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CLINICAL REPORT

Pulsed radiofrequency treatment within brachial plexus for the management of intractable neoplastic plexopathic pain

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Abstract We report on the use of pulsed radiofrequency (RF) within the plexus for the management of intractable pain in three patients with metastatic or invasive plexopathy. The patients were a 38-year-old woman with a history of breast cancer 6 years earlier whose computed tomography (CT) scans revealed a mass lesion at the infraclavicular part of the right brachial plexus, a 68-year-old man diagnosed with advanced lung cancer whose CT scans revealed a bone metastasis in the right humerus invading the axillary region of the right brachial plexus, and a 67-year-old woman diagnosed with advanced lung cancer whose CT scans revealed a bone metastasis in the left humerus invading the axillary region of the left brachial plexus. Ultrasound-guided pulsed RF was performed within the interscalene brachial plexus. During the follow-up period, their intractable pain was moderately controlled.

Keywords Pulsed radiofrequency · Metastatic or invasive brachial plexopathy · Intractable pain

Introduction

Neoplastic brachial plexopathy is a known, rare, late-stage complication of cancer [1, 2]. Since this form of plexopathy can lead to severe and intractable pain at times, a multimodality approach to alleviate this pain is necessary, such as an adequate use of opioids, antidepressants, and gabapentin, local and regional blocks, sympathectomy. and rhizotomy [1, 3].

In recent years the procedure of pulsed radiofrequency (RF) has been providing anecdotal benefits for the management of chronic and intractable pain conditions [4]. Although pulsed RF dramatically reduces neuropathic pain, chronic pain, and vertebral metastatic pain [4–7], there is no published data on application within the interscalene brachial plexus for metastatic brachial plexopathy. Here we report the cases of three patients who suffered from uncontrolled pain due to neoplastic brachial plexopathy whose pain we successfully treated by pulsed RF.

Case report 1

A 38-year-old woman complained of pain and progressive weakness in her right upper extremity. Her history included breast cancer 6 years earlier, which had been treated with modified mastectomy, axillary node dissection, and chemotherapy. Computed tomography (CT) imaging revealed a nodular lesion in the right axilla. Following consultation with a radiation oncologist, the patient received a 4,000-cGy dose of radiotherapy and chemotherapy. Despite these treatments, the nodular lesion gradually grew. Our clinic was then consulted for the treatment of intractable pain in the upper extremity and shoulder on the right side. The patient was administered 20 mg of long-acting oxycodone every 8 h, 30 mg of long-acting morphine once a day, 75 mg of pregabalin every 8 h, 10 mg of imipramine twice a day, and 20 mg of oral ketamine twice a day. She complained of a continuous tight feeling of pain described on a numerical rating scale (NRS) of pain intensity as 9/10 (NRS from 0 to 10; 0 = no pain; 10 = worst pain imaginable). CT imaging revealed a growing mass lesion at the

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infraclavicular part of the right brachial plexus (Fig. 1). The region innervated by C6–8 showed sensory disturbance, and in an intensity rating of motor function, based on a manual muscle test on a scale from 0 (no movement) to 5 (normal), the patient reported a score of 0/5 for biceps, 0/5 for triceps, and 0/5 for brachioradialis. She complained of a tight feeling of pain at the region innervated by C6–8. An interscalene brachial plexus block with 10 ml of Lidocaine 2 % and 40 mg of methylprednisolone were then administered, which provided temporary relief (NRS = 2) for 2 days.

For the RF procedure, the patient was positioned in the left semilateral position with the neck extended to facilitate guidance by ultrasonography (US). After the skin had been sterilized with chlorhexidine, a RF needle with a 5-mm active tip (KT, guiding needle; Hakko Co., Tokyo, Japan) was inserted in-line with the ultrasound probe in the transverse plane. While the two outermost nerve roots of C5 and C6 between the anterior and the middle scalene muscles were visible [8], the needle was guided and the location of the needle tip was confirmed to be very close to the root of C6 using not only US imaging but also electrostimulation. The needle was connected to a RF generator (JK-3; Neurotherm, Morgan Automation, Liss, Hampshire, UK). With an output of <0.3 V, the patient felt a sensation in the C6 region with electrostimulation at 50 Hz, and there were weak contractions of the deltoid muscle with electrostimulation at 2 Hz [5]. The pulsed RF consisted of the passage of an RF current of 2 Hz at 40 V with 20-ms-long active periods and 480-ms-long silent periods. The pulsed RF treatment within the interscalene brachial plexus consisted of two sets of RF current for 2 min, whereby the temperature at the needle tip did not exceed 42 °C [5]. The patient did not experience any post-procedure complications and subsequently reported that her pain had markedly decreased (to an intensity rating score of 3/10 on the NRS) in the absence of any changes in her sensory disturbance and motor function. While taking the same dose of analgesics as originally prescribed, she maintained a NRS score of 3/10, and her breakthrough pain was well controlled with oral rescue oxycodone during the 3-month follow-up period.

Case report 2

A 68-year-old man complained of pain and numbness from the right shoulder to the right hand. He was diagnosed with advanced lung cancer, and CT imaging revealed a bone metastasis in the right humerus that had invaded the axillary region of the right brachial plexus (Fig. 2). He reported burning or shooting pain which he assessed as 9/10 on the NRS. Following consultation with a radiation oncologist, the patient was scheduled for radiotherapy (3,000 cGy dose) and chemotherapy. Simultaneously, he was administered 20 mg of oxycodone, 400 mg of gabapentin, and 10 mg of imipramine every 12 h, which caused severe nausea and provided inadequate pain relief. Our clinic was then consulted for the treatment of intractable pain in the upper extremity and shoulder on the right side. He complained of continuous shooting pain which he described as 6/10 on the NRS. The region innervated by C5–8 showed sensory disturbance, and in an assessment of motor function, based on a manual muscle test, as described in previous section, the patient reported an score of 5/5 for biceps 4/5, 4/5 for triceps, and 4/5 for brachioradialis. He complained of shooting pain at the region innervated by C5–7. He underwent the same RF procedure described in the previous section. The patient did not experience any post-procedure complications and subsequently reported

Fig. 1 Computed tomography (CT) image of a growing mass lesion at the infraclavicular part of the right brachial plexus (*arrow*)

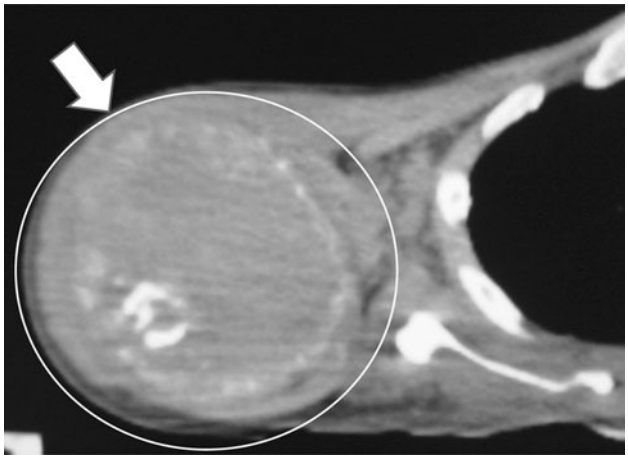

Fig. 2 Computed tomography image of a bone metastasis invading the axillary region of the right brachial plexus (*arrow*)

that his pain had markedly decreased (to a score of 1/10 on the NRS), with an increased intensity rating of 5/5 for his motor function but no changes in his sensory disturbance. While taking the same dose of analgesics as before the RF procedure, he maintained a NRS score of 1/10 during the 2-month follow-up period. Three months after the RF procedure, he began suffering from uncontrollable pain with a NRS score of 6/10. Following a second RF procedure, he reported that his pain had markedly decreased to a NRS of 1/10, and he maintained a NRS score of 1/10 during the 1-month follow-up period.

Case report 3

A 67-year-old woman diagnosed with advanced lung cancer complained of pain and numbness in her left upper arm. CT imaging revealed a bone metastasis in the left humerus that had invaded the axillary region of the left brachial plexus (Fig. 3). She reported shooting pain with an intensity rating of 6/10 on the NRS. Following consultation with a radiation oncologist she was scheduled for radiotherapy (3,000 cGy dose) and chemotherapy. Simultaneously, she was administered 10 mg of oxycodone, 400 mg of gabapentin, and 10 mg of imipramine every 12 h, which caused moderate nausea and provided inadequate pain relief. Our clinic was then consulted for the treatment of intractable pain in the upper extremity on the left side. She complained of continuous shooting pain which she assessed as 6/10 on the NRS. The region innervated by C6–8 showed sensory disturbance, and in an assessment of motor function, based on a manual muscle test, as described in previous section, the patient reported a score of 5/5 for biceps, 4/5 for triceps, and 5/5 for brachioradialis. She complained of shooting pain at the region innervated by C6 and underwent the same procedure as described in the previous section. The post-procedure period was without complications, and the patient reported that her pain had markedly decreased to an intensity rating of 0/10 on the NRS without any change in sensory disturbance and motor function. During the 3-month follow-up period, her NRS maintained a score of 0/10 with the same dose of analgesics that she had previously received.

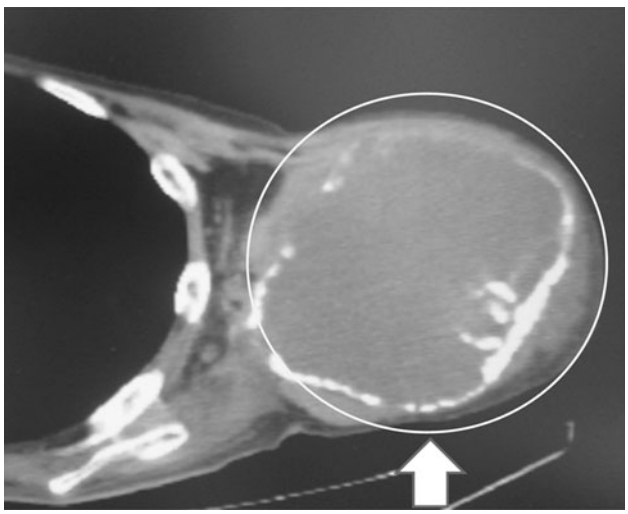

Fig. 3 Computed tomography image of a bone metastasis invading the axillary region of the left brachial plexus (*arrow*)

Discussion

This is the first report in which one nerve root within the interscalene brachial plexus of pulsed RF provided much longer pain relief of the widespread region innervated by a few or several nerve roots. Neoplastic brachial plexopathy is a known, rare, late-stage complication of cancer, especially at the time of regional progression of the primary breast cancer [1, 2]. Although the frequency of neoplastic brachial plexopathy is considerably low (an incidence of less than 0.5 %), pain is the most common symptom [1, 9]. Since the plexopathy leads to severe and intractable pain at times, a multimodality approach is necessary [1, 3]. Radiochemotherapy is also recommended [2, 9]. When these treatments do not provide adequate pain relief, more invasive procedures, including radiculotomy, cordotomy, and RF ablation, are needed [1, 3].

Pulsed RF is applied to not only the dorsal root ganglion (DRG) but also to the peripheral nerve, which provides sound pain relief for several pain conditions for 2–6 months [4–7]. Studies using animal models have clarified the antinociceptive effects of pulsed RF on the DRG [10–12]. Pulsed RF applied to the DRG induces inhibition of excitatory c-fiber responses and a global reduction of evoked synaptic activity.

In contrast, the effects of pulsed RF applied to the peripheral nerve have not been confirmed. Several authors have reported that the antinociceptive actions induced by pulsed RF would be the enhancement of noradrenergic and serotonergic descending pain inhibitory pathways and the inhibition of excitatory c-fibers [13, 14]. However, we found that within the interscalene brachial plexus, only pulsed RF close to the root of C6 provided much longer pain relief of the widespread region innervated by C5–8. The most likely causes of RF pathologic lesions could be high electric fields and high current fields [15, 16]. Electric fields give birth to charged molecular structures that may cause their distortion and dislocation as well as the disruption of cellular function [16]. In addition, high current fields could influence cellular structures by inducing collisions of ions and molecules [16]. We thus postulate that in the patients described here, the electric fields and current

fields induced by pulsed RF would have relatively longer and more widespread effects on molecular structures of the peripheral nerves.

In conclusion, the pulsed RF procedure within the interscalene brachial plexus provided sound pain relief our three patients with intractable, neoplastic brachial plexopathy.

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