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Effects of Adding Adductor Canal Block to Popliteal Sciatic Nerve Block in Hallux Valgus Correction Operations

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Abstract

Study Objective: This study aims to assess the impact of combining the adductor canal block with the popliteal sciatic nerve block on the need for sedation, tourniquet pain, postoperative pain and patient-surgeon satisfaction in hallux valgus surgery.

Desing: Randomized controlled clinical trial.

Setting: Preoperative preparation room, operating room, post-anesthesia care unit.

Patients: Informed consent was obtained from 52 patients classified as ASA I-III, with ages ranging from 18 to 80 years. Exclusion criteria encompassed 2 individuals with coagulopathy, wounds or infections in the block region, known allergies to local anesthetic drugs, significant peripheral neuropathy or neurogenic disorders affecting the lower extremity, peripheral arterial disease, intellectual disabilities, and those who declined to provide consent.

Interventions: Patients are randomized into two groups. One group receives only a popliteal sciatic nerve block using 10 ml of 0.5% bupivacaine and 10 ml of 2% prilocaine in the prone position (Group PSNB, n=26), while the other group receives an adductor canal block with 10 ml of 0.5% bupivacaine and 10 ml of 2% prilocaine in addition to the popliteal sciatic nerve block (Group ACB+PSNB, n=26).

Outcomes: Sensory-motor block onset time, surgery-tourniquet time, tourniquet pain, motor block time, pain onset time, first analgesic administration time, opioid consumption, and patient-surgeon satisfaction were recorded.

Results: Sensory and motor block onset times, tourniquet pain, the need for additional sedation, and the duration until the second dose of analgesic administration were all statistically significantly lower in Group ACB+PSNB. Moreover, patient satisfaction was significantly higher in this group. Surgeon satisfaction, complication rate, motor block time, time to first pain, time to first analgesic administration, and opioid consumption were similar between the two groups.

Conclusions: Adding the adductor canal block to the popliteal sciatic nerve block increases the quality of the peripheral nerve block and patient satisfaction with decreasing tourniquet pain and sedation need in hallux valgus surgery.

1. Introduction

Hallux valgus is one of the most common chronic foot deformities, with lateral deviation of the forefoot toe and medial deviation of the first metatarsal. Surgical correction is the preferred method in the treatment of this deformity [1], [2]. While it can be performed with local, general or regional anesthesia, regional anesthesia techniques provide excellent analgesia without general anesthesia side effects [3]. Regional anesthesia has important advantages such as the patient's wakefulness to be able to express their complaints, preservation of spontaneous breathing and better respiratory reflexes, better

perioperative pain management, and early mobilization [4]. By performing the peripheral nerve blocks as part of the regional anesthesia techniques, the duration of hospitalization is shortened, the time to mobilization is shortened, and the postoperative complications are also reduced [5], [6].

The sensory innervation of the hallux and the first metatarsophalangeal region arises from branches of both the sciatic and femoral nerve systems, creating a complex pattern that is relevant for postoperative analgesia. The deep peroneal nerve, originating from the common peroneal division of the sciatic nerve, provides sensory fibers to the first interdigital web space and contributes articular branches to the dorsal capsule of the first metatarsophalangeal joint. These fibers participate in transmitting pain associated with dorsal capsular stretch and surgical manipulation during hallux valgus correction. In contrast, the saphenous nerve, a purely sensory terminal branch of the femoral nerve, innervates the medial forefoot, including the medial aspect of the hallux and the soft tissues overlying the medial eminence. Because hallux valgus surgery predominantly involves medial bone and soft-tissue structures, postoperative pain may arise from the saphenous nerve distribution.

Popliteal sciatic nerve block (PSNB) provides both motor and sensory blockade of the leg below the knee, except for the medial aspect of the leg and foot, which is innervated by the saphenous nerve [7]. Therefore, additional saphenous nerve blockade has been suggested for surgeries involving the medial aspect of the foot [8]. The adductor canal block (ACB) targets the saphenous nerve within the adductor canal and is considered a predominantly sensory block that largely preserves quadriceps motor function [9], [10].

In addition to surgical incision site pain, pneumatic tourniquet application during below-knee orthopedic procedures, commonly used to provide a bloodless surgical field and reduce intraoperative blood loss, can cause significant discomfort and pain during regional anesthesia. Patients may experience a poorly localized, dull, or burning pain at the site of tourniquet application that gradually increases in intensity over time. Although the exact mechanism of tourniquet pain remains unclear, the combined effects of nerve ischemia and mechanical compression of tissues beneath the cuff are considered likely contributors [11]. Because an adductor canal block performed at the mid-thigh level anesthetizes the saphenous nerve and several sensory branches supplying the medial knee and proximal tibial region, it may also contribute to reducing tourniquet-related discomfort [12].

Given the anatomical contribution of the saphenous nerve to medial forefoot innervation and the potential role of this nerve in both surgical and tourniquet-related pain, we hypothesized that adding an adductor canal block to a popliteal sciatic nerve block may improve perioperative analgesia in patients undergoing hallux valgus surgery. Therefore, this study aimed to evaluate the effects of adding ACB to PSNB on intraoperative sedation requirements, tourniquet-related pain, postoperative pain, recovery time from motor block, and patient and surgeon satisfaction.

2. Methods

This randomized controlled trial was approved by the Ethics Committee of Istanbul Medeniyet University Goztepe Education and Research Hospital, Istanbul, Turkey (Approval No. 2021/0419; September 25, 2021). The study was conducted in accordance with the Declaration of Helsinki and all relevant guidelines and regulations and was reported in accordance with the CONSORT guidelines. The trial was registered at ClinicalTrials.gov under the registration number NCT05960422. Written informed consent was obtained from all participants before enrollment after they were provided detailed information about the preoperative peripheral nerve block procedures. Patients aged 18 to 80 years with ASA score I-III were assessed for eligibility. Patients with coagulopathy, wounds or infections in the block region, allergies to local anesthetic drugs, significantly impaired peripheral neuropathy and neurogenic disorders affecting the lower extremity, peripheral arterial disease, and patients who did not provide consent were not included in the study. Gender, age, body mass index (BMI), and ASA scores of all patients were recorded. The patients were randomized into two groups, the PSNB group (n = 26), and the PSNB + ACB group (n = 26), by using a computer program.

In the preoperative preparation room, patients underwent standard monitoring, including electrocardiography (ECG), peripheral oxygen saturation (SpO_2), and non-invasive arterial blood pressure measurement. Mean arterial pressure (MAP), SpO_2, and heart rate (HR) were recorded at 15-minute intervals. Sedation was achieved using midazolam and fentanyl administered according to standardized weight-based dosing to maintain a Ramsay Sedation Scale score of 2 prior to the block procedures. All blocks were performed by the same anesthesiologist investigator, while perioperative data were recorded by another anesthesiologist who was blinded to the randomization group. To ensure internal validity and minimize variability related to procedural experience and technique, block procedures and perioperative assessments were performed consistently by the same investigators throughout the study. Also the hallux valgus deformities of the patients participating in the study were corrected by applying the chevron osteotomy surgical technique by the same surgeon.

For patients undergoing PSNB in the prone position, the anode (+) of the nerve stimulator (Plexygon Nerve Stimulator, VYGON, 7501.31, Ecouen, FRANCE) was connected to the ECG electrode placed on the foot. A 21-gauge 100-mm block needle (Vygon Echoplex, Vygon, Ecouen, France) was connected to the cathode (-) pole of the stimulator. The high-frequency linear probe of ultrasound (Samsung Ultrasound H60; Hampshire, Korea) was prepared in a sterile technic. After visualizing the popliteal artery in the popliteal fossa with the probe it was advanced proximally in a horizontal and minimally lateral position to determine the point of separation of the tibial and peroneal nerves. Before the stimulator needle was advanced towards the sciatic nerve with in-plane approach, Bupivacaine and prilocaine mixture was injected subcutaneously to achive perineural injection. While passing through the skin and subcutaneous tissue, the nerve stimulator was opened up to 1 mA. After observing dorsiflexion or plantar flexion of the foot, the stimulator was reduced to 0.3–0.5 mA until disappearing the movement. When making sure that the movement has disappeared at the point where the needle is located, bupivacaine 0.5%, 10 ml and prilocaine 0.2%, 10 ml were administered to the target tissue (Fig. 1).

The patients in PSNB + ACB group were given in supine position with the extremity to be blocked slightly externally rotated. The femoral artery was visualized by advancing the ultrasound probe distally, and the saphenous nerve was identified just lateral to the femoral artery, beneath the Sartorius muscle at the anterior part of the thigh. At the junction of the Sartorius muscle and vastus medialis, bupivacaine 0.5% 10 ml and prilocaine 2% 10 ml were applied around the saphenous nerve. Then the popliteal sciatic block as mentioned above was performed (Fig. 2).

The medial, lateral, and sole of the foot were tested with a 10 mN pinprick test to evaluate the sensory block of the tibial nerve. The anterior of the distal part of the leg and lateral and back of the foot were tested to evaluate the sensory block of the peroneal nerve. Internal malleolus sensation was tested for evaluating the sensory block of the saphenous nerve. The patients with pinprick test score 2 were evaluated as successful blocks. Motor block efficiency was evaluated with the Modified Bromage Scale, and the scale below 3 was also considered an unsuccessful block. Modified Bromage Scale and pinprick test were evaluated by the same investigator.

When additional sedation was needed during the intraoperative period it was provided with midazolam 1 mg i.v. and ketamine 50 mg i.v to maintain sedation score of RAMSEY 2 Postoperative pain control was achieved with 50 mg dexketoprofen. For rescue analgesic, morphine 0.5 mg/kg was administered PRN.

Onset times of sensory and motor block, tourniquet and surgery durations, tourniquet pain as numerical rate pain scores (NPRS), and sedation needs were recorded independently from a blinded anesthesiologist to intervention group intraoperatively. Motor block return times, the times of first analgesic administration, and the amounts of opioid-NSAID used were recorded postoperatively. Complications such as nausea and vomiting, and local anesthetics toxicity were recorded. Patient-surgeon satisfaction was evaluated with the Likert satisfaction rating scale.

2.1 Statistical Analysis

Power analysis was performed using the G*Power (v3.1.9.2) program to determine the number of samples. A pilot study was carried out with 15 people in each group at the beginning of the study. The mean NRPS for pain in the groups was 0.17 for ACB+PSNB group and 0.80 PSNB group. The effect size was calculated as W = 0.836, and there should be at least 24 people in the groups to achieve 80% power at $\alpha = 0.05$ level. For statistical analysis, the NCSS (Number Cruncher Statistical System) 2007 software program from Kaysville, Utah, USA was used. Descriptive statistical methods such as mean, standard deviation, median, frequency, percentage, minimum, and maximum were used for data evaluation. The normal distribution of quantitative variables was tested using the Shapiro-Wilk test and graphical examinations. Independent samples t-test was used for the comparison of quantitative variables with a normal distribution between two groups, while the Mann-Whitney U test was used for the comparison of quantitative variables without a normal distribution between two groups. For within-group comparisons of quantitative variables with a normal distribution repeated measures analysis of variance (ANOVA) was performed, and Bonferroni-corrected pairwise comparisons were used for the evaluation of individual

comparisons. Friedman test was used for within-group comparisons of quantitative variables without a normal distribution, and Bonferroni-corrected Wilcoxon signed-ranks test was used for evaluating individual comparisons. Pearson chi-square test, Fisher's exact test, and Fisher-Freeman-Halton exact test were employed for comparing qualitative data. Spearman correlation analysis was used for assessing the relationships between quantitative variables. Statistical significance was considered at $p < 0.05$.

3. Results

Per protocol analysis. The study was completed with 54 patients, and since the blocks in 2 patients were unsuccessful the statistical analysis was performed with 52 patients. 2 patients required general anesthesia and are not included to analysis due to failed pinprick test. There were no statistically significant differences in terms of gender, age, BMI, and ASA scores between the groups ($p > 0.05$) (Table 1). There was no statistically significant difference in terms of baseline hemodynamic parameters between the groups ($p > 0.05$). While the MAP values of the ACB+PSNB group at 15th min were found to be significantly higher than those of the PSNB group ($p = 0.016$), there were no statistically significant differences in the other MAP values between the groups ($p > 0.05$). There were no statistically significant differences in HR values at all times between the groups ($p > 0.05$). Although the SpO_2 values of PSNB group at 30th, 45th, and 60th min were significantly higher compared with ACB+PSNB group ($p = 0,001$, $p = 0,001$, $p = 0,009$), these values were not clinically significant.

Table 1
Demographic Data

			Block		*p**
		Total	ACB+PSNB	PSNB	
Gender	**Female**	40 (76,9)	20 (76,9)	20 (76,9)	[a]**0,542**
	Male	12 (23,1)	6 (23,1)	6 (23,1)	
Age	*Mean*	43,69 ± 16,18	45,77 ± 17,33	41,62 ± 14,99	[b]**0,234**
	Median (Min-Max)	38,5 (18–78)	48,5 (18–78)	34 (22–70)	
BMI	*Mean*	25,9 ± 4,74	26,54 ± 5,43	25,27 ± 3,94	[c]**0,230**
	Median (Min-Max)	25,1 (17,2–39,1)	25,9 (17,2–39,1)	24,7 (20,4–38,1)	
ASA	**I**	14 (26,9)	7 (26,9)	7 (26,9)	[d]**1,000**
	II	37 (71,2)	18 (69,2)	19 (73,1)	
	III	1 (1,9)	1 (3,8)	0 (0)	

[a]Pearson Chi Square Test, [b]Mann Whitney U Test, [d]Fisher Freeman Halton Test, [e]Fisher's Exact Test. **p***: *Evaluation between groups*

The sensory block and motor block onset times of the PSNB group patients were found to be statistically significantly longer compared to those in the AKB+PSNB group (p = 0,002, p = 0,003). The tourniquet pain scores and rates of additional sedation need were also found to be statistically significantly higher in the PSNB only group (p = 0,004, p = 0,020). There were no statistically significant differences between the groups in terms of tourniquet duration, surgical duration, motor block duration, time to first pain sensation (p > 0.05). As for incidence of complication, there were no statistical differences in patients with nausea and vomiting (Table 2). Local anesthetic toxicity has not been seen in any patient.

Table 2
Distribition of data by groups

		BLOCK		*P**
		ACB+PSNB	**PSNB**	
Sensory block onset time	*Meant ± SD*	3,58 ± 1,42	5,00 ± 2,23	[b]**0,002**
	Median (Min-Max)	3 (2–6)	5 (1–10)	
Motor block onset time	*Meant ± SD*	7,58 ± 2,00	10,04 ± 4,40	[b]**0,003**
	Median (Min-Max)	7 (5–11)	10 (2–20)	
Tourniquet duration (min)	*Meant ± SD*	55,15 ± 29,6	45,58 ± 20,92	[b]*0,198*
	Median (Min-Max)	46 (20–125)	43 (15–93)	
Surgery duration (min)	*Meant ± SD*	64,77 ± 31,57	58,04 ± 21,98	[b]*0,923*
	Median (Min-Max)	55 (30–141)	55 (20–110)	
NRPS pain (tourniquet)	*Meant ± SD*	0,19 ± 0,57	0,88 ± 0,99	[b]**0,004**
	Median (Min-Max)	0 (0–2)	0 (0–2)	
Additional sedation		4 (15,4)	10(38,5)	[a]**0,020**
Motor block duration	*Meant ± SD*	467,85 ± 113,56	530,92 ± 276,59	[b]*0,956*
	Median (Min-Max)	482 (292–703)	465 (165–1235)	
Nausea/Vomiting		3 (11,5)	4 (15,4)	[e]*1,000*

[a]Pearson Chi Square Test, [b]Mann Whitney U Test, [d]Fisher Freeman Halton Test, [e]Fisher's Exact Test. ***p*:** *Evaluation between groups*

While first dose administration times in pain treatment and choice of first-second analgesic drug were statistically the same between groups ($p > 0.05$) (Table 3).

Table 3
Distribution of postoperative analgesia outcomes by groups.

		BLOCK		*P**
		ACB+PSNB	**PSNB**	
Time of first pain	*Meant ± SD*	611,77 ± 139,99	683 ± 305,99	*[b]0,596*
	Median (Min-Max)	603,5 (380–877)	642 (180–1422)	
Time of first dose administration	*Meant ± SD*	683,33 ± 142,25	669,48 ± 215,49	*[c]0,807*
	Median (Min-Max)	675 (400–907)	675 (217–1051)	
1.Dose Drugs	**None**	5 (19,2)	5 (19,2)	*[d]0,641*
	Morphine	0 (0)	2 (7,7)	
	NSAID	21 (80,8)	19 (73,1)	
2. Dose Drugs	**None**	13 (61,9)	7 (33,3)	*[d]0,083*
	Morphine	0 (0)	1 (4,8)	
	NSAID	7 (33,3)	13 (61,9)	
	Morphine+ NSAID	1 (4,8)	0 (0)	

[c]Student T Test, *[d]Fisher Freeman Halton Test.* **p***: *Evaluation between groups*

Patient satisfaction was found to be significantly higher in the ACB+PSNB group compared to the PSNB group (p = 0,009). However, no statistically significant difference was detected in surgeon satisfaction between the groups (p > 0.05) (Table 4).

Table 4
Distribution of patient and surgeon satisfaction by groups.

		Block		*P**
		ACB+PSNB	PSNB	
Patient satisfaction	**Medium**	2 (7,7)	0 (0)	**[d]0,009**
	Good	4 (15,4)	13 (50,0)	
	Great	20 (76,9)	13 (50,0)	
Surgeon satisfaction	**Medium**	0 (0)	1 (3,8)	*[d]1,000*
	Good	3 (11,5)	3 (11,5)	
	Great	23 (88,5)	22 (84,6)	

[d]Fisher Freeman Halton Test. **p***: *Evaluation between groups*

4. Discussion

Peripheral nerve blocks are increasingly being preferred in patients undergoing orthopedic procedures to reduce postoperative pain and opioid consumption [13]. While the popliteal sciatic nerve block is suitable for anesthesia and analgesia in foot surgery, a more proximal block is required for surgeries on the posterior aspect of the foot and medial ankle with the tourniquet applied distal to the thigh. In ACB, the strength of the quadriceps muscle is largely preserved by staying distal to the efferent branches of the quadriceps muscle and affecting the two largest sensory branches of the femoral nerve, the saphenous nerve, and the vastus medialis, as well as the branches of the obturator nerve that innervate the joint [14]. Chen et al.[15] presented two cases for demonstrating the applicability of proximal saphenous nerve block (ACB) in foot and ankle surgery despite the absence of a medial incision. The saphenous nerve innervates the distal tibial periosteum, medial and ventral capsules of the ankle joint, and in some cases, the medial aspect of the talocalcaneonavicular joint, indicating the important role of ACB in patients undergoing ankle surgery. Considering all these factors, the addition of ACB to PSNB may become an appropriate technique for hallux valgus correction surgery.

Inadequate postoperative pain management is known to reduce patient satisfaction and function, as well as delay hospital discharge and rehabilitation [16]. In a study conducted by Li et al.[17] comparing the control group with the PSNB group performed with ropivacaine 0.5% 20 ml in patients operated for calcaneus fracture surgery, they found that the time to first analgesic administration (15.57 hours) was longer, the duration of patient-controlled analgesia use was shorter, and the number of weight-bearing steps was lesser in PSNB group. The reason for the earlier onset of pain, unlike the study of Li et al., may be the use of long-acting drug bupivacaine in a lower volume in our study. In a study comparing the addition of femoral nerve block (FNB) or ACB to PSNB in patients operated for lower limb surgery, Sertcakacılar et al.[18] found that the motor block duration was 10.84 hours and the sensory block

recovery time was 8.44 hours in the PSNB + ACB group. The motor block duration in the ACB+PSNB group was measured 7.79 ± 1.89 hours, and the time to first pain sensation was recorded as 10.19 ± 2.33 hours. In a study by Fanelli et al.[19] comparing equal volume of ropivacaine 0.75%, bupivacaine 0.5%, and mepivacaine 2% for sciatic and femoral nerve blockade together for hallux valgus repair surgery with tourniquet, they found the motor block duration of 788 minutes and an analgesic duration of 880 minutes in bupivacaine group. In a study by Dabir et al. [20], the onset time of anesthetic effect in the group receiving peripheral nerve block was determined as 11.83 ± 2.45 minutes. The times found in these studies were similar to the times we found. In the study by Migues et al. [21], the block formation time was 8.6 ± 5 minutes for ankle block and 10.48 ± 6 minutes for PSNB without statistically significant and the block formation time was recorded as 10.04 ± 4.40 minutes in our study. The pain scores were similar at 6, 12, 18, and 24 hours, and the average analgesic duration was 10.96 ± 7.56 hours for the ankle block group and 14.32 ± 7.73 hours for the PSNB group in the study. The time from block administration to the first analgesic application in the PSNB group was recorded as 11.92 ± 6.46 hours. While the time of the first analgesic application was similar in both groups, the time of the second analgesic application needed more in the PSNB group. However, the amount of drug administered as a second dose of analgesic was found similar in both groups. In our study, after the block procedures, the patients in the PSNB + ACB group had first pain after 10,18 ± 2.3 hours, while it was 11,38 ± 5 hours in the PSNB group, but it was not statistically significant. Besides the frequency of second-dose analgesic use, 61.9% of patients in the ACB+PSNB group and 33.3% of patients in the PSNB group did not receive analgesics and the addition of ACB reduced analgesic consumption.

While popliteal sciatic nerve block provides sufficient anesthesia and analgesia for foot surgery, we believe that ACB is highly beneficial for patients who undergo thigh-level tourniquet application during the surgery. Pain and discomfort in the tourniquet area during regional anesthesia is a common complication of tourniquet application. Patients may experience a localized progressive dull or burning pain in the tourniquet area [22]. It has been suggested that the source of tourniquet pain is ischemia of the compressed nerves and compression of the tissues under the tourniquet [11]. To alleviate discomfort related to the tourniquet, we believe that ACB is appropriate because proximal ACB at the mid-thigh level may affect the saphenous nerve and several other sensory nerves that innervate the anterior surface of the knee and the proximal tibia [23]. While the average tourniquet duration was similar between groups, the PSNB group had higher tourniquet pain scores in our study and this result may cause high patient satisfaction scores and lower pain scores in the ACP+PSNB group. In the study by Li et al. [17] patient, surgeon, and nurse satisfaction were better in patients in the PSNB group compared to the control group.

On the other hand; in a study by Joe et al. [24] that included patients undergoing foot and ankle surgery with PSNB + FNB and PSNB + ACB blocks, they found no significant difference in VAS scores, while quadriceps muscle strength was preserved mostly in the ACB group; additional analgesic use, patient satisfaction, surgical and recovery times were similar in both groups.

Migues et al. [21] found that the success rate was 92.5% in the ankle block and 96% in the PSNB and our success rate of PSNB was 96.29% similar to this study. Tsai et al. [25], performed subsartorial saphenous nerve block and sciatic nerve block in lower extremity surgery and found that the success rate of all blocks was 77%. Two failures occurred in the blocks applied to the patients during our study.

In a study conducted by Tian et al. [26] the most common side effect in both groups was nausea (13%), and there was no difference in side effects between the FNB + PSNB group and local infiltration analgesia group performed in the patients operated for total knee arthroplasty. Similarly, Sehmbi et al. [27] examined ACB with placebo or FNB and they reported that there were similar results in postoperative nausea and vomiting risk, antiemetic use, or postoperative sedation in groups. There was no difference in nausea and vomiting between the groups in our study.

There were some limitations in this study. Since nerves can be reached from different regions in the ACB+PSNB group, the patients of this group underwent two separate invasive procedures. Because the observation period was limited to 24 hours postoperatively, we could not assess the longer effects of the applied blocks. The dosage adjustments could not be done for local anesthetics according to their weight, and a standard medication regimen was used for all patients. However the average BMI levels were similar between groups.

5. Conclusion

In conclusion, based on our observations, adding ACB to PSNB block in patients undergoing hallux valgus surgery has shown beneficial effects; it shortens the onset of motor and sensory block, reduces tourniquet pain, increases patient satisfaction, and reduces the need for sedation. Therefore, adding ACB to the PSNB block is advantageous in patients undergoing hallux valgus surgery in our study.

Abbreviations

ACB
adductor canal block
ASA
American Society of Anesthesiologists
BMI
body mass index
ECG
electrocardiography
HR
heart rate
MAP
mean arterial pressure
NPRS

numerical pain rating scale
NSAID
nonsteroidal anti-inflammatory drug
PSNB
popliteal sciatic nerve block
SpO_2
peripheral oxygen saturation.

Declarations

Ethics approval and consent to participate:

This study was approved by the Ethics Committee of Istanbul Medeniyet University Goztepe Education and Research Hospital, Istanbul, Turkey (Approval No. 2021/0419; September 25, 2021). The study was conducted in accordance with the Declaration of Helsinki and all relevant guidelines and regulations. Written informed consent was obtained from all participants before enrollment.

Consent for publication:

Not applicable.

Competing Interests:

The authors declare that they have no competing interests.

The use of AI and AI-assisted technologies in scientific writing

The authors declare that they did not use AI and AI-assisted technologies in the writing process.

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Author Contribution

E.P and HK conceived and designed the study. E.P, M.G.N.O, and H.K contributed to patient recruitment, perioperative management, data collection, and study conduct. M.E.U performed the surgical procedures and contributed to the surgical aspects of the study design and interpretation of the findings. A.G contributed to the literature review, interpretation of the results, and drafting and critical revision of the manuscript. E.P and A.G prepared the initial manuscript draft. All authors contributed to the revision of the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

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Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Figures

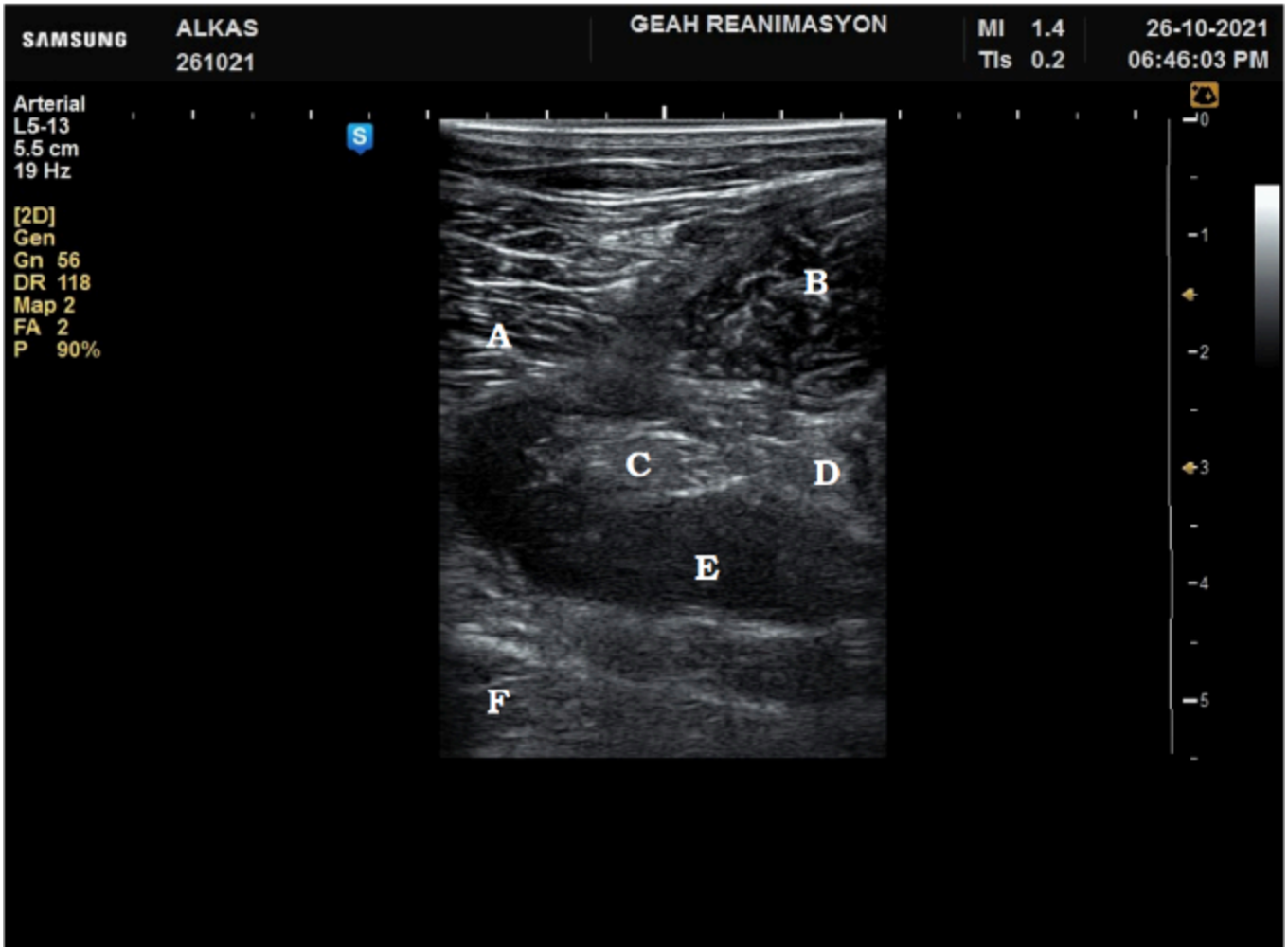


Figure 1

Sonographic anatomy of the popliteal sciatic nerve (tibial and peroneal nerves): A: Biceps femoris muscle; B: Semimembranosus-semitendinosus muscles; C: Peroneal Nerve; D: Tibial nerve; E: Local anesthetic infiltration; F: Femur

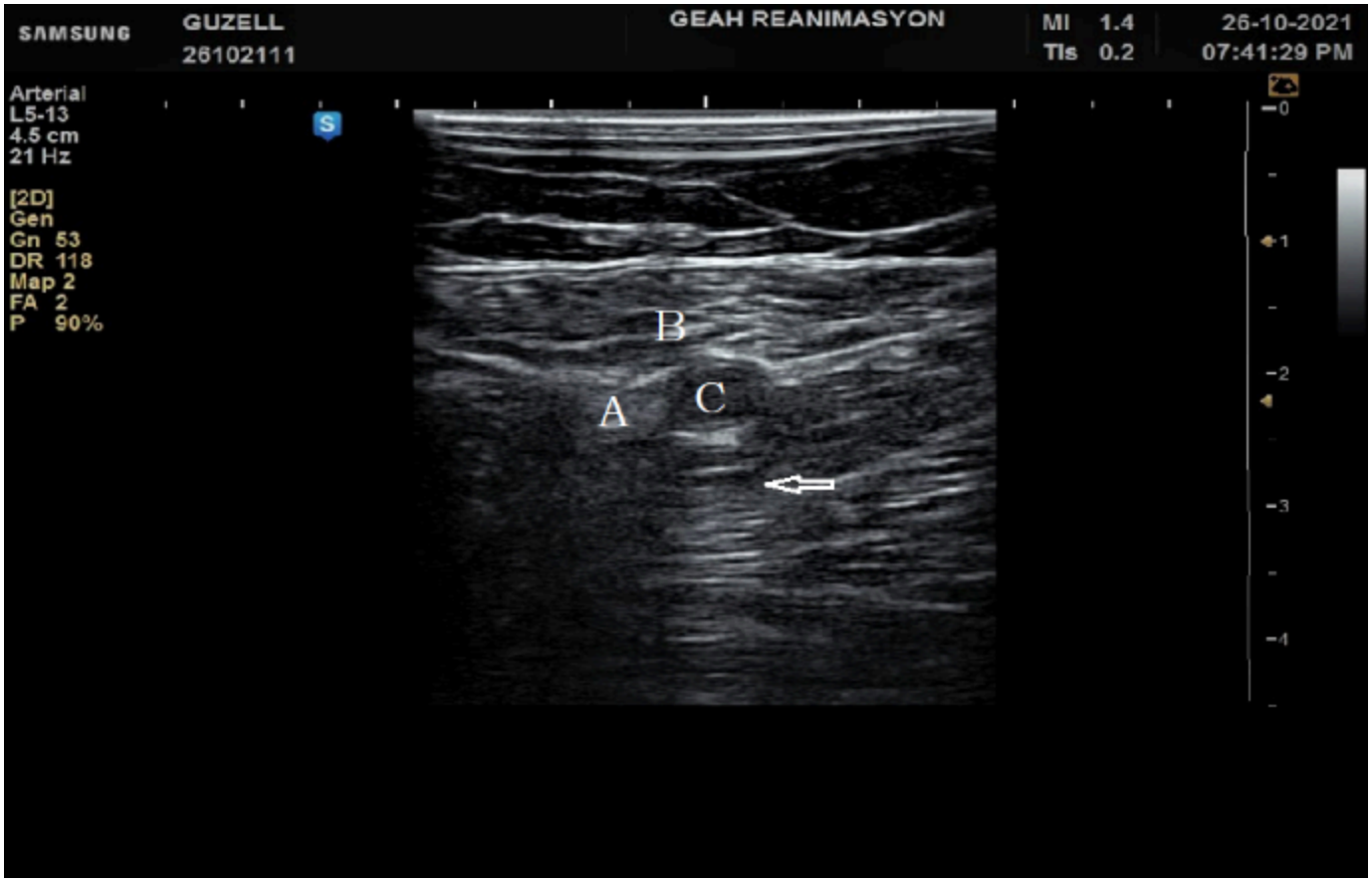


Figure 2

Sonographic anatomy of the adductor canal: A: Saphenous nerve; B: Sartorius muscle; C: Femoral artery; Arrow: Collapsed femoral vein.