

CERVICAL MEDIAL BRANCH RADIOFREQUENCY ABLATION USING BIPOLAR MULTI-TINED CANNULAE IN A PATIENT WITH AN IMPLANTED CERVICAL SPINAL CORD STIMULATOR: A CASE REPORT

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Background: Cervical medial branch radiofrequency ablation (RFA) is an established treatment for chronic cervical facet joint pain. However, RFA procedures generate electromagnetic interference (EMI) that can pose a significant safety risk, potentially leading to spontaneous activation or damage of implanted electronic devices, such as spinal cord stimulators (spinal cord stimulation [SCS]). Previous reports have highlighted the successful use of conventional bipolar RFA, but data are limited regarding large-volume lesioning techniques in patients with SCS implants.

Case Report: A 70-year-old man, who had a prior C7-T1 fusion and an implanted cervical SCS for refractory radicular pain, presented with axial neck pain. Following confirmation via diagnostic medial branch blocks (MBBs), the patient underwent cervical medial branch RFA using a bipolar multi-tined cannula technique. Strict protocols, including turning off the SCS device and performing neurophysiological monitoring, ensured the procedure was completed safely without complications or device malfunction.

Conclusions: This case demonstrates the safe and effective application of bipolar multi-tined RFA, a large-volume lesioning technique, in a patient with a cervical SCS implant. This approach leverages bipolar configuration and minimizes current dispersion, offering clinicians an important alternative to mitigate EMI risks and achieve durable pain relief in this complex patient population.

Key words: Cervical, medial branch, radiofrequency ablation, spinal cord stimulation, multi-tined, bipolar

BACKGROUND

Chronic neck pain is a prevalent issue, with the cervical facet joints implicated as the primary source in 36-60% of patients, as determined by response to medial branch blocks (MBBs) (1-7). Cervical medial branch radiofrequency ablation (RFA) is a validated and commonly performed interventional technique for well-selected individuals who have failed a trial of conservative treatment after confirmation by diagnostic MBBs (8,9). The efficacy of cervical medial branch RFA was first demonstrated by Lord et al in 1996 and it is

supported by multiple systematic reviews and clinical practice guidelines (8-11). One hundred percent pain relief with dual comparative MBBs is the most reliable predictor of subsequent response to RFA; however, less stringent criteria are often employed (11). Similar responses to cervical medial branch RFA have been observed when utilizing comparative blocks with ≥80% relief as the cut-off and one guideline recommends 50% relief with a single block (9,12). Despite strong evidence for the utility of cervical medial branch RFA, it is ineffective for meaningfully reducing axial neck symptoms in

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approximately 49% of individuals, even when selected based on 100% relief of pain with dual comparative medial branch blocks (11). For those who do not respond to cervical medial branch RFA, intraarticular injections or therapeutic medial branch blocks can be attempted; although, the evidence is less robust, and they are not universally supported by all guidelines (8,12).

Concurrently, spinal cord stimulation (SCS) is a widely utilized therapeutic option for chronic pain, treating conditions such as persistent pain following cervical spine surgery, complex regional pain syndrome, and persistent spinal pain syndrome (13,14). The presence of an SCS device, which includes electrodes in the epidural space and an internal pulse generator (IPG) located subcutaneously, complicates RFA procedures (15). The electrical currents from RFA generate electromagnetic interference (EMI), risking unintended energy transfer that can cause device malfunction or spontaneous activation (15). This risk is evident in reports where patients experienced spontaneous SCS activation, resulting in severe pain and paresthesia, even when the device was officially turned off, especially when monopolar RFA techniques were employed (16,17).

To mitigate these risks, established guidelines recommend using bipolar RFA to minimize current dispersion, programming the IPG to "Surgery Mode" or turning it off, and employing continuous monitoring (15). While conventional bipolar RFA has been successfully reported in this patient population, the application of newer, large-volume lesioning technologies, such as bipolar multi-tined cannulae, has not been previously reported (18).

CASE REPORT

The patient is a 70-year-old man with persistent cervical facet-mediated pain requiring repeat RFA despite a prior C7-T1 fusion and an existing cervical SCS implant. The patient has a significant medical history, including asthma, hyperlipidemia, and chronic sinusitis. His current medications include amitriptyline, Oxycodone, ipratropium, salbutamol, rosuvastatin, montelukast, and cetirizine. In 2016, following a motor vehicle accident (MVC), he sustained a stable fracture at C3 and an unstable fracture at C7, necessitating a C7-T1 Anterior Cervical Decompression and Fusion (ACDF). Postoperatively, he developed severe C8 radicular pain that was refractory to standard conservative management, including physical therapy, medication management, and

epidural steroid injections. A cervical SCS was trialed and permanently implanted in 2022 for the management of these radicular symptoms. The SCS system consisted of a Medtronic Intellis™ implantable pulse generator and a Medtronic Vectris™ SureScan™ percutaneous lead with 8 contacts.

As his initial radicular symptoms improved, the patient developed axial neck pain, which was also refractory to conservative management. In late 2021, he demonstrated an adequate response to diagnostic MBBs at multiple levels: right C3, C4, and C5; and left Third Occipital Nerve (TON), C3, and C4.

Based on the successful diagnostic blocks, the patient initially underwent cervical medial branch RFA in March 2022, utilizing a bipolar lesioning technique with multi-tined electrodes, and returned for repeat treatment 6 times, approximately every 6 months thereafter, noting meaningful relief lasting about 6 months.

Prior to the most recent procedure, the patient was instructed to, and did, turn off his implanted spinal cord stimulator. The RFA employed a precise, fluoroscopy-guided technique utilizing multi-tined (Trident™) cannulae with 5-mm active tips. A perpendicular approach was taken, positioning the cannulae coaxial with the lateral fluoroscopic beam along anesthetized skin tracts immediately ventral and dorsal to the midpoint of each articular pillar (Fig. 1).

To ensure safety and proper placement, motor stimulation was conducted at 0.5, 1.0, and 1.5 V, and the patient was continuously encouraged to report any sensory or motor phenomena in his upper extremities. After testing, 1 mL of 1% lidocaine was injected through each cannula prior to delivering the lesion. Bipolar RFA was performed for 90 seconds at 80°C at each target level.

Following the completion of the RFA cycle, 1 mL of 0.25% bupivacaine was administered through each cannula before withdrawal. The patient subsequently turned his SCS device back on, and it continued to function without issue, validating the safety of the procedure. The procedure was well tolerated by the patient, with no immediate or short-term complications reported.

DISCUSSION

This case is noteworthy as it demonstrates the successful and safe use of a large-volume bipolar lesioning technique for treating cervical facet pain in a patient with a previously implanted cervical SCS device. It should

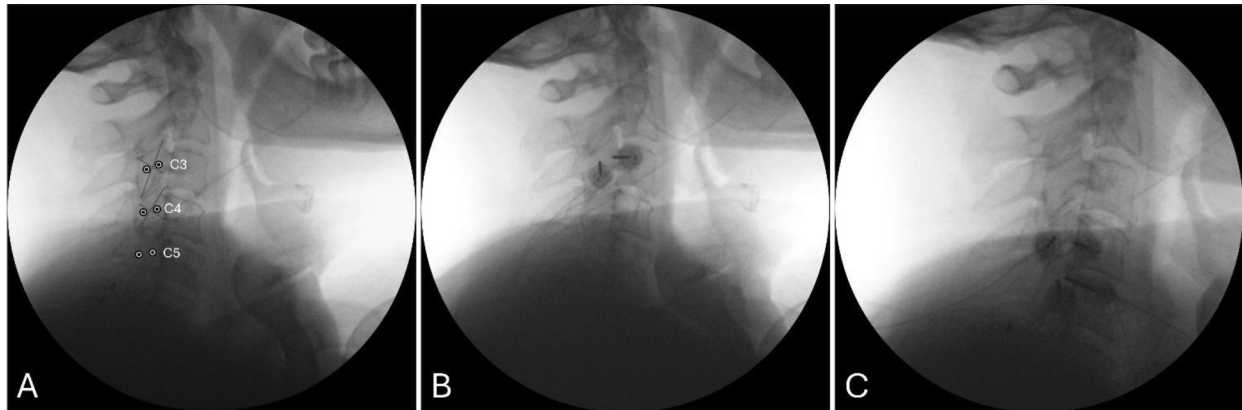


Fig. 1. Lateral fluoroscopic images depicting ideal target locations (A) and multi-tined (Trident™) cannulae in their final positions for the C3 (B), C4 and C5 (C) levels.

be noted that routine cervical medial branch RFA of more than 2 levels should be avoided due to the risk of head drop (19-21). In cases where more coverage is desired, the risks and benefits need to be carefully considered and a shared-decision making approach should be utilized with the patient (19-21).

Cervical RFA procedures necessitate rigorous safety precautions due to the risk of EMI interfering with implanted neuromodulation devices (15). Monopolar RFA, which uses an electrical current that travels across the patient's body to a distant grounding pad, has been associated with device malfunction and unwanted stimulation (15-17). By contrast, the use of bipolar RFA confines the flow of electrical energy to a short distance between the 2 active electrodes, significantly minimizing current dispersion and reducing the risk of interference with the SCS system (15,18).

The decision to use multi-tined cannulae, rather than conventional electrodes, aligns well with the need for safety in this unique patient population. Multi-tined electrodes produce a larger burn volume and a unique lesion morphology that makes the perpendicular approach feasible and reliable, whereas conventional electrodes are generally not recommended for this approach (9,22,23). Computer modeling shows that Trident cannulae create a conical lesion that extends beyond the active tip (24). Placing 2 trident cannulae in the configuration outlined in this case report theoretically creates 2 overlapping conical lesions along the course of the cervical medial branches, while confining the size of the electric field to the distance between the 2 electrodes (Fig. 2). This may further confine the electrical field and limit the chance of unintended energy transfer

compared to conventional electrode approaches previously described in the literature (18). This technique inherently minimizes but does not entirely eliminate the risk of EMI transmission to the SCS components while offering the clinical benefits associated with a larger lesion volume, such as decreased procedural time and reduced radiation exposure (22,23,25-27).

Aside from the type of electrode utilized, there are other factors the impact lesion volume (9). Pre-injection of fluid, ablation time, ablation temperature and the use of internally cooled electrodes all influence lesion volume (9,28). Ninety-second ablation time after a 30 second ramp time was utilized in the case, as previous research has demonstrated that 87% of maximal ablation volume can be achieved in 90 seconds, most of which occurs early in the ablation cycle (28). Although lesion size does increase further after 90 seconds; the additional time and patient discomfort may not be worth the marginal increase in lesion size (28). An 80°C ablation temperature was selected based on author experience and is concordant with the temperature utilized in 3 recent studies utilizing Trident canulae (22,25,26).

The clinical safety protocol followed in this case adhered to established recommendations for managing RFA in patients with implanted devices (15). Key safety measures implemented included confirming that the SCS was deactivated pre-procedure, using the bipolar technique to contain the electromagnetic field, and conducting motor stimulation testing to ensure the ablation field was safely distant from adjacent neurological structures. Absence of sedation allowed the patient to be communicative throughout the procedure, ensuring immediate reporting of any abnormal sensations or muscle contractions.

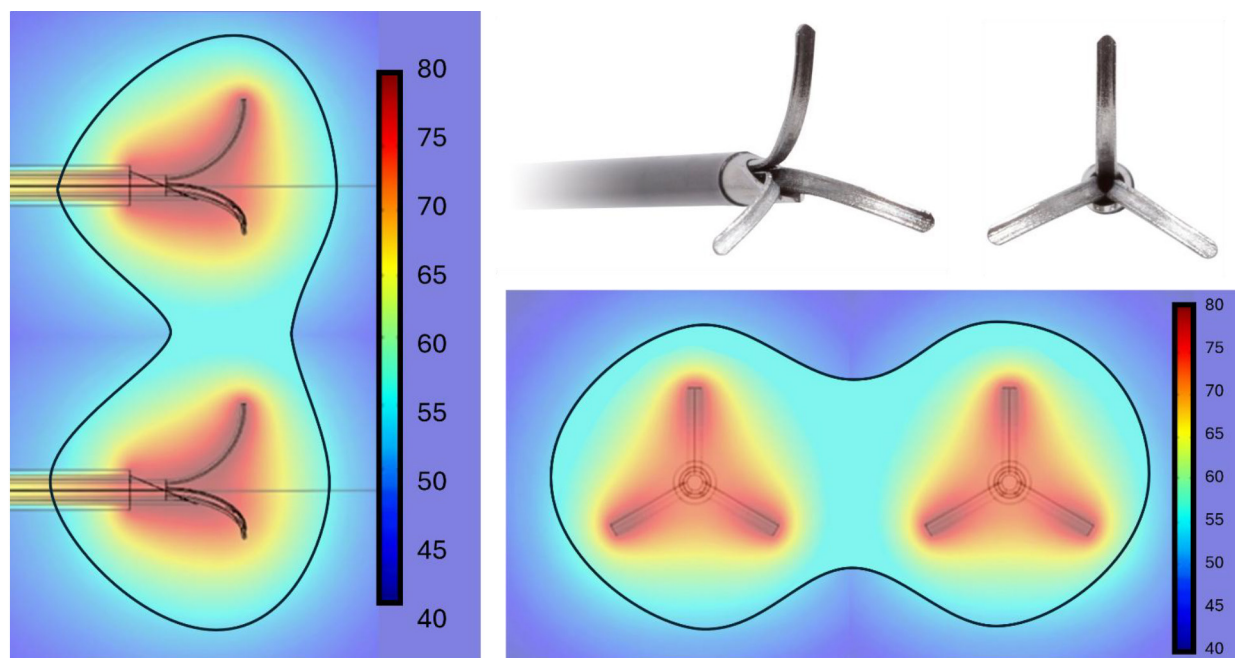


Fig. 2. An estimation of the unique lesion morphology created by 2 multi-tined electrodes placed in a bipolar configuration based on computer modeling of monopolar lesions (24).

Given that the patient has experienced successful pain relief lasting approximately 6 months following his repeat RFA procedures using this specific technique, this case supports that the bipolar multi-tined approach is both safe and effective in managing cervical facet joint pain in patients with cervical SCS implants. This clinical observation is consistent with data supporting the effectiveness of multi-tined RFA generally (22,23,25-27). Research, such as an ongoing prospective randomized controlled trial, continues to compare the effectiveness of perpendicular versus parallel RFA, which may further inform the use of this specialized technique (29). Furthermore, this technique may be employed in other scenarios where minimizing EMI is desired, including the presence of a deep brain stimulator, dorsal root ganglion stimulator, implantable cardiac device, peripheral nerve stimulator or cochlear implant (15). However, it would be critical to reference the manufacturer's recommendations prior to proceeding with RFA in the presence of other implanted medical devices (15).

Limitations to the widespread adoption of large volume lesioning techniques exist (27). Cost is a significant barrier to utilizing large volume lesions as multi-tined and internally cooled electrodes are considerably more expensive than conventional electrodes (27). Further,

much of the efficacy data were collected using conventional electrodes (8-11).

CONCLUSIONS

This case successfully illustrates the safe and effective treatment of chronic cervical facet-mediated pain using bipolar multi-tined cervical medial branch RFA in a patient with a functional cervical SCS implant. By employing bipolar energy delivery and large-volume lesioning techniques, clinicians can mitigate the inherent risks of EMI and unintended energy transfer associated with RFA in patients with implanted neuromodulation devices. This technique should be considered a valuable addition to the procedural options available to pain clinicians for managing complex patients requiring both RFA and SCS therapy.

Author Contributions

Both authors substantially contributed to conducting the underlying research and drafting this manuscript. YK and JP identified the case for submission. Ethics application, consent and manuscript drafting was conducted by JP. YK and JP revised the manuscript draft. JP formatted and submitted the final manuscript for publication.

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