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Intraarticular Pulsed Radiofrequency *vs.* Radiofrequency Neurotomy in Patients with Chronic Knee Pain due to Osteoarthritis (OA)

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Abstract

Background: Advanced age usually suffer from painful osteoarthritis of knee (OA). Treatment of OA pain by non-steroidal anti-inflammatory is of restricted benefit and surgery is challenging in many patients due to associated medical problems. In this study we used either intraarticular PRF or radiofrequency neurotomy to control pain in patients with chronic knee pain.

Aim: The primary outcome of the study was the pain score 10 cm Visual Analog Scale (VAS). The secondary outcome of the study was (1) WOMAC scores (2) Amount of analgesic medications.

Methods: This study was conducted on 100 adult patients more than 60 years with chronic knee pain (grade 3 or grade 4) osteoarthritis. Patients were divided into two groups each group contain 50 patients. In group I (intraarticular PRF), patients were treated with PRF where patient was placed in a supine position on the fluoroscopy table, knee joint was flexed to 15°, No genicular block tests were performed. Group 2 (radiofrequency neurotomy), patients were treated with radiofrequency neurotomy. Where patients were placed in a supine position on the fluoroscopy table, knee joint was flexed to 15° and genicular block tests were performed.

Results: Our results showed that both groups were comparable regarding age, sex, weight and height. A significantly improvement of pain was noticed in group II when compared to group I at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months (3.2 ± 1.9, 1.8 ± 0.4, 1.9 ± 0.5, 2.1 ± 0.8, 2.2 ± 0.5, 2.9 ± 0.6) $p<0.001$. In Group 1, there was a significant decrease in mean of VAS scores in comparison to the pre-study values at 1 week, 1 month, 3 months and 6 months (5.6 ± 0.8, 3.8 ± 1.7, 3.9 ± 1.9, 4.2 ± 1.6). While in Group 2 the significant decrease present at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months compared with pretreatment values was (3.2 ± 1.9, 1.8 ± 0.4, 1.9 ± 0.5, 2.1 ± 0.8, 2.2 ± 0.5, 2.9 ± 0.6).

Conclusion: Both, the radiofrequency neurotomy or pulsed radiofrequency controls pain in patients with chronic knee pain, decreases amount of analgesic medications consumption, minimize post-operative complications with the upper hand to radiofrequency neurotomy.

Keywords: Intraarticular PRF; Radiofrequency neurotomy; Chronic knee pain

Introduction

Old age usually suffers from painful osteoarthritis of knee (OA) [1,2]. Pain is a main symptom of OA due to cartilage degeneration, diminished joint space, osteophytes, and loose bodies [3].

Many side effects are also associated with inadequate movement, sleep disturbance, and psychosocial disturbances [4-7]. Together with inflammatory responses to OA resulted from Infectious, metabolic, autoimmune, traumatic, and degenerative processes, leading to production of pro-inflammatory cytokines such as tumor necrosis factor (TNF)-α, interleukin (IL)-1β, and IL-6 [8,9] in joints.

The use of non-steroidal anti-inflammatory is of restricted benefits due to grave side-effects, such as gastrointestinal ulcers, intraarticular injection with steroids or hyaluronic acid or the use of acupuncture and periosteal stimulation therapy does not profit, especially in grade 3 and grade 4 knee OA [10-16].

Total Knee replacement is a final treatment in Knee OA, but surgery itself, carries many risks due to multiple medical complications and results in more use of analgesics (opioids) [17], Radiofrequency ablation (RFA) and Pulsed Radiofrequency Denervation (PRFD) might be successful replacement methods for management of chronic serious knee OA.

Articular branches of different nerves such as femoral, common peroneal, saphenous, tibial and obturator nerves are the chief innervation of the knee joint [18,19] under fluoroscopic guidance genicular nerves can be easily approached. Radiofrequency ablation (RFA) acts by treating painful area by cutting its innervation using radio wave-induced heat to create a lysis in a sensory nerve [20]. In continuous radiofrequency (CRF) applications, tissue temperature reaches 60-80°C with damage of the target nerves.

The aim of RFA is to alleviate pain by Interrupting the transmission of pain signals from the sensory nerve to the brain [21,22]. through heating the tip of R F probe to high (70-90°C) to the target nerves to be damaged [20].

Pulsed Radiofrequency Denervation (PRFD) is a non-ablative alternative to RFA. The temperature of the tissue does not exceed 42°C in PRFD with no tissue damage [23,24]. PRFA does not deliver steady flow of RF current produced by continuous RF generators but it delivers short bursts of radiofrequency (RF) current. So, the tissue can cool between bursts. RF generator produces pulses with amplitude of 45 V and duration of 20 ms; a silent phase of 480 ms comes after each pulse [25-27]. The RF generator adjusts parameters of the subsequent pulses until the temperature falls within the limit of 42°C: the signal amplitude (volt) or the pulse duration are modified [27]. Both RFA and PFRA are performed in the outpatient setting.

Aim of the Work

The aim of our study is to compare the effectiveness of both the intraarticular PRF, with the radiofrequency neurotomy in patients with chronic knee pain.

Patients and Methods

100 patients above the age of 60 years having chronic knee pain (grade 3 or grade 4 osteoarthritis according to Kellgren-Lawrence system) and not responding to pharmacological treatment in the outpatient pain management unit, Tanta University Hospital, were included in the study. From the August 2016 to August 2017. After approval of the ethics committee and obtaining verbal and written informed consent from each patient.

Any unexpected side effects during the study was cleared to the patient and the ethical committee on time and the proper management was done for the benefit of the patient.

Inclusion criteria

Patients with intractable knee pain intensity >5 on an 11-point visual analog scale (VAS) (where 0=no pain and 10=worst pain imaginable) for longer than three months and unable to do knee replacement surgery, Patients failed traditional anti-inflammatory medication and physical therapy.

Exclusion criteria

Patients with acute knee pain, preceding knee surgery, other connective tissue diseases affecting the knee, anticoagulant medications, neurologic or psychiatric disorders, injection with steroids or hyaluronic acids during the earlier 3 months, sciatic pain, pacemakers, and prior electroacupuncture treatment.

Any history of metabolic, infectious, or autoimmune diseases that may lead to chronic form of pain must be cleared before the study. The baseline values of visual analogue scale (VAS) prior to the approach was taken.

During the study, patients were shifted to the operation room with proper monitoring and aseptic defence and divided into 2 groups:

Group 1 (intraarticular PRF): 50 patients with grade 3 or grade 4 osteoarthritis (the Kellgren-Lawrence classification) were treated with PRF.

On the fluoroscopy table, the patient was placed in a supine location and the treated knee joint was flexed to 15°. No genicular block tests were performed, under fluoroscopic guidance (Allura, Philips, The Netherlands), the antero-posterior facet of the tibio-femoral joint was obtained to make the femoral and tibial bone aligned as possible. So, a good view of the joint expanse was achieved, and the diseased knee was sterilized with iodine then a local anesthetic was injected in a point mid-way between the femoral and tibial bones. A 20-gauge cannula, 10 cm in length, was introduced and placed. With lateral fluoroscopicy, the cannula was situated in the center of the joint space for 10-15 mins with a temperature of 42°C.

(Neurotherm, Neurotherm Inc., Wilmington, Massachusetts): 1, 200 pulses at high voltage (45 V), with 20-ms duration followed by 480-ms silent phases.

Group 2 (radiofrequency neurotomy): 50 Patients with grade 3 or grade 4 osteoarthritis were treated with radiofrequency neurotomy. On the fluoroscopy table, the patients were placed in a supine location. The treated knee joint was flexed to 15°, and genicular block tests were performed. The selected Genicular nerves are, SL, SM and IM which travels along the femur to the lateral epicondyles and from the tibia to the medial epicondyles.

The patients were placed supine on a fluoroscopy table with a support under the popliteal fossa for patient comfort. A 10 cm 22-gauge RF cannula with a 10 mm active tip (NeuroTherm^{TM}, Medipoint GmbH, Hamburg, Germany) was injected in the mid joint space, and advanced percutaneously towards areas connecting the bones to the epicondyle, "tunnel technique"

The sensory stimulation threshold was less than 0.6 V. and the Motor stimulation was at 50 Hz. lidocaine (2 ml of 2%). The RF electrode was then inserted through the cannula, and the electrode tip temperature was elevated to 80°C for 1 min.

Measurements

The primary outcome of the study was evaluation of the pain using Visual Analog Scale (VAS 0-10), and the secondary outcome of the study was evaluation of the WOMAC scores (The Western Ontario and McMaster Universities Osteoarthritis Index) and the amount of analgesic medications required at; Before the study, 1 week, 1 month, 3 months, 6 months, 9 months and 12 months later.

Statistical analysis

The full detailed form is: SPSS 20, IBM, Armonk, NY, United States of America. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent-samples t-test of significance was used when comparing between two means. Chi-square (X^2) test of significance was used to compare proportions between two qualitative parameters.

Results

The sample size was chosen after reviewing many randomized control studies on the same subject. Our results showed that both groups were comparable regarding age, sex, weight and height (Table 1). A significantly improvement of pain was noticed in group II when compared to group I at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months (3.2 ± 1.9, 1.8 ± 0.4, 1.9 ± 0.5, 2.1 ± 0.8, 2.2 ± 0.5, 2.9 ± 0.6) $p<0.001$. In Group 1, there was a significant decrease in mean of VAS scores in comparison to the pre-study values at 1 week, 1 month, 3 months and 6 months (5.6 ± 0.8, 3.8 ± 1.7, 3.9 ± 1.9, 4.2 ± 1.6). While in Group 2 the significant decrease present at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months compared with pretreatment values was (3.2 ± 1.9, 1.8 ± 0.4, 1.9 ± 0.5, 2.1 ± 0.8,

2.2 ± 0.5, 2.9 ± 0.6) (Table 2). As regard to WOMAC, there was a significant improvement in group II compared to group I at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months (30 ± 2.7, 19 ± 2.2, 19 ± 2.9, 25 ± 2.1, 28 ± 2.2, 30 ± 2.9). In Group 1, there was a significant decrease in mean of WOMAC scores in comparison to the pre-study values which was (53 ± 2.6, 31 ± 2.4, 35 ± 2.9, 41 ± 2.7) at 1 week, 1 month, 3 months and 6 months While in Group 2 the significant decrease present at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months compared with pretreatment values was (30 ± 2.7, 19 ± 2.2, 19 ± 2.9, 25 ± 2.1, 28 ± 2.2, 30 ± 2.9). (Table 3).

Characteristics	Group 1 (intraarticular PRF)	Group 2 (radiofrequency neurotomy)	
Age (years)	65.5 ± 4.7	67.8 ± 7.5	0.069
Sex			
Female	35	30	0.295
Male	15	20	
Weight (kg)	62.15 ± 5.2	61.65 ± 8.0	0.712
Height (cm)	154.3 ± 17.7	150.9 ± 16.5	0.323

Table 1: Characteristics of the study population (P value: comparison between G I & G II).

	Before session	1 week after	1month	3 months	6 months	9 months	12 months
P	0.218	0.001*	0.001*	0.001*	0.001*	0.001*	0.001*
Group 1	7.2 ± 1.5	5.6 ± 0.8	3.8 ± 1.7	3.9 ± 1.9	4.2 ± 1.6	6.8 ± 1.4	6.9 ± 1.5
P 1		0.001*	0.001*	0.001*	0.001*	0.171	0.32
Group 2	7.5 ± 0.8	3.2 ± 1.9	1.8 ± 0.4	1.9 ± 0.5	2.1 ± 0.8	2.2 ± 0.5	2.9 ± 0.6
P 2		0.001*	0.001*	0.001*	0.001*	0.001*	0.001*

Table 2: Mean VAS scores before (intraarticular PRF and CRF) and at 1 week, 1 month, 3 months, 6 months, 9 months and 1 year after the procedure. (P value: comparison between GI & GII (T test) P1: comparison in G I (ANOVA) P2: comparison in G II (ANOVA)).

	Before session	1 week after	1month	3 months	6 months	9 months	12 months
P	0.254	0.001*	0.001*	0.001*	0.001*	0.001*	0.001*
Group 1	73 ± 4.5	53 ± 2.6	31 ± 2.4	35 ± 2.9	41 ± 2.7	72 ± 3.6	71 ± 3.9
P 1		0.001*	0.001*	0.001*	0.001*	0.223	0.105
Group 2	74 ± 4.2	30 ± 2.7	19 ± 2.2	19 ± 2.9	25 ± 2.1	28 ± 2.2	30 ± 2.9
P 2		0.001*	0.001*	0.001*	0.001*	0.001*	0.001*

Table 3: Mean WOMAC scores before (intraarticular PRF and CRF) and at 1 week, 1 month, 3 months, 6 months, 9 months and 1 year after the procedure. (P value: comparison between GI & GII (T test) P1: comparison in G I (ANOVA) P2: comparison in G II (ANOVA)).

The analgesic requirements (nonsteroidal anti-inflammatory drugs (NSAIDs)) was significantly decreased in group II when compared to group I at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months (299.21 ± 55.32, 102.21 ± 32.52, 106.2 ± 31.33, 136 ± 20, 141.2 ± 1.15, 201.21 ± 2.45). In Group 1, There was a significant decrease in mean of analgesic requirements scores at 1 week, 1 month, 3 months and 6 months when compared to the pre-study values which was (900 . 71 ± 98.21, 335.13 ± 70.23, 340.22 ± 77.25, 370.58 ± 89.24) While in Group 2 the significant decrease present at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months compared with pretreatment values was (299.21 ± 55.32, 102.21 ± 32.52, 106.2 ± 31.33, 136 ± 20, 141.2 ± 1.15, 201.21 ± 2.45) (Table 4).

	Group I (n=50) Mean ± SD	Group II (n=50) Mean ± SD	T-test	
			t	P-value
Before session	1485.68 ± 124.68	1491.46 ± 119.62	0.237	0.814
1 week after	900.71 ± 98.21	299.21 ± 55.32	37.733	<0.001**
1 month	335.13 ± 70.23	102.21 ± 32.52	21.281	<0.001**
3 months	340.22 ± 77.25	106.2 ± 31.33	19.851	<0.001**
6 months	370.58 ± 89.24	136 ± 40	16.961	<0.001**
9 months	1425.21 ± 258.27	141.2 ± 51.15	34.485	<0.001**
12 months	1455.26 ± 225.33	201.21 ± 42.45	38.673	<0.001**
Paired t-test				
Before & 1 wk.	<0.001**	<0.001**		
Before & 1 mon.	<0.001**	<0.001**		
Before & 3 mons.	<0.001**	<0.001**		
Before & 6 mons.	<0.001**	<0.001**		
Before & 9 mons.	0.139	<0.001**		
Before & 12 mons.	0.405	<0.001**		

Table 4: Mean amount of analgesic medacations (nonsteroidal anti-inflammatory drugs (NSAIDs)) before (intraarticular PRF and CRF) and at 1 week, 1 month, 3 months, 6 months, 9 months and 1 year after the procedure. (P value: comparison between GI & GII (T test) P1: comparison in G I (ANOVA) P2: comparison in G II (ANOVA)).

	Group I	Group II	T-test	
	(n=50)	(n=50)		
	Mean ± SD	Mean ± SD	t	P-value

Before session	1477.68 ± 122.13 k	1486.46 ± 108.72	0.38	0.705
1 week after	865.71 ± 89.26	293.21 ± 51.43	39.296	<0.001**
1 month	331.13 ± 67.45	104.21 ± 30.95	21.621	<0.001**
3 months	334.22 ± 73.26	102.2 ± 35.16	20.19	<0.001**
6 months	368.58 ± 82.37	131 ± 34.06	18.847	<0.001**
9 months	1433.21 ± 223.29	137.2 ± 42.17	40.329	<0.001**
12 months	1425.26 ± 206.03	195.21 ± 40.15	41.437	<0.001**
Paired t-test				
Before & 1 wk.	<0.001**	<0.001**		
Before & 1 mon.	<0.001**	<0.001**		
Before & 3 mons.	<0.001**	<0.001**		
Before & 6 mons.	<0.001**	<0.001**		
Before & 9 mons.	0.22	<0.001**		
Before & 12 mons.	0.126	<0.001**		

Table 5: Mean amount of analgesic medacations (glucosamine) before (intraarticular PRF and CRF) and at 1 week, 1 month, 3 months, 6 months, 9 months and 1 year after the procedure. (P value: comparison between GI & GII (T test) P1: comparison in G I (ANOVA) P2: comparison in G II (ANOVA)).

Table 5 and table 6 i.e. the analgesic requirements of glucosamine and pregabaline respectively, showed the same manner as table 4. There was significant decrease in group II when compared to group I at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months and a significant decrease in mean of analgesic requirements scores at 1 week, 1 month, 3 months and 6 months when compared to the pre-study values in group I, while in group II the significant decrease present at 1 week, 1 month, 3 months and 6 months, 9 months and 12 months when compared with pretreatment values.

	Group I (n=50)	**Group II (n=50)**	**T-test**	
Pregabaline	**Mean ± SD**	**Mean ± SD**	**t**	**P-value**
Before session	280.22 ± 24.21	277.52 ± 13.11	0.693	0.489
1 week after	150.22 ± 25.43	100.22 ± 31.37	8.755	<0.001**
1month	105.52 ± 33.22	74.52 ± 13.22	6.131	<0.001**
3 months	100.92 ± 35.28	50.92 ± 25.39	8.134	<0.001**
6 months	140.16 ± 31.37	75.52 ± 33.22	10.004	<0.001**
9 months	273.32 ± 14.51	100.16 ± 41.57	27.809	<0.001**
12 months	275.12 ± 34.22	101.15 ± 32.34	26.127	<0.001**
Paired t-test				
Before & 1 wk.	<0.001**	<0.001**		
Before & 1 mon.	<0.001**	<0.001**		
Before & 3 mons.	<0.001**	<0.001**		
Before & 6 mons.	<0.001**	<0.001**		
Before & 9 mons.	0.087	<0.001**		
Before & 12 mons.	0.391	<0.001**		

Table 6: Mean amount of analgesic medacations (pregabaline) before (intraarticular PRF and CRF) and at 1 week, 1 month, 3 months, 6 months, 9 months and 1 year after the procedure. (P value: comparison between GI & GII (T test) P1: comparison in G I (ANOVA) P2: comparison in G II (ANOVA)).

Discussion

The present study compared pulsed radiofrequency (PRF) with radiofrequency neurotomy (RFN) and demonstrated that at 1 week, 1 month, 3 months, 6 months, 9 months and 12 months after treatment initiation.

The response rate in this study was analyzed by definition of a 50% reduction in VAS [28] score compared with baseline, but we think that any lessening of pain compared with baseline might be relevant to the

participants who had been unresponsive to analgesic medacations which were combination of Naproxen Na, Glucosamine and Pregabaline.

In our study 70% to 80% of participants in Group 2 (radiofrequency neurotomy) had a reduction of >50% of the VAS and WOMAC score which is significant from 1 week till 12 months when compared to the pretreatment values, whereas in Group 1 (intraarticular PRF) 50% of participants had a reduction of >50% of the VAS and WOMAC score which is significant from 1 week till 6 months only when compared to the pretreatment values [29-31].

Patients in the PRF group i.e Group I also used less analgesic medications which is significant from 1 week till 6 months when compared to the pretreatment values whereas in Group II (radiofrequency neurotomy) the amount of analgesic medications (Naproxen Na, Glucosamine and Pregabaline) showed significant improvement from 1 week till 12 months when compared to the pretreatment values [31-34]. The analgesic medications used in this study were Naproxen Na which is nonsteroidal anti-inflammatory drugs, Glucosamine (2-amino-2-deoxy-β-d-glucopyranose) which is an aminosugar (sugar molecule with a nitrogen) naturally present in the human body and in shellfish [35,36] and Pregabaline which is a GABAergic anticonvulsant and sedative of the central nervous system (CNS). It is classified as a GABA analogue and gabapentinoid [37].

In the present study, RFN provides better pain ease and rapid improvements in physical activities with the application of RFN to patients with osteoarthritis related chronic knee pain than PRF. comparative-effectiveness studies found pulsed radiofrequency (PRF) to be second to radiofrequency neurotomy [31].

Two retrospective studies comparing pulsed radiofrequency (PRF) to radiofrequency neurotomy for sacroiliac joint disease have different results, but 1 study found a trend for senior results with pulsed radiofrequency (PRF) [32,33].

The both procedures may be a replacement method for elderly patients who would not be able to undergo surgery, the improvement may extend up to one year in RFN and 6 monthes only in intraarticular PRF.

In our study, seven patients in group 1 (intraarticular PRF) i.e. nonablative did not benefit from the procedure and resorted to total replacement whereas in group 2 only two patients resorted to surgery.

Reasons for the similarity between analgesia and change in function in participants who received RF neurotomy is based on the theory that cutting the nerve supply to a painful area may allay pain and restore function [29].

In the RF neurotomy procedure, tissue temperature reaches 60-80°C with destruction of the target nerves [25,26].

Pulsed RF transports short bursts of radiofrequency (RF) current and the tissue can cool between bursts [27]. So, it produces little tissue destruction with prolonged suppression of evoked synaptic activity [30] During PRF, temperatures do not overreach 42°C [20].

Closeness of genicular arteries to the nerves innervating the knee joint elevates the possibility of vascular trauma, although Franco and colleagues [34] did not find evidence of extensive vascularity around periarticular nerves to the knee.

In our study subcutaneous hematoma appeared in six patients (related to needle puncture) in group 1 and two in group 2.

Some patients have chronic knee osteoarthritis pain in both knee so, it is very difficult for the patient to tolerate the RF neurotomy or PRF in both knees in a single sitting because of pain due to several injections therefore only botulinum toxin injection 50 units is given in the lesser involved knee which acts by blocking the release of acetylcholine from presynaptic cholinergic ending of various nerves causing chemical dennervation near to RF genicular branch [29].

RF Neurotomy is therefore a safe and authentic intervention to reduce the knee pain in advanced cases of osteoarthritis, who are otherwise not candidates for total knee replacement and provides lot of patient fulfilment to the extent of 70-80% in pain improvement originating from the knee joint, improve the functional activities and reduces amount of analgesic consumption.

Conclusion

Both, the radiofrequency neurotomy or pulsed radiofrequency controls pain in patients with chronic knee pain, decreases amount of analgesic medications consumption, minimize post-operative complications with the upper hand to radiofrequency neurotomy.

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