

# Tumescent local anesthesia for subcutaneous implantable cardioverter-defibrillator implantation: An alternative for general anesthesia



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## Introduction

The subcutaneous implantable cardioverter-defibrillator (S-ICD) (Boston Scientific, Marlborough, MA) is an effective alternative to transvenous ICD (T-ICD) in an attempt to minimize some of the major complications associated to T-ICD, including serious infections and lead-related malfunction.<sup>1</sup> S-ICD implantation tends to be a longer procedure, as it requires dissection of subcutaneous or muscular tissues, the use of tunneling tools, and extended cautery use. Therefore, general anesthesia (GA) was initially considered the most appropriate approach during this procedure. However, GA is time-consuming, is not readily available at all times, carries physical discomfort, and is associated with hemodynamic instability during interventions, which might compromise perfusion of vital organs. Other major complications related to GA are hypoxemia and dysrhythmias.<sup>2</sup>

Alternatives to avoid GA have been described, such as serratus plane block and monitored anesthesia care (MAC). However, MAC has been related to respiratory complications in obese patients and only some anesthesiologists with prior training in regional blocks are capable of successfully performing serratus nerve blockage, which may limit the generalizability of this technique.<sup>3</sup>

Although standard local anesthesia can be used, the recommended maximum dose for subcutaneous infiltration of lidocaine without epinephrine is 4.5 mg/kg, and with epinephrine is 7 mg/kg, limiting the amount of anesthetic that can be admin-

## KEY TEACHING POINTS

- Tumescent local anesthesia (TLA) is a feasible and promising alternative for general anesthesia (GA) in patients undergoing subcutaneous implantable cardioverter-defibrillator (S-ICD) implantation.
- TLA is associated with reduced perioperative and postoperative pain and might be performed without invasive interventions (eg, arterial line) related to GA.
- TLA is easy and efficacious and allows S-ICD implants in centers that do not have anesthesia support, offering economic advantages.

istered. These restrictions preclude proper anesthesia delivery to the pocket and subxiphoid region, and more importantly at the sternum, which is extremely painful, as the lead should be placed close to the sternum and the periosteum might be scratched during tunneling.<sup>4</sup>

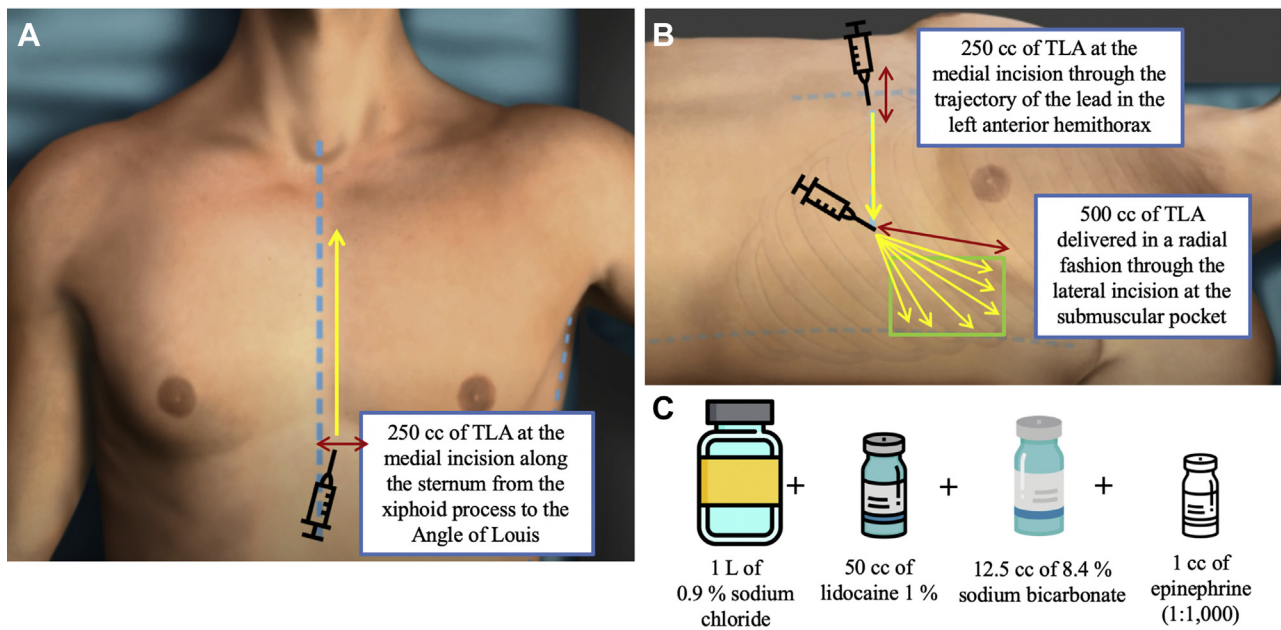
An alternative to the aforementioned approaches is tumescent local anesthesia (TLA), which provides nerve blockage to larger areas of the skin and subcutaneous tissue by using direct infiltration of large volumes of a diluted local anesthetic solution into the subcutaneous fat.<sup>5</sup> TLA allows for a wider therapeutic window than standard lidocaine administration, with maximal safe dosages of lidocaine found to be as high as 28 mg/kg without liposuction and 45 mg/kg with liposuction (Figure 1).<sup>4</sup> TLA was described in the 1930s and recently has been implemented in plastic surgery mainly owing to the reduced rates of postoperative pain.<sup>6</sup> Adequate infiltration using TLA is associated with firm tissue turgor, *peau d'orange* appearance, and blanching of the overlying skin.<sup>4</sup>

Herein, we describe three cases of S-ICD implantations using TLA in patients at high risk for complications related to GA owing to comorbidities. The institutional review board

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**Figure 1** Tumescent local anesthesia (TLA): Preparation and administration. **A:** Administration through the medial incision. **B:** TLA delivery at the medial and lateral incision. **C:** TLA components. Blue lines: Sternal, midaxillary, and left anterior hemithorax lines. Red arrows: Medial and lateral incisions. Yellow arrows: TLA infiltration. Green box: Submuscular pocket.

from Montefiore Medical Center provided approval for the study, and all patients provided written informed consent.

### Intraprocedural sedation and medication

All S-ICD implantations were performed under the guidance of an anesthesiology team according to institutional protocol. Initially, 1 mg of midazolam and 25 mcg of fentanyl were administered intravenously to each patient; and based on their level of comfort during the procedure more medication was provided accordingly. On average, for the 3 patients, 3 mg of midazolam and 75 mcg of fentanyl were required.

Continuous electronic monitoring was performed as in standard procedures. No other medications were used throughout interventions.

### TLA technique: Preparation and administration

TLA was prepared by using 1 L of 0.9% sodium chloride, 50 mL of 1% lidocaine, 1 mg of epinephrine (1/1,000), and 12.5 mL of 8.4% sodium bicarbonate (Figure 1). Before its administration, 2 mL of 1% lidocaine was infiltrated using a small needle (22G × 40 mm) at one of the corners of the medial and lateral incisions. The 3–5 mm medial incision was performed at the xiphoid process, and the 3–5 mm lateral incision at the fifth intercostal space between the mid and anterior axillary lines. A large volume of the anesthetic solution (~1000 mL) was infiltrated into the subcutaneous tissue across these small incisions using a Touhy needle (17G × 6 inches) mounted on a 60 mL syringe (Figure 2). Through the medial incision, 250 mL of TLA was administered subcutaneously along the sternum towards the angle of Louis; 250 mL was infiltrated via the medial incision in the trajectory of the lead in the left anterior hemithorax; and 500 mL of the solution was

infiltrated at the pocket through the lateral incision in a radial fashion. Finally, a 10- to 15-minute waiting period was conducted to obtain adequate anesthesia and vasoconstriction. Subsequently, S-ICDs were implanted uneventfully according to the standard implantation technique (Figure 3).

### S-ICD testing

Our current practice is to not perform defibrillation threshold testing (DFT) in patients during ICD implantation for primary prevention, as it is not associated with additional benefits.<sup>7</sup> Instead, we obtained impedance measurements after a synchronous 10 J shock as a surrogate. If an impedance of 110 ohms or lower is obtained, no further testing is performed.

### Procedural and skin-to-skin times

Procedural time was the amount of time since local anesthesia was provided until the pocket was closed. Skin-to-skin time was defined as the period between the first incision until pocket closure.

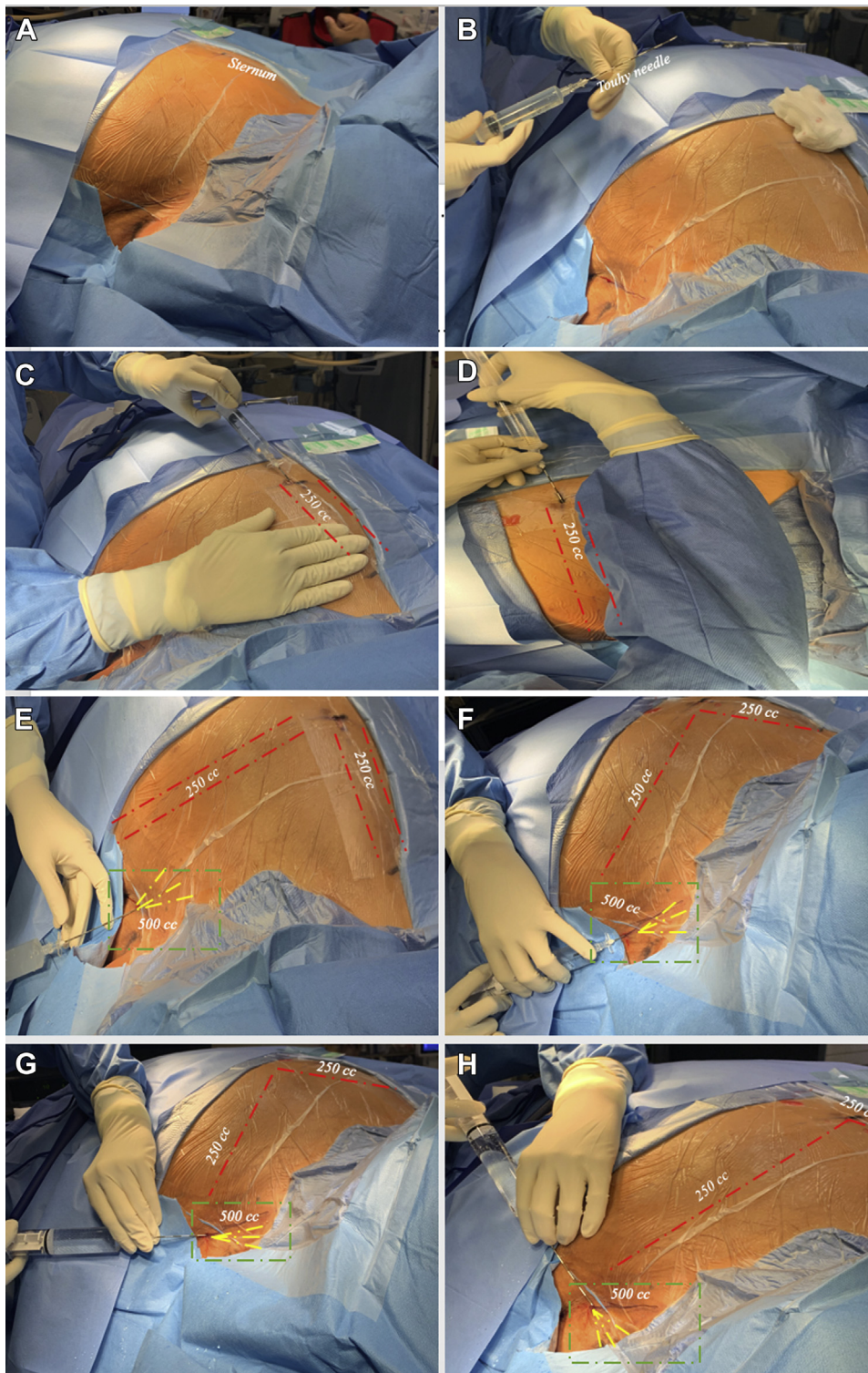
### Pain assessment

Patients were asked to verbally rate their pain at 1, 12, and 24 hours post-intervention. A numerical scale from 0 to 10 was used (0: none; 1–3: mild; 4–6: moderate; and 7–10: severe).

### Case report

#### Patient 1

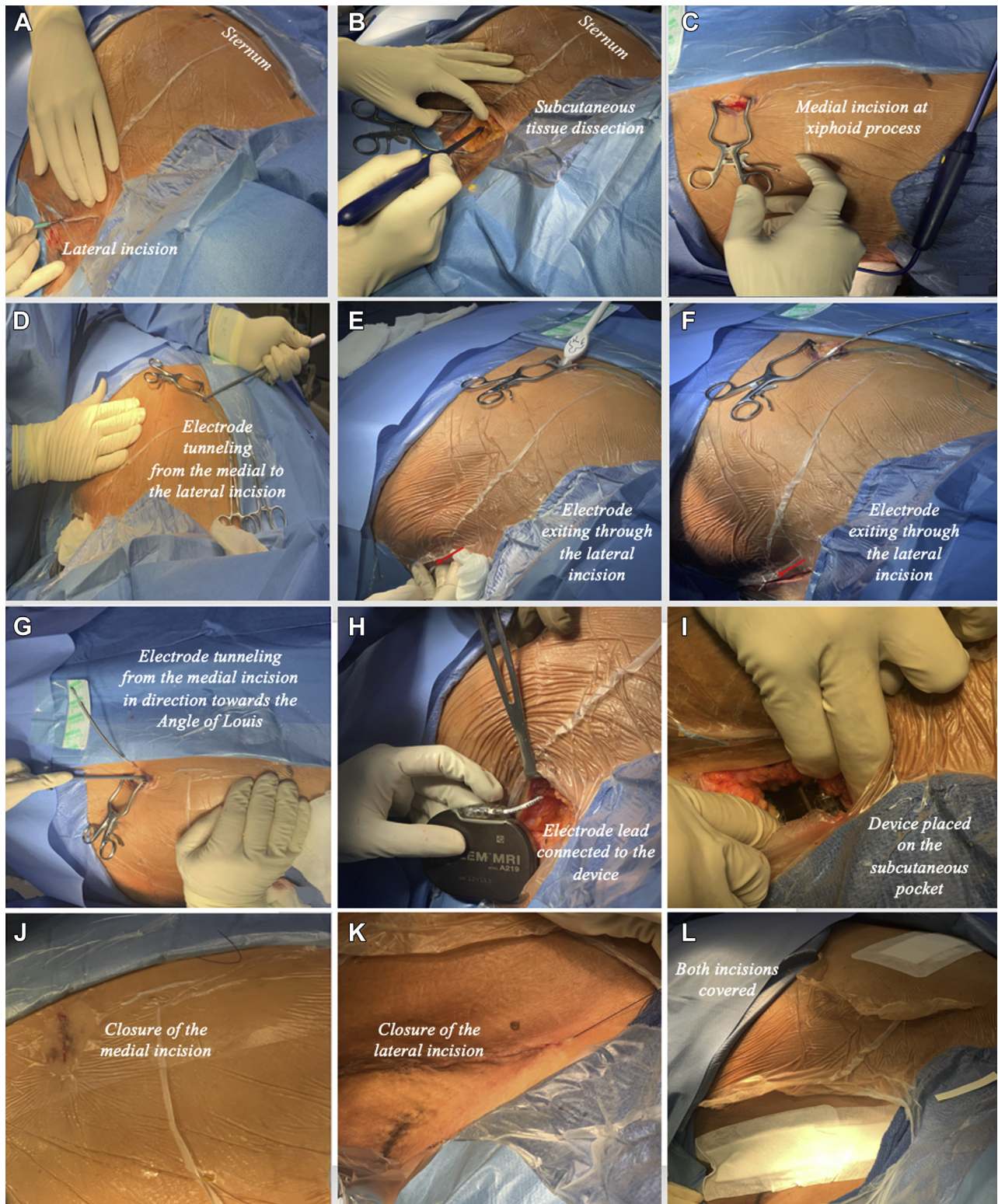
Patient 1 is a 34-year-old man with the diagnosis of Becker muscular dystrophy (BMD) and nonischemic cardiomyopathy with reduced left ventricular ejection fraction (LVEF 30%). S-ICD was recommended as primary



**Figure 2** Tumescent local anesthesia (TLA) technique. **A,B:** Sterile field preparation. **B:** Touhy needle for TLA delivery. **C:** 250 mL of TLA infiltrated at the medial incision towards the angle of Louis (red lines). **D:** 250 mL of TLA solution delivered through the medial incision in the left anterior hemithorax (red lines). **E–H:** Submuscular pocket (green box) infiltration with 500 mL of TLA in radial fashion (yellow lines).

prevention of sudden cardiac death. TLA was used because the use of volatile anesthetics and succinylcholine are absolutely contraindicated in patients with BMD owing to the high risk of anesthetic-related complications. Adequate sedation was obtained prior to the

intervention. Device testing showed an impedance of 51 ohms and adequate sensing was obtained. Procedural and skin-to-skin times were 68 and 54 minutes, respectively. No pain was reported at 1, 12, and 24 hours post-procedure. No other medications were used.



**Figure 3** Subcutaneous implantable cardioverter-defibrillator implantation. **A,B:** Pocket dissection at the lateral incision. **C:** Medial incision. **D–G:** Tunneled electrode attached to the device. **H,I:** Lead connected to the device and inserted into the pocket. **J–L:** Closure of the incisions.

### Patient 2

Patient 2 is a 37-year-old morbidly obese woman with a body mass index of  $71.5 \text{ kg/m}^2$  and past medical history of hypertension and hypertrophic cardiomyopathy with reduced

LVEF (25%). ICD implantation was suggested for primary prevention. Given the lack of abnormalities in the conduction system, her age, and the risk of lead-related complications during long-term follow-up, S-ICD implantation was considered

more suitable for this case. Likewise, TLA was considered appropriate in order to avoid GA, which may have resulted in a high risk of respiratory and cardiovascular complications. Proper sedation was obtained, and the S-ICD was implanted uneventfully using a 45 cm electrode. Impedance measurement was 83 ohms and adequate sensing was registered. Procedural and skin-to-skin times were 72 and 48 minutes, respectively. No pain was referred at 1, 12, and 24 hours.

### Patient 3

Patient 3 is a 46-year-old woman with a history of hypertension, type 2 diabetes mellitus, severe pulmonary hypertension, and nonischemic cardiomyopathy (LVEF 35%) who was referred for ICD implantation as primary prevention. Because of her young age and multiple comorbidities, an S-ICD was considered appropriate. TLA was proposed considering her high risk of respiratory complications with GA given the PASP > 70 mmHg. Sedation was obtained uneventfully and device implantation was performed successfully. Impedance measurements showed 62 ohms with adequate sensing obtained. Procedural and skin-to-skin times were 69 and 39 minutes, respectively. During the 1-hour follow-up, she rated her pain as 1 (mild), which was controlled during follow-up (i.e., 12 and 24 hours) with 500 mg of acetaminophen.

### Discussion

The use of S-ICD as an alternative to T-ICD is particularly appealing when considering that lead-related complications remain the most common cause of ICD malfunction in young patients. Larger device dimension, the need for subcutaneous tunneling, and prolonged procedural times related to S-ICD initially made GA the preferred method for this intervention. The aim of this strategy was to provide adequate anesthesia and analgesia during certain steps of S-ICD implantation (ie, pocket dissection and tunneling). However, as S-ICD became more available, other anesthetic techniques have been proposed in order to provide an alternative for patients at high risk of complications with GA.

Regional anesthesia (serratus nerve blockage) has been proposed for S-ICD implantation, but it is technically demanding and requires highly trained personnel and ultrasound guidance, thus limiting its widespread use.<sup>8</sup> MAC has proved to be feasible and similar to GA regarding patient outcomes. One fundamental advantage of MAC is that it bypasses the need for airway manipulation, but this is not translated into reduced procedural times.<sup>9</sup> Moreover, MAC has been related to increased risk of hypoxemia, similarly to GA.<sup>2</sup> This is particularly evident in patients with a body mass index greater than 30 kg/m<sup>2</sup>, even in the absence of other comorbidities.<sup>10</sup>

As a consequence, the use of S-ICD has been limited in scenarios where GA is not convenient owing to a high risk of complications, such as the cases presented above with BMD, morbid obesity, and severe pulmonary hypertension. Other similar situations are patients with prohibitive risk for GA like severe valvular heart disease or those who do

not wish to undergo GA, for whom TLA could be proposed as an alternative anesthetic approach.

TLA has been used for decades as an adjunctive to GA during liposuction, hand surgery, and other esthetic procedures. Recently, TLA has been used in the placement of a subpectoral pacemaker.<sup>11</sup> Some benefits related to TLA are reduced procedural times and reduced postprocedural pain reported by patients.<sup>6</sup> Also, the epinephrine-induced vasoconstriction decreases the risk of bleeding and therefore the risk of hematoma formation and infections.<sup>12</sup> Similarly, this vasoconstriction helps to prolong pain control by reducing anesthetic reabsorption.<sup>13</sup>

Administration of substantial amounts of fluid facilitates surgical dissection by reducing trauma to surrounding tissues, and the use of tumescent solution, by itself, could have anesthetic properties independent of the use of lidocaine.<sup>14</sup> Additionally, the use of bicarbonate creates a buffered solution that reduces periprocedural pain during infiltration. In our cases, the use of TLA resulted in adequate anesthesia during the procedure, patient comfort, and acceptable postprocedural pain.

Although concerns for lidocaine toxicity exist, TLA increases the therapeutic dose of lidocaine to 28–45 mg/kg,<sup>4</sup> allowing for a wider safety margin. Similarly, the slow release of lidocaine from tissues secondary to vasoconstriction lowers the risk for toxicity even more. The amount of lidocaine used in the device implantations described above was 500 mg in the TLA solution, and no complications were reported during the 24-hour follow-up.

The procedural times recorded in this series were shorter than those reported on GA or MAC.<sup>9</sup> This reduction was observed owing to the avoidance of airway manipulation and DFT. Our protocol is to deliver a 10 J shock after device implantation to obtain impedance measurements as a surrogate of DFT, as the latter has been related to myocardial damage and prolonged asystole.<sup>15</sup> Moreover, similar rates of successful termination of ventricular arrhythmias have been reported from ICD with and without DFT.<sup>15</sup>

### Conclusion

TLA is a promising alternative to GA in S-ICD implantation, particularly in patients with a high risk of complications owing to comorbidities or any contraindication for GA. In this case series, the benefits of S-ICD implantation with TLA technique, such as reduced procedural times and steady pain control after the intervention, were displayed in all patients. Further studies are required to validate the findings exposed herein.

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