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Sternal Nonunion Treated by Radiofrequency Thermocoagulation of the Anterior Cutaneous Branch of the Intercostal Nerve: A Case Report

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Background: For painful sternal nonunion, conservative treatment by radiofrequency thermocoagulation nerve block of the anterior cutaneous branch of the intercostal nerve can be indicated when surgery is not feasible.

Case Report: A 44-year-old man with a history of open-heart surgery was referred to our department due to a complaint that was strongly suspected to be associated with stress. He wished to restart archery, however, doing so was difficult due to the painful sternal nonunion. Surgical treatment and external fixation were not appropriate due to his past medical history and desire to resume archery. Radiofrequency thermocoagulation (90°C, 120 seconds) of the anterior cutaneous branch of the intercostal nerve was performed because he had only 2 tender points. After performing thermocoagulation several times to achieve long-term analgesia, the patient was allowed to resume archery.

Conclusions: Radiofrequency intercostal nerve thermocoagulation is an effective conservative treatment for sternal nonunion pain.

Key words: Sternal nonunion, conservative treatment, radiofrequency thermocoagulation of the anterior cutaneous branch of the intercostal nerve, case report

BACKGROUND

Nonunion is the failure of a fracture to heal. The commonly agreed standard definition of nonunion, developed by the US Food and Drug Administration, is a fracture that shows no signs of healing for 3 months, persists for a minimum of 9 months, and can causes pain (1). Surgery is indicated for painful sternal nonunion, and conservative treatment is indicated when it is not feasible. Conservative treatment by radiofrequency thermocoagulation nerve block of the anterior cutaneous branch of the intercostal nerve, which innervates the sternum, can be indicated.

Herein, we report a case in which radiofrequency thermocoagulation of the anterior branch of the intercostal nerve was effective in treating pain due to sternal nonunion after cardiac surgery. The patient provided consent for publication of this case report.

CASE PRESENTATION

A 44-year-old man (height, 166 cm; weight, 71 kg; body mass index, 25.8 kg/m^2) was referred to our department due to a chief complaint of painful bilateral lateral thoracic-to-lateral abdominal paroxysmal muscle contractions, which began after pulmonary artery valve replacement (PVR). The patient had undergone intracardiac repair for tetralogy of Fallot when he was 3 years old and PVR for pulmonary valve regurgitation when he was 41 years old. The patient had a wound infection and a sternal nonunion after PVR. Three-dimensional computed tomography showed sternal nonunion (Fig. 1).

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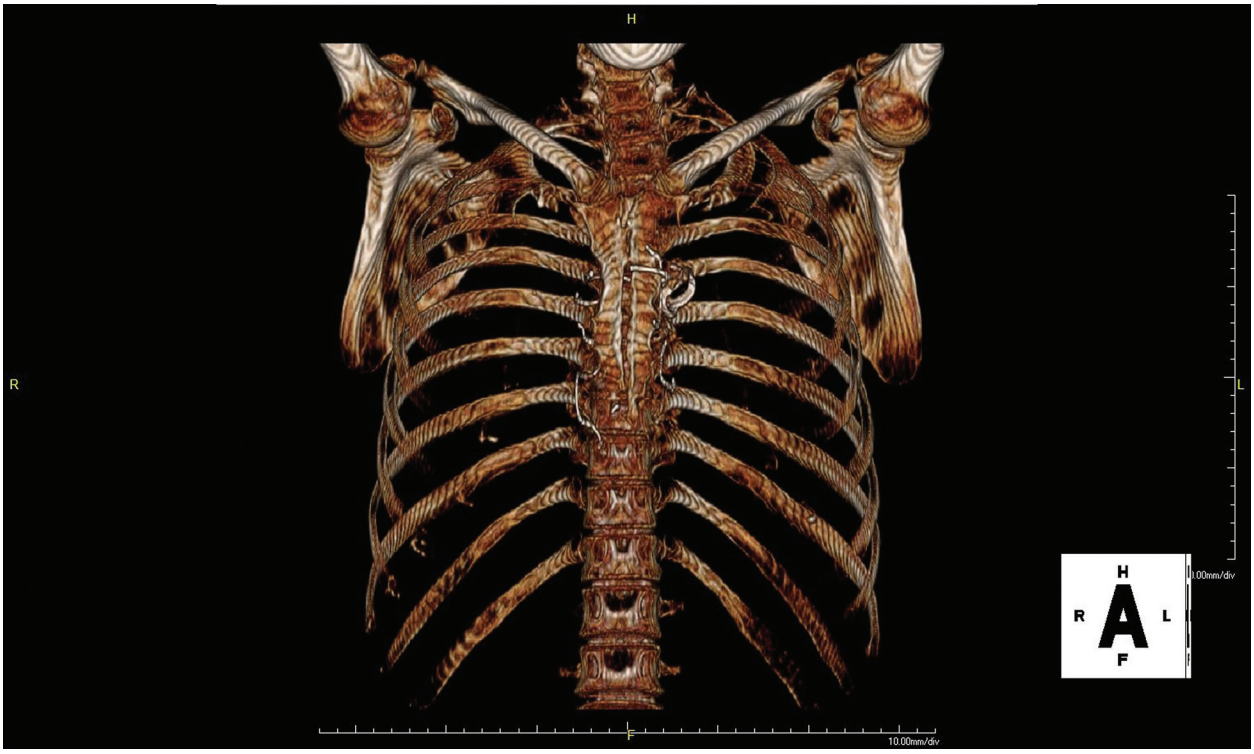

Fig. 1. Three-dimensional computed tomography image showing sternal nonunion.

The symptoms of the patient were strongly suspected to be associated with psychosocial factors based on the timing of their onset. He wished to restart archery, which he had practiced previously, and we recommended it for him to relieve stress. However, doing so was difficult due to the sternal pain. Sternal pain also hindered his job of polishing cars. He took 2 tramadol and acetaminophen combination tablets daily; however, this did not provide sufficient pain relief on motion.

Surgical treatment was indicated because of the chronic pain of the sternal nonunion. However, it was considered difficult for the patient because of possible pericardial adhesion. Therefore, conservative treatments were indicated. An external fixation device was considered effective for conservative treatment; however, it was not acceptable because it hindered playing archery. The sternal pain was bilateral, but it was localized at 2 points (Fig. 2). Analgesia was considered possible with a deep parasternal intercostal plane (DPIP) block, which is a block of an anterior cutaneous branch of the intercostal nerve innervating sternum. The procedure was performed without discontinuation of the aspirin the patient was taking. Prolonged compression was applied after the puncture to prevent hemorrhage. Under ultrasound guidance using an ultrasound machine (S-Nerve, FUJIFILM-SonoSite, Tokyo, Japan) with high frequency (15-6 MHz) linear transducer, a local anesthetic (0.75% ropivacaine, 2 mL/site) was administered to the anterior cutaneous branch of the intercostal nerve (right T3 and left T5) in the intercostal spaces corresponding to the tender points (Fig. 3). This resulted in analgesia and improved thoracic movement. Therefore, we judged the anterior cutaneous branch of the intercostal nerve block to be effective.

To prolong the effects of the intercostal nerve block, we planned to perform radiofrequency thermocoagulation. We asked the attending cardiac surgeon about the disadvantages of increasing the range of motion of the sternum via pain relief by performing radiofrequency thermocoagulation of an anterior cutaneous branch of the intercostal nerve. He denied them and agreed to perform radiofrequency thermocoagulation. Radiofrequency thermocoagulation was performed on the anterior cutaneous branch of the intercostal nerve at the right T3 and left T5. A radiofrequency needle (NeuroTherm Reusable Radiofrequency Electrode 10 cm; Abbott Medical Japan LLC, Tokyo, Japan) was inserted under ultrasound guidance toward the intercostal

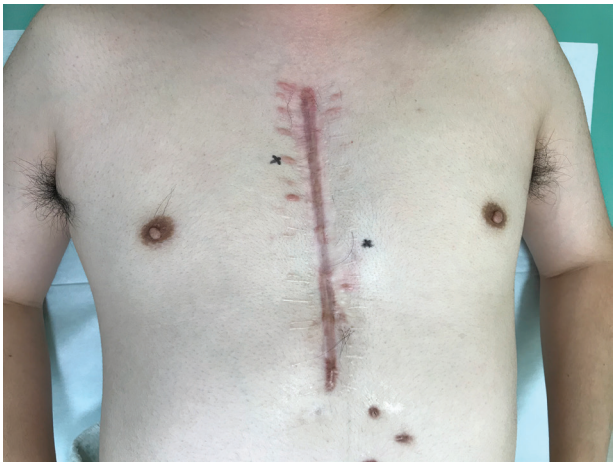

Fig. 2. Photograph of the chest of the patient. The "x" marks indicate the tender points.

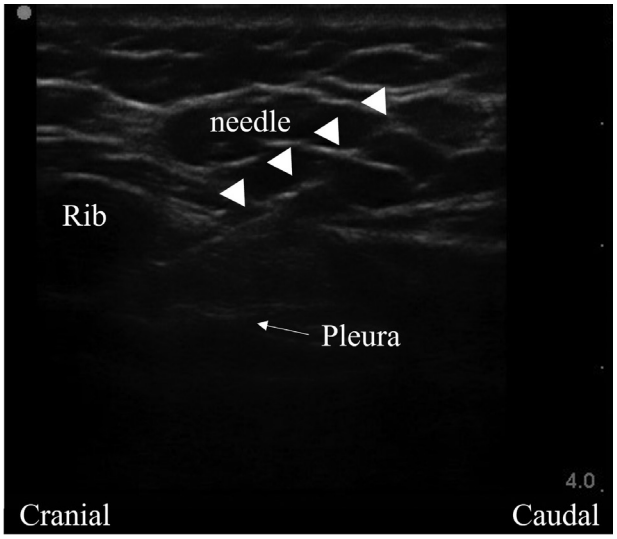

Fig. 3. Ultrasound image of the DPIP block. DPIP, deep parasternal intercostal plane.

Fig. 4. View of the puncture on the left side.

nerve, and needle placement was confirmed using sensory stimulation to assess its proximity to the target nerve. At this point, radiofrequency thermocoagulation was applied for 120 seconds at 90 °C using a radiofrequency thermocoagulator (NeuroTherm NT500; Abbott Medical Japan LLC, Tokyo, Japan) (Fig. 4). However, the tenderness persisted on the right side. The pain disappeared when a local anesthetic was administered to T4. Therefore, radiofrequency thermocoagulation was also performed under the same conditions, which led to the resolution of the pain. There were no specific adverse effects. An additional radiofrequency thermocoagulation (right T3 × 2, T4 × 1, left T5 × 1) had to be performed using the same method in the subsequent month.

After performing thermocoagulation several times, the patient had long-term analgesia while taking the tramadol and acetaminophen combination tablets. He could polish cars with ease and resumed practicing archery with good analgesia and satisfaction. Thermocoagulation had to be performed on each side approximately every 6 months. Additionally, there was a diminution in the frequency of painful bilateral lateral thoracic-to-lateral abdominal paroxysmal muscle contractions.

DISCUSSION

Chronic pain, instability, limitation of activities of daily living, and altered respiratory mechanisms are indications for surgery for cases of sternal nonunion (2). Aseptic nonunion is considered a precursor to osteomyelitis, mediastinitis, and deep sternal cavity infections, all of which have high mortality rates. Various sternal repair and fixation tools have been reported, including steel bands, polymer tape, and absorbable sutures. Rigid plate and screw fixation using methods adapted from the fixation of craniofacial and orthopedic fractures has recently been used routinely for primary and secondary sternal closure (2).

Conservative treatment does not significantly increase early mortality rates. It was selected for this case because of the risks associated with reopening the chest due to the patient's history of multiple median sternotomy surgeries and assumed presence of pericardial adhesions. External fixation with a device is an effective conservative treatment (3); however, it was not accept-

able in this case because of the desire of the patient to resume archery. Therefore, an anterior cutaneous branch of the intercostal nerve block was performed for pain treatment.

The anterior cutaneous branch of the intercostal nerve innervates the sternum (4). A DPIP block, which blocks the anterior branch of the intercostal nerve, has been reported to effectively provide analgesia during median sternotomy in cardiovascular surgery (5). Multiple intercostal nerve blocks are needed for analgesia of the entire sternum, but local anesthetics can spread after being injected at a single location. Radiofrequency thermocoagulation, which needs to be performed on each nerve individually, is more difficult to perform than blocks using local anesthetics. However, the targeted nerves are few when the tender points are localized, as in the present case, making this treatment feasible. Therefore, a DPIP block was performed. We conducted it using a combination of ultrasound guidance and nerve stimulation. It was not performed under fluoroscopic guidance; therefore, it was impossible to determine whether the needle tip was inside the sheath. Several attempts were made to achieve a satisfactory effect, and it may have been better to perform contrast-enhanced fluoroscopy to confirm that the needle tip was indeed inside the sheath.

In general, painful nonunion often results in a reduced range of motion due to pain and prevents dislocation. Therefore, increasing the range of motion via pain relief has potential disadvantages. Consulting the attending surgeon about the disadvantages is important.

The patient was taking aspirin and had a risk of hemorrhage. In the "Pain Procedures Classification to the Potential Risk of Serious Bleeding" section of the American Society of Regional Anesthesia guidelines, nerve blocks on the body surface, such as intercostal nerve blocks, are collectively referred to as peripheral nerve blocks and are classified as low-risk procedures, the least risky of the 3-level classification of risk procedures (6). Therefore, discontinuation of aspirin is not always considered necessary when performing these blocks.

CONCLUSIONS

Herein, we report a case in which radiofrequency thermocoagulation of the anterior cutaneous branch of the intercostal nerve was effective in the treatment of pain due to sternal nonunion. This approach may be considered as a useful approach for conservative treatment.

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