Chronic post-thoracotomy pain (CPTP) is a common complication of thoracotomy. CPTP, which often causes refractory and nocturnal pain and decreases patients' quality of life, remains a stubborn problem for pain physicians. However, spontaneous muscle contraction is a very rare complication of thoracotomy. Here we present a case of extreme pain with spontaneous muscle contraction (SMC) after thoracotomy. The patient was treated with pulsed radiofrequency (PRF) targeting the intercostal nerves through the angulus costae.
which was approximately 15 times per minute, in 5-minute cycles, with 50-60 cycles each day. The diagnosis was CPTP with neuropathic pain (NPP) according to the following criteria: 1) ID-pain scale showed 3 points; 2) The pain occurred around the scar after the surgery; 3) The pain lasted for more than 2 years. The patient had been treated during the past 2 years with gabapentin (1800mg/day) and amitriptyline (100mg/day) as well as thoracic epidural analgesia, with only 10-20% pain relief. In addition, the above therapies did not improve the SMC, which was still the stubborn problem in this case.

Acting on the result of some studies and clinical experiences (1), we performed an intercostal nerve block (INB). The experimental INB provided short-term moderate relief of pain. Because CPTP is a type of neuropathic pain, and after our successful application of pulsed radiofrequency (PRF) in the treatment of postherpetic neuralgia (PHN) (2), we performed PRF on the intercostal nerves through the angulus costae as the next treatment, to begin 2 weeks after the INB.

The specialized medical instrument required for the intervention was a radiofrequency (RF) generator (Baylis PM230) with a 15 cm RF cannula with a 5mm exposed electrode tip. During the intervention the patient was placed in a prone position and locally anesthetized by lidocaine. The skin projection position of the angulus costae was marked under the guidance of a C-arm x-ray machine. The RF cannula was vertically inserted at the lower edge of the angulus costae of T5 until the cannula tip touched the rib. After connecting the RF generator and setting it to the testing mode (50HZ, 0.3V), adjustments were made to the depth and position of the RF cannula slowly and slightly to reposition the tip into the intercostal groove. When the patient felt numbness or another abnormal sensation, the tip was near the target nerve. Next, the RF cannula was kept stable and the mode of the RF machine was turned to the therapy mode (42°C, 120s). After 2 cycles of PRF, a nerve-blocking mixture of ropivacaine and diprospan (2 mL total volume) was administered. The same injection was then applied in T6. The patient received these PRF treatments 3 times, at 2-week intervals.

The patient reported pain relief of 50% a few days after the intervention. The frequency and amplitude of SMC was reduced by approximately 70% and 40% respectively. The patient’s pain intensity was reduced to 25% and the frequency of SMC was ultimately reduced to 10%. In a total of 2 years of follow-up (with 1 day, 3 day, 2 week, 2 month, 6 month, 2-year time points), the level of pain and SMC was roughly stable.

**DISCUSSION**

**Diagnoses and Clinical Characteristics of CPTP and NPP**

CPTP is defined as pain occurring or persisting in the area of the thoracotomy incision for more than 2 months (3). The risk factors of CPTP include female,
age < 60 years old, prolonged duration of post-operative chest tube drainage, post operative pain management, hypertension, extensive surgery, radiotherapy and pleurectomy (4,5). Video assisted thoracic surgery (VATS) brings a higher incidence of CPTP than open procedures, because insertion of a trocar could result in intercostal nerves and muscle damage during VATS (6). Though it has been accepted that intercostal nerve damage was the main reason of CPTP, visceral stimulation during the surgery could also play a role in sensitization of the central nervous system (5).

NPP after thoracotomy is pain lasting for more than 6 months after the surgery, presenting symptoms such as spontaneous pain or evoked pain (e.g. allodynia). NPP carries an incidence of approximate 29% (7). In other studies, 32.5%-50% patients suffering CPTP were also diagnosed as NPP (4,5). The diagnostic tools for NPP are various, including ID pain questionnaire, DN4 questionnaire, The PainDETECT and grading system proposed by Treede (4,5,7). The patients with NPP component suffered more severe pain. Therefore, to predict the prognosis and perform effective treatments, it is important to diagnose the NPP component.

SMC and Pain-Spasm-Pain

In this patient, the pain was of greater intensity during the SMC. SMC is a very rare complication after thoracotomy, which increased the difficulty of the treatment in this case. The dysfunctional muscle identified by clinical examination was the intercostal externi, dominated by intercostal nerves. It has been known that peripheral nerve injury could lead to muscle spasm (8). In the pain-spasm-pain model, pain would lead to muscular hyperactivity such as spasm, which in turn would cause pain. The possible mechanism of SMC is that nociceptors affect the output of muscle spindles via direct excitatory projection on the gamma motor neurons and then the increased muscle spindles output will cause the hyperexcitability of the alpha motorneuron pool. During the muscle contraction, the accumulations in the muscle such as bradykinin, potassium and lactate could cause pain. In this case, the improvement of both pain and SMC may have been due to the PRF treatment that led to pain reduction by relieving the peripheral sensitization, and then improved the vicious cycle of pain-spasm-pain.

Treatments of CPTP

Conservative treatments of CPTP include nonsteroidal anti-inflammatory drugs (NSAIDs) and pregabalin (9). It has been accepted that early treatment of pain could reduce the incidence of CPTP (6,10). Aggressive analgesia such as thoracic epidural analgesia, paravertebral blocks and intercostal nerve blocks were effective in the early phase (10). However, these therapies provided limited long-term analgesia in CPTP (11). One single case report showed that botulinum toxin relived pain in CPTP (12). Peripheral nerve and spinal cord stimulation for the treatment of CPTP have also been reported in a series of case reports (3,13-15). As for PRF, both intercostal nerves and dorsal root ganglion (DRG) have been targeted in the treatment of CPTP in several studies and case series (16,17).

Therapeutic Target on Peripheral Nerves System in the Treatment of NPP

The peripheral nervous system plays an important role in central sensitization (18). In a functional magnetic resonance imaging (fMRI) study, it was found that peripheral acupuncture could modulate the amygdala network which encompasses brain structures implicated in pain sensation and pain modulation (19). Other functional neuroimaging studies showed that numerous peripheral nerve stimulations led to brain activity in various disorders including chronic migraine (20). In addition, in animal studies, PRF on peripheral nerve (or DRG) induced the change of numerous pain-related molecules including TNF-a, IL-6, GABAB-R1 and met-enkephalin in the spinal cord (21,22).

Treatments on the peripheral nerve system have been applied in many NPP and other chronic pain diseases such as chronic migraine (23, 24). For example, 5% lidocaine patch and capsaicin patch are both first-line drugs for PHN. A previous study has shown that tactile stimulation of the area evoking pain resulted in a reduction in the area of allodynia for at least 1h in patients with NPP (25); subcutaneous peripheral nerve adjustment by cannular needle provided dramatic pain relief for at least 14 days in PHN patients (24); subcutaneous peripheral nerve stimulation for the treatment of NPP such as CPTP and thoracic PHN also showed good results (13). In a recent clinical trial conducted in our pain management center, PRF on the intercostal nerves through angulus costae provided significant pain relief in PHN patients (2).

According to these studies and our successful experimental intercostal nerve block, we decided to perform PRF on the intercostals nerves in this case.
PRF on Intercostal Nerves in the Treatment Of CPTP

PRF has been regarded as a safe and effective treatment for various post-operative and non-post-operative pain (26). The clinical effects of PRF are more reversible and less destructive than RF, because the temperature of cannula tip during the therapy is 42°C, lower than the irreversible tissue destruction threshold for nerves which is 45°C-50°C (27). PRF on intercostal nerves in treating CPTP has been reported in a few studies (16, 17). An earlier study suggested that PRF targeting the dorsal root ganglia is superior to targeting intercostal nerves in the treatment of CPTP (16). However, in this retrospective study, the accurate puncture point was not mentioned. In another case series, the puncture point was 8 cm lateral to the spinous processes (17). By contrast, in this case, angulus costae were accurately targeted under fluoroscopy, because in this manner, PRF could modulate the entire axis of intercostal nerves including dural, lateral and anterior nerve branches to maximize the range of analgesia (2). In addition, compared with DRG, PRF on the intercostal nerves is easier to manipulate, and brings less risk in pneumothorax (2).

Conclusions

SMC with extreme pain is a rare complication after thoracotomy. PRF targeting the intercostal nerves through angulus costae could provide long-term efficacy of analgesia, decreased frequency and range of spontaneous muscle contraction and eventually improved quality of life for the patient.

References


