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Case Report

Using Pulsed Radiofrequency Ablation to Treat Pain Associated with a Tumor Involving the Brachial Plexus

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Pain associated with cancer is often difficult to treat, even more so when tumors involve peripheral nerves. Therapy is complex and often requires a multimodal approach that can include medications, radiation, and interventional techniques. These components are utilized with variable success, but are also limited by known complications or adverse effects.

We present the case of a 53-year-old woman with a metastatic axillary tumor that involved her brachial plexus. Attempts to control her pain with medication were unsuccessful despite escalation and use of adjunct agents. She was not deemed to be a surgical candidate due to the size and location of the tumor. Radiation was discussed but, obviously, would not work immediately. Our team decided to employ a brachial plexus catheter for continuous nerve block, which provided almost complete relief of pain. Since her pain was deemed to be of peripheral etiology, pulsed radiofrequency ablation of her brachial plexus was used for more long-term pain relief. The patient responded very well with minimal pain issues and no apparent complications. On follow-up, the patient had good relief for almost 2 months.

Pulsed radiofrequency is a poorly understood technology that has increasing evidence for certain pain conditions; however, for cancer and peripheral nerves the evidence is slim to none. Our case presents a successful use for pain management of a brachial plexopathy due to a tumor. We propose that pulsed radiofrequency may present a non-neurodestructive pain management technique for tumors involving peripheral nerves, though more data is definitely needed.

Key words: Pulsed radiofrequency, brachial plexopathy, brachial plexus, tumor, cancer, pain

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Tumors involving the brachial plexus are uncommon, but metastatic tumors leading to brachial plexopathy are extremely rare. They have an incidence below 0.5% and generally arise from breast and lung cancers (1). Pain tends to be a pervasive issue as patients commonly present in advanced stages and, due to location and tissues involved, the tumors are difficult to treat. Depending on the portion of the plexus involved, pain can be localized or involve the entire arm on the affected side. Treatment of the tumor usually involves radiation therapy, but chemotherapy and surgery can be used as well. Recommendations for pain management involve the use of analgesics, nerve blocks, and rarely spinal ablative and neurolytic techniques (1, 2). Unfortunately, analgesic use is limited by adverse effects and neurodestructive techniques are limited by potential loss of neurological function and deafferentation pain (2,3).

Pulsed radiofrequency ablation is a relatively newer technology that remains poorly understood; however, it is has been used to treat different pain pathologies (3-10). It has the advantage of providing prolonged pain relief without the condemning effects of neurodestructive techniques. There is little data regarding its use for peripheral nerves or cancer, so we present a case involving the efficacious use in a

woman with painful brachial plexopathy secondary to a metastatic tumor.

Case Report

A 53-year-old woman with a history of breast cancer was admitted with a painful new axillary mass. Four years earlier she had been treated with mastectomy, radiation, and chemotherapy. Imaging noted a new left axillary tumor that encompassed the subclavian artery and vein and the entire brachial plexus from the axilla to just distal of the scalene muscles (Figs. 1-2). She was also noted on imaging to have pulmonary and bony metastases. She was treated with multiple analgesics for pain, but due to inadequate control (8-10/10 VAS by patient [Visual analog scale 0 = no pain, 10 = worst pain imaginable]), the acute pain service was consulted. At the time, she was on Methadone 45mg daily, Gabapentin 1800mg daily, and a Morphine Patient Controlled Analgesia device (using from 20 to 100 mg IV daily). On interview, her only complaint was of severe pain throughout the left arm, described as burning and lancinating. She endorsed a history of increasing dysesthesias and weakness over the past 4 months and, currently, had no motor function of the left arm. Her opioid medication had been recently increased, but with no significant relieving effect.

After discussion with the oncology and palliative care team, it was determined that even with radiation and chemotherapy, it was not expected that she would have any return of motor function to the left arm due to the size (3.6 x 8.6 x 3.4 cm) and location of the tumor. In order to determine if her pain was due to peripheral neuralgia/neuropathy or deafferentation, we decided to place a left brachial plexus catheter for continuous nerve block. After consent, a catheter was placed using ultrasound guidance with a supraclavicular approach (interscalene approach was technically difficult due anatomical variance from the tumor). She was given a 10mL bolus of Lidocaine 2% and noted almost immediate relief, with VAS down to 0 – 2/10. This relief remained with a continuous infusion of Ropivicaine 0.2% at 8mL/hr.

Since it was established that her pain was peripheral in nature, we decided to proceed with radiofrequency ablation of her brachial plexus nerves. Even though it was not believed that she would have any return of motor function to the arm, we decided to try pulsed radiofrequency ablation prior to any neurodestructive technique in order to preserve any possibility. In anticipation of this, she was consented and her infusion was stopped the night before the radiofrequency procedure. The next morning, she noted return of pain to baseline and was taken to the operating room where the nerve catheter was removed. Using ultrasound guidance, we identified the brachial plexus trunks along the interscalene groove and placed a 20g,

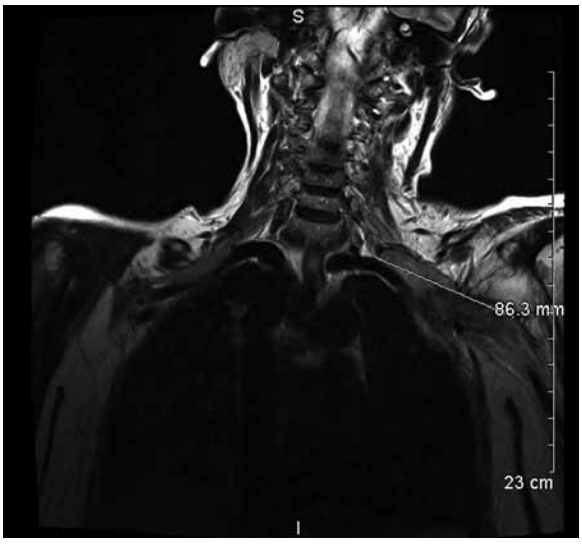

Fig. 1. *MRI image of tumor coronal.*

Fig. 2. *MRI image of tumor sagittal.*

100mm radiofrequency needle with 10 mm active tip (Smith and Nephew; Andover, MA) towards this location attempting to elicit her usual pain in the left arm with sensory stimulation at 50Hz aiming for a value below 0.5V. Once an appropriate site was identified, we performed pulsed radiofrequency using a temperature maximum value of 42°Celsius with 20ms pulse duration for a total of 90 seconds at each site. A total of 10 lesions were performed along the plexus trunks. After the last lesion and prior to removal of the needle, 10 mL of bupivicaine 0.25% was injected with appropriate spread along the trunks noted on ultrasound. There were no noted complications.

The next day, she reported minimal to no pain (VAS 0 - 2/10) and her opioids had to be titrated down due to oversedation. One day later, we repeated the pulsed radiofrequency procedure using the same technique for 10 lesions again in order to ensure that all trunks were equally affected. The patient was subsequently discharged to home a few days later on methadone 15 mg 3 times a day and gabapentin 900 mg 3 times a day.

On follow-up in the palliative care clinic one month later, she was doing well with minimal pain issues. Two months later, her pain had increased, now with radiation to the scapula, and repeat ablation was discussed.

Discussion

To our knowledge, this is one of the first reports regarding use of pulsed radiofrequency to the brachial plexus for pain relief. In addition, there are few reports of its use for cancer pathology as well.

Brachial plexopathy can be due to tumor invasion, radiation changes, chemotherapy, or trauma (1,11,12). Its incidence is low in general, but the incidence of plexopathy due to metastatic tumor is even rarer. Usually metastatic tumors involving the brachial plexus are due to primary breast or lung cancers. These patients often present in advanced stages and, thus, pain tends to be a debilitating issue. Patients afflicted are usually treated with high doses of opioids for pain; however, this can lead to adverse effects such as sedation, constipation, and nausea/vomiting. These complications often result in a poor quality of life in a patient with potentially limited time. Other treatment options involve the use of nerve blocks and, rarely, spinal ablative techniques and neurolysis (1,2). Unfortunately, neurodestructive techniques have been related to phantom pain, which can be just as distressing, if not more so (2). In addition, potential neuritis and deafferentation pain are possible adverse events (3). The ideal treatment modality would allow for pain relief with minimal adverse effects and impairment of function. Pulsed radiofrequency is a relatively new technology that can potentially fill this gap in the pain management armamentarium.

Conventional radiofrequency ablation has been used to treat pain for several decades; it does this through thermal destruction of nervous tissue, usually conducted up to 80° Celsius. The continuous application of radiofrequency energy leads to molecular oscillation with subsequent heat production. The heat leads to coagulation necrosis, Wallerian degeneration, and myelin sheath disruption of nerves (13,14). The procedure essentially "denervates" the pain generator; however, pain can return due to presumed inadequate nerve destruction or nerve regeneration. Initially, this technology was used for refractory trigeminal neuralgia but it has been used successfully for cervical and lumbar facet pain. Studies have shown efficacy with at least 50% reduction of facet mediated pain for up to one year or longer (6,13). The procedure has also been used for sacroiliac joint pain, but with an efficacy of shorter duration (15).

Pulsed radiofrequency ablation was conceived out of research that showed that thermal destruction was not necessary to affect pain relief. It presented potential for nerves that could not be destroyed without consequences, such as motor disturbance and deafferentation pain. The technique allows for heat dissipation, usually being applied up to 40 - 42° Celsius, by applying "pulses" of radiofrequency energy with intervening pauses. The mechanism of action is poorly understood, but is likely due to neuromodulation from electrical fields created. Evaluation of the technique using light and electron microscopy has found minimal neuronal damage compared to conventional radiofrequency (14), but alterations in mitochondria and microfilaments/microtubules have been seen, more so in C fibers (4,16). Signal interruption in small nerve fibers and alterations of c-fos levels in the dorsal horn have been seen as well (4,17,18). There is a paucity of literature regarding its use, but there are studies documenting its effective use for spinal facet pain (4,6,8), trigeminal neuralgia, cervical radicular pain (4,8), and chronic shoulder pain (3,4). For peripheral nerves and in cancer patients there are mostly anecdotal case reports regarding its use and efficacy (5,7,9,10,19). When used for purposes similar to conventional radiofrequency, it has been found to have long-lasting pain relief but usually not as long. For example, studies looking at lumbar facet pain have typically shown 3 – 6 months of relief with pulsed ra-

diofrequency ablation as opposed to 12 months with conventional (6,13). Generally, the modality has shown efficacy from weeks to years depending on the nerve treated (4,13,20), but since there are limited studies of its use, efficacy cannot truly be stated.

This case is an example of an efficacious use of pulsed radiofrequency to treat pain related to a malignant tumor. The patient had significant pain relief with decreased medication needs and no apparent impairment or complication from the procedure. There are very few reports of the technique being used for tumor related pain. One series described by Zeldin and Ioscovish (20) involved 3 patients with metastatic vertebral body or paravertebral tumors with similar results. The use of pulsed radiofrequency to the thoracic and lumbar dorsal root ganglia led to significant decreases in pain for 2 - 6 months. In addition, the use of pulsed radiofrequency ablation has not been described for the brachial plexus before to our knowledge, but similar uses described include to the cervical dorsal root ganglion for radicular pain and to the suprascapular nerve for shoulder pain (3,4,8). The use of conventional radiofrequency in our patient could have had similar pain relieving effects; however, it would have condemned her to permanent loss of motor function of her arm since her brachial plexus was involved. In addition, there was concern for potential deafferentation pain. Ultimately, this modality may present a new option for pain relief in complex cases such as this one.

There are limitations to this case report, it obviously involves only one patient and thus cannot be generalized to all patients with brachial plexopathy or tumor related pain. In addition, her pain relief only lasted about 2 months; however, it could be argued that her disease was likely worsening.

Conclusion

We propose that pulsed radiofrequency may present a non-neurodestructive pain management technique that can be applied to patients with pain due to peripheral nerve injury from malignancy.

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