ORIGINAL ARTICLE

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.[1,2]

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.[3]

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.[4]

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.[4]

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.[5]

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.[6]
- **Sheath-assisted techniques (mechanical, plastic, or rotational):** recommended for chronic electrodes or those with significant adhesions, allowing for safe cable release.[4,6]
- **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.[4,6]

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.[7]

RESULTS

A total of 40 patients were analyzed. The mean age was 62.5 ± 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.[7]

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.

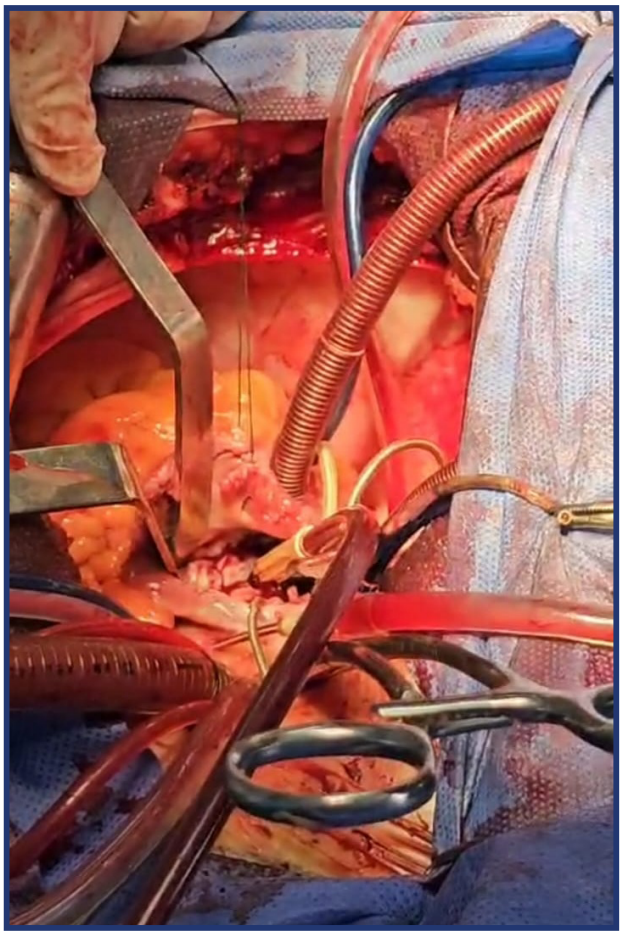

FIGURE 1. Removal of pacemaker leads via sternotomy and cardiopulmonary bypass.

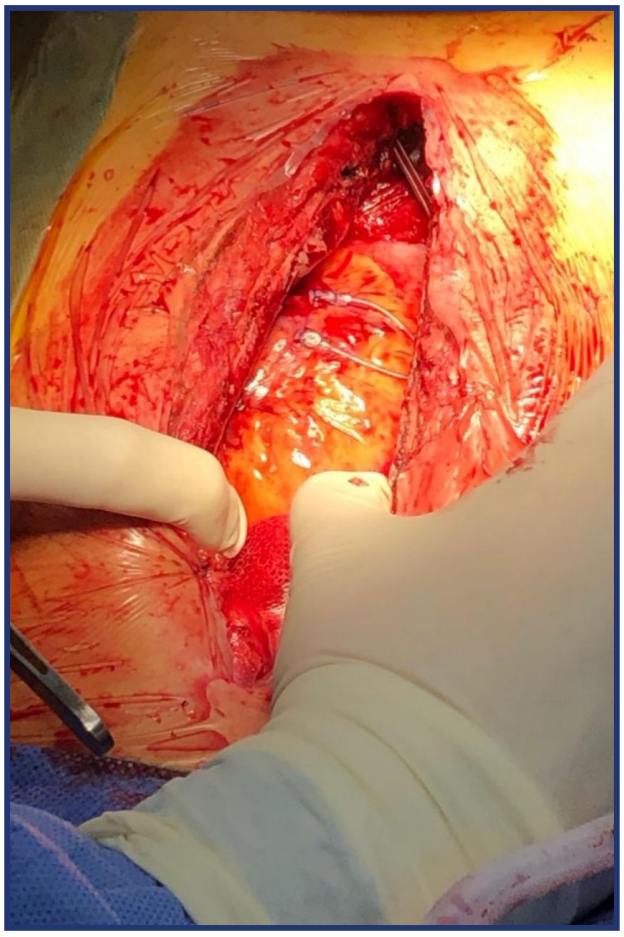

FIGURE 2. Epicardial pacemaker implantation following lead extraction via sternotomy.

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