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NEUROPATHIC PAIN (A. ABD-ELSAYED, SECTION EDITOR)

Safety and Efficacy of Radiofrequency Ablation of the Medial Branch Nerves with Preexisting Spinal Hardware. A Case Series and Review of Literature

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Abstract

Purpose of Review To explore the efficacy of radio frequency ablation in treating pain in patients with hardware at site of the procedure.

Recent Findings There is very limited data in literature about this topic. One study performed in 2016 indicated no complications when performing RFA close to hardware in patients with chronic pain conditions.

Summary Radiofrequency ablation can be safely and effectively performed close to hardware. While heating of the hardware can happen which can theoretically lead to tissue injury or decreased heat going to target nerve, this does not seem to be of clinical significance. More studies are needed to confirm this finding.

Keywords Safety · Efficacy · Radiofrequency ablation · Medial branches · Hardware

Introduction

It is not uncommon for chronic back pain patients to present for consideration of radiofrequency ablation (RFA) of the medial branch nerves with embedded metal hardware from prior spine surgery. A study in 2016 found that out of the 2520 patients that had RFA performed on the lumbar spine, 40 had pedicle screws present and with no RFA-related complications. The RFA procedure is performed by a probe being inserted near the desired tissue, and the probe then transmits radiofrequency waves to generate heat which ablates the nerve as a result. Ablation of nerve tissue results in a decreased ability for the nerve to transmit signals to the central nervous system, which causes a decrease in pain felt by the patient [1]. There is theoretical risk involved in treating these patients with RFA, as the needle tip will be in close proximity to this metal. Heat transfer could increase the risk of thermal damage to surrounding tissues, and may also direct energy away from the target site, thereby reducing its rise in temperature and decreasing the effectiveness of treatment. Generally speaking, the metals that have been used in recent history are poor thermal conductors. For example, the thermal conductivity of titanium is 19–23 W/mK and that of stainless steel is 12–45 W/mK, compared to copper's conductivity of ~ 369 W/mK. However, clinical studies to determine the efficacy and safety of RFA in this specific subset of the chronic pain population are lacking. A study of RFA used in cardiac arrhythmias found RFA near metal hardware lead to a significant increase in tissue heating [2]. Though, RFA has been used in close proximity to metal stents to treat malignant biliary occlusions with a high success rate and minimal complications [3, 4]. Here, we describe multiple successful treatments with the use of RFA of patients carrying these potential risks from spinal hardware.

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Case Series

Case 1

This was a 58-year-old male patient with history of hypertension and hyperlipidemia who presented to interventional pain clinic with chronic right arm, bilateral cervical, and lumbar pain due to a motor vehicle accident 5 years prior. He had multiple discs herniate, leading to C4-C5 and L5-S1 fusions. The screws from this lumbar surgery became displaced, requiring a revision L4-S1 fusion. Ultimately, he has intervertebral fusion cages between L4-L5 and L5-S1 with two, left-sided titanium pedicle screws, along with a plate secured by four titanium screws spanning C4-C5. By the time of presentation, he had received several epidural steroid injections (ESI) to both sites without significant relief. He underwent RFA of the bilateral medial branches of L4-S1. On his initial follow-up, he had a subjective 70% decrease in his pain symptoms, which improved to 90% by his 6-month visit. At 12 months, his relief is ongoing. He subsequently requested an interventional procedure for relief of his cervical spine pain. He received a trial of cervical ESI, without change of his symptoms. RFA was performed on the medial branches of C4-C7, bilaterally. His pain scores in the right neck decreased by 80%, which is ongoing at 6 months post-procedure. He experienced a pain reduction of 50% from baseline in the left neck by 1 month; however, this decreased to < 25% pain relief by 4 months post-procedure. Overall, the patient was satisfied with his care, and his quality of life improved as a result of these interventions.

Case 2

This was a 36-year-old female who presented to our interventional pain clinic with a 6-year history of low back and left leg pain. Prior to her visit, she had received several ESIs with transient benefit, followed by an L3-S1 fusion, which only demonstrated a modest benefit in her leg pain. Bilateral pedicle screws remained in the vertebrae at each of these levels. Afterward, she received two more ESIs without benefit. Two sets of bilateral medial branch blocks were performed at L4-5 and L5-S1, with 60% relief lasting 1 day each. She then underwent RFA of the left medial branches of L4-5 and L5-S1. Within 1 week of the ablation, she did report a worsening of her radicular left leg pain, increasing from 6/10 to 7/10 on visual analog scale (VAS). This was managed with a short course of prednisone. Shortly after, she proceeded with RFA of the right medial branches of L4-5 and L5-S1. There was no follow-up until 9 months later when she was requesting a repeat of the RFA procedure. Her pain score at the follow-up visit was at 4/10, with a patient-reported 70% reduction in her back and leg pain lasting for roughly 8 months. The patient received RFA bilaterally 3 months later, and there has not been subsequent follow-up to date.

Case 3

This was a 58-year-old female who presented to the interventional pain clinic with a 1-year history coccygeal pain after a fall. She also had a long-standing history of low back pain status post L5-S1 fusion in 2004 due to a disc herniation. Her surgery left her with two metal cages at the L5-S1 interspace. Her baseline pain score was 3–5/10 on VAS. She received a ganglion impar block for her coccygeal pain, with significant relief. Left medial branch blocks were performed on L3-4, L4-5, and L5-S1, with 90% pain reduction lasting several hours. She then underwent RFA of the left medial branches of these same levels. At her 6-week follow-up visit, she reported a 70% reduction in her low back pain, with a score of 1/10. She was noted to also be suffering from sacroiliac joint dysfunction causing new left buttock pain. For this, she received an SI joint steroid injection, with 70% pain reduction. At 7 months post-RFA, pain control is ongoing.

Case 4

Metal hardware not only poses possible challenges in regard to RFA treatment for back pain but also peripheral joint pain. CC is a 71-year-old female who presented to clinic with chronic right shoulder, left knee, and right hip pain. She had suffered from the progressive left knee pain for roughly 2 years following total knee arthroplasty. She rated this pain 5/10 on VAS. She had 70% pain reduction lasting several days following two separate genicular nerve blocks. The affected knee was subsequently treated with RFA of the left superior medial and lateral, and inferior medial, genicular nerves. At her 2-month follow-up, she was noted to have > 95% pain relief in the left knee. There were no complications. At 7 months post-treatment, pain relief is ongoing.

Case 5

This was a 56-year-old male who presented to clinic with long-standing neck and shoulder pain. He is status post anterior C5-C7 discectomy and fusion, with six metal screws and a plate in place. He received bilateral medial branch blocks at C4-7. He reported a change in his pain score from 7/10 to 2/10 on VAS for roughly 6 h. This was followed by RFA of the left, then right, medial branches of C4-5, C5-6, and C6-7. At his 6-week follow-up, his assessment of his neck pain was unclear, as he was suffering from a recurrence of his chronic headaches. Overall, he estimated a 30% reduction in his pain. His headaches are currently being managed by neurology. Otherwise, at 11 months post-RFA treatment, his pain relief appears to be ongoing.

Discussion

The safety and efficacy of performing RFA in patients with preexisting hardware from prior spinal surgery has received limited attention in the literature. As such, it is worth reviewing literature for other applications of RFA (e.g., ablation of hepatic tumors, biliary strictures). Although, they are not the same, as these different applications will be using a variety of RFA settings in several types of tissues with differing impedances.

Of papers reviewing RFA efficacy and safety, only one retrospective study by Klessinger has analyzed lumbar spine RFA in the presence of posterior pedicle screws [5••]. RFA was performed on 38 patients with pedicle screws present at time of procedure. All patients reported no adverse effects or worsening of pain after RFA and 20 patients (52.6% of procedures) achieved a pain reduction of at least 50% for a minimum of 3 months. No clinical effects from heating of metal pedicles were observed. Though this paper is limited in scope due to the exclusion of patients with other metal devices (e.g., interspinous devices or disc prosthesis) and narrow cases, it demonstrates that RFA on lumbar spine patients with metal pedicles can be successful.

The only studies focusing on heat sinks impairing RFA treatment are those involving ablation of hepatocellular tumors. However, in these cases, large, blood vessels act as heat sinks, cooling the tumor site as blood flows away. This data will not give significant insight into the current topic of vertebral hardware heat sinks.

A paper was completed by S. Thakur et al., measuring the degree of heat transfer to surrounding tissue in an ex vivo 10% agar gel model representing a human calf for the simulation of endovascular RFA [6]. The RFA tip was heated to 120 °C (versus typically 80 °C in RFA of medial branches), and temperature measurements were taken at distances of 0.25 cm, 0.5 cm, and 1 cm over 140 s. It was demonstrated that heat conduction occurred radially from the center of the catheter. The temperature changes noted at each of the distances was found to be clinically insignificant (e.g., 1.5 °C at the closest measurement of 0.25 cm). However, this does not account for the presence of metal implants like in our population.

Some papers have highlighted the risk of thermal injury to nearby structures during RFA. A retrospective study of 447 RF ablations of liver tumors in 153 patients described common causes of morbidity in their sample [7]. In total, there were 36 complications across 18 patients (23.7% of RFA procedures). They demonstrated that biliary injury was the second most common complication, following localized infection, comprising 14% of all complications. Thermal injuries to the skin, diaphragm, and stomach were another common cause of morbidity, making up 11% of the total.

A recent case report from A. Kruger and S. Krishna described a case of apparent RFA-induced pancreatitis due to thermal injury [8]. RFA was performed through a self-expanding metal biliary stent to treat stenosis from ingrowing tumor. Immediately after the treatment, the mucosa was noted to be blanched. She developed pancreatitis the following day, and this was ultimately attributed to thermal injury. It is not noted in the study what metals comprised the stent; however a common, current stent in the USA would be a platinum-cored nitinol (nickel/titanium alloy) wire. These metals are relatively poor thermal conductors (platinum 73 W/mK, nickel 90 W/mK, titanium 19–23 W/mK), yet were able to conduct enough heat to lead to thermal injury of nearby tissue.

There are two studies by Gazelka et al. and Lamer et al. specifically addressing the concern for heat transfer in vertebral hardware in patients undergoing RFA treatment. In a cadaver study, Gazelka et al. demonstrated that RFA cannula brought about a significant temperature increase in the pedicle screw, both when in direct contact with the screw and when positioned in the typical location for RFA treatment [9•]. This temperature increase was noted along the shaft of the screw and in the surrounding soft tissue, raising the concern for possible injury to these structures. In a small study by Lamer et al., the temperature of the pedicle screws in six patients (ten screws total) was measured during RFA treatment [10••]. Sixty percent of screws experienced a rise in temperature, with a mean increase of 2 °C. In two cases, the treatment was aborted after noting a screw temperature of 42 °C. These two studies reveal that heat transfer does occur in these scenarios; however, the clinical significance has yet to be elucidated. Furthermore, these studies are small in scope, limiting the power of the data. No studies to date have specifically explored the notion that heat transfer away from the target site may decrease the effectiveness of treatments. Cases like the one described above suggest that RFA can be safely and successfully performed in this population. Further clinical research should be completed to formally validate this perspective.

Conclusion

Radiofrequency ablation may be a safe and effective treatment for patients with preexisting spinal hardware.

Compliance with Ethical Standards

Conflict of Interest Alaa A. Abd-Elsayed, Kenneth Fiala, Sean Nguyen, and Jeff VanderWood declare no conflict of interest. Dr. Abd-Elsayed is a consultant for Medtronic, Halyard, StimWave, SpineLoop and Sollis. Dr. Kaye is on the Speakers Bureau for Depomed, Inc. and Merck.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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