Indications of the Neurotomy of Genicular Nerves by Radiofrequency for the Treatment of Knee Osteoarthritis: A Literature Review*

Indicações da neurotomia dos nervos geniculares por radiofrequência para o tratamento da osteoartrite do joelho: uma revisão de literatura

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Abstract

Osteoarthritis (OA) is one of the most frequent and incapacitating pathologies today, especially of the knee. Among the possible approaches for knee OA, the neurotomy of the genicular nerves by radiofrequency (RF) has been gaining prominence. However, as this is a relatively new procedure, indications for its implementation are still unclear. The objective of the present review is to identify the main indications of the use of RF for the treatment of knee OA in the medical literature. A review of the literature was performed in January 2018 through a search in the PubMed, ClinicalKey and Google Scholar databases. After reviewing the main articles on the subject, it was concluded that the main indications of the use of RF for the treatment of knee OA were: OA Kellgren-Lawrence grades 3 and 4, with moderate to severe pain and failure of conservative treatment, mainly in elderly people; persistence of pain even after total knee arthroplasty (TKA); patients with an indication for TKA who refuse to undergo surgical treatment.

Keywords
- neurosurgical procedures
- radio waves
- rhizotomy
- osteoarthritis, knee
- knee joint

Resumo

A osteoartrite (OA) é uma das patologias mais frequentes e incapacitantes na atualidade, principalmente do joelho. Dentre as abordagens possíveis para OA, a neurotomia dos nervos geniculares por radiofrequência (RF) vem se destacando. Todavia, por se tratar de um procedimento relativamente novo, as indicações para sua realização ainda não estão bem definidas. O principal objetivo da presente revisão foi identificar as principais indicações do uso da RF para o tratamento da OA do joelho

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- ondas de rádio
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- osteoartrite do joelho
- articulação do joelho

na literatura médica. Foi realizada uma revisão da literatura em janeiro de 2018, através de pesquisa nas bases de dados PubMed, ClinicalKey e Google Scholar. Após a revisão dos principais artigos sobre o assunto, foi concluído que as principais indicações do uso da RF para o tratamento da OA do joelho foram: pacientes com OA graus 3 e 4 da classificação de Kellgren-Lawrence, com dor de moderada a severa e falha do tratamento conservador, principalmente idosos; persistência da dor, mesmo após a realização de artroplastia total de joelho; pacientes com indicação de artroplastia total de joelho que se recusam a se submeter ao tratamento cirúrgico.

Introduction

Osteoarthritis (OA) is a condition of multifactorial origin that degenerates the articular cartilage, affecting the components of the involved joint. It is a musculoskeletal disorder, usually insidious, progressive and slow, which typically affects the joints of the hands, of the spine, of the hip, and of the knee, impairing work capacity and daily activities of these patients. It is the most common joint disorder, affecting between 6 and 12% of the adult population, and more than one third of individuals $>$ 65 years old.[1,2]

Progression of knee OA is the most common reason for total joint replacement. In addition, it is one of the most important factors of health care costs in our society.[3]

Since the main therapeutic goal of knee OA is to provide pain relief and to improve the functional status of the patients, a multidisciplinary approach is required for better functional results.[4–6]

The initial approach to OA is with nonsurgical, that is, conservative treatment, which is performed through analgesic medication and lifestyle changes, such as weight reduction, exercises, physical therapy, and even acupuncture.[3] Anti-inflammatory agents are usually reserved for rescue in acute flares. Other medications often used, such as glucosamine, chondroitin, unsaponifiable soy and avocado extract, diacerein, collagen, and viscosuplementation with hyaluronic acid, frequently present conflicting and inconsistent results in the literature.[1,7–10]

Surgical treatment is indicated in cases with conservative treatment failure, and it should occur if there is progressive reduction of independence in daily living activities. The available surgeries include arthroscopic debridement, osteotomies, arthroplasties, and arthrodeses.[11,12]

Currently, the ablative radiofrequency (RF) treatment at temperatures ranging from 80°C to 90°C has been used to treat several painful conditions, such as trigeminal neuralgia, as well as in the symptomatic treatment of oncologic pain and of spinal facet pain.[13–16]

Radiofrequency is an alternating electric current with an oscillatory frequency of 500,000 Hz, which generates the necessary heat for the desired neuronal damage. In addition to the conventional ablative RF, pulsed RF (with temperatures of up to 45°C) and refrigerated ablative RF can be used.[16,17]

At the knee, the main target of RF consists of peri- or intra-articular sensory innervation through genicular branches.

In the last 5 years, some scientific publications have suggested an important role of RF in the treatment of knee OA and in cases of persistent pain after total knee arthroplasty (TKA).[16]

Since this is a new method, it is fundamental to gather the main current scientific evidence, so that the real significance of RF in the treatment of gonarthrosis can be determined.

Thus, the main objective of the present review was to identify the main indications of RF for the treatment of knee OA in the medical literature.

Methodology

An electronic research was conducted in January 2018 by 2 authors (Gonçalves M. C. K. and Lima D. A.) in the PubMed, ClinicalKey and Google Scholar databases, using the last 5 years as a date limit.

The following indexing terms were used for the search: *knee radiofrequency neurotomy*, *knee rhizotomy*, *knee radiofrequency ablation*, *genicular neurotomy*, and *knee neurolysis*.

Titles and abstracts were used to select papers complying with the research objective. Thus, only papers mentioning genicular rhizotomy in titles or abstracts were selected. The selected papers were read in their full version, and their reference lists were manually searched for additional relevant publications. Data extraction discrepancies were solved through discussions between the authors.

As inclusion criteria, only clinical studies performing genicular rhizotomies were selected. Only papers that had a full version in English or at least an abstract in English were included. Studies in which patients were followed-up for $<$ 3 months, which were purely anatomical, and case report studies were excluded, as well as review articles that did not contain original data.

The following data were searched in the included studies: indication of rhizotomy, authors and date of publication, sample size, mean age, and follow-up.

Results

Retrieved Papers

A total of 505 papers were found in PubMed (knee radiofrequency neurotomy [437], knee rhizotomy [08], knee radiofrequency ablation [41], genicular neurotomy [5], and knee neurolysis [14]), 521 in ClinicalKey (knee radiofrequency

neurotomy [67], knee rhizotomy [23], knee radiofrequency ablation [281], genicular neurotomy [11], and knee neurolysis [139]), and 4,341 in Google Scholar (knee radiofrequency neurotomy [990], knee rhizotomy [198], knee radiofrequency ablation [952], genicular neurotomy [191], and knee neurolysis [2010]).

Next, papers simultaneously indexed in >1 database were excluded, resulting in 3,820 papers.

After reading the titles and abstracts, 57 articles were obtained. Eventually, after a complete reading of the papers and the application of the exclusion criteria, the search was terminated, with a total number of 19 retrieved papers (►**Fig. 1**).

Patients

These 19 studies included a total of 859 patients, most of them female. The average age ranged from 60 to 70 years old. All of the patients were submitted to clinical and imaging evaluation prior to the indication to treatment with RF.

Follow-up

The studies followed-up the patients for at least 3 months after the procedure. For the clinical follow-up, pain and functional measurement scales, such as the visual analogue scale (VAS),[18] The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC),[19] the Patient's Global Impression (PGI-I),[20] the Knee Society Score (KSS),[21] the Oxford Knee Score (OKS),[22] the Numeric Rating Scale (NRS),[23] and the Goldberg Anxiety and Depression Scale (GADS), were used.[24]

Radiofrequency Type and Adjuvant Imaging Technique

The types of RF used included three modalities: conventional ablative, refrigerated ablative, or pulsed ablative RF.

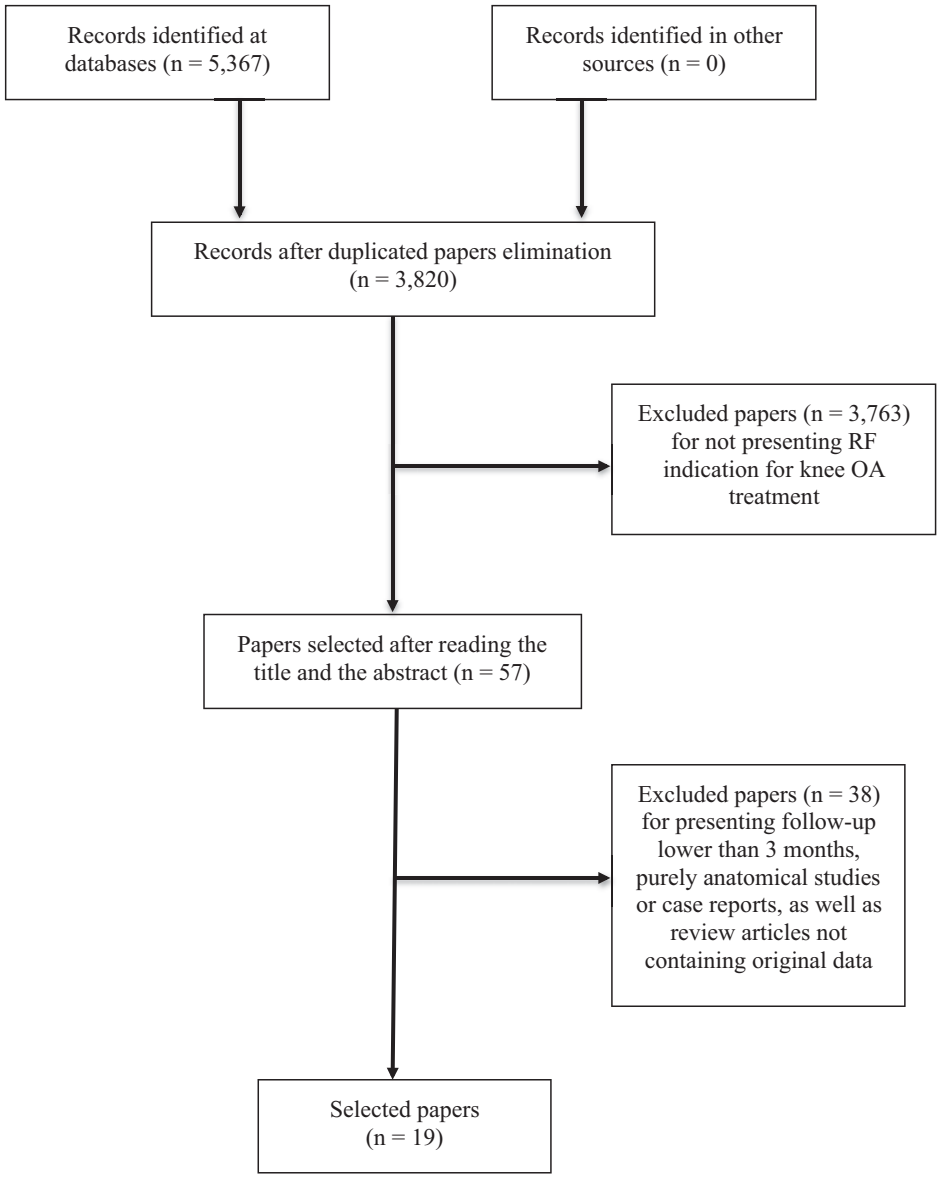

Fig. 1 Paper selection flow chart. Abbreviations: OA, osteoarthritis; RF, radiofrequency.

Fluoroscopy and ultrasonography were cited as adjuvant methods for the correct positioning of the electrodes during the application of RF.

Radiofrequency Indication

Studies have shown the indications for RF in the treatment of knee OA.

Indications for the use of RF in the treatment of gonarthrosis and the respective conclusions of the papers are listed in ►**Table 1**.[25–43]

Procedure Results

Among the selected papers, the best results were obtained in the 1st 6 months of follow-up. McCormick et al[31] reported complete pain relief in this period.

After 6 months, the results decreased. Iannaccone et al[32] report no more than 60% of pain relief after 6 months.

Santana Pineda et al[26] reported that the treatment effect started to decrease after 6 months; however, up to 1 year after the intervention, 32% of the patients reported an improvement $\geq$ 50% compared to the pretreatment VAS results. According to Bellini et al,[29] there was clinically relevant pain relief and functional improvement up to 12 months of follow-up.

Discussion

The present review study evaluated 19 papers searching for the main indications of RF for the treatment of knee OA.

Radiofrequency is a relatively new addition in the knee OA-related pain management, and it is used in many procedures aimed at pain relief, with effective medium- and long-term results, as demonstrated by van Kleef et al,[44] who evaluated this therapeutic modality in chronic low back pain.

Knee OA is a clinical condition that often leads to disability. Approximately 12% of the population $>$ 60 years old have knee OA-related symptoms. A study estimates that the medical costs associated with this condition range from USD 1,000 to USD 4,100 per person/year.[45]

Total knee arthroplasty is still considered the gold standard surgical procedure for the treatment of knee OA cases that are both symptomatic and refractory to conservative therapy.[46] However, TKA, as a major procedure, can generate complications such as infection, instability, neurovascular lesions, thromboembolism, and even absence of pain control.[47]

In the present review, the careful reading of the 19 analyzed papers suggests that RF can be considered as another weapon in the therapeutic armamentarium to alleviate chronic knee pain secondary to OA or persistent pain after TKA.

In addition to pain control, some evidence suggests an improvement in the function of the patients, especially in older individuals.

None of the studied papers report serious complications related to the use of RF. Santana Pineda et al[26] concluded that this treatment is safe and minimally invasive, and that it can be performed in an outpatient setting.

However, there are concerns about quality, outcome monitoring, and the time in which this procedure is most beneficial to the patient.

The present study concluded that RF presents effective results, culminating in complete pain relief after 6 months of follow-up, especially when using refrigerated RF, as demonstrated by McCormick et al.[31]

Part of the studies used the Kellgren-Lawrence classification when assessing the indications for RF.

The Kellgren-Lawrence classification is one of the earliest radiograph-based classification for OA. It is graded in 5 stages, in which 0 is the absence of OA and 4 is the most severe grade. As highlighted by Rodrigues et al,[48] this classification is easily memorized and interpreted, allowing its safe use. In the knee, it requires only radiographs in anteroposterior views, but not monopodal support or joint extension.[48]

Authors used pain and function measurement scales to aid the indication of RF genicular neurotomy. These scales are measurement instruments often employed to quantify a feature that cannot be directly determined. In the VAS, pain intensity can be assessed by one of the versions of this scale, which consists of a 10-cm horizontal line ranging from no pain in one extremity to the worst possible pain in the other. Numerical values, verbal descriptors and/or suffering faces may be determined, and these are potentially useful characteristics for patients who have difficulties in understanding numerical scales.[18]

In addition to the Kellgren-Lawrence classification stage and to the use of pain and function measurement scales, refractoriness to the conservative treatment was one of the most cited factors.

The failure of conservative treatment in OA management, even in patients submitted to TKA, is, along with the pain level, one of the most frequent indications for RF genicular neurotomy.

Eyigor et al[42] also suggest that this procedure is effective and safe for the treatment of pain in patients with advanced knee OA and that, in the future, it may be included in the guidelines for chronic pain treatment, especially with the increase in the number of studies in the area.

It is worth noting that the use of RF in the treatment of gonarthrosis is still a recent issue. The main evidence suggests consistent results in the 1st year of follow-up, highlighting the 1st 6 months.[26,29,31,32]

As such, as expressed in the conclusions of Mata et al[37] and of Qudsi-Sinclair et al,[33] it is clear that further studies with larger sample sizes and longer follow-up periods are required, mainly to evaluate the long-term treatment response.

Final Considerations

In the analyzed papers, the main indications for the use of RF in the treatment of knee OA included patients with Kellgren-Lawrence grades 3 and 4 OA, with moderate to severe pain and failure of conservative treatment, mainly in elderly individuals; persistence of pain even after TKA; and patients

Table 1 Radiofrequency indication for the treatment of knee osteoarthritis

Author and year	Indication	Study Conclusion
Kirdemir et al, 2017[25]	Patients with grade 2 to 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 6 months.	Genicular neurotomy results in a significant pain reduction and functional improvement in elderly patients with chronic pain due to gonarthrosis and, therefore, it may be an effective treatment in such cases.
Santana Pineda et al, 2017[26]	Patients with grade 3 and 4 OA at the Kellgren-Lawrence classification and VAS score $\geq$ 5 for $>$ 6 months under conservative treatment.	Ultrasound-guided RF genicular neurotomy relieves intractable pain and disability in most patients with advanced knee OA. This treatment is safe and minimally invasive, and it can be performed in an outpatient setting.
Sarı et al, 2018[27]	Patients with grade 2 to 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 3 months, moderate to severe pain, and not eligible for TKA.	RF genicular neurotomy is a safe and efficient treatment, providing functional improvements and analgesia in patients with chronic knee OA.
Kesikburun et al, 2016[28]	Patients with grade 3 and 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 6 months and who had at least a 50% reduction on the VAS scale after genicular nerves blocking with an anesthetic solution.	Pulsed RF genicular neurotomy was considered safe and beneficial in OA-associated knee pain.
Bellini et al, 2015[29]	Patients with OA that was refractory to conservative treatment for 3 months and with moderate and severe pain.	Most patients with chronic knee pain experienced clinically relevant pain relief and functional improvement after refrigerated RF genicular neurotomy at 1-, 3-, 6- and 12-month follow-up.
Davis et al, 2018[30]	Patients with grade 2 to 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 6 months with NRS $\geq$6, OKS $\geq$35, use of opioids or equivalents and who had at least a 50% reduction on the NRS scale after genicular nerves blocking with an anesthetic and corticoid solution.	Refrigerated RF genicular neurotomy is a long-term therapeutic option to manage pain and improve function and quality of life in patients with gonarthrosis when compared to corticosteroid injections.
McCormick et al, 2017[31]	Patients with OA that was refractory to the conservative treatment and who had an improvement after genicular nerves blocking with an anesthetic solution.	Refrigerated RF genicular neurotomy demonstrated a success rate of 35%, and 19% of the procedures resulted in complete pain relief after 6 months of follow-up.
Iannaccone et al, 2017[32]	Patients with OA that was refractory to the conservative treatment and who had an improvement of at least 80% after genicular nerves blocking with an anesthetic solution.	Refrigerated RF genicular neurotomy can provide an average of $>$ 60% pain relief at a 6-month follow-up.
Qudsi-Sinclair et al, 2017[33]	Patients with persistent pain for at least 6 months after TKA and refractory to conservative treatment.	More studies are required to further evaluate the long-term response.
Sarı et al, 2017[34]	Patients with grade 2 to 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 3 months.	The results of RF neurotomy aided with ultrasound or fluoroscopy are similar.
Shen et al, 2017[35]	Patients with persistent pain due to OA for at least 3 months and VAS $\geq$6.	RF genicular neurotomy is more effective than regular treatment to relieve refractory pain and promote functional recovery in patients with knee OA.
Mogahed et al, 2017[36]	Patients with OA that was refractory to conservative treatment for 3 months and VAS $>$ 5, and not eligible for TKA.	Both conventional and pulsed RF neurotomy control pain in patients with knee OA, decreasing the amount of analgesic medication required.
Mata et al, 2017[37]	Patients with grade 2 to 4 OA at the Kellgren-Lawrence classification that was refractory to	The study is not yet concluded, but it recommends that further researches are required to assess long-term responses.

(*Continued*)

Table 1 (*Continued*)

Author and year	Indication	Study Conclusion
	conservative treatment for 6 months and had VAS $\geq$4 for more than 3 months.	
Gulec et al, 2017[38]	Patients with grade 2 and 3 OA at the Kellgren-Lawrence classification with pain for at least 3 months.	Bipolar RF is more advantageous in reducing chronic knee pain and improving functional recovery compared to unipolar RF. Further studies are required.
Masala et al, 2014[39]	Patients with grade 3 and 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 6 months.	Pulsed RF genicular neurotomy appears to be an effective and reliable technique for palliative management of chronic pain in patients with knee OA.
Hashemi et al, 2016[40]	Patients with grade 2 and 3 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 3 months.	RF genicular neurotomy and intraperiarticular ozonation are good clinical indications in knee OA, with RF superiority at patients $>$ 65 yearsold.
Ramírez Ogalla et al, 2014[41]	Patients with grade 3 and 4 OA at the Kellgren-Lawrence classification that was refractory to conservative treatment for 3 months and had VAS $\geq$5.	RF genicular neurotomy has shown significant benefit in terms of pain reduction and functional improvement at a 6-month follow-up in patients with chronic knee OA and, therefore, it can be an effective treatment in such cases. Further trials with larger sample sizes and longer follow-up periods are required.
Eyigor et al, 2015[42]	Patients with grade 3 OA at the Kellgren-Lawrence classification that was refractory to the conservative treatment.	It is possible to affirm that RF genicular neurotomy is effective and safe for pain management in patients with advanced knee OA. Therefore, we believe that this procedure will be included in the guidelines for the treatment of chronic pain in the future, especially with the increase in the number of studies.
Yuan et al, 2016[43]	Patients with OA refractory to conservative treatment.	The effect of pulsed RF genicular neurotomy is obviously superior to the use of intra-articular betamethasone injection in the treatment of refractory knee OA, being an effective method in elderly patients.

Abbreviations: NRS, numeric rating scale; OA, osteoarthritis; OKS, Oxford knee score; RF, radiofrequency; TKA, total knee arthroplasty; VAS, visual analogue scale.

with TKA indication but who refuse to undergo surgical treatment. It is highlighted that further studies are required to corroborate these findings.

Conflicts of interests

The authors have no conflicts of interests to declare.

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