthetic ring. Mitral ring plasty, according to the clinical practice guidelines of the American Society of Cardiology and the European Society of Cardiology, should be the first surgical choice for treating severe primary mitral regurgitation.

It is emphasized that this technique has this indication level in centers whose surgical teams can offer a high probability of durable repair.

In the MIDA registry (Mitral Regurgitation International Database), with a mean follow-up of 9.4 years (range 4.4 to 18.1 years), mitral valve repair surgery showed superiority over valve replacement in overall survival and freedom from valve-related adverse events. The 30-day mortality of valve repair was 0.2% versus 4.4% for valve replacement. This superiority of mitral plasty was even more marked at 20 years, both in terms of long-term survival (41% vs. 24%;  $p < 0.001$ ) and event-free survival (83% vs. 50%).

The spectrum of lesions presenting an insufficient mitral valve of primary cause can involve one, two, or more segments of the valve, the subvalvular apparatus, and/or the mitral annulus. Depending on the primary damage and its impact on ventricular geometry and physiology, one lesion may be more challenging to repair than another; its pathology may vary significantly if repair is achieved. For this reason, mitral plasty programs are formed by surgeons trained in the technique and with an adequate follow-up for at least ten years.

The beginning of the first mitral valve surgeries is not entirely clear since it seems that the original pioneers were forgotten in time for reasons ranging from being frowned upon by their colleagues to premature death. One such case was Horace Smithy, in Charleston, South Carolina, who, on January 10, 1948, 5 months before Barley and Harken, performed a partial mitral valvotomy with access through the left atrial appendage. He achieved an impressive seven successful cases out of 8 procedures performed. Unfortunately, however, Smithy died that same year from aortic stenosis, which prevented him from publishing his cases, unlike Barley and Harken, who were able to document their procedures. Among these two, Barley was the one who most extensively developed his technique and coined the term "closed mitral commissurotomy"<sup>1,2</sup>.

During the following years, several instrumental devices were developed by Dubous, Tubss, and Logan, among others, to improve closed mitral commissurotomy. Finally, after the invention of extracorporeal circulation by Gibbon and Lillehei, open mitral commissurotomy was developed<sup>1,2</sup>. This led to the first mitral valve replacement performed by Albert Starr in 1960, who implanted his cage prosthesis, but the patient died the night after surgery due to air embolism<sup>1,2</sup>.

In 1967, Allan Carpentier, who had previously developed the first bioprosthesis (porcine aortic valve), performed the first mitral replacement using a bioprosthesis. His purpose was to avoid the need for anticoagulation, to which all patients with mechanical prostheses are subjected. However, contrary to Carpentier's interests, he gave greater relevance to the possibility of repairing the mitral valve tissues themselves, obeying functional, anatomopathological, and etiological principles of valvular insufficiency<sup>3-5</sup>.

In Ecuador, until 2013, 100% of mitral insufficiencies were treated by mitral valve replacement, by mechanical or biological prosthesis; only on rare occasions and in very selected cases, a restrictive annuloplasty with a pericardial band was performed; however, there is no record of these. Commercial mitral rings were only available in our environment in 2018; this year, such a procedure began to be performed in our hospital.

## HYPOTHESIS

It is possible to develop a mitral plasty program and achieve results similar to those of first-world hospitals in our center, the Luis Vernaza Hospital of the Junta de Beneficencia de Guayaquil, Ecuador.

## METHODOLOGY

A retrospective observational study included 22 patients who underwent mitral valve plasty surgery due to severe mitral insufficiency at the Hospital Luis Vernaza de la Junta de Beneficencia de Guayaquil from January 2018 to January 2022. All patients have a minimum follow-up of 1 year via telephone to check their post-surgical evolution, with clinical evaluations and at least one echocardiogram per year. Preoperative, surgical technique, intraoperative data and immediate postoperative, short-term, and long-term follow-up were collected. The collected data were managed in an Excel database and analyzed using Rstudio™ statistical software.

## RESULTS

Twenty-two patients (73% men) were operated on, with a mean age of 48 years (range 36 to 72 years). All patients presented severe mitral regurgitation, 91% of which were of primary etiology. Eighty-six percent of the patients had a preoperative left ventricular ejection fraction of less than 45%. Seventy-seven percent of patients had NYHA III-IV dyspnea at the time of surgery, with a left ventricular diameter at systole (LVSD) greater than 54 mm in 18% of patients (*Table 1*).

The most frequently operated segment was the P2 segment in 54.5% of patients, followed by the P2-P1/3 segment with 22.7%. Only two operators worked on 100% of the patients, and one performed 70% of the cases. The extracorporeal circulation time ranged from 79 to 130 minutes, with a mean of 102, and the mean clamping time was 90 minutes (range 65 to 130 minutes).

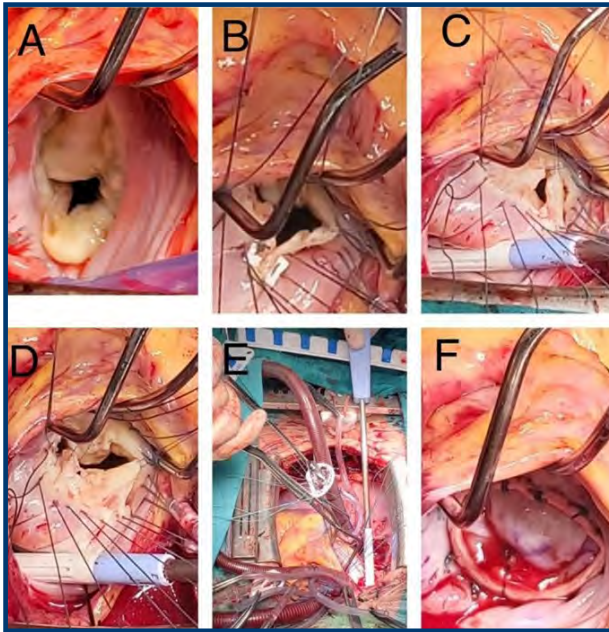
The most commonly used surgical technique was P2 quadrangular resection in 72.8% of patients, followed by P2-P3 resection/sliding in 13.6%, A2 triangular resection in 4.5%, A1 triangular resection in 4.5%, A2-A3 cleft closure in 9.1% and commissural Alfieri in 9.1%, combining two or more of these techniques in 54.4% of patients. The semi-rigid mitral ring was implanted in 100% of the patients. Chordal transposition was performed in 9.1%, and no neo-strings were implanted. Concomitant procedures were performed in 3 patients (coronary artery bypass grafting at 4.5%, aortic valve replacement at 4.5%, and tricuspid valve plasty at 4.5%).

Only two patients were reoperated after surgery. One of them, two days after surgery, was due to new severe regurgitation caused by mitral annulus disinsertion; this was the only case of cardiovascular mortality in the entire study, and it was intraoperative during the reintervention. The second was reintervened at three months due to rupture of new chordae tendineae at A2; previously, a resection at P2, ring plication, and annuloplasty with a semirigid ring had been performed (*Image 1*). Moderate or severe residual mitral regurgitation at one year was absent in all patients (*Image 2*).

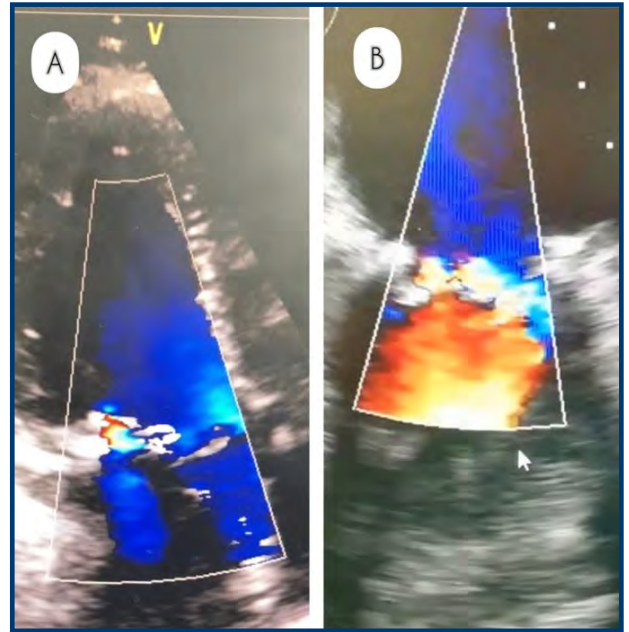
Mortality at six months only occurred in 2 patients, and these were due to non-cardiovascular causes (one due to lack of access to hemodialysis during the COVID-19 pandemic and the other due to hemorrhagic stroke). After more than one year, only one patient died (13 months) due to intraparenchymal cerebral hemorrhage; he had atrial fibrillation and was on anticoagulant therapy (*Figures 1 and 2*).

VARIABLES	Plasty (n = 22) N (%)
Preoperative	
Age	48 (36 - 78)
LVEF <45	3 (13.6)
NYHA III-IV	17 (79)
LVSD	54 (4 - 22)
Segment repaired	
P2	12 (54)
P2-P1/3	5 (22.7)
Intraoperative	
Quadrantectomy	19 (86.4)
Alfieri	2 (9.1)
Triangular A2	1 (4.5)
Triangular A1	1 (4.5)
Two segments	8 (36.4)
Three segments	1 (4.5)
Chordal transposition	2 (9)
Time of ECC	102 (79 - 130)
Clamp time	90 (65 - 130)
Ring	
CG FUTURE MED TRONIC™	11 (50)
SMJ TAILOR™	11 (50)
Ring size	30.5 (30-31)
Concomitant procedures	3 (13.6)
OUTCOMES	
Short term (<30 days)	
Perioperative mortality	0 (0)
Cardiovascular mortality	1 (4.5)
Reintervention	2 (9.1)
Plasty failure	2 (9.1)
Long-term (30 days – 66 months)	
Cardiovascular mortality	0 (0)
Reintervention	0 (0)
Plasty failure	0 (0)
NYHA III-IV	0 (0)
Mitral insufficiency	0 (0)

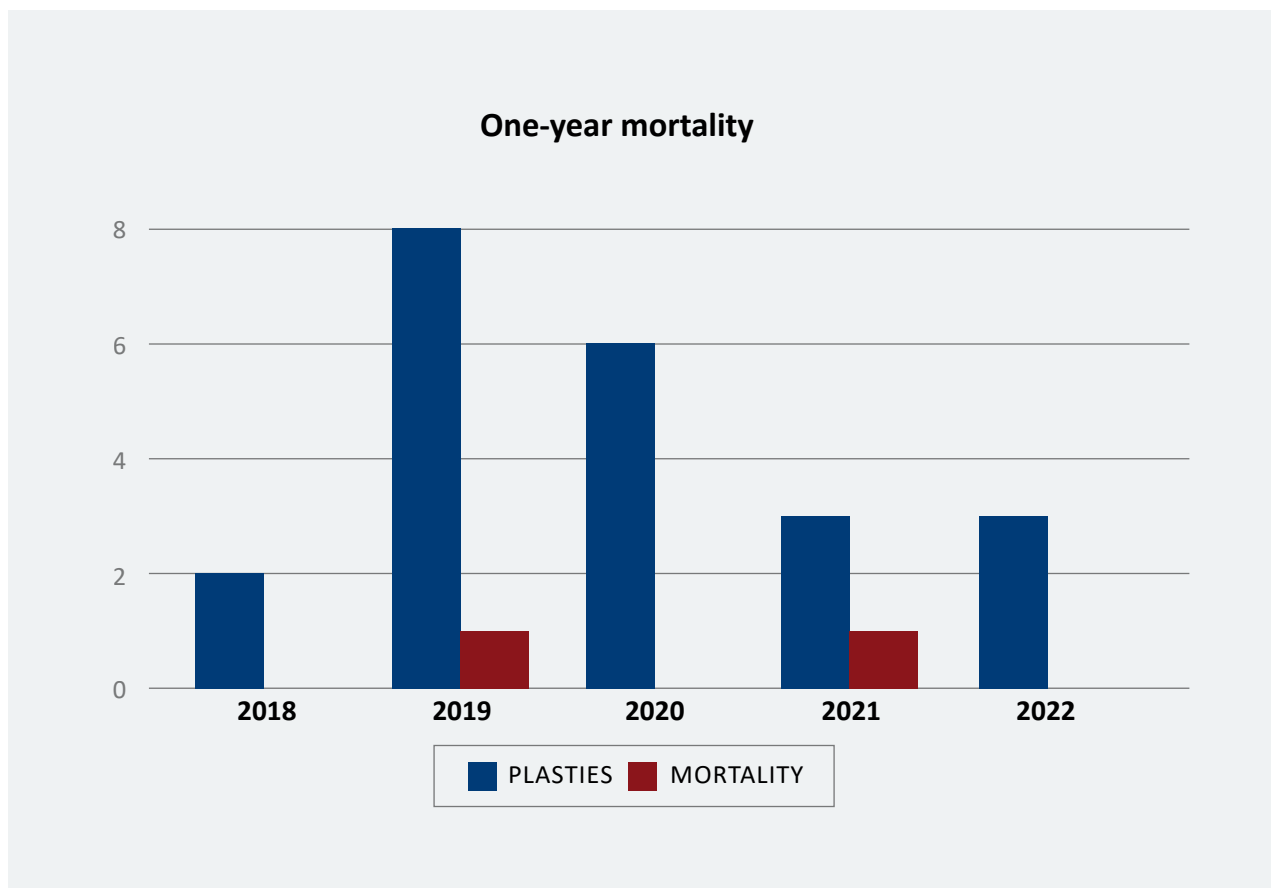
**TABLE 1.** Baseline, clinical-surgical characteristics and results of patients who underwent mitral plasty (n = 22).



**IMAGE 1.** Most frequently used technique. A. Exploration (chordal rupture and P prolapse). B. Posterior ring plication. C. Quadrantectomy and P2 sliding. D. Suture placement in mitral annulus. E. Mitral prosthetic ring implantation. F. Result.



**IMAGE 2.** Post-surgical echocardiographic control. A. Apical transthoracic. B. Intraoperative transesophageal echocardiography.



**FIGURE 1.** One-year mortality of patients undergoing primary cause mitral valve repair up to one year of follow-up.

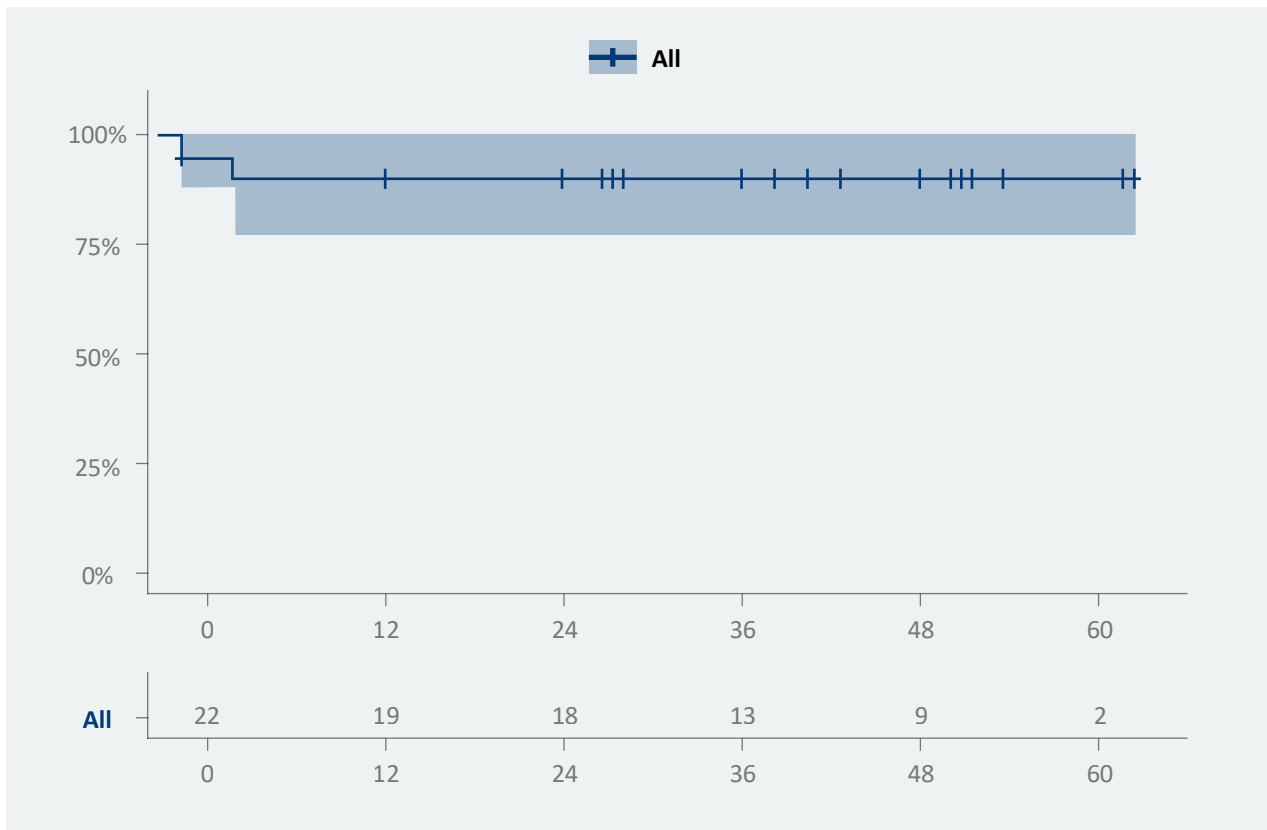


FIGURE 2. Event-free mitral plasty patency during the 5-year follow-up of all patients.

## DISCUSSION

Mitral valve repair has widely demonstrated better results than valve replacement. It is currently considered the treatment of choice for primary mitral regurgitation but has a marginal role in secondary regurgitation. There are many techniques of mitral repair (plasty), but they are divided into three schools: resective, conservative, and hybrid. Regardless of the technique used in a health center, the results will depend on the adequate training and expertise of the surgical team, as well as on a correct pre-surgical assessment and patient selection, so much so that the guidelines reinforce the indication only if the surgeon can offer a high certainty of repair and durability of the plasty.

The road to the current results has been extended. The initial experience was with digital mitral commissurotomy, followed by the instrumental variant. Finally, surgical commissurotomy with or without papillotomy, especially in rheumatic patients, is later displaced by percutaneous valvuloplasty and valve replacement.

Implementing the Alfieri technique, which consisted of joining the free edges of the mitral leaflets so that the edge of the prolapsed leaflet was fixed to the edge of the healthy contralateral leaflet, proved effective

in maintaining valvular continence. However, this technique generated a progressive annular dilatation that conditioned its prognosis so that a high recurrence at one year was recorded.

Physiological repair came onto the scene with Carpentier, followed by restrictive annuloplasty and neochord implantation. Today, we have new devices and less invasive and more physiological techniques that apply only to a small group of patients.

The resective school, which removes the diseased segment and reconstructs the leaflet, with or without plication of the posterior mitral annulus plus implantation of a prosthetic ring, has the philosophy that diseased tissue, whether removed or not, will always be prone to problems. Therefore, if it is repaired without removing it, it will end up causing insufficiency again due to elongation or rupture. Resective techniques include segmentectomy (the most frequent is that of the P2 segment), chordal transposition, sliding technic with leaflet height reduction, anterior leaflet height enlargement, height enlargement of both leaflets for functional failure and pericardial patch for leaflet defects; the latter is usually used in cases of endocarditis.

The conservative school, in which we could include:

- the Alfieri technique (central or commissural)

- restrictive annuloplasty
- modulating restrictive annuloplasty (Geofoam) for ischemic functional failure due to posterolateral abutment dysfunction
- PTFE neo chord implantation (direct, preformed loops, and multiple preformed loops, among others)
- transapical chordae implantation and parietal transeptal ventricular remodeling.

From our perspective, the hybrid school in which most of us cardiovascular surgeons who perform these techniques find ourselves is characterized by a more flexible and adaptable approach than the others because it employs both resective and conservative philosophies interchangeably, according to the specific needs of each case, to achieve a repair that is both physiologic and coherent.

Overall mortality in mitral plasty of primary mitral regurgitation in high-volume centers is around 0.8% (0.2 to 2.9), with reports of up to 4.3%<sup>6-8</sup>. With a tendency to perform more repairs and an increasing focus on repairing primary insufficiency, the minimally invasive approach plays an increasingly important role with results that can be extrapolated to the median sternotomy approach<sup>8-10</sup>.

Considering that we are a center that does not have a high volume of mitral surgeries, the perioperative mortality and mitral plasty pathology results are very similar to those documented in important series.

## CONCLUSION

Mitral valve plasty at the Hospital Luis Vernaza de la Junta de Beneficencia de Guayaquil, like reports from other centers with a higher surgical volume, is a safe and effective procedure, with reproducible results maintained over time.

## Declarations

The authors declare no conflict of interest.

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