EURASIAN JOURNAL OF EMERGENCY MEDICINE
Original Article
DOI: 10.4274/eajem.galenos.2022.37640
Eurasian J Emerg Med. 2023;22(1): 41-8

One-man Below-knee Analgesia in the Emergency Department with Minimal Equipment Using the Single-operAtor Nerve block under Direct ultrasound visualization in emergencY ('SANDY') Technique: A Retrospective Analysis

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Abstract

Aim: To demonstrate the efficacy of single-person bedside ultrasound guided (USG) Popliteal-Sciatic Nerve Block (PSNB) using minimal equipment in the emergency department (ED) for managing below-knee trauma.

Materials and Methods: This single-centre retrospective analysis was done at the ED of a tertiary care centre in Southern India from 01/12/2021 to 31/06/2022. The charts of all adult patients who received the block were reviewed and the reduction in pain score after the block, block success rate, and incidence of side effects were analyzed.

Results: One hundred and three patient records were reviewed during the study period. Ninety-eight males (95.1%) and 5 females (4.9%) had received the block. 87.4% of the patients were road accident victims. The block was given by a single operator under ultrasound guidance with the stylet of an 18 gauge intravenous cannula mounted on a syringe filled with 1% lidocaine. The mean pain score before and 10 minutes after administering the block was 8.85 [standard deviation (SD) ±0.78] and 2.06 (SD ±1.75) respectively. The block success rate was found to be 93.2%. Except for 7 failed blocks, there were no adverse events following the procedure.

Conclusion: USG PSNB is a safe, consistent, and relatively long-lasting anesthetic technique in the management of below-knee trauma in the ED.

Keywords: Analgesia, emergency department, nerve block, Popliteal-Sciatic, ultrasound

Introduction

Open lower limb trauma is a common presenting complaint in any emergency department (ED) and is most often due to high-velocity road traffic accidents, or workplace-related injuries (1,2). Assessing the degree of pain can be challenging and often requires a multimodal approach that can be difficult in the emergency setting. Thus, for acutely traumatized patients in pain, the Numerical Rating Scale (NRS) is a quick and useful tool to quantify and triage patients accordingly. Primary wound care is the responsibility of the emergency physician (EP), and the widespread availability of intravenous (IV) anesthetic agents in the ED facilitates early wound washing, debridement, and splintage often in conjunction with the orthopaedic and trauma surgery team. However, procedural sedation and analgesia (PSA) in the ED are not without challenges, like the chance of excessive sedation in at-risk patients such as the elderly or the obese, or post-anesthetic complications such as vomiting, delirium, and hypoxia. The response among different patients to anesthetic doses also varies, with some having blunted or exaggerated responses to "standard" doses of anesthetic drugs. Therefore, PSA is ideally a monitored service, and a healthcare provider should be designated to monitor the patient and administer titrated doses of anesthetic or dissociative drugs throughout the period of wound care. This can put a logistic strain on personnel, especially in a high-volume ED with staff numbers already stretched thin.

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Cite this article as: David SN, Katumalla PD, Ganesan P, Abhilash Kundavaram PP. One-man Below-knee Analgesia in the Emergency Department with Minimal Equipment Using the Single-operAtor Nerve block under Direct ultrasound visualization in emergencY ('SANDY') Technique: A Retrospective Analysis. Eurasian J Emerg Med. 2023;22(1): 41-8.

Received: 05.09.2022
Accepted: 23.12.2022

Bedside ultrasound guided (USG) nerve blocks of the lower limb are an attractive alternative that obviates the need for IV agents, and all the side effects that come with them, as well as freeing up ED personnel for other more pressing tasks. In our study, we used the USG Popliteal-Sciatic Nerve Block (PSNB) as the sole anesthetic technique for lower limb wound management, as it is relatively safe with a wide sensori-motor coverage below the knee, save for the medial aspect of the leg. It is commonly performed by anesthesiologists for below-knee surgeries and post-operative analgesia. This study was undertaken to demonstrate the easy and effective pain management for lower limb injuries in the ED while conserving labor and resources, without the need for specialized equipment. Furthermore as there is a dearth of published large -scale regional-anaesthesia-based studies from an ED standpoint and with the portable ultrasound machine now being ubiquitous and invaluable in any ED, this could show the potential of bedside USG nerve blocks and can be potentially expanded to provide effective analgesia to other common injuries as well such as upper limb trauma and rib fractures as a standard analgesic practice. We hypothesized that USG PSNB can be used as an effective technique for safe and consistent lower limb analgesia for wound management. Our study aimed to demonstrate the efficacy of single-person bedside USG PSNB using minimal equipment in the ED for managing below-knee trauma. Our objectives were to analyse the reduction in pain score following the nerve block, to determine the success rate of the nerve block being done in the ED, to determine the incidence of supplemental analgesia during wound care following the nerve block, and to determine the incidence of side effects following the nerve block.

Materials and Methods

Study Design and Setting: This retrospective observational cohort-based single-centre study was undertaken at a 60 bedded ED in a major tertiary care hospital and referral center in Southern India. The chart review process was initiated after approval by the Christian Medical College Institutional Review Board Ethics Committee (IRB number: 14288, date: 29/9/2021). The authors attest that the STROBE guidelines were adhered to during the preparation of this manuscript.

The Selection of Participants: The charts of all patients with below-knee trauma who presented between the months of December 2021 and May 2022 and received bedside PSNB before primary wound care were reviewed. Informed consent for publication was not obtained from the patients due to retrospective design; however, procedural consent was sought from all patients. Patients included consisted of all those 16 years and above presenting with below-knee trauma along the distribution of the tibial and common peroneal nerves who received the block. The excluded charts comprised of those patients for whom the trauma lay outside the distribution of the sciatic nerve, those who did not consent for the procedure, those who were taking oral anticoagulant drugs, and those with pre-existing neuropathies or clinically evident nerve damage following the trauma as per their medical records. Furthermore, since only a few EPs were trained to administer the block, a significant number of patients were excluded due to the unavailability of the concerned doctors.

Measurements: The nerve block was given at the bedside by a single operator before wound management, such as wound wash, splintage, or debridement by the orthopaedic team. The local anesthetic (LA) used was 10 to 15 mL of 1% lidocaine (Jackson Laboratories Pvt Ltd., 22-24 Majitha Road, By-Pass, Amritsar, India. 143001), and was injected using the stylet of an 18 gauge IV cannula (Vasofix® Luer Lock, B. Braun Medical Industries Bayan Lepas-free Industrial Zone 11900, Penang, Malaysia) with direct visualization of the nerve using a high frequency ultrasound probe (6-13-Hz HFL38, SN 04QGNX, FUJIFILM SonoSite Inc. 21919 30th Drive SE Bothell, WA 98021. USA). The block was performed with the patient in the supine position with the ipsilateral knee in the semi-flexed position. A check-scan was performed to pre-emptively locate the sciatic bifurcation above the popliteal fossa and to look for the presence of any aberrant vessels or other anatomical variations. Once the injection site was confirmed, an antiseptic solution was applied to the lateral side of the distal thigh. The probe was reapplied to the area held by the non-dominant hand of the EP, keeping the sciatic bifurcation in view. Using a lateral-to-medial approach, the stylet attached to a syringe pre-loaded with LA was inserted into the lateral thigh with the dominant hand of the EP, and using in-plane needling under direct vision, the needle was gently guided to the bifurcation of the sciatic nerve into the tibial and common peroneal nerves (Figure 1). 1% lidocaine was slowly injected sub-paraneurally after negative aspiration, followed by caudal screening to look for the spread of the drug around both nerves (Figure 2). The spread around both nerves was visually confirmed by the gradual appearance of an owl-eyes sign around both nerves. After every needle reposition, gentle aspiration was done to ensure no ingress of any vessels, and during injection constant slow pressure was given to the syringe while looking for severe shooting pain, which would indicate intrafascicular injection. The pain score 10 minutes after the block was noted, and the patient underwent the procedure. The block was deemed successful if the NRS 10 minutes post block was at least 50% of the initial score, and if the patient could undergo wound management without any PSA. The success rate of the block and how often rescue analgesia had to be administered during the

procedure was determined, and the patient was monitored till the return of sensation for any side effects such as LA toxicity or prolonged paraesthesia.

Statistical Analysis

The data was collected from the patients' records using the hospital's electronic medical system and compiled on Microsoft Excel (Microsoft Corporation, Redmond, Washington, USA). Demographic details such as the patient's age and sex were noted, along with the mechanism of injury. The degree of pain was recorded using the NRS before and after the block. The success rate of the block was calculated and the incidence of side effects such as neuropraxia was looked for (Table 1). The mean [standard deviation (SD)] was calculated for the continuous variables, and categorical variables were expressed in percentages.

Figure 1. Bedside ultrasound guided Popliteal-Sciatic Nerve Block

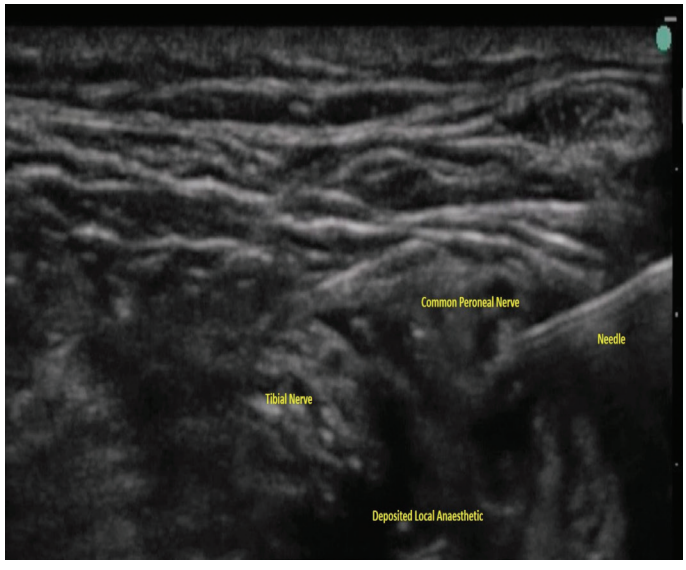

Figure 2. Ultrasound image of the nerve block

Results

The charts of 3689 trauma patients who presented to our ED were screened, and 405 patients were identified as having presented with below-knee trauma. Of that cohort, 302 patients were excluded as they did not meet the inclusion criteria, or because they presented at a time when the doctors trained in USG-PSNB administration were not on shift. A total of 103 eligible patients were subsequently included in the review process (Figure 3). The mean age was found to be 51.17 (±14.17) years, the majority of patients were male (n=98; 95.1%). Ninety patients were road traffic accident victims (87.4%) and 13 patients were victims of trauma by occupational injuries (12.6%). Out of the patients screened, 96 out of 103 (93.2%) patients had successful blocks and underwent wound care without additional or rescue analgesics, with the rest having pain either before or during the procedure and needing rescue analgesia (Figure 4). The mean pain score at presentation was 8.85 (±0.78), and the mean pain score 10 minutes after the block was found to be 2.06 (±1.75). The success rate of the block when performed in the ED was found to be 93.2%, and all patients with successful blocks underwent the wound care procedures such as wound decontamination, splintage, suturing, or even K-wire fixation without any additional sedo-analgesia. Seven patients (6.8%) had a failed block and required supplemental sedo-analgesia for primary wound management by the orthopaedic or trauma surgery team. Besides block failure, there was no incidence of significant side effects such as LA toxicity, adverse drug reaction or neuropraxia after administration of the USG-PSNB, and the duration of action of the blocks using 1% lidocaine lasted between 3-4 hours.

Discussion

The USG-PSNB is an extremely useful tool in the armament of anesthesiologists, often performed as the sole method of anesthesia in below-knee surgery with an additional saphenous nerve block given for medial leg coverage if required (3,4). Although sedation and analgesia in the ED has come a long way with regards to access to drugs and better understanding of drug pharmacokinetics and pharmacodynamics, it is not without risks including vomiting, over-sedation, and airway compromise (5-7). Drugs such as propofol, midazolam, fentanyl, ketamine, and dexmedetomidine, though short acting, would require continuous monitoring and experience in their usage. Patients such as the elderly or those on cardio-respiratory medications are also at higher risk for immediate and delayed adverse

Table 1. Demographic details, injury profile and pain scores of the patients analysed in the study period

S. no	Sex	Age	Mechanism of Injury	Initial NRS	Post-block NRS	Successful block
1	M	43	Road traffic accident	10	3	Yes
2	M	54	Road traffic accident	8	1	Yes
3	M	36	Road traffic accident	9	1	Yes
4	M	72	Road traffic accident	10	3	Yes
5	M	65	Occupational injury	10	1	Yes
6	M	47	Road traffic accident	9	2	Yes
7	M	64	Road traffic accident	8	2	Yes
8	M	53	Road traffic accident	8	1	Yes
9	F	26	Road traffic accident	9	3	Yes
10	M	32	Road traffic accident	8	1	Yes
11	M	41	Road traffic accident	9	2	Yes
12	M	52	Road traffic accident	10	2	Yes
13	M	67	Road traffic accident	10	3	Yes
14	M	58	Occupational injury	9	3	Yes
15	M	82	Road traffic accident	8	2	Yes
16	M	65	Road traffic accident	9	1	Yes
17	F	25	Road traffic accident	8	1	Yes
18	M	20	Road traffic accident	10	2	Yes
19	M	47	Road traffic accident	10	1	Yes
20	M	42	Occupational injury	9	9	No
21	M	34	Road traffic accident	10	1	Yes
22	M	37	Road traffic accident	9	1	Yes
23	M	64	Road traffic accident	8	1	Yes
24	M	38	Road traffic accident	8	1	Yes
25	M	74	Road traffic accident	9	2	Yes
26	M	25	Road traffic accident	10	4	Yes
27	M	58	Road traffic accident	10	1	Yes
28	M	63	Road traffic accident	9	1	Yes
29	M	72	Road traffic accident	8	1	Yes
30	M	62	Road traffic accident	9	2	Yes
31	M	93	Occupational injury	9	1	Yes
32	M	46	Road traffic accident	8	2	Yes
33	M	34	Road traffic accident	9	1	Yes
34	M	52	Road traffic accident	10	1	Yes
35	M	62	Road traffic accident	9	2	Yes
36	M	57	Occupational injury	10	1	Yes
37	M	66	Road traffic accident	9	9	No
38	M	72	Road traffic accident	10	1	Yes
39	M	84	Road traffic accident	8	1	Yes
40	M	35	Road traffic accident	9	1	Yes
41	M	47	Road traffic accident	10	2	Yes
42	M	41	Road traffic accident	9	1	Yes
43	M	57	Occupational injury	10	3	Yes
44	M	43	Road traffic accident	9	1	Yes

Table 1. Continued

S. no	Sex	Age	Mechanism of Injury	Initial NRS	Post-block NRS	Successful block
45	M	77	Road traffic accident	9	8	No
46	M	39	Road traffic accident	10	1	Yes
47	M	37	Occupational injury	8	1	Yes
48	M	48	Road traffic accident	10	2	Yes
49	M	71	Road traffic accident	9	1	Yes
50	M	47	Road traffic accident	10	2	Yes
51	M	53	Occupational injury	9	1	Yes
52	M	57	Road traffic accident	8	2	Yes
53	M	62	Road traffic accident	9	3	Yes
54	M	36	Road traffic accident	8	1	Yes
55	M	42	Road traffic accident	8	1	Yes
56	M	47	Road traffic accident	8	1	Yes
57	M	39	Road traffic accident	9	8	No
58	M	42	Road traffic accident	8	1	Yes
59	M	74	Road traffic accident	9	2	Yes
60	M	65	Road traffic accident	10	3	Yes
61	M	69	Road traffic accident	8	8	No
62	M	47	Road traffic accident	9	2	Yes
63	M	52	Occupational injury	8	1	Yes
64	M	37	Road traffic accident	9	1	Yes
65	F	58	Road traffic accident	9	1	Yes
66	M	63	Road traffic accident	9	1	Yes
67	M	49	Occupational injury	8	2	Yes
68	M	57	Road traffic accident	8	5	No
69	M	52	Road traffic accident	9	2	Yes
70	M	61	Road traffic accident	9	1	Yes
71	M	44	Road traffic accident	8	2	Yes
72	M	76	Road traffic accident	8	2	Yes
73	M	54	Road traffic accident	9	1	Yes
74	M	57	Road traffic accident	9	2	Yes
75	M	68	Road traffic accident	9	1	Yes
76	M	43	Road traffic accident	10	8	No
77	M	46	Road traffic accident	8	1	Yes
78	M	47	Occupational injury	9	1	Yes
79	M	52	Road traffic accident	8	2	Yes
80	M	68	Road traffic accident	9	3	Yes
81	M	62	Road traffic accident	9	2	Yes
82	M	37	Road traffic accident	8	1	Yes
83	M	39	Road traffic accident	7	2	Yes
84	M	31	Road traffic accident	7	2	Yes
85	M	46	Road traffic accident	8	2	Yes
86	M	48	Road traffic accident	10	1	Yes
87	M	54	Road traffic accident	10	2	Yes
88	M	42	Occupational injury	9	1	Yes

Table 1. Continued

S. No	Sex	Age	Mechanism of Injury	Initial NRS	Post-block NRS	Successful block
89	M	48	Road traffic accident	10	2	Yes
90	M	58	Road traffic accident	9	1	Yes
91	M	54	Road traffic accident	8	2	Yes
92	F	57	Road traffic accident	9	2	Yes
93	M	35	Road traffic accident	8	2	Yes
94	M	33	Road traffic accident	8	1	Yes
95	M	31	Road traffic accident	8	2	Yes
96	M	37	Road traffic accident	9	2	Yes
97	M	39	Road traffic accident	8	1	Yes
98	F	49	Occupational injury	9	2	Yes
99	M	49	Road traffic accident	9	2	Yes
100	M	48	Road traffic accident	9	2	Yes
101	M	47	Road traffic accident	8	3	Yes
102	M	36	Road traffic accident	9	2	Yes
103	M	47	Road traffic accident	8	2	Yes

*The failed blocks are highlighted.
F: Female, M: Male, NRS: Numerical Rating Scale

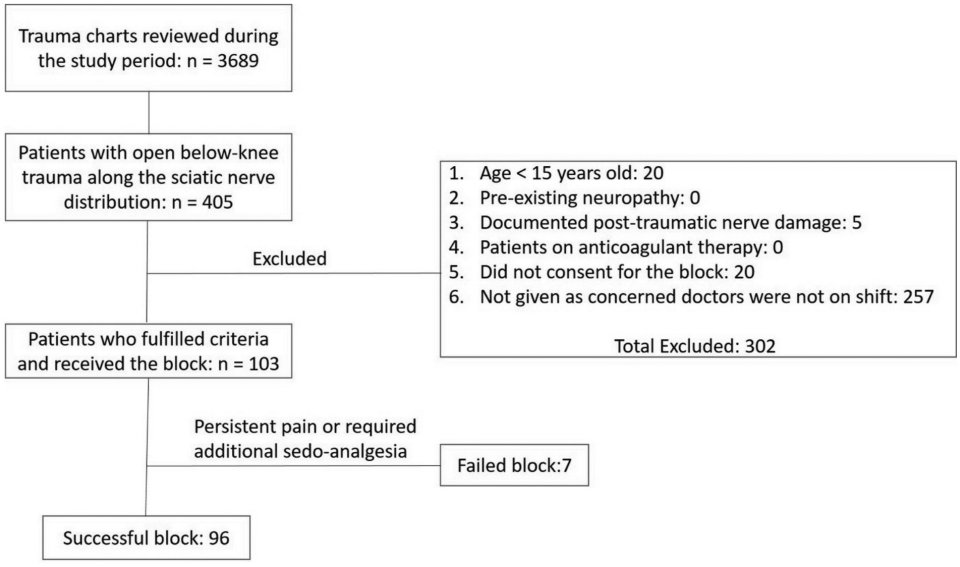

Figure 3. STROBE diagram of patient analysis and results

effects of PSA. Additionally, PSA requires a designated healthcare professional to monitor the patient throughout the procedure, taking someone away from an already busy ED floor when their presence may be needed elsewhere for more pressing matters.

Although USG nerve blocks are being performed in EDs with increasing frequency, published data is largely restricted to case reports and instructional articles (8-10). Furthermore, regional anesthesia is typically administered by anesthesiologists in a separate block room by 2 or more individuals using specialized equipment such as block needles and peripheral nerve stimulators (11-13). Given the dearth of large -scale published data and considering the need for logistic and ergonomic conservation in a busy ED, we modified the existing anesthesiology technique of the PSNB to a bedside single-person-delivered nerve block using the stylet of an 18 gauge IV cannula, termed the 'SANDY' approach as many open injuries or mangled

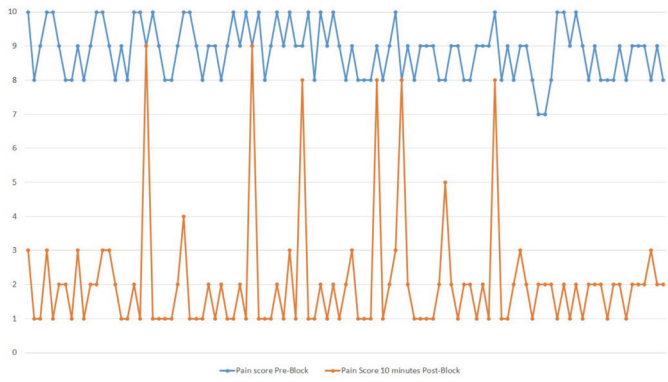

Figure 4. Graphical representation of pre and post-block pain scores

limbs are contaminated with mud or sand. Under USG and with repeated negative aspirations, the drug was slowly injected sub-paraneurally, which has been described by Perlas et al. (14) and Cappelleri et al. (15) to be safe for administering nerve blockade without causing nerve damage. The intrafascicular injection was prevented by constantly monitoring for sudden shooting limb pain or paraesthesia, along with careful slow injection of the drug. All our patients were given 10-15 mL of 1% lidocaine sub-paraneurally regardless of age, sex, or weight. Following the block, the mean pain score dropped significantly from 8.85 to 2.06 within 10 minutes. We had an ED block success rate of 93.2%, with 7 block failures that required additional sedo-analgesia during the wound management procedure. This is encouraging from an ED standpoint and comparative to several anesthesiology-based perioperative nerve block studies with similar success rates; David et al. (4) performed USG-PSNB on 50 pre-operative patients using 0.2% Ropivacaine with a success rate of 94%; meaning that patients underwent the surgical procedure purely under regional anesthesia without any IV agents. Arjun et al. (16) showed a 100% success rate when this block was combined with a saphenous nerve block for lower limb surgeries and Jeon et al. (17) reported a patient satisfaction rate of 95% in a study comparing post-operative pain relief following PSNB with nerve catheter insertion compared with spinal anesthesia. A recent Cochrane Database analysis and several published review articles further demonstrate the utility and efficacy of USG nerve blocks, and could give hope that ED-based nerve blocks using the SANDY approach can have similar rates of success as those done in the operating room while conserving resources and labor (18-21). To the authors' knowledge, this is the largest ED-based study under these parameters with results comparable to regional anesthesia techniques done with ideal anesthetic conditions and equipment. As most EDs have in-house portable ultrasound machines, this technique could be adopted and be an effective tool in wound management.

Regional anesthesia techniques in the ED have a promising future and could be beneficial from the viewpoint of efficient and competent patient care, as well as being safe and long lasting for patients at risk of systemic anesthesia (22-24). Nerve blocks when done in the ED have the advantage of sparing labor while obviating the need for potentially dangerous or dependence forming drugs such as opioids or ketamine. Looking ahead, more robust studies could be done in the future such as prospective observational studies and randomized controlled trials comparing nerve blocks using the SANDY approach to the usual departmental methods of analgesic care, and expanding the one-man technique for other described nerve blocks such as axillary, supraclavicular, or fascia iliaca blocks in the ED. The procedure performed with the short -acting agent lidocaine did not manifest any unwanted effects such as nerve damage or LAST. Hence, longer acting LA agents such as Bupivacaine and Ropivacaine could be potentially be used for the procedure, which could result in even longer periods of safe and consistent analgesia.

Study Limitations

As the study is a retrospective analysis, no comparison arm with standard analgesic protocols could be analyzed. Furthermore, case numbers were relatively limited because the doctors administering the block were not always on shift.

Conclusion

Popliteal-Sciatic block using the 'SANDY' technique is an effective, long -lasting, consistent, and safe method for wound management for below-knee trauma in the ED. It is promising as an anesthetic - sparing method for analgesia and can save valuable labor and patient cost as well.

Ethics

Ethics Committee Approval: The study was approved by the Christian Medical College Institutional Review Board Ethics Committee (IRB number: 14288, date: 29/9/2021).

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: S.N.D., P.D.K., Design: S.N.D., P.D.K., Data Collection or Processing: S.N.D., P.D.K., P.G., Analysis or Interpretation: S.N.D., P.D.K., P.G., P.P.A.K., Literature Search: S.N.D., Writing: S.N.D.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Chen EH. Lower Extremity Injuries. In: Sherman SC, Weber JM, Schindlbeck MA, Rahul G P eds. Clinical Emergency Medicine. 2014.
2. Mitra S, Jain K, Singh J, Saxena P, Nyima T, Selvam SR, et al. Clinical Utility of the Behavioral Pain Assessment Tool in Patients Admitted in the Intensive Care Unit. Indian J Crit Care Med. 2020;24:695-700.
3. Jeong JS, Shim JC, Jeong MA, Lee BC, Sung IH. Minimum effective anaesthetic volume of 0.5% ropivacaine for ultrasound-guided popliteal sciatic nerve block in patients undergoing foot and ankle surgery: determination of ED50 and ED95. Anaesth Intensive Care. 2015;43:92-7.
4. David SN, Varghese DC, Valiaveedan S. What is the minimum effective anesthetic volume (MEAV90) of 0.2% ropivacaine required for ultrasound-guided popliteal-sciatic nerve block? J Anaesthesiol Clin Pharmacol. 2021;37:402-5.
5. Bhatt M, Johnson DW, Chan J, Taljaard M, Barrowman N, Farion KJ, et al. Risk Factors for Adverse Events in Emergency Department Procedural Sedation for Children. JAMA Pediatr. 2017;171:957-64.
6. Taylor DM, Bell A, Holdgate A, MacBean C, Huynh T, Thom O, et al. Risk factors for sedation-related events during procedural sedation in the emergency department. Emerg Med Australas. 2011;23:466-73.
7. Raffay V, Fišer Z, Samara E, Magounaki K, Chatzis D, Mavrovounis G, et al. Challenges in procedural sedation and analgesia in the emergency department. J Emerg Crit Care Med. 2020;4:27.
8. Herring AA, Stone MB, Fischer J, Frenkel O, Chiles K, Teismann N, et al. Ultrasound-guided distal popliteal sciatic nerve block for ED anesthesia. Am J Emerg Med. 2011;29:697.e3-5.
9. Tirado A, Nagdev A, Henningsen C, Breckon P, Chiles K. Ultrasound-guided procedures in the emergency department-needle guidance and localization. Emerg Med Clin North Am. 2013;31:87-115.
10. Mori T, Hagiwara Y. Ultrasound-Guided Popliteal Sciatic Nerve Block for an Ankle Laceration in a Pediatric Emergency Department. Pediatr Emerg Care. 2017;33:803-5.
11. Mehmood R, McGuire AJ, Mansoor Z, Fink AB, Atanasov G. Regional Anaesthetic Techniques and Their Implications During the COVID Pandemic. SN Compr Clin Med. 2021;3:2222-8.
12. Mazda Y, Peacock S, Wolfstadt J, Matelski J, Chan V, Gleicher YJ. Developing a business case for a regional anesthesia block room: up with efficiency, down with costs. Reg Anesth Pain Med. 2021;46:986-91.
13. Brown B, Khemani E, Lin C, Armstrong K. Improving patient flow in a regional anaesthesia block room. BMJ Open Qual. 2019;8:e000346.
14. Perlas A, Wong P, Abdallah F, Hazrati LN, Tse C, Chan V. Ultrasound-guided popliteal block through a common paraneural sheath versus conventional injection: a prospective, randomized, double-blind study. Reg Anesth Pain Med. 2013;38:218-25.
15. Cappelleri G, Cedrati VL, Fedele LL, Gemma M, Camici L, Loiero M, et al. Effects of the Intraneural and Subparaneural Ultrasound-Guided Popliteal Sciatic Nerve Block: A Prospective, Randomized, Double-Blind Clinical and Electrophysiological Comparison. Reg Anesth Pain Med. 2016;41:430-7.
16. Arjun BK, Prijith RS, Sreeraghu GM, Narendrababu MC. Ultrasound-guided popliteal sciatic and adductor canal block for below-knee surgeries in high-risk patients. Indian J Anaesth. 2019;63:635-9.
17. Jeon HJ, Park YC, Lee JN, Bae JS. Popliteal sciatic nerve block versus spinal anesthesia in hallux valgus surgery. Korean J Anesthesiol. 2013;64:321-6.
18. Lewis SR, Price A, Walker KJ, McGrattan K, Smith AF. Ultrasound guidance for upper and lower limb blocks. Cochrane Database Syst Rev. 2015;2015:CD006459.
19. Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: part 1. Br J Anaesth. 2010;104:538-46.
20. Marhofer P, Greher M, Kapral S. Ultrasound guidance in regional anaesthesia. Br J Anaesth. 2005;94:7-17.
21. Hadzic A, Dewaele S, Gandhi K, Santos A. Volume and dose of local anesthetic necessary to block the axillary brachial plexus using ultrasound guidance. Anesthesiology. 2009;111:8-9.
22. Stone A, Goldsmith AJ, Pozner CN, Vlassakov K. Ultrasound-guided regional anesthesia in the emergency department: an argument for multidisciplinary collaboration to increase access while maintaining quality and standards. Reg Anesth Pain Med. 2021;46:820-1.
23. Fuzier R, Tissot B, Mercier-Fuzier V, Barbero C, Caussade D, Mengelle F, et al. Evaluation de l'utilisation de l'anesthésie locorégionale dans un service d'urgence [Evaluation of regional anesthesia procedure in an emergency department]. Ann Fr Anesth Reanim. 2002;21:193-7.
24. Malik A, Thom S, Haber, B, Sarani N, Ottenhoff J, Jackson B, et al. Regional Anesthesia in the Emergency Department: an Overview of Common Nerve Block Techniques and Recent Literature. Curr Emerg Hosp Med Rep. 2022;10:54-66.