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Short- and mid-term clinical results of ultrasound-guided genicular nerve block in arthroplasty-related chronic postsurgical pain

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Abstract

One-third of patients experience knee arthroplasty-related chronic postsurgical pain (CPSP), and CPSP negatively affects all dimensions of quality of life. We aimed to evaluate the short- and mid-term clinical results and success of ultrasound-guided genicular nerve block in patients with knee arthroplasty-related CPSP. The secondary outcome aimed to evaluate the relationship between clinical success and the presence of neuropathic pain. This study is a retrospective chart review of patients with knee arthroplasty-related CPSP who were referred to a pain clinic and were unresponsive to conservative treatments. We obtained the clinical evaluations of the patients at one, three, and six months before and after the procedure from patient records. We evaluated pain intensity with a 10-point numerical rating scale (NRS), the effects of knee pain on function with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scoring system, and the presence of neuropathic pain with the Douleur Neuropathic Pain 4 Questions. We accepted the clinical success of the procedure as a 50% or more reduction in pain intensity. We evaluated a total of 21 patients. The therapy was successful in 13 (61.9%), 12 (57.1%), and 7 (33.3%) patients at the first, third, and sixth-month visits, respectively. There was a statistically significant difference between the NRS and WOMAC scores. At baseline, neuropathic pain was present in 61.9% (n = 13) of the patients, and its presence was not related to clinical success at the first, third, and sixth-month visits. Ultrasound-guided genicular nerve block relieves pain and improves short- and mid-term functionality for patients with knee arthroplasty-related CPSP. The study resulted in clinical success in two-thirds of the patients in the early period and one-third in the sixth month.

Keywords: knee arthroplasty, chronic postsurgical pain, genicular nerve block, neuropathic pain

1. Introduction

Knee osteoarthritis is essential in clinical practice because of its increasing prevalence, multimorbidity, and negative impact on life (1). It is typically managed with stepwise treatment, including education, structured exercise programs, topical analgesics, specific and nonspecific nonsteroidal anti-inflammatory drugs, intra-articular steroid injections, aquatic exercises, gait aids, cognitive-behavioral therapy, and intra-articular hyaluronic acid injections (2). In patients unresponsive to conservative treatments, knee arthroplasty is the gold standard treatment (3).

The most important determinant of satisfaction in patients undergoing knee arthroplasty is pain relief and the functionality gained from pain relief (4). Persistent pain for at least three months after knee arthroplasty is defined as chronic postsurgical pain (CPSP) (5) and detected at a frequency of 16–47% (6-8). Knee arthroplasty-related CPSP can be nociceptive or neuropathic, affecting the biopsychosocial aspects of patients' quality of life because of the multifactorial etiology of knee arthroplasty-related CPSP, which is not fully understood. A multidisciplinary and comprehensive pain management approach is recommended that involves the cooperation of orthopedic surgeons, physiatrists, pain specialists, and psychiatrists (9).

No guidelines have been established for managing knee arthroplasty-related CPSP, and there is insufficient evidence about interventional treatments' clinical value and success (10). However, studies have shown that intra-articular Botulinum toxin injections (11), periarticular subcutaneous perineural injections (12), dry needling (13), and genicular nerve blocks and radiofrequency treatments (14, 15) may improve pain and functionality.

The genicular nerve consists of anastomoses of the tibial, common peroneal, saphenous, femoral, and obturator nerves, and it provides sensory innervation of the knee joint (16). To explore whether genicular nerve block application might be beneficial in knee pain (16), researchers have examined the clinical results of blockade and ablation treatments in various patient groups (14, 15, 17, 18). In this study, we retrospectively evaluated the clinical outcomes of ultrasound-guided steroid-added genicular nerve blockade and the relationship between clinical success and the presence of neuropathic pain during short- to mid-term follow-up in patients with knee arthroplasty-related CPSP.

2. Materials and Methods

2.1. Study design and setting

This study involved a single-center retrospective analysis. We

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acquired the data by screening the files of patients treated between April 1, 2019, to July 31, 2020, at our institution, after obtaining approval from the ethics committee of Necmettin Erbakan University (No. 2021/3127, approved March 2, 2021). We conducted this study per the declaration of Helsinki.

2.2. Participants

We evaluated the patients referred to the pain clinic between April 2019 and July 2020 who were unresponsive to nonsurgical treatment (physical therapy, exercise programs, and pharmacological treatments) and had pain from arthroplasty that persisted for three months. We included those who had undergone a genicular nerve block with triamcinolone and bupivacaine and excluded those who changed pharmacological therapy, exercise program, and orthotic devices two months before undergoing the procedure or at the end of the follow-up period. We also excluded those who received physical therapy or rehabilitation during the six months before the procedure, and those with a history of psychiatric disease, dementia, malignancy, inflammatory rheumatologic disorders, and neurological diseases

2.3. Variables and outcomes

We reviewed the patients' clinical follow-up files for the following: Demographic data, Douleur Neuropathic Pain 4 Questions (DN-4), pre-procedural clinical findings regarding pain duration before the procedure, and pre and post-procedural pain intensity scores (Numeric Rating Scale (NRS) and Western Ontario and MacMaster Universities osteoarthritis index (WOMAC). We analyzed pain intensity and WOMAC results at one, three, and six months after the procedure.

We obtained pain intensity data before the genicular nerve block and at one, three, and six months after the procedure. At those intervals, we asked the patients to determine the mean pain intensity from the past week using the NRS (0–10 at each visit, with 0 meaning "no pain" and 10 meaning "the most severe pain I can imagine"). Clinical success constituted a 50% or higher reduction in pain intensity (19).

The WOMAC is a valid, reliable osteoarthritis-specific questionnaire that contains 24 questions under three subheadings: pain, stiffness, and physical function. Each question is scored on a Likert scale as 0 = none, 1 = mild, 2 = moderate, 3 = severe, or 4 = very severe. The score for each section is calculated individually, and the total score ranges from 0 to 100. High scores indicate increased pain and stiffness and impaired physical function (20).

The DN-4 consists of 10 questions, seven focusing on symptoms and three determined by clinical examination. The symptom questions include the following: burning, painful cold, electric shock, tingling, pricking, numbness, and itching. The senses examined are light touch hypoesthesia, pinprick hypoesthesia, and brushing allodynia. Each question with a yes answer is given one point. The scores obtained by symptom questioning and clinical examination are added to calculate the total score, which is 10 points maximum. Patients with a score of 4 or above are considered to have neuropathic pain (21).

2.4. Intervention

The injection area was sterilized with a povidone-iodine solution. The ultrasound-guided genicular nerve block was applied as defined by Kim et al. (17). Each patient was placed in a supine position with a pillow under the popliteal fossa to avoid discomfort. A 12-MHz linear transducer (Siemens Acuson S2000, Germany), covered with a sterile disposable sheath, was first placed parallel to the lower extremity to identify the medial and lateral epicondyle of the femur and proximal aspect of the tibia. The tract of the genicular artery was identified and confirmed using color Doppler mode. The genicular nerve block target points were determined, which are usually next to the superior lateral, superior medial, and inferior medial genicular arteries. The needle was inserted into the plane of the ultrasound probe in the long-axis view. Gentle aspiration was performed, and the injectate was administered. The same procedure was performed for the three injection sites (superior lateral, superior medial, and inferior medial genicular arteries), with a total volume of 6 ml, comprising 5 ml of 0.5% bupivacaine and 1 ml of 40/mg/ml triamcinolone divided between the three injection sites for each knee. At the end of the procedure, ice was applied for 20 minutes.

2.5. Statistics

After finalizing the study, we performed a post hoc sample size analysis using the G*power software package for power analysis (version 3.1.6; Franz Faul, Kiel University, Kiel, Germany). We included 21 items in the final analysis and calculated the power as 0.69 with an effect size of 0.5 and an alpha error level of .05. We conducted data analysis using SPSS version 20.0 (IBM Corporation, Somers, NY, USA).

We used the Shapiro-Wilk and Kolmogorov-Smirnov tests to test the hypothesis of normal distribution and presented the descriptive data as frequencies (n) and percentages (%) for the categorical variables. For numerical variables, we reported whether the mean (standard deviation) and median with 25–75% percentiles were normally distributed or not. We used the Chi-square or Fisher's exact tests to compare categorical variables between independent groups and analyzed variables with non-normal distributions with Friedman's analysis. We used the Wilcoxon Rank Sum Test to compare repetitive measurements, a Bonferroni correction to avoid possible type 1 errors and Pearson's correlation coefficient or Spearman's rank correlation to assess the relationship between variables.

3. Results

We included 21 patients in the study (Fig. 1). Their average age was 64.0 (58.5–69.5), and 81.0% (n = 17) were female. The postoperative time was 18.0 (5.5–43.0) months, and the

postoperative pain duration was 7.0 (4.0–35.5) months. The postoperative times were 6 ≤ months in 6 (28.57%), 7–12 months in 3 (14.28%), 13–24 months in 4 (19.04%), and ≥ 25 months in 8 (38.09%) patients. The right side was painful in 10 (47.6%), while the left side was in 11 (52.4%). Neuropathic pain was present in 13 (61.9%).

Fig 1. Flow diagram

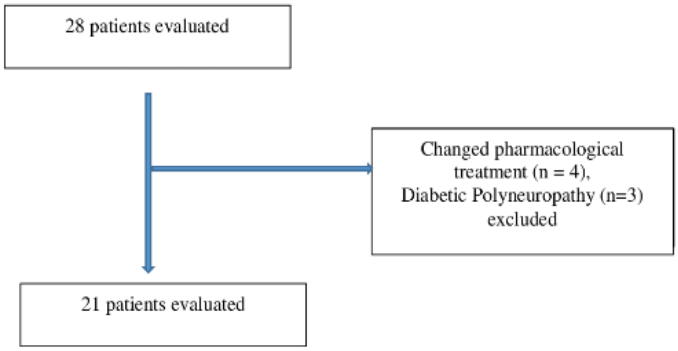

Table 1 shows the pre and post-procedural pain intensity scores (NRS). There was a statistically significant difference between pain intensity values before and after the procedure (p-value < .001). In the post hoc analysis, there was a statistically significant difference in pain intensity scores between the pre-procedure period and the first, third, and sixth-month visits (Table 2).

Table 1. Pain intensity NRS (0–10) at the follow-up period

Time	Pain intensity NRS (0-10)	
	Median (25-75% percentiles)	95%C.I.*
Baseline	7.0 (5.0-8.0)	5.77-7.33
1st month visit	3.5 (1.5-6.0)	2.37-5.03
3rd month visit	4.0 (1.5-7.0)	2.79-5.60
6th month visit	6.0 (2.0-8.0)	3.85-6.54

*95% Confidence Interval for Difference

Table 2. Pairwise comparisons of baseline and postprocedural pain intensities

Time		P*	Z score	Effect size
Baseline	**1st month**	0.000	-3.627	0.79
	3rd month	0.003	-3.232	0.70
	6th month	0.030	-2.565	0.56

* Bonferroni correction was done

Table 3 shows the pre-procedural and post-procedural WOMAC total scores. There was a statistically significant difference between pre and post-procedure total WOMAC scores (p-value < .001). In the post hoc analysis, there was a statistically significant difference in WOMAC total scores between the pre-procedure and first, third, and sixth-month visits (Table 4).

Table 3. WOMAC total scores at the follow-up period

Time	WOMAC total score	
	Mean ± standard deviation	95%C.I.*
Baseline	61.66 ± 17.09	53.88-69.44
1st month visit	44.94 ± 20.90	35.43-54.45
3rd month visit	47.52 ± 21.89	37.55-57.49
6th month visit	55.26 ± 20.47	45.94-64.57

*95% Confidence Interval for Difference

Table 4. Pairwise comparisons of baseline and postintervention WOMAC total scores

Time	P*	Z score	Effect size	
Baseline	**1st month**	0.000	-3.623	0.79
	3rd month	0.003	-3.181	0.69
	6th month	0.034	-2.121	0.46

* Bonferroni correction was done

The average percentage of pain relief after the procedure was 52.78% (14.58–73.21%) (32.29–63.65, 95% CI), 50.0 (0.0–73.21) (23.92–57.41, 95% CI), and 0.0 (0.0–55.00) (9.88–39.60, 95% CI) at the first, third, and sixth-month visits, respectively, compared with the baseline. There was a statistical difference in pain relief between the first and third, third and sixth, and first and sixth months (p = 0.027, 0.017, 0.020, respectively).

There were no statistical differences between the groups with and without neuropathic pain in terms of age, postoperative time (the time between arthroplasty surgery and steroid-added genicular nerve blockade), pain duration, baseline pain intensity, or baseline WOMAC scores (Table 5) neither in clinical success in the first, third, and sixth-month visits between the patients with and without neuropathic pain ($\chi2 = 3.590$, p = .085; $\chi2 = 4.863$, p = .067; $\chi2 = 1.615$, p = .346, respectively). We also evaluated the complications. No patients developed infection, weakness, or neuralgia.

Table 5. Preoperative variables comparisons of patients with neuropathic pain and without neuropathic pain

Variables	Median (25-75%)		P
	Without neuropathic pain	With neuropathic pain	
Age (years)	62.0 (58.5-69.25)	67.0 (57.5-69.5)	0.79
Baseline pain intensity (NRS)	5.0 (4.25-7.75)	7.0 (5.5-8.0)	0.08
Baselin WOMAC score	63.54 (32.55-68.75)	64.58 (53.64-75.0)	0.53
Postoperative time (months)	12.5 (6.25-46.0)	24.0 (5.-43.0)	0.88
Pain duration (months)	7.0 (4.5-37.5)	3.5 (3.0-29.5)	0.56

4. Discussion

We found that pain intensity decreased by half in the early period, and pain intensity and functionality improved at short and mid-term follow-ups with a steroid-added genicular nerve blockade. In their randomized controlled study of 28 patients with knee arthroplasty-related CPSP, Qudsi-Sinclair et al. (17) compared pulsed radiofrequency treatment for the genicular nerve to steroid-added genicular nerve blockade. They evaluated pain intensity with the NRS and functionality with the Oxford Knee Score and observed a decrease in pain intensity that started on the first day and improved functionality that started in the first month; both results continued through the third and sixth months, without any difference between the groups (17). Erdem and Sir (15) retrospectively analyzed the pain intensity and WOMAC scores of 23 patients with chronic knee pain who had undergone pulsed radiofrequency after genicular nerve blockade. They analyzed follow-up data from the third week and the third month after the procedure. As in our study, Erdem and Sir (15) found an improvement in pain intensity and functionality in the short and mid-term. Ghai et al. (22) applied a single session ultrasound-guided genicular nerve blockade with a mixture of 4.5 mL of 0.5% bupivacaine and 1.5 mL (60 mg) of methylprednisolone to patients with osteoarthritis-related chronic knee pain. Improvement in pain severity as measured by NRS and functionality as assessed by WOMAC was demonstrated at a 3-month follow-up (22). Guler et al. (23) showed that ultrasound-guided genicular nerve blockade with a total mixture of 5 ml of 2% lidocaine and 40 mg of triamcinolone, to patients with knee osteoarthritis has sustained improvement in pain, physical function, and physical capacity for up to 12 weeks. Fonkoue et al. (24) performed a single session genicular nerve blockade with a mixture of lidocaine and triamcinolone, using scopy-controlled classic and revised target techniques, to patients with chronic knee pain due to osteoarthritis. In both groups, improvement was detected at the 12^{th}-week control compared to baseline in pain severity assessed by NRS, functionality assessed by WOMAC, and physical and mental health assessed by SF-12 (24). The common point of these studies in patients with knee osteoarthritis is that long-term efficacy was demonstrated with a single-session block with added steroids. It has been shown that steroid-added blocks inhibit pain pathways (25). In our study, midterm efficacy may be related to the addition of steroids in the nerve blockade procedure. Elsaman et al. (26) assessed the effect of genicular nerve block on the inflammatory joint disease. In patients with knee involvement due to rheumatoid arthritis, genicular nerve blockade with bupivacaine was shown to improve pain severity and functionality in a 12-week follow-up (26). Elsaman et al. (26) argued that this clinical efficacy may be related to the anti-inflammatory effects of local anesthetics (27). In our study, we evaluated the clinical outcomes of patients with knee arthroplasty-related CPSP. It has been shown that arthroplasty surgery has a neuroinflammatory effect (28). The clinical improvement in our study may be related to the suppression of neuroinflammation by the genicular nerve blockade.

Kim et al. evaluated the clinical results of ultrasound-guided steroid-added genicular nerve blockade in patients with chronic knee pain due to osteoarthritis. They found that the pain and functionality improvements observed at weeks two and four regressed to the pre-procedure baseline levels at week eight (17). Our finding that the block efficacy lasted longer than in Kim et al.'s study may be due to the development of spontaneous remission with increased follow-up time in arthroplasty-related chronic pain (29, 30).

Our study evinced that pain scores significantly decreased at the first-month visit after the procedure, and the analgesic effect gradually decreased toward the sixth month. Erdem and Sir (15) found no statistically significant change in pain relief with the progression of the follow-up period, although the improvement in functionality decreased. Qudsi-Sinclair et al. (14) reported that the analgesic efficacy started at the month-one visit in the genicular block group remained stable during the sixth-month follow-up period. The stability of pain palliation these studies reported can be explained by the higher drug doses and volumes than ours or by the combined radiofrequency therapy. In addition, our findings supported Qudsi-Sinclair et al.'s (14) recommendation to perform strict pain follow-up after the blockade, as it may require procedure repetition in the first six months.

In our study, approximately three-fifths of the patients had neuropathic pain. This prevalence rate was higher than reported in the literature (31, 32). Comparing the groups with and without neuropathic pain, we found no difference between the groups regarding the clinical success of the genicular nerve blockade. In the literature, studies have shown that peripheral nerve blockades can be beneficial for patients with neuropathic pain of various etiologies (33, 34). Consistent with our findings, Eker et al. (34) concluded from their double-blind controlled study on patients with neuropathic pain that prolonged efficacy could be achieved using peripheral nerve blockades with added steroids.

The main limitations of the study were its retrospective design and limited sample size. In addition, the absence of control groups and the limited follow-up data make the findings difficult to generalize.

In conclusion, ultrasound-guided steroid-added genicular nerve blockade is a safe treatment option that reduces pain intensity by half in the early period and relieves pain in the short to mid-term. Its clinical success is not associated with the presence of neuropathic pain in patients with arthroplasty-related CPSP. Future long-term follow-up studies should investigate the need for blockade repetition and the addition of genicular nerve blockade to the management algorithm for knee arthroplasty-related CPSP. Also, prospectively designed

studies could evaluate the strength of our findings by using more extensive patient participation and control groups.

Conflict of interest

None.

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Authors' contributions

Concept: S.B, M.Z.G., Design: S.B, M.Z.G., Data Collection or Processing: S.B, M.Z.G., Analysis or Interpretation: S.B, M.Z.G., Literature Search: S.B, M.Z.G., Writing: S.B, M.Z.G.

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