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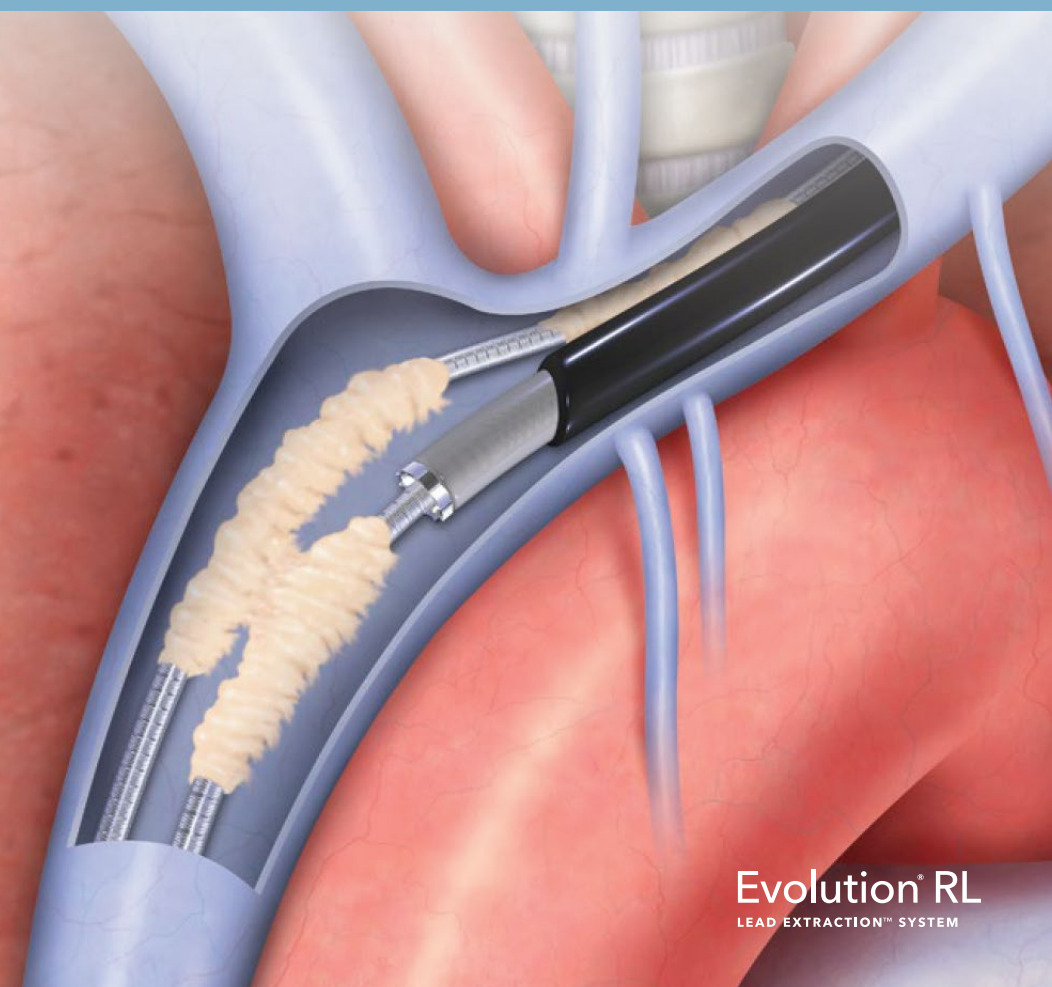


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# EXPERIENCE IN PACEMAKER LEAD EXTRACTION: RETROSPECTIVE ANALYSIS OF A SINGLE CENTER

## ABSTRACT

**Introduction:** Therapy with implantable cardiac devices, such as pacemakers, has increased, leading to improved survival and quality of life, but also to a greater need for electrode extractions due to various complications.

**Objective:** To describe a single-center experience with pacemaker lead extractions from January 2017 to September 2024 and to analyze the indications, techniques used, and outcomes obtained. Primary and secondary success rates were evaluated.

**Materials:** A retrospective study of 40 patients (74 leads) between January 2017 and September 2024. The main indications for extraction were pocket infection (27.5%), device or lead displacement (25%), endocarditis (22.5%), device replacement or failure (10%), and device exposure (5%). 20% of patients were referred from other institutions. The initial technique used was endovascular extraction with simple traction, or, if necessary, with sheaths.

**Results:** The mean age of the patients was 62.5 years; 70% were men; the most common comorbidities were hypertension (62.5%), diabetes (20%), and severe left ventricular dysfunction (32.5%). The success rate for endovascular lead extraction was 95.94%. The duration of catheter placement was shorter with simple traction (23.6 months) than with complex techniques (100.9 months), with a significant difference ( $p = 0.0019$ ). Three patients required sternotomy for complete removal. The overall success rate (endovascular and sternotomy) was 100%.

**Conclusion:** The main cause of extraction was infection. Simple traction was effective for catheters with shorter dwell times; more complex techniques, including sheaths and sternotomy, were reserved for more difficult cases.

**Keywords:** lead extraction; pacemaker; infection; endovascular.

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## INTRODUCTION

Therapy with implantable cardiac devices, such as pacemakers, has experienced exponential growth in recent decades, significantly improving the prognosis and quality of life for patients with cardiac rhythm disorders. This advancement has been driven by both technological progress and the expansion of clinical indications. However, the increase in the number of implants has led to a growing need for revision procedures, particularly lead extraction, driven by infections, malfunctions, lead breaks, or device replacements.<sup>1,2</sup>

Electrode extraction is a complex procedure from both technical and clinical perspectives. It involves significant risks such as cardiac perforation, bleeding, or embolization, and therefore requires trained personnel and specialized technology. The presence of fibrosis and adhesions, particularly in long-standing electrodes, increases the difficulty of the procedure, making the experience of the centers performing it essential.<sup>3</sup>

Device-related complications, such as infections or structural failures, require an effective therapeutic approach. In many cases, complete removal of the system is the only definitive strategy to eradicate the infection and prevent recurrences or serious adverse events.<sup>4</sup>

This study retrospectively analyzes a leading center's seven-year experience with pacemaker lead extraction. It describes the indications, techniques used, and outcomes achieved, and discusses these findings in light of current scientific evidence. The literature highlights that this is a high-risk procedure, especially in patients with comorbidities or chronic implants, in whom the appropriate selection of technique and the team's expertise are critical to the treatment's success and safety.<sup>4</sup>

The primary objective of this study was to describe the experience of a single center in the removal of pacemaker leads performed between January 2017 and September 2024. The indications for the procedure, the techniques used, and the results obtained were analyzed. Additionally, the rates of primary success (complete removal via endovascular approach) and secondary success (removal via surgical approach with sternotomy) were evaluated, as was the incidence of procedure-related complications.

## MATERIALS AND METHODS

A retrospective study included 40 patients who underwent pacemaker lead extraction between January 2017 and September 2024, with a total of 74 leads evaluated. The main indications for extraction were device pocket infection (27.5%), displacement of the generator or pacemaker leads (25%), endocarditis (22.5%), lead dysfunction or the need for replacement (10%), and generator exposure (5%). In 20% of cases, patients were referred from other institutions (*Table 1*).

The initial technique was endovascular extraction via simple traction or advanced sheath techniques (metal, plastic, or rotational), depending on the system age and electrode characteristics. In selected cases in which the endovascular technique failed or was incomplete, sternotomy was performed to remove residual leads (*Table 2*).

The most common indication for electrode extraction is system infection, whether local (pocket infection) or systemic (endocarditis or persistent bacteremia). Current evidence supports complete system removal in these cases, as retention of infected material is associated with a higher risk of recurrence and mortality. Other indications include lead dysfunction or failure, rupture or displacement, device exposure, and the need for replacement or technological upgrade.<sup>5</sup>

| Indication                             | Percentage (%) |
|--|----------------|
| Device pocket infection                | 27.5           |
| Generator or electrode displacement    | 25             |
| Endocarditis                           | 22.5           |
| Lead malfunction or device replacement | 10             |
| Exposure of the generator              | 5              |
| Referral from other institutions       | 20             |

TABLE 1. Indications for electrode extraction

| Technique                                     | Main indication                                    | Success rate as the technique of choice (%) |
|---|--|---|
| Simple traction                               | Recent electrodes (<48 months)                     | 78  |
| Sheaths (mechanical, plastic, and rotational) | Chronic electrodes (>48 months) and adhesions      | 92.4  |
| Surgical (sternotomy)                         | Failure of the endovascular technique or high risk | 100 (selected cases)                        |

**TABLE 2.** Extraction techniques used

The choice of technique depends on multiple factors, including the duration of implantation, the type of electrode, the presence of adhesions, and the operator's experience. The main techniques for removing the entire system are as follows:

- **Simple traction:** suitable for recently implanted electrodes, with a high success rate and low risk of complications.<sup>6</sup>
- **Sheath-assisted techniques (mechanical, plastic, or rotational):** recommended for chronic electrodes or those with significant adhesions, allowing for safe cable release.<sup>4,6</sup>
- **Open surgery (sternotomy):** reserved for cases in which endovascular extraction fails or there is a high risk of complications. Although it is more invasive, it allows for extraction under direct visualization.<sup>4,6</sup>

Recent literature highlights the importance of a multidisciplinary approach and having a surgical support team, due to the potential risk of serious complications, such as myocardial perforation or massive bleeding.<sup>7</sup>

## RESULTS

A total of 40 patients were analyzed. The mean age was  $62.5 \pm 29.6$  years, with a predominance of males (70%). The most common comorbidities included hypertension (62.5%), diabetes mellitus (20%), and severe left ventricular dysfunction (32.5%).

A total of 74 leads were extracted, of which 95.94% were successfully removed using an endovascular approach. The mean lead residence time was significantly shorter in the simple traction group (23.6 months) than in the complex-technique group (100.9 months), with a statistically significant difference ( $p = 0.0019$ ).

Three patients (7.5%) required sternotomy to complete the removal of a residual lead in each case. The overall success rate, combining endovascular and surgical approaches, was 100%.

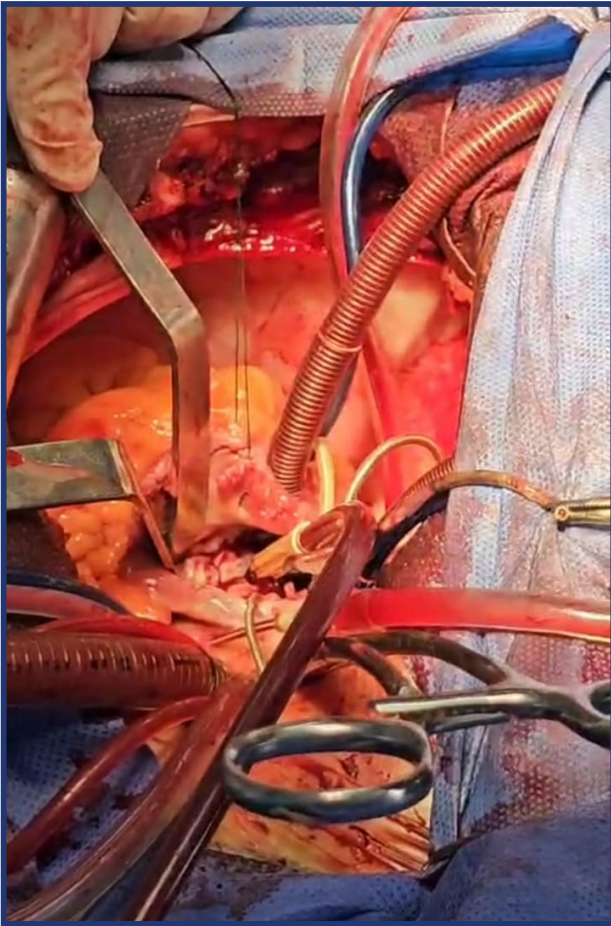
Major complications were rare and were observed only in patients who required sternotomy; in all cases, rupture of the pacemaker electrode was recorded. All cases were satisfactorily resolved using cardiopulmonary bypass to remove the remaining leads (*Figure 1*); in one case, implantation of an epicardial pacemaker system was necessary due to a history of superior vena cava syndrome and total dependence on the cardiac pacing device (*Figure 2*). The observed results are consistent with those reported in the literature, which describes success rates exceeding 95% in centers with experience in combining endovascular and surgical techniques.<sup>7</sup>

## DISCUSSION

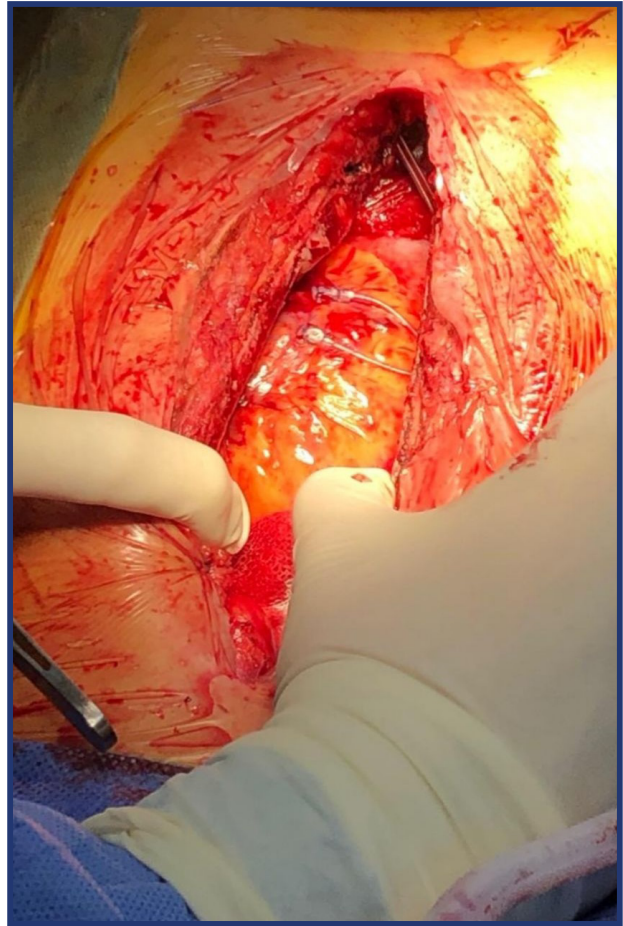
Pacemaker lead extraction is a safe and effective procedure when performed in experienced centers, with success rates exceeding 95% and a low incidence of serious complications. Infection is the most common indication, and simple traction is effective primarily for leads with shorter implantation times. In contrast, complex techniques and surgical approaches are reserved for selected cases, particularly for long-term fixation or when endovascular extraction fails. Appropriate selection of the approach, along with the team's experience and the availability of adequate technology, is key to maximizing the procedure's success and ensuring patient safety.

### Declaration

The authors declare no conflicts of interest.



**FIGURE 1.** Removal of pacemaker leads via sternotomy and cardiopulmonary bypass.



**FIGURE 2.** Epicardial pacemaker implantation following lead extraction via sternotomy.

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# GIANT LEFT ATRIAL MYXOMA WITH RIGHT ATRIAL PROTRUSION VIA ATRIAL SEPTAL DEFECT: ECHOCARDIOGRAPHIC AND SURGICAL CORRELATION

## ABSTRACT

Cardiac myxomas are the most common primary tumors of the heart and are predominantly located in the left atrium. The clinical presentation depends on the site of implantation and the hemodynamic effect it generates. We present the case of a patient with an intracardiac mass attached to the interatrial septum that, on echocardiography, prolapsed into the right ventricle during diastole and was associated with dilatation of the right chambers. No atrial septal defect was evident on the preoperative study, so it was initially interpreted as a probable right atrial myxoma. During surgery, a pedicle implanted on the left side of the interatrial septum was found, protruding through a previously undiagnosed wide atrial septal defect. A complete resection with septal closure was performed, with a favorable outcome. This case highlights the importance of considering associated septal defects in atypical presentations and the need for correlation between echocardiographic and surgical findings.

**Keywords:** atrial myxoma; atrial septal defect; cardiac tumors; echocardiography; cardiac surgery.

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## INTRODUCTION

Primary cardiac tumors are a rare condition; among them, myxomas are the most common (50% of cases). More than 75% originate in the left atrium, usually at the edge of the foramen ovale of the interatrial septum, while approximately 20% develop in the right atrium, and a small percentage may be located in both atria or in the ventricles. They most commonly affect patients aged 40 to 60, with a slight predominance among females.<sup>1,2</sup> Their clinical presentation depends on size, mobility, and location; they may present with obstructive, embolic, or systemic symptoms.

Atrial septal defect (ASD) is a common congenital heart defect in the adult population. Although many ASDs are diagnosed in the neonatal period or during childhood and undergo spontaneous closure, a significant proportion persist into adulthood.<sup>3</sup> In these cases, chronic right ventricular volume overload, right atrial dilation, and arrhythmias may occur, even in the absence of symptoms in the early stages.

In exceptional cases, the coexistence of a left atrial myxoma and an ASD may allow tumor protrusion into the contralateral cavity, altering the expected hemodynamic pattern. This circumstance can result in a predominantly right-sided clinical presentation in a tumor of left origin and complicate preoperative echocardiographic interpretation, particularly when the septal defect is not detected in the initial study.

## CLINICAL CASE

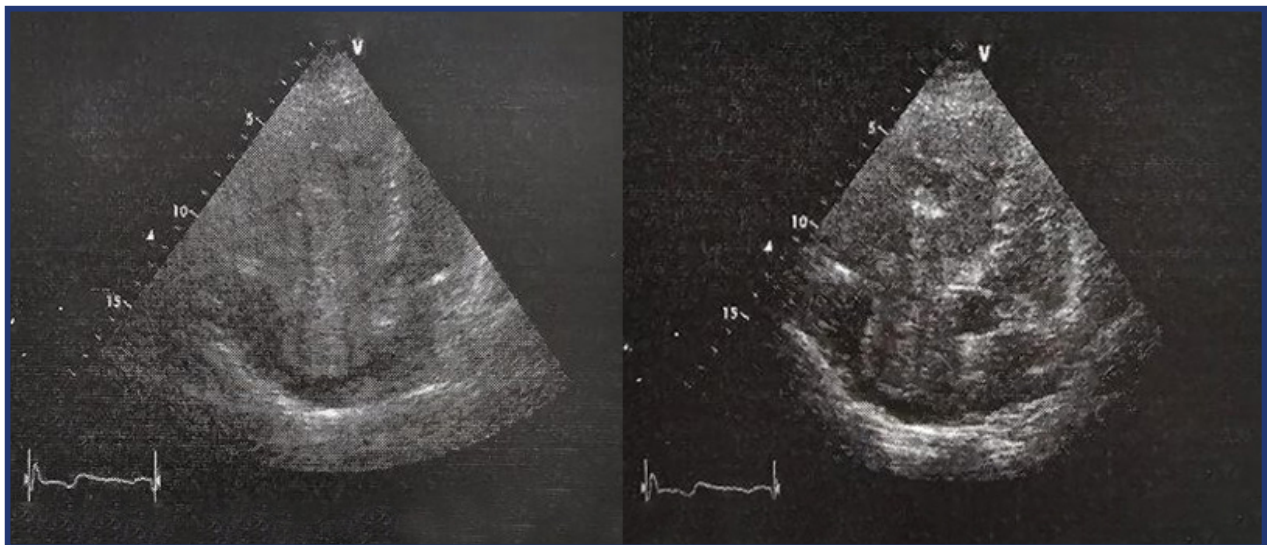
A 74-year-old female patient with a history of hypertension, dyslipidemia, and liver cirrhosis of probable drug-induced origin. She presented with dizziness and asthenia that had been present for 48 hours.

A Doppler echocardiogram was performed, revealing preserved systolic function with an ejection fraction of 72%, dilated right chambers, and a large, heterogeneous, multilobulated, and mobile mass (approximately 10 cm in diameter), which appeared to be attached to the interatrial septum and, during diastole, prolapsed into the right ventricle through the tricuspid valve (*Figure 1*). No associated septal defect was noted.

Surgical correction was indicated via median sternotomy, aortic and bicaval cannulation, and an approach through the right atrium under cardiopulmonary bypass.

During surgery, a pedunculated myxoma was found implanted on the left surface of the interatrial septum, protruding through a previously undiagnosed wide interatrial communication into the right atrium. Complete *en bloc* resection was performed, with wide excision of the pedicle and closure of the defect using an autologous pericardial patch (*Figure 2*).

The postoperative course was favorable, with no significant residual defects on echocardiographic follow-up.



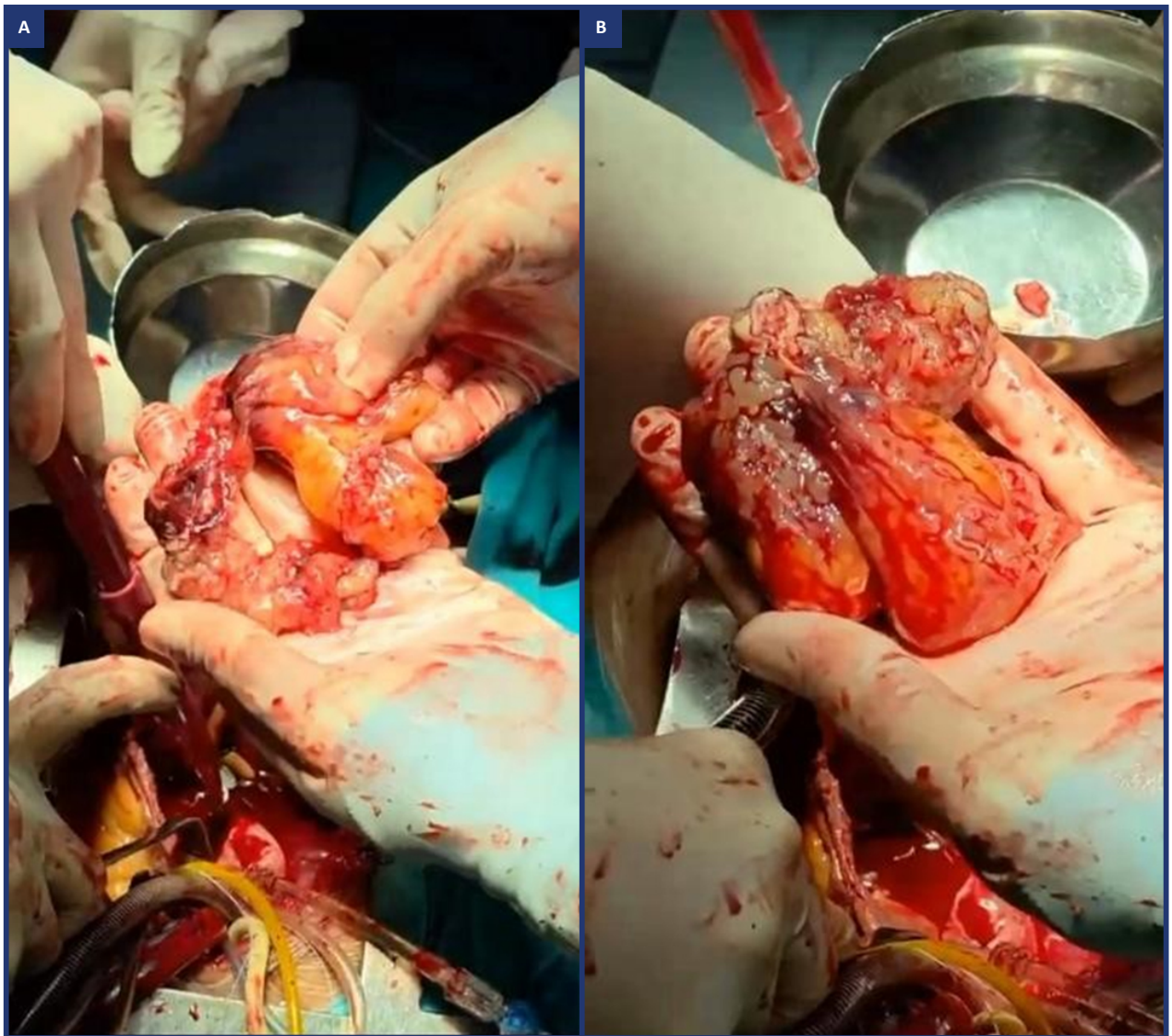
**FIGURE 1.** Preoperative echocardiogram. A mobile mass was observed in the right atrium extending through the tricuspid valve into the right ventricle.

## DISCUSSION

Atrial myxoma is the most common benign primary tumor in adults, with a clear predominance in females and a higher incidence among those aged 40 to 60 years.

The anatomical origin of the myxoma is determined by the site of the pedicle's attachment, while the clinical

presentation depends on the hemodynamically affected chamber. Obstructive symptoms occur when the myxoma prevents proper filling of the affected atrium, and/or interferes with mitral or tricuspid valve function.<sup>4</sup> In this case, transseptal protrusion through an undiagnosed atrial septal defect led to



**FIGURE 2. A and B:** Intraoperative findings. A large atrial tumor with a pedicle attached to the left side of the interatrial septum.

predominantly right-sided physiology, mimicking a primary right atrial tumor.

The absence of echocardiographic visualization of the atrial septal defect may be due to limitations of the transthoracic study, especially in the presence of large masses that alter septal anatomy. The transeptal approach confirmed the left-sided origin and enabled complete resection with adequate closure of the defect.

This case underscores that, in the presence of septal masses with discordant hemodynamic behavior, the possibility of associated atrial septal defects should be considered, even when they are not evident on the initial echocardiographic evaluation.

### CONCLUSION

A left atrial myxoma can mimic a right-sided tumor when it protrudes through an undiagnosed atrial septal defect. The hemodynamic impact does not

always reflect the anatomical site of implantation; therefore, echocardiographic and surgical correlation is essential for a definitive diagnosis.


### Declaration

The author declares no conflicts of interest.

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# ARTIFICIAL INTELLIGENCE HAS DECISIVELY CHANGED THE TRANSMISSION OF INFORMATION AND KNOWLEDGE

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Two months ago, a television producer asked me to comment on a news story published by an AI-generated news network. Upon reviewing the story, I realized it was based on the results of the CREST-2<sup>1</sup> study published in the *New England Journal of Medicine*. I was astonished to read the article; the title alone highlighted the numerous benefits of carotid angioplasty over carotid endarterectomy. Among other errors, the article failed to distinguish between the benefits of carotid angioplasty and carotid endarterectomy and noted that the study reported beneficial results in asymptomatic patients. However, I was even more surprised when I read the Society for Vascular Surgery<sup>2</sup> (SVS) editorial on this study. Later, at the start of the interview, the first thing I pointed out to the reporter was that the news story did not accurately reflect the results presented in the academic article and, worse still, that mixing symptomatic and asymptomatic patients was an even greater error. As you know, it was very difficult to explain all these points in a television format, but I tried. Most interestingly, almost simultaneously, in late January, the results of the CREST-2 study were replicated on the websites and apps of societies for Cardiology, Interventional Cardiology, Interventional Radiology, and Neurointerventionalism, particularly in countries where transcatheter revascularization is not yet widespread. This simple account illustrates the fragility of the specialty of vascular surgery in the face of constant industry attacks, which support practices and procedures performed by other medical specialties that interpret evidence-based medicine only when it suits them. None of these stakeholders reflected on the results of the CREST-1 study.<sup>3,4</sup> Let's reflect on the results of the CREST-2 study, endorse the findings published by the SVS, and disseminate them to the entire community:

- The only database evaluating real-world outcomes of transfemoral carotid angioplasty (TF-CAS), transcatheter carotid angioplasty (TCAR), and carotid endarterectomy (CEA) is the SVS's Vascular Quality Initiative.<sup>3,4</sup> According to VQI data and numerous published articles involving thousands of patients, both CEA and TCAR have consistently demonstrated superior outcomes compared to TF-CAS, in both asymptomatic and symptomatic patients, and across standard-risk and high-risk patients.

- It is unlikely that the superior medical management observed in CREST-2 will be replicated in clinical practice outside of a controlled study such as this one. Medical treatment has not advanced as much as anticipated, as the annual risk of stroke in the Asymptomatic Carotid Artery Study (ACAS) was 2% and decreased to less than 1% over time. The CREST-2 study achieved an annual stroke risk with medical treatment of 1.7% in the TF-CAS group and 1.5% in the CEA group. Therefore, even with medical treatment that is unlikely to be reproducible, revascularization provided a small benefit.
- The stroke rate for TF-CAS<sup>2-5</sup> has been reported to be twice that of CEA in nearly all randomized trials before CREST-2; statistically significant differences were observed more consistently in symptomatic patients, who have higher baseline event rates. Trials in asymptomatic patients did not have sufficient statistical power to detect a difference in stroke incidence.
- Notable differences in operator selection and anatomical considerations were observed between TFA-CAS and CEA. These strict and unequal exclusion criteria create a study population that differs significantly from that of real-world patients, reducing the generalizability of the results and making them less applicable to routine clinical decision-making.
- We are concerned that less experienced TF-CAS operators may apply the CREST-2<sup>2,6</sup> recommendations to a broad group of asymptomatic patients, without the same careful selection of low-risk anatomies.
- Kakkos et al.<sup>7</sup> summarized nine randomized carotid trials and concluded that the 30-day stroke/death rate was significantly higher for TF-CAS (2.9%) than for CEA (1.9%; odds ratio [OR], 1.6;  $P = 0.044$ ); the 30-day stroke rate was significantly higher for TF-CAS (2.9%) than for CEA (1.8%; OR, 1.6;  $p = 0.032$ ); the rate of myocardial infarction at 30 days was non-significantly lower for CAS (0.66%) compared with CEA (1.5%; OR, 0.5;  $p = 0.105$ ); and the rate of stroke/death at 30 days plus ipsilateral stroke during 1-year follow-up was significantly higher for TF-CAS (3.6%) than for CEA (2.4%; OR, 1.5;  $p = 0.04$ ).
- Stent-assisted carotid angioplasty (TCA), whether TF-CAS or TCAR, is less favorable in cases of severe calcification, angulation, or tortuosity of the internal carotid artery than CEA.<sup>8,9</sup> TF-CAS may be contraindicated or carry a higher risk in diseased, tortuous, or angulated aortic arch entry vessels.
- CEA is less favorable in the presence of severe cardiac or pulmonary disease, prior neck radiation, prior

major neck surgery, highly cephalic lesions, cervical spine immobility, contralateral vocal cord paralysis, and, possibly, occlusion of the contralateral internal carotid artery. These strengths and weaknesses highlight the value of having all revascularization strategies available, allowing physicians to select the most appropriate modality for each patient.

It is indisputable that artificial intelligence has decisively changed the transmission of information and knowledge. In this field, we are walking on a fine line. Scientific truth is based primarily on the constant raising of doubts, “a suspect truth,” as Karl Popper put it. We must not allow dogma to take us back to the Middle Ages. As experienced professionals, we always support the training of future generations. We also have an obligation to defend the values and scope of our specialty. We must ensure that our medical residents can grow and develop, feel pride in being vascular surgeons, and, above all, in belonging to the Argentine College of Cardiovascular Surgeons.

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## EDITOR'S LETTER

# WELCOME THE LATIN AMERICAN ASSOCIATION OF VASCULAR SURGERY AND ANGIOLOGY TO THE EDITORIAL BOARD OF RACCV

Dear colleagues:

We are pleased to announce that, starting with this issue, the *Argentine Journal of Cardiovascular Surgery* will feature the participation of an Editorial Committee from the Latin American Association of Vascular Surgery and Angiology (ALCVA, by its Spanish acronym). In 2011, the Committee began its journey to ensure the continuity of the Latin American chapter of the International Society for Cardiovascular Surgery (ISCVS), leaving an indelible mark by participating in major global consensus initiatives, such as the Transatlantic Society Consensus on the Treatment of Peripheral Arterial Disease (TASC I-II). With a new philosophy, the Editorial Committee has maintained a solid, well-organized institution and has become a worthy representative of the vascular surgeons in our region.

The RACCV is proud to strengthen ties with vascular and endovascular surgery organizations and societies in Latin America to disseminate the profession's advances and share the latest developments and challenges.

**Dr. Javier Ferrari Ayarragaray**  
**Editor-in-Chief**

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