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Cooled radiofrequency system relieves chronic knee osteoarthritis pain: the first case-series

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Abstract

Background: Knee osteoarthritis is a frequent cause of chronic knee pain. Therapeutic solutions include intra-articular injections with short-term pain relief and surgical therapy. Radiofrequency (RF) of genicular nerves has been previously reported with varying success. Cooling tissue adjacent to the electrode (cooled RF) increases the radius of lesion. We present here the first retrospective data on pain relief and changes in function after such cooled RF denervation.
Methods: We reviewed the records of nine patients with chronic knee pain who underwent cooled RF of genicular nerves. Visual analogue scale (VAS) and Western Ontario McMaster Universities OA index (WOMAC) were analysed.
Results: We observed an improvement in VAS pain scores 2 ± 0.5 at one month, 2.3 ± 0.7 at three months, 2.1 ± 0.5 at six months, and 2.2 ± 0.2 at 12 months after the procedure, and WOMAC score 20 ± 2, at one month, 22 ± 0.5 at three months, 21 ± 1.7 at six months, and 20 ± 1.0 at 12 months.
Conclusion: The majority of patients with chronic knee pain experienced a clinically relevant degree of pain relief and improved function following cooled RF of genicular nerves at one, three, six and 12 months follow-up.

Key words: cooled radiofrequency, chronic pain, knee, osteoarthritis

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Knee osteoarthritis (OA) is a leading cause of disability in older adults [1], with a growing prevalence in people over the age of 50. Symptoms related by patients with knee OA include pain, stiffness, joint instability, functional limitations, and muscle weakness [2].

Conservative approaches include physical therapy, analgesic drugs, intra-articular injection of steroids, and visco-supplementation [3, 4]. Pharmacological therapy is often of limited benefit for OA pain, but non-steroidal anti-inflammatory drugs are associated with serious side effects, such as bleeding and gastrointestinal ulcers. Non-surgical interventions, including intra-articular injections with steroids of hyaluronic acids, ago-puncture and periosteal stimulation therapy, are often used as complementary therapies, but are not sufficient to control chronic severe knee OA pain [2]. Sometimes these therapies are not successful and sometimes the main surgical approaches such as arthroscopy and total knee joint replacement are not indicated for limiting comorbidities.

Standard radiofrequency (RF) technology is limited in size and shape of lesion, making it difficult to reach the affected areas; in contrast, the cooled RF system has a continuously circulating coolant that moderates the temperature near the tip of the probe allowing more energy to be applied. As a result, larger spherical-shaped lesions are produced that accomplish an effective denervation [5].

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Figure 1. Anteroposterior views of a knee joint under fluoroscopy. After guidance of each of the 3 needles under ultrasound, a frontal spot fluoroscopic image was obtained to document the final needle position

No one has studied the effect of cooled radiofrequency on genicular nerves: we examined the efficacy of this application to sensory nerves as a novel alternative treatment for refractory knee pain.

METHODS

This study was conducted at the Pain Management Unit of San Carlo Clinic of Paderno Dugnano, Milan, Italy. All participants provided written informed consent and were treated with cooled RF (Fig. 1). Between March 2013 and March 2014, patients with knee pain were examined to ascertain their eligibility. After clinical and radiological assessment, the study subjects comprised elderly patients with chronic knee pain (i.e. knee pain of at least moderate intensity on most days for > 3 months) and radiologic tibio-femoral OA. These patients did not respond to other treatments including physiotherapy, oral analgesics and intra-articular injection with hyaluronic acids or steroids.

The exclusion criteria included acute knee pain, other connective tissue disease affecting the knee, serious neurologic or psychiatric disorders, injection with steroids of hyaluronic acids during the previous three months, and pacemakers. Most of our patients could not be submitted to invasive procedures due to comorbidities. A total of nine patients were chosen, and the follow up was extended to one, three, six and 12 months after the procedure.

Demographic characteristics are described in Table 1.

Three patients underwent total knee arthroplasty. All procedures were C-arm fluoroscopy-guided. Minimal sedation was used, allowing subjects to communicate for the duration of the procedure. After patients underwent routine monitoring (e.g. pulsoximetry, TA and ECG), and they were placed on the fluoroscopy table. The area where the procedure was to be performed was cleaned with an iodine antiseptic solution and draped to maintain a sterile environment.

Table 1. Demographic characteristics of study patients

Age (years)	Mean ± SD	72 ± 0.4
	range	46–91
Gender	Female n (%)	6 (66.6)
	Male n (%)	2 (22.2)
Duration of symptom (mo)	Mean ± SD	67.8 ± 50
	Range	10–230
Symptomatic knee side	Right n (%)	2 (22.2)
	Left n (%)	1 (11.1)
	Bilateral n (%)	5 (55.5)
Treatment forms applied before	Analgesic drugs (NSAIDs and/or opioids)	1 (11.1)
	Analgesic drugs (NSAIDs and/or opioids) + physical therapy	1 (11.1)
	Analgesic drugs (NSAIDs and/or opioids) + physical therapy + intra-articular injection (steroid or hyaluronan)	6 (66.6)
Total knee arthroplasty	Women n (%)	3 (33.3)
	Men n (%)	0
Comorbidities	Neurinoma n (%)	1 (11.1)
	Rheumatoid arthritis n (%)	3 (33.3)
	Pott disease n (%)	1 (11.1)
	Diabetes mellitus n (%)	5 (55.5)
	Ischaemic cardiopathy n (%)	3 (33.3)

NSAID — non-steroidal anti-inflammatory drug; SD — standard deviation

Pain Visual Analogue scale (VAS) and the patient's global assessment were used as outcome measures. The Western Ontario McMaster Universities OA index (WOMAC) [6] was used: the score has three discrete domains — pain (five questions, possible subscale score 0–20), stiffness (two questions, 0–8), and physical functioning (17 questions, 0–68) and thus has a minimum score of 0 (best score) and a maximum score of 96 (worst score).

Patients answered the WOMAC questionnaire before the procedure and during each follow-up after treatment. Pain was evaluated with VAS where 0 indicates no pain, whereas 100 indicates intractable pain. Paired-samples Student *t* test was used to compare mean VAS and mean WOMAC scores to baseline values at each follow up. A *P* value of 0.05 was

Table 2. WOMAC and VAS values

	1 month	3 months	6 months	12 months
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
VAS	2 ± 0.5	2.3 ± 0.7	2.1 ± 0.5	2.2 ± 0.2
P value				
Basal VS	< 0.01	< 0.01	< 0.01	< 0.01
	1 month	3 months	6 months	12 months
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
WOMAC	20 ± 2	22 ± 0.5	21 ± 1.7	20 ± 1.0
P value				
Basal VS	< 0.01	< 0.01	< 0.01	< 0.01

Basal value VAS 8 ± 1.5 and WOMAC 88 ± 1.9; VAS — visual analogue scale; WOMAC — Western Ontario McMaster Universities OA index

considered statistically significant in all analyses. The values were given as mean ± SD.

RESULTS

Basal VAS and WOMAC are respectively 8 ± 1.5 and 88 ± 1.9. VAS and WOMAC scores decreased one month after treatment (mean VAS scores 2 ± 0.5; mean WOMAC scores 20 ± 2). In the following months, there was a stabilisation of painful symptomatology (means VAS scores 2.3 ± 0.7 at three months, 2.1 ± 0.5 at six months, and 2.2 ± 0.2 at 12 months). Patients also had improved autonomy in daily life (mean WOMAC scores 22 ± 0.5 at three months, 21 ± 1.7 at six months, and 20 ± 1.0 at 12 months). No patients developed complications (infection, haemorrhage, loss of motor and sensory control in the corresponding area of the genicular nerves) during the early or late period of follow up. *P* values are reported in Table 2.

Relief was maintained beyond 12 months.

In one of the three patients with knee replacement, WOMAC scores decreased significantly (*P* value < 0.01), even though VAS values did not decrease significantly (*P* value > 0.05), probably due to prosthesis pain.

Genicular nerve ablation successfully improved pain and restored function after total knee arthroplasty in two out of three patients.

DISCUSSION

Chronic knee osteoarthritis (OA) is a major public health problem: population-based studies have revealed that symptomatic knee OA is present in 20–30% of the elderly population aged > 65 years [1]. The knee joint is innervated by the articular branches of various nerves, including the femoral, common peroneal, saphenous, tibial and obturator nerves [2]. These articular branches around the knee joint are known as genicular nerves. RF treatment has been used for several painful conditions such as trigeminal neuralgia, cancer pain, and spinal pain. In order to destroy nerves or disrupt the transmission of pain signals, originally by means of producing heat lesions, RF current is applied to the trigeminal ganglion, the spinothalamic tracts of the spinal cord, the medial braches of posterior rami and the dorsal root ganglion [4]. Therefore, it is essential to place the electrode tip as close as possible to the target nerve: there are several reasons for the difficulty in localising the target nerve, for example the variability of the anatomical course of each target nerve and the sensory nature of target nerves. Also it is impossible to elicit an objective response by the electrical nerve stimulation, such as muscle contractions in localising a motor nerve. Cooled RF is a novel technology whereby internally cooled RF probes can reportedly yield larger tissue lesions than those created by standard RF probes [7].

Raadiofrequency neurotomy is used successfully in OA patients [8]: Choi et al. [5] investigated the use of RF treatment to alleviate chronic knee osteoarthritis pain. The randomised controlled trial demonstrated greater improvements in pain, function, and satisfaction for patients treated with RF than for controls.

Although severe knee osteoarthritis with refractory pain is commonly treated surgically, this is often not an option for patients with a poor health status or who are unwilling to undergo major surgery, as was the case with most of our patients.

Only a few papers have investigated the use of radiofrequency ablation of the genicular nerves to alleviate chronic knee pain after total knee replacement [9]: our study showed a positive relief in two out of three patients.

CONCLUSIONS

Our research has some limits. One is the small number of patients. Secondly, the follow up was limited to 12 months.

Even given these limitations, our results suggest than cooled RF neurotomy of genicular nerves has the potential to significantly improve pain, function, and satisfaction, with the possibility of probing a larger tissue lesion than classical RF neurotomy. Moreover, cooled RF can be used in patients in whom an invasive procedure is not recommended. The decreases of chronic pain and medication usage, along with the improvement in quality of life and high degree of treatment satisfaction, may justify the use of cooled RF in a broader population.

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