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CASO CLÍNICO

Pulsed Radiofrequency of Genicular Nerves Guided by Ultrasound: Three Case Reports

Radiofrequência Pulsada dos Nervos Geniculares Guiada por Ecografia: Três Casos Clínicos

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ABSTRACT

Knee osteoarthritis is a major cause of disability and pain. Conservative therapies have shown limited efficacy. Radiofrequency ablation of genicular nerves has proven its effectiveness. Pulsed radiofrequency (PFR) is a safe option causing neuromodulation of sensitive fibers without nerve damage, when performed with ultrasound allows a better visualization of the anatomy without the use of radiation. We report 3 cases of patients with chronic knee pain with previous unsuccessful treatments who were submitted to ultrasound-guided PRF of genicular nerves. The Brief Pain Inventory (BPI) and Western Ontario and McMaster Universities Osteoarthritis (WOMAC) scores were assessed before and 30 days following the procedure. All patients had a reduction of perceived pain within 30-day reassessment showing improvement of 30%-65% in WOMAC and 15%-85% in BPI. The results support the safety and potential efficacy of FRP whose patient selection basis, ultrasound references, frequency and duration of treatment require a better definition given the heterogeneity and scarcity of reports in the literature.

RESUMO

A osteoartrite do joelho é uma causa importante de incapacidade e dor, frequentemente com resposta limitada a terapias conservadoras. A radiofrequência ablativa dos nervos geniculares guiada por fluoroscopia revelou-se um método eficaz em casos refratários. No entanto, a introdução mais recente da radiofrequência pulsada (PFR) surge como alternativa segura baseada na neuromodulação de fibras sensitivas, sem lesão nervosa associada e, que quando combinada com uso de ecografia, permite uma melhor visualização da anatomia sem uso de radiação. Reportamos 3 casos de doentes com dor crónica do joelho submetidos a PRF de nervos geniculares guiada por ecografia. O *Brief Pain Inventory* (BPI) e o *score* de Osteoartrite das *Western Ontario* e *McMaster Universities* (WOMAC) foram avaliados antes e 30 dias após o procedimento. Reportou-se uma resposta favorável, variável em termos quantitativos e temporais, com uma redução entre 26% a 65% no WOMAC e 15% a 85% no BPI aos 30 dias e uma noção de melhoria mantida entre 3 e 9 meses. Os resultados corroboram a segurança e potencial eficácia da FRP cuja base de seleção de doentes, referências ecográficas, frequência e tempo de tratamento necessitam de uma melhor definição dada a heterogeneidade e escassez de relatos na literatura.

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INTRODUCTION

Knee osteoarthritis is a major cause of disability and pain. Conservative therapies have shown limited efficacy. Radiofrequency ablation of genicular nerves has proven its effectiveness.[1] With a growing impact of advanced age and obese population, knee osteoarthritis (KOA) has a reported prevalence of 22.9% in patients aged 40 or over.[2] It causes inflammation and progressive degeneration of all joint components triggering pain, stiffness and, in worst cases, deformity and weakness of the joint. It presents itself has a major cause of chronic pain and disability all over the world. In the long term and with disease progression, conservative therapies consisting of physiotherapy, analgesics or intraarticular infiltrations lose effectiveness. Total knee arthroplasty (TKA) remains the gold standard for advanced stages with tri-compartmental osteoarthritis or chronic pain that persists despite conservative treatments. However, 15% to 30% of patients continue experiencing pain and functional limitation after surgery.[3]

Table 1. Characteristics of the patients

	Patient A	Patient B	Patient C
Age	72	73	74
Gender	Female	Female	Female
Body mass index (Kg/m^2)	33	25	31
Comorbidities	DM2 Carpal tunnel syndrome	Depression Hip OA	DM2 HTA Lumbar degenerative disc disease Peroneal neuropathy
Previous ipsilateral surgeries	TKA	THA	Peroneal decompression at the knee
Kellgren-Lawrence score	TKA	III	III
Daily opioid use	No	No	Yes

AO – osteoarthritis, DM2 – diabetes *mellitus* tipo 2, HTA – hypertension, THA – total hip athroplasty, TKA – total knee athroplasty

This sensory conductivity to the knee is given by different branches of femoral, obturator, saphenous, tibial, and common peroneal nerves that surround the joint constituting the so-called genicular nerves (GN).[3] Ablative radiofrequency of these nerves before entering the knee was initially described by fluoroscopy for the treatment of severe chronic pain with favourable outcomes.

Despite that, many patients followed in pain clinics, to still receive long term AINES and opioids intended to reduce pain. Ultrasound (US) and pulsatile radiofrequency (PRF) emerged has valid, secure, and more accessible alternatives that can be set into practice at earlier stages of the disease.4

Based on these principles, we report the cases of 3 patients submitted to PRF of GN guided by US and follow-up of the results.

CASE REPORTS

Three female patients in the 7th decade of life, comorbidities described in Table 1, presented at pain consultation with KOA causing persistent pain with limited response to previous therapies and the diagnosis of chronic musculoskeletal pain.[4] Western Ontario and McMaster Universities Osteoarthritis (WOMAC) score and Brief Inventory Pain (BIP) were calculated, and they were classified as having chronic musculoskeletal pain due to ongoing nociception from damaged tissue and knee inflammation with years of evolution. By that time, the long course of the disease, joint destruction and potentially damage to sensory fibers may be implicated in the positive DN4 questionnaire score for neuropathic pain in 2 of the patients.

Patient A, previously submitted to TKA 9 years ago with persistent pain since then, unresponsive to physical therapy program and with worsening complaints of "pins and needles", burning, numbness and tingling sensation in the previous 2 months was medicated with paracetamol 1 g and metamizole 575 mg during periods of Numeric Pain Score (NPS) equal or above 7.

Patient C, with previous diagnose of peroneal neuropathy submitted to surgical decompression at the knee level 2 years ago, complicated by post-operative infection and difficult rehabilitation. The knee pain felt since then worsened by activity but was also present at rest accompanied by growing sensation of "pins and needles", numbness, tingling and burning. She was medicated with transdermic fentanyl 25 mcg, pregabalin 150 mg/day, metamizole 575 mg and morphine 10 mg as rescue therapy for NPS equal or above 7.

Patient B with a history of total hip arthroplasty and ipsilateral KOA with progressive pain intensified by movement, joint stiffness, swelling and "pins and needles" sensation. She was already submitted to 3 intra-articular injections of hyaluronic acid and physical therapy with no effect and medicated with tramadol 200 mg/day and metamizole 575 mg for NPS equal or above 7.

After explanation of the procedure and informed consent, the technique was performed under aseptic conditions and standard of care monitorization (3-lead electrocardiogram, pulse oximetry and non-invasive blood pressure), no premedication was needed.

The patients were placed in supine position with slight leg flexion, landmarks for radiofrequency of the superior medial, inferior medial and superior lateral genicular nerves were an adaptation of those described by L. Fonkoue *et al* in their anatomic study.[5]

The points were achieved with a radiofrequency echogenic needle (22-G, 10 cm) guided by a high frequency linear probe (HFL38xp, 13-6 MHz).

In a coronal plane of the knee, the probe was moved medially and superiorly to the adductor tubercle of the femur and the insertion of the adductor magnus tendon.

Then, the probe was changed to the axial plane until the transition between medial and posterior cortex, radiofrequency (RF) area for superior medial GN (Figs. 1, A1, A2).

In a medial and coronal position, moving the probe down, to the distal insertion of medial collateral ligament (MCL) of the tibia, the probe was axially rotated to find the transition

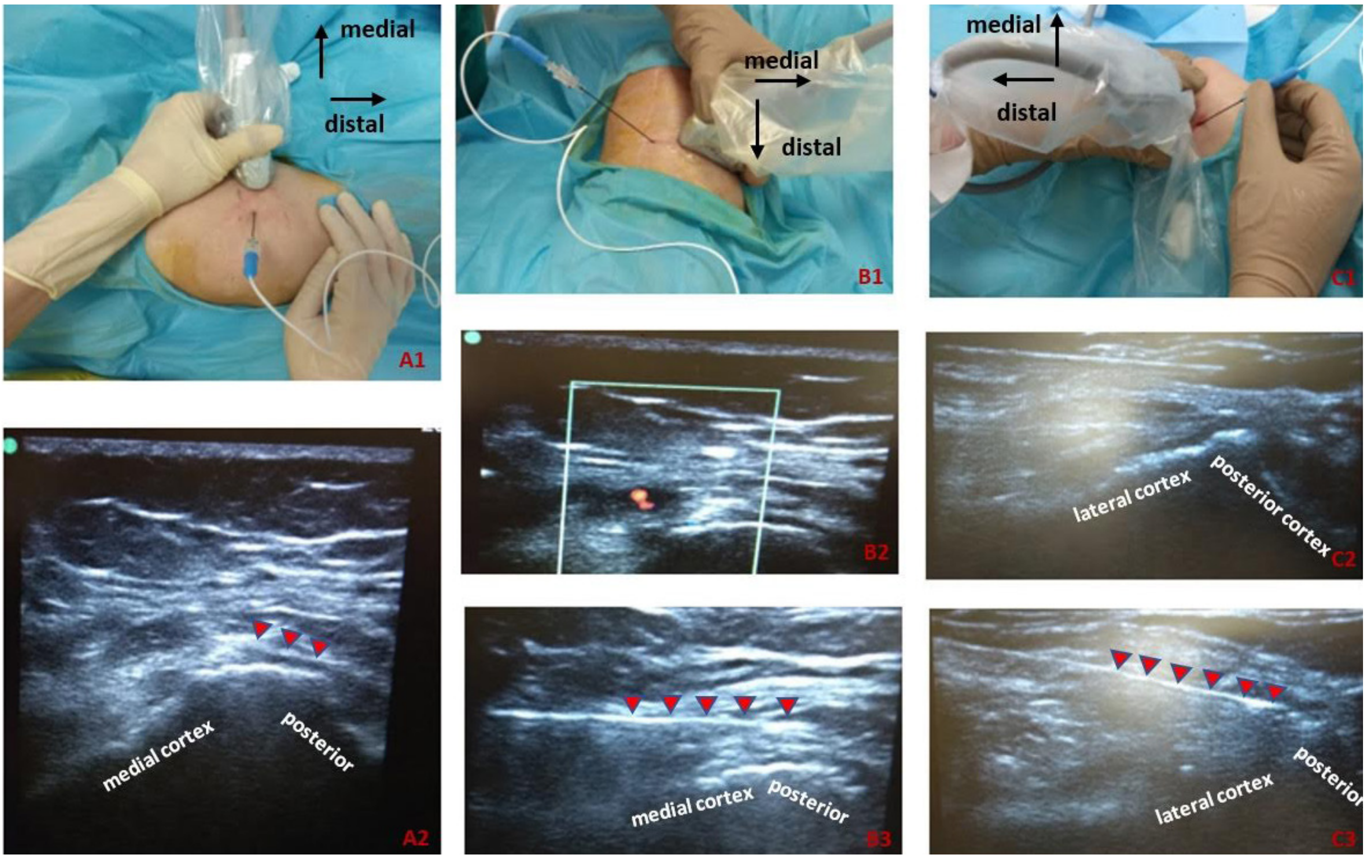

Figure 1. Ultrasound guided radiofrequency of the right knee. NOTE: red arrows indicating the needle position
A. Image of the knee at the level of femoral medial epicondyle for superior medial genicular nerve. US periosteum placement of the needle between medial and lateral cortex of the femur in axial plane.
B. Image of the knee at the level of tibial medial epicondyle for inferior medial genicular nerve. US periosteum and periarterial placement of the needle in axial plane of the tibia.
C. Image of the knee at the level of femoral lateral epicondyle for superior lateral genicular nerve. US placement of the needle at 45º reaching the crest between lateral and posterior sides in a transverse plane of the femur.

between anterior and posterior sides of the tibia, close to the bone and under MCL, RF area for inferior medial GN (Figs. 1, B1, B2, B3).

From the lateral side of the joint and moving up in a coronal plane until the level between lateral epicondyle and femoral epiphysis, the probe was axially rotated and dislocated to find the posterior border of femoral cortex and the area of superior lateral GN (Figs. 1, C1, C2, C3).

Radiofrequency needles were inserted in plane guided by ultrasound after skin infiltration with lidocaine 1%. Sensory stimulation was performed at 50 Hz with low voltage, ideally close to 0.6 V, to obtain paresthesia indicative of a close position of the nerve and stimulation with 2 Hz and 2 V, whose absence of motor response aimed a safe distance to motor fibers.

Once the points have been located, one radiofrequency pulse cycle of 180 seconds was carried out with a maximum temperature of 42ºC followed by infiltration of 1.5 mL Ropivacaine 0.2% and methylprednisolone 125 mg at each point. No incidents occurred and the patients were discharged home with telephone reassessment in 8 days medicated with their standard medications.

One month after the technique, the 3 patients were evaluated in a face-to-face consultation. WOMAC and BIP scores were repeated, reporting improvement in pain and functionality. The reduction in WOMAC score was 30% in Patient A, 26% in Patient B, and 65% in Patient C. The reduction in BIP score was 51% in Patient A, 15% in Patient B and 85% in Patient C.

After 9 months, the patients retrospectively classified the improvement of pain in a scale from 0 (no pain relief) to 100% (total pain relief).

Patient A reported 60% pain improvement up to the present 9^{th} month. Patient B reported 60% pain relief for 3 months and Patient C reported 70% relief for 1.5 months, both referring a progressive reduction of the effect after that period.

One of the patients reported a small transient hematoma near the joint. No other adverse events were noticed (Table 2).

DISCUSSION

Radiofrequency is a recognised treatment for chronic pain. Conventionally used in an ablative way, its high frequency alternating current acts by continuous heat above 45°C-50°C, causing injury to nerve tissue and inhibition of nociceptive afferences.[1] However, some complications may occur related with damage of surrounding tissues and vessels including aneurisms, neurolytic blocks with motor deficit

Table 2. Comparison of pain scores before and after the treatment

	Patient A	Patient B	Patient C
WOMAC score pre-treatment	80	81	75
WOMAC score 30 days post-treatment	56	60	26
Reduction in WOMAC score	30%	26%	65%
BIP pre-treatment	70	72	65
BIP 30 days post-treatment	34	61	10
Reduction in BIP	51%	15%	85%
Pain relief	60%	60%	70%
Maximum effect time (months)	9	3	1.5
Notion of improvement at 9 months	60%	0%	40%
Adverse effects	-	-	Transitory hematoma

BIP - Brief inventory pain questionnaire, score ranges: 0-to-110. WOMAC - Western Ontario and McMaster Universities Osteoarthritis, score ranges: 0-to-96

and increasing neuropathic pain.[6] By limiting the maximum temperature to 42°C with the use of radiofrequency applied in pulses of high electrical intensity but low cumulative temperature, PRF avoids thermal lesion making it a less neurodestructive process and more tolerable for the patient. It is specially promising in cases of neuropathic pain whose thermal lesion may be harmful to an already damaged nerve.[6]
Although KOA pain is typically of nociceptive characteristics, an important neuropathic component cannot be excluded during the degeneration process,[7] as is the case of the three patients described. Radiofrequency waves and their electrical fields are capable of modifying conductivity of the fibers that transmit pain, but its mechanism of action, efficacy and duration of effect is still debatable. The three patients reported favourable results from PRF guided by US. It should be noted that Patient A, whose notion of improvement has remained for at least 9 months, had been reporting a worsening pain with neuropathic components in the two months prior to the technique. The pain accompanied by the "pins and needles" sensation and numbness had a significant improvement after the procedure. Patient C, with a briefer beneficial effect of the treatment by 1.5 months, was a user of fentanyl transdermal patch due to generalized osteoarticular pain of difficult control. The results were measured by WOMAC score, a standardized questionnaire applied in other studies[6] to evaluate KOA. The BIP questionnaire provided a global perspective of pain with multiple questions rated 0-to-10 as well as pain relief to treatment in a scale 0-to-100% helping to understand how the improvement in knee pain reduced physical and emotional limitation of the patient.

The heterogeneity of the results matches different descriptions of PRF of GN in the literature, with positive outcomes of varying duration.

The 9-month period evaluation was selected to document the maximum temporal effect and based on previous descriptions of beneficial effects of PRF up to 12 months.[8] However, during that time, the treatment could have been repeated attempting to improve global outcomes us other described studies described.[9]

Radiofrequency affects a circumscribed area around the electrode located at the tip of the needle, as such, to achieve effective treatment, its correct location is essential. Still, there is a lack of standardized method and consensual approach to GN nerves.[10] Anatomic studies of nerve trajectories were undertaken,[10-12] but its reduced size makes it difficult to visualize. Regardless of the technique, previous knee surgery was performed in Patient A and C, both obese.

These are conditions known to interfere with anatomic landmarks and that made it difficult to locate the structures, probably interfering with results. We believe that despite the small sample and incomplete relief, these descriptions, highlight the use of pulsed radiofrequency us part of a multimodal strategy that may be considered in the initial approach of neuropathic knee pain.

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