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SPOTLIGHT

Application of ultrasound-guided tumescent local anesthesia in prepectoral pacemaker implantation: A detailed procedural report

Yohei Kawatani | **Takaki Hori**

Cardiovascular Surgery, Kamagaya General Hospital, Chiba, Japan

Correspondence
Takaki Hori, Department of Cardiovascular Surgery, Kamagaya General Hospital, 929-6, Hatsutomi, Kamagaha-Shi, Chiba-Ken 273-0121, Japan.
Email: heart@kamagaya-hp.jp

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The number of pacemaker implantation surgeries is increasing in Japan, with up to 43 919 surgeries performed in 2020. During these procedures, pacemakers are often implanted into prepectoral pockets under local anesthesia. Achieving a deep pocket position is better, with optimal placement being just above or below the pectoral fascia (subfascial and prepectoral) and not into the subcutaneous fat tissue.[1] However, simple local anesthesia cannot induce sufficient analgesia in these deeper subcutaneous areas. In our facility, to achieve sufficient and precise analgesia, we use the tumescent local anesthesia (TLA) method under real-time ultrasound guidance. In addition to its effectiveness in analgesia, TLA makes surgical procedures easier and safer. TLA was introduced in plastic surgery for broad analgesia in subcutaneous liposuction surgeries.[2] The method has recently been reported to be effective in many areas, such as treatments for great saphenous vein insufficiency and inguinal hernia repair. We apply this technique in prepectoral pacemaker implantation surgeries. We described a technical note.

1. TLA solution is prepared; The TLA solution consists of 100 ml of normal saline, 5 ml of sodium bicarbonate, and 10 ml of 1% lidocaine. We do not use intravenous sedatives and analgesics routinely.
2. A guidewire is inserted into the left axillary vein under ultrasound image guidance; approximately 3–5 ml of TLA solution is injected into the dermis at the point of puncture and the area through which the puncture needle passes. The guidewire is inserted into the vein to prepare for later insertion of introducer sheaths using the Seldinger method (Figure 1A).
3. A generator pocket is created using TLA; the operator controls a 23-gauge 7-cm-long injection needle with one hand and the ultrasound probe with the other (Figure 1B). An adequate amount of the TLA solution is injected into the tissue between the subfascial space and the dermis over the area for generator pocket creation, which is approximately 10 cm in diameter in the chest area (Figures 1C and 2A–C). Total amount of the TLA solution is 60 ml. The area tends to become edematous (Figure 2B,C). Next, a 4-cm incision is made 1–2 cm below the puncture point (Figure 3A). The subcutaneous tissue is then cut and dissected, exposing the pectoral fascia (Figure 3A,B). For cases using the prefascial technique, the prefascial pocket is created just above the pectoral fascia after incision. For cases using the subfascial technique, the subfascial pocket is created just below the pectoral fascia after incision (Figure 3A,B). The pocket is created by electronic cautery and digital dissection (Figure 3B,C). Identification of anatomical structures, such as the subcutaneous fascia and pectoral fascia, and dissection for pocket creation are easily accomplished owing to the hydrodissection effect of TLA.
4. Pacemaker leads placement; the guidewires are transposed into the pocket, and introducer sheaths are inserted into the axillary vein using the Seldinger method. Pacemaker leads are placed at precise positions through the sheaths.
5. Pocket closure; the generator and leads are connected and placed into the pocket. The wound is finally closed using absorbable sutures (Figures 3D and 4A,B).

Although deeper pockets in prepectoral pacemaker implantation surgeries are recommended by the guidelines set by Japanese society of circulation,[1] gaining sufficient analgesia in such deep and broad areas using simple local anesthesia is exceptionally difficult. Blindly inserting a needle into deep tissue can result in accidental puncture and injecting large amounts of local analgesic agents such

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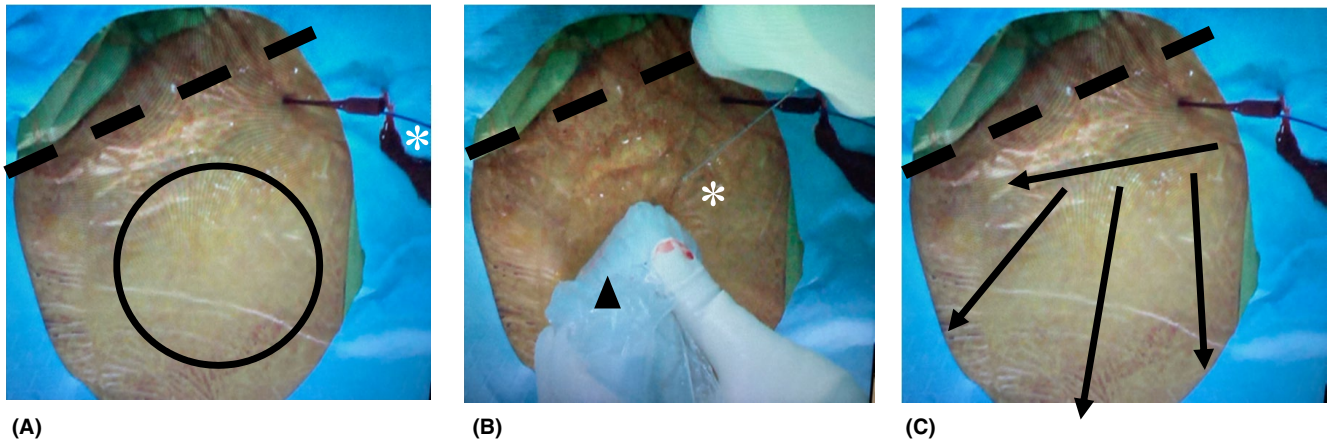

FIGURE 1 Photographs during the surgery. (A) A guidewire (indicated by "*") is inserted into the left axillary vein. Circle: Generator pocket plan. Dotted line: The left clavicle. (B) Injection of TLA solution. A 7-cm 23-gauge needle (*) is controlled with the right hand and ultrasound probe (arrow head) is controlled with the other. (C) Indicating the position of the injection needle. Dotted line: The left clavicle. Arrow marks indicate the insertion site of the injection needle. Insertion of full length of the 7-cm injection needle can induce tumescent local analgesia over an area of approximately 10 cm in diameter

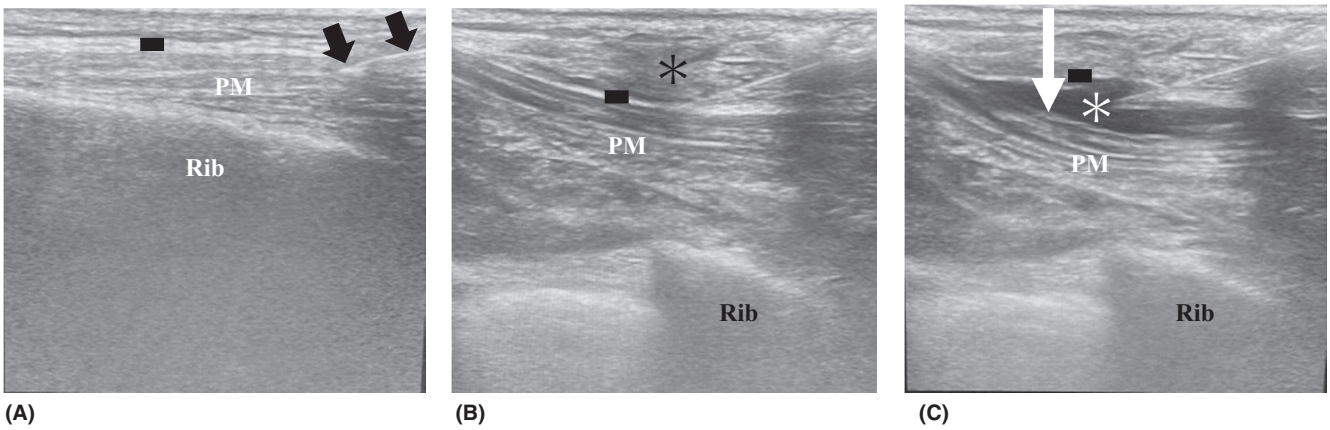

FIGURE 2 Ultrasound images during real-time ultrasound-guided tumescent local anesthesia (TLA). (A) Before infusing the TLA solution (black arrows indicate the injection needle). (B) The subcutaneous tissue was edematous after injecting the TLA solution (*). (C) Subfascial space appears while injecting the TLA solution into the subpectoral fascia (*). The space from the dermis to the subfascial space can become edematous (white arrow). Square: Pectoral fascia. PM: Pectoralis major muscle. Rib: Rib

as lidocaine can cause toxicity. The Japanese Society of Anesthesia recommends 100 mg of lidocaine as a safe dose and 200 mg as the maximum recommended dose.[3] Based on these guidelines, a safe dose of 1% lidocaine solution is 10 ml, a volume of which is likely insufficient for inducing analgesia in the areas required for pocket creation. We administer 60 ml of TLA solution in our operations, which is the equivalent of only 52 mg of lidocaine. The lidocaine is diluted to 0.087% in the TLA solution, enabling injection of a much larger total volume and broader penetration into the target areas. This in turn induces effective analgesia over a broader area enough for generator pocket creation. In addition, injecting a larger volume of TLA solution resulted in the hydrodissection effect,[4] allowing easy dissection and hemostasis during pocket creation (Figure 3A–C). Both prefascial and subfascial tissues are edematous following injection of the TLA solution (Figures 2B,C and 3A,B); as a result, the operator can dissect one of the spaces without strong manipulation (Figure 3C).

The original TLA method does not include ultrasound image guidance[2]; however, recently, more TLA procedures are being performed under real-time ultrasound image guidance, making needle insertion safer, and allowing for more accurate injection of TLA solution into the target layer (Figure 2B,C). In our facility, we injected the TLA solution through the dermis into the subfascial space to induce sufficient analgesia on the fascia (Figure 2A–C). Pain is experienced by the pectoral fascia during manipulation, although the fascia itself is not incised. Therefore, even in prefascial pocket creation, we recommend injecting the solution into the subpectoral fascia space to induce sufficient analgesia on the fascia. In addition, we used real-time ultrasound image guidance while puncturing the axillary vein. Studies have shown that this helps avoid complications.[5] We also completed the axillary vein puncture without a contrast agent.

TLA solutions originally comprise epinephrine, lidocaine, and bicarbonate diluted with normal saline.[2] However, in Japan, a drug

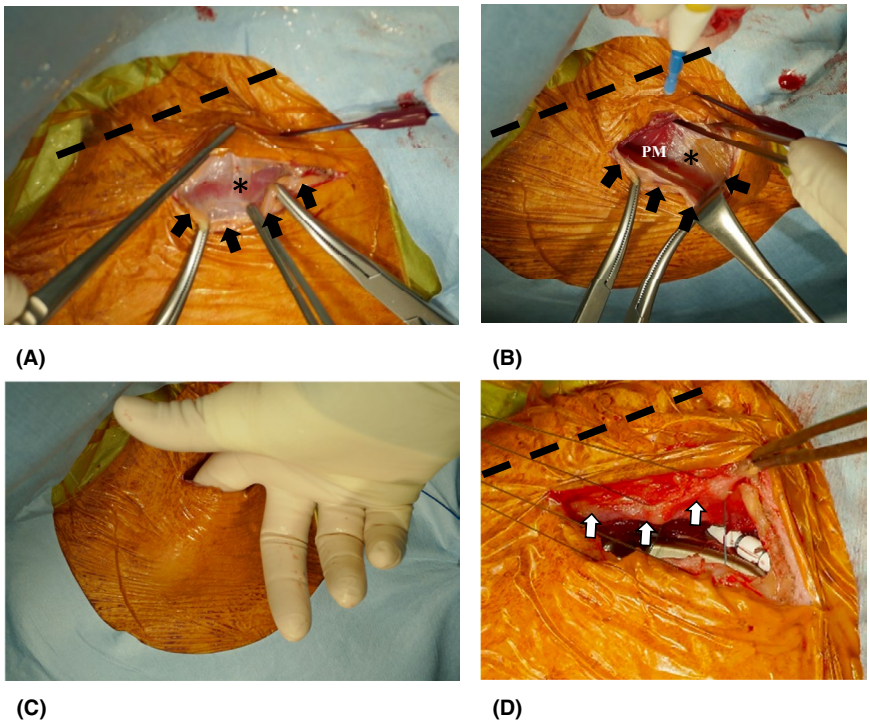

FIGURE 3 Photographs during the production of a generator pocket. (A) The pectoral fascia (black arrows) is lifted using forceps after incising. The subfascial space (*) is edematous and became loose by injecting the tumescent local anesthesia (TLA) solution. (B, C) The subfascial space is dissected by electronic cautery and digitally to produce a generator pocket. Sufficient analgesia is obtained using the TLA solution, and the edematous tissue becomes weak, making manipulation easy. (D) The pectoral fascia is easily identifiable and sutured after placing the generator and leads into the pocket. Dotted line; the left clavicle. Pectoralis major muscle

product of lidocaine with epinephrine is contraindicated in patients with "severe arrhythmias." Therefore, a TLA solution without epinephrine is used in our surgeries.

The analgesic effect achieved by TLA is very effective. Once the TLA solution is administered at the beginning of the surgery, the analgesia is sustained throughout the procedure. The analgesic effect of TLA is reported to remain by the next day, which provides good postoperative analgesia. As far as our experience, the pain assessed by numerical rating scale during our surgery ranged from 0 to 4.

The TLA technique in a pacemaker implantation surgery is simple and does not require significant additional training, as long as the operator is familiar with ultrasound-guided puncturing techniques. In the surgeries, the surgical field is the precordium, in which the ultrasound probe and injection needle are easily controlled by the operator. Ultimately, applying the TLA technique does not require additional time as the TLA procedure duration ranges from 5 to 10 min in our facility.

We conclude that our anesthesia technique is useful in prepectoral pacemaker implantation.

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CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

ORCID

Yohei Kawatani https://orcid.org/0000-0002-5021-8521

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