Original Article

Intercostal Nerves Pulsed Radiofrequency for Intractable Neuralgia Treatment in Athletes with Sport Trauma of the Chest: A Case-Series Study

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Abstract

Background: Athletes with trauma to the chest could be injured and suffer from an acute disturbing chest wall pain due to intercostal neuralgia. Pulsed radiofrequency (PRF) is an emerging safe therapy in many neurologic pain syndromes. **Objectives:** This study aimed to determine the effect of PRF on intercostal neuralgic pain in athletes complaining of severe chest pain and limited range of motion. **Materials and Methods:** This case-series study was conducted on athlete patients who suffered from severe chest pain that has limited their function. Eighteen athletes who were absent from physical training and sports activity due to intercostal neuralgia in their current season were admitted to our pain clinic. Intercostal nerve PRF was used to treat patients. Pain scale and return to sports activity were measured after PRF. **Results:** The mean time of absence from sports activity was 1.3 ± 0.6 weeks. The mean score of pain severity (numeric rating scale [NRS]) was 8.46 ± 1.85. In this study, 16 of 18 (88%) patients had effective pain relief (NRS <3) after PRF therapy. Besides, the NRS scores reduced by at least 90% in 16 of 18 (88%) patients as compared to the baseline. The mean NRS score was followed-up for 4 weeks. The scores significantly decreased at 1 ($P = 0.001$), 2 ($P = 0.0015$), and 4 ($P = 0.0002$) weeks following PRF compared to pre-PRF time. **Conclusions:** Pulsed radiofrequency is a suitable therapy for athletes with intercostal nerve entrapment pain, which provides adequate and quick pain relief, thus enabling them to resume their sport activities.

Keywords: Athletic injuries, intercostal nerves, neuralgia, pulsed radiofrequency treatment

Introduction

Athletes with trauma to the chest could be injured and suffer from an acute disturbing chest wall pain due to intercostal neuralgia. This pain could severely interrupt athletes' trainings and matches and cause absence from their season. Intercostal neuralgia could be induced by intercostal nerve entrapment, which can give rise to dull chest pain indistinguishable from the pleuritic chest pain. Furthermore, intercostal nerve entrapment can be caused by an overgrown callus from a fractured rib. The athletes with intercostal neuralgia have a history of recent or remote chest trauma or fractured rib.

The exact pathophysiology remains unknown, but this is mostly due to chest trauma during physical activities. In addition, athletes may be subjected to sudden large loads of indirect forces or overuse. Stress fractures of the ribs caused by sport activities have been extensively reported. Intercostal neuralgia pain is so severe that in many cases, athletes have to sit on the sidelines due to their troublesome chest pain.

The period of recovery after conservative therapies such as physical therapy is too long, which means athlete should rest for months before returning to the competition. This could endanger their career and costs would be disastrous to the clubs. Corticosteroid injection may also be useful in few cases. However, corticosteroids are in the list of drugs banned in athletes determined by the World Anti-Doping Agency, in which administration of any steroids is prohibited and requires

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a therapeutic use exemption. Short-term pain relief can be achieved by intercostal nerve blocks, which can be used as diagnostic tools for chest wall pain.[1]

Pulsed radiofrequency (PRF) is an emerging therapy in many neurologic pain syndromes. This is a safe option without risk of doping or delayed treatment.[2,3] The produced heat can be cooled off, since the high-frequency current is delivered in short burst intervals. The output of the generator is arranged in a way that the electrode tip temperature does not surpass 42°C.[4]

Objectives

This study aimed to determine the effect of PRF on intercostal neuralgic pain in athletes complaining of severe chest pain and a limited range of motion.

Materials and Methods

The review board of the university and the Ethics Committee of the hospital approved the present study. The subjects were thoroughly informed about the study in both verbal and written forms. Written informed consent forms were also obtained from the participants before enrollment in the study.

Patient selection

This was a consecutive case-series cross-sectional study that included patients among the professional soccer players who had a history of chest rib trauma during their sports activity which induced a dull referred pain which may origin from the chest wall, thoracic spine costochondritis, sternocostal joint sprain, intercostal muscle strain, rib stress fracture, or side strain. However, this was not a sharp pain such as rib fracture, and there was no localized tenderness on the ribs. Besides, there should be no obvious lesion on chest imaging.

Duration of pain in the patients should have been at least 3 weeks; the pain was not reduced after the conservative therapy and limited the patients' activity. Eighteen athletes who were absent from physical trainings and sport activities due to intercostal neuralgia in their current season were admitted to our pain clinic. All the patients had a history of conventional therapies (physiotherapy or pharmacotherapy) before including in the study. Besides, pain was resistant to those conservative treatments. All other complications were ruled out and all needed workups; imaging and laboratory tests were negative before inclusion in the study. Then, patients were candidates for intercostal PRF.

Pulsed radiofrequency

The applications of PRF using a NeuroTherm (NeuroTherm, Inc., Middleton, MA, USA) PRF generator were made under the guidance of C-arm fluoroscopy by the same person for all patients. Of note, the common applied approach for the guidance is an ultrasound-guided method.[5-7]

The patients were positioned prone, with their hands under their heads. Ultrasonography was performed to determine rib blockage at the posterior axillary line. The physician applied the index and middle fingers on the rib to specify the needle insertion region. Afterwards, an antiseptic solution and local anesthetics were used for preparing the skin. After prep and drape, a linear high frequency ultrasound transducer is then placed in the longitudinal plane over the rip. Then, a 22-gague and 54-mm radio-frequency needle with a straight tip (4 mm) is advanced from the inferior border of the ultrasound transducer using an in-plane approach with the trajectory being adjusted parallel to the nerve. Once a needle reaches the bone,it is walked inferiorly under the rib and moved forward. By this maneuver, the needle was positioned close to the costal groove, which includes the intercostal nerve, artery, and vein. After confirmation of proper needle placement with fluoroscopy, sensory stimulation was performed at 50 Hz (2 V). Proper placement of the needle caused paresthesia in the target intercostal nerve. As soon as a suitable pattern of stimulation was recognized, PRF lesioning was performed through heating five times at a temperature of 42°C for 90 s.

Pain and function measurements

A numeric rating scale (NRS) was used for pain assessment. Pain score (NRS) and function were measured by an orthopedic and sport medicine surgeon blinded to the procedure that we used for the patients.

Results

Eighteen athlete patients with chest pain and diagnosis of intercostal neuralgia were referred to our clinic. Diagnosis was made by our orthopedic surgeon. Age, sex, body mass index, and other demographic features of the subjects are presented in Table 1. The mean age of the participants was 23.4 ± 8.6 years (range = 17–38 years). The mean time of absence from sport activity was 1.3 ± 0.6 weeks. The mean score of pain severity (NRS) was 8.46 ± 1.85. All the patients had conventional therapies (physical therapy or pharmacotherapy) before participating in the study but the therapies were not effective.

Effective pain and functional relief after pulsed radiofrequency

In our study, 16 out of 18 (88%) patients had effective pain relief (NRS < 3) after the PRF therapy. Besides, the NRS scores decreased by at least 90% in 16 of 18 (88%) patients compared to the baseline. The mean NRS score was followed-up for 4 weeks. Based on the findings, the NRS scores significantly decreased at 1 ($P = 0.001$), 2 ($P = 0.0015$), and 4 ($P = 0.0002$) weeks after PRF compared to the pre-PRF period [Figure 1].

All 16 patients who responded to the PRF therapy were returned to their normal physical activity during 48 h after the PRF procedure. No early- or late-term complications including neuritis and dysesthesia were observed in any of the patients.

Discussion

This cross-sectional case series demonstrates the efficacy of

Table 1: Mean pain numerical rating scale at 4 weeks of follow-up after pulsed radiofrequency in athletes with intercostal neuralgia

	PRF (n=28)
Age, year	23.4±8.6
Sex (male/female)	28/0
BMI	21.4±2.5
Severity of pain (NRS)	8.46±1.85
Duration of pain (weeks)	1.5±0.8
Duration of missed activity (weeks)	1.3±0.6

NRS: Numeric rating scale, PRF: Pulsed radiofrequency

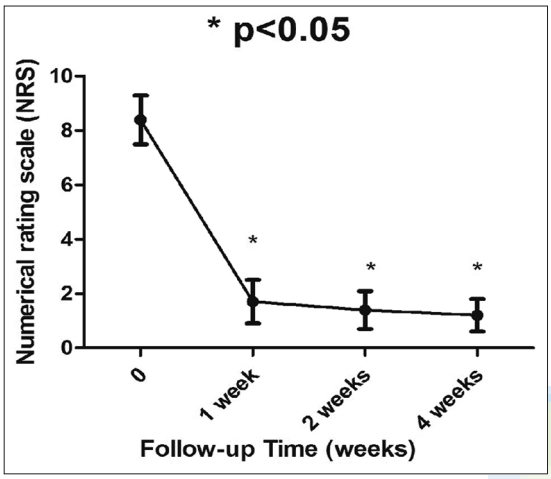

Figure 1: Mean pain numerical rating scale at 4 weeks of follow-up after pulsed radiofrequency in athletes with intercostal neuralgia

PRF to treat intercostal neuralgia in athletic patients who are injured and absent from their sport activity due to severe, intolerable chest pain. PRF, as a minimally invasive strategy, has been used effectively for overcoming neuropathic pain.

In this study, athlete patients had too severe chest pain, due to intercostal neuralgia, to perform any sport activity. Conservative therapies such as physiotherapy or pharmacotherapy were not effective in these patients when they were referred to our clinic. All of our 18 athlete patients had suffered severe intractable chest pain for a few days. The severity of pain was measured above 8 of 10 in majority of these athletes, limiting their range of motion.

Our athlete patients showed significant improvement and pain relief after the PRF therapy. Radiofrequency can be effectively used to treat chronic pain. Evidence have shown that the use of RF and PRF for neuralgic pain is gradually gaining strength.[5] Several recent RCTs have provided solid evidence on the effectiveness of PRF in the treatment of lumbar facet pain,[6,7] cervical facet,[8] SI joint,[9] and trigeminal neuralgia.[10] In addition, PRF could provide faster recovery and increase the range of motion.[11,12] PRF lacks the systemic side effects seen with medications; for PRF procedure, therapeutic effects in neuralgic pains are longer lasting than local anesthetic blocks and steroid injection; besides, the recovery time is much shorter. Quick recovery time is an important issue for athletes.

For this study, 18 athlete patients with chest pain due to intercostal neuralgia were treated with PRF, and 88% of them experienced quick pain relief. The rib at the level to be done PRF is identified by palpation exam. All treated athletes were able to resume their training from the next day, with adequate pain relief for their sport activity, even attending a physical competition such as professional soccer match. Besides, none of the patients had recurrence of pain during the 2-week follow-up. The results demonstrated that PRF application on the posterior axillary line can have appropriate coverage on this acute traumatic pain. Of interest, two latter patients who did not get the result by the PRF trail were both treated with more medical treatments and procedures (e.g., using the corticosteroid therapy).

A study by Wu *et al*. indicated that application of PRF in the suprascapular nerve, complemented with physical therapy, led to more effective and rapid pain alleviation, decreased morbidity, and increased mobility in comparison with physical therapy alone; the observed influence continued for at least 12 weeks.[13]

The effectiveness of intercostal PRF was estimated in about 88% of our athlete patients. Intercostal PRF is more efficient compared to intercostal nerve blocks using steroids and local anesthetics. In a study by Gulati *et al*., pain alleviation increased in 79% of individuals receiving intercostal nerve blocks (using local anesthetics and steroids); furthermore, 22% of the subjects experienced prolonged pain relief (average, 21.5 days).[14]

Overall, PRF allows thermal dissipation through reaching a temperature of 42°C–43°C, thereby causing a transitory damage, which only influences C group fibers in charge of pain conduction.[4,15] Evidently, development of electromagnetic fields using RF currents changes the transfer of C group fibers possibly through altering the activity of sodium channels and c-Fos expression in the posterior gray column.[16]

To date, different *in vitro* and *in vivo* studies have been performed to determine the mechanism of action in PRF to identify and promote the effectiveness of such interventions for the management of radicular pain.[17] PRF is thought to create a neuromodulatory lesion rather than a destructive thermal lesion. It uses the same circuit as in thermal RF. However, the current is applied in brief pulses and at a temperature lower than 42°C, to avoid heating the target nerve.[18] Therefore, it does not cause thermal lesions and any nerve destruction.

PRF induces neuromodulation instead of neurodestruction; on the other hand, conventional RF (CRF) induces neurodestruction. Akkaya and Ozkan used CRF successfully applied in treating intercostal neuralgia.[19] According to this study, although radiofrequency thermocoagulation (RFTC) can be effectively used for the management of chronic pain, thermal degeneration of tissues around the nerves is possible. Thermal or CRF creates thermal neurodestruction. Although conventional RFTC has been efficiently used in the treatment of intercostal neuralgia, it is a neurodestructive

method.[20] Compared to thermal CRF, PRF avoids possible complications of postprocedure neuritis, motor dysfunction, and deafferentation pain. As a matter of fact, destruction could cause neuritis and dysesthesia and other side effects. In addition, PRF greatly reduces or even eliminates the risk of neuritis, which is induced by the degeneration of nerve tissues. However, since no obvious nerve tissue destruction was observed, the mechanism of neuromodulation was speculated to account for the rapid pain alleviation.[21]

One limitation of our study is that we did not compare PRF with any other methods in these athlete patients since implementation of controlled, double-blind studies on chronic pain can be troublesome among athletes, as they are too valuable for their clubs to be allowed to undergo such trials.

Conclusions

Pulsed radiofrequency is a suitable therapy for athletes with intercostal nerve entrapment pain, which provides adequate and quick pain relief, thus enabling the athletes to resume their sport activities.

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Conflicts of interest

There are no conflicts of interest.

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