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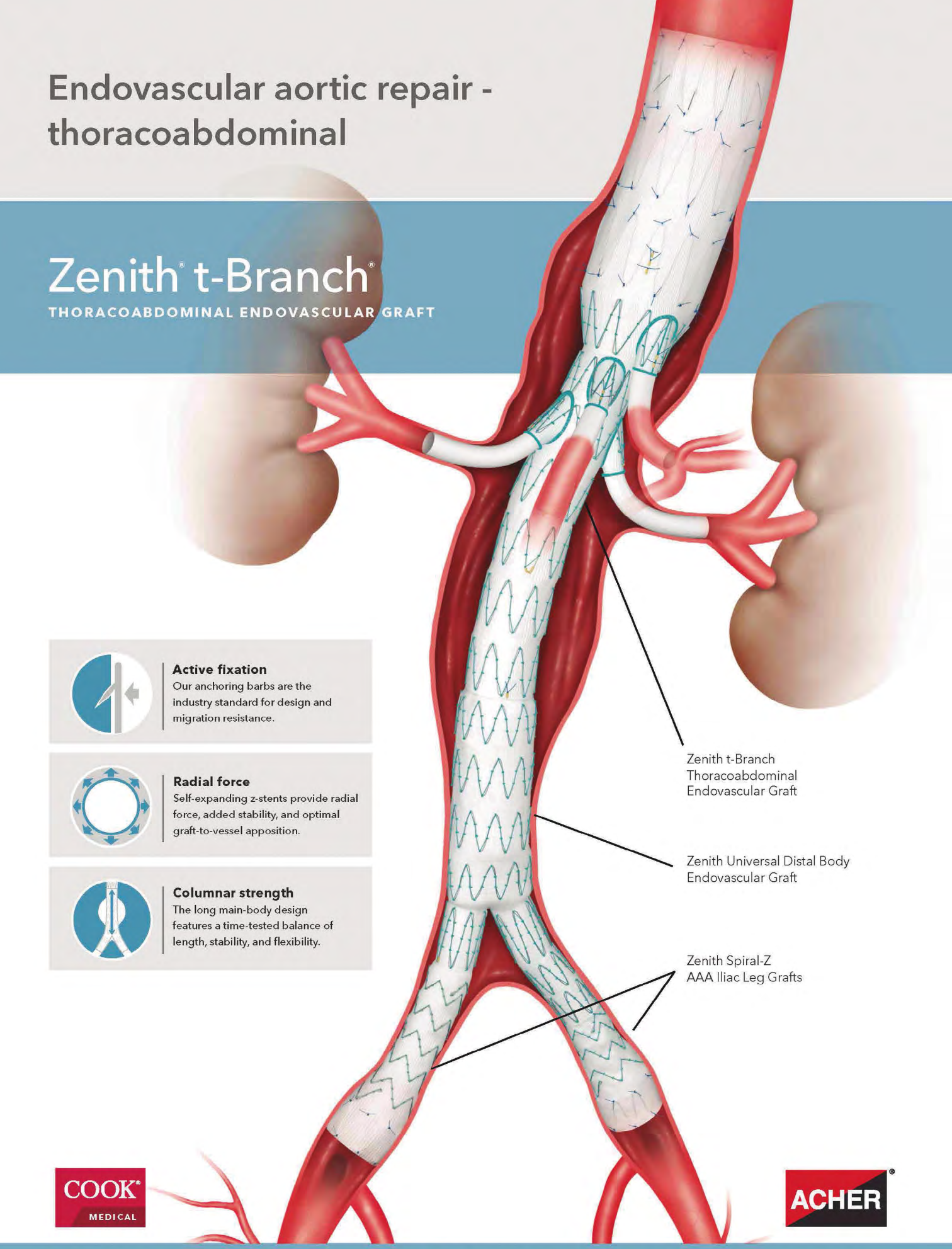

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SUMMARY

ORIGINAL ARTICLE

IMPACT OF COVID-19 PANDEMIC ON HEALTHCARE ACTIVITY IN CARDIAC SURGERY SERVICE IN THE SOUTHERN AREA OF THE METROPOLITAN AREA OF BUENOS AIRES

ABSTRACT

Introduction and objective: The Pandemic caused by the SARS-CoV-2 virus (COVID-19) impacted healthcare, which led surgical services to adapt their functional structure according to the different temporal phases.

This paper aims to analyze the pandemic's impact on outpatient care and surgical interventions in the Cardiac Surgery Service of a third-level public hospital in the Southern area of the Metropolitan Area of Buenos Aires, Argentina.

Methods: The consecutive medical records of 561 operated patients and the office records of 943 patients treated were retrospectively evaluated from March 2018 to December 2022. The number of consultations and surgeries, the epidemiological parameters, and the postoperative evolutions were analyzed.

Results: During the pandemic, concerning the pre-pandemic period, a significant decrease in the monthly number of consultations (18.9 vs. 14.8; $p < 0.05$) and of surgeries (12 vs. 8.3; $p < 0.0001$) was recorded. A significant increase in patients referred from the Intensive Care Unit before surgery was also observed ($p < 0.005$). Among the presurgical risk factors, a significantly higher prevalence of acute myocardial infarction (AMI) and insulin-requiring diabetes (IR-DBT) was found, as well as a more significant number of patients with deterioration of left ventricular systolic function (LVSF) ($p < 0.005$). The total amount of infections increased significantly ($p < 0.05$), with respiratory infections as the primary cause ($p < 0.05$). However, this cause was associated with COVID-19 in only one patient.

Conclusions: During the pandemic, consultations and surgeries decreased in the Cardiac Surgery Service, with more patients referred from intensive care areas. The patients who underwent surgery had a more significant history of AMI, DBT, and impaired LVFS. Infections increased, predominantly due to respiratory causes, although unrelated to COVID-19.

Keywords: *pandemic, cardiac surgery, respiratory infections.*

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INTRODUCTION AND OBJECTIVES

COVID-19 disease, caused by SARS-CoV-2 virus infection, generated the most significant health crisis in recent decades[1-3]. The World Health Organization (WHO) declared a health emergency, and its rapid spread led to its characterization as a pandemic on March 11, 2020[4,5].

In Argentina, the first case was confirmed on March 3, 2020. The rapid extension and saturation of health systems in other countries motivated the national government to decree a quarantine as of March 20, 2020, as a sanitary measure to combat COVID-19[6].

The quarantine was divided into two phases. The first one was preventive and compulsory social isolation (ASPO, for its acronym in Spanish), in which people had to remain isolated in their usual residences, with a prohibition to attending work, except for those workers considered essential[7,8]. With greater flexibility, the second phase allowed the population to circulate, work, and carry out certain activities under strict protocols. It was called social, preventive, and obligatory distancing (DISPO, for its acronym in Spanish)[9].

Due to the population density and the increase in cases, the Buenos Aires Metropolitan Area (AMBA, for its acronym in Spanish) was one of the areas of the country with the strictest and longest quarantine in the world[10]. Finally, on July 19, 2021, a progressive reopening and subsequent cessation of quarantine was announced[11].

The requirement of health care resources, directed to preventing the spread and affection of the SARS-CoV-2 virus, led various surgical services and associated critical areas to adapt their functional structure according to the different stages and needs of the pandemic[12-15].

Therefore, the present study aimed to analyze the impact of the pandemic on surgical care and intervention in the Cardiac Surgery Service of a tertiary-level public hospital located in the southern area of the AMBA.

METHODS

Consecutive medical records of patients who underwent cardiac surgery and consecutive office care records of the Cardiac Surgery Service from April 2018 to December 2022 were retrospectively evaluated.

This study's prepandemic period (PrP) was taken as April 2018-March 2020. The COVID-19 (C19) pandemic was considered from April 2020 to December 2022. In turn, the C19 was divided into 3 phases: confinement phase (CP) from April 2020 to September 2020, flexibility phase (FP) from October 2020 to June 2021, and normalization phase (NP) from July 2021 to December 2022 (*Figure 1*).

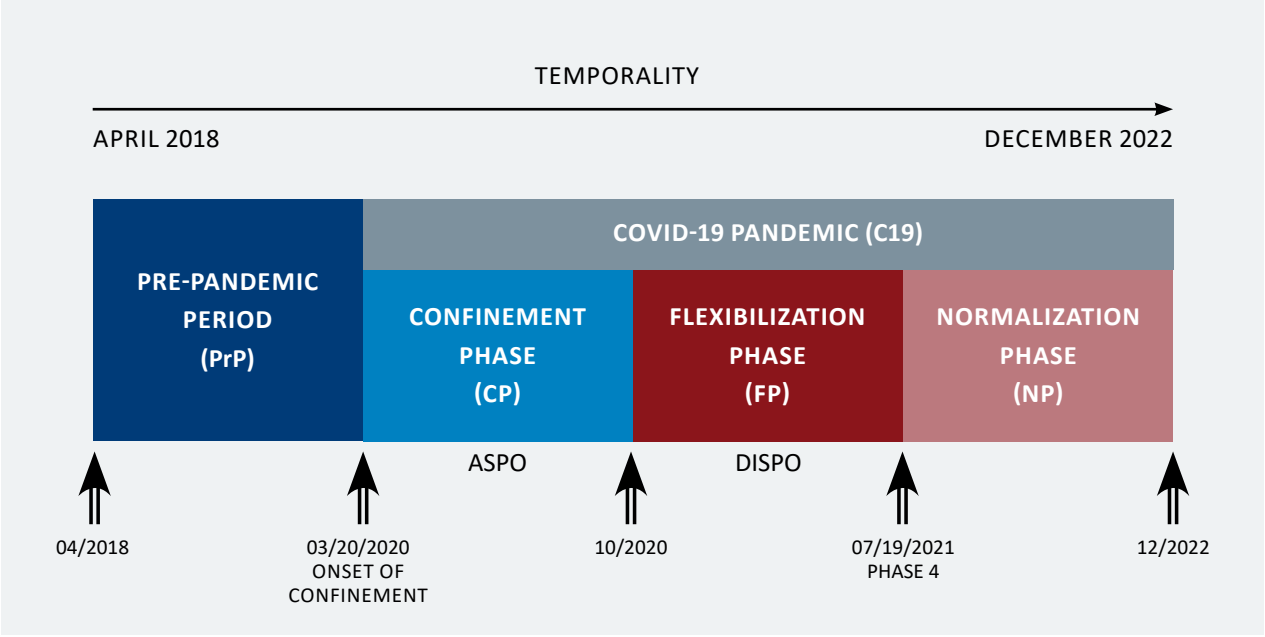

FIGURE 1. Schematic of the temporality covered by the study. The pre-pandemic stage (PrP) is shown in blue, whose data were compared with those of the COVID-19 pandemic stage (C19) (grey) and with those of each of its component phases: confinement phase (CP) in light blue; the flexibilization phase (FP), in red; and, finally, normalization phase (NP), in pink.
ASPO: preventive and compulsory social isolation (for its acronym in Spanish); DISPO: social, preventive, and obligatory distancing (DISPO, for its acronym in Spanish).

Epidemiological descriptive variables were studied: sex, the origin of patients before surgery, traditional cardiovascular risk factors (hypertension, diabetes mellitus, sedentary lifestyle, smoking, obesity), and cardiovascular history (acute myocardial infarction [AMI], angioplasties, and previous cardiac surgery). In addition, the following aspects were evaluated: results of preoperative studies (echocardiogram, cine-coronary angiography, spirometry) and postoperative evolution of all the patients who underwent surgery (postoperative extubation time, need for reintubation, requirement and time of inotropic drugs, prevalence, and type of infections).

The activities performed were evaluated: number of medical consultations (C) and cardiac surgeries (Q) and the type of surgical intervention.

Calculations and statistical analysis

Values are presented as mean ± standard deviation of the mean and percentage. Statistical analysis was performed with SPSS v24™ statistical software (IBM SPSS Statistics 24.0, 2021, IBM, NY, USA). Student's test and chi-square test were used. The significance level was established when the p-value was <0.05.

RESULTS

Between March 2018 and December 2022, 943 patients were followed by outpatient clinics, and 561 patients underwent surgery.

During C19, there was a significant decrease in C per month relative to PrP (C19: 14.8 vs. PrP: 18.9; p <0.05). This reduction was even more critical in FC (PrP: 18.9 vs. FC: 5.6; p <0.0001; FC: 5.6 vs FF: 14.1 p<0.001). There was also a significant monthly Q reduction in C19 (C19: 12 vs PrP: 8.3; p <0.0001). FC was the phase with the most significant decrease in Q per month (PrP 12 vs FC: 3.7; p <0.0001). However, within this comparison of the PrP and C19 period, no significant differences were found between PrP and FN about C (C: PrP: 18.9 vs. FN:18.3; pns) and Q per month (PrP:12 vs. FN:10.4; pns) (*Figure 2*).

The origin of patients operated on in C19 from the Intensive Care Unit (ICU) increased significantly concerning PrP (C19: 9.49% vs PrP: 3.5%; p <0.005); this increase was even more significant in FP (PrP: 3.5% vs FP: 10.9%; p <0.005). Patient referral from services within the hospital increased considerably in C19 (C19: 48.6% vs. PrP: 35.9%; p <0.005), being even more in FF (PrP 35.9% vs FP: 55%; p <0.0001). There was a significant decrease in outpatients in C19 compared to PrP (PrP: 72.5% vs. C19: 52.9%; p <0.005), being even more evident in FP (PrP: 72.5% vs FP: 39.1%; p <0.005) (*Figure 3*).

Within the risk factors and cardiovascular history of the population operated on in C19, the only parameters found with significant differences were insulin-requiring diabetes (IR-DBT) (FP: 10.1% vs. PrP: 5.2%; p <0.05) and AMI (FP: 70.3% vs PrP: 56.8%; p <0.05).

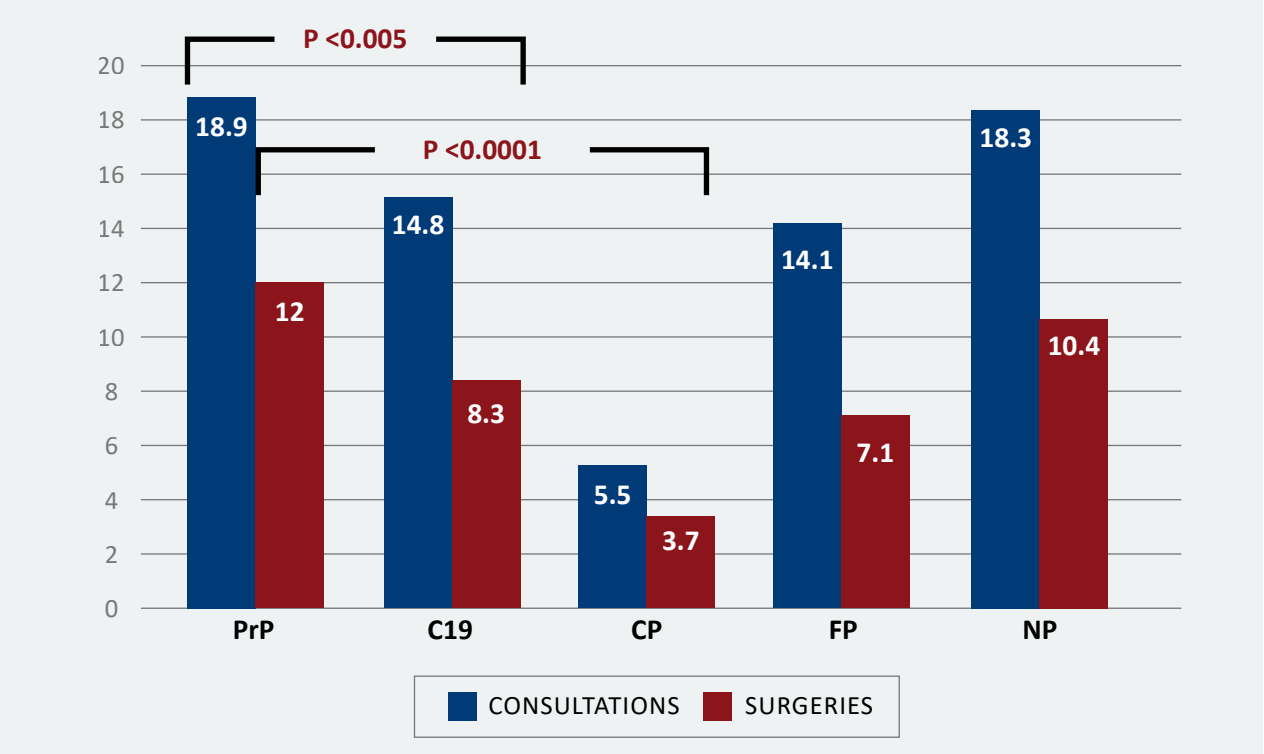

FIGURE 2. Average number of consultations (blue) and surgeries (red) per month during the pre-pandemic stage (PrP) and COVID-19 (C19) stages and the confinement (CP), flexibilization (FP), and normalization (NP) phases .

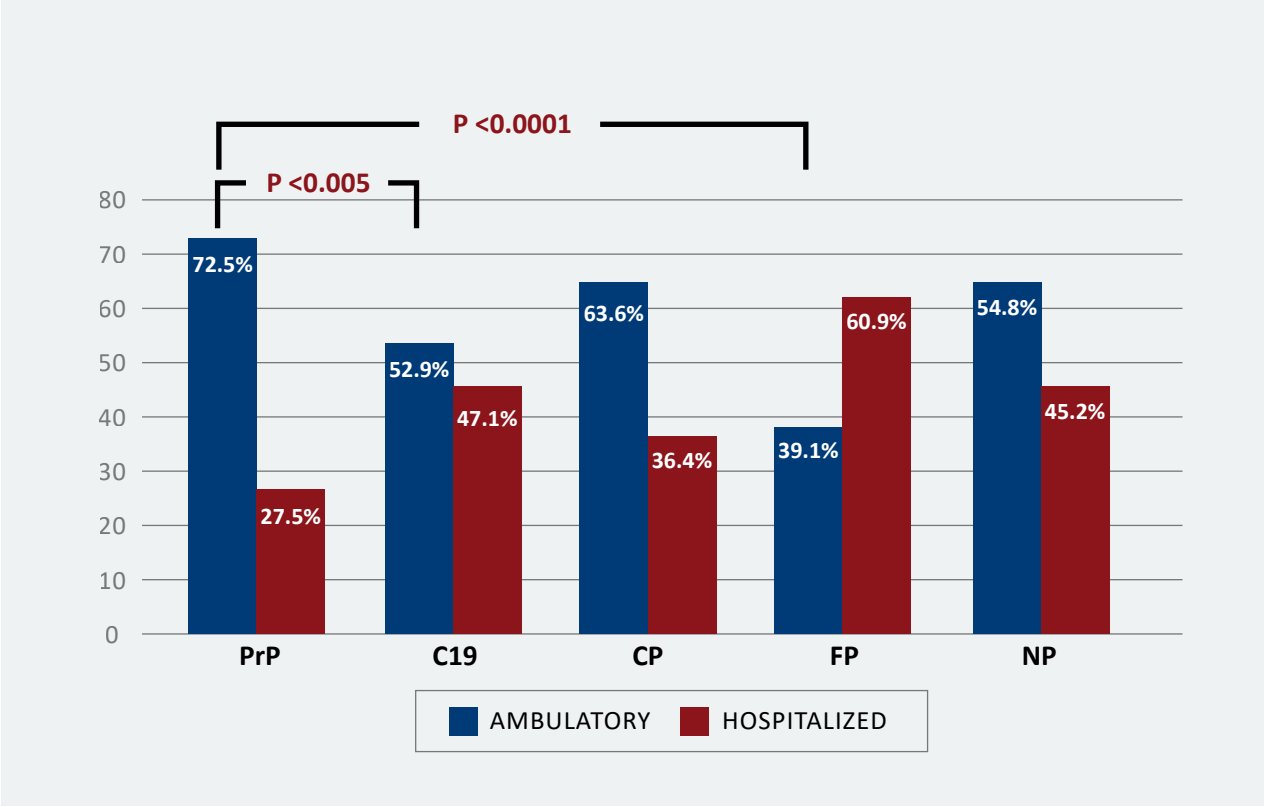

FIGURE 3. Percentage of origin of patients admitted to cardiac surgery, ambulatory (blue) and hospitalized (red) during the pre-pandemic (PrP) and COVID (C19) stages, and the confinement (CP), flexibilization (FP), and normalization (NP) phases.

There was no significant difference between the findings in C19 vs PrP regarding the lesions described in the cine-coronary angiography. Regarding preoperative complementary studies, the practice of spirometry decreased considerably in C19 (C19: 58.4% vs. PrP: 87.1%; p <0.05), being significantly lower in CP (CP: 36.4 vs PrP 87.1%; p <0.05). At the echocardiogram level, a lower number of patients with preserved left ventricular systolic function (LVSF) was observed in C19 about PrP (C19:53.3% vs PrP: 61.7%; p <0.05) (*Figure 4*).

When analyzing the surgical procedures performed, there was only a significant difference in the increase of aortic valve replacement (AVR) in NP (NP: 20.2% vs PrP: 11.5%; p <0.005).

Regarding postoperative evolution, there was no significant difference in extubation time, need for reintubation, time, and requirement of inotropic drugs. Regarding the prevalence of infections, a substantial increase in total infections was observed in CP concerning PrP (CP: 36.4% vs. PrP 18.8%; p <0.05) at the expense of respiratory infections (CP: 27.3% vs PrP 8.7%; p <0.05) (*Figure 5*). However, only one positive case of SARS-CoV-2 virus was detected.

Regarding respiratory infections, it was observed that patients who had them in CP had a history of smoking (CP: 100% vs. PrP: 44%; p <0.01) and referral from another institution (CP: 83.3% vs FN: 42.9%; p <0.05).

CONCLUSIONS

During C19, a decrease in the monthly C and Q numbers in the Cardiac Surgery Service was observed. However, no differences were found between PrP and NP. In addition, there was a decrease in outpatient consultations and, in contrast, a more significant referral of patients from the ICU, mainly in the FP.

Among the risk factors and cardiovascular history, a higher prevalence of previous AMI and IR-DBT was found.

Throughout C19, fewer previous spirometries were performed in operated patients, and a more significant deterioration of LVSF, assessed echocardiographically, was observed.

Finally, there was an increase in total infections at the expense of respiratory infections related to smoking and referral from other institutions.

Declarations
The authors declare no conflict of interest.

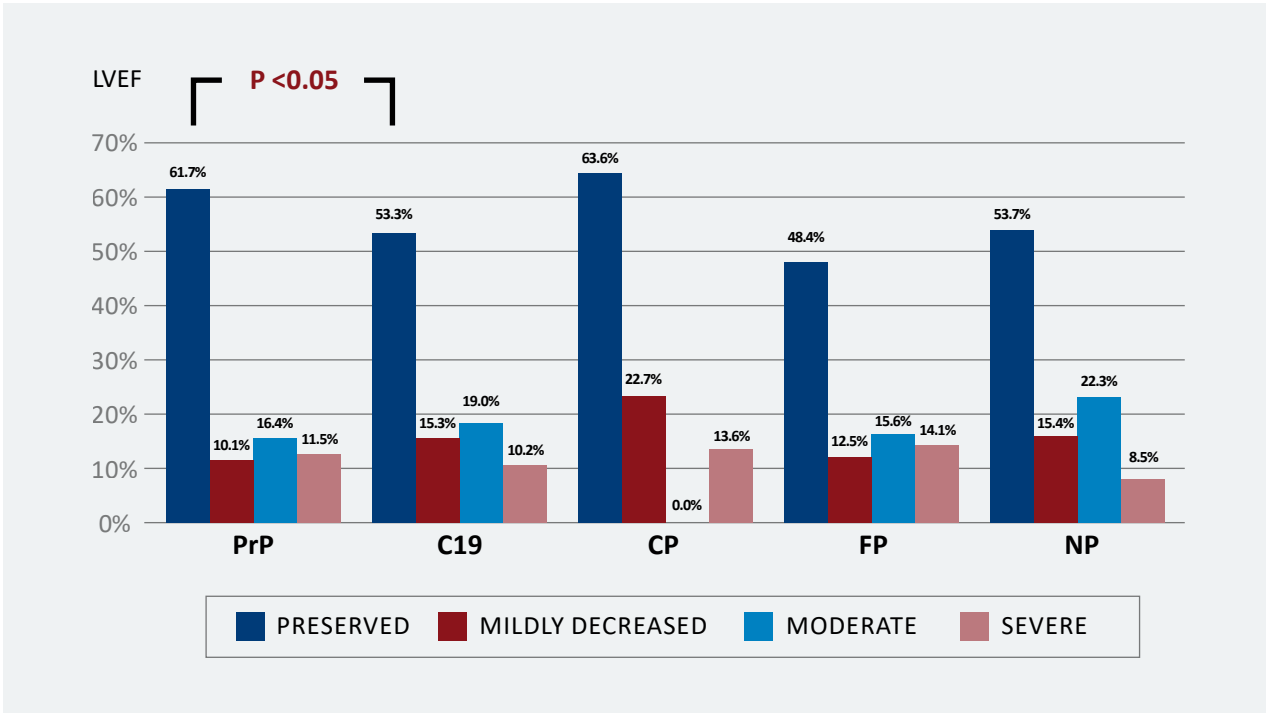

FIGURE 4. Ventricular function in the operated patients, assessed by echocardiography with left ventricular ejection fraction (LVEF), distributed according to the values found in LVEF preserved: ≥50% (blue) and mildly decreased: 49-40% (red), moderate: 39-30% (light blue) and severe: <30% (pink) during the pre-pandemic (PrP) and COVID (C19) stages, and the confinement (CP), flexibilization (FP), and normalization (NP) phases.

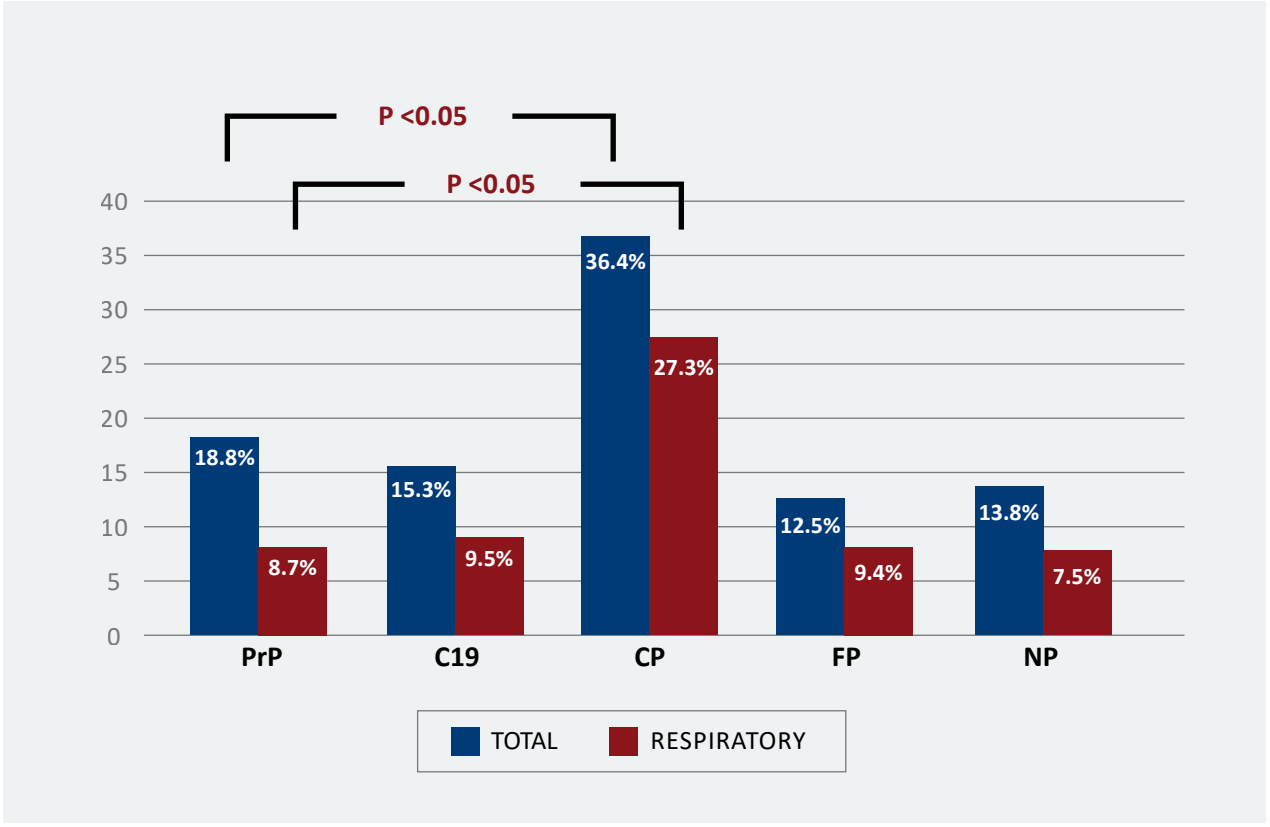

FIGURE 5. Prevalence of infections in operated patients (total in blue and respiratory in red) during the pre-pandemic (PrP) and COVID-19 (C19) stages, and the confinement (CP), flexibilization (FP) and normalization (NP) phases.

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ORIGINAL ARTICLE

SALVAGE OF MEGA-FISTULA WITH NEZAKATGOO TECHNIQUE

ABSTRACT

Introduction: Mega-fistula is understood as an arteriovenous fistula that is very dilated throughout its course, tortuous, sometimes aneurysmal, and that presents flows above 2L/min; this carries the risk of generating multiple complications (from aneurysmal rupture, recirculation, and heart failure due to overload, among others). Its usual treatment is ligation or prosthetic replacement.

Material and methods: The technique described by Nezakatgoo et al. was performed on three patients with mega fistulas (operated between 2020 and 2023) in whom salvage surgery and recovery of the entire fistula was performed. Complete dissection of the fistula from its anastomosis to the arch of the cephalic vein is performed, the vein is calibrated with a 24-34 Fr chest tube, and the excess of the mega-fistula and aneurysms are resected. In the case of stenotic areas, these are enlarged, or new anastomoses are made, and in the case of stenosis of the arch, a new anastomosis is made in the axillary vein.

Results: The first case describes a left humerocephalic fistula made in 2011, which, after the plastic surgery, required two angioplasties due to stenosis in the middle third (at 125 and 236 days after the plastic surgery). It remains patent, with a total patency of 156 months since its initial confection and 36 months since the plastic. The second patient presents a mega-fistula performed in April 2019, which, after plastic surgery, required angioplasty for stenosis at one time at 509 days and continues to be permeable to date, with a total patency of 56 months and 30 months since plastic. The third fistula was operated in the context of total fistula thrombosis and required, in the first instance, a thrombectomy prior to reconstruction. It evolved in two episodes (at months 2 and 5), with stage IIb steal treated by banding (Miller technique) on both occasions. It presents a total patency of 57 m and 18 m from the plastic. All patients remain on dialysis to date due to the reconstructed fistula.

Conclusions: Salvage of mega-fistula is a valid procedure to continue the useful life of native fistulas in the short and medium term; if necessary, complementary procedures are required to solve problems similar to those of other fistulas.

Keywords: *mega-fistula, hemodialysis, native arteriovenous fistula.*

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INTRODUCTION

Due to dialysis patients' increasing number and longevity, vascular accesses must last as long as possible. Using native arteriovenous fistulas (AVF) becomes ideal since they have a higher patency rate, low risk of infections, and the possibility of being maintained more cost-effectively in the long term.

Multiple factors influence the proper functioning of vascular access (arterial inflow, stenosis, dilatations, theft, hematomas, and thrombosis, among others); transformation into a mega-fistula is one of them. A mega-fistula is defined as one that presents significant dilatation along its entire course; it is tortuous and usually has flows greater than 2 L/minute. In addition, they may present cardiopulmonary recirculation greater than 20%, heart failure with cardiac output greater than 4-8 L/min, and a cardiac index greater than 3[1]. A systematic review of 43 studies that included 11,374 fistulas describes an incidence of 1.5% per year[2]. As a predisposing factor, it is common to find critical stenosis at the exit (cephalic arch or subclavian vein), which would explain the aneurysmal dilatation of the entire vein. It is also frequent in post-transplant patients, either due to their factors or because of the lack of follow-up of the access[2].

The usual treatments for this situation are resection of the dilated segment and anastomosis, resection with prosthetic interposition, or even ligation and abandonment of the access, generally using the association of a catheter, either transient or semi-permanent[2,3].

MATERIAL AND METHODS

The technique described by Nezakatgoo et al.[4] makes it possible to rescue these mega-fistulas so that the patient can continue dialysis with his native fistula, with the benefits that this implies, and without the need to place a catheter a posteriori. The following is a description of the technique according to the author.

Anesthesia is decided according to the patient's characteristics. The operation begins with control of the AVF within 2 cm of the arterial anastomosis and the venous end proximal to the venous dilatation. Control is acquired up to the deltopectoral groove, depending on the degree of aneurysmal degeneration of the AVF. Heparin is administered intravenously. The fistula is clamped near the arterial anastomosis and as proximal as possible along the venous end. The fistula is then sectioned 2 cm from the venous clamp, and a stump of vein is left with the arterial anastomosis. A longitudinal elliptical skin incision is made over the aneurysmal portion of the AVF, and any thinned or ulcerated skin is excised. The vein is released circumferentially along its entire length. Once fully mobilized, the vein is opened longitudinally, and the excess aneurysmal fistula tissue is removed. An appropriately sized thoracostomy tube (24 Fr-36 Fr) is placed into the vein (to gauge its final diameter). Then, the vein is sutured longitudinally over the tube with a continuous, monofilament, nonabsorbable suture. The integrity of the suture line is tested with heparinized saline before tunneling. The vein is sutured to the tapered portion of the thoracostomy tube, which is attached to a tunneling device. The circumferential suture from the vein to the thoracostomy tube distributes pressure evenly while pulling the vein through the tunnel, resulting in less trauma.

The repaired vein is then tunneled through a new anteromedial subcutaneous tunnel and pulled out through the original incision. This tunneling is performed by rotating the vein through 90 degrees, which allows the suture line of the repaired mega-fistula to be hidden and buried in the central face of the tunnel. This rotation is critical because it protects the suture line from further dialysis punctures and allows a vein surface that has not previously been used for access or has not been involved in the repair to be most suitable for future punctures. A 90-degree rotation distributed in a manner has not caused kinkings. A term-terminal venous anastomosis is performed with a 5-0 polypropylene suture. After the operation, patients are usually discharged on the same day. The revised AVF is used for dialysis access on the first postoperative day without transitional catheter placement.

EXPERIENCE OF OUR GROUP

Case number 1

A 28-year-old man with a history of renal transplantation and hyperparathyroidism. Dialyzed for a humerocephalic fistula made in 2011. He consults for inadequate flow and pain during dialysis. A fistulography was performed, showing tortuosity, multiple aneurysms, and significant stenosis in the arch of the cephalic vein. Under general anesthesia, the technique described above was performed, and the fistula was anastomosed to the axillary vein due to the stenosis in the arch (*Image 1*). The patient evolved with compartment syndrome (first described as atraumatic compartment syndrome associated with dialysis vascular access surgery) in the legs that required fasciotomy and evolved favorably without sequelae. He required two angioplasties at 125 days and 236 days after plastic

surgery for stenosis. He is dialyzed through the access 36 months after the plastic and 156 months since its creation.

Case number 2

A 51-year-old woman with a history of tuberous sclerosis dialyzing for a humerocephalic fistula created in April 2019. A fistulography is performed that shows multiple aneurysms with stenosis between them, without stenosis at the distal level. Under plexus anesthesia, the Netzakangoo technique is performed, but with the variation of requiring resection of the stenosed segment and preparation of an intermediate anastomosis (*Image 2*).

Angioplasty is required 509 days after plastic surgery. It is permeable 56 months after its creation and 30 months after the plastic surgery.

Case number 3

A 41-year-old man with a right humerocephalic fistula made in March 2019. He presented with inadequate flows and elevated venous pressure on dialysis. A fistulography showed significant tortuosity with multiple sites of stenosis and dilatation. Before the scheduled surgery, the patient presented thrombosis, requiring thrombectomy in addition to 2 resections of stenotic segments with anastomosis and distal anastomosis in the axillary vein due to stenosis of the cephalic arch. After two months, the patient developed ischemia syndrome associated with stage IIa dialysis access with a flow rate of 3 L/min (*Image 3*). Banding was performed with the modified Miller technique[5] on two occasions (64 and 169 days). It has been permeable for 57 months after its creation and 18 months since the plastic.

DISCUSSION

The development of a mega fistula is due to multiple factors and is a conditioning factor for the proper functioning of the access during hemodialysis. Netzakangoo describes in his original work that he obtained a primary patency of 67.1 months in 102 patients until the first revision. The primary functional patency of the rescued mega-fistula was 90.2% at 95 months, with a mean follow-up of 36.29 months. The range of recovered functional patency was 7 to 95 months. Fourteen patients required further revision (13.7%); other complications described were steal syndrome (6.9%), thrombosis (4.9%), development of stenosis (2.9%) and infection (2.0%). Transplantation was performed in 10 patients, and another 10 patients died, all with functioning fistulas.

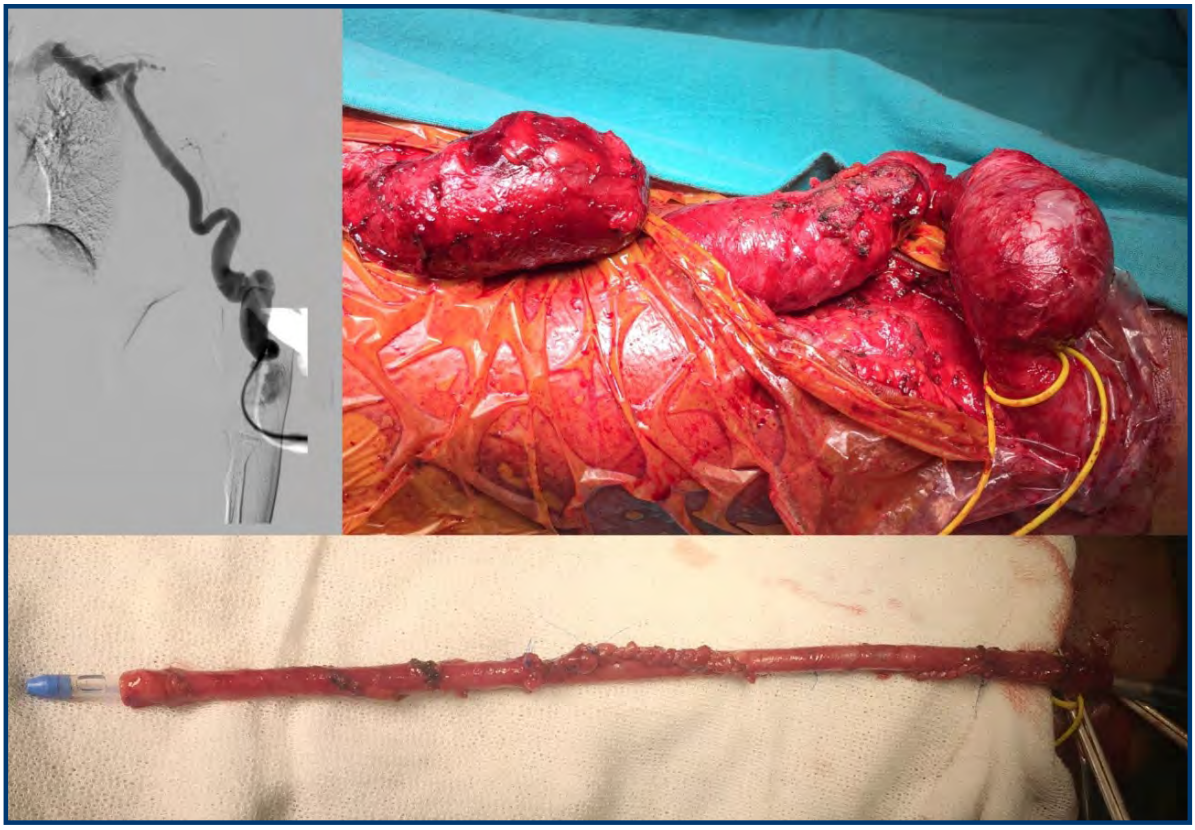

IMAGE 1. Top: aneurysmal and tortuous mega-fistula. **Below:** the prepared vein over the thoracotomy tube.

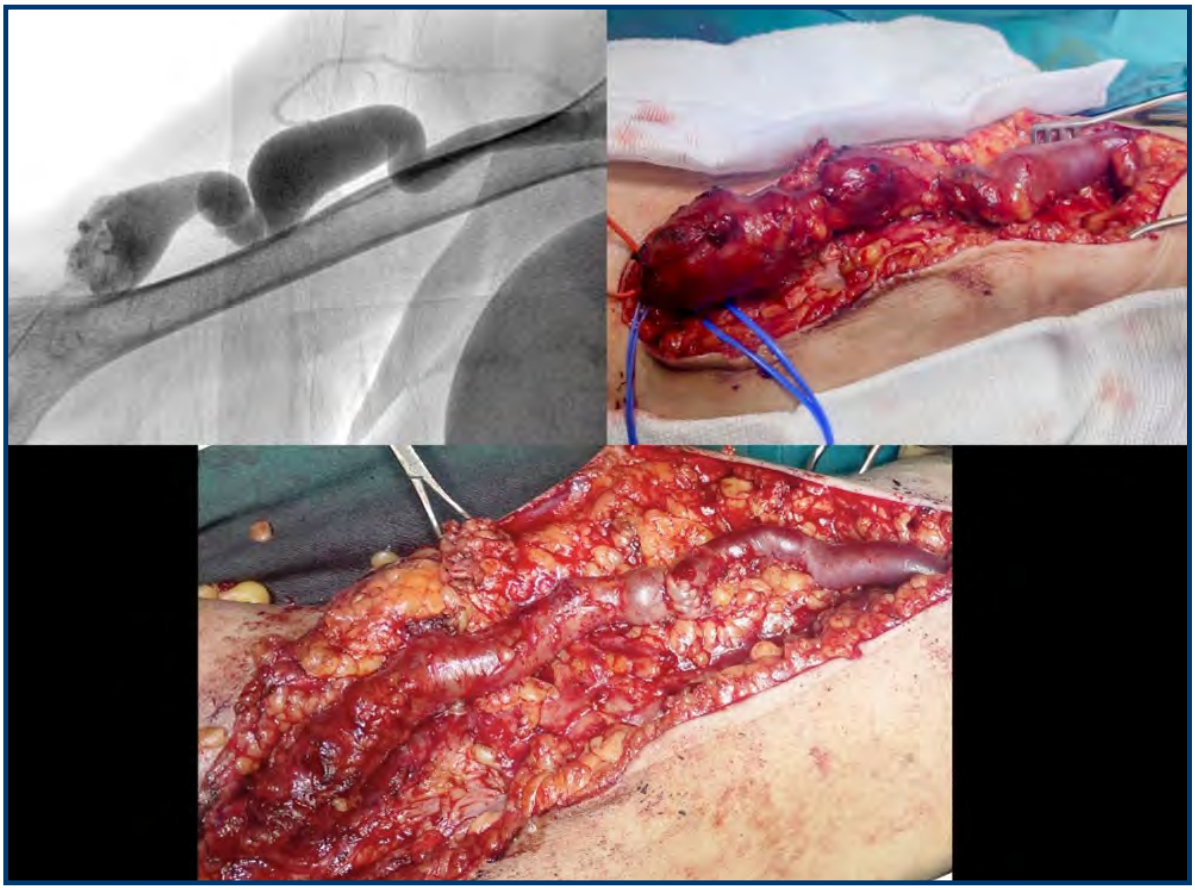

IMAGE 2. Above: aneurysmal and tortuous mega-fistula. **Below:** The vein is already repaired, and anastomosis is observed in the distal third.

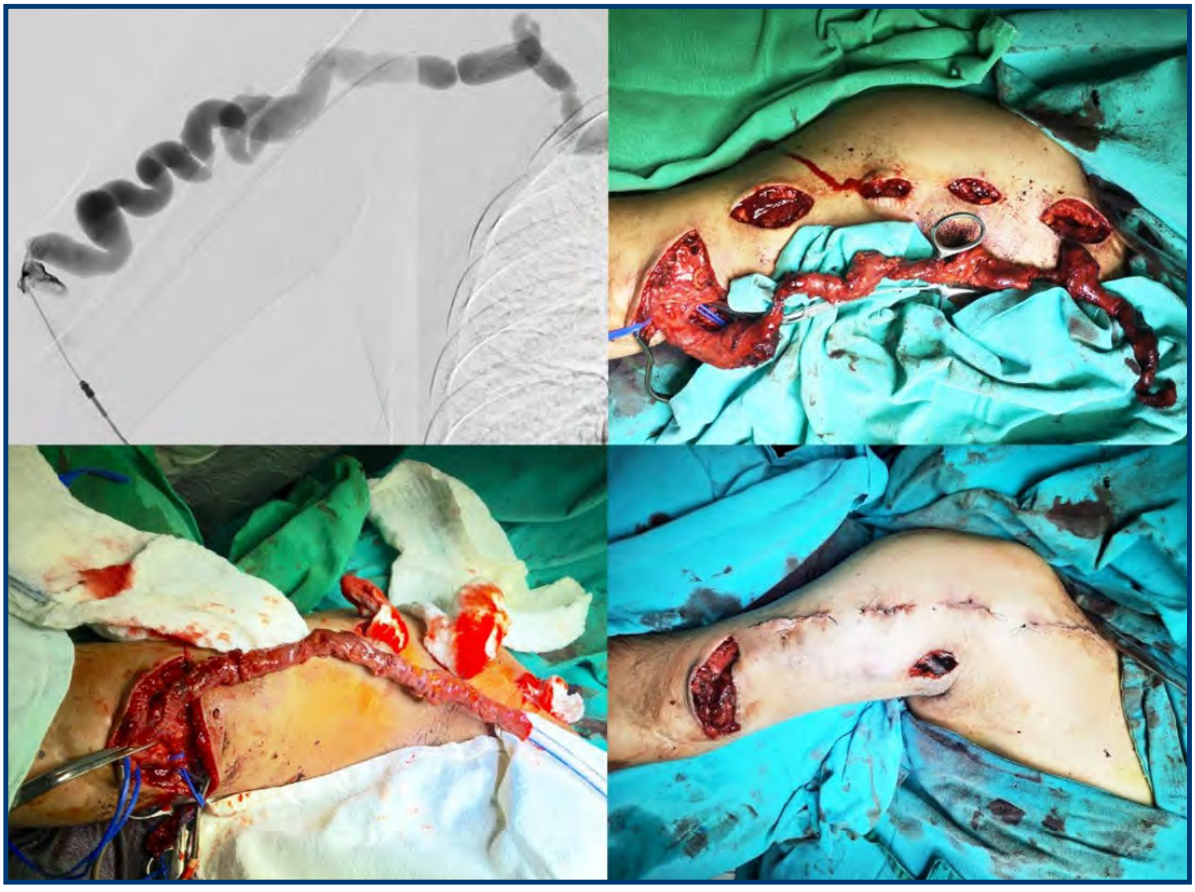

IMAGE 3. Above: Aneurysmal, tortuous, and multiple stenosis mega-fistula. **Below:** Vein already repaired.

RESULTS

Due to these favorable results, we decided to initiate our own experience. All our patients are on adequate dialysis through the same access despite having presented post-surgical complications (stenosis, steal, and compartment syndrome); all of them resolved without sequelae. The mean follow-up was 835 days (range 503-1021). The duration of primary assisted patency until the first procedure was 232 days (range 64-209), with 100% primary assisted patency to date. One of the things we learned after the relatively early stenoses of the first cases was to prefer a 28 Fr chest tube as we did in the last case. We also chose limb block as the anesthesia of choice, as these are prolonged surgeries (mean: 130 minutes), and we believe that the compartment syndrome in the first case was related to decubitus and arterial hypotension associated with general anesthesia in the context of poor arterial beds. As these were our first cases, we preferred to use a transitional catheter for one week until the surgical site was in better condition for the first puncture, performed without intercurrences.

As an observation, although the number of patients does not seem significant, the dialysis center of our institution has approximately 100 patients on hemodialysis, so our incidence is within the expected range.

CONCLUSIONS

Salvage of mega-fistulas is a technically feasible procedure with morbidity comparable to other vascular accesses with superlative long-term results, considering that conventional treatments would otherwise most likely be associated with loss of access or a shortening of its useful life.

Declarations

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

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

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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.*

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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"[1,2].

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[1,2]. 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[1,2].

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[3-5].

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).

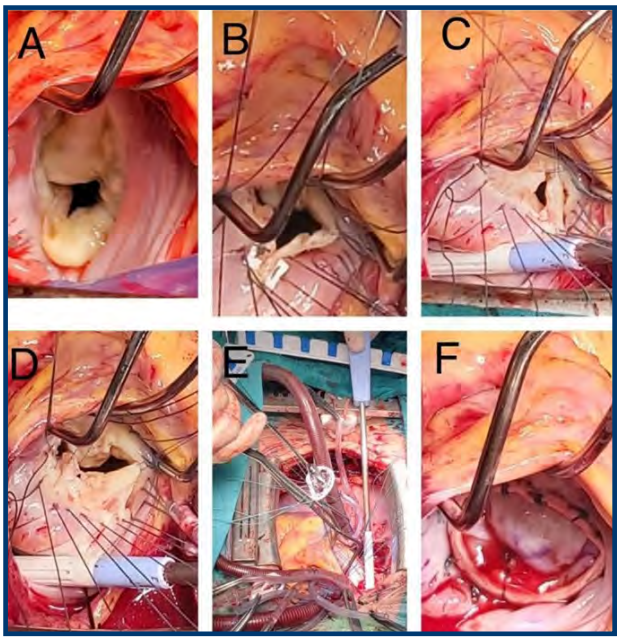

IMAGE 1. Most frequently used technique. A. Exploration (chordal rupture and P prolapse). B. Posterior ring plication. C. Quadrantectomy and P2 sliding. D. Suture placement in mitral annulus. E. Mitral prosthetic ring implantation. F. Result.

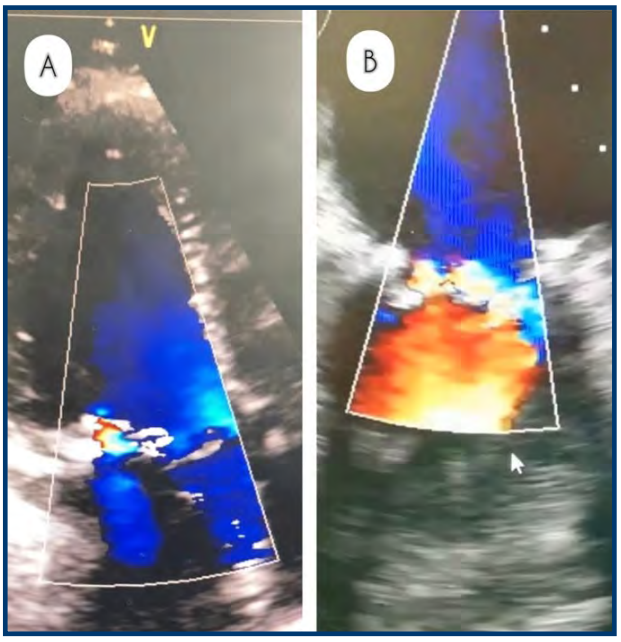

IMAGE 2. Post-surgical echocardiographic control. A. Apical transthoracic. B. Intraoperative transesophageal echocardiography.

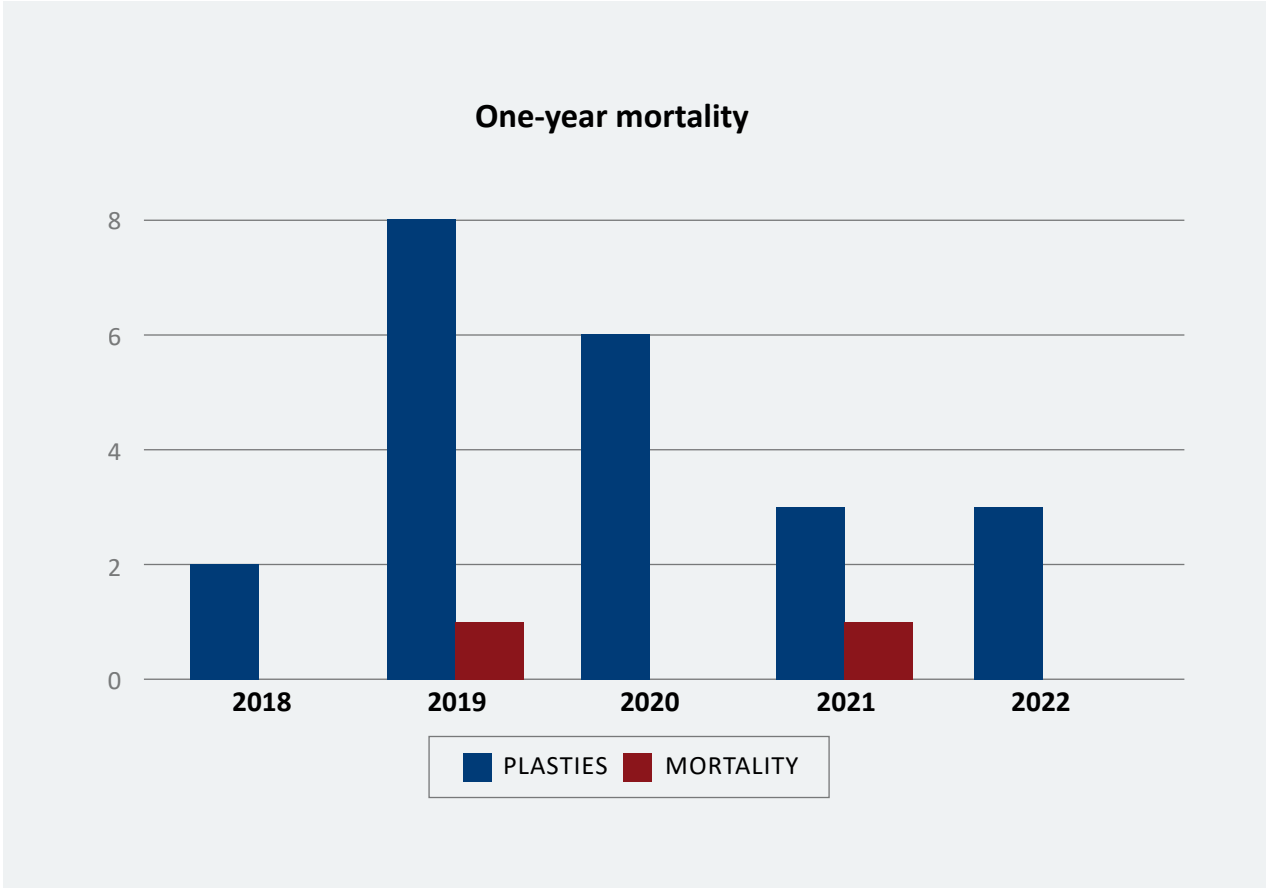

FIGURE 1. One-year mortality of patients undergoing primary cause mitral valve repair up to one year of follow-up.

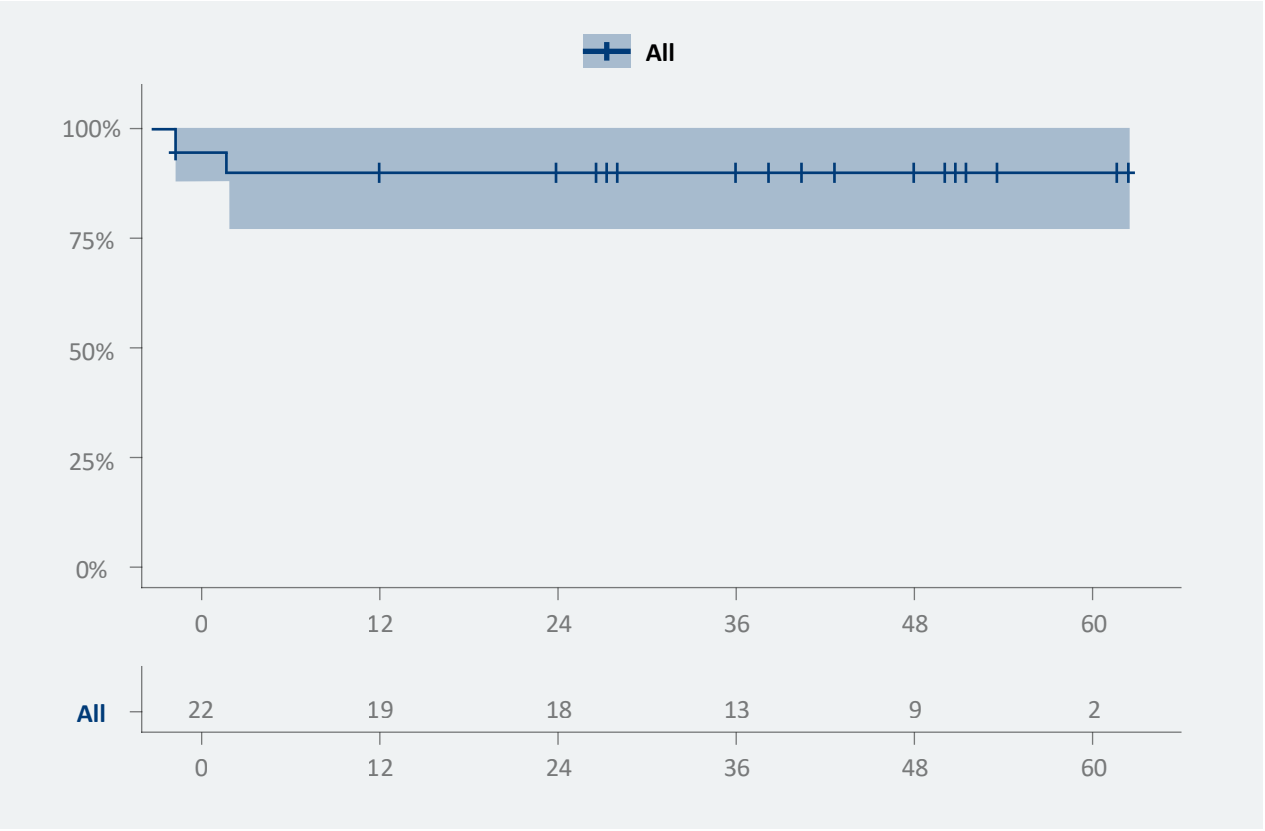

FIGURE 2. Event-free mitral plasty patency during the 5-year follow-up of all patients.

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%[6-8]. 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[8-10].

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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SCIENTIFIC LETTER

PITFALLS OF ROBICSEK'S PROCEDURE: SAFEST AVANT-GARDE ALTERNATIVES TO REDUCE STERNUM SURGICAL COMPLICATIONS

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ABSTRACT

Robicsek's technique is a surgical methodology mainly used for sternal dehiscence, stabilization of the chest wall, and maintaining respiratory dynamics. Returning to an infected and anatomically altered scenario after cardiac surgery fosters a high risk of rupture, tears of previous repairs, and vascular bypasses. Classically, the dense adhesion of the left internal mammary artery to the posterior plate of the sternum makes the dissection of half of the fractured and dehisced sternum a prone situation for transection avulsion of the artery conduit, requiring ligating the most critical bypass to the heart. Our proposal brings a solid and safe surgical alternative to avoid dealing with the dangerous situation of dissecting the posterior sternum to perform Robicsek's procedure.

Keywords: *Robicsek's technique, sternum infections avulsion, dissecting sternum.*

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HOW TO DO IT?

Faced with the challenges of sternum infections, we frequently refer to the work of Dr. Francis Robicsek. His contributions to the sternum armamentarium surgical management have been a cornerstone in treating sternal bone dehiscences and infections and have favorably enhanced and guided our cardiothoracic surgery techniques. Nevertheless, Robicsek's procedure is not always suitable because of the patients' peculiar anatomical variabilities, complex adhesions, particular infections, previous surgical procedures, and unique fractures[1, 2].

During Robicsek's technique closure, our main concern -particularly during vascular graft surgeries- is the right ventricle, but even aware of this, oodles of different calamities take place. For example, when a patient has had a left internal mammary artery (LIMA) graft into the left anterior descending artery (LAD), we have wistfully identified the LIMA densely adhered to the posterior sternum in the left upper sternal manubrium area[3]. Conjointly, in these cases, the vessel has ended up easily damaged without chance of repairment, massively bleeding, and requiring an urgent need to ligate the artery to save the patient's life. After this event, the bypass graft is lost, and nothing can be done to fix it.

Considering this, we grew concerned about how to tackle these drawbacks and decided to work in an alternative to Robicsek's procedure. As a result, we started using Zimmer Biomet's SternaLock Blu™ and SternaLock 360™ (supplied by Surgical Solutions, Guaynabo, Puerto Rico)[4]. The SternaLock Blu™, a sternal closure system, comprises plates, screws, and three stainless steel wires. At the same time, the top-of-the-line SternaLock™ 360 only includes three plates and a titanium ribbon that exclusively helps patients with osteoporosis and osteopenia[1]. Thenceforth, we have experienced a decrease in thoracic infections and a lower rate of sternal bone dehiscence. An example of the SternaLock Blu™ efficacy is a patient who underwent a full sternotomy, three coronary artery bypass graft insertions, and an aortic valve replacement (*Image 1*). A week before discharge, despite an adequate recovery, the patient had a complete atrioventricular blockage and twenty-three resuscitation events. Thankfully, not only was this fixed with a permanent pacemaker, but the sternum was fully intact after compressions.

Through the Zimmer-Biomet thoracic tools, we have also created other approaches to stabilize the patient's sternums. After cleaning and debriding infected/dehisced sternums, we have developed a "fracture-stabilization" technique by using the ribs alongside SternaLock Blu™ (*Image 2*). Mainly used in patients unsuitable for wires or SternaLock Blu™ closure, and with the concern of iatrogenic injury to the LIMA, we decided to reduce injuries and avoid

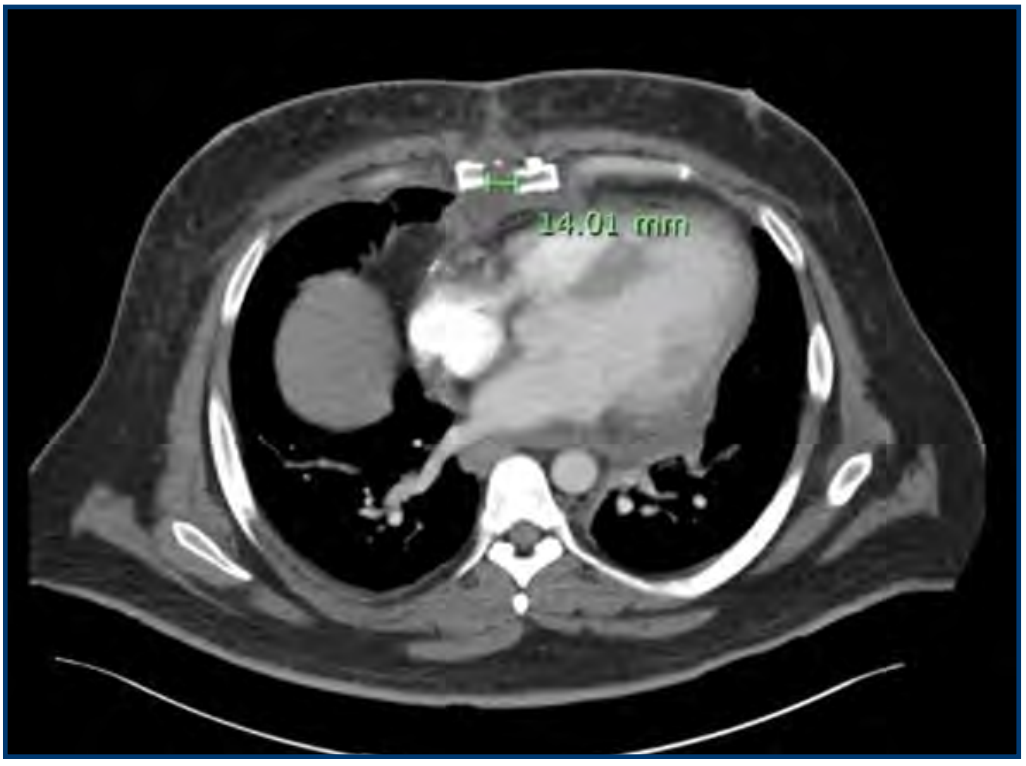

IMAGE 1. This image confirms that the patient has sternum dehiscence with fracture (measuring 14.01 mm in length), loose bone fragments in the surrounding area, mediastinitis, and fluid collection.

the usage of grafts[1, 3]. Hence, through this technique, we used Zimmer-Biomet long rib plates and inserted three plates on the anterior plane of the ribs (from cephalad to caudal), which helped the sternum to achieve complete stability and impermeability. The material's anti-septic characteristics and two intrathoracic Hemovac™ drainages in place (one anterior and one posterior to the sternum) for 28 days allow for the breastbone to heal effectively. In the six cases in which we have carried out this technique, after three weeks of drainage and antibiotics therapy, the patients were all discharged home, sternum stabilization was fully achieved, and no recurrence of infections was reported. Through this experience, we invite all cardiothoracic surgeons to embrace these advances since they will allow us to grow and enhance that patient's management. Even though Robiseck's closure will remain in our armamentarium, we have proved that this sophistication is another effective way to approach our cardiothoracic patients.

Declarations
The authors declare no conflict of interest.

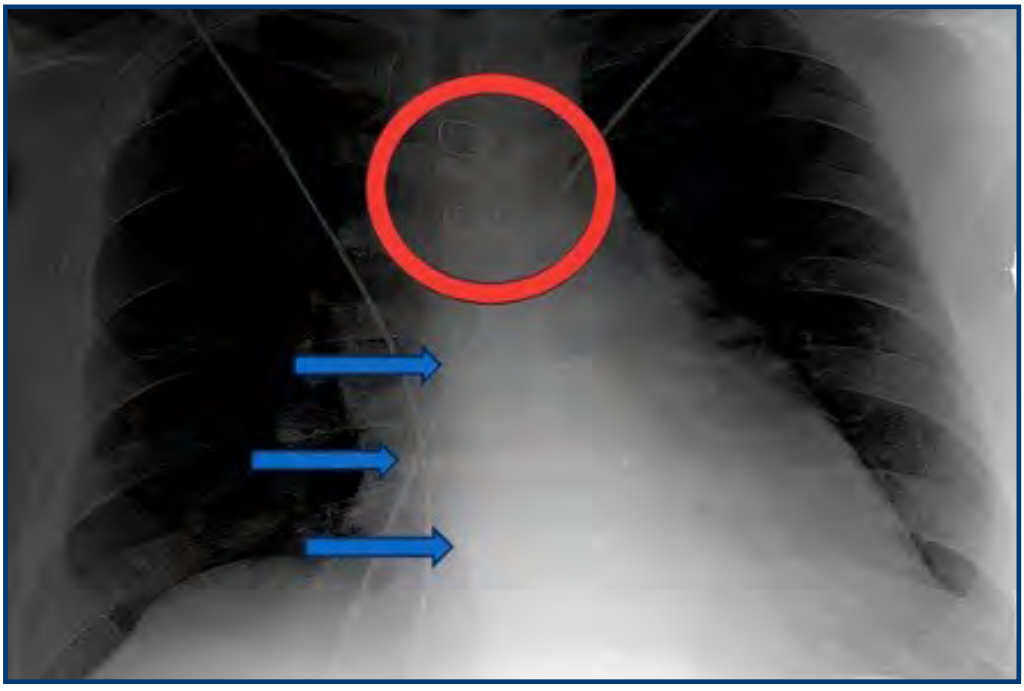

IMAGE 2. Initial remanent of SternaLock Blu™ closure system (red circle) and rib plates across sternum (blue arrows) for apposition of sternal bone fracture and dehiscence.

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SCIENTIFIC LETTER

RARE COMPLICATION OF INFERIOR VENA CAVA FILTER IMPLANTATION

ABSTRACT

Inferior vena cava filters are a valid option in treating patients with deep vein thrombosis of the lower limbs with contraindication or failure of anticoagulation or in cases of recurrent pulmonary embolism under adequate levels of anticoagulation. It should be recognized that, like any procedure, the implantation of these devices is not without complications, and migration is a rare but potentially severe late complication. The authors present the case of migration of a vena cava filter into the right ventricle in a 54-year-old female patient with a history of arterial hypertension and previous hospitalization for bilateral infrapatellar DVT.

Keywords: *inferior vena cava filters, implantation, deep vein thrombosis, lower limbs, pulmonary embolism.*

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INTRODUCTION

Inferior vena cava filters (IVCF) are a valid option in the treatment of patients with lower limb deep vein thrombosis (DVT) with contraindication or failure of anticoagulation or in cases of recurrent pulmonary embolism under adequate levels of anticoagulation[1]. Currently, this strategy is an alternative to long-term oral anticoagulation, and these devices may be increasingly implanted in patients without contraindications for anticoagulation, thus reducing the impact that these drugs can have on the quality of life of patients. However, it should be recognized that, like any procedure, the implantation of these devices is not free of complications, and migration is a rare but potentially severe late complication[1,2]. The authors present the migration of a vena cava filter into the right ventricle in an adult female patient.

CASE REPORT

A 54-year-old female patient with a history of arterial hypertension and previous hospitalization for bilateral infrapatellar DVT, in whom onco-gynecological pathology was suspected at first instance, with an indication for ICVF implantation for eventual surgical resolution of the underlying pathology. During hospitalization, the oncological cause was ruled out, so the patient was discharged with anticoagulation and scheduled outpatient removal of the device.

After six months, the patient went to the hospital for phlebography, visualizing that the inferior vena cava and right iliac vein were permeable, free of thrombi with evidence of the device, which seems to be adhered to the inferior aspect of the right ventricle (*Image 1*). Upon physical examination, the patient was hemodynamically stable without angina dyspnea or pump failure signs. At that time, it was decided to hospitalize the patient. A transesophageal echocardiogram was performed, which revealed a hyperechogenic image at the level of the right ventricular inflow tract, which compromised the opening and closing of the tricuspid valve, generating moderate to severe tricuspid insufficiency with mild dilatation of the right chambers and mild deterioration of right ventricular systolic function due to apical hypokinesia (*Image 2*).

After interdisciplinary evaluation and given the impossibility of percutaneous removal, it was decided to remove the device by surgery. A median sternotomy was performed with arterial cannulation at the level of the ascending aorta and venous cannulation to the superior and inferior vena cava. Extracorporeal circulation (ECC) was used after systemic heparinization. Right atriotomy with evidence of vena cava filter adhered to subvalvular plane and perforation of posterior leaflet of tricuspid valve; the device was then removed for bacteriological study and subsequent tricuspid valve repair with 5.0 polypropylene stitch, confirming correct valvular sufficiency with hydraulic test; the point of impact on the ventricular wall was reinforced using 4.0 polypropylene stitches reinforced with pledget. Subsequently, the right atrium was closed, and rigorous hemostasis control was performed; ECC was performed, with aortic clamping time of 14 minutes and a total of 22 minutes (*Image 3*). This patient had an intraoperative requirement of 3 units of red blood cells and low doses of noradrenaline. After surgery, the patient underwent the postoperative period in the cardiovascular recovery unit with ventilatory weaning in the first 6 hours after the procedure and the start of motor and respiratory kinesic assistance 24 hours after removing the drains. During hospitalization, negative cultures were confirmed; the echocardiogram showed good tricuspid valve function, and one week after surgery, it was decided, due to promising clinical evolution, to discharge the patient with oral anticoagulation for six months, as indicated by the Department of Hematology. The patient is under annual follow-up by the specialty, well controlled and without over-aggregated complications.

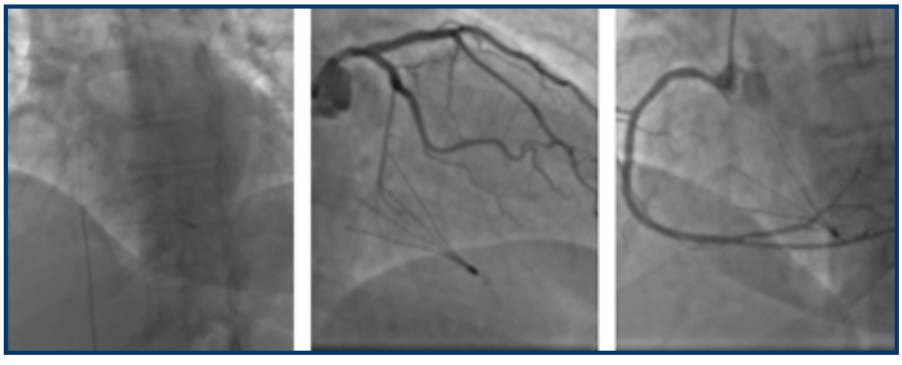

IMAGE 1. Phlebography showing free inferior vena cava without thrombosis with the device inside the right ventricle.

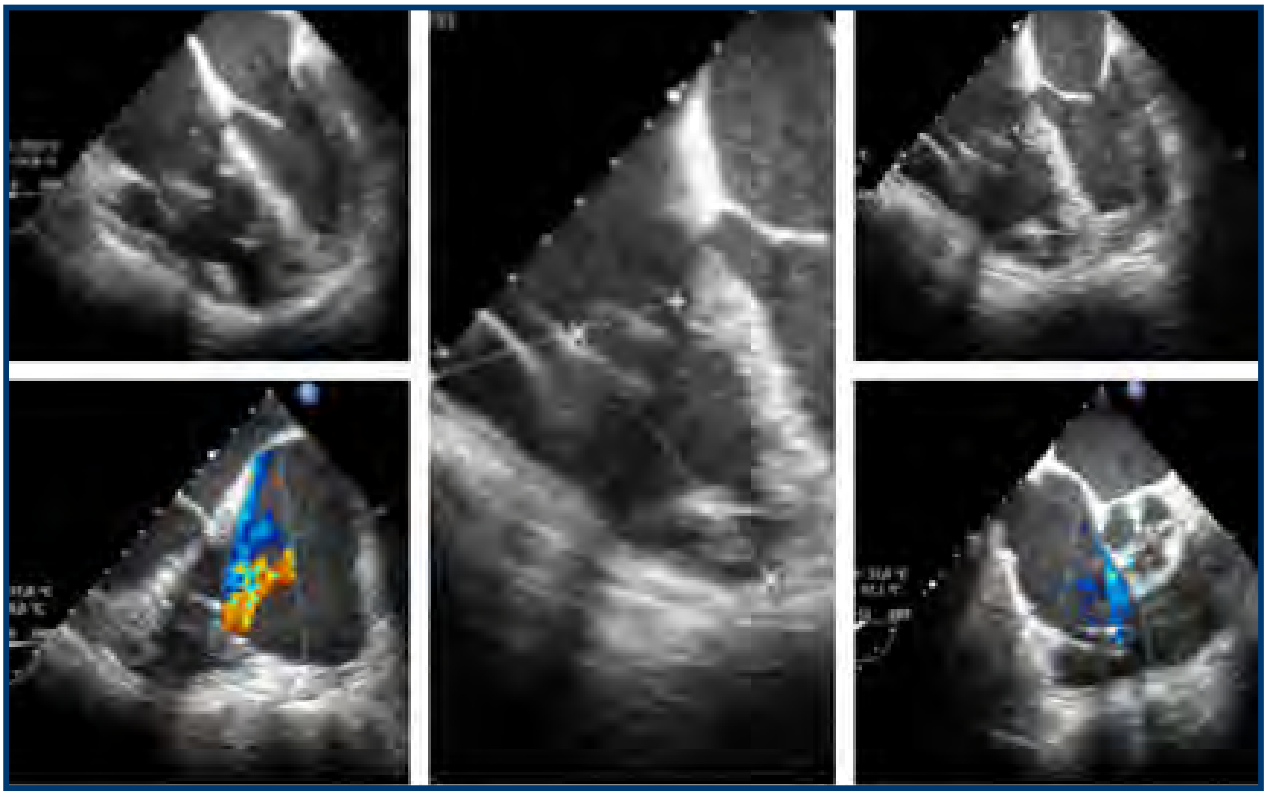

IMAGE 2. Transesophageal echocardiogram showing hyperechogenic image at the level of the tricuspid valvular plane, which generates moderate-severe insufficiency.

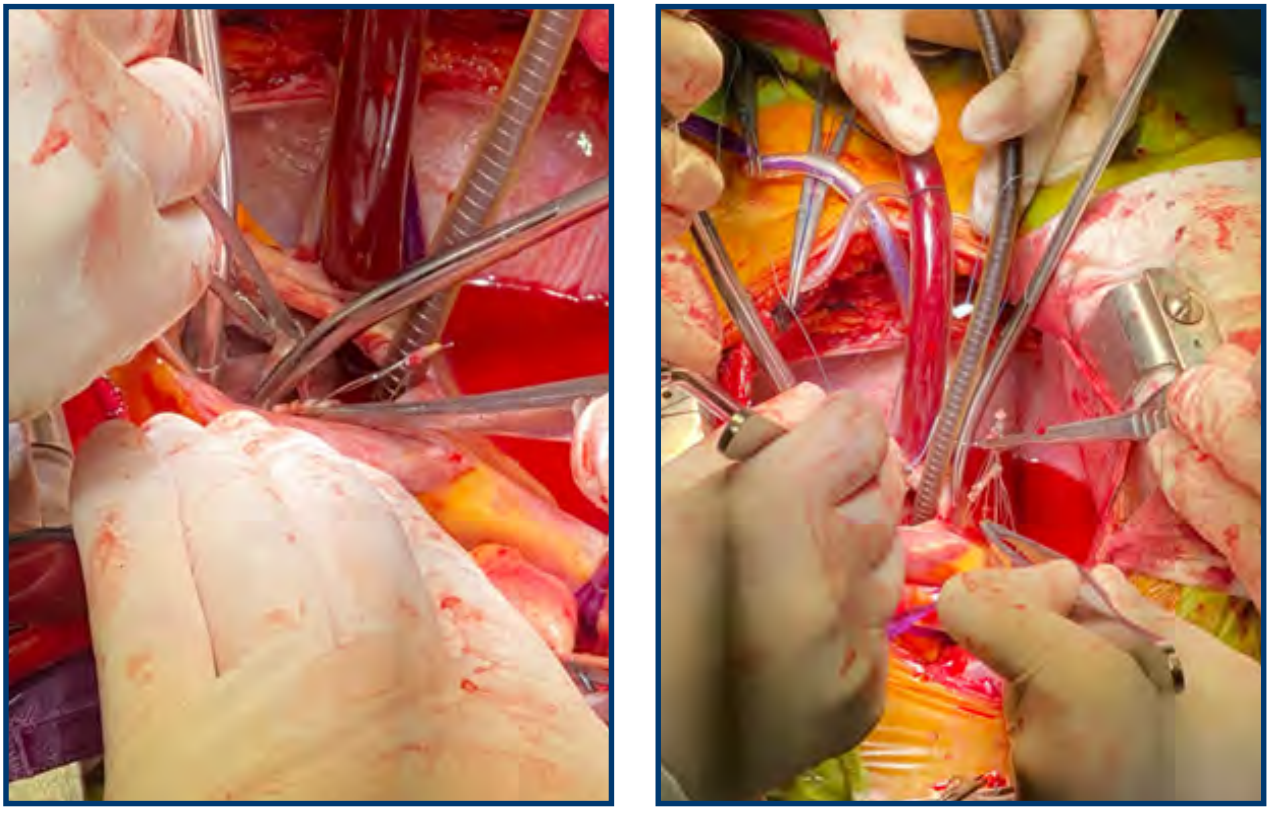

IMAGE 3. Right, atriotomy with evidence of vena cava filter adhered to the subvalvular plane and perforation of the posterior leaflet of the tricuspid valve (left side); removal of the device sent for bacteriological study (right side).

DISCUSSION

Complications that may arise during or after inferior vena cava filter implantation fall into two categories: early-onset and late-onset[1]. Early complications include bleeding, infection, malpositioning, incomplete deployment, or embolism of the filter or its components[1]. On the other hand, late complications include thrombosis of the inferior vena cava or any of its branches, perforation of the venous wall, filter fracture, retrograde embolization of filter fragments, and filter migration[1].

IVCF migration is defined as cephalic or caudal displacement greater than 1 cm from the original position of the device. Although this complication is rare, it can be potentially serious. Most registries are single case studies with very few data that, unfortunately, do not allow us to determine the factors responsible for their etiopathogenesis[1]. Migrations of the filter or device fragments into the right atrium, pulmonary artery, right gonadal vein, lumbar veins, and even into the aorta have been reported[2].

In a comprehensive review of the medical literature, Owens et al. described 98 cases of intracardiac filters, of which almost half were located at the level of the right atrium. The other locations, such as the tricuspid valvular plane, the right ventricle, and the pulmonary vascular tree, accounted for the other half1.

The mechanism of device migration has yet to be well understood and is often multifactorial[1,3]. The placement of an inadequately sized filter or the lack of device opening are causes that can generate early migration[3]. On the other hand, filter obstruction by thrombus with the consequent "sail phenomenon" is a cause associated with late migration.

In terms of diagnosis, this complication is usually an unexpected radiological finding with a wide range of symptoms that can simulate pathologies such as MI, pericarditis, or arrhythmias. Transesophageal echocardiography (TEE) is a valuable tool for detecting vena cava filter migration[3]. In our case, TEE not only provided us with essential data (such as the location of the device and its relationship with intracardiac structures) but also allowed us to establish the degree of valve compromise and prepare for different intraoperative scenarios.

All studies agree that the treatment of IVCF migration is its immediate removal through surgery or image-guided percutaneous removal whenever possible and safely. Although information on the migration and removal of these devices is currently minimal, the procedure of choice, it is clear, should be chosen on the basis of the patient's characteristics, the operator's experience, and the location of the filter[3]. Percutaneous removal has a high success rate and a low complication rate, provided it is performed in experienced centers with a multidisciplinary team[4-6]. Surgical removal is a less frequent and more invasive option, which is reserved for cases in which percutaneous removal is not feasible or has failed. In our case, the decision to remove the device by conventional surgery was based on the good health status of the patient, the intracardiac location of the device that could not be removed percutaneously, and the degree of valvular compromise defined in the TEE.

CONCLUSIONS

IVCF migration is an uncommon and little-studied pathological entity. The repercussions of device migration are related to its location, and although this complication is not the most frequent, once diagnosed, the device should be removed whenever possible and safely. Finally, the choice of the approach route will depend on certain factors, such as the patient's general condition, the experience of the medical team, and the location of the vena cava filter.

Consent

Written informed consent was obtained from the patient to publish this case report.

Declarations

The authors declare no conflict of interest.

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