Original Article

Fluoroscopy guided Genicular Nerve Radiofrequency Ablation for Refractory Knee Osteoarthritis: Three Months Outcome

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ABSTRACT

OBJECTIVE: To evaluate the therapeutic effectiveness of fluoroscopy-guided genicular nerve radiofrequency ablation for treating refractory knee osteoarthritis.

METHODOLOGY: This quasi-experimental study was conducted in Peoples Medical College Hospital from July 2020 to June 2022 on patients suffering from refractive knee osteoarthritis treated by fluoroscopy-guided genicular nerve radiofrequency ablation (FGGNRA). Eighty-six patients enrolled using a convenient sampling technique. The outcome measures included a reduction in pain scores assessed by the Visual Analog Scale (VAS) at 1, 2, 4, 6, and 12 weeks, though follow-up at six and nine months intervals. Data was collected on a predesigned proforma and analyzed using SPSS version 26, and a P value of less than 0.05 was considered significant.

RESULTS: A total of 86 patients were treated, with the highest number of patients in the age group of 41-50 years (n=30, 34.9%, Mean. 54.3, Min. 35, Max. 85) having ASA Status-I (n=81, 94.2%). VAS score before the therapeutics block was at an average of 6.6 (±0.8); however, after the procedure, the average score was 2.0 (±0.8). The consequent observation after 1, 2, 4, 6, 12 weeks, six, and nine months showed an average VAS score of 1.9 (±0.8), 1.9 (±0.8), 1.8 (±0.8), 1.8 (±0.8), and 1.9 (±0.9), 2.5 (±0.8) and 2.5 (±0.9) respectively. Major complications after the procedure were numbness (43.0%, n=37), weakness (37.2%, n=32), vascular injury (12.8%, n=11), and paresthesia (7.0%, n=6).

CONCLUSION: The FGGNRA technique for refractory knee osteoarthritis can be a promising option for treating knee pain with minor complications and long-term effects.

KEYWORDS: Refractory knee osteoarthritis, Radiofrequency ablation, Genicular nerve block, Visual Analog Scale.

INTRODUCTION

Knee osteoarthritis is ranked at 12th position among the leading causes of disability across the world[1]. Most of the population affected by the said chronic disease is usually females above 45 years of age[2,3]. Most of the adults, because of this 5th leading cause of knee impairment, suffer from either limited movement or inability to do routine work respectively[4]. A study in the United States of America (USA) by the National Health Interview Survey Organization showed that about 14 million people presented with clinical manifestations of osteoarthritis. Among these, more than 3 million people belong to racial or ethnic minorities[5]. Collins English Dictionary states that "refractory" is stubborn, manageable, or unresponsive to available treatments[6]. The American College of Rheumatology Diagnostic and Therapeutic Committee defines osteoarthritis as, it is a condition that is heterogonous, leading to signs and symptoms of joints, which in turn are associated with articular cartilage, along with variations in the underlying bone located at joint margins[7]. Thus, refractory disease can be viewed as a disease that shows resistance to various agents considered specific for treating such conditions[8].

Knee osteoarthritis presents various clinical manifestations such as joint pain, tenderness, restricted motion, bone swelling, deformation, and instability. The primary symptom of knee osteoarthritis is pain, which usually can be relieved by rest and may show progression through three stages. In the first place, the pain is sharp but usually predictable as it occurs due to any mechanical insult. Secondly, it starts affecting routine activities because of its persistent but unpredictable episodes. Lastly, along with constant nature, the severity of pain increases, which is exhausting and thus affects life quality[9]. For the analysis of the severity of pain, various specific tools for its measurement are available. One of the tools used is the Visual Analogue Scale (VAS)[10]. Other than the Western Ontario and McMaster

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University (WOMAC) pain scale, VAS is categorized as one of the most frequent tools for determining osteoarthritis pain intensity[11]. VAS is a scale of length usually 100mm, and both corners are labeled as "no pain" and "worst pain imaginable". According to their perception of pain intensity, the patient marks on the scale. Afterwards, the mark distance from the left is measured and recorded in mm[12].

Both pharmacological and non-pharmacological interventions are available as treatment options for knee osteoarthritis. Pharmacological interventions include analgesics such as NSAIDs and steroids given locally, i.e., through intraarticular route and hyaluronic acid injections. Their use has been limited because of the serious side effects of these interventions in the long term. They found attractive results of intra-articular injections but in mild-moderate forms of disease. Thus, researchers are searching for new modalities for chronic pain. Physical therapy and rehabilitation also provide weightage for the treatment of knee osteoarthritis. Platelet-rich plasma (PRP) given through the intra-articular route is another option for knee osteoarthritis treatment that is durable for a few months and thus has more extended therapeutic consequences. Other treatment options include botulinum toxin, acupuncture, balneotherapy, and periosteum stimulation therapy. In patients where knee surgery has been performed but still, patients are presented with pain complaints, in such cases, limited options are left behind to be used for long-term consequences[2,3,13-15].

The nerves, such as common peroneal, tibial, saphenous, obturator, and femoral nerves, collectively called genicular nerves, constitute the nerve supply of the knees[2]. Choi et al. (2011) provided a novel technique for alleviating chronic pain. The said procedure is performed by targeting lateral superior, medial superior, and medial inferior genicular nerves through the utilization of radiofrequency under fluoroscopic guidance[16]. In this procedure, heat is generated by giving current to targeted tissues. Heat generation is caused by friction among molecules, resulting in the formation of thermal lesions[15]. The selection of genicular nerves offers two main advantages. In the first place, these nerves are the main branches that innervate knee joints. The second advantage is that nerves connect the bone as these are adjacent to the periosteum; thus, their location can easily be approached under the guidance of fluoroscopy by using bony landmarks[14].

Therefore, the present study aims to evaluate the therapeutic effectiveness of fluoroscopy-guided genicular nerve block through the application of radiofrequency ablation therapy to treat refractory knee osteoarthritis.

METHODOLOGY

The quasi-experimental study was conducted in Peoples Medical College Hospital (PMCH), a tertiary care hospital attached to the Peoples University of Medical and Health Sciences for Women (PUMHSW), Nawabshah, Shaheed Benazir Abad.

Patients suffering from refractive knee osteoarthritis registered Pain Management Center PMCH from July 2020 to June 2022 after their consent were enrolled in the study.

Patients with refractory unilateral or bilateral knee pain for more than six months were included in the study. Patients with scores of 6–9 by the VAS and not responding to pharmacological and physiotherapy modalities, a diagnosis of radiologically verified osteoarthritis Grade-III or Grade-IV as per Kellgren-Lawrence Grading Scale with prominent narrowing in the medial tibiofemoral joint space were part of the study.

Patients with a history of knee surgery, acute knee pain associated with inflammation, connective tissue disease affecting the knee joint, patients with severe cardiopulmonary insufficiency, psychiatric or neurological disease, sciatica, current use of anticoagulant drugs, and having received intra-articular hyaluronic acid or steroid injection within the previous 3threemonths were excluded from the study.

Ethical Approval was requested from the Ethical Review Committee of PUMHSW (Ref. No. PIMHSW/ SBA/Reg./372. Consent was taken from all the patients or their kin/attendants through a written consent form (English/Urdu). The patients participated in the study voluntarily, and no compensation was paid to them. The confidentiality of the participants was maintained throughout the study.

Procedure: The fluoroscopy-guided genicular nerve block procedure was used in 113 knees (n = 54 bilateral, 59 unilateral). An experienced interventionist performed a fluoroscopic scanning of the knees. A continuous radiofrequency ablation will follow this diagnostic genicular nerve block if it remains successful.

Successful block means if the patient reported significant improvement in pain scores (VAS of 3/10 with activity and 1/10 at rest) and function with diagnostic block and was scheduled for continuous Radiofrequency Ablation (RFA) the following week.

Diagnostic Block: Each patient was placed supine on a dedicated fluoroscopy table with support to maintain mild knee joint flexion. All monitors were applied, and an intravenous line was placed in hand. After all aseptic measures, a skin wheal of 1 mL of 1% lidocaine was raised using a 25-gauge needle, through which a 25-gauge 90mm Whitacre needle was placed at 3 identified specific anatomic sites to block the superior medial, superior lateral, and inferior medial genicular nerve.

The superior medial genicular nerve is located at the convergence of the medial femoral shaft and the medial femoral condyle in the anteroposterior view and at the midpoint of the femur in the lateral view, and the needle was inserted just anterior to the adductor tubercle. On the anterior-posterior (A-P) view, the needle tip was advanced to the superior

edge of the medial femoral condyle till it encountered the bone. The c-arm was then rotated to see the lateral view of the knee while aligning the two femoral condyles. The needle was then readjusted to lie anterior to the midpoint between the medial condyle and posterior femoral cortex. The superior lateral genicular nerve is located at the union of the lateral femoral shaft, the lateral femoral condyle in the anteroposterior view and at the midpoint of the femur in the lateral view. The inferior medial genicular nerve site was located at the convergence of the medial tibial shaft and the tibial flare in the anteroposterior view and the midpoint of the tibia in the lateral view.

Accurate needle placement was confirmed using fluoroscopy in both anterior-posterior and lateral views, and 1-2ml of dye (Ultravist-370) was injected to rule the intravascular placement of the needle, after which two milliliters of 2% lidocaine was injected to anaesthetize each genicular nerve.

Therapeutic Block: Patients who reported successful diagnostic block are selected for radiofrequency ablation of genicular nerves. Each patient was placed in the supine position, and the genicular nerves were identified using the fluoroscopic technique. Skin and soft tissues were anaesthetized with 1-2 mL of 1% lidocaine at each of the three anatomic sites of genicular nerves. A 10 cm length 22-gauge RF (Radiofrequency) insulated cannula (OWL) was advanced by viewing the anterior-posterior and lateral views until the needle reached the specified area of the target nerve. The proper tip position is confirmed by giving 2mls of radio-contrast dye to avoid accidental intravascular damage. A Radiofrequency generator (THERMEDICO NK1) was turned on, and an RF probe was placed through an RF cannula. A 50 Hz-frequency sensory stimulation frequency of 50 Hz and a voltage threshold of 0.6 V was given, and the patient was inquired about pain and discomfort in the knee area. Motor stimulation was done by using a frequency of 2 Hz and a voltage of 2.0 V to elicit any muscle jerk or fasciculation. After confirming the absence of sensory and motor response, 2mls of 1% lidocaine was given through the RF cannula to anaesthetize the region before thermal ablation. RF probe was reinserted into the cannula, and ablation was done by applying continuous current through the electrode tip to each genicular nerve for 90 seconds at 60°C.

Study Instrument: The study instrument proforma was divided into three sections: demographics, diagnostic block, and therapeutic block. The demographic section included information about patient gender, marital status, age, duration of pain in years, and height and weight of patients. Demographics also included information about the knee, which was having pain, the ASA Status (American Society of Anesthesiologists), and the comorbidity of the patients.

The diagnostic block section included data about the VAS score before the diagnostic block (baseline VAS score), after the procedure, and after 24, 48, and 72 hours. The therapeutics block section collected information about VAS scores before and after the procedure, after 1, 2, 4, 6, and 12 weeks. The pain-relieving effect was also observed after 6 and 9 months.

After collecting data on a predesigned proforma, Statistical Package for Social Sciences (SPSS) version 26.0 was employed for data analysis. For the description of qualitative variables, frequency and percentages were shown. Mean and standard deviations (SD) were calculated to describe quantitative data, taking $p<0.05$ as statistically significant.

RESULTS

During the study period of two years, a total of 86 patients were included in the study. Table 1 shows the demographics of the study participants. Most enrolled patients were male (n=50, 58.1), while 36 were female (41.9%). Furthermore, 84 (97.7%) of the subjects were married, with the highest number of patients reported being 41-50 years (n=30, 34.9%). The average age of the patients was 54.3 years (Min. 35, Max. 85). It was observed that most of the patients were suffering from problems in the last 2-5 years (n=63, 73.3%). The average weight of the patients was 65.5kg, with most patients residing in the weight range of 61-70kg (n=37, 43.0%), while the average height of the patients was 160.9cm. Moreover, most participants had ASA Status-I (n=81, 94.2%) and significant problems in their right knee (n=32, 37.2%). Although 62(72.1%) patients had no comorbidity, 20 (23.3%) were suffering from hypertension and 11 (12.8%) from diabetes mellitus.

Table I: Demographics of the study population

Variable	Group	Frequency	Percentage
Gender	Female	36	41.9
	Male	50	58.1
Marital Status	Married	84	97.7
	Single	2	2.3
Age (years)	31-40	9	10.5
	41-50	30	34.9
	51-60	29	33.7
	61-70	15	17.4
	71-80	2	2.3
	81-90	1	1.2
Duration of pain (years)	<2	12	14.0
	2 to 5	63	73.3
	>5	11	12.8
Weight (kg)	51-60	35	40.7
	61-70	37	43.0
	71-80	14	16.3

Height (cm)	131-140	1	1.2
	151-160	41	47.7
	161-170	41	47.7
	171-180	1	1.2
	181-190	2	2.3
ASA Status	I	81	94.2
	II	5	5.8
Comorbidity	None	62	72.1
	Diabetes Mellitus	11	12.8
	Hypertension	20	23.3
Knee involved	Bilateral	27	31.4
	Left	27	31.4
	Right	32	37.2

Diagnostic Block

In most cases (n=52, 60.5%), the procedure was 15-30 minutes, while in the rest of the cases (n=34, 39.5%) the procedure was performed in 30-45 minutes.

Table 2 shows the VAS scores of patients before and after the diagnostic block. It was observed during the study that the average VAS score before the diagnostic procedure was 7.8 (S.D. ±0.7, Min. 6, Max. 9), with half of the patients having a VAS score of 8.0 (n=43, 50%). After the diagnostic block, the average VAS score reduced to 0.8 (S.D. ±1.0), with more than half of the patients (n=51, 59.3%) having no pain symptoms (VAS score 0). The maximum VAS score after a diagnostic block was 3.0. Furthermore, the VAS score was also observed after 24, 48, and 72 hours. The average VAS score with activity was 1.2 (±1.2), 2.2 (±0.9) and 6.4 (±1.1) after 24, 48 and 72 hours respectively. However, the VAS score at rest was much less than with activity. The average VAS scores at rest were 0.3 (±0.8), 0.4 (±0.8) and 3.4 (±1.6) after 24, 48 and 72 hours respectively.

Table II:
VAS scores of subjects after a diagnostic block

Duration	VAS Score	No of Patients	Per-centage	Mean (S.D.)
Before Procedure	6.0	3	3.5	7.8 (±0.7)
	7.0	25	29.1	
	8.0	43	50.0	
	9.0	15	17.4	
After Procedure	0	51	59.3	0.8 (±1.0)
	1.0	2	2.3	
	2.0	28	32.6	
	3.0	5	5.8	
After 24 hours (with activity)	0	37	43.0	1.2 (±1.2)
	1.0	2	2.3	
	2.0	37	43.0	
	3.0	8	9.3	
	4.0	2	2.3	
After 24 hours (at rest)	0	75	87.2	0.3 (±0.8)
	2.0	8	9.3	
	3.0	3	3.5	
After 48 hours (with activity)	0	4	4.7	2.2 (±0.9)
	1.0	3	3.5	
	2.0	56	65.1	
	3.0	15	17.4	
	4.0	7	8.1	
	5.0	1	1.2	
After 48 hours (at rest)	0	70	81.4	0.4 (±0.8)
	1.0	1	1.2	
	2.0	12	14.0	
	3.0	3	3.5	
After 72 hours (with activity)	4.0	5	5.8	6.4 (±1.1)
	5.0	9	10.5	
	6.0	32	37.2	
	7.0	27	31.4	
	8.0	13	15.1	
After 72 hours (at rest)	0	2	2.3	3.4 (±1.6)
	2.0	32	37.2	
	3.0	15	17.4	
	4.0	19	22.1	
	5.0	8	9.3	
	6.0	7	8.1	
	7.0	2	2.3	
	8.0	1	1.2	

Therapeutic Block

In most cases (n=49, 57%) the procedure time was 30 -45 minutes, while in the rest of the cases (n=37, 43%) the procedure was performed in 15-30 minutes. In most cases (n=49, 57%), the procedure was 30-45 minutes, specifically when RF ablation was done bilaterally, while in the rest of the cases (n=37, 43%) the procedure was performed in 15-30 minutes.

Table 3 shows the VAS score after the therapeutic block. VAS score before the therapeutics block was observed at an average of 6.6 (±0.8), with most patients having a score of 7.0 (n=33, 38.4%), while the minimum score before the procedure was 5.0 and the maximum was 8.0. However, after the procedure, the VAS score of most of the patients was 2.0 (n=49, 57%), while the average score was also 2.0 (±0.8). The minimum score after the procedure was 0, while

the maximum was 4.0. The consequent observation after 1, 2, 4, 6, and 12 weeks showed an average VAS score of 1.9 (±0.8), 1.9 (±0.8), 1.8 (±0.8), 1.8 (±0.8), and 1.9 (±0.9) respectively. The maximum VAS score after six weeks was 6, but only one patient had that score. However, 41.9% (n=36) had a VAS score of 2.0. Furthermore, the average VAS score was observed after six and nine months, with S.D. ±0.8 and ±0.9, respectively.

Moreover, while observing the complications, 43.0% (n=37) felt numbness, 37.2% (n=32) felt weakness, 12.8% (n=11) had a vascular injury and 7.0% (n=6) had paresthesia, Finally, when asked from the patient that whether they would recommend this procedure to others, more than two-thirds (n=59, 68.6%) agreed that they would recommend this procedure to other, while about one-third (n=27, 31.4%) denied.

Table III: VAS scores of subjects after the therapeutic block

Duration	VAS Score	No of Patients	Percentage	Mean Score (S.D.)
Before Procedure	5.0	7	8.1	6.6 (±0.8)
	6.0	32	37.2	
	7.0	33	38.4	
	8.0	14	16.3	
After Procedure	0	4	4.7	2.0 (±0.8)
	1.0	13	15.1	
	2.0	49	57.0	
	3.0	19	22.1	
	4.0	1	1.2	
After 1 Week	0	6	7.0	1.9 (±0.8)
	1.0	13	15.1	
	2.0	48	55.8	
	3.0	18	20.9	
	4.0	1	1.2	
After 2 Weeks	0	6	7.0	1.9 (±0.8)
	1.0	13	15.1	
	2.0	51	59.3	
	3.0	16	18.6	
After 4 Weeks	0	4	4.7	1.8 (±0.8)
	1.0	25	29.1	
	2.0	44	51.2	
	3.0	11	12.8	
	4.0	2	2.3	
After 6 Weeks	0	4	4.7	1.8 (±0.8)
	1.0	28	32.6	
	2.0	39	45.3	
	3.0	13	15.1	
	4.0	2	2.3	
After 12 Weeks	0	3	3.5	1.9 (±0.9)
	1.0	28	32.6	
	2.0	36	41.9	
	3.0	16	18.6	
	4.0	2	2.3	
	6.0	1	1.2	
After 6 Months	2	63	73.3	2.5 (±0.8)
	3	3	3.5	
	4	20	23.3	
After 9 Months	2	60	69.8	2.5 (±0.9)
	3	2	2.3	
	4	24	27.9	

DISCUSSION

The secondary complication of osteoarthritis is chronic knee pain, and despite available treatment, which may seem insufficient, this issue remains unaddressed. Total knee replacement therapy is an option but because of various concerns and complications, it cannot be performed in most of the patients and pain can even worsen after surgery. Most of the patients are not satisfied with this procedure. Because of this, RFA of the genicular nerve is now an option[17]. The RFA could be made painless, precise, and easy with the help of fluoroscopic or ultrasonography guidance; this properly explains how RF treatment immediately relieves pain.

Patients with chronic knee pain may limit activities affecting the knee joint in their daily lives out of fear of the pain. Patients are more likely to consider their disease state better and express high life satisfaction in the long-term follow-up period as the knee pain subsides. The quantity of functional activity increases, such as climbing and descending stairs[18]. Thus, in the present study, we evaluated the effectiveness of the RFA of the genicular nerve both as a diagnostic and therapeutic tool. In our research, most of the patients were married males. Most patients fall in the ASA-I category, and the affected knee is right.

A study by Reddy RD 2016[19] showed that when cooled, RFA was carried out for diagnostic purposes, a 90% reduction in pain was observed during six months with no severe complications. In our study, with the hot RFA, the VAS score in most included patients was reduced from 8.0 to 0.8 when taken as the mean. Another study on pulsed RFA by Kesikburun S 2016[20] showed that the reduction in pain observed was 50%. In our research, after performing continuous RFA as a therapeutic modality, the average decrease in VAS score was 2.0, while before the procedure showed promising results.

Hong T 2019[21] conducted a systematic review and meta-analysis utilizing 12 randomized controlled trials and included 841 individuals. They hypothesized that RF use would reduce the risk of certain diseases. The

patients' pain scores (VAS) after one week and one month, indicated no appreciable improvement in knee function at three months following treatment, which is inconsistent with our study as the VAS pain score was reduced.

Additionally, even though the current findings of the study regarding the effectiveness and safety of RF treatment were consistent with those of earlier meta-analyses by Li G 2021[22] the heterogeneity calls for additional future research. The study carried out by Davis T et al. [23] and Kapural L 2019[24] showed that the patients experiencing knee pain whose duration is almost one year are relieved by radiofrequency ablation therapy, which is also consistent with the present study findings.

In this study, about one-third of the patients (31.8%) received diagnostic genicular nerve block, and the procedure failed as more than 50% of analgesia was not achieved, consistent with previous literature. However, this scenario needs to be further evaluated as these findings are secondary to psychological complications, a history of smoking, and diabetes mellitus. Hence, less success rate may be because of patient factors rather than technical factors[25]. The results of the present study showed that the VAS score significantly reduced after performing a diagnostic block.

The complications of the procedure may also cause a hindrance to its success. In a study by McCormick ZL 2018[26], the 3rd-degree complication was observed with conventional RF. Still, the study by Konya ZY 2020[27] showed no serious complications apart from hematoma and ecchymosis, which were resolved within a short period. One of the study by Ikeuchi M 2011[28] reported minor subcutaneous bleeding at the injection site. In this study, patients felt numbness followed by weakness, thus indicating the safety of the procedure.

CONCLUSION

The results of the present study indicate that FGGNRA for refractory knee osteoarthritis can be used as a promising option for the treatment of knee pain that is secondary to one of the leading causes of disability. The study's positive outcomes, with minor complications, hint at the efficacy of this treatment modality.

Ethical Approval: Peoples University of Medical & health sciences for Women ERC letter No. PUMHSW/ SBA/Reg./-372.

Conflict of Interest: There is no conflict of interest among the authors.

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AUTHOR CONTRIBUTION

Khaskheli MS: Substantial contributions to the introduction and discussion writing.
Tabassum R: Substantial contributions to the concept and design of the work, drafting the methodology, results, and discussion.
Awan AH: Literature search
Naeem M: Development of Proforma
Akhund A: Data analysis
Langah AI: Data collection
Qureshi M: Drafting
Ahmed Z: Data interpretation

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