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Case Report

Endoscopic Pulsed Radiofrequency Ablation of Genicular Nerves for the Treatment of Chronic Knee Pain

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Chronic knee pain is the second most common cause of chronic pain in the United States. Occasionally, patients become refractory to conventional treatments such as intraarticular cortisone injections and viscosupplementation. Patients who have exhausted these therapies or have a contraindication to the therapies may be candidates for diagnostic genicular nerve block and if successful, subsequent radiofrequency ablation (RFA).

For patients who have undergone image-guided genicular nerve radiofrequency ablation with fluoroscopic or ultrasound guidance without success, an endoscopic approach can be used as an alternative modality with success. With direct visualization of the genicular nerves, the likelihood of success with an endoscopic approach increases as some patients can have varying anatomy of the genicular nerves for which cannot always be detected with fluoroscopy or ultrasound.

The purpose of this study is to demonstrate the utilization of a direct endoscopic approach for genicular nerve RFA for patients with chronic knee pain that have failed to improve after image-guided genicular RFA with fluoroscopic or ultrasound guidance.

Two patients who had underwent successful diagnostic genicular nerve blocks were assessed for pre-procedure and post-procedure visual analog scale (VAS) scores following endoscopic genicular nerve RFA after failure of the conventional image guided approach at 6 and 12 months.

Both patients reported greater than 80% reduction in VAS score and improvement in function at 6 and 12 months

Limitations of the current study is a limited number of patients, and lack of the use of a formal functional scale to demonstrate improvement.

Ultimately, the conclusion was drawn that an endoscopically-guided genicular nerve RFA can be utilized successfully due to direct visualization of the genicular nerves when conventional approaches with Fluoroscopic/ultrasound guidance has failed to achieve analgesia and functional improvement.

Key words: Genicular nerve block, endoscopic, radiofrequency ablation. knee pain, chronic osteoarthritis, genicular neuritis, genicular neuralgia, total knee arthroplasty, arthritis

Chronic knee pain is the second most common cause of chronic pain in the United States. The majority of patients who suffer chronic knee pain do so as a result of chronic knee osteoarthritis. There are many pharmacologic and non-pharmacologic modalities that exist for the management of chronic knee osteoarthritis. Pharmacologic approaches are limited by end organ effects such as gastrointestinal ulcers, bleeding with non-steroidal anti-inflammatories, and the addiction risk with opioids. Non-pharmacologic approaches such as intraarticular corticosteroid injections carry the risk of complications related to steroid exposure and have limited efficacy in chronic severe OA pain. Intraarticular hyaluronic acid injec-

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tions have demonstrated efficacy in restoration of function in patients with mild to moderate OA, but clinicians do not rely on this method as a modality to treat chronic knee pain. Joint replacement surgery has demonstrated efficacy in severe OA pain, but due to limiting comorbidities, certain patients may not be able to benefit from this intervention. Patients who continue to experience pain after joint replacement surgery are left with even fewer options in terms of therapeutic interventions for long-lasting pain relief.

Radiofrequency ablation (RFA) is a therapeutic modality that utilizes current to create heat in target tissues by providing friction among molecules. A thermal lesion is formed by the heat generated from this current (1). The RFA procedure is used in various clinical conditions such as trigeminal neuralgia and facetogenic pain. Recently, this process has been applied in the management of knee osteoarthritis.

Conventional RF, which may lead to permanent injury in the nerves, was implemented on the genicular nerve branches. This method is generally preferred for patients with end-stage knee osteoarthritis who are not candidates for total knee replacement in order to achieve the longest pain relief possible.

To the best of our knowledge, this present study is the first utilizing a pulsed RFA method in patients with knee osteoarthritis. Pulsed RFA uses current in short, high-voltage bursts and the silent phase of pulsed RF allows time for heat elimination, generally keeping the target tissue below 42 degrees Celsius. Therefore, pulsed RF does not cause thermal lesions and avoids any nerve destruction which could lead to Charcot joints and neuropathic pain.

To our knowledge, there have been no large-scale follow-up studies focusing on genicular nerve RFA of any kind to confirm its efficacy. In addition, there have been no large-scale studies evaluating genicular nerve RFA of any kind in patients with chronic knee OA pain or in patients that continue to experience pain after total knee arthroplasty (2).

Conventional genicular nerve RFA was first demonstrated by Choi (2) to be an effective therapy in the treatment of patients with pain due to chronic knee osteoarthritis. In another report, conventional genicular RFA provided improvement in chronic knee pain after total knee replacement (3).

Studies utilizing pulsed RFA technique for chronic knee OA or knee pain following surgery have yet to gain prominence when compared to the conventional approach for the same indication.

Traditionally, genicular nerve blocks have been performed using fluoroscopic or ultrasound guidance with reference to bony landmarks. Limitations with this technique are due to the anatomic variation of genicular nerves. Patients who do not benefit from diagnostic genicular nerve blocks due to variations in anatomy may continue to suffer from chronic pain.

Anatomic variation has been well-documented in the anatomy of the medial branch nerves innervating the facet joints especially within the lumbar spine.

These variations led to the development of an endoscopic approach for medial branch nerve block and RFA. Using an endoscopic approach, facet rhizotomy has shown to be effective for patients who have significant chronic axial back pain and clinical demonstration of facet disease who do not respond to traditional fluoroscopically- guided medial branch nerve blocks and RFA.

By applying this concept to the genicular nerves innervating the knee, the goal of endoscopic RFA is to avoid insufficient pain relief that may result due to the anatomical variations of genicular nerves commonly encountered when utilizing traditional fluoroscopic or ultrasound guided landmarks for RFA probe placement (4-6).

Our endoscopic approach utilizes direct visualization of the genicular nerves with subsequent use of a pulsed method high frequency/low temperature (40 degrees Celsius) via Endovapor Vaporflex/Triggerflex (Joimax, Irvine, CA) flexible RFA probe for lesioning of the genicular nerves in 2 patients suffering from chronic knee pain.

We present 2 cases of a successful new novel endoscopic approach to radiofrequency ablation (RFA) of the genicular nerves innervating the knee for treatment of chronic knee pain.

METHODS

The first patient is a 67-year-old male who underwent right total knee arthroplasty due to chronic osteoarthritis and continued to suffer from persistent knee pain 12 months after surgery. The second patient is a 64-year-old male with severe chronic knee osteoarthritis that caused significant debilitating knee pain and subjective decrease in function. Both patients had diagnostic genicular nerve blocks with 2 mL of 0.25% bupivacaine at each location that provided greater than 80% pain relief for 1 day indicating a subsequent RFA.

The endoscopic procedure utilized the following methods.

The patient was placed in a supine position and anteroposterior/lateral fluoroscopic views were used to visualize the knee joint.

The landmarks used for the superior medial (SM) and superior lateral (SL) genicular nerves were the connection of the femoral shaft with the medial and lateral epicondyles. The landmark for the inferior medial (IM) genicular nerve was the medial aspect of the tibia at the shaft-epicondyle intersection (3).

The skin was anesthetized with 1% lidocaine and 0.25% bupivacaine solution. A 3.5-inch 22-gauge spinal needle was advanced under fluoroscopic guidance in an antero-posterior fashion towards the aforementioned landmarks. Following contact with periosteum, a guide wire was inserted down to the bone and then secured on to the surface. A 5-mm incision was made, followed by introduction of a guiding rod with subsequent insertion of a working channel over the guiding rod. To allow adequate working environment a 6.3mm Joimax Foraminoscope (Joimax, Irvine, CA) was inserted through the working channel.

Using endoscopic views provided by the standard Joimax Foraminoscope HD Endoscopy Tower System, each of the genicular nerves were visualized (Figs. 1 and 2). With direct visualization confirming the location of the genicular nerves, radiofrequency ablation was performed using pulsed high frequency/low temperature (40

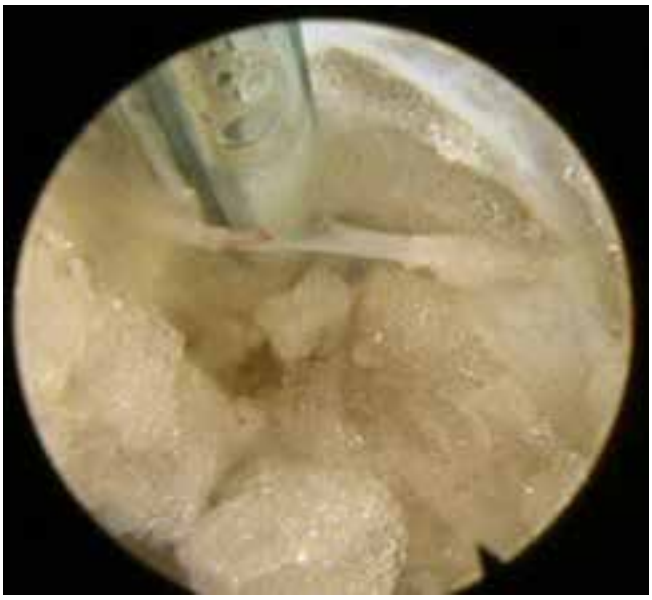

Fig. 1. Endoscopic view of Genicular nerve.

Fig. 2. Endoscopic view of Genicular nerve.

Fig. 3. Endoscopic view RFA of Genicular nerve.

Fig. 4. Endoscopic working channel view.

degrees Celsius) method via Endovapor Vaporflex/Triggerflex flexible RFA probes for 90 seconds (Figs. 3 and 4).

At the conclusion of the procedure the working channel and foraminoscope were removed. The skin was closed using a single suture in each site.

RESULTS

Both patients experienced 100% pain relief immediately after the procedure.

At 12-month follow-up, both patients reported greater than 80% reduction in knee pain and subjective improvement in function based on number of blocks walked without experiencing discomfort. No short or long-term complications were reported at 12-month review.

DISCUSSION

Greater than 12% of the American population experiences pain and functional limitations from chronic knee osteoarthritis provides evidence that 53% of people continue to have knee pain after undergoing TKA (7,8).

Recently, investigators began using radiofrequency ablation applied to articular nerve branches innervating the knee (otherwise known as the genicular nerves). The genicular nerves have been targeted because they are the main innervating articular branches for the knee joint, and these nerves are adjacent to the periosteum connecting bone thus can be easily located using bony landmarks under fluoroscopic imaging (9).

Choi (2) showed that conventional RFA of genicular nerves seems to be a safe, effective, and minimally invasive therapeutic procedure for chronic knee OA patients with a positive response to diagnostic block. Choi's study (2) resulted in 2 patients in the

radiofrequency group (12%) that achieved poor or no response to the treatment, possibly due to variations in their genicular nerve anatomy making it difficult to adequately locate and ablate the appropriate genicular nerves using traditional fluoroscopic guidance.

Given the fact there have been cases where patients did not achieve adequate pain control due to anatomic variation encountered with traditional fluoroscopic guided diagnostic genicular nerve blocks/RFA, alternative approaches using endoscopic techniques have been explored.

Due to the cost-effectiveness, and the lack of radiation exposure for clinicians and patients there has been a rise in popularity surrounding ultrasound-guided procedures. Yaser (9) applied an ultrasound guided approach to genicular nerve blocks for chronic knee pain. Yaser's cadaveric study examined the anatomic location and accuracy of ultrasound guided genicular nerve blocks. The study demonstrated the superior medial genicular nerve (SMGN) to curve around the femur shaft and pass between the adductor magnus tendon and the femoral medial epicondyle, then descend approximately 1 cm anterior to the adductor tubercle. The inferior medial genicular nerve (IMGN) was confirmed to be situated horizontally around the tibial medial epicondyle and passes beneath the medial collateral ligament at the midpoint between the tibial medial epicondyle and the tibial insertion of the medial collateral ligament. The number of cadavers studied was small and only 2 genicular nerves were examined; therefore, limitations in study design exist. It is worth noting, the cadaver knees studied had no prior interventional procedure/surgical procedures performed. Finally, ultrasound imaging of the genicular nerves in clinical practice may not be achieved every time due to possible technical issues regarding ultrasound proficiency and technology. Patient factors such as thick subcutaneous fat tissue found in obese patients might decrease the quality of ultrasound images (9,10).

In this present study, we were able to avoid the limitations of fluoroscopic and ultrasound guidance using a direct visualization of the genicular nerves with our novel endoscopic approach

Anatomical variation of medial branch nerves has been well documented in patients with chronic facet arthropathy. For patients with clinical manifestations of facet joint syndrome that did not respond to fluoroscopically-guided medial branch nerve block and RFA, endoscopically-guided approaches have shown to be equal or better regarding pain scores and function versus traditional fluoroscopic approaches (11). A criticism beyond anatomic variation of the fluoroscopic guided lumbar medial branch RFA is that extensive ablation using multiple needles at single level and repetitive ablation can scar adjacent muscular and ligamentous structures, which in itself can become source of chronic low back pain. In our present study, the need for an extensive ablation is abated due to direct endoscopic visualization thereby theoretically decreasing the risk of unwanted sequelae (11,12).

It has been reported (9) that RFA of only 2 (superomedial and inferomedial branches) of the previously reported 3 genicular nerves are necessary to achieve effective pain relief. This was examined in Yaser's study (9) where the SMGN and IMGN were targeted for the pulsed RF treatment. Chronic knee osteoarthritis most commonly affects the medial compartment due to repeated varus stress. Yaser's (9) approach may be considered as a more specific treatment for knee osteoarthritis affecting the medial compartments only. In our present study, we utilized direct visualization of all 3 genicular nerves. Results comparing RFA of 2 versus 3 genicular nerves based on approach is limited and further studies are warranted (13). There have also been studies investigating the effect of interventional procedures to other peripheral nerves around the knee joint for acute and chronic pain. Vas (14) conducted a study to examine the efficacy of ultrasound-guided RF treatment of the saphenous, tibial, and common peroneal nerves along with subsartorial, peripatellar, and popliteal plexuses in 10 patients with osteoarthritis. They revealed that the RF procedure on the sensory and motor nerves appeared to be a safe, effective, and minimally invasive technique. In another study, Egeler (15) performed nerve block to the lateral and intermediate cutaneous nerves of the thigh, the infrapatellar nerve, and 3 genicular nerves including the superomedial, superolateral, and inferomedial branches. Improvements in postoperative pain after total knee arthroplasty were obtained. The results of the present study suggested

that our novel endoscopic RFA approach might be more than sufficient for pain relief in chronic and more specifically medial compartment osteoarthritis (15).

Genicular nerve block is usually performed as a diagnostic test. In Choi's study (2), 4 of 63 patients had no pain after diagnostic genicular nerve block. In Yaser's study (9) more patients were determined to have obtained long-term benefit from the nerve block versus Choi. This may have been due to the administration of both lidocaine and betamethasone in the genicular nerve block injections. Corticosteroid was used to contribute an analgesic effect to the local anesthetic. It has been reported that corticosteroids may provide analgesia by blocking the transmission in nociceptive C-fibers (16).

In our present study, we were able to achieve long-term pain relief and achieve the specified objectives with the use of pulsed RFA with endoscopic visualization without the use of corticosteroid, but there were some limitations to the study. The number of participants was limited, so there is a requirement for further research with larger patient populations to assess the efficacy and adverse reactions of endoscopic guided genicular RFA. Another limitation of the study is the lack of a control group. Thus, these protocols could not be compared with other treatment modalities. Further studies are also needed to evaluate the long-term effect of endoscopic RFA treatment. Finally, if difficulty was encountered attempting to locate the inferomedial genicular nerve, the Triggerflex RFA probe was utilized in a 360-degree manner to offset this limitation. The Triggerflex RFA probe allows easy implementation through working channels for navigational, targeted application of RF treatment on target tissues and has been utilized in several notable endoscopic procedures (11,17).

CONCLUSION

In conclusion, an endoscopic approach for genicular nerve RFA using a pulsed technique avoids anatomic variation in genicular nerve anatomy and appears to be a safe, effective, and a minimally invasive therapeutic procedure for patients with chronic knee pain when conventional therapy with fluoroscopy or ultrasound has failed to achieve desired results.

We believe that these preliminary results could be used in the development of future prospective cohort studies and randomized controlled trials that focus on the use of endoscopic radiofrequency ablation to treat chronic knee pain especially in patients with chronic knee pain secondary to osteoarthritis, patients with failed knee replacement surgery, patients unfit for knee replacement, and patients who wish to avoid surgery.

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