Peertechz

Journal of Cardiovascular Medicine and Cardiology
submitpaper@peertechz.com
MEDICAL GROUP
JOURNAL OF Cardiovascular Medicine and Cardiology OPEN ACCESS JOURNAL
ISSN: 2455-2976
DOI: https://dx.doi.org/10.17352/jcmc

Case Report

Subcutaneous Cardioverter-defibrillator Implantation after Cardiac Surgery and Endocardial Device Infection

Daniel Ruiz Domínguez[1]* and Raúl Cano del Val Meraz[2]

[1]Cardiology resident at Hospital Central Sur de Alta Especialidad, PEMEX Picacho. Anillo Perif. 4091, Fuentes del Pedregal, Tlalpan, 14140 Mexico City, Mexico
[2]Specialized in cardiac electrophysiology at Hospital Central Sur de Alta Especialidad, PEMEX Picacho. Anillo Perif. 4091, Fuentes del Pedregal, Tlalpan, 14140 Mexico City, Mexico

Received: 22 August, 2025
Accepted: 29 August, 2025
Published: 30 August, 2025

***Corresponding author:** Dr. Daniel Ruiz Domínguez, Cardiology resident at Hospital Central Sur de Alta Especialidad, PEMEX Picacho. Anillo Perif. 4091, Fuentes del Pedregal, Tlalpan, 14140 Mexico City, Mexico, E-mail: danielrdmed@gmail.com

Keywords: Defibrillator; Subcutaneous ICD; Sudden death; Heart failure; Reduced LVEF, HFrEF

https://www.organscigroup.com

Check for updates

Abstract

Introduction: The implant of a Subcutaneous Implantable Automatic Defibrillator (ICD) is not common in some countries due to their specific indications, the novelty of the technique and the device, the large infrastructure needed, and the high cost. In this paper, we present the 17th implantation of this device in our country.

Background: This is a man with heart failure with reduced ejection fraction (HFrEF) of ischemic etiology associated with mitral and tricuspid valve disease in whom coronary revascularization surgery, mitral valve replacement, and tricuspid annuloplasty were initially performed.

Results: During follow-up and after optimal medical treatment, a Subcutaneous ICD was implanted as primary prevention for sudden cardiac death; during follow-up, he developed an infection of the implant site, and after ruling out endocarditis, subcutaneous ICD placement was necessary.

Conclusion: This case exposes the clinical scenarios for the indication of a subcutaneous ICD, its effectiveness in reversing sudden death, and recovery after implantation.

Relevant points: Although the indications for Implantable Cardioverter-Defibrillator (ICD) placement are well established in both national and international literature, subcutaneous implantation of this device remains uncommon in our country. This case is relevant given the limited local experience and seeks to provide Mexican cardiologists with a clearer understanding of the indications and nature of the procedure.

Introduction

In Mexico, experience with subcutaneous ICD implantation remains limited. According to data from the device manufacturer, the patient presented herein received the 17th device implanted nationwide, and at the time of manuscript acceptance, a total of 51 such devices had been placed (EMBLEM™ S-ICD, Boston Scientific). This limited use is attributable to several factors, including its specific indications, the novelty of the technique and device, the infrastructure required, and associated costs. The subcutaneous implantable cardioverter-defibrillator (S-ICD) has emerged as an established alternative to the transvenous ICD (TV-ICD) for the prevention of sudden cardiac death in carefully selected patients. By eliminating the need for transvenous leads, the S-ICD reduces the risk of lead-related complications such as vascular occlusion, endocarditis, and cardiac perforation. This characteristic makes it particularly attractive for young patients, those with limited venous access, individuals with a history of systemic infection, and patients with congenital heart disease. The principal limitation of the device is its lack of pacing capabilities beyond brief post-shock support, rendering it unsuitable for individuals requiring chronic bradycardia pacing, cardiac resynchronization therapy, or frequent antitachycardia pacing (ATP). In this report, we present the case of a male patient with ischemic heart failure with reduced ejection fraction (LVEF) and concomitant mitral

Citation: Domínguez DR, Del Val Meraz RC. Subcutaneous Cardioverter-defibrillator Implantation after Cardiac Surgery and Endocardial Device Infection. J Cardiovasc Med Cardiol. 2025;12(3):89-92. Available from: https://dx.doi.org/10.17352/2455-2976.000232

and tricuspid valvulopathy. During a single surgical procedure, he underwent coronary artery bypass grafting, mitral valve replacement, and tricuspid annuloplasty. During follow-up, and despite optimal medical therapy (OMT), he required an ICD for primary prevention. Subsequently, he developed an infection at the implantation site, which necessitated extraction and replacement with a subcutaneous ICD.

Case description

The patient was a 52-year-old man with no relevant family history of cardiovascular disease. He led a sedentary lifestyle, had grade I obesity, and was a former smoker.

His cardiovascular history began in 2021 with exertional angina and dyspnea. Transthoracic echocardiography revealed chamber dilation, severe mitral regurgitation (Carpentier I), systolic dysfunction with a reduced LVEF of 22%, moderate tricuspid regurgitation, high probability of pulmonary hypertension, and generalized hypokinesia.

A comprehensive workup for cardiomyopathy was initiated, including viral serologies, TORCH profile, antibodies against *Trypanosoma cruzi* (Chagas disease), and an autoimmune panel, all of which were negative. Thyroid studies demonstrated subclinical hypothyroidism.

The patient was admitted to the hospital and, as part of the diagnostic evaluation, underwent invasive coronary angiography. This demonstrated three-vessel coronary artery disease: the left main coronary artery was free of significant lesions; the proximal left anterior descending artery showed total functional occlusion with bifurcation disease involving the first diagonal branch, as well as a mid-segment stenosis of 70%; the intermediate ramus presented an ostial 80% stenosis; the dominant circumflex artery was totally occluded proximally; and the dominant right coronary artery had a proximal 90% lesion, a mid-segment stenosis of 80%, multiple distal tandem lesions, and a chronically occluded posterior descending artery. The calculated SYNTAX score was 55 points.

Given the complexity of the coronary anatomy and the coexistence of severe mitral and moderate tricuspid regurgitation, the case was presented at a multidisciplinary heart team conference, where surgical intervention was recommended. The patient underwent mitral valve replacement with a 29 mm mechanical prosthesis, tricuspid annuloplasty with a 34 mm ring, and myocardial revascularization with a left internal mammary artery graft to the left anterior descending artery and a reversed saphenous vein graft to the intermediate ramus. Due to technical limitations, grafting to the obtuse marginal and posterior descending arteries was not feasible. The postoperative course was uneventful, and the patient was discharged on guideline-directed medical therapy and referred to the outpatient clinic.

Follow-up echocardiography demonstrated normal prosthetic mitral valve function, severely reduced LVEF (18%), decreased right ventricular systolic function, dilation of all four chambers, and mild tricuspid regurgitation with high probability of pulmonary hypertension.

An exercise stress test was subsequently performed to assess functional capacity. Using a modified Bruce protocol, the patient achieved only 55% of his age-predicted maximum heart rate, and the test was terminated due to fatigue. The energy expenditure was 3.6 METS. The test was negative for ischemia but revealed poor exercise tolerance (NYHA class III).

Based on these findings, the cardiology team determined the patient was a candidate for primary prevention ICD. An endocardial device was implanted in the left subclavian region without complications. However, during follow-up, he developed device exposure and was hospitalized with a diagnosis of cardiac implantable electronic device infection. Transesophageal echocardiography excluded vegetations or intracavitary thrombi, and complete device extraction was performed. After negative blood cultures and clinical improvement, he was discharged with the plan for later reimplantation (Figure 1).

The patient was subsequently evaluated at the electrophysiology clinic and deemed a candidate for subcutaneous ICD implantation. In late 2023, he was readmitted and underwent successful implantation of an EMBLEM™ S-ICD (Boston Scientific). Figure 2 illustrates ventricular tachycardia induction, arrhythmia detection, shock delivery, and restoration of sinus rhythm. Figure 3 depicts the fluoroscopic image of the implanted device.

At present, the patient remains free of complications and has experienced no inappropriate discharges. He is asymptomatic with respect to angina and is in NYHA functional class II under

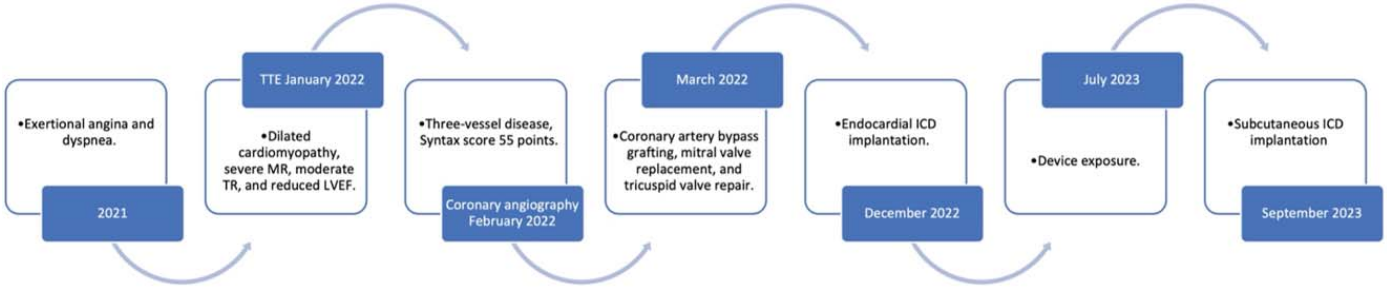

Figure 1: Temporal evolution and relevant facts of the condition.Timeline showing the date of onset of symptoms, diagnostic approach, evolution, and date of ICD implantation. Note: Figure created by Daniel Ruiz Domínguez, 2025.

Citation: Domínguez DR, Del Val Meraz RC. Subcutaneous Cardioverter-defibrillator Implantation after Cardiac Surgery and Endocardial Device Infection. J Cardiovasc Med Cardiol. 2025;12(3):89-92. Available from: https://dx.doi.org/10.17352/2455-2976.000232

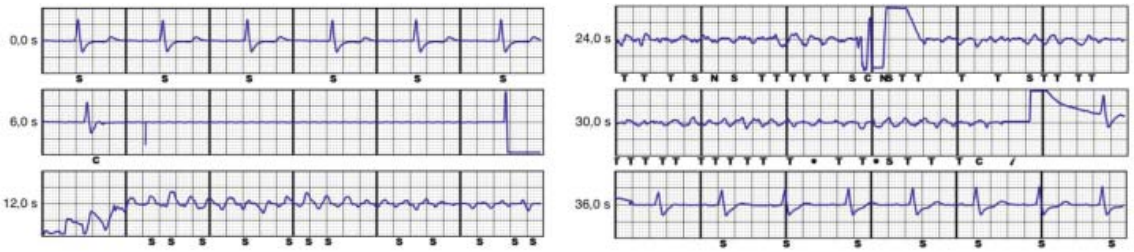

Figure 2: Tracing of ventricular tachycardia induction and successful device shock. Tracing recorded by the device, where in the line corresponding to second 0 (0.0 s) sinus rhythm is seen. Subsequently, in the tracing corresponding to second 6 (6.0 s), induction of tachycardia is shown (isoelectric line). In the line of second 12 (12.0 s), the tracing corresponding to established ventricular tachycardia is seen. In the line of second 24 (24.0 s), the device senses the tachycardia ending at the line of second 30 (30.0 s) with a shock (indicated by a lightning bolt icon at the bottom of the line), and subsequently sinus rhythm is evidenced in the line corresponding to second 36 (36.0 s). S (Sensing); T (Tachycardia); ϟ (Shock/Discharge).

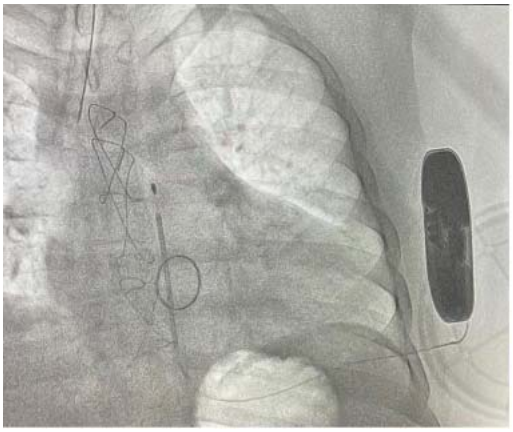

Figure 3: Post-implant fluoroscopy of ICDs. Image obtained by fluoroscopy immediately after implantation performed in the electrophysiology room, where the coil and generator are seen in adequate position, in addition to the valve prosthesis and the sternal cerclage.

optimal pharmacologic therapy, consistent with guideline-directed management for chronic coronary syndromes, valvular disease, and heart failure.

Discussion

Sudden cardiac death accounts for approximately 50% of all cardiovascular mortality in developed nations [1]. The implantable cardioverter-defibrillator (ICD), introduced into clinical practice nearly three decades ago, has consistently demonstrated its ability to reduce mortality both in primary and secondary prevention [2], regardless of whether the underlying etiology is coronary or non-coronary. It significantly improves survival in patients with a history of ventricular arrhythmias and reduced ejection fraction [3].

Over the years, ICD technology has undergone significant evolution. Initially, devices were implanted via thoracotomy with epicardial leads. Subsequently, endocardial approaches were developed, adding pacing capabilities. Despite these advances, transvenous implantation carries risks such as hemopericardium, pneumothorax, systemic infection, vascular occlusion, and lead displacement or dysfunction—the latter two considered the Achilles' heel of transvenous systems [4-11]. Long-term data indicate mechanical complication rates as high as 25% at 10 years [6]. In contrast, complications associated with subcutaneous ICDs (S-ICDs) tend to be less severe, with up to 92% of patients free from adverse events at six months post-implant [10]. Moreover, the S-ICD has been shown to reduce moderate or severe lead-related complications by over 90% compared with transvenous devices [12].

The need to avoid vascular access, prevent intravascular mechanical stress leading to lead dysfunction, and reduce the complexity of device extraction spurred the development of the S-ICD. Since 2010, accumulating evidence has demonstrated the clinical utility of S-ICDs [6]. Early support was derived primarily from non-randomized studies [7,8], but in 2020, the pivotal *PRAETORIAN trial* established non-inferiority of the S-ICD versus the transvenous ICD with respect to inappropriate shocks and complications, while underscoring its main limitation—lack of pacing support.

Compared with endocardial devices, S-ICDs are associated with fewer complications, most commonly minor bleeding, superficial infection, generator displacement, or local tissue injury [9,10]. Large registries and clinical trials have confirmed their efficacy and safety. The *IDE* and *EFFORTLESS* registries demonstrated high first-shock success rates and acceptable complication profiles, forming the basis for real-world adoption. The *PRAETORIAN trial* confirmed equivalence in outcomes compared with transvenous ICDs, with fewer lead-related complications. The *UNTOUCHED study* showed particularly low rates of inappropriate therapy in patients with reduced left ventricular function under optimized programming, supporting the avoidance of routine defibrillation testing in most cases. More recently, the *ATLAS trial corroborated* these findings in younger patients, highlighting a lower incidence of lead-related complications without loss of efficacy.

Technological refinements have also improved outcomes. Intermuscular generator placement has enhanced comfort and cosmetic results while reducing erosion. Simplified two-incision techniques and radiographic scoring tools, such as the *PRAETORIAN score*, facilitate optimal positioning and reduce oversensing. Programming innovations—including dual-zone detection, high-rate cutoffs, and algorithms such as *SMART Pass*—have significantly lowered the incidence of inappropriate shocks related to T-wave oversensing. Collectively, these advances have aligned the performance of S-ICDs with that of the best transvenous systems.

Citation: Domínguez DR, Del Val Meraz RC. Subcutaneous Cardioverter-defibrillator Implantation after Cardiac Surgery and Endocardial Device Infection. J Cardiovasc Med Cardiol. 2025;12(3):89-92. Available from: https://dx.doi.org/10.17352/2455-2976.000232

Current clinical practice shows increasing adoption of S-ICDs among populations at elevated risk for complications from intravascular hardware. These include younger patients with a long expected device lifespan, individuals on chronic hemodialysis, and patients requiring reimplantation after systemic infection. Growing use is also seen in adults with congenital heart disease, where anatomical complexity often precludes transvenous placement. Although the lack of antitachycardia pacing remains a limitation in those with frequent monomorphic ventricular tachycardia, integration with leadless pacing systems may expand the candidate population. Furthermore, emerging platforms such as the extravascular ICD may offer hybrid solutions by combining pacing and defibrillation without the need for traditional venous access.

In Mexico, where the first S-ICD was implanted in 2008, national experience remains limited, and long-term outcome data are scarce. Efforts to establish a national registry are underway, though the timeline for publication is uncertain. Regarding cost, S-ICD implantation remains expensive, with a total cost of approximately USD 25,000 when including device, hospitalization, and supplies, though this may be reduced by around USD 5,000 in public institutions.

In summary, the S-ICD has transitioned from a niche therapy to a robust alternative to transvenous ICDs in appropriately selected patients. Evidence consistently supports its safety and efficacy, particularly its reduction of lead-related complications. As integration with leadless pacing technologies advances, the clinical utility of the S-ICD will likely continue to expand, consolidating its role in the long-term prevention of sudden cardiac death.

Conclusion

In patients with an established indication for ICD placement—whether for primary or secondary prevention—yet in whom endocardial device implantation is not feasible, referral to a tertiary center for multidisciplinary evaluation should be strongly considered. In such scenarios, implantation of a subcutaneous ICD represents a viable and effective alternative.

Ethics

This study was approved by the institutional ethics committee, and informed consent was obtained from the patient.

Key learning points

This case highlights the importance of recognizing the limitations of transvenous devices and the clinical scenarios in which a subcutaneous ICD should be considered as an appropriate alternative.

References

1. Zipes DP, Wellens HJJ. Sudden cardiac death. Circulation. 1998;98(21):2334-51. Available from: https://doi.org/10.1161/01.cir.98.21.2334
2. Hauser RG. The subcutaneous implantable cardioverter-defibrillator. J Am Coll Cardiol. 2013;61(1):20-2. Available from: https://doi.org/10.1016/j.jacc.2012.07.069
3. Khi Yung Fong, Colin Jun Rong Ng, Yue Wang, Yeo C, Tan VH. Subcutaneous Versus Transvenous Implantable Defibrillator Therapy: A Systematic Review and Meta-Analysis of Randomized Trials and Propensity Score–Matched Studies. J Am Heart Assoc. 2022;11(11):e024756. Available from: https://doi.org/10.1161/jaha.121.024756
4. van Rees JB, de Bie MK, Thijssen J, Borleffs CJW, Schalij MJ, van Erven L. Implantation-related complications of implantable cardioverter-defibrillators and cardiac resynchronization therapy devices. J Am Coll Cardiol. 2011;58(10):995-1000. Available from: https://doi.org/10.1016/j.jacc.2011.06.007
5. Maisel WH, Kramer DB. Implantable cardioverter-defibrillator lead performance. Circulation. 2008;117(21):2721-3. Available from: https://doi.org/10.1161/circulationaha.108.776807
6. Bardy GH, Smith WM, Hood MA, Crozier IG, Melton IC, Jordaens L, et al. An entirely subcutaneous implantable cardioverter–defibrillator. N Engl J Med. 2010;363(1):36-44. Available from: https://doi.org/10.1056/nejmoa0909545
7. Weiss R, Knight BP, Gold MR, Leon AR, Herre JM, Hood M, et al. Safety and efficacy of a totally subcutaneous implantable cardioverter defibrillator. Circulation. 2013;128(9):944-53. Available from: https://doi.org/10.1161/circulationaha.113.003042
8. Lambiase PD, Barr C, Theuns DAMJ, Knops R, Neuzil P, Johansen JB, et al. Worldwide experience with a totally subcutaneous implantable defibrillator: early results from the EFFORTLESS S-ICD Registry. Eur Heart J. 2014;35(25):1657-65. Available from: https://doi.org/10.1093/eurheartj/ehu112
9. Pagore PA, Gaidhane SA. Effects and Complications of Subcutaneous Implantable Cardioverter-Defibrillator in the Prevention of Sudden Cardiac Death: A Narrative Review. Cureus. 2022;14(10):e30170. Available from: https://doi.org/10.7759/cureus.30170
10. Friedman P, Murgatroyd F, Boersma LVA, Manlucu J, O'Donnell D, Knight BP, et al. Efficacy and Safety of an Extravascular Implantable Cardioverter–Defibrillator. N Engl J Med. 2022;387(16):1292-1302. Available from: https://doi.org/10.1056/nejmoa2206485
11. Hedayati Goudarzi MT, Moradi M, Abrotan S, Saravi M, Shirafkan H, Irilouzadian R, et al. Complications of Implantable Cardioverter Defibrillator and Their Potential Risk Factors in Patients with Hypertrophic Cardiomyopathy. Cardiol Res Pract. 2023;2023:4552100. Available from: https://doi.org/10.1155/2023/4552100
12. Healey JS, Krahn AD, Bashir J, Amit G, Philippon F, McIntyre WF, et al. Perioperative Safety and Early Patient and Device Outcomes Among Subcutaneous Versus Transvenous Implantable Cardioverter Defibrillator Implantations: A Randomized, Multicenter Trial. Ann Intern Med. 2022;175(12):1658-65. Available from: https://doi.org/10.7326/m22-1566

Citation: Domínguez DR, Del Val Meraz RC. Subcutaneous Cardioverter-defibrillator Implantation after Cardiac Surgery and Endocardial Device Infection. J Cardiovasc Med Cardiol. 2025;12(3):89-92. Available from: https://dx.doi.org/10.17352/2455-2976.000232