Brief Commentary

Spontaneous Muscle Contraction with Extreme Pain after Thoracotomy Treated by Pulsed Radiofrequency

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Background: Chronic post thoracotomy pain (CPTP) was a common complication after thoracotomy, while spontaneous muscle contraction (SMC) was very rare. Neuropathic pain components appeared in some CPTP patients. The patients with neuropathic pain (NPP) often suffered from more severe pain.

Objective: We presented a case of a 57 year- old Chinese male, suffering from SMC with extreme chronic pain after thoracotomy for 2 years. The patient was treated by pulsed radiofrequency (PRF). Then we reviewed the related progresses including recent view on NPP in CPTP, the possible mechanism of SMC, treatments for CTPT, and peripheral nerve treatments in NPP.

Study Design: Case report and review of the literature.

Methods: The patient was diagnosed as CPTP with SMC. After the experimental intercostal nerve block provided short-term analgesia, we performed PRF through the angulus costae on intercostal nerves under x-ray guidance. We performed PRF for 3 times in all, at an interval of 2 weeks. Then we had followed up the pain intensity, frequency and amplitude of SMC of this patient during the 2 years.

Results: The pain intensity decreased from 8 to 2 on the visual analogue scale (VAS). The frequency of muscle contraction was decreased by 90%, and the amplitude was decreased by 60%. The treatment also improved the patient's sleep quality. These improvements were stable in 2 years' follow-up. In our review of the literature, the SMC may be based on the pain-spasm-pain model.

Limitation: Single case report.

Conclusion: Pulsed radiofrequency provided good efficacy in CPTP with SMC in this case.

Key words: Chronic post-thoracotomy pain, pulsed radiofrequency, intercostal nerve, angulus costae, neuropathic pain, muscle spasm

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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.

The patient, a 57-year-old Chinese male, underwent lung cancer resection surgery in 2009. The patient suffered consistent severe pain immediately after the surgery. Two years after the surgery the patient still felt throbbing, prickling and numbing pain around the surgical scar which is located near the intercostal nerves from T5 to T6. Allodynia existed in these areas, and the degree of pain was scored as 8 on a 10-point visual analogue scale (VAS). Nocturnal pain greatly decreased the patient's sleep quality. In addition, SMC around the surgical scar developed in this patient, the frequency of

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 occuring or persisting in the area of the thoracotomy incision for more than 2 months (3). The risk factors of CPTP include female,

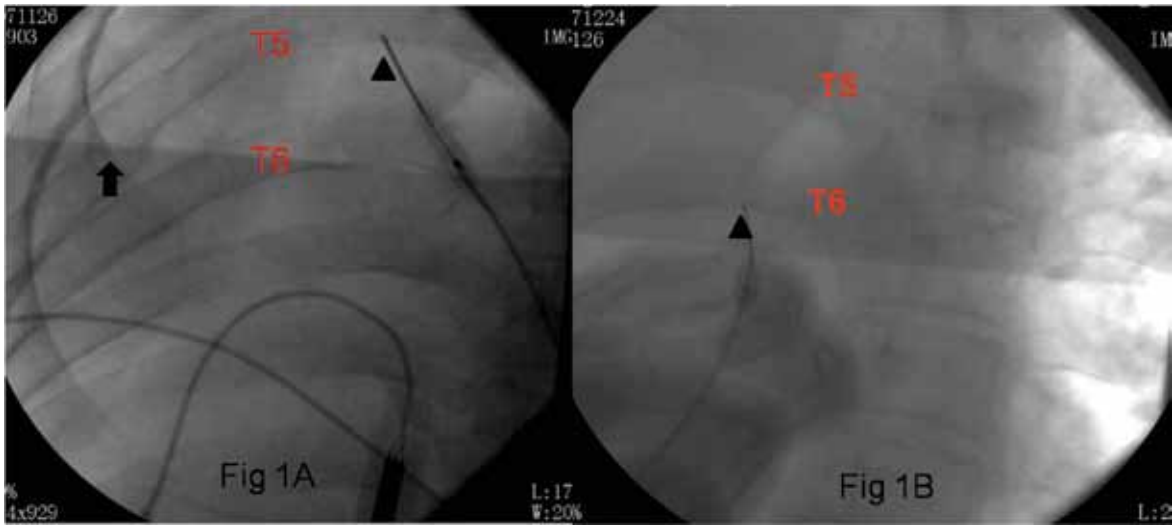

Fig 1. *The digital figures captured during the intervention: The old rib fracture after the thoracotomy (arrowed in Fig 1A), the exposed tip on the intercostal nerve through angulus costae of T5 (arrowhead in Fig 1A) and T6 (arrowhead in Fig 1B).*

age < 60 years old, prolonged duration of post-operative chest tube drainage, post operative pain management, hypertension, extensive surgery, radiotheraphy 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 dermal, 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

1. 1. Roy C, Chatterjee N, Ganguly S, Sengupta R. Efficacy of combined treatment with medial branch radiofrequency neurotomy and steroid block in lumbar facet joint arthropathy. *J Vasc Interv Radiol* 2012; 23:1659-1664.
2. Ke M, Yinghui F, Yi J, Xeuhua H, Xiaoming L, Zhijun C, Chao H, Yingwei W. Efficacy of pulsed radiofrequency in the treatment of thoracic postherpetic neuralgia from the angulus costae: A randomized, double-blinded, controlled trial. *Pain Physician* 2013; 16:15-25.
3. Graybill J, Conermann T, Kabazie AJ, Chandy S. Spinal cord stimulation for treatment of pain in a patient with post thoracotomy pain syndrome. *Pain Physician* 2011; 14:441-5.
4. Peng Z, Li H, Zhang C, Qian X, Feng Z, Zhu S. A retrospective study of chronic post-surgical pain following thoracic surgery: Prevalence, risk factors, incidence of neuropathic component, and impact on qualify of life. *PLoS One* 2014; 9:e90014.
5. Steegers MA, Snik DM, Verhagen AF, van der Drift MA, Wilder-Smith OH. Only half of the chronic pain after thoracic surgery shows a neuropathic component. *J Pain* 2008; 9:955-961.
6. Gottschalk A, Cohen SP, Yang S, Ochroch EA. Preventing and treating pain after thoracic surgery. *Anesthesiology* 2006; 104:594-600.
7. Guastella V, Mick G, Soriano C, Vallet L, Escande G, Dubray C, Eschalier A. A prospective study of neuropathic pain induced by thoracotomy: Incidence, clinical description, and diagnosis. *Pain* 2011; 152:74-81.
8. Miller TM, Layzer RB. Muscle cramps. *Muscle Nerve* 2005; 32:431-442.
9. Matsutani N, Kawamura M. Successful management of postoperative pain with pregabalin after thoracotomy. *Surg Today* 2014; 44:712-715.
10. Joshi GP, Bonnet F, Shah R, Wilkinson RC, Camu F, Fischer B, Neugebauer EA, Rawal N, Schug SA, Simanski C, Kehlet H. A systematic review of randomized trials evaluating regional techniques for postthoracotomy analgesia. *Anesth Analg* 2008; 107:1026-1040.
11. Kirvela O, Antila H. Thoracic paravertebral block in chronic postoperative pain. *Reg Anesth* 1992; 17:348-350.
12. Fabregat G, Asensio-Samper JM, Palmisani S, Villanueva-Perez VL, De Andres J. Subcutaneous botulinum toxin for chronic post-thoracotomy pain. *Pain Pract* 2013; 13:231-234.
13. Tamimi MA, Davids HR, Langston MM, Krutsch J, Yakovlev A, Barolat G. Successful treatment of chronic neuropathic pain with subcutaneous peripheral nerve stimulation: Four case reports. *Neuromodulation* 2009; 12:210-214.
14. Freynet A, Falcoz PE. Is transcutaneous electrical nerve stimulation effective in relieving postoperative pain after thoracotomy? *Interact Cardiovasc Thorac Surg* 2010; 10:283-288.
15. Goyal GN, Gupta D, Jain R, Kumar S, Mishra S, Bhatnagar S. Peripheral nerve field stimulation for intractable post-thoracotomy scar pain not relieved by conventional treatment. *Pain Pract* 2010; 10:366-369.
16. Cohen SP, Sireci A, Wu CL, Larkin TM, Williams KA, Hurley RW. Pulsed radiofrequency of the dorsal root ganglia is superior to pharmacotherapy or pulsed radiofrequency of the intercostal nerves in the treatment of chronic postsurgical thoracic pain. *Pain Physician* 2006; 9:227-235.
17. Akkaya T, Ozkan D. Ultrasound-guided pulsed radiofrequency treatment of the intercostal nerve: Three cases. *J Anesth* 2013; 27:968-969.
18. Campbell JN, Meyer RA. Mechanisms of neuropathic pain. *Neuron* 2006; 52:77-92.
19. Qin W, Tian J, Bai L, Pan X, Yang L, Chen P, Dai J, Ai L, Zhao B, Gong Q, Wang W, von Deneen KM, Liu Y. FMRI connectivity analysis of acupuncture effects on an amygdala-associated brain network. *Mol Pain* 2008; 4:55.
20. Bari AA, Pouratian N. Brain imaging correlates of peripheral nerve stimulation. *Surg Neurol Int* 2012; 3:S260-S268.
21. Vallejo R, Tilley DM, Williams J, Labak S, Aliaga L, Benyamin RM. Pulsed radiofrequency modulates pain regulatory gene expression along the nociceptive pathway. *Pain Physician* 2013; 16:E601-613.

22. Wu B, Ni J, Zhang C, Fu P, Yue J, Yang L. Changes in spinal cord met-enkephalin levels and mechanical threshold values of pain after pulsed radio frequency in a spared nerve injury rat model. *Neurol Res* 2012; 34:408-414.
23. Silberstein SD, Dodick DW, Saper J, Huh B, Slavin KV, Sharan A, Reed K, Narouze S, Mogilner A, Goldstein J, Trentman T, Vaisma J, Ordia J, Weber P, Deer T, Levy R, Diaz RL, Washburn SN, Mekhail N. Safety and efficacy of peripheral nerve stimulation of the occipital nerves for the management of chronic migraine: Results from a randomized, multicenter, double-blinded, controlled study. *Cephalalgia* 2012; 32:1165-1179.
24. Ma K, Zhou QH, Xu YM, Xu T, Du DP, Huang X, Jiang W. Peripheral nerve adjustment for postherpetic neuralgia: A randomized, controlled clinical study. *Pain Med* 2013; 14:1944-1953.
25. Love-Jones SJ, Besson M, Steeds CE, Brook P, Chizh BA, Pickering AE. Homotopic stimulation can reduce the area of allodynia in patients with neuropathic pain. *Eur J Pain* 2009; 13:942-948.
26. Guo L, Kubat NJ, Isenberg RA. Pulsed radio frequency energy (PRFE) use in human medical applications. *Electromagn Biol Med* 2011; 30:21-45.
27. Nagda JV, Davis CW, Bajwa ZH, Simopoulos TT. Retrospective review of the efficacy and safety of repeated pulsed and continuous radiofrequency lesioning of the dorsal root ganglion/segmental nerve for lumbar radicular pain. *Pain Physician* 2011; 14:371-376.