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Emergency practitioner-administered ultrasound nerve blocks in the emergency department: A retrospective analysis

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Abstract:

OBJECTIVES: In the realm of acute pain management within emergency departments (EDs), the prevalent reliance on systemic analgesics, notably opioids, presents challenges due to associated risks and suboptimal efficacy. The emerging alternative of ultrasound-guided nerve blocks (USGNBs) has shown promise in prospective studies. However, the safety and efficacy of USGNBs when performed by emergency medicine practitioners remain largely unexplored, necessitating this study to address the research gap. The primary objectives of this study were to assess the efficacy of Emergency physician-performed USGNBs and changes in patient-reported pain (pre- and postnerve block) at 15 and 30 min. In addition, the time taken to perform nerve blocks, type of nerve block, frequency, indications, procedure time, and complications were all studied.

METHODS: Conducted at a Tertiary Care Teaching Hospital in Pune, India, this single-center, retrospective observational study aimed to evaluate the effectiveness of USGNBs in the ED context. A retrospective analysis covered 274 emergency practitioner-performed USGNBs recorded from January 2022 to December 2023. Participants included consecutive ED patients consenting to nerve blocks, with practitioners utilizing bupivacaine (0.25%) and ropivacaine (0.25%) based on individual preferences. The study systematically recorded patient demographics, block types, indications, complications, and pre- and postpain scores on a Numerical Rating Scale.

RESULTS: The study demonstrated a significant reduction in pain scores post-USGNB, with an average decrease of 2.9 ± 1.08 at 15 min and 5.8 ± 1.39 at 30 min. Commonly performed blocks included the femoral nerve, fascia iliaca, and serratus anterior, with notable pain relief in fracture management cases. Procedural durations varied, ranging from 2 to 12 min, while four complications were reported, including diaphragmatic paresis and arterial punctures during interscalene nerve block and fascia iliac compartment blocks, respectively.

CONCLUSION: This extensive study in an academic ED setting supports the proficiency of emergency practitioners in performing USGNBs. The findings emphasize the transformative potential of USGNBs in academic ED pain management, showcasing notable pain reduction and minimal complications. These results advocate for the integration of advanced pain relief techniques into emergency medicine training programs, contributing to a comprehensive approach to acute pain management.

Keywords:

Emergency medicine, nerve block, regional anesthesia

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Box-ED section

What is already known on the study topic?

- Ultrasound-guided nerve blocks (USGNBs) have shown efficacy and safety in acute pain management, but data on their use by emergency practitioners are limited.

What is the conflict on the issue? Has it importance for readers?

- The use of USGNBs by emergency practitioners raises questions about safety, efficacy, and integration into practice, which is vital for optimizing acute pain management in the emergency department (ED).

How is this study structured?

- This single-center, retrospective observational study evaluates 274 USGNBs performed by emergency practitioners in a tertiary care teaching hospital, focusing on outcomes, complications, and procedural details.

What does this study tell us?

- The study demonstrates the effectiveness and safety of USGNBs performed by emergency practitioners, highlighting their potential as a core component of acute pain management in the ED and emphasizing the need for further integration into practice and education.

Introduction

In the realm of acute pain management within the emergency department (ED), a paradigm shift is underway, driven by the quest for optimal, safe, and resource-efficient analgesia. Conventionally, the approach to pain relief in ED patients has often relied heavily on systemic analgesics, such as opioids, despite their risk of side effects and potential for sub-optimal efficacy.[1,2] Over the years, ultrasound-guided nerve blocks (USGNBs) have emerged as a promising alternative to tackle acute pain effectively and safely. These nerve blocks, conventionally administered by anesthetists, have been the subject of large prospective studies, showcasing their remarkable efficacy and safety.[3] Despite the surging interest in USGNBs administered in the ED,[4-6] there is a dearth of data assessing the safety and efficacy of these blocks when performed by emergency medicine practitioners. Our study aims to address this research gap by evaluating the effectiveness of USGNBs in the ED. In addition, we aim to emphasize the practicality of nerve blocks in the ED as a functional and potent modality of analgesia. Offering empirical evidence on the safety and efficacy of ED physicians wielding USGNBs can pave the way for wider adoption of this advanced pain relief technique and implementation into emergency medicine training programs in a more comprehensive manner compared to the existing practice.

Methods

Study design and setting

This was a single-center, retrospective observational study conducted at a tertiary care teaching hospital with an annual intake of approximately 45,000 patients. This study is a retrospective analysis of all 274 emergency practitioner-performed USGNBs recorded during January 2022–December 2023 in the ED. The institutional ethics committee approved the study protocol (Institutional Ethics Committee of Dr. D. Y. Patil Medical College and Hospital, Approval Date: September 25, 2023; Approval No: IESC/FP/33/2023).

Selection of participants and interventions

Participants in this study constituted a sample of consecutive ED patients who had presented with conditions necessitating and consenting to receive a nerve block. Practitioners had offered USGNBs whenever necessary. All nerve blocks that did not require ultrasound guidance had been excluded from the registry, as well as those where patients were unable to accurately assess pain scores due to intoxication and/or head injuries.

In accordance with the departmental protocol [Table 1], USGNBs were considered part of a multimodal first-line acute pain management strategy. All nerve blocks had been performed by 2nd or 3rd-year residents under the supervision of an attending ED consultant with substantial expertise in USGNBs. All residents who had

Table 1: Broad strategy of ultrasound-guided regional anesthesia in our emergency departments

Anatomical location	First-line strategy	Second-line strategy
Upper and lower limb		
Shoulder	Interscalene block	Suprascapular block, axillary, and suprascapular block
Arm	Brachial plexus block	Brachial plexus blocks
Forearm	Brachial plexus block/ selective nerve block	Brachial plexus blocks
Hip	FICB	Femoral, FICB, PENG block
Femur and knee	Femoral nerve block	FICB, adductor canal block
Ankle and foot	Saphenous nerve block, popliteal sciatic	Ankle block
Plantar foot	Posterior tibial nerve block	-
Trunk		
Chest wall	Serratus anterior plane block	Intercostal nerve block, erector spine nerve block
Abdominal	Rectus sheath block	-

FICB: Fascia-iliaca block, PENG: Pericapsular nerve group

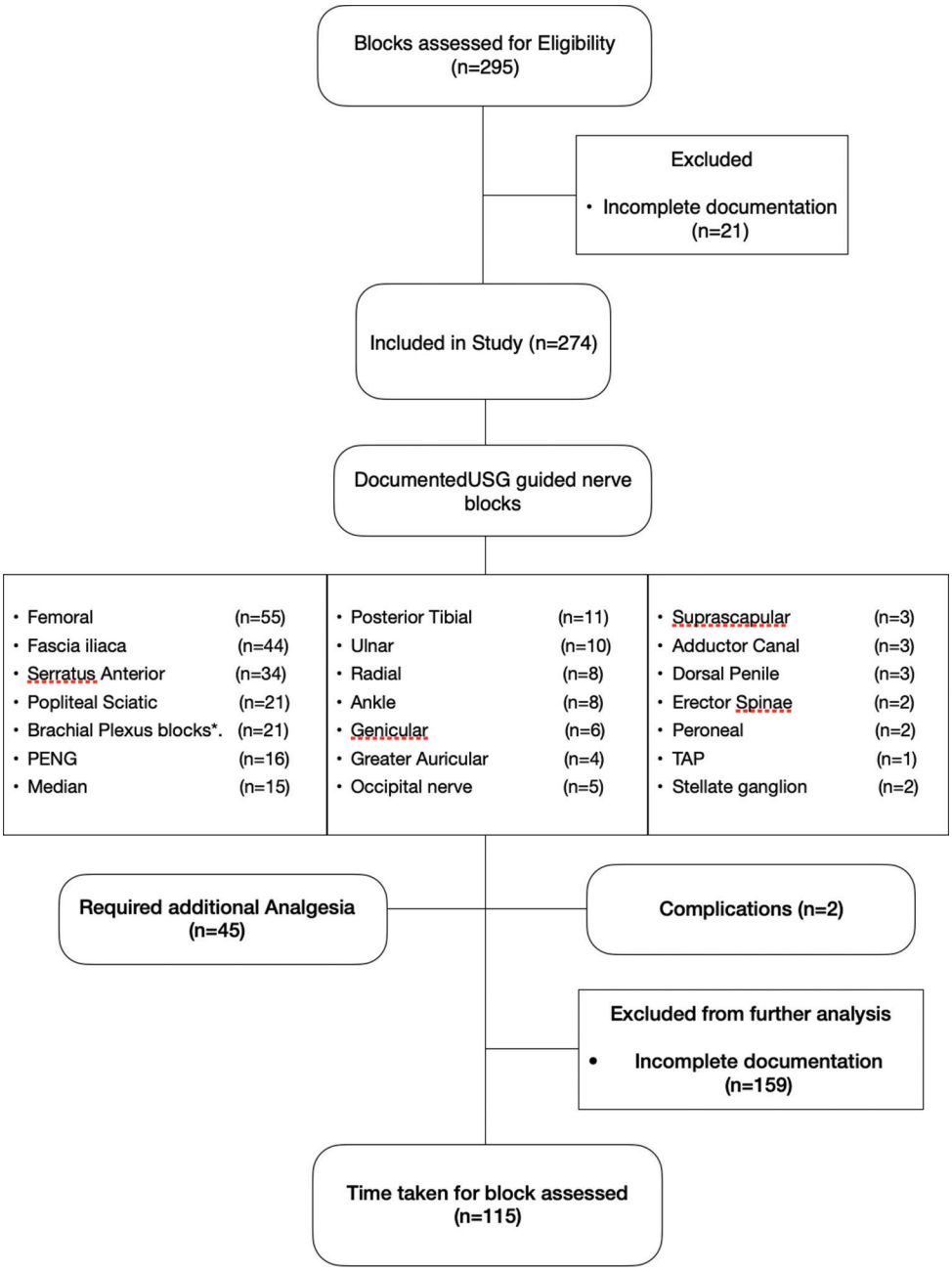

Figure 1: Case selection for ultrasound-guided nerve block analysis

performed the procedures underwent systematic training in USGNBs as an integral component of their medical curriculum and comprehensive training program and had been deemed competent.

The selection of block anesthetics and their respective concentrations had been determined in alignment with the individual preferences and availability of the practitioners, with bupivacaine (0.25%) and ropivacaine (0.25%) emerging as the most commonly employed agents within this sample. Typically, a combination of bupivacaine or ropivacaine with lignocaine had been utilized to achieve a dual effect of rapid onset and prolonged action. All nerve blocks had been executed employing 20G or 21G Quincke tip spinal needles (Romsons Spinal Needle, GS-2029). In addition to the nerve block, clinicians had administered supplementary medications as necessitated, based on patient feedback and clinical requirements.

Methods and measurements

USGNBs were routinely logged in a standardized and objective format uniformly adopted by all clinicians in our ED. Procedure notes were reviewed and entered by ED consultants. The primary investigators independently ensured accuracy by reviewing and

adjusting discrepancies in all samples. Abstractors conducted a thorough examination of each patient's ED medical notes, nursing notes, and follow-up notes (if admitted to the hospital) to identify any potential nerve block-related complications, including, but not limited to, hematomas, pneumothorax, phrenic nerve paralysis, and local anesthetic systemic toxicity. The investigators calculated the difference in Numerical Rating Scale (NRS) scores at 15 and 30 min. All individuals involved in data entry were study authors and were unblinded to the objectives. For patients undergoing multiple block procedures, each specific block was recorded as a distinct entry. Although the study comprised 274 individuals undergoing various nerve block procedures, data on the time taken (from USG localization to completion of block) for nerve blocks were systematically recorded in only 115 cases. Entries of atypical blocks, indications, and side effects were also documented. Injury types and diagnoses were obtained from provisional or final diagnoses. In case of a missing diagnosis, a thorough review of medical notes and diagnostic studies was conducted. Time taken for blocks was extracted from practitioner procedure notes, rounded to the nearest minute. Blocks lacking information on initiation and completion times in procedural documentation were excluded from definitive analysis.

Outcomes

Primary study objectives included assessing the efficacy of Emergency physician-performed USGNBs and changes in patient-reported pain (pre- and postnerve block) at 15 and 30 min (on a 0–10 NRS scale). Additional variables examined included type of nerve block, frequency, indications, procedure time, and complications.

Statistical analysis

The outcomes, including patient demographics, type of nerve block, indications, complications, prepain scores, postpain scores, time taken for the block, and drugs used, were recorded and managed using Numbers version 11.1 by Apple Inc. (Cupertino, California, United States). Descriptive statistical approaches (domains, frequency, percentage, and mean ± standard deviation) were utilized for each category. Statistical software including SPSS, Version 16.0. (Released 2007, SPSS Inc., Chicago, IL, USA), Systat 12 (Systat Software, Inc., Chicago IL, USA), and MedCalc for Windows 2000/XP/Vista/7 (MedCalc Software BVBA, Belgium) were employed for statistical analysis.

Results

During the study period, a total of 295 USGNBs were performed and recorded Figure 1. Twenty-one cases were excluded due to incomplete/missing data, and 274 were considered for further analysis. Table 2 describes the characteristics of all 274 patients who received USGNBs during the study period.

Table 3 exhibits the frequency of various block types performed and the corresponding pre- and postnerve block pain scores at 15 and 30 min. Among the 274 USGNBs, the pain scores were reduced by an average of 2.9 ± 1.08 at 15 min and 5.8 ± 1.39 at 30 min, respectively. In the study sample, the most commonly performed USGNBs in the ED were the femoral nerve (22.4%), fascia iliaca (18%), serratus anterior (13.9%), popliteal sciatic (8.6%), and brachial plexus blocks (8.6%), respectively. Dorsal penile nerve blocks had the most significant pain relief with NRS reducing from 9.3 ± 1.53 to 2.0 ± 0.82 at 15 min and 0.3 ± 0.58 at 30 min, respectively. Nerve blocks were most commonly used for fracture reduction and pain management (46.7% of cases), and least for medical conditions such as refractory occipital migraine, pancreatitis, and electrical storm (2.6%).

The time taken for nerve block (USG localization to completion of block) was documented in only 115 cases. Notably, the observed durations spanned from a minimum of 2 min for dorsal penile nerve blocks to a

Table 2: Patient characteristics of 274 emergency department patients with ultrasound-guided nerve blocks

Demographic variables	*n* (%)
Age groups (years)	
12–20	12 (4.4)
21–30	34 (12.4)
31–40	59 (21.5)
41–50	69 (25.2)
51–60	81 (29.6)
61–70	17 (6.2)
71–80	2 (0.7)
Gender	
Male	184 (67.2)
Female	90 (32.8)
Drug used	
Bupivacaine	243 (88.7)
Ropivacaine	31 (11.3)
Indications	
Fractures*	128 (46.7)
Laceration	44 (16.1)
Rib fracture	27 (9.9)
Crush injury	21 (7.7)
Foreign body	13 (4.7)
Procedures†	12 (4.4)
Amputation	11 (4.0)
Dislocation	9 (3.3)
Medical conditions‡	9 (3.3)

*Fractures excluding rib fractures, †Procedures include chest tube insertions (8), priapism drainage (3), rectus wall hematoma (1), ‡Medical conditions include electrical storm (2), pancreatitis (2), refractory occipital migraine (5)

Table 3: Emergency physician-performed ultrasound-guided nerve block preprocedure and postprocedure (15 and 30 min) scores by block type

Nerve block	*n* (%)	Preprocedure pain score (min), mean±SD	Postprocedure pain score (min), mean±SD		Difference in pain score (min), mean±SD	
			15	30	15	30
Femoral	55 (22.4)	7.5±0.92	4.5±0.94	1.56±0.98	2.9±1.08	5.8±1.39
Fascia iliaca	44 (18.0)	7.9±1.19	5.8±1.48	3.1±1.27	2.0±0.95	4.4±1.15
Serratus anterior	34 (13.9)	7.1±0.87	4±0.98	1.6±0.82	3.1±1.03	5.5±0.75
Popliteal sciatic	21 (8.6)	7.4±0.86	5.2±1.18	2.9±1.41	2.0±0.79	4.2±1.16
Brachial plexus*	21 (8.6)	7.7±1.20	3.5±1.95	1.6±1.07	4.0±1.93	6.0±1.51
PENG	16 (6.5)	6.1±0.93	3.4±0.92	1.6±0.61	3.1±1.44	4.6±0.81
Median	15 (6.1)	7.4±0.59	4.1±1.46	1.1±1.31	3.3±1.29	6.1±1.26
Posterior tibial	11 (4.5)	7.5±0.92	3.5±1.53	1.0±1.15	3.5±1.44	6.5±1.83
Ulnar	10 (4.1)	7.0±0.95	5.3±1.19	1.7±1.94	2.1±1.05	5.7±1.28
Radial	8 (3.3)	7.0±1.08	4.6±1.17	1.6±0.89	2.4±0.48	5.6±0.55
Ankle	8 (3.3)	8.4±1.29	5.4±1.41	2.1±1.45	3.0±1.34	6.4±1.37
Genicular	6 (2.4)	8.0±0.97	3.3±1.58	1.0±1.15	5.0±2.21	7.2±1.71
Greater auricular	4 (1.6)	7.5±0.58	4.5±0.58	1.8±1.03	3.0±0.82	5.8±1.30
Occipital nerve	5 (2.0)	8.0±0.63	3.8±0.75	0.4±0.55	4.2±0.98	7.6±0.55
Suprascapular	3 (1.2)	8.3±0.58	2.3±0.58	1.7±0.58	6.0±0	6.7±0.58
Adductor canal	3 (1.2)	8.0±1.41	4.7±1.53	1.7±1.15	3.3±1.53	6.3±1.53
Dorsal penile	3 (1.2)	9.3±1.53	2.0±0.82	0.3±0.58	7.3±1.53	9.0±1.00
Erector spinae	2 (0.8)	9.0±1.41	5.5±0.71	3.5±0.71	3.5±0.71	5.5±0.71
Peroneal	2 (0.8)	7.0±0	5.5±0.71	3.0±0	1.5±0.71	4
TAP	1 (0.4)	8	6	4	2	4
Stellate ganglion	2 (0.8)	-	-	-	-	-

*Axillary (9) supraclavicular (9) interscalene (3). PENG: Pericapsular nerve group, TAP: Transversus abdominis plane, SD: Standard deviation

Table 4: Medical diagnoses and requirement of additional agents

Indication	*n* (%)
Amputation	11 (100)
Crush injury	21 (100)
Electrical storm	2 (100)
Foreign body	3 (23.1)
Fracture*	6 (4.7)
Rectus wall hematoma	1 (100)
Rib fracture	1 (3.7)
Total cases	45 (16.4)

*Fractures excluding rib fractures

maximum of 12 min for genicular nerve blocks. Figure 2 provides a comprehensive overview of the temporal aspects of nerve block interventions, offering insights into procedural efficacy and potential variability across different types of blocks. The precise documentation of time taken for each procedure establishes a robust foundation for subsequent statistical analyses and subgroup examinations to explore factors influencing procedural durations within our study population.

Table 4 shows an overview of medical diagnosis and the requirement of additional agents. In 45 cases (16.4%), additional analgesics, including NSAIDs and opiates such as tramadol and fentanyl, were administered. Both amputation ($n = 11$) and crush injury ($n = 21$) cases required additional drug intervention, accounting for

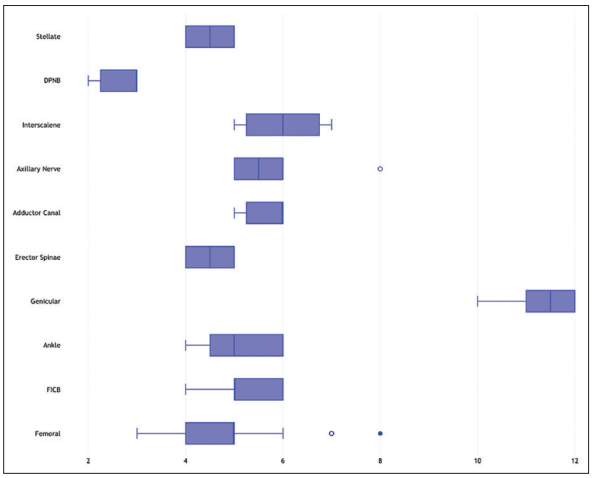

Figure 2: Box plot for time taken to complete 115 USG-Guided nerve blocks

100% of their respective categories. Notably, in two cases classified as electrical storm, drugs such as amiodarone and other antiarrhythmic drugs were utilized.

The analysis of the study revealed a cumulative total of two complications. One case of diaphragmatic paresis was noted following interscalene nerve block, and the patient required support of 1–2 L of oxygen through nasal prongs. In addition, one complication involved an arterial puncture during the fascia iliac compartment block (FICB) using a parasagittal supra-inguinal approach. The FICB was performed on a male patient

for a femoral fracture. As a standard precaution, blood aspiration was routinely conducted before anesthetic administration. Following the recognition of blood on aspirate, the needles were promptly withdrawn, pressure was applied, and repositioning was performed in both cases. The suspected culprit artery was the deep circumflex artery in both cases. Notably, no further complications were observed during the entire length of the ED stay for both patients.

Discussion

USGNBs have become increasingly prevalent in EDs as an effective means of managing acute pain. In this study, we conducted a comprehensive retrospective analysis of 274 USGNBs, focusing on procedural efficacy, pain relief outcomes, procedural durations, indications, complications, and additional drug interventions.

Our findings indicate that USGNBs offer significant pain relief within a short timeframe. On average, pain scores decreased by 2.9 points at 15 min postblock and 5.8 points at 30 min postblock. This highlights the rapid onset and sustained efficacy of USGNBs in alleviating acute pain in ED settings. Dorsal penile nerve blocks demonstrated particularly remarkable pain relief, with pain scores plummeting from 9.3 to 0.3 at 30 min postblock, underscoring the efficacy of this intervention for specific indications.

The most commonly performed nerve blocks in our study were femoral nerve, fascia iliaca, serratus anterior, popliteal sciatic, and brachial plexus blocks. This diversity in block types reflects the broad spectrum of acute pain conditions encountered in the ED, ranging from extremity fractures to abdominal and thoracic injuries. Fracture management and reduction emerged as the predominant indication for nerve blocks, comprising 46.7% of the study population, highlighting the significance of nerve blocks in enhancing patient comfort during orthopedic procedures.

Procedural durations varied across different nerve blocks, with dorsal penile nerve blocks being the quickest (2 min) and genicular nerve blocks being the longest (12 min). This variability underscores the importance of efficient procedural workflows and targeted training to optimize time management in ED settings. Figure 2 provides a visual representation of procedural durations, facilitating comparative analyses and identification of potential areas for improvement.

Complications associated with USGNBs were infrequent but notable. Diaphragmatic paresis following interscalene nerve block and arterial punctures during FICB underscore the importance of meticulous technique and anatomical knowledge in minimizing adverse events. Prompt recognition and management of complications, as demonstrated in our study, are paramount in ensuring patient safety and optimizing outcomes.

Additional drug interventions were required in 16.4% of the cases, primarily for analgesia augmentation in complex pain scenarios such as amputations and crush injuries.

USGNBs are positioned as a transformative measure, aligning with the growing recognition of the limitations associated with traditional systemic analgesics.[7] The findings of this study align with existing literature on the efficacy and safety of USGNBs, and the outcomes also echo the principles outlined by the Australasian College of Emergency Medicine and the American College of Emergency Physicians, which consider USGNBs as a core component of multimodal pain control in the ED and well within the scope of practice for emergency medicine physicians.[8]

This underscores the potential for USGNBs and regional anesthesia techniques to be seamlessly integrated as fundamental components of emergency medicine training pathways. To align with this evolving practice, the training curriculum for emergency physicians should be updated to include substantial exposure to regional anesthesia techniques, either by block champions[9] or anesthetists trained in USGNB.

Furthermore, specific medical conditions like electrical storm necessitated targeted pharmacological interventions. Less common and newer regional anesthesia blocks, including the pericapsular nerve group block,[10,11] suprascapular block for shoulder dislocation,[12] sensory-only genicular nerve block,[13] and stellate ganglion block[14] for refractory ventricular arrhythmias, highlight the versatility of USGNBs in managing diverse pain etiologies in the ED.

Conclusion

The case for integration of USGNBs into emergency medicine education and practice is further fortified by the results of this research. The study contributes to the growing body of evidence affirming the effective incorporation of ultrasound-guided regional anesthesia and nerve block techniques by emergency practitioners into comprehensive pain management strategies within the emergency setting.

Limitations

The retrospective nature of this study poses inherent limitations, hindering the control of variables causing bias. There is potential selection bias, possibly overlooking

cases due to high patient volumes, a limited number of procedurally competent physicians, and competing procedures. Consideration of confounding factors like head or spinal cord injuries, intoxication, and delirium is essential for understanding potential measurement bias in self-reported pain scores and its impact on the study's accuracy in assessing block effectiveness. Additionally, the single-center setting, although an academic ED with a substantial workforce, may limit generalizability to diverse health-care structures and practices. The study acknowledges its unique context, emphasizing the need for cautious extrapolation to smaller EDs or nonacademic settings. Despite these constraints, the study provides valuable insights into emergency practitioner-performed USGNBs within its specified context.

Author contribution statement

Authorship provides credit for a researcher's contributions to a study and carries accountability. Authors are expected to fulfill the criteria below:

- SB – Writing - Original draft (lead), formal analysis (lead), final draft (lead); VS – Conceptualization (lead), supervision (lead), methodology (lead); IL – Methodology (supporting), writing - original draft preparation (supporting); PK – Writing - Original draft (supporting), Writing - Original draft preparation (supporting); TSD – Data Curation (supporting) and original draft preparation (supporting).

Conflicts of interest

None declared.

Ethical approval

The Institutional Ethics Committee approved the study protocol (Institutional Ethics Committee of Dr. D. Y. Patil Medical College and Hospital, Approval Date: September 25, 2023; Approval No: IESC/FP/33/2023).

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