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Knee Joint Osteo Arthritis: Role of Radiofrequency in Managing Pain

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Abstract

Background: Pain due to knee joint osteo arthritis is one of most common health problems in old age and many treatment options have been used to control pain but none of them is completely effective and also have their side effects. The knee joint is supplied by genicular nerves which convey the sensory input to higher centers. The aim of present study was to evaluate the effectiveness of radio frequency ablation of genicular nerves in controlling pain due to knee joint osteo arthritis and to compare the pain relief and effect on analgesic intake with control group at 1st, 4th, 8th and 12th week of post procedure period. *Materials and Methods:* Fifty, American Society of Anaesthesiologist, grade 1 and 2 adult patients in age group of 40 to 70 years and suffering from knee joint osteoarthritis and on regular analgesic drug intake were randomly divided into two groups. 22G Radiofrequency cannula with 100 mm length and 10mm active tip and radio frequency machine G4 Cosman was used for sensory and motor stimulation for locating and ablation of genicular nerves. In Group I (Control group), the radiofrequency needles were placed extra articularly around knee joint under C-Arm guidance and genicular nerves were located with sensory and motor stimulation and one ml of 1%xylocaine was given at each needle site. No thermal or pulsed RF was given. In Group II (Study group), the RF needles were placed extra articularly at specified genicular nerves and after sensory and motor stimulation one ml of 1% xylocaine was given at each needle site. Radio frequency was given with target temperature of 70°c for three cycles, each of 1.5 minutes duration. Post procedure observations were made by an independent anesthetist not associated with procedure team. The post procedure VAS scores and analgesic intake were noted at 1st, 4th, 8th and 12th week in both groups. Statistical Analysis Used – SPSS version 14.0 (SPSS Inc., Chicago, IL), Chi square test, student's t test. p-Value < 0.05 was taken as statistically significant. *Results:* The VAS score in Gp I, in immediate post procedure period was 0.80±0.500 as compared to base line score of 6.80±0.645 9 ($p< 0.001$). The VAS at 1st, 4th, 8th and 12th week follow up was 6.56±0.651, 6.88±0.666, 6.92±0.640 and 6.92± 0.572 and change was statistically insignificant ($p >0.05$). In immediate post procedure period the VAS score in Gp II, was 0.92±0.572 as compared to pre procedure VAS of 7.0±0.707 ($p <0.001$). The VAS at 1st, 4th, 8th and 12th week follow up was 1.84±0.987, 1.96±0.978, 2.36±1.075 and 2.60±1.041 respectively and the change in VAS was highly significant ($p <0.01$). The mean consumption of capsule Raceclo per week in pre procedure period in Gp I & II was 6.44±0.917 and 6.44±0.961 showing no significant intergroup difference statistically ($p >0.05$).In Gp I, the mean weekly consumption of capsule Raceclo at 1st, 4th, 8th and 12th week follow up was 5.52±0.823, 6.161 ±0.746, 6.28±0.737 and 6.68±0.690 respectively and the change was statistically insignificant($p >0.05$). The mean post procedure weekly consumption of capsule Raceclo in Gp II, at 1st, 4th, 8th and 12th week was 0.60±1.190, 0.56±1.356, 0.96±1.567 and 1.52±1.447 respectively and the decrease in analgesic consumption was statistically highly significant on intra group and inter group comparison. All the Gp II patients except one were relieved of pain. Two patients in Gp II reported pain relief in other knee also. No complications such as infection hemorrhage; thermal injury and sensory or motor weakness/loss were reported.

Keywords: Genicular Nerves; Knee; Osteo Arthritis; Radio Frequency.

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Introduction

Osteoarthritis (OA) of knee joint is one of the most common causes of pain and disability in elderly population and more than 100 million of population worldwide is believed to be suffering from it [1].

More than 50% of adults above age of 65 years show radiological changes of OA in knee joint. The patients with OA knee joint presents with morning stiffness and aggravation of pain with weight bearing and relieved by rest. On physical examination there is tenderness, usually on medial side of knee with limitation of movements in advanced stages.

As per statement quoted "India is expected to be chronic disease capital with 60 million people suffering with arthritis by 2025". As there is overall increase in life expectancy, the alarming increase in prevalence of knee OA is also expected [2]. The associated risk factors like obesity, progressive sedentary life style, diet routine and work conditions also play important role in OA .The OA knee is chronic degenerative and often progressive joint disease.

Despite of development of newer diagnostic modalities, the X-ray of knee joint remains the most accessible tool in evaluating knee OA, available even in peripheral institutes. Radiographs are taken in various views to see joint space narrowing and osteophyte formation. Kellgren-Lawrence grading scheme and Osteoarthritis Research Society International classification score establish guidelines to evaluate OA progression [3,4].

As there is no known cure for OA, the primary aim of treatment is to reduce pain, maintain joint mobility and to restrict the functional impairment. Combination of diet control and regular exercise reduces the obesity and restores the joint mobility. Physical therapy, which aims to strengthen the supporting muscles groups and improve flexibility, is mainstay of treatment which may even delay the need for surgical intervention [5].

Total knee replacement currently remains the definite treatment for refractory OA knee joint. Radio frequency ablation of sensory nerves has recently emerged as alternative treatment for pain control in chronic pain conditions. The sensory innervations of knee joint is through genicular nerves [6,7,8].

The aim of present study was to compare the pain relief provided by radio frequency ablation of Genicular nerves of knee with control group at 1, 4, 8, and 12 weeks of post procedure period.

Material and Methods

After approval of institutional research ethics committee, the study was conducted in prospective randomized double blind manner in patients clinically diagnosed with OA knee joint in pain clinic of our institution. The patients willing to participate in this study were informed about the purpose of this study, procedure details, VAS scoring in PAC clinic and their informed consent in writing were obtained. The patients were also informed that they can opt out of the study any time without assigning any reason

The target sample of 50 patients was divided into two groups of 25 patients in each group using random allocation software. The random number was kept in envelope under custody of consultant in charge and the envelope was opened at the time of procedure in operation theatre and the patient was assigned to respective group. Post procedure observations and follow up were made by independent anesthetist not associated with block giving team.

The inclusion criteria included patients aged between 40-70 years, with pain localized to knee joint with no referral, without gross structural deformity of knee, ASA grade I and II, on drug treatment for knee pain for at least 6 months and radiological findings (X-ray) showing Kellgren–Lawrence grading between 1-3.

Exclusion criteria included age less than 40 years or more than 70 years, visible gross deformity of knee, ASA grade III or above, patient refusal to participate in study, radiological changes showing Kellgren–Lawrence grading 4, hemorrhagic diathesis, on anti platelet/anti coagulant therapy, local or systemic infection, acute knee pain or prior knee surgeries and any psychiatric illness.

All patients underwent pre-anesthetic checkup and investigations like hemoglobin, fasting blood sugar, serum urea and creatinine, bleeding time (BT), clotting time (CT), ECG and X-rays (chest and knee joint) checked. Premedication was given (Tab. Alprazolam 0.25 mg) at bed time. Overnight fasting was ensured in all patients. In operation theatre the monitors were attached to record heart rate (HR), non invasive blood pressure (NIBP), ECG and pulse oximetry (SpO_2). Intravenous line was secured with 20 G cannula and 0.9% normal saline started. Following the standard monitoring, the patients were asked to lie supine on radio lucent operation table

with affected knee supported on pillow. Free rotation of the C-ARM around knee joint to obtain antero-posterior (AP view) and lateral view was ensured. The C-ARM was used to guide the direction and depth for placement of radiofrequency needles. The procedure was carried out under intravenous sedation with inj. Fentanyl (1 µg/kg body weight) and local anesthesia (xylocaine 1%). In case of discomfort during needle placement or during RF procedure, Inj. Fentanyl was used (1µg/Kg body weight).

The affected knee was cleaned with iodine based antiseptic solution and was draped properly. The needle entry sites were marked under C-ARM guidance and skin over needle entry sites were anaesthetized with 1% xylocaine. 22G Radiofrequency cannula with 100 mm length and 10mm active tip (Cosman RFK, Cosman medical Inc, USA) were used for the procedure. The procedure was carried out using radio frequency machine G4 Cosman Version 2(Cosman medical, Burlington, Massachusetts, USA) for sensory and motor stimulation to locate genicular nerves and also for ablation of these nerves (Fig. 1).

Fig. 1: Radio frequency generator (COSMAN G 4, Version 2)

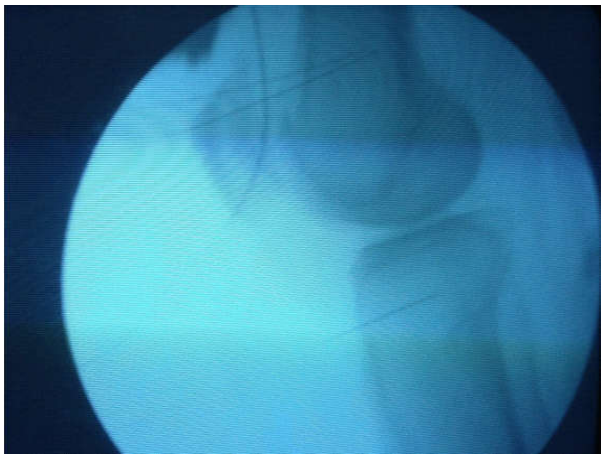

Fig. 2: Targeting the genicular nerves in lateral view of knee joint.

The nerves targeted include superior lateral genicular nerve, superior medial genicular nerve and inferior medial genicular nerve (Fig. 2).

The patients were divided into two groups of 25 each. In Group I (Control group, n-25), the radiofrequency needles were placed extra articularly around knee joint under C-Arm guidance and genicular nerves were located with sensory stimulation (50Hz and 0.2 V) and motor stimulation (2 Hz and 0.5V). After locating above mentioned genicular nerves, one ml of 1% xylocaine was given at each needle site. No thermal or pulsed RF was given. Needles were removed and sterile dressing applied.

In Group II (Study group, n-25), the RF needles were placed extra articularly at above mentioned genicular nerves after sensory (50Hz and 0.2V) and motor stimulation (2 Hz and 0.5V). After locating the above mentioned genicular nerves, one ml of 1% xylocaine was given at each needle site. Radio frequency was given with target temperature of 70°C for three cycles, each of 1.5 minutes duration. Needles were removed and sterile dressing applied.

Following the procedures, the patients in both groups were kept in recovery area for two hours for observation of any complication or side effects and were discharged later. Post procedure observations were made by an independent anesthetist not associated with procedure team. The patients were directed to attend the pain clinic OPD on specified dates at interval of 1, 4, 8 and 12 weeks or were contacted on phone.

In both groups, rescue analgesic was capsule Raceclo (containing Acelofenac 100 mg as sustain released pellets and rabeprazole 20 mg as enteric coated pellets) s to be used once a day after meals. If pain persists after taking Cap. Raceclo then additional analgesic drug as tablet tramadol 50 mg (tablet Contramal, Abbot) SOS up to maximum dose of 400 mg/day was advised.

All the data collected was analyzed statistically using student's t test.

Results

The total of 50 patients were divided into two groups of 25 patients each using random allocation software. The mean age (in years) in Gp I (control group) was 63.68±6.47 and in Gp II (study group) was 61.40±5.75 (p 0.194).Thus the mean age in both groups was comparable. Mean weight (in Kg) in group I was 60.00±6.33 and in Gp II was 62.20± 8.25 (p 0.296) and was comparable. Out of total patients

62%were female (31/50) and 38%were male (19/50). In Gp I, 15 patients were females and 10 patients were male while in Gp II 16 patients were female and nine patients were male and both groups were comparable. In Gp I mean heart rate was 83.56±5.76 and in Gp II was 83.32±5.95 (p 0.885) and was comparable. The base line MAP in Gp I and II was 98.76±8.08 and 97.92±9.15 respectively and was comparable with p value 0.732. Mean SpO_2 in Gp I and II was 94.44±2.16 and 94.72±2.26 and was comparable (p 0.657). No statistically significant change was noted during procedure in heart rate, MAP and SpO_2 in both groups (Table 1).

The VAS in Gp I at pre procedure time was 6.80±0.645 and in Gp II was 7.00±0.707 and difference was statistically insignificant (p 0.302). In Gp I, VAS in immediate post procedure period was decreased to 0.80±0.500 and the change in VAS was statistically significant (p < 0.001).In Gp II, VAS in immediate post procedure period was 0.92±0.572 and the change was statistically significant (p < 0.001). When both groups were compared for VAS in immediate post procedure period the change was statistically insignificant (p 0.302). (Table 2; Fig. 3)

In Gp I, VAS at one week follow up was 6.56±0.651 which was close to initial baseline of 6.80±0.645 and the difference was statistically insignificant (p 0.056) indicating that by first week the pain has returned to original intensity .In Gp II the VAS at one week follow up was 1.84±0.987 from baseline VAS of 7.00±0.707 and the difference was statistically highly significant (p < 0.001). (Table 2; Fig. 3)

Table 1: Baseline parameters comparing two groups

Age	Gp 1 Gp II	63.68±6.47 61.40±5.75	p 0.194
Sex (F/M)	Gp 1 Gp II	15 /10 16/09	p 0.05
Weight (kg)	Gp I Gp II	60±6.33 62.20±8.25	p 0.296
HR(bpm)	Gp I Gp II	83.56±5.76 83.32±5.95	p 0.885
MAP (mmHg)	Gp I Gp II	98.76±8.08 97.92±9.15	p 0.732
SpO_2	Gp I Gp II	94.44±2.16 94.72±2.26	p 0.657

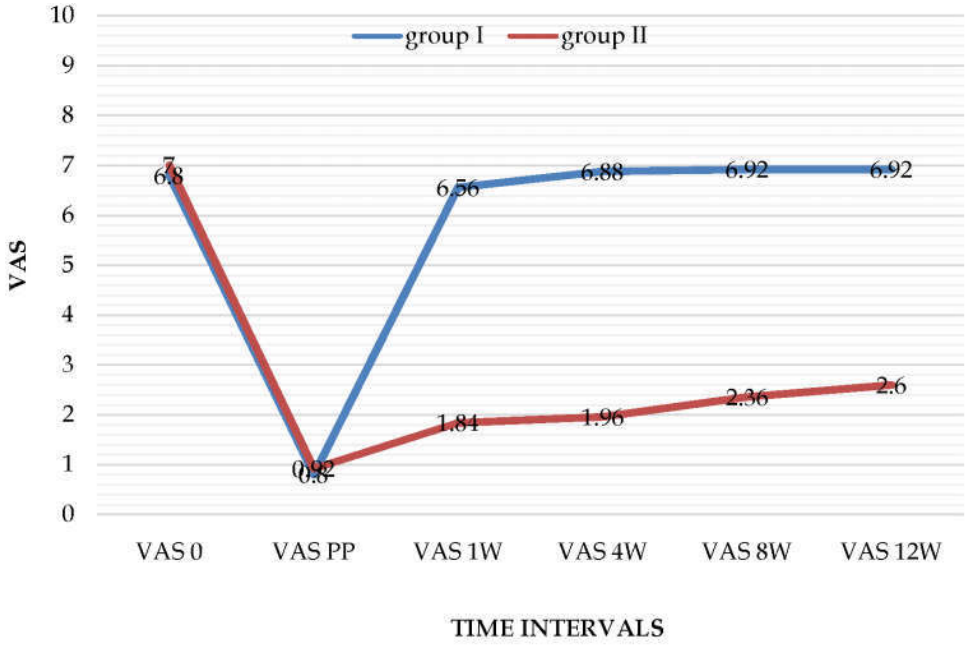

Fig. 3: Comparison of VAS scoring in pre and post procedure periods

Table 2: VAS Scoring in post procedure period

VAS	Mean ± SD		P value
	GP I	Gp II	
VAS 0 pre procedure	6.80±0.645	7.00±0.707	0.302
VAS post procedure	0.80±0.500	0.92±0.572	0.433
VAS at 1 wk	6.56±0.651	1.84±0.987	0.000
VAS at 4th wk	6.88±0.666	1.96±0.978	0.000
VAS at 8th wk	6.92±0640	2.36±1.075	0.000
VAS at 12th wk	6.92±0.572	2.60±1.041	0.000

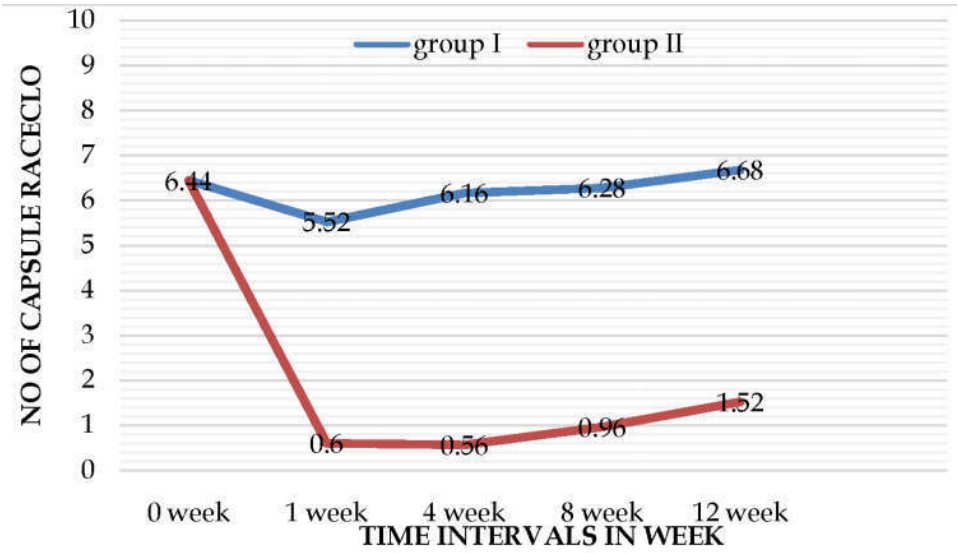

Fig. 4: Mean consumption of cap. Raceclo in two groups

VAS scores at 4th week follow up in Gp I was 6.88±0.666 which was almost same to pre procedure VAS scores and was statistically insignificant ($p > 0.05$) while in Gp II it was 1.96±0.978 from baseline VAS score of 7.00±0.707 and change was statistically highly significant ($p< 0.001$). (Table 2; Fig.3)

In Gp I, VAS scores at 8th week follow up was 6.92±0.640 and was close to base line VAS score and was statistically insignificant ($p >0.05$). In Gp II, VAS score at 8th week follow up was 2.36±1.075 from base line VAS score of 7.00±0.707 and the change was significant statistically ($p< 0.001$). VAS scores at 12th week follow up in Gp I was 6.92±0.572 and when compared to pre procedure VAS scores the change was insignificant statistically ($p > 0.05$). In Gp II, VAS scores were 2.60±1.041 at 12th week which was significantly lower than base line VAS scores ($p< 0.001$) (Table 2; Fig. 3).

When both groups (Gp I and II) were compared for VAS scores at one, four, eight and twelve weeks intervals , the VAS scores were significantly lower in Gp II at all intervals ($p< 0.001$) (Table 2; Fig. 3).

The mean consumption of cap. Raceclo per week in pre procedure period in Gp I was 6.44±0.917 and in Gp II was 6.44±0.961 and was comparable ($p >0.05$). In Gp I, mean consumption of cap. Raceclo at first week of follow up was 5.52±0.823 while in Gp II the mean consumption was 0.60±1.190. The mean consumption was lower in both the groups but the decrease was highly significant in Gp II ($p< 0.001$) (Fig. 4).

In Gp I, mean consumption of cap. Raceclo at 4th, 8th and 12th week was 6.16±0.746, 6.28±0.737 and 6.68±0.690 respectively which is close to base line consumption of 6.44±0.917 ($p>0.05$) while in Gp II it was 0.56±1.356, 0.96±1.567 and 1.52±1.447 respectively with the baseline initial consumption of 6.44±0.961 ($p <0.001$) (Fig. 4).

When both groups were considered for mean consumption of cap. Raceclo at 4th , 8th and 12th week, it was less in Gp II and the difference was statistically highly significant ($p <0.001$) (Fig. 4).

In this study all patients used cap. Raceclo as rescue analgesic and none of the patients in both groups required tab. Contramal as second line analgesic.

In Gp I, in immediate post procedure period, 13 out of 25 patients gave excellent review while 12 patients said it was good showing that they were satisfied with the procedure initially but by the first week of follow up, all the patients in the Gp I started experiencing pain in the knee joint and the whole 25 patients in group I were not satisfied from 1st to 12th weeks of follow up.

In Gp II, in the immediate post procedure period, 14 out of 25 patients gave excellent review and 11 patients said it was good, which is similar to the immediate post procedure reviews of Gp I patients . At 1st week follow up, out of 25 patients, 6 patients gave excellent review and 18 patients said it was good while one patient was not satisfied.

On further follow up at 4th week, 2patients gave excellent review, 22 said it was good and same one patient was not satisfied. At 8th week follow up, 1 patient gave excellent review, 23 said it was good and one patient was not satisfied. On the final follow up at 12th week, 24 patients in Gp II said that the effect of intervention done 12 weeks back was good, while one patient, who was not satisfied from 1st week of follow up consistently said that she was not satisfied.

Discussion

Knee osteoarthritis (OA) is one of the most common causes of disability in older adults, with an estimated prevalence of symptoms in 20-30% of individuals over 65 years of age. Pain associated with knee OA may have a many reasons including intra articular chemical mediators of pain, mechanical compression, vasospasm, irritation of richly innervated periosteum, synovium and joint capsule as well as peripheral genicular nerve sensitization and also central nervous system component. Knee OA, in general, is treated conservatively with weight loss (when indicated), physical therapy, oral analgesic medications, and intra articular corticosteroid or hyaluronic acid injections. If this approach fails to provide adequate pain relief and functional restoration, patients may be offered total knee arthroplasty (TKA), if they are surgical candidates.

While, TKA is generally a safe procedure, like any major open surgery, it is associated with a risk of serious complications; a large cohort study of 83,756 patients demonstrated the annual incidence of venous thrombo embolism (0.6%), myocardial infarction (0.5%), stroke (0.5%), and a 90 days mortality (0.7%) to all be significantly higher than the general population. More over some patients may not be candidate for TKA due to co morbidities or other reasons.

Radiofrequency ablation (RFA) of genicular nerves of knee joint presents a promising intervention for patients with chronic painful knee due to osteo arthritis having failed conservative management and are either not willing or not eligible for TKA. The exact mechanism by which the Radio frequency works over the affected area is still not well understood, but RF lesion is believed to stop nociceptive (A-γ and C-fibers) pain input from the periphery to the central nervous system without destroying the motor or sensory (A-β) fibers. More specifically, the postulated mechanism of action for clinical benefit of thermal RFA involves the heat generation resulting in thermo coagulation and localized neuronal tissue destruction. These lesions have been shown to demonstrate the characteristics of scar formation, including an acute inflammatory response, cell necrosis and fibrosis with collagen fiber deposition, occurring over 3 weeks following the procedure. It has been shown that the basal lamina of Schwann cells may be preserved after RFA (Radiofrequency Ablation), which would allow nerve regeneration. The ablative heat is provided via flow of electrical current, generating a well-delineated lesion. Additionally, RFA produce a local electrical field, which is thought to promote neuro modulation by inhibition of the excitatory C-fibers.

In this study, both the groups were comparable in demographic variables like age, weight and sex. There were more number of female patients in both the group with total number of 31 out of total 50 patients (i.e. 62%) and 19 out of 50 patients (i.e. 38%)were males. General physical examination and investigation of all the patients were within normal limits.

There was statistically significant reduction in VAS scores in both groups in immediate post procedure period and can be explained due to analgesia provided by inj fentanyl which was given at the start of procedure and also to administration of xylocaine at genicular nerve sites blocking the transmission of pain impulse from knee joint in both groups.

No significant reduction in VAS scores were noted in Gp I at 1st, 4th, 8th and 12th week follow up while in Gp II significant reduction in VAS scores were observed at same time intervals. The patients in group II were relieved of pain due to nerve ablation caused by radiofrequency treatment.

The results were comparable with studies by Mashahiko Ileuchi et al. [8] where the RF treated group had significantly decreased knee pain as measured by the VAS scores for 2–3 months compared with the control group. Similar results were observed by Choi et al., where the knee pain VAS scores were lower at all post-procedure assessment points compared with baseline ($p < 0.001$) in both the case and control group [9]. By contrast, in the control group the VAS pain scores were lower than baseline up to one week. When comparing knee pain improvement from baseline, the RF group showed superior improvement compared with the control group at both 4th week ($p < 0.001$) and 12th week ($p < 0.001$). Wen-Sheng Shen et al, concluded that RF have better efficacy in relieving refractory pain for longer duration and promoting functional recovery in patients with knee OA than regular treatment [10]. The resembling and comparable results were seen by Pakize Kirdemir et al., Ferdinand Iannaccone et al and Sonai datta showing significant pain relief in patients treated with radiofrequency ablation of genicular nerves [11,12,13].

We also compared the requirement of rescue analgesic in the form of Capsule Raceclo prescribed to be used once a day after meal when required. The mean consumption of rescue analgesic was significantly lower in Gp II up to 12th week of observation implying that there is significant decrease in the use of analgesic in the group II patients after the radiofrequency ablation of genicular nerves of the affected knee joint. In Gp II, only one patient complained of no relief in pain intensity during observation period. The procedure outcome depends upon patient's response to sensory stimulation. If patient complains of diffuse pain in knee at the time of sensory stimulation then stimulating needle is close to genicular nerve and better results are obtained. If patient complains of pain due to needle touching the bone periosteum then target genicular nerve is away from RF needle and poor results are obtained. In Gp II, two patients reported pain relief in other knee also and this may be due to pain relief in more affected knee leading to removal of abnormal stress placed on less affected knee and also due to decrease in central sensitization.

In the current study, no complications such as infection, hemorrhage, thermal injury, or sensory or motor loss in the procedure area or leg developed in any of the 50 patients. No participant reported a post-procedure adverse event during the follow up period, and there were no withdrawals from the study owing to an adverse event.

Summary

The RF thermal ablation procedure of genicular nerves of knee joints is an effective, safe, and minimally invasive treatment that can be offered to the patients having osteoarthritis-related chronic knee pain. In this study, we could appreciate the therapeutic efficacy of thermal radiofrequency genicular nerve ablation in providing pain relief till 12 weeks of follow ups and would recommend it as a treatment of choice for the conservative management of pain relief due to osteoarthritis of knee joint in all age group from 40 to 75 years old patients which have prolonged period of analgesic intake for the pain control and those who are either not fit to undergo surgical management or those who do not wish to undergo surgery. Superomedial, inferomedial, and superolateral genicular nerve branches

have been targeted because the genicular nerves are the main innervating articular branches for the knee joint, and as these nerves are adjacent to the periosteum connecting the bone, they can be located using bony landmarks under x-ray imaging.

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Presentation at a meeting: Nil

Conflicting Interest: Nil

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