


Intermuscular S-ICD Implantation in Pediatric Patients

Andrea Ferreiro-Marzal^{1,*} Fernando Rodríguez-Serrano^{2,3,*} María Esteban-Molina¹
Teresa González-Vargas¹ Francesca Perin⁴ Jose Manuel Garrido^{1,2,3,5} 

¹ Department of Cardiovascular Surgery, Virgen de las Nieves University Hospital, Granada, Spain

² Institute of Biopathology and Regenerative Medicine (IBIMER), University of Granada, Granada, Spain

³ Biosanitary Research Institute of Granada (ibs.GRANADA), Granada, Spain

⁴ Pediatric Cardiology Unit, Virgen de las Nieves University Hospital, Granada, Spain

⁵ Department of Surgery and its Specialities, Universidad de Granada, Granada, Spain

Address for correspondence Jose Manuel Garrido, MD, PhD, Department of Surgery and its Specialities, Universidad de Granada, Avd. de la Investigación 11, Granada 18016, Spain (e-mail: josemgarrido@ugr.es).

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Abstract

The use of conventional implantable cardioverter-defibrillators (ICDs) in children presents important technical challenges. We present the surgical technique necessary to adapt the subcutaneous ICD (S-ICD) implantation designed for adults, to children, including patients weighing less than 20 kg. The implant procedure implies a two-incision technique and interfascial serratus anterior–latissimus dorsi dissection to accommodate the device. S-ICD implantation was successfully performed in three patients of 19, 28, and 24 kg, respectively, two of them suffered cardiorespiratory arrest. Intermuscular thoracic implantation of S-ICD might represent an effective strategy for primary or secondary prevention of sudden cardiac death in pediatric patients.

Keyword

- ▶ pediatric
- ▶ chest wall
- ▶ cardiac

Introduction

The use of conventional implantable cardioverter-defibrillators (ICDs) in children presents important technical challenges due to the small size of the venous system, the large size of the electrodes and the generator, the presence of congenital heart diseases, and child growth.¹ In this article, we describe the surgical technique to adapt the subcutaneous ICD (S-ICD) implantation designed for adults, to underweight children, including patients weighing less than 20 kg (▶ **Table 1**).

Technique Description

In the three cases reported, elective S-ICD (EMBLEM MRI S-ICD A219, Boston Scientific) implantation was performed for primary or secondary prevention employing a modified

two-incision technique. The device dimensions are 83.1 × 69.1 × 12.7 mm (W × H × D), 59.5 cm³, and 130 g. The implant procedure was initiated by an incision of 5 cm in the left antero-lateral thoracic wall between T4 and T7, caudal and posterior to the mammilla, following the oblique costal line. After the dissection of subcutaneous tissue, the plane of the serratus anterior muscle was located (▶ **Fig. 1A**). The dissection continued along the fascia that covers the muscle until the latissimus dorsi muscle was found at a dorsal position. Then, interfascial serratus anterior–latissimus dorsi dissection was continued toward a posterior direction until reaching the paravertebral muscular plane, for developing an intermuscular thoracic pocket with sufficient size to accommodate the device without pressure (▶ **Fig. 1B–D**). During the procedure, the use of electrocautery has to be restrictive and careful, since in pediatric patients only a few centimeters separate this position from the spinal cord. Subsequently, a second incision of 1.5 cm was made at the subxiphoid area for the tunneling and fixation of

* Both authors contributed equally to this work.

Table 1 Demographics and characteristics of patients who received an intermuscular thoracic implantation of S-ICD

Gender	Male	Female	Female
Age at implant, y	5	9	7
Weight at implant, Kg	19	28	24
LVEF, %	55	63	65
Underlying heart disease	Giant primary cardiac fibroma	Nonobstructive hypertrophic cardiomyopathy (MYH7 gene mutation)	Nonobstructive hypertrophic cardiomyopathy (TNNI-3 gene mutation)
Indication for implant	Secondary	Secondary	Primary
Prior sternotomy	Yes (tumor resection and ventricular septum reconstruction under CBP)	No	No
Following up, mo	7	21	1

Abbreviations: CBP, cardiopulmonary bypass; LVEF, left ventricular ejection fraction; S-ICD, subcutaneous implantable cardioverter-defibrillator.

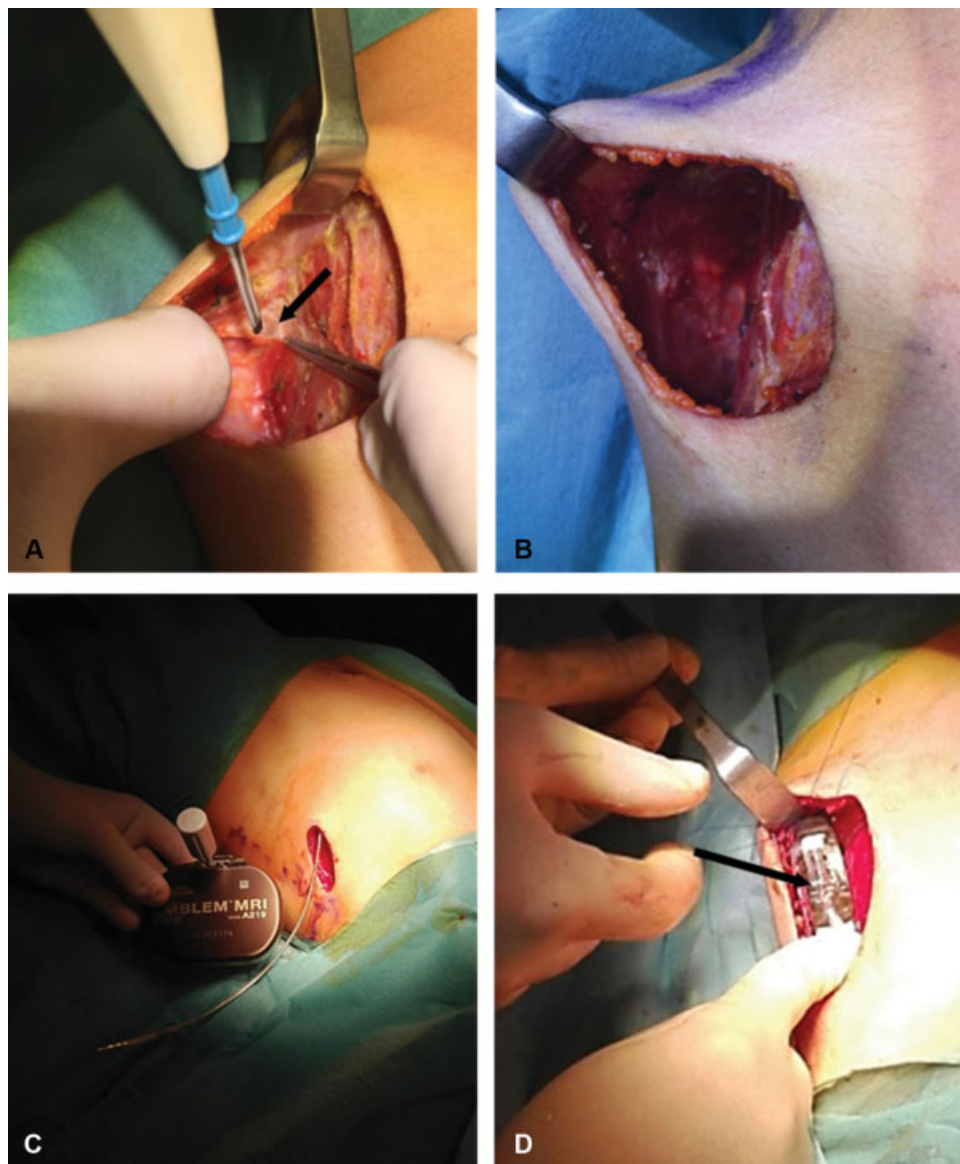


Fig. 1 Subcutaneous implantable cardioverter-defibrillator (S-ICD) implantation into the intermuscular serratus anterior–latissimus dorsi plane. (A) Surgical image showing the plane of dissection between serratus anterior and latissimus dorsi (black arrow). (B) Intermuscular pocket to place the S-ICD. (C) S-ICD. Note the relative size of the device in relation to the thoracic wound and the reduced dimension of the patient’s thorax. (D) S-ICD (black arrow) inserted into the intermuscular pocket.

the electrode at the right or left parasternal margin. Subcutaneous tunneling was performed using an 11F introducer, avoiding the third incision parallel to the manubrium. Finally, the intermuscular, subcutaneous, and dermal-epidermal layers were sutured by planes (►Fig. 2A, B). The functionality of the ICD was confirmed after electrical induction of ventricular fibrillation (65J) and successful rescue in sinus rhythm.

Discussion

The present technique may constitute the first choice surgical option for S-ICD implantation in low weight young patients, including children weighing less than 20 kg. Studies involving adult patients show that the location of the device in the intermuscular serratus anterior–latissimus dorsi plane represents a safe and effective alternative to the subcutaneous implantation that reduces potential complications including decubitus and aesthetic implications.² We have demonstrated an effective surgical technique in three cases that are some of

the youngest patients reported internationally³ (►Fig. 2C, D). This is the position recommended by the manufacturer due to extensive experience in adults indicates that it provides the most appropriate defibrillation vector, and therefore it allows to recruit more ventricular mass. Abdominal or retroperitoneal implantation described in children,⁴ does not reproduce the recommended vector and thus the ICD efficiency could be compromised, especially during the child's growth. Moreover, the two-incision technique employed avoids a superior parasternal incision, simplifying the procedure and reducing the appearance of surgical complications.⁵ Intermuscular thoracic implantation of S-ICD is an effective strategy for secondary prevention of sudden cardiac death in pediatric patients. Postsurgical follow-up of the operated patients and future pediatric cases will assess the medium- and long-term efficacy and safety. During the follow-up, none of the patients presented a registered arrhythmic event or an appropriate or inappropriate shock, as well as any problem associated with the S-ICD.

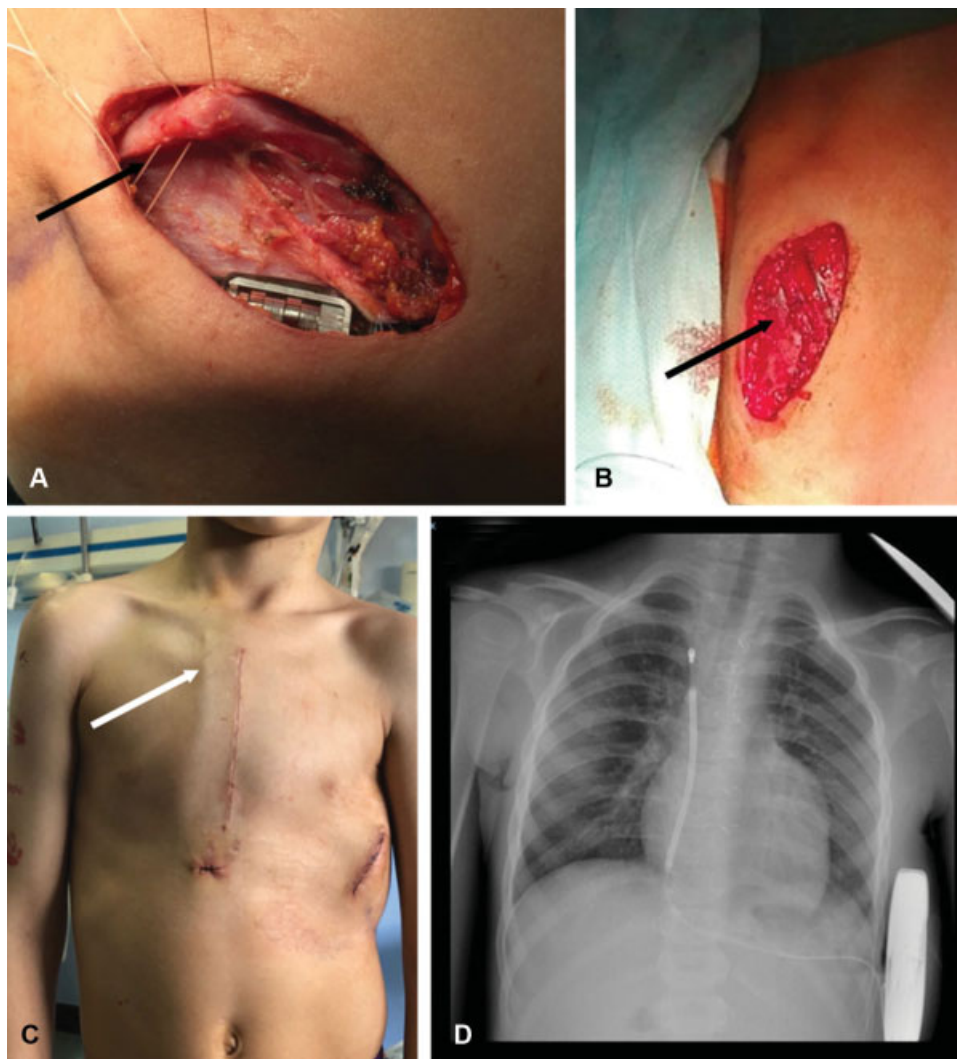


Fig. 2 Pocket closure and final subcutaneous implantable cardioverter-defibrillator (S-ICD) position. (A, B) Closure of the muscular planes (black arrow). (C) External appearance of the S-ICD 10 days postimplant. The white arrow indicates the electrode at the subcutaneous right parasternal margin. (D) Radiological image 10 days postimplant. Note the relative large size of the device in relation to the child's heart and thorax dimensions.

Conflict of Interest

The authors declare no conflicts of interests related to the publication of this study.

Acknowledgments

A.F.-M. and F.R.-S. contributed equally to this work. Both authors conducted the collection of data, data analysis/interpretation, and writing of the manuscript. This article is related to the Ph.D. thesis of A.F.-M.

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