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Case Report: Successful Pain Relief with Cooled Radiofrequency Ablation in Two Patients with Chronic Pain

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Abstract **Case Report**

Chronic lower back pain and knee osteoarthritis-related pain are common and often refractory to conservative and interventional treatments. Conventional radiofrequency ablation (RFA) is limited by its narrow lesion size and the risk of tissue injury. Cooled RFA (C-RFA) creates larger and more spherical lesions, potentially improving its efficacy and safety. Two patients with chronic pain who were unresponsive to prior therapy underwent C-RFA. A 59-year-old man with discogenic L2/3 back pain experienced near-complete relief of axial and radicular symptoms that persisted for 17 months after transdiscal C-RFA. A 61-year-old woman with severe knee osteoarthritis (Kellgren–Lawrence grade 4) received C-RFA targeting the genicular nerves, resulting in substantial pain reduction (Numerical Rating Scale: 9→1) and improved function. C-RFA provides significant and durable pain relief in patients with chronic discogenic back pain and advanced knee osteoarthritis. The ability to create large, uniform lesions may offer benefits in both areas requiring extensive lesion coverage and anatomically complex regions. These cases suggest that C-RFA is an effective interventional option for refractory chronic pain and warrant further studies.

Keywords: Cooled radiofrequency ablation, Discogenic pain, Knee osteoarthritis, Genicular nerve block, Biacuplasty.

INTRODUCTION

Low back and knee pain are among the most common musculoskeletal disorders in adults, with a high prevalence and variable patterns and intensities of pain, necessitating a broad range of therapeutic approaches. Conventional treatments typically include pharmacotherapy, physical therapy, nerve blocks, and prolotherapy (Hoy *et al.,* 2010; Vanneste *et al.,* 2025). However, these treatments often fail to provide sufficient pain control, or even if temporary relief is achieved, symptoms frequently recur within a short period. This represents a significant challenge that clinicians continuously encounter in practice.

Radiofrequency ablation (RFA) is another interventional treatment option for patients who do not adequately respond to conventional therapies. This technique uses heat generated by an electrode to selectively ablate target sensory nerves, thereby interrupting pain transmission. Conventional monopolar RFA produces a narrow, elongated, oval-shaped lesion that may limit its ability to encompass the entire target nerve. Heat-related tissue damage has been associated with complications, such as neuritis, tissue injury, and motor nerve injury (Ballantyne *et al.,* 2018).

To address these limitations, cooled RFA (C-RFA) was developed. C-RFA employs an internal cooling system within the electrode to maintain a relatively low temperature at the electrode–tissue interface, preventing the rise in impedance caused by tissue charring. Consequently, the high-frequency energy is delivered uniformly in all directions (Cedeño *et al.,* 2017). Compared with conventional RFA, C-RFA creates lesions that are over four times larger and more spherical, increasing the likelihood of encompassing the target nerves, particularly in regions with anatomically dispersed nerves or where precise nerve localization is challenging. These advantages result in superior ablation efficacy while reducing the incidence of adverse events (Vallejo *et al.,* 2014).

C-RFA has demonstrated efficacy and safety at various anatomical sites, and accumulating clinical evidence supports its use. However, data regarding its real-world applications and effectiveness are limited. Sharing successful clinical experiences with C-RFA provides valuable information for clinicians in decision-

making and contributes to the evidence base supporting the development of treatment algorithms incorporating C-RFA. Therefore, this case report presents two patients with chronic pain who had an insufficient response to conventional therapies and experienced marked pain improvement following C-RFA (Cheng & Rosenquist, 2018).

CASE REPORT

CASE 1

The first patient was a 59-year-old man who reported lower back pain with a Numerical Rating Scale (NRS) score of nine and bilateral lower limb radicular pain with an NRS score of five. During the 5 years after symptom onset, the patient did not respond to pharmacotherapy, prolotherapy, or nerve blocks. On magnetic resonance imaging (MRI) evaluation at our institution, degenerative changes of the L2/3 intervertebral disc were observed, including low signal intensity on T2-weighted images because of dehydration and a high-intensity zone indicative of annular tears and inflammation.

Figure 1: Sagittal and coronary view of the lumbar spine of MRI

Subsequently, provocative discography was performed, and contrast injection into the L2/3 disc reproduced the patient's characteristic pain, confirming a diagnosis of discogenic pain.

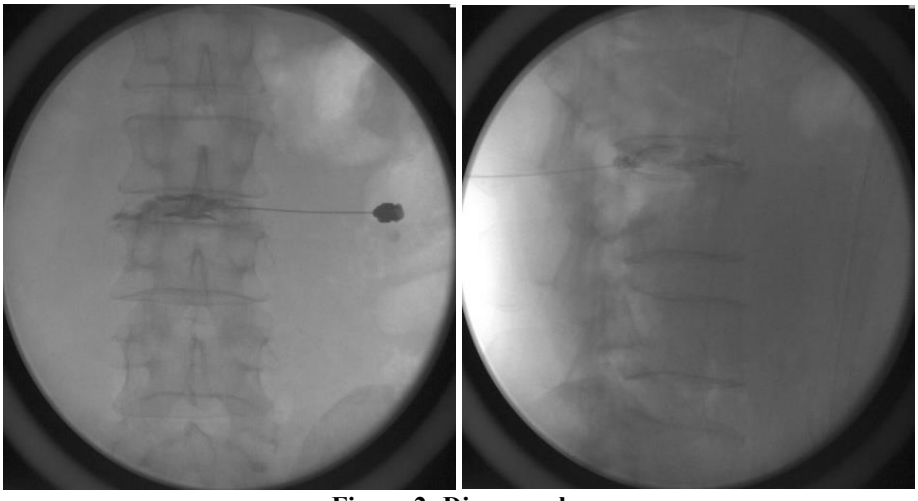

Figure 2: Discography

The L2/3 disc was targeted for C-arm-guided C-RF transdiscal lesioning. A 30°–45° oblique approach was used. The electrode tip was positioned at the posterior one-third of the disc in the lateral view; in the anteroposterior view, it was aligned with the medial border of pedicles. The interelectrode distance was 22 mm. Cooled radiofrequency energy was applied at 50°C for 15 minutes (Desai *et al.,* 2016).

At the 1-week outpatient follow-up, the patient reported a reduction in pain to NRS one, with near-complete resolution of bilateral lower limb radicular pain. Controlled pain remission was maintained for 17 months. However, after this period, the pain recurred to an NRS of approximately seven. The patient expressed a desire to undergo repeat C-RFA, and the procedure was scheduled.

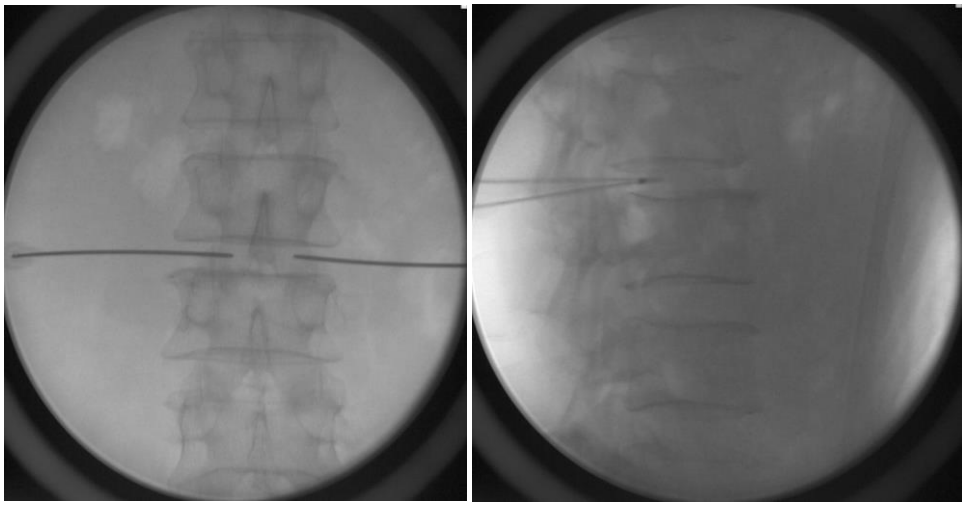

Figure 3: Biacuplasty

CASE 2

The patient was a 61-year-old woman who reported knee pain persisting for over 10 years, with more severe pain in the right knee, rated at NRS nine during walking. Radiographs revealed severe degenerative osteoarthritis of the knee, corresponding to Kellgren–Lawrence grade 4. The patient underwent multiple courses of physical therapy, pharmacotherapy, intraarticular PDRN injections, and prolotherapy, all of which provided temporary relief. Additionally, the patient declined surgical intervention.

Figure 4: Knee radiograph, Anteroposterior view

A diagnostic genicular nerve block provided short-term pain relief, confirming that the pain was mediated by the genicular nerves. Based on this finding, C-RFA was planned and subsequently performed.

The procedure was performed under C-arm fluoroscopic guidance, targeting the superolateral and superomedial genicular nerves (located at the junction between the shaft and epicondyle in the anteroposterior view and at the midpoint of the shaft in the lateral view), inferomedial genicular nerve (at the junction of the tibial shaft and epicondyle in the anteroposterior view and at the mid-shaft level in the lateral view), and vastus intermedius branch (at the midline anterior aspect of the femoral shaft with bone contact, approximately 2 cm proximal to the superior pole of the patella) (Conger *et al.,* 2019). For each nerve branch, sensory stimulation at 50 Hz and 1 V and motor stimulation at 2 Hz and 2 V were applied to confirm accurate electrode placement

and avoid unnecessary motor nerve injury. Subsequently, C-RFA was performed at 60°C for 150 seconds.

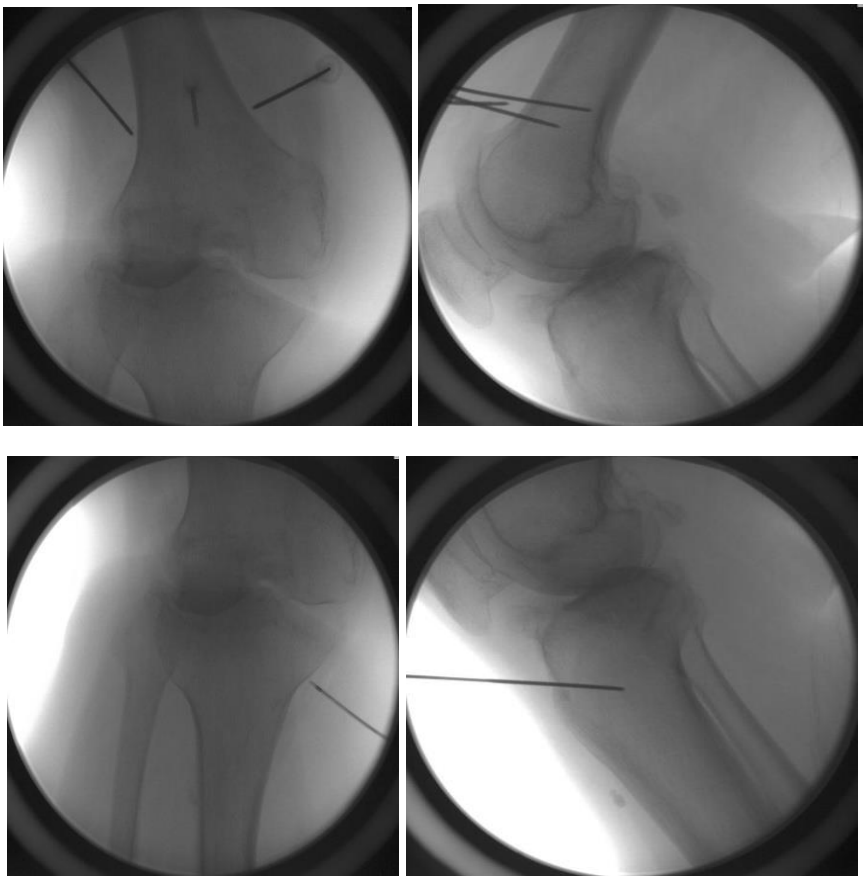

Figure 5: Cooled RFA lesioning of genicular nerve

At the 2-week outpatient follow-up, the patient reported a reduction in pain to NRS one during walking, with a significant improvement in functional activity.

DISCUSSION

In this case report, we present two patients with chronic pain who were refractory to conventional conservative and interventional treatments and achieved significant and sustained pain relief following C-RFA.

In Case 1, the patient experienced discogenic back pain, in which the intervertebral disc was the primary source of pain. Disc degeneration leads to a reduction in proteoglycan content and hydration of the nucleus pulposus, resulting in impaired intrinsic pressure regulation and increased mechanical stress on the annulus fibrosus. This process leads to annular fissures, which allow the abnormal ingrowth of blood vessels and the sinuvertebral nerve, thereby increasing pain sensitivity. Simultaneously, various inflammatory mediators are secreted at fissure sites, causing local inflammation. The combination of structural damage, inflammatory responses, nerve ingrowth, and sensitization renders the disc a major source of pain (Ballantyne *et al.,* 2018).

The ablation of sinuvertebral nerves and sealing of annular fissures form the core principles of percutaneous intradiscal radiofrequency thermocoagulation for internal disc disruption. The techniques include conventional RFA and C-RFA-based biacuplasty. Conventional RFA creates narrow, elliptical lesions that make it difficult to cover the entire annular fissure and widely distributed pain-mediating nerves. So, this approach may only achieve short-term pain relief, with limited long-term efficacy (Gelalis *et al.,* 2022). By contrast, C-RFA generates large, nearly spherical lesions that can more effectively block the extensive pain transmission area in the posterolateral annulus, providing more effective and longer-lasting analgesia than conventional RFA (Kapural *et al.,* 2008; Pauza, 2008).

These characteristics are particularly advantageous not only for discs, which require coverage of a broad area, but also for anatomically variable regions where accurate visualization of the nerve location is challenging, such as the genicular nerves of the knee. Conventional RFA produces elliptical lesions requiring precise nerve localization and parallel electrode placement for effective ablation. This technical requirement may lead to variable outcomes depending on the operator and patient, and high-temperature lesions

increase the risk of injury to the surrounding tissues or motor nerves if electrode placement is inaccurate. By contrast, the spherical lesion created by C-RFA allows effective ablation of the genicular nerves from nearly any angle, providing more reliable outcomes compared with conventional RFA (McCormick *et al.,* 2017).

In both cases, no complications were observed, supporting the notion that C-RFA, despite its higher-energy delivery, may minimize collateral tissue damage through electrode cooling. However, unlike Case 1, Case 2 did not exhibit a reduction in outpatient visit frequency. This could be attributed to two factors. First, residual posterior knee pain remained. While anterior knee pain is mediated by the genicular nerves, posterior knee sensation is transmitted via the main branch of the tibial nerve and common peroneal nerve, which cannot be lesioned because of the risk of motor nerve injury. Second, discomfort due to intraarticular fluid persisted. This is because, unlike the sealing of disc fissures, as in C-RFA, it cannot treat the underlying pathological progression of osteoarthritis itself. Nevertheless, the patient experienced substantial relief from anterior knee pain, expressed high satisfaction with the overall pain management, and reduced reliance on medications.

Conclusion

In this case report, we demonstrated that C-RFA provided meaningful pain relief and long-term symptom control in two patients with chronic low back pain and knee osteoarthritis who had been refractory to conventional conservative and interventional treatments. Although this report is based on a small number of cases, it suggests that C-RFA can be an effective and durable pain management option for patients who are unresponsive to standard therapies. These findings indicate that C-RFA may be particularly useful in clinical scenarios where broad coverage is necessary, such as in discogenic lumbar pain, or where there is considerable anatomical variability in nerve pathways, such as in the knee. Future prospective studies with larger patient cohorts and cost-effectiveness analyses are warranted to establish the clinical value of C-RFA and its potential role in the development of treatment algorithms for various pain conditions.

Ethical Approval and Consent

This case report was reviewed and approved for exemption from ethical review and exemption from written informed consent by the Institutional Review Board of Inje University Sanggye Paik Hospital (IRB No. SGPAIK 2025-12-014)

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