ORIGINAL ARTICLE

Effectiveness of Genicular Nerve Block and Platelet Rich Plasma versus Platelet Rich Plasma alone in Primary Knee Osteoarthritis: A Quasi-Experimental Study

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Abstract

Background: Osteoarthritis (OA) is a degenerative disorder resulting from loss of joint cartilage and underlying bone, which causes pain and loss of function. The treatment of knee OA is still a challenge because of the poor self-regeneration capacity of cartilage. Recently, several studies suggested that platelet-rich plasma (PRP) is safe and effective in primary knee osteoarthritis (OA). However, the combination of platelet-rich plasma (PRP) and genicular nerve block (GNB) would be beneficial in reducing post-PRP pain in patients with primary knee osteoarthritis. The objective of this study was to observe the effectiveness of GNB in reducing pain associated with PRP therapy in patients with primary knee osteoarthritis.

Methods: This Quasi-experimental study was carried out for 18 months after getting permission from the Ethical Review Committee of Dhaka Medical College. The enrolled patients were divided into two groups (25 in each group) by computer generation random number table. Group A received intra-articular PRP only and Group B received GNB before PRP injection. The patient's pain was assessed by NRS score and the patient's analgesic requirements in the first 24 hours after giving PRP was recorded. Finally, patient satisfaction was evaluated by a Likert scale and compared between the groups.

Result: A total of 50 patients were included in this study. The NRS score was significantly reduced after receiving PRP between the groups ($P<0.05$). The analgesic requirement was significantly reduced in group B ($P<0.05$). However, the satisfaction rate was similar in Group A and Group B after 3 months of PRP therapy.

Conclusion: Genicular nerve block with PRP is more effective in reducing post-PRP injection pain in patients with primary knee OA.

Key words: Pain, Knee Osteoarthritis, Platelet Rich Plasma, Genicular Nerve Block, Numerical Rating Scale.

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Introduction

In Bangladesh, one of the most prevalent joint disorders is Knee osteoarthritis (OA)[1] which predominantly affects middle-aged and elderly individuals. Osteoarthritis is a degenerative joint disorder with symptoms that can range from moderate to severe[2] which includes knee discomfort, restricted range of motion, and stiffness in the knee joint[3,4]. When combined, these symptoms make it difficult for patients to carry out everyday tasks including walking, climbing stairs, and even getting up from a seated posture[5]. Other problems that OA patients may have include limb misalignment, instability, stiffness, and audible joint noises during movement (crepitation)[6].

From a pathological perspective, knee OA is marked by alterations in the structure of the knee joint and its surrounding areas. There are significant structural changes that occur in knee osteoarthritis. These changes include the deterioration of cartilage and the development of osteophytes. These processes can trigger inflammation and lead to a breakdown of the cartilage. Additionally, early surface changes can occur, such as the formation of deep fissures and erosion of the cartilage and subchondral bone formation[7,8].

Clinical guidelines recommend a range of non-surgical treatment options for knee OA like, non-pharmacological, pharmacological, and interventional managements[9-11]. The non-pharmacological approaches include patient education and self-management, exercise, weight management, walking aids (such as crutches), bracing, shoe and sole modifications, local temperature therapy (cooling or heating), acupuncture, and electromagnetic therapy. On the other hand, pharmacological treatment options include paracetamol, non-steroidal anti-inflammatory drugs, opioids, and glucosamine and chondroitin sulfate. Intervention techniques include invasive and non-invasive modalities. Non-invasive options are intraarticular (IA) injections, which may involve corticosteroids, viscosupplements, blood-derived products, and neurolytic procedures like- local anaesthesia block, alcohol neurolysis and radiofrequency ablation represent the final non-surgical option that can be considered[9,10,12].

Considering the wide variety of possible conservative treatment strategies, two main areas of agreement emerge: firstly, the most successful conservative care of OA in the knee requires a combination of pharmaceutical and non-pharmacological treatment techniques, suitable to the specific needs of each patient. Second, the core goals of conservative care are constant throughout recommendations, with an emphasis on pain relief, enhancing the quality of life and function, and slowing the advancement of the disease[10-12]. To stop the progression of OA, there has been an increasing amount of interest in investigating alternative treatment approaches in recent years.

Biological therapies such as platelet-rich plasma (PRP), bone marrow mesenchymal stem cells, micro-fragmented adipose tissue, and mesenchymal stromal/stem cells (MSC) are being used more and more in the treatment of musculoskeletal problems. These are growth factors that have been studied both in vitro and in vivo as effective factors for the healing of cartilage in OA with promising results[7,13-15]. Growth factors are important for several aspects of tissue regeneration, such as chondrocyte proliferation, mesenchymal stem cell differentiation, chemotaxis, and the synthesis of bone, cartilage, and synovium. As such, they are vital to the process of cartilage tissue remodeling and repair[16,17].

Platelet-rich plasma (PRP) is a biological treatment derived from a patient's own blood plasma, enriched with growth factors released from platelets and embedded within an inherent fibrin scaffold. The underlying principle behind the utilization of PRP is to induce the natural healing process and tissue regeneration through release of platelet-derived growth factors directly at the treatment site[13,16,18]. Platelet-rich plasma (PRP) has demonstrated its efficacy in the early stages of knee OA. But initially after application of the PRP, it may be associated with pain and swelling. Pain is usually intensified in the first few days than the usual pain the patient has[19-21].

In patients with chronic knee OA, a genicular nerve block (GNB) has been shown in many studies to be beneficial in reducing pain and enhancing knee functionin[22,23]. These therapy methods have been used

in the superomedial, inferomedial, and superolateral genicular nerve (SMGN, IMGN, and SLGN) branches in earlier research[24,25]. Studies on the efficacy of the GNB on knee OA revealed a reduction in pain and improvement in knee function[26-29].

As PRP causes severe pain in the first few days, GNB can reduce the pain and suffering in between this time[30]. Thus, the purpose of this study was to examine how well GNB relieves pain following PRP therapy in individuals with knee OA.

Methods

This Quasi-experimental study was carried out at the Pain Clinic in the Department of Anaesthesia, Pain, Palliative and Intensive Care, Dhaka Medical College and Hospital, Dhaka. The adult patient having primary osteoarthritis of the knee was allocated according to the selection criteria. The study period was 18 months (April 2022 to September 2023). After allocating patients with inclusion and exclusion criteria, the total sample was grouped into group A and group B by using a computer-generated random number table.

After obtaining approval from the Ethical Review Committee, DMCH, a total of 50 patients were allocated according to the selection criteria. Study subjects were divided into two groups (Group A: 25 patients received PRP and Group B: 25 patients received PRP with GNB). A baseline physical examination was conducted at the Pain clinic and intensity of the pain was assessed by using NRS score.

Procedures of PRP Therapy

Injections were performed in the affected knee with PRP. PRP was obtained using the centrifuged machine, specialized for PRP (TD4C PRP centrifuge, Yingtai, Chaina). Twenty milliliters of the patient's blood was obtained via venepuncture and mixed with 1 ml of anticoagulant citrate dextrose formula. The 20 ml of anticoagulated blood was put into two separated disposable tubes with 10 ml each and centrifuged at 2200 rpm in a dedicated centrifuge machine (TD4C PRP centrifuge, Yingtai, China). The Plasma was separated and again 2nd centrifugation was done with 3200 rpm. Finally, 3-4 ml of PRP was obtained from the lower 1/3rd of the disposable tube.

No pre-medications or sedatives were administered. Each patient was placed in the supine position with a pillow under the popliteal fossa to alleviate discomfort. The examined area was prepared and draped according to standard sterile techniques, and the 12 MHz linear transducer (SonoSite M-Turbo) was covered with sterile plastic or gloves. The transducer was first positioned transverse or longitudinal plane to the knee just above the patella and moved up or down to identify the suprapatellar recess. Then the probe was turned 90 degrees into the axial or sagittal plane to visualize the exact location for the injection. Before the injection of the PRP, the skin will be anesthetized with 1 ml of 1% Lidocaine infiltration. The 3-4 ml of PRP was injected.

The patients were also instructed to limit the use of their affected knee (limit within basic household activities, no long-standing or walking, and keep the knee at rest as long as possible) for 72 hrs post-injection, after which normal activities could resume. They were advised for cold compression around the knee joint for 10-15 min or according to their tolerability to cold for the next 48-72 hours. No standardized physical therapy protocol was used during the treatment and post-injection phases.

USG-guided GNB Procedures

The transducer was first placed parallel to the long bone shaft and moved up or down to identify the epicondyle of the long bone and the probe was placed middle to the junction of the shaft and the epicondyle. The genicular arteries were identified at the junctions of the epicondyle and the shafts of the femur and tibia as a pulsatile anechoic shadow and then confirmed with colour doppler ultrasound. Accordingly, GNB target points were next to each genicular artery because each genicular nerve lies together along with each genicular artery.

Before performing the GNB, the skin was anaesthetized by 1 ml of 1% Lidocaine infiltration. After using the colour doppler to confirm the genicular artery, the needle was inserted in the plane of the ultrasound probe in the long-axis view. After confirming the placement of the needle-tip next to a genicular artery, a gentle aspiration was performed, and 2 mL of 0.25% Bupivacain injection was

administered. This method was used to inject a total of 6 mL of 0.25 % bupivacaine at 3 target sites: the superior lateral, superior medial, and inferior medial genicular nerves. After the completion of GNB, PRP was introduced into the suprapatellar recess as the previously described process.

NRS was assessed before the procedure and after 24 hours of the procedure during the PRP application. The NRS score and the total amount of analgesic required (paracetamol in grams) after each session of PRP in both groups were assessed over the telephone after 24 hours of the procedure. The satisfaction was investigated with a rating scale from very dissatisfied to highly satisfaction by Likert's scale.

Statistical analysis

Data were statistically described in terms of mean ± standard deviation (±SD), or frequencies and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student t- test for independent samples. For comparing categorical data, Chi square test was performed. P-values less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Product and Service Solutions; IBM SPSS statistics version 29.0.2.0).

Results

This prospective quasi experimental study included 50 patients with primary knee OA. The data were collected before and after PRP injection. Data like demographic and clinical status was collected from the patient's record file. NRS score, analgesic requirements in first 24 hours after giving PRP, and patient's satisfaction score were collected.

The mean age of the patients of group A and group B was 57.2±4.96 years and 55.0±4.85 years, respectively. Most of the patients were female in both groups (68.0% in group A and 60.0% in group B). The average BMI of group A was 25.4±2.35 and group B was 25.5±2.26. There was no statistical difference observed in case of demographic characteristics of patients of both groups (Table-I).

Table I: Demographic characteristics of patients of both groups (n=50).

Characteristics		Group A(n=25)	Group B(n=25)	p value
Age (years)		57.2±4.96	55.0±4.85	0.120
Gender	Male	8 (32.0%)	10 (40.0%)	0.556
	Female	17(68.0%)	15(60.0%)	
BMI (kg/m^2)		25.4±2.35	25.5±2.26	0.951

Values are expressed as Mean±SD and within parenthesis percentage (%) over column in total.

After considering Kellgren-Lawrence grade (K-L) by radiology; most of the patients both of group A (68.0%) and group B (60.0%) belonged to grade II. On the first visit to the pain clinic, group A patients had a mean NRS score of (4.88±0.726) and group B had a mean NRS score (of 4.92±0.702). No significant statistical difference was observed between the groups. (Table-II).

Table II: Comparison of clinical data of the patients between the two groups (n=50).

Clinical parameters		Group A(n=22)	Group B(n=23)	p-value
Kellgren-Lawrence grade(K-L)	Grade II	17(68.0%)	15(60.0%)	0.556
	Grade III	8(32.0%)	10(40.0%)	
NRS score before PRP		4.88±0.726	4.92±0.702	0.844

Values are expressed as Mean±SD and within parenthesis percentage (%) over column in total.

Table III: Comparison of NRS score between the two groups after 24 hrs of PRP (n=50)

	Group A(n=25)	Group B(n=25)	p-value
Before PRP	4.88±0.726	4.92±0.702	0.844
24hrs after PRP	5.76±1.96	3.06±1.47	< .001

Values are expressed as Mean±SD.

After 24 hours of PRP NRS score was increased in group A. But reduction of the NRS was seen in group B. After 24hrs of PRP NRS score was (5.76±1.96) in group A, and NRS score was (3.06±1.47) in group B. The difference was statistically significant between the two groups ($p < 0.001$). (Table-III).

Table IV: The amount of analgesic (gm) required in the first 24 hrs after PRP (n=50).

Groups	The amount analgesic (gm)	p-value
Group A(n=25)	2.56±0.507	< .001
Group B(n=25)	1.20±0.645	

Values are expressed as Mean±SD

When considering the analgesic required by the patients in the group, it was found that the analgesic requirement had reduced in the patients of group B after the application of PRP. The mean amount of the analgesic required by the patients in the first 24 hrs after PRP was higher in group A (2.56±0.507) than the group B (1.20±0.645). That was statistically significant as the p-value was <0.001 (Table IV).

Table IV: Comparison of Patient satisfaction by Likert's scale 3 months after PRP between the groups (n=50).

Level of satisfaction	Group A (n=25)	Group B (n=25)	p-value
Very Satisfied	4 (16.0%)	5 (20.0%)	0.976
Satisfied	11 (44.0%)	10 (40.0%)	
Neutral	2 (8.0%)	3 (12.0%)	
Dissatisfied	5 (20.0%)	4 (16.0%)	
Very Dissatisfied	3 (12.0%)	3 (12.0%)	

Values are expressed as within parenthesis percentage (%) over the column in total.

In group A, 16.0% were very satisfied and 44.0% were satisfied 3 months after PRP therapy. In group B, 20.0% of patients were very satisfied and 40.0% were satisfied 3 months after PRP therapy. On the other hand, 20.0% of patients in group A were dissatisfied and 12.0% of patients were very dissatisfied. In group B, 16.0% of patients were dissatisfied and 12.0% were very dissatisfied 3 months after PRP therapy. No significant difference was observed (p>0.05).

Discussion

Osteoarthritis (OA) is one of the most common causes of knee pain in adults, and is the leading cause of musculoskeletal pain and locomotive disability in Bangladesh and as well as all over the world[1]. The focus of OA treatment is to alleviate pain, enhance joint mobility, minimize physical limitations, enhance quality of life, slow down joint damage, and provide patients with education on managing this condition[24]. In our study, the combination of GNB with PRP therapy might help to achieve the objectives.

The demographic characteristics were comparable in the two studied groups. Most of the patients in both groups were female. No significant difference was observed in the case of mean BMI between the groups. A similar result was observed by Sampson et al., (2010)[31]. They observed the age range of the enrolled patients at the pre-injection visit was 18 – 87 years with a median of 51.8 years. The average body mass index for participants was 25.0 kg/m^2, with a range of 20.9 –32.5 kg/m^2. There was significant improvement in the VAS scale after 1-year reassessment and patient satisfaction survey was filled out at the 1-year follow-up to assess patient satisfaction. Eight of the 13 patients achieved their individual goals with the injection which also resembles with this study.

Kim et al. (2019) found that K-L grade II was 64.3% in one group but the other group had 43.3%[32]. They also found the duration of symptoms 14 vs 12 months between the groups. When the baseline pain score, no significant difference was observed in NRS-11 between the groups. The above observations were matched with this study. Others studies also compared VAS and NRS for the studied groups before the procedure. They also observed no significant difference between the groups[22,30].

This study observed that the NRS score was reduced in both groups after completing treatment. However the reduction of NRS score was more in group B after 24 hours of post-PRP and that was significant between the groups (p <0.05). Another study assessed the therapeutic efficacy of TENS vs ultrasound-guided GNB in patients with Knee OA[33]. The study found that after continuous 3 weeks of daily TENS therapy, knee pain improved from a mean VAS of 7.35 (±0.81) at baseline to 3.66 (±1.14) at the end of 1 month. Whereas, after a single session of GNB, the mean VAS improved from a baseline value of 7.41 (±0.86) to 2.87 (±0.92) at the end of 1 month. Thus, GNB shows a significantly better result in improving

knee pain than TENS therapy at 1 month. However, at the end of 3 months, the VAS in both groups again became comparable ($p = 0.21$)[33]. This reduction in VAS score was consistent with our findings where NRS score was reduced. Other studies where US-guided GNB were performed show significant reduction of NRS score from 2 weeks to 12 weeks[22,29-34]. So, GNB may be a better option to reduce the pain intensity as well as improve pain after the PRP.

In our study, we have performed GNB under ultrasound guidance, which has been reported to be safer and superior to the traditional fluoroscopic guided procedure, especially in the presence of anatomic variations of the genicular nerves. Previous studies mentioned that direct visualization of the needle position and trajectory using ultrasound can guarantee a successful GNB because of proper localization of the injected nerve[35]. In addition, ultrasound is considered portable and affordable and does not expose the patient or investigator to radiation[35,36].

Elashmawy and colleagues observed that after 1 and 6 months from the injection, VAS and NRS scores were significantly improved in patients who underwent US-guided GN alcohol neurolysis compared to those with GNB. The improvement was remarkable after the 1st month in both groups but after 6 months only in the GN alcoholic neurolysis group[30].

This study showed patients who received GNB before PRP, had less analgesic requirements in the first 24 hours in each session. Similarly, the study had showed that only 2 patients in the GNB group experienced pain at the site of the injection and received paracetamol with resolution by the first week, and where PRP group had more pain score which responded to ice packs and paracetamol requirement was high[2]. It was found that analgesia requirements were significantly decreased in the GNB group more than in the Intra-articular injections PRP group in all follow-up sessions[37].

After 3 months of PRP therapy, the satisfaction rate was similar in group B and the group A. Other studies showed significantly higher satisfaction in the GNB group in comparison to the control group in the 3rd and 6th months[37]. Follow-up values of the likert scale showed better satisfaction when compared to their basal value in each group[6].

From this study, it is evident that PRP combined with ultrasound-guided GNB is more successful than PRP alone in treating patients with primary knee OA in terms of pain reduction after the PRP injection and reduced analgesic needs.

Conclusion

Genicular nerve block reduces post-PRP injection pain in primary knee OA. It also reduces the analgesic requirements rather than solely using PRP.

Declaration

Ethics approval:

The study was approved by the Ethical Review Committee of DMCH (Memo No. ERC-DMC/EC-C/2022/422).

Author contributions

Conception and development of the idea AKMAH, AKMA
Writing AKMAH
Data analysis SKM, SA, MSA
Data collection MAH, MMA, RMR
Review and Editing AKMAH, MAH

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Conflict of interests: None

References

1 Haider MZ, Bhuiyan R, Ahmed S, Zahid-Al-Quadir A, Choudhury MR, Haq SA, et al. Risk factors of knee osteoarthritis in Bangladeshi adults: a national survey. BMC Musculoskelet Disord. 2022 Apr 8; 23(1):333.

2 Elawamy A, Kamel EZ, Mahran SA, Abdellatif H, Hassanien M. Efficacy of Genicular Nerve Radiofrequency Ablation Versus Intra-Articular Platelet Rich Plasma in Chronic Knee Osteoarthritis: A Single-Blind Randomized Clinical Trial. Pain Physician. 2021 Mar; 24(2):127–34.

3 Ma Q, Hei X, Zhu S, Tian X, Chen Y, Zhu N, et al. The Clinical Efficacy of Platelet-Rich Plasma versus Conventional Drug Injection in the Treatment of Knee Osteoarthritis: A Study Protocol for a Randomized Controlled Trial. Fioravanti A, editor. Evidence-Based Complementary and Alternative Medicine. 2022 Apr 25; 2022:1–7.

4 Neogi T. The epidemiology and impact of pain in osteoarthritis. Osteoarthritis and Cartilage. 2013 Sep; 21(9):1145–53.

5 ROGERS MW, TAMULEVICIUS N, COETSEE MF, CURRY BF, SEMPLE SJ. Knee Osteoarthritis and the Efficacy of Kinesthesia, Balance & Agility Exercise Training: A Pilot Study. Int J Exerc Sci. 2011 Apr 15; 4(2):124–32.

6 El-Hakeim EH, Elawamy A, Kamel EZ, Goma SH, Gamal RM, Ghandour AM, et al. Fluoroscopic Guided Radiofrequency of Genicular Nerves for Pain Alleviation in Chronic Knee Osteoarthritis: A Single-Blind Randomized Controlled Trial. Pain Physician. 2018 Mar; 21(2):169–77.

7 Primorac D, Molnar V, Rod E, Jeleč Ž, Čukelj F, Matišić V, et al. Knee Osteoarthritis: A Review of Pathogenesis and State-Of-The-Art Non-Operative Therapeutic Considerations. Genes. 2020 Jul 26; 11(8):854.

8 Xia B, Di Chen, Zhang J, Hu S, Jin H, Tong P. Osteoarthritis Pathogenesis: A Review of Molecular Mechanisms. Calcif Tissue Int. 2014 Dec; 95(6):495–505.

9 Beckmann NM, Villamaria EE. Interventional Therapies for Osteoarthritis: An Update. American Journal of Roentgenology. 2022 Dec; 219(6):929–39.

10 Zhang W, Nuki G, Moskowitz RW, Abramson S, Altman RD, Arden NK, et al. OARSI recommendations for the management of hip and knee osteoarthritis: part III: Changes in evidence following systematic cumulative update of research published through January 2009. Osteoarthritis Cartilage. 2010 Apr; 18(4):476–99.

11 National Collaborating Centre for Chronic Conditions (UK). Osteoarthritis: National Clinical Guideline for Care and Management in Adults [Internet]. London: Royal College of Physicians (UK); 2008 [cited 2024 Dec 14]. (National Institute for Health and Clinical Excellence: Guidance). Available from: http://www.ncbi.nlm.nih.gov/books/NBK48984/

12 Kon E, Filardo G, Drobnic M, Madry H, Jelic M, Van Dijk N, et al. Non-surgical management of early knee osteoarthritis. Knee Surg Sports Traumatol Arthrosc. 2012 Mar; 20(3):436–49.

13 Raeissadat SA, Rayegani SM, Hassanabadi H, Fathi M, Ghorbani E, Babaee M, et al. Knee Osteoarthritis Injection Choices: Platelet- Rich Plasma (PRP) versus Hyaluronic Acid (A one-year randomized clinical trial). Clin Med Insights Arthritis Musculoskelet Disord. 2015 Jan;8: CMAMD.S17894.

14 Kon E, Mandelbaum B, Buda R, Filardo G, Delcogliano M, Timoncini A, et al. Platelet-Rich Plasma Intra-Articular Injection Versus Hyaluronic Acid Viscosupplementation as Treatments for Cartilage Pathology: From Early Degeneration to Osteoarthritis. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2011 Nov; 27(11):1490–501.

15 Gobbi A, Karnatzikos G, Mahajan V, Malchira S. Platelet-Rich Plasma Treatment in Symptomatic Patients With Knee Osteoarthritis: Preliminary Results in a Group of Active Patients. Sports Health: A Multidisciplinary Approach. 2012 Mar; 4(2):162–72.

16 Tandon DK, Kumar DA, Kumar DV. Role of Intra-Articular Injection of Platelet-Rich Plasma (Prp) In Symptomatic Patients with Knee Osteoarthritis. Journal of Pharmaceutical Negative Results. 2022 Nov 27; 2976–87.

17 Moinuddin M, Mony SA, Kamal MM, Islam MN, Sharmin S, Akhtaruzzaman AKM. Duloxetine in Addition with Platelet Rich Plasma in Managing Neuropathic Knee Pain: A Comparative Study. Bangladesh J. Pain 2022; 2(2): 18-27. doi:10.62848/bjpain.v2i2.5777

18 Bai MY, Vy VPT, Tang SL, Hung TNK, Wang CW, Liang JY, et al. Current Progress of Platelet-Rich Derivatives in Cartilage and Joint Repairs. IJMS. 2023 Aug 9; 24(16):12608.

19 Shetty, V, Desouza, C. Catastrophic complication after intra-articular injection of platelet-rich plasma – Case report. Journal of Orthopaedic Reports. 2024; 3(1):100254.

20 Prodromidis AD, Charalambous CP, Moran E, Venkatesh R, Pandit H. The role of Platelet-Rich Plasma (PRP) intraarticular injections in restoring articular cartilage of osteoarthritic knees. A systematic review and meta-analysis. Osteoarthritis and Cartilage Open. 2022 Dec; 4(4):100318.

21 Laudy ABM, Bakker EWP, Rekers M, Moen MH. Efficacy of platelet-rich plasma injections in osteoarthritis of the knee: a systematic review and meta-analysis. Br J Sports Med. 2015 May; 49(10):657–72.

22 Fitzpatrick B, Cowling M, Poliak-Tunis M, Miller K. Effect of Genicular Nerve Radiofrequency Ablation for Knee Osteoarthritis: A Retrospective Chart Review. WMJ. 2021 Jul; 120(2):156–9.

23 Cankurtaran D, Karaahmet OZ, Yildiz SY, Eksioglu E, Dulgeroglu D, Unlu E. Comparing the effectiveness of ultrasound guided versus blind genicular nerve block on pain, muscle strength with isokinetic device, physical function and quality of life in chronic knee osteoarthritis: a prospective randomized controlled study. Korean J Pain. 2020 Jul 1; 33(3):258–66.

24 Pérez MJ, Nájera Losada DC, Herrero Trujillano M, Gálvez Mateos R, Sánchez García MA, Vela de Toro A, et al. Genicular nerve radiofrequency in osteoarthritis-related chronic knee pain. Rev Soc Esp Dolor. 2021; 2021(3):157–67.

25 Protzman NM, Gyi J, Malhotra AD, Kooch JE. Examining the Feasibility of Radiofrequency Treatment for Chronic Knee Pain after Total Knee Arthroplasty. PM&R. 2014 Apr; 6(4):373–6.

26 Choi WJ, Hwang SJ, Song JG, Leem JG, Kang YU, Park PH, et al. Radiofrequency treatment relieves chronic knee osteoarthritis pain: A double-blind randomized controlled trial. Pain. 2011 Mar; 152(3):481–7.

27 Kim DH, Lee MS, Lee S, Yoon SH, Shin JW, Choi SS. A Prospective Randomized Comparison of the Efficacy of Ultrasound- vs Fluoroscopy-Guided Genicular Nerve Block for Chronic Knee Osteoarthritis. Pain Physician. 2019 Mar; 22(2):139–46.

28 Billesberger LM, Fisher KM, Qadri YJ, Boortz-Marx RL. Procedural Treatments for Knee Osteoarthritis: A Review of Current Injectable Therapies. Pain Research and Management. 2020 Feb 18; 2020:1–11.

29 Güler T, Yurdakul FG, Önder ME, Erdoğan F, Yavuz K, Becenen E, et al. Ultrasound-guided genicular nerve block versus physical therapy for chronic knee osteoarthritis: a prospective randomised study. Rheumatol Int. 2022 Apr; 42(4):591–600.

30 Elashmawy MM, Shabana AAH, Elsaid TO, Elhawary GM. Ultrasound-guided genicular nerve block versus alcoholic neurolysis for treatment of advanced knee osteoarthritis patients. The Egyptian Rheumatologist. 2022 Oct; 44(4):307–11.

31 Sampson S, Reed M, Silvers H, Meng M, Mandelbaum B. Injection of Platelet-Rich Plasma in Patients with Primary and Secondary Knee Osteoarthritis: A Pilot Study. American Journal of Physical Medicine & Rehabilitation. 2010 Dec; 89(12):961–9.

32 Kim DH, Choi SS, Yoon SH, Lee SH, Seo DK, Lee IG, et al. Ultrasound-Guided Genicular Nerve Block for Knee Osteoarthritis: A Double-Blind, Randomized Controlled Trial of Local Anesthetic Alone or in Combination with Corticosteroid. Pain Physician. 2018 Jan;21(1):41–52.

33 Vikas Kumar. Comparative Assessment of the Outcome in Patients with Knee Osteoarthritis Treated Using of TENS Therapy and Ultrasound- Guided Genicular Nerve Block. International Journal of Pharmaceutical and Clinical Research. 2022; 14(1):267–71.

34 Yilmaz V, Umay E, Gundogdu I, Aras B. The comparison of efficacy of single intraarticular steroid injection versus the combination of genicular nerve block and intraarticular steroid injection in patients with knee osteoarthritis: a randomised study. Musculoskelet Surg. 2021 Apr; 105(1):89–96.

35 Cheng PH, Kim HJ, Ottestad E, Narouze S. Ultrasound-guided injections of the knee and hip joints. Techniques in Regional Anesthesia and Pain Management. 2009 Jul; 13(3):191–7.

36 Huntoon MA. Ultrasound in Pain Medicine: Advanced Weaponry or Just a Fad? Regional Anesthesia and Pain Medicine. 2009 Sep; 34(5):387–8.

37 Rady HME, Elgebaly ASA, Hamed AMS, Salem AE. Comparative study between intra-articular injections of hyaluronic acid with platelet-rich plasma versus genicular nerve thermal radiation in management of pain in knee osteoarthritis. Egyptian Journal of Anaesthesia. 2020; 36(1):134–9.