Current Opinion

Technical Modification of Cervical Facet Joint Radiofrequency Ablation: A Novel Approach

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Background: Current standards of practice recommend performing the cervical medial branch block (MBB) and applying the subsequent radiofrequency ablation (RFA) electrode via anterior-posterior (AP) and lateral fluoroscopic views. The lateral views of the lower cervical segment are frequently hindered by patients' anatomical factors and prevent the accurate and safe placement of the RFA needle.

Objective: The goal of this technical modification is to introduce and standardize an oblique angle view using fluoroscopy to enable more accurate placement of the MBB needle and RFA needle electrode in the cervical facet joint.

Study Design: The technical modification was developed using a cadaveric skeletal model. Then, in an actual patient, this additional oblique view was tested in an RFA procedure for a cervical facet joint.

Setting: This protocol was produced at a single musculoskeletal and interventional spine center.

Methods: A team of interventional pain specialists developed a step-by-step technique that utilized a 50-degree ipsilateral fluoroscopic view, in addition to AP and lateral views, by simulating a cervical facet joint RFA in a cadaveric skeletal model. The technique was then tested in an actual patient's cervical facet joint RFA procedure.

Results: The team successfully developed a technique to confirm placement of the RFA needle electrode at the articular pillar to denervate the medial branch for treating pain in the cervical facet joint. This technique allows for the clear visualization of the needle RFA electrode to overcome patient factors that can obscure the electrode, including physiological aspects such as short neck and shoulder musculature.

Limitations: A potential disadvantage of this technical modification is the additional radiation exposure, which is caused by the addition of an oblique view.

Conclusions: Our technical modification of an oblique angle view enables clear visualization, thus increasing the accuracy and potentially the safety of RFA needle electrode placement in lower cervical facet joint RFA over those of the conventional approach.

Key words: Cervical facet joint pain, radiofrequency ablation, medial branch block

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Neck pain is one of the leading causes of disability globally, ranking 21st out of 291 diseases for the total burden of health based on the disability-adjusted life years (DALY) scale (1,2). As such, neck pain poses a serious health problem, since it can contribute to decreased quality of life and functional impairment. Among these cases, cervical facet (zygapophyseal) joints are the leading source of pain in 49-60% of patients with chronic neck pain and 50% of patients with whiplash-associated disorders (3-5). It has been well established that the cervical facet joints are innervated by the medial branch (MB) of the dorsal ramus spinal nerve (6,7). In facet joints below C2-C3, innervation comes from the articular branches of 2 medial branches from the dorsal rami at and above the level of the joint (5).

Currently, dual comparative medial branch blocks (MBBs) are widely considered the accepted standard for diagnosing cervical facet joint pain (8). This method distinguishes facet joint pain from other general causes of neck pain and is used to determine if a patient is a candidate for radiofrequency ablation (RFA). In addition, if a dual comparative medial branch block is used, the likelihood of a false-positive result is decreased (9). According to the 2020 American Society of Interventional Pain Physicians Guidelines on Facet Joint Interventions, dual cervical facet joint diagnostic blocks ideally require greater than 80% pain relief for the diagnosis of cervical facet joint pain to be made (10). Patients who meet this criterion are candidates for thermal radiofrequency ablation of the MB (11).

RFA utilizes thermal energy from radiofrequency currents to create a predictable area of tissue destruction that targets the MB nerves, which are responsible for transmitting pain sensations from facet joints (12). RFA can target precise nerves specifically, which will alleviate pain from the affected facet joints while exerting no effect on adjacent facet joints, discs, or ligaments (9). Under fluoroscopic guidance, both lateral and anterior-posterior (AP) views are used during needle placement to confirm that the electrode is positioned parallel to the targeted MB nerve at the articular pillar of the cervical facet joint (14-16). Once the placement of the electrode is confirmed in all views, thermal RFA is performed to denervate the facet joint (16). An alternating current is applied continuously, heating the tissue surrounding the electrode and eventually causing coagulation of the medial branch (18).

However, the current cervical thermal RFA technique, which uses lateral views for the RF electrode position, is oftentimes limited due to shoulder musculature restricting the visibility of the lower cervical facet joints. This issue is further complicated by patients with increased body habitus or physiologically short necks (19). In the lateral view, shoulder anatomy can obscure cervical spine visibility. Shoulder retraction and subsequent depression is often used to increase visibility of the lower cervical spinal columns; however, conscious sedation, along with patient anxiety and discomfort during the procedure, can cause the patient to move their shoulder involuntarily, thereby obscuring visibility and increasing the risk of intraoperative complications (13). Iatrogenic complications stemming from thermal RFA, although rare, include neuromuscular instability due to extensive denervation, neuroma formation, hyperesthesia, accidental ablation of the nerve roots, and damage to the surrounding cervical structures, including the esophagus and trachea (14).

The technical recommendation described in this paper introduces a modification to the conventional cervical thermal RFA procedure. Specifically, an oblique fluoroscopic imaging technique is utilized to increase visualization of 2 RFA electrodes, thus allowing for accurate placement in the lower cervical spine facet joint as well as potentially reducing intraoperative complications and increasing efficacy.

Methods

When oblique fluoroscopic views are used in the performance of cervical interlaminar epidural injections, the needle tip is visualized in a certain way. We concluded that a similar approach would be viable for cervical RFA needle placement. The modified cervical RFA electrode placement was developed as follows: in a cadaveric skeletal model, with the C6 level used as an example, a metal pointer was placed at the articular pillar in a traditional RF electrode position. In this location, the RF tip was found to be slightly posterior to the superior articular process of the C5/C6 neuroforamen. We initially started the RF electrode placement in AP view using traditional methods (Fig. 1A). Upon making bone contact with the lateral edge of the articular pillar, the RF electrode was advanced deeper for 2-3 mm by following the articular pillar laterally. Further advancement was then performed using a 50-degree ipsilateral oblique fluoroscopic view until the tip of the RF electrode reached the point just posterior to the superior articular process (Fig. 1C). The RF electrode position placed by the oblique view corresponded to the same targeted RF position from the traditional AP

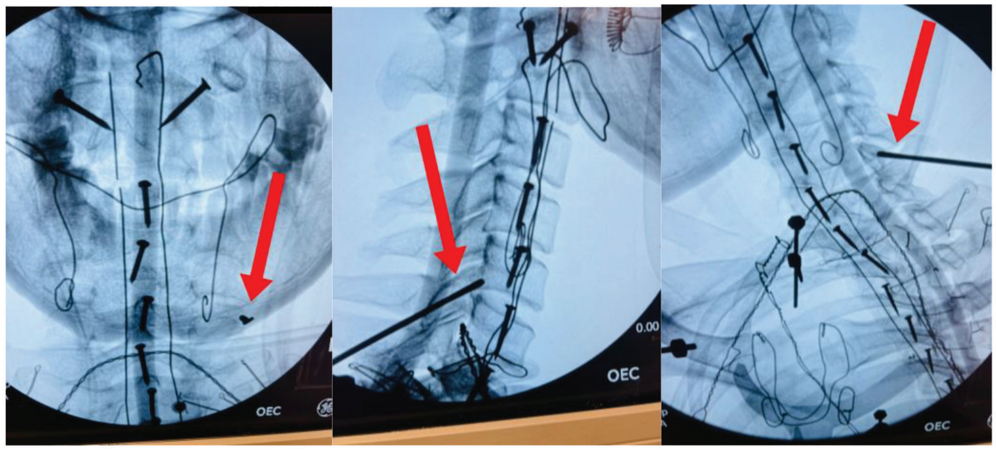

Fig. 1. *(A) AP view of cadaveric skeletal model with RFA needle at C6 cervical articular pillar (red arrow). (B) Lateral fluoroscopic view of cadaveric skeletal model with RFA needle at C6 cervical articular pillar (red arrow). (C) Oblique fluoroscopic view of cadaveric skeletal model with RFA needle at C6 cervical articular pillar (red arrow).*

and lateral views, with greater visualization of the surrounding structures (Fig. 1B). This observation is especially true for patients with large shoulder musculature or shorter necks.

The modified cervical RFA technique is performed thusly: the patient is placed in the prone position without shoulder retraction. A C-arm fluoroscope is placed over the patient and centered upon their cervical spine. In the AP view, the spinous process was placed in the middle of the viewing field. The targeted level of the facet joint line and articular pillars were visualized. Sterile skin preparation is performed, sterile draping is applied, and local anesthetic needles are inserted under fluoroscopic guidance along the projected needle pathways for the subsequent RF needle electrodes. While the current standard for directing the RF introducer needle electrodes involves taking lateral and AP views, the modified technique utilizes a 50-degree ipsilateral oblique view. The 50-degree oblique angle is added to better visualize needle advancement toward the cervical articular process (Fig. 2A). Following the confirmation of needle placement one-2 mm posterior to the neuroforamen in the oblique view (Fig. 2C), which corresponds to the final lateral placement of the RF electrodes, according to the results of our cadaveric study, local anesthetic is given through the introducer needles. The stylets are then removed and replaced by the electrodes. Once the placement of the electrodes are confirmed, they are subsequently heated through RF currents, forming lesions that promote Wallerian degeneration of the medial branches that innervate the facet joints.

This study used a cadaveric skeletal model and a human model for demonstration purposes.

Results

We successfully developed a fluoroscopic-guided technique to confirm the precise placement of the RFA electrode at the cervical articular pillar to facilitate medial branch denervation for the treatment of cervical facet joint pain. In a cadaveric skeletal model, the RFA needle was reliably positioned at the C6 articular pillar in AP, lateral, and oblique fluoroscopic views (Fig. 1). These images demonstrated the feasibility of the technique in a controlled anatomical model.

In a clinical setting, the technique was applied to patients undergoing cervical medial branch RFA. Fluoroscopic imaging in AP, lateral, and oblique views confirmed the appropriate placement of RFA needles at C3, C4, and C5 (Fig. 2). Importantly, lateral imaging highlighted the challenge posed by patient-specific anatomical factors, such as a short neck or dense shoulder musculature, which can obscure visualization of the RFA electrode. Despite these challenges, the oblique view facilitated the identification and verification of electrode placement, ensuring accurate targeting of the medial branch nerves.

Discussion

This study seeks to improve the accurate and safe placement of the thermal RF electrode for the lower cervical facet joints. Facet joints are considered common sources of chronic localized neck pain. In addition to localized neck pain, cervical facet joints may refer pain to adjacent structures, such as the head and shoulders. Patients with neck pain seek pain relief, functional improvement, and psychological improvement. In the Medicare population, the rate of cervical and thoracic RFAs has been gradually increasing, with over 300,000

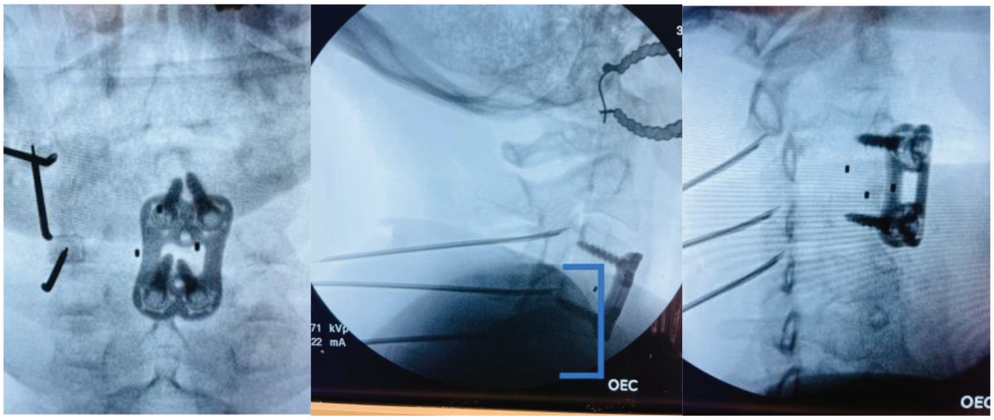

Fig. 2. *(A) AP fluoroscopic view of RFA needle at C3, C4, and C5 in a patient. (B) Lateral fluoroscopic view of three RFA needles, located at C3, C4, and C5 in a patient with obstruction of RF needle at C4 and C5 due to the dark silhouette of the shoulder (blue bracket). (C) Oblique fluoroscopic view of RFA needle at C3, C4, and C5 in a patient.*

RFAs being performed yearly since 2011 in the United States (8).

In Fig. 2, fluoroscopic imaging shows ideal needle placement at the C5 cervical articular pillar in oblique angle views in a patient without the visual obstruction of the cervical spine by nearby shoulder structures, specifically at the C5 level. With the addition of a third oblique angle view, there is greater certainty of RF needle tip placement at the correct location to initiate thermal RFA which is otherwise not well visualized in the lateral view due to obstruction by the shoulder (Fig. 2B). This approach is especially helpful in challenging patients with large body habitus, large shoulders, or short necks but this approach is also viable in all patients to reduce the risk of injury to the adjacent vital structures due to misplacement of the RF electrodes.

Limitations

Potential disadvantages of our approach include increased radiation exposure and lengthened procedural time. However, with greater visualization, safer placement of electrodes during RFA procedures ultimately decreases the possibility of iatrogenic injury. To avoid complications that may arise from a misdirected needle straying from the target zone, obtaining adequate visualization is critical. Complications, such as nerve root injuries or spinal cord injuries, can occur during cervical medial branch blocks and cervical thermal RFA due to insufficient views of the target region (20).

Conclusion

Although the use of an oblique imaging technique has been surmised in previous studies on cervical RFA outcomes in patients with complex body habitus, there currently exists no literature that explains the detailed implementation of such a technique in a human model (19). Therefore, we hope that this technical modification can serve as an initial study toward the application of oblique fluoroscopy imaging in human patients who receive thermal RFA to reduce the complications caused by cervical facet joint pain. We also hope that this study can potentially improve the efficacy of the RFA procedure.

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