ORIGINAL ARTICLE

EVALUATION OF THE EFFECT OF SCIATIC NERVE BLOCK ON POSTOPERATIVE ANALGESIA AND INFLAMMATORY RESPONSE IN KNEE ARTHROPLASTY

Siyatik Sinir Bloğunun Postoperatif Ağrı ve İnflamatuar Yanıt Üzerine Etkilerinin İncelenmesi

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ABSTRACT

Objective: Postoperative pain significantly impact on the recovery and hospitalization following orthopedic surgeries. The aim of the study was to investigate the effects of sciatic nerve block together with to femoral nerve block on the inflammatory response and postoperative pain in total knee arthroplasties (TKA).

Material and Methods: The study was carried out at Afyonkarahisar Health Science University, Department of Anesthesiology and Reanimation. The patients with ASA I-III patients aged 40-80 years undergoing elective unilateral TKA were enrolled. Participants were randomly assigned into two groups: Group I received only femoral nerve block, while Group-II received both femoral and sciatic nerve blocks. Postoperative pain was assessed using the Visual Analog Scale(VAS) at postoperative 2, 4, 8, 12, and 24 hours. Inflammatory markers TNF-alpha, IL-6, IL-8, and IL-10 were measured preoperatively and at 24 hours post-surgery. The results were compared between the groups.

Results: Forty five patients were enrolled to the study (22 in Group-I and 23 in Group-II). Group II exhibited significantly lower VAS scores at rest and during movement within the first 12 hours compared to Group I ($p<0.05$). The first analgesic requirement occurred earlier in Group I ($p<0.001$). Although cytokine levels increased in both groups, the rise was less pronounced in Group I ($p>0.05$). The comparison of tramadol consumption between the groups revealed significantly lower in Group II. ($p=0.040$)

Conclusion: This study shows that the addition of sciatic nerve block to femoral nerve block effectively enhances postoperative pain management and may attenuate the inflammatory response in TKA patients.

Keywords: *Sciatic Nerve Block; Femoral Nerve Block; Total Knee Arthroplasty; Postoperative Pain; Postoperative Inflammation*

ÖZET

Amaç: Postoperatif ağrı, ortopedik ameliyatlardan sonra iyileşme ve hastaneye yatış üzerinde önemli bir etkiye sahiptir. Çalışmanın amacı, total diz artroplastilerinde (TDA) femoral sinir bloğu ile birlikte uygulanan siyatik sinir bloğunun inflamatuar yanıt ve ameliyat sonrası ağrı kontrolü üzerindeki etkilerini araştırmaktır.

Gereç ve Yöntemler: Çalışma Afyonkarahisar Sağlık Bilimleri Üniversitesi Anesteziyoloji ve Reanimasyon Anabilim Dalı'nda gerçekleştirildi. Elektif TDA geçiren 40-80 yaş aralığındaki ASA I-III hastalar çalışmaya dahil edildi. Katılımcılar rastgele iki gruba ayrıldı: Grup I'e sadece femoral sinir bloğu uygulanırken, Grup II'ye hem femoral hem de siyatik sinir bloğu uygulandı. Ameliyat sonrası ağrı, Görsel Analog Skala (VAS) kullanılarak postoperatif 2, 4, 8, 12 ve 24. saatlerde değerlendirildi. İnflamatuar belirteçler TNF-alfa, IL-6, IL-8 ve IL-10 preoperatif ve operasyondan 24 saat sonra ölçüldü. Sonuçlar gruplar arasında karşılaştırıldı.

Bulgular: Çalışmaya 45 hasta dahil edildi (Grup-I'de 22 ve Grup-II'de 23). Grup-II'de, ilk 12 saat içinde dinlenme ve hareket sırasında Grup-I'e kıyasla daha düşük VAS skorları görüldü ($p<0,05$). İlk analjezik gereksinimi Grup-I'de daha erken gerçekleşti ($p<0,001$). Her iki grupta da sitokin seviyeleri artmasına rağmen, artış Grup-I'de daha az belirgindi ($p>0,05$). Gruplar arasında tramadol tüketimi karşılaştırıldığında Grup II'de anlamlı derecede düşük bulundu ($p=0,04$).

Sonuç: Bu çalışma, femoral sinir bloğuna siyatik sinir bloğu eklenmesinin, postoperatif ağrı yönetimini etkili bir şekilde iyileştirdiğini ve TDA hastalarında inflamatuar yanıtı hafifletebileceğini göstermektedir.

Anahtar Kelimeler: *Siyatik Sinir Bloğu; Femoral Sinir Bloğu; Total Diz Artroplastisi; Postoperatif Ağrı; Postoperatif İnflamasyon*

INTRODUCTION

Postoperative pain begins with surgical trauma and resolves as tissue healing. Numerous systems, including the neuroendocrine system, metabolic response, respiratory function, and renal function, are involved in this process. Effective analgesia for postoperative pain accelerates healing and reduces complications. It contributes to faster mobilization of patients and shortens the hospitalization duration (1-3). Applying regional anesthesia with preemptive analgesia eliminates somatosensory evoked potential through afferent blockade and blocks transmission within the sympathetic chain (4).

Surgical interventions act as a stress-inducing stimulus in the body that triggers an inflammatory response. Every organism subjected to trauma produces responses to overcome it. The neuroendocrine, metabolic, respiratory, and renal functions that arise under stress, along with the inflammatory response, represent mechanisms developed for survival, correlating positively with the elevated levels of stress hormones (5, 6). The kind and intensity of the trauma may influence these reactions (7). Interleukins and tumor necrosis factor-alpha (TNF-alpha) play a role in the inflammatory response secondary to trauma (8-10).

In patients having total knee arthroplasty, a meta-analysis showed that nerve blocks improved postoperative pain management, decreased narcotic analgesic consumption, and the incidence of postoperative nausea and vomiting (11). Studies examining the effectiveness of peripheral nerve blocks in postoperative pain control following total knee arthroplasty (TKA) suggest that nerve blockade may be helpful in pain management and could reduce opioid usage (12-14). Research continues on the effects of different anesthetic agents and methods on the stress and inflammatory responses elicited by surgery continues to be a topic of research (15-17). Since arthroplasty surgeries cause significant surgical stress responses, reducing them will contribute positively to recovery.

This prospective study aims to investigate the effects of sciatic nerve block added to femoral nerve block on the postoperative pain and inflammatory response in single knee joint arthroplasties.

MATERIALS AND METHODS

This clinical trial, which was prospective and randomized, took place in the Anesthesiology and Reanimation Clinic, Orthopedics Clinic, and Biochemistry Laboratories of Afyonkarahisar Health Science University. The clinical research ethics committee at Afyonkarahisar Health Science University accepted the study (decision numbered 2018/126 and dated 04.05.2018). All procedures involving human subjects were conducted in accordance with the 2013 Helsinki Declaration and its revisions, the ethical requirements of the national and/or institutional research committees, or comparable ethical standards. In this study, volunteer patients aged 40 to 80 years who underwent elective orthopedic total knee arthroplasty were enlisted. Inclusion criteria were defined as individuals who have an elective unilateral total knee arthroplasty scheduled aged 40-80 years and classified as ASA I-III. Exclusion criteria included patients younger than 40 and older than 80 years, presence of active inflammation or use of anti-inflammatory drug use, creatinine level>1.5, preoperative neurologic deficit, inability to assess visual pain scores, chronic opioid use and contraindications to spinal anesthesia or peripheral nerve block.

Participants were randomly divided into two groups according to their registration order using the website (www.randomizer.org): Group I (n=22), comprising patients receiving only femoral nerve block, and Group II (n=23), consists of patients who received sciatic and femoral nerve blocks.

All patients received IV 1 mg of midazolam for premedication. Patients in Group I underwent femoral nerve block with 10 mL of 0.25% bupivacaine under ultrasound guidance using a nerve stimulator and prior to the application of the local anesthetic, the quadriceps muscle's motor response was noted in the supine position.

The sciatic nerve was situated at the medial thigh level, 6–8 cm deep, with the thigh slightly abducted, following femoral nerve block, which was carried out in the same way for every patient in Group II. We administered 10 mL of 0.25% bupivacaine after obtaining a motor response with a nerve stimulator under ultrasonography guidance. Both groups were received spinal anesthesia for the operation.

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The Visual Analog Scale (VAS) was used to assess postoperative pain levels at rest and during activity at 2, 4, 8, 12, and 24 hours after surgery. Additionally, block-related problems, and the presence of opioid-related nausea, vomiting, and itching, patient satisfaction were all examined. The blocks' and the analgesics' adverse effects were assessed and compared.

Scores on the Visual Analog Scale varied from 0 to 10, with 0 representing "no pain" and 10 representing "unbearable pain." Blood samples were obtained from the patients one hour prior to (T0) and twenty-four hours following (T1) the procedure in order to measure the body's inflammatory response. TNF-alpha, IL-6, IL-8, and IL-10 levels were measured in the biochemistry laboratory. Every assay was carried out in compliance with the guidelines provided by the manufacturer (ChemWell-2910 Awareness Technology, Inc., Martin Hwy., Palm City, USA). The difference between cytokine levels measured at T0 and T1 was used to evaluate the inflammatory response.

The study data was statistically examined using IBM SPSS (Statistical Package for the Social Sciences) version 25.0. The data's normal distribution was assessed using the skewness-kurtosis coefficients, histogram, and Shapiro-Wilk test. Mann-Whitney U test was utilized for parameters without a normal distribution. The chi-square test was used to assess the categorical variables. Statistical significance was defined as a p-value of less than 0.05.

Inspired by a previous study where the effect size was determined as 1.25, with an 85% power and an α of 0.05, we calculated that 38 patients—19 in each group—would be needed under two tails conditions to identify a statistically significant difference between groups (18). We intended to recruit 46 patients in total, accounting for a 20% loss from patient dropout or insufficient follow-up.

RESULTS

This study included 46 patients; however, one patient in Group 1 withdrew from participation. Thus, there were 22 patients in Group I and 23 in Group II. Table 1 displays the clinical characteristics and demographic data of the study participants. Age parameters were statistically significant between the groups (p=0.030), while not observed for gender (p=0.339) and ASA score (p=0.814) (Table-1).

The analysis revealed significant differences in VAS scores between the groups. Table 2 displays the patients' VAS scores and analgesic use for the study participants. These findings suggest that patients in Group II, as indicated by lower VAS scores at rest and during movement in the first 12 hours postoperatively, compared to patients in Group I ($p<0.05$). The 24th hour VAS scores of the groups were comparable both at rest and during movement (p=0.747, p=0.898, respectively). The first 24 hours of tramadol consumption was significantly lower in Group II (p=0.040). The first analgesic requirement occurred earlier in Group I than in Group II ($p<0.001$).

Changes in IL-6, IL-8, IL-10 and TNF-alpha levels are summarized in Table 3. Comparison of variations between groups in TNF alpha (p=0.751), IL-6 (p=0.964), IL-8 (p=0.296), and IL-10 (p=0.340) levels revealed no statistically significant differences. Nevertheless, Group II experienced a less pronounced rise in cytokine levels than Group I.

The comparison of side effects between groups is presented in Table 4. The incidence of nausea, which was 31.8% in Group I and 26.1% in Group II, did not differ significantly between the groups (p=0.672). In addition, vomiting and pruritus were not observed in either group.

DISCUSSION

Peripheral nerve blocks (PNBs) are effective techniques commonly used in postoperative pain management. A systematic review by Mufarrih et al. highlighted the positive effects of regional anesthesia on postoperative outcomes and demonstrated its advantages over general anesthesia (19). Soffin et al. investigated the outcomes of perioperative regional anesthesia in knee surgery, showing that these techniques significantly reduced pain levels and decreased opioid analgesic consumption (20). When compared to traditional anesthesia methods, side effects like nausea and vomiting may be reduced with PNBs (12-14, 21).

A previous study concluded that combined femoral-sciatic block represents the most appropriate approach for patients at high risk of postoperative opioid consumption or acute pain after TKA. The study underscores the efficacy of this combined

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Table 1. Demographic characteristics of patients according to the groups

Demographic Characteristic	Group I (n=22)	Group II (n=23)	p
Age (Median(Min-Max))(years)	72 (58-80)	68 (51-79)	0.030*
Gender (n (%))			0.339**
Female	18 (81.8%)	16 (69.6%)	
Male	4 (18.2%)	7 (30.4%)	
ASA Score (n (%))			0.814**
ASA I	1 (4.5%)	1 (4.3%)	
ASA II	19 (86.4%)	21 (91.3%)	
ASA III	2 (9.1%)	1 (4.3%)	

ASA: American Society of Anesthesiology, *Mann Whitney U test, **Pearson Ki-square test

Table 2. Comparison of data on postoperative pain between groups

Visual Analog Scale Scores	Group I Median(Min-Max)	Group II Median(Min-Max)	p
2 Hours at Rest	1(1-4)	1(0-3)	0.019
4 Hours at Rest	3(2-6)	2(2-4)	0.029
8 Hours at Rest	6(2-8)	2(2-6)	< 0.001
12 Hours at Rest	6(3-8)	4(1-6)	< 0.001
24 Hours at Rest	6(3-8)	6(2-8)	0.747
2 Hours with Movement	3(2-6)	2(1-4)	< 0.001
4 Hours with Movement	4(2-8)	2(2-6)	0.025
8 Hours with Movement	2(2-8)	2(2-7)	< 0.001
12 Hours with Movement	6(4-8)	6(3-8)	0.025
24 Hours with Movement	8(4-8)	8(3-8)	0.898
Tramadol consumption)mg)	200(100-400)	200(100-300)	0.040
First analgesic time(hour)	10(5-18)	20(8-24)	< 0.001

Mann Whitney U Test, Min-Max: Minimum-Maximum, mg:miligram

Table 3. Comparison of inflammatory response between groups.

	Group I Median(Min-Max)	Group II Median(Min-Max)	p
IL-6	49.97(4.81-202.84)	36.60(7.96-163.79)	0.964
IL-8	12.54(0.01-295.63)	8.90(0.87-400.44)	0.296
IL-10	5.09(1.03-25.09)	3.57(1.09-18.93)	0.340
TNF-alpha	0.72 (0.08-10.13)	0.65(0.24-2.13)	0.751

Mann Whitney U Test, Min-Max: Minimum-Maximum, IL: Interleukın, TNF:Tumor Necrosis Factor

Table 4. Comparison of side effects between groups

	Group I n=22	Group II n=23	p
Nausea	7(31.8%)	6 (26.1%)	0.672
Vomiting	0	0	-
Itching	0	0	-

block, particularly in reducing postoperative opioid requirements and enhancing pain management strategies. This recommendation is based on the superior analgesic outcomes observed with the dual-block technique, demonstrating its potential to significantly improve patient recovery and minimize opioid-related complications (22). Our study shows that patients who received both femoral and sciatic nerve blocks achieved better postoperative pain control and lower VAS scores compared to patients who received only femoral nerve blocks. We believe that the reason why the VAS score decrease observed in Group II in the first 12 hours did not continue until the 24th hour mark is the completion of the drug effect period. If this analgesic effect is desired to be sustained, long-term catheter use may be beneficial.

PNBs should be considered as a viable option for the treatment of postoperative pain in individuals having total knee arthroplasty. Implementing these blocks can significantly enhance pain management, reduce opioid consumption, and facilitate recovery following surgery. Additionally, PNBs can lessen the incidence of opioid-induced adverse effects like nausea and vomiting. In our study, although not statistically significant, the rate of opioid-induced nausea was lower in Group II.

Additionally, the impact of PNBs on inflammatory responses is an important area of research. Postoperative pain is predominantly driven by the inflammatory response to tissue injury. Many key inflammatory mediators (histamine, serotonin, bradykinin, prostaglandins, leukotrienes, and various cytokines) are involved in this process, all of which contribute to nociceptive sensitization and the overall pain experience. These mediators play critical roles in amplifying the inflammatory cascade and exacerbating tissue irritation, ultimately influencing both the intensity and duration of postoperative pain (9, 23). Our study indicates that the inflammatory response was less pronounced in Group II. This observation suggests that the combined application of these blocks may lead to a more effective modulation of postoperative inflammation. By reducing pro-inflammatory cytokines levels, this approach could enhance recovery outcomes for patients undergoing knee surgery. The findings highlight the importance of utilizing comprehensive pain management strategies to mitigate systemic inflammation, thereby improving overall postoperative recovery.

Furthermore, the modification of nociceptive pathways and the ensuing emergence of hyperalgesia are significantly influenced by cytokines. These pro-inflammatory cytokines increase pain perception and encourage an excessive pain response after tissue damage by interacting with nociceptors and sensitizing peripheral and central pain mechanisms. Their involvement is crucial in both the initiation and maintenance of the inflammatory pain state (7, 9).

Although the power of our study was high at 85%, a higher power and a larger number of patients could have been studied. A standardized analgesia protocol was applied for postoperative analgesic use, but a postoperative analgesia protocol that provides more objective data, such as patient-controlled analgesia devices, would have been more appropriate.

CONCLUSION

PNBs are expected to gain an important place in anesthesia practice, thus increasing patient comfort and improving the quality of healthcare services. The findings show that sciatic nerve block is a useful PNB for managing postoperative pain and aids with the healing process for patients whose inflammatory cytokine levels have increased more moderately. In particular, patients who received double nerve block experienced fewer problems with nausea.

In conclusion, the use of femoral and sciatic nerve blocks is beneficial for reducing side effects and is crucial for managing postoperative pain. This encourages the adoption of more advanced approaches to pain management. Future studies will support the current findings by investigating the effectiveness of these techniques in a wider patient population and in different surgical procedures.

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