JATI

ISSN 3090-3580

EDITORIAL

Regional Anesthesia and Ultrasound-Guided Peripheral Nerve Blocks in Current Practice

DOI: 10.24843/8p9ktj40

The present issue of Jurnal Anestesiologi dan Terapi Intensif highlights a timely and meaningful development in contemporary anesthesiology. Across original articles, review articles, and case reports, regional anesthesia appears as a recurring and dominant theme, particularly in relation to peripheral nerve block techniques and ultrasound-guided practice. This concentration is not merely coincidental; rather, it reflects a broader transformation in the field, in which regional anesthesia is increasingly recognized as a strategic component of modern perioperative care.[1,2]

Over the last decade, regional anesthesia has moved well beyond its traditional role as an adjunct to perioperative analgesia. It is now widely regarded as an important approach to improving perioperative outcomes through better pain control, reduced opioid exposure, earlier mobilization, and more individualized anesthetic planning. In this context, peripheral nerve blocks have gained particular prominence because they provide targeted analgesia while limiting the systemic adverse effects commonly associated with general anesthetics and opioids. Their growing use also mirrors larger shifts in perioperative medicine toward precision, safety, enhanced recovery, and patient-centered care.[1,2]

One of the principal drivers of this development has been the widespread adoption of ultrasound guidance. Ultrasound has transformed regional anesthesia from a practice that was once largely dependent on surface landmarks and operator experience into one that is more visual, anatomy-based, and reproducible. By enabling real-time identification of nerves, surrounding structures, needle trajectory, and local anesthetic spread, ultrasound has improved not only procedural confidence but also educational value. For both trainees and experienced practitioners, ultrasound-guided blocks represent more than a technical refinement; they also promote a deeper understanding of sonoanatomy and contribute to safer, more consistent block performance.[2–4]

The concentration of manuscripts on this topic in the current issue may also be interpreted as a reflection of changing priorities in anesthesiology practice. Increasingly, anesthesiologists are expected to contribute not only to intraoperative stability, but also to multimodal analgesia, enhanced recovery pathways, and opioid-sparing perioperative strategies. Regional anesthesia aligns naturally with these expectations. Whether used as the primary anesthetic technique in selected patients or as part of a broader multimodal analgesic plan, peripheral nerve blocks are now closely associated with efforts to improve the quality and value of perioperative care.[1,2]

At the same time, the growing enthusiasm for regional anesthesia should be accompanied by equal attention to standardization, training, and safety. Ultrasound guidance, although highly valuable, does not eliminate the need for strong anatomical knowledge, careful patient selection, appropriate dosing of local anesthetics, and vigilance for potential complications. The expansion of block techniques in routine practice must therefore be matched by structured supervision, competency-based education, and clear reporting standards in the literature.[5,6] Technical innovation should not advance more quickly than the systems required to ensure its safe and consistent application. In this regard, journals play an important role not only in disseminating technical developments, but also in shaping the academic and clinical standards by which those developments are evaluated.[3]

The current issue therefore offers more than a thematic collection of manuscripts. It provides a useful snapshot of an evolving discipline in which regional anesthesia is becoming increasingly central to perioperative decision-making. The prominence of peripheral nerve blocks and ultrasound-guided techniques signals a field that is moving toward greater precision and integration, where procedural expertise must remain aligned with patient-centered outcomes and evidence-based practice. At the same time, this evolution raises important questions regarding equitable access to training, consistency in technique reporting, and the extent to which current expansion is supported by robust outcome-based evidence.[1–5]

As readers engage with the articles in this issue, they may recognize that regional anesthesia is no longer a peripheral interest within anesthesiology. It is becoming one of the defining expressions of contemporary practice. Its growing prominence also suggests that the role of the anesthesiologist is being reshaped—not only as a provider of intraoperative anesthesia, but also as a perioperative physician expected to deliver precise, safe, and recovery-oriented care. The challenge ahead is therefore not simply to expand technical capability, but to ensure that innovation in regional anesthesia remains grounded in education, standardization, safety, and clinical relevance.[1–5] Future progress in this field should be accompanied by stronger training frameworks, more rigorous reporting standards, and continued emphasis on clinically meaningful outcomes.

Tjokorda Gde Agung Senapathi
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Prof. Tjokorda Gde Agung Senapathi
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
tjoksenapathi@unud.ac.id

Submitted: 31-Mar-2026
Accepted: 02-Apr-2026
Published: 05-Apr-2026

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

No new data were generated or analysed in this study.

References

1. Hewson DW, Ferry J, Macfarlane AJR. Celebrating the state of the art and innovations in regional anaesthesia in the British Journal of Anaesthesia. *Br J Anaesth*. 2024;132(5):1012-1015. doi:10.1016/j.bja.2024.02.008
2. Johnstone D, Taylor A, Ferry J. Optimizing peripheral regional anaesthesia: Strategies for single shot and continuous blocks. *Curr Opin Anaesthesiol*. 2024;37(5):541-546. doi:10.1097/ACO.0000000000001407
3. Lemke E, Johnston DF, Behrens MB, et al. Neurological injury following peripheral nerve blocks: a narrative review of estimates of risks and the influence of ultrasound guidance. *Reg Anesth Pain Med*. 2024;49(2):122-132. doi:10.1136/rapm-2023-104855
4. Satapathy AR, Khalid I Bin, Fathil SM. Simulation in Regional Anaesthesia: A Narrative Review of Its History, Evolution and Future Prospects. *Journal of Clinical Medicine 2025, Vol 14,*. 2024;14(1). doi:10.3390/jcm14010067
5. El-Boghdadly K, Albrecht E, Wolmarans M, et al. Standardizing nomenclature in regional anesthesia: an ASRA-ESRA Delphi consensus study of upper and lower limb nerve blocks. *Reg Anesth Pain Med*. 2024;49(11):782-792. doi:10.1136/rapm-2023-104884
6. Soaida SM, Nassar HM, Hazem A, et al. Effectiveness of Ultrasonographic Unilateral Dual Transversus Abdominis Plane Block in Pain Control in Pediatric Renal Transplantation: A Randomized Controlled Trial. *Bali Journal of Anesthesiology*. 2025;9(2):62-68. doi:10.4103/bjoa.bjoa_61_25

JATI

ISSN 3090-3580

ORIGINAL ARTICLE

Diaphragm Thickening Fraction vs Rapid Shallow Breathing Index in Predicting Weaning Success: A Prospective Diagnostic Study

Deif Tunggal[1], I Gusti Ngurah Mahaalit Aribawa[2], Dewa Ayu Mas Shintya Dewi[2]

[1]Department of Anesthesiology and Intensive Therapy, Nusa Cendana University, Kupang, Indonesia
[2]Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Deif Tunggal, MD
Department of Anesthesiology and Intensive Therapy, Nusa Cendana University, Kupang 85001, Indonesia
deif.tunggal@staf.undana.ac.id

Submitted: 12-Jan-2026
Revised: 11-Feb-2026
Accepted: 31-Mar-2026
Published: 05-Apr-2026

How to cite this article:
Tunggal D, Aribawa IGNM, Dewi DAMS. Diaphragm thickening fraction vs rapid shallow breathing index in predicting weaning success: a prospective diagnostic study. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):4-9. doi:10.24843/bnr74z53.

Abstract

Introduction: Weaning from mechanical ventilation is a critical step in intensive care, and inaccurate assessment may increase the risk of complications. The rapid shallow breathing index (RSBI) is widely used to evaluate weaning readiness but does not directly assess diaphragmatic function. Diaphragm thickening fraction (DTF), measured by bedside ultrasound, has been proposed as an additional predictor of weaning success. This study aimed to compare the diagnostic performance of DTF and RSBI in mechanically ventilated ICU patients.

Patients and Methods: This prospective diagnostic accuracy study was conducted in a tertiary hospital in Denpasar, Indonesia, from September to December 2022, in accordance with STARD 2015 guidelines. Adult patients aged 18–65 years who received invasive mechanical ventilation for >24 hours and were considered ready for weaning were included. RSBI and right-sided DTF were measured at the fifth minute of a spontaneous breathing trial. Weaning success was defined as extubation without reintubation, noninvasive ventilation, or death within 48 hours.

Results: Fifty-six patients were included, of whom 73.2% achieved successful weaning. DTF demonstrated high sensitivity (95.4%) and moderate specificity (75.0%), with a positive predictive value of 93.3% and a negative predictive value of 81.8%. RSBI showed sensitivity of 97.5% and specificity of 80.0%, with higher discriminative performance (AUC 0.88 vs 0.79). Confidence intervals and statistical comparisons between AUCs were not performed.

Conclusion: Both RSBI and DTF were associated with weaning success. RSBI demonstrated superior overall diagnostic performance and remains the primary assessment tool. DTF may provide additional physiological information on diaphragmatic function and serve as a complementary parameter during weaning assessment.

Keywords: Diaphragm; Intensive Care Units; Mechanical Ventilation; Ultrasonography; Ventilator Weaning

Introduction

Weaning from mechanical ventilation is a critical component of the care of critically ill patients and is often challenging in the intensive care unit. A substantial proportion of the total duration of mechanical ventilation is spent during the weaning phase, and inappropriate timing may adversely affect patient outcomes. Premature extubation can lead to respiratory muscle fatigue and the need for reintubation. Conversely, delayed weaning increases the risk of ventilator-associated pneumonia, prolonged ICU stay, and higher mortality.[1,2] Therefore, identifying patients who are likely to achieve successful weaning is essential.

The Rapid Shallow Breathing Index (RSBI) is widely used to assess readiness for weaning. An RSBI value of <105 breaths/min/L is generally considered predictive of successful weaning.[3]

However, RSBI has several limitations. It does not directly assess diaphragm function, which plays a crucial role in spontaneous breathing. In addition, RSBI may be influenced by factors such as fever, sepsis, anxiety, patient positioning, and airway resistance, potentially reducing its accuracy in certain clinical conditions. [4,5]

Diaphragm dysfunction is common in patients receiving mechanical ventilation and represents a major cause of weaning failure. Recently, diaphragm ultrasound has emerged as a bedside, noninvasive method for evaluating diaphragm function. One parameter, diaphragm thickening fraction (DTF), reflects diaphragmatic contraction during inspiration and has shown potential in predicting weaning outcomes.[6] However, reported cutoff values for DTF vary considerably, and its diagnostic accuracy remains inconsistent. Previous studies have reported heterogeneous cutoff values, ranging from approximately 20% to 40%, likely due to differences in patient populations, ventilator settings, and ultrasound techniques. Furthermore, data from Indonesian or regional ICU populations remain limited, where patient characteristics and clinical practices may differ.

Therefore, this study aimed to compare diaphragm thickening fraction and rapid shallow breathing index in predicting weaning success in mechanically ventilated adult ICU patients. In addition, this study sought to identify an optimal cutoff value for diaphragm thickening fraction and to evaluate whether DTF could serve as an adjunct to RSBI during weaning assessment. We hypothesized that RSBI would demonstrate superior overall diagnostic performance, while DTF would provide additional physiological information as a complementary parameter in predicting weaning success.

Patients and Methods

This was a prospective diagnostic accuracy study conducted in a tertiary hospital in Denpasar, Indonesia, between September and December 2022. The study was reported in accordance with the STARD 2015 guidelines for diagnostic accuracy studies. Ethical approval was obtained from the Institutional Ethics Committee of the Faculty of Medicine, Universitas Udayana and RSUP Prof. Dr. I.G.N.G. Ngoerah (No. 2887/UN14.2.2.VII.14/LT/2022, issued in 2022). Written informed consent was obtained from all patients or their legal representatives prior to enrollment. A formal sample size calculation was not performed. The sample size was

determined based on consecutive eligible patients during the study period.

Furthermore, a journal article is not similar to textbook writing or thesis report. That implies that authors should follow the design-specific guidelines that are presented on our website (i.e., clinical trials should follow CONSORT checklist, observational studies should follow STROBE checklist, etc.).

Adult patients receiving invasive mechanical ventilation and undergoing the weaning process in the ICU were screened for eligibility. Inclusion criteria were age 18–65 years, duration of mechanical ventilation >24 hours, and readiness for weaning based on routine clinical assessment by the attending intensivist. Attending clinicians were not blinded to patient condition as part of standard care. Patients were excluded if they had known diaphragmatic disease, neuromuscular disorders, prior diaphragmatic weakness, phrenic nerve palsy, open wounds or recent surgery at the ultrasound probe placement site, or other conditions that could interfere with diaphragm ultrasound assessment. Ultrasound examinations were performed by a trained operator experienced in bedside diaphragm ultrasonography who was not involved in clinical decision-making; however, full blinding to RSBI values and clinical outcomes was not implemented, and intra- and interobserver variability were not formally assessed.

All included patients underwent a spontaneous breathing trial (SBT) according to standard ICU protocol. At the fifth minute of the SBT, the rapid shallow breathing index (RSBI) and diaphragm thickening fraction (DTF) were measured simultaneously. RSBI was calculated as the ratio of respiratory rate to tidal volume (breaths/min/L), using a cutoff value of <105 breaths/min/L to predict weaning success. Diaphragm ultrasound was performed on the right hemidiaphragm using a high-frequency linear transducer placed at the zone of apposition. Diaphragm thickness was measured at end-expiration and end-inspiration, and DTF was calculated as follows: DTF (%) = [(thickness at end-inspiration − thickness at end-expiration) / thickness at end-expiration] × 100.

An initial cutoff value of DTF ≥26% was applied based on previous literature. The reference standard was the clinical outcome of weaning. Weaning success was defined as successful extubation without the need for reintubation, noninvasive ventilation, or death within 48 hours after extubation. Patients requiring ventilatory support or reintubation within this period were classified as weaning failure.

Statistical analysis was performed using STATA software. Categorical variables are presented as frequencies and percentages. Diagnostic accuracy of RSBI and DTF was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy. Receiver operating characteristic (ROC) curve analysis was used to determine the area under the curve (AUC) and to identify the optimal cutoff value for diaphragm thickening fraction. A p-value <0.05 was considered statistically significant.

Results

A total of 56 patients receiving mechanical ventilation and undergoing the weaning process were included in the analysis. The study population consisted of equal numbers of male and female patients (28 each). Successful weaning was achieved in 41 patients (73.2%), while 15 patients

(26.8%) experienced weaning failure within 48 hours after extubation. No significant difference in sex distribution was observed between patients with successful weaning and those with weaning failure.

Table 1. Diagnostic Test of the Diaphragm Thickening Fraction

		Weaning Success		Total
		Success	Failure	
DTF(%)	≥ 26%	38	4	42
	< 26%	3	11	14
Total		41	15	56

The diagnostic performance of diaphragm thickening fraction (DTF) for predicting weaning success is presented in Table 1. Using a cutoff value of ≥26%, DTF demonstrated a sensitivity of 95.4% and a specificity of 75.0%. The positive predictive value was 93.3%, and the negative predictive value was 81.8%, resulting in an overall diagnostic accuracy of 91.0%.

Receiver operating characteristic (ROC) curve analysis showed an area under the curve (AUC) of 0.79, indicating good discriminative ability. Further analysis identified a higher cutoff value of ≥33% as the optimal threshold, providing a better balance between sensitivity and specificity for predicting successful weaning (Table 2 and Figure 2).

Table 2. Optimal Cutoff Value of Diaphragm Thickening Fraction

Cutoff (%)	Sensitivity	Specificity
≥ 26	95.4%	75.0%
≥ 33	95.5%	100.0%

The diagnostic performance of the rapid shallow breathing index (RSBI) is summarized in Table 2. Using a cutoff value of <105 breaths/min/L, RSBI demonstrated a sensitivity of 97.5% and a specificity of 80.0%. The positive predictive value and negative predictive value were 93.0% and 92.3%, respectively, with an overall diagnostic accuracy of 92.0%. ROC curve analysis demonstrated an AUC of 0.88 for RSBI, indicating superior discriminative performance compared with DTF (Figure 1).

Comparative ROC analysis showed that RSBI had a higher AUC than DTF (0.88 vs 0.79), suggesting better overall diagnostic performance. However, the statistical significance of the difference between AUC values was not evaluated (e.g., using the DeLong test), and confidence intervals for AUC were not calculated.

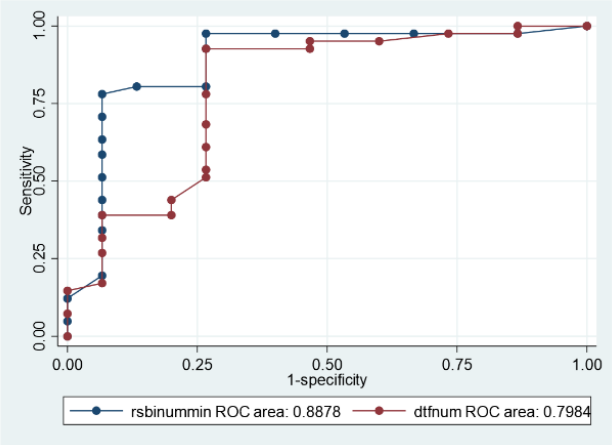


Figure 1. ROC Graph of RSBI and DTF

Discussion

This study aimed to evaluate the diagnostic accuracy of diaphragm thickening fraction (DTF) compared with the rapid shallow breathing index (RSBI) in predicting weaning success in mechanically ventilated ICU patients. The main findings indicate that both parameters demonstrated high sensitivity and acceptable diagnostic accuracy. RSBI showed superior overall discriminative ability, as reflected by a higher area under the ROC curve, whereas DTF may serve as a clinically useful adjunct in assessing readiness for weaning.

In this study, most patients were successfully weaned, and no significant difference in sex distribution was observed between the successful and failed weaning groups. These findings are consistent with previous reports suggesting that demographic factors alone have limited predictive value for weaning outcomes. Variations in weaning success rates across studies may be attributable to differences in patient characteristics, duration of mechanical ventilation, and local weaning protocols.[7]

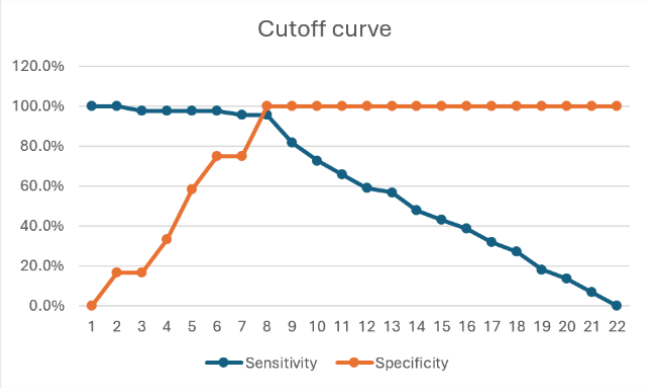


Figure 2. Cutoff Curve of RSBI and DTF

RSBI is widely used as a simple and sensitive predictor of weaning success, and its performance in the present study is consistent with previous studies.[4,5] The high sensitivity and relatively high AUC observed support its role as a primary screening tool in routine ICU practice. However, RSBI may be influenced by non-respiratory factors such as fever, sepsis, anxiety, and patient positioning, which may reduce its reliability in certain clinical settings.[4] These limitations underscore the need for complementary tools that more directly assess respiratory mechanics.

Diaphragm ultrasound has increasingly been used to evaluate respiratory muscle function at the bedside. In this study, DTF demonstrated high sensitivity and good diagnostic accuracy, consistent with previous observational studies.[6,8] The optimal cutoff value identified (≥33%) suggests that greater diaphragmatic contraction is associated with successful spontaneous breathing. Variability in reported cutoff values across studies may be explained by heterogeneity in patient populations, ventilator settings, and ultrasound measurement techniques.[9,10] The novelty of this study lies in the direct comparison of DTF and RSBI within the same patient population during the weaning process, highlighting the role of DTF as an adjunct rather than a replacement for RSBI. Although RSBI demonstrated superior overall diagnostic performance, DTF provides additional physiological insight by directly reflecting diaphragm function, which is often impaired in critically ill patients after prolonged mechanical ventilation. Previous studies have suggested that combining diaphragm ultrasound parameters with conventional indices may improve clinical decision-making, particularly when RSBI results are inconclusive.[11,12] The findings of this study support the role of DTF as a complementary tool to enhance weaning assessment in selected patients.

The relatively lower discriminative performance of DTF compared with RSBI observed in this study may be explained by several physiological factors. Although DTF directly reflects diaphragmatic contractility, it is influenced by patient effort during spontaneous breathing trials, ventilatory support settings, and measurement variability. In contrast, RSBI integrates respiratory rate and tidal volume, thereby indirectly reflecting the balance between respiratory load and muscle capacity.

From a practical perspective, diaphragm ultrasound requires operator expertise, specialized equipment, and additional time compared with RSBI, which may limit its

routine use in all ICU settings. However, DTF may be particularly useful in selected patients in whom RSBI results are inconclusive or when diaphragmatic dysfunction is suspected. The optimal cutoff value identified in this study (≥33%) was derived from the same dataset and may therefore be subject to overfitting; external validation in larger and more diverse populations is warranted before clinical implementation.

Several limitations should be acknowledged. The absence of a formal sample size calculation may limit statistical power, particularly for comparisons between diagnostic parameters. Although ultrasound measurements were performed by an operator not involved in clinical decision-making, incomplete blinding may introduce observational bias. In addition, subgroup analyses based on underlying diagnoses were not performed. Larger multicenter studies with standardized ultrasound protocols are needed to better define the role of diaphragm thickening fraction in predicting weaning outcomes. Furthermore, detailed data on causes of weaning failure, such as indications for reintubation or causes of mortality, were not systematically collected. The lack of comprehensive baseline clinical characteristics, including severity scores (e.g., APACHE II or SOFA) and primary diagnoses, limits the assessment of potential confounding factors.

Conclusion

Both diaphragm thickening fraction and the rapid shallow breathing index demonstrated high sensitivity and acceptable diagnostic accuracy for predicting weaning success in mechanically ventilated ICU patients. RSBI showed superior overall discriminative performance and remains a practical primary tool for routine weaning assessment.

Nevertheless, diaphragm thickening fraction provides additional physiological insight by directly assessing diaphragm function and may serve as a complementary parameter, particularly when the reliability of RSBI is limited.

Further multicenter studies with larger patient populations and standardized ultrasound protocols are needed to clarify the role of diaphragm ultrasound as an adjunct in weaning prediction. The optimal cutoff value identified in this study requires external validation before widespread clinical application.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author's Contributions

Conceptualization: IGNMA, DASD. Methodology: IGNMA, DASD, and DT. Investigation: DT. Data curation: DT. Formal analysis: DT. Writing – original draft: DT. Writing – review & editing: IGNMA, DASD, and DT. Supervision: IGNMA. All authors approved the final manuscript.

References

1. Tobin MJ. Assessment and technique of weaning. In: Webb A, Angus DC, Finfer S, Gattinoni L, Singer M, eds. *Oxford Textbook of*

Critical Care. 2nd ed. Oxford University Press; 2016:471-473.
2. Beduneau G, Pham T, Schortgen F, et al. Epidemiology of weaning outcome according to a new definition the WIND study. *Am J Respir Crit Care Med*. 2017;195(6):772-783. doi:10.1164/rccm.201602-0320OC
3. Yang KL, Tobin MJ. A Prospective Study of Indexes Predicting The Outcome of Trial of Weaning From Mechanical Ventilation. *N Engl J Med*. 1991;324:1072-1077.
4. Karthika M, Al Enezi FA, Pillai L V., Arabi YM. Rapid shallow breathing index. *Ann Thorac Med*. 2016;11(3):167-176. doi:10.4103/1817-1737.176876
5. Duarte H, França DLG, Portes MCF, et al. Comparison of different methods of obtaining the rapid shallow breathing index. *Brazilian Journal of Anesthesiology (English Edition)*. 2022;(xx). doi:10.1016/j.bjane.2021.05.001
6. Pirompanich P, Romsaiyut S. Use of diaphragm thickening fraction combined with rapid shallow breathing index for predicting success of weaning from mechanical ventilator in medical patients. *J Intensive Care*. 2018;6(1):1-7. doi:10.1186/s40560-018-0277-9
7. Jati SW, Aditianingsih D, George Y, Risadayanti R. Effect of hemoglobin levels on the success of weaning and extubation processes in critical patients with mechanical ventilation: a systematic review. *Bali Journal of Anesthesiology*. 2023;7(4):197. doi:10.4103/bjoa.bjoa_263_22
8. Turton P, Alaidarous S, Welters I. A narrative review of diaphragm ultrasound to predict weaning from mechanical ventilation: where are we and where are we heading? *Crit Ultrasound J*. 2019;11(1). doi:10.1186/s13089-019-0117-8
9. Alam MJ, Roy S, Iktidar MA, et al. Diaphragm ultrasound as a better predictor of successful extubation from mechanical ventilation than rapid shallow breathing index. *Acute and Critical Care*. 2022;37(1):94-100. doi:10.4266/ACC.2021.01354
10. Santana PV, Cardenas LZ, de Albuquerque ALP, de Carvalho CRR, Caruso P. Diaphragmatic ultrasound: A review of its methodological aspects and clinical uses. *Jornal Brasileiro de Pneumologia*. 2020;46(6):1-17. doi:10.36416/1806-3756/e20200064
11. Banerjee A, Mehrotra G. Comparison of lung ultrasound-based weaning indices with rapid shallow breathing index: Are they helpful? *Indian Journal of Critical Care Medicine*. 2018;22(6):435-440. doi:10.4103/ijccm.IJCCM_331_17
12. Kilaru D, Panebianco N, Baston C. Diaphragm Ultrasound in Weaning from Mechanical Ventilation. *Chest*. 2021;159(3):1166-1172. doi:10.1016/j.chest.2020.12.003

JATI

ISSN 3090-3580

ORIGINAL ARTICLE

Pre-induction Stroke Volume Variation as a Predictor of Early Post-induction Hypotension in Non-Cardiac Surgery: a Cross-Sectional Observational Study

Marthen Luther King Elmas[1,2], Putu Agus Surya Panji[1], I Ketut Wibawa Nada[1]

[1]Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia
[2]Department of Anesthesiology and Intensive Therapy, Perpetua J. Safanpo General Hospital, Asmat, Indonesia

Corresponding Author
Marthen Luther King Elmas, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
marthenelmas@gmail.com

Submitted: 27-Jan-2026
Revised: 15-Feb-2026
Accepted: 15-Mar-2026
Published: 05-Apr-2026

How to cite this article:
Elmas MLK, Panji PAS, Nada IKW. Pre-induction stroke volume variation as a predictor of early post-induction hypotension in non-cardiac surgery. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):11-17. doi:10.24843/s6hn5y93.

Abstract

Introduction: General anesthesia induction-related hypotension is common and is associated with postoperative organ injury. Dynamic indices derived from echocardiography may help identify patients at risk, although stroke volume variation (SVV) is conventionally more robust under controlled mechanical ventilation than during spontaneous breathing. We investigated whether pre-induction transthoracic echocardiography-derived SVV was associated with arterial pressure 10 min after induction in adult elective non-cardiac surgical patients.

Patients and Methods: This single-centre cross-sectional observational study enrolled consecutive adult patients undergoing elective non-cardiac surgery with general anesthesia at a tertiary hospital (August–September 2022). Pre-induction SVV was measured in the supine position using the left ventricular outflow tract method during standardized spontaneous breathing. Anesthesia was induced with propofol 1.5 mg kg−1, fentanyl 2 μg kg−1, and atracurium 0.5 mg kg−1. Non-invasive arterial pressure was recorded for 10 min after induction. The prespecified primary outcomes were systolic blood pressure (SBP) and mean arterial pressure (MAP) at 10 min. Spearman's rank correlation was used.

Results: Sixty-four patients were analysed (mean age 48.4 yr; 57.8% male; 62.5% ASA physical status II). Mean pre-induction SVV was 13.4% (SD 4.3). Mean systolic blood pressure (SBP) decreased from 116.1 (7.9) mmHg pre-induction to 93.3 (6.3) mmHg at 10 min; mean arterial pressure (MAP) from 93.4 (12.3) to 76.8 (6.1) mmHg. Higher pre-induction SVV correlated with lower SBP at 10 min (Spearman r = −0.494; 95% CI −0.660 to −0.282; P < 0.001) and lower MAP at 10 min (r = −0.676; 95% CI −0.790 to −0.516; P < 0.001).

Conclusion: Pre-induction transthoracic echocardiography-derived SVV was associated with lower arterial pressure 10 min after induction. Because the study was observational and measurements were obtained during spontaneous breathing, the findings should be interpreted as hypothesis-generating and warrant confirmation in prospective studies.

Keywords: Echocardiography; General Anesthesia; Hemodynamics; Hypotension; Stroke Volume; Surgical Procedures, Operative

Introduction

General anesthesia induction–related hypotension (GAIH) is a common and clinically significant event in routine anesthetic practice, often occurring before surgical incision.[1] Even brief episodes of mean arterial pressure (MAP) below widely accepted thresholds have been associated with adverse postoperative outcomes, including myocardial injury and acute kidney injury. These findings underscore the importance of early hemodynamic optimization during the peri-induction period. However, predicting which patients will develop hypotension immediately after induction remains challenging, particularly in elective non-cardiac surgery. Early identification of at-risk patients may enable clinicians to tailor pre-induction optimization strategies and select appropriate induction techniques to mitigate hemodynamic instability.

Stroke volume variation (SVV) is a dynamic hemodynamic parameter that reflects heart–lung interactions and serves as an indicator of preload responsiveness.[1,2] Traditionally, SVV is derived from arterial waveform analysis during controlled mechanical ventilation, where cyclic changes in intrathoracic pressure are predictable and reproducible. In recent years, transthoracic echocardiography (TTE) has emerged as a non-invasive alternative for estimating stroke volume using the left ventricular outflow tract (LVOT) method. This approach offers the potential to assess hemodynamic status at the bedside before induction of anesthesia. Pre-induction TTE-derived SVV may therefore represent a practical tool for anticipating post-induction hypotension. Nevertheless, its physiological validity outside controlled ventilation settings remains uncertain, as spontaneous breathing introduces variable intrathoracic pressure fluctuations that may affect measurement reliability.[1–3]

Given these considerations, further evaluation of pre-induction SVV obtained using TTE is warranted to determine its clinical utility in predicting early hemodynamic changes after induction of anesthesia. Therefore, this study aimed to investigate the association between pre-induction TTE-derived SVV (LVOT method) and arterial pressure 10 minutes after induction of general anesthesia in adult patients undergoing elective non-cardiac surgery. We hypothesized that higher pre-induction SVV would be associated with lower systolic blood pressure (SBP) and mean arterial pressure (MAP) following induction.

Patients and Methods

This single-centre cross-sectional observational study was conducted in the operating theatre of a tertiary general hospital from August to September 2022. The study protocol was approved by the Research Ethics Committee of the Faculty of Medicine, Udayana University, Denpasar, Indonesia (No. 2284/UN14.2.2.VII.14/LT/2022; approved on 22 August 2022). Written informed consent was obtained from all participants prior to enrolment.

Consecutive adult patients scheduled for elective non-cardiac surgery under general anesthesia were screened for eligibility. Eligibility criteria were designed to ensure reliable left ventricular outflow tract (LVOT) Doppler assessment and appropriate hemodynamic interpretation. Detailed inclusion and exclusion criteria are provided in Online Supplementary File S1.

Pre-induction echocardiographic measurements were performed using transthoracic echocardiography. Participants were instructed to breathe slowly and deeply (approximately 6–8 breaths min^{-1}) and to avoid talking or movement during image acquisition. Although respiratory rate was standardised, tidal volume was not quantified and may have influenced stroke volume variation (SVV) measurements.

Using a parasternal long-axis view, the LVOT diameter was measured in mid-systole, 1 cm proximal to the aortic valve, and averaged over three measurements. LVOT velocity–time integral was obtained using pulsed-wave Doppler with the sample volume positioned 1 cm proximal to the aortic valve and aligned parallel to blood flow. Values were averaged over three consecutive beats, or five beats in cases of irregular rhythm. Stroke volume was calculated by the ultrasound system, and SVV was computed as: SVV (%) = [(SVmax − SVmin) / SVmean] × 100.

SVmax and SVmin were derived from Doppler-based stroke volume measurements across at least three consecutive respiratory cycles during spontaneous breathing. Each acquisition was repeated three times, and the mean SVV value was used for analysis. Measurements were obtained after a 2-minute stabilisation period.

All echocardiographic examinations were performed by a single trained operator with experience in more than 50 focused transthoracic echocardiography examinations. Standardised acquisition settings were applied, and consistent LVOT landmarks were used. If image quality was inadequate, measurements were repeated; patients were excluded if adequate imaging could not be obtained. LVOT diameter and velocity–time integral were measured three times and averaged to reduce intraobserver variability. Formal reproducibility metrics were not assessed. [4]

Standard intraoperative monitoring, including non-invasive blood pressure, pulse oximetry, and heart rate, was applied. Baseline hemodynamic parameters were recorded before induction. Preoxygenation was performed with 100% oxygen at 6 L min^{-1} for 3 minutes. Anesthesia was induced with propofol 1.5 mg kg^{-1} (administered via syringe pump at 200 mL h^{-1}), fentanyl 2 μg kg^{-1}, and atracurium 0.5 mg kg^{-1}. Blood pressure was recorded for 10 minutes after induction.

Hypotension was defined as mean arterial pressure <65 mmHg, systolic blood pressure <90 mmHg, or a ≥30% decrease from baseline. Management followed a standardised protocol consisting of crystalloid administration (200 mL over 2 minutes, repeatable up to 400 mL), followed by intravenous ephedrine 5 mg if hypotension persisted. Potential confounders, including baseline blood pressure, ASA physical status, comorbidities, medication use, and pre-induction fluid status, were considered.[5]

The primary outcomes were systolic and mean arterial pressure measured 10 minutes after induction. The primary explanatory variable was pre-induction SVV. This time point was selected to capture early hemodynamic effects before surgical stimulation.

Data are presented as mean (standard deviation). Normality was assessed using the Kolmogorov–Smirnov test. The association between pre-induction SVV and arterial pressure was analysed using Spearman's rank correlation with a two-

sided α of 0.05. Given the exploratory design and limited sample size, analyses were restricted to bivariable correlations without multivariable adjustment or receiver operating characteristic analysis. Statistical analyses were performed using SPSS version 25.

Results

A total of 64 participants were included in the final analysis. Baseline characteristics are summarised in Table 1. The mean (SD) age was 48.39 (6.37) years, 57.8% of participants were male, and 62.5% were classified as ASA physical status II. Mean body mass index was 22.35 (2.05) kg m^{-2}, and mean pre-induction stroke volume variation (SVV) was 13.39% (4.30).

Hemodynamic parameters decreased after induction of general anesthesia. Mean systolic blood pressure decreased from 116.07 (7.95) mmHg before induction to 93.26 (6.31) mmHg at 10 minutes after induction. Mean arterial pressure similarly decreased from 93.37 (12.30) mmHg to 76.80 (6.06) mmHg. Because the analysis focused on hemodynamic values at the 10-minute time point, cumulative burden metrics, such as the duration of mean arterial pressure below 65 mmHg, were not assessed.

Correlation analysis showed a significant inverse association between pre-induction SVV and post-induction arterial pressure.

Table 1. Baseline characteristics (n=64)

Variable	Value
Age, yr	48.39 ± 6.37
Male sex, n (%)	37 (57.8)
ASA physical status I, n (%)	24 (37.5)
ASA physical status II, n (%)	40 (62.5)
Body mass index, kg m−2	22.35 ± 2.05
Pre-induction SVV, %	13.39 ± 4.30
Pre-induction SBP, mmHg	116.07 ± 7.95
Pre-induction MAP, mmHg	93.37 ± 12.30
SBP at 10 min, mmHg	93.26 ± 6.31
MAP at 10 min, mmHg	76.80 ± 6.06

**Values are presented as mean ± standard deviation unless otherwise indicated. ASA = American Society of Anesthesiologists; SVV = stroke volume variation; SBP = systolic blood pressure; MAP = mean arterial pressure.*

Pre-induction SVV was moderately negatively correlated with systolic blood pressure at 10 minutes after induction (Spearman r = −0.494; 95% CI −0.660 to −0.282; P < 0.001) and lower MAP at 10 min (r = −0.676; 95% CI −0.790 to −0.516; P < 0.001), as shown in Table 2.

Table 2. Correlation between pre-induction SVV and arterial pressure at 10 min after induction

Outcome	Spearman r	P value
SBP at 10 min	−0.494 (95% CI −0.660 to −0.282)	<0.001
MAP at 10 min	−0.676 (95% CI −0.790 to −0.516)	<0.001

**CI calculated using Fisher z transformation.*

Discussion

In this single-centre observational study of adult patients undergoing elective non-cardiac surgery, higher pre-induction TTE-derived SVV was associated with lower SBP and MAP at 10 minutes after induction of general anesthesia. These findings suggest that greater preload dependency prior to

induction may be linked to a more pronounced early post-induction decrease in arterial pressure. However, because of the observational design, causality cannot be inferred.

This association is biologically plausible and consistent with established hemodynamic principles. Higher stroke volume variation reflects greater preload dependency and positioning on the steeper portion of the Frank-Starling curve, where cardiac output is more sensitive to changes in venous return. During induction of anesthesia, vasodilatation and myocardial depression caused by hypnotic agents and opioids may reduce venous return and cardiac output, thereby precipitating hypotension. In patients with higher pre-induction SVV, this reduction in preload may be less well tolerated, resulting in a greater decline in arterial pressure following induction.[6,7]

These findings complement previous literature highlighting the clinical relevance of early post-induction hypotension and support the potential role of non-invasive hemodynamic assessment in peri-induction risk stratification. Compared with conventional predictors such as baseline blood pressure, age, and comorbidity burden, TTE-derived SVV provides a physiological measure of preload responsiveness, although it remains operator dependent. This approach may be particularly useful in resource-limited settings where invasive hemodynamic monitoring or advanced predictive tools, such as the Hypotension Prediction Index, are not readily available.[6,8,9]

This study has several strengths. The use of a standardised anesthetic induction and hypotension management protocol reduced treatment variability and improved internal validity. In addition, the echocardiographic method used to estimate stroke volume variation was clearly defined and applied consistently across participants. These features support the reliability of the observed associations within the study context.

Several limitations should also be acknowledged. The single-centre design and relatively homogeneous population, including a restricted ASA physical status range, may limit generalisability. Blood pressure was measured intermittently using non-invasive monitoring, which may have underestimated the incidence and duration of transient hypotensive episodes. In addition, SVV was measured during spontaneous breathing prior to induction, whereas dynamic preload indices are classically validated under controlled mechanical ventilation. Variability in intrathoracic pressure and unmeasured differences in respiratory depth may therefore have affected measurement accuracy. Echocardiography-derived stroke volume calculations are also subject to variability in LVOT diameter and VTI measurements, despite efforts to standardise acquisition and average repeated measurements. Formal intraobserver reproducibility metrics were not assessed, which may have further influenced measurement precision. The statistical analysis was limited to bivariable correlation and did not adjust for potential confounders, including age, baseline hemodynamics, comorbidities, ASA classification, and preoperative medication use. Moreover, the study assessed arterial pressure at a single time point and did not evaluate cumulative hypotension burden or postoperative clinical outcomes.

Future studies should validate these findings in larger multicentre cohorts with

broader patient populations and use multivariable models to adjust for confounding factors. Prospective interventional studies are also needed to determine whether stroke volume variation-guided pre-induction optimization strategies, such as targeted fluid administration, early vasopressor use, or modified induction techniques, can improve clinically meaningful outcomes, including reduced hypotension burden and postoperative organ dysfunction.

Conclusion

This study demonstrates that higher pre-induction TTE–derived SVV is associated with lower systolic and MAP shortly after induction of general anesthesia. These findings highlight the potential role of pre-induction hemodynamic assessment in identifying patients at risk of early post-induction hypotension. The use of non-invasive, bedside echocardiographic parameters may support more individualised anesthetic planning, particularly in settings where advanced monitoring is limited. However, given the methodological limitations and absence of multivariable adjustment, these results should be interpreted with caution. Further prospective, adequately powered studies are required to validate the predictive value of pre-induction SVV and to determine whether SVV-guided optimization strategies can improve clinically relevant outcomes.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

No new data were generated or analyzed in this study.

Author's Contributions

Conceptualization: MLK. Methodology: PAS. Investigation: MLK. Data curation: MLK. Formal analysis: PAS. Writing – original draft: IKWN. Writing – review & editing: MLK. Supervision: PAS, IKWN. All authors approved the final manuscript.

References

1. Weinberg L, Li SY, Louis M, et al. Reported definitions of intraoperative hypotension in adults undergoing non-cardiac surgery under general anesthesia: a review. *BMC Anesthesiol*. 2022;22(1):69. doi:10.1186/s12871-022-01605-9
2. Kouz K, Wegge M, Flick M, et al. Continuous intra-arterial versus intermittent oscillometric arterial pressure monitoring and hypotension during induction of anesthesia: the AWAKE randomised trial. *Br J Anaesth*. 2022;129(4):478-486. https://pubmed.ncbi.nlm.nih.gov/36008202/
3. Kouz K, Monge García MI, Cerutti E, et al. Intraoperative hypotension when using hypotension prediction index software during major noncardiac surgery: a European multicentre prospective observational registry (EU HYPROTECT). *BJA Open*. 2023;6:100140. https://pmc.ncbi.nlm.nih.gov/articles/PMC10430826/
4. Wibawa Nada I, Pradhana A. The use of echocardiography as a routine perioperative monitoring standard: The perspective of a cardiothoracic anesthesiologist. *Bali Journal of Anesthesiology*. *Wolters Kluwer Medknow Publications*. 2019;3(1):58-61. doi:10.15562/bjoa.v3i1.144
5. Hehsan MR, Chew CY, Ibrahim K, Khan MHKH. Push-Dose Adrenaline versus Ephedrine for the Management of Intraoperative Hypotension: A Retrospective Observational Study. *Bali Journal of Anesthesiology*. 2026;10(1):16-21. doi:10.4103/bjoa.bjoa_302_25
6. Wesselink EM, Wagemakers SH, van Waes JAR, Wanderer JP, van Klei WA, Kappen TH. Associations between intraoperative hypotension, duration of surgery and postoperative myocardial injury after noncardiac surgery: a retrospective single-centre

cohort study. *Br J Anaesth*. 2022;129(4):487-496. https://pubmed.ncbi.nlm.nih.gov/36064492/

7. Saugel B, Fletcher N, Gan TJ, Grocott MPW, Myles PS, Sessler DI. Perioperative Quality Initiative (POQI) international consensus statement on perioperative arterial pressure management on behalf of the Perioperative Quality Initiative XI (POQI XI) Workgroup Members. *Br J Anaesth*. 2024;133(2):264-276. https://www.thepoqi.org/
8. Saugel B, Sessler DI. Perioperative blood pressure management. *Anesthesiology*. 2021;134(2):250-261. https://pubmed.ncbi.nlm.nih.gov/33206118/
9. Meng L. Heterogeneous impact of hypotension on organ perfusion and outcomes: a narrative review. *Br J Anaesth*. 2021;127(6):845-861. https://pubmed.ncbi.nlm.nih.gov/34392972/

JATI

ISSN 3090-3580

NARRATIVE REVIEW

Linea Semilunaris vs. Lateral Transversus Abdominis Plane (TAP) Block after Caesarean Section: A Narrative Review

Luh Ratna Oka Rastini*, Putu Kurniyanta

Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Luh Ratna Oka Rastini, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
ratnarastini@student.unud.ac.id

Submitted: 02-Sep-2025
Revised: 16-Oct-2025
Accepted: 11-Dec-2025
Published: 05-Apr-2026

How to cite this article:
Rastini LRO, Kurniyanta P. Linea semilunaris vs lateral transversus abdominis plane (TAP) block after caesarean section: a narrative review. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):18-24. doi:10.24843/qg4fmv98.

Abstract

Cesarean section (CS) is a major obstetric surgery with a prevalence of moderate to severe postoperative pain exceeding 80% within the first 24 hours. Pain involves both somatic and visceral components, and inadequate pain management may impair early mobilization, hinder breastfeeding, increase the risk of postpartum depression, and contribute to chronic pain. The Transversus Abdominis Plane (TAP) block is an effective regional analgesia technique that can reduce somatic pain after CS and decrease opioid requirements. Two commonly used approaches are the linea semilunaris and lateral approaches; however, direct comparisons of their effectiveness in CS patients remain scarce in Indonesia. This narrative review was conducted through a literature search between 2015 and 2025 and included clinical studies evaluating pain intensity, analgesia duration, opioid requirements, and adverse effects in post-CS patients. The results show that linea semilunaris may offer broader analgesic coverage and longer duration of analgesia compared to the lateral approach in post-CS patients. Large-scale, well-designed RCTs are needed to confirm its clinical superiority and establish optimal dosing guidelines.

Keywords: Anesthesia, Local; Cesarean Section; Enhanced Recovery After Surgery; Postoperative Pain; Visual Analog Scale

Introduction

Postoperative pain remains a major concern in patients undergoing caesarean section. According to World Health Organization data, the incidence of moderate to severe pain within the first 24 hours after CS exceeds 80%. Such pain may impair early mobilization, disrupt breastfeeding, and increase the risk of chronic postoperative pain.[1]

Postoperative pain may be somatic or visceral. Somatic pain originates from abdominal wall incision, while visceral pain results from uterine manipulation and traction of surrounding tissues.[1] Pain mechanisms involve activation of peripheral nociceptors by inflammatory mediators such as prostaglandins, bradykinin, hydrogen ions, interleukin-1β, and tumor necrosis factor-α. These nociceptive impulses are transmitted through A-δ and C fibers to the dorsal horn of the spinal cord, then relayed to the thalamus and perceived in the cerebral cortex. Inadequate pain control may lead to central sensitization, increasing pain intensity and prolonging recovery.[2]

A multimodal analgesia approach has become the standard for post-CS pain management, including the TAP block. This technique aims to block pain transmission from the thoracolumbar nerve plexus (T6–L1) that innervates the abdominal wall.[3] Two commonly used approaches are the lateral and linea semilunaris approaches. The lateral approach is technically simpler and effective for infraumbilical analgesia, whereas the linea semilunaris approach provides wider dermatomal coverage, including the supraumbilical region, with a longer analgesic duration.[4]

In the context of CS, selection of the optimal TAP block technique must consider analgesic coverage, duration, opioid-sparing effects, and potential adverse events. Studies indicate that high-quality regional blocks facilitate earlier mobilization, reduce postoperative nausea and vomiting, and improve patient satisfaction.[3] Therefore, direct comparison between lateral and linea semilunaris approaches is clinically relevant, particularly in resource-limited healthcare settings.

Semilunaris versus Lateral TAP Block

TAP block is a regional analgesic technique targeting somatic nerves of the abdominal wall, particularly the anterior branches of the intercostal nerves (T6–T11), the subcostal nerve (T12), and the iliohypogastric and ilioinguinal nerves (L1). Local anesthetic is injected into the interfascial plane between the internal oblique and transversus abdominis muscles, thereby blocking nociceptive transmission from the skin, muscles, and parietal peritoneum.[5,6] This peripheral nerve conduction blockade significantly reduces nociceptive input to the spinal cord, attenuating central pain pathway activation and decreasing systemic analgesic requirements. TAP block functions as a field block rather than a classic nerve block, as it targets tissue planes traversed by sensory nerves rather than a single nerve trunk. Consequently, the extent of analgesia depends on anesthetic volume and spread within the interfascial space.[6]

Two main TAP block approaches are used: the semilunaris and lateral approaches, which differ in anatomical targets, dermatomal coverage, and analgesia duration. The semilunaris approach, also known as the paramedian umbilical TAP, follows the linea semilunaris at the junction of the rectus sheath with the internal oblique and transversus abdominis muscles. Injection at this site produces a combined effect of medial TAP and rectus sheath block, potentially covering dermatomes T7–T12. In contrast, the lateral TAP block is performed at the mid-axillary line and primarily covers dermatomes T10–T12, without significant cranial spread.[4,7]

TAP block typically uses 20-30 mL of local anesthetic per side and provides approximately 12 hours of analgesia.[7,8] Adjuvants such as dexmedetomidine, lipophilic opioids, or magnesium sulfate may further prolong analgesia through synergistic mechanisms. Dexmedetomidine acts on presynaptic α-2 adrenergic receptors, reducing norepinephrine release and decreasing postsynaptic neuronal excitability in the dorsal horn. This mechanism not only enhances analgesia but also attenuates sympathetic responses and promotes hemodynamic stability.[4]

Clinically, the linea semilunaris TAP block demonstrates a longer duration of analgesia, with a delayed requirement for rescue analgesics (>6–8 hours) and lower VAS scores in the early postoperative period. In comparison, the lateral TAP block

has an average effective duration of approximately 4–6 hours and is associated with higher opioid requirements. The advantages of broader coverage and longer analgesic duration with the linea semilunaris approach are offset by greater technical complexity and the need for more advanced ultrasonographic skills. Conversely, the lateral approach is simpler, quicker to perform, and more suitable for resource-limited settings. These fundamental differences are important when selecting a TAP block technique for caesarean section, as they influence pain control, opioid consumption, early mobilization, and implementation of obstetric Enhanced Recovery After Surgery (ERAS) protocols.[9]

Postoperative Pain Scores

A single-arm study in laparotomy patients demonstrated that the semilunaris TAP block significantly reduced VAS scores at multiple postoperative time points.[8] Median VAS scores were 2 (IQR: 1–2) at 4 hours and increased to 4 (IQR: 4–5) at 10 hours postoperatively. The broader analgesic distribution—extending below the xiphoid process, above the pubic symphysis, and laterally from the midclavicular line—likely contributed to lower early pain scores due to the combined rectus sheath and TAP block effects.[4,7]

A study also reported higher Numeric Analog Scale (NAS) scores in the lateral TAP group compared with the posterior TAP group at 6 hours (2.94 ± 0.51 vs 2.65 ± 0.62; p=0.03), 12 hours (4.63 ± 0.75 vs 3.15 ± 0.67; p<0.001), and 24 hours (4.02 ± 0.85 vs 3.47 ± 0.76; p=0.004) postoperatively. This study indicates shorter analgesia duration and reduced efficacy of the lateral approach.[8]

Time to First Rescue Analgesia

Analgesia duration was assessed by the time to first patient-controlled analgesia (PCA) demand. Xu et al. reported that the semilunaris TAP block provided rapid and effective analgesia with moderate duration, attributable to extensive interfascial spread and combined block effects, while maintaining a favorable safety profile due to lower total anesthetic doses.[7]

A study observed that patients receiving lateral TAP blocks required rescue analgesia at a mean of 6.73 hours postoperatively, compared with 13.3 hours in the posterior TAP group. Although direct comparisons with semilunaris TAP in CS remain limited, the wider analgesic area suggests a potentially longer effective duration for the semilunaris approach.[8]

Postoperative Opioid Consumption

Total intravenous opioid consumption within 24–48 hours postoperatively is an important indicator of TAP block efficacy. A study demonstrated that semilunaris TAP blocks significantly reduced postoperative analgesic requirements following open abdominal surgery.[4,7]

A meta-analysis reported higher meperidine consumption in lateral TAP block patients compared with posterior TAP blocks within the first 24 hours.[9] Although not a direct comparison with semilunaris TAP, these findings suggest that lateral TAP blocks may require greater opioid supplementation due to limited coverage.[9] Another meta-analysis also confirmed that TAP blocks, particularly using 0.375% ropivacaine, significantly reduce opioid consumption during the first 24 hours postoperatively.[10]

10.24843/qg4fmv98

Jurnal Anestesiologi dan Terapi Intensif | © Rastini et al (2026). Published by Universitas Udayana

Table 1. Literature Comparison

No.	Writer (Year)	Title	Objective	Study Design	Intervention	Result	Study Strength	Study Limitation
1.	Faiz et al. (2017)	Comparison of ultrasound-guided posterior transversus abdominis plane block and lateral transversus abdominis plane block for postoperative pain management in patients undergoing cesarean section: A randomized double-blind clinical trial study.	To compare the effectiveness of posterior versus lateral transversus abdominis plane (TAP) blocks for postoperative pain management in patients undergoing caesarean section.	RCT, double-blind	Posterior TAP block versus lateral TAP block using bupivacaine.	Pain scores were higher in the lateral TAP block group at 6, 12, and 24 hours postoperatively compared with the posterior technique; the mean time to first request for rescue analgesia was 6.73 hours in the lateral TAP group versus 13.3 hours in the posterior group; and meperidine consumption within the first 24 hours was higher in the lateral TAP group (41.8 mg) than in the posterior group (29.2 mg).	A double-blind randomized controlled trial comparing two TAP block techniques; with an adequate sample size; and clearly measured outcomes including pain scores, analgesia duration, and opioid consumption.	Included only a caesarean section population; did not evaluate long-term outcomes; and the results cannot be generalized to all type of abdominal surgery.
2.	Xu et al. (2023)	Effectiveness and safety of new umbilical paramedian semilunaris approach for transverse abdominis plane block: a prospective, single-arm, observational, evaluation study	To evaluate the effectiveness and safety of the linea semilunaris approach to the transversus abdominis plane (TAP) block in open abdominal surgery.	Prospective, observational, single-arm study	Linea semilunaris TAP block using ropivacaine.	The median VAS score at 4 hours postoperatively was 2 (IQR: 1–2), increasing to 4 (IQR: 4–5) at 10 hours; analgesic distribution was broad (3.46 cm below the xiphoid process, 1.74 cm above the pubic symphysis, and 2.02–2.19 cm lateral to the midclavicular line); the duration of analgesia was moderate, with a delayed time to first analgesic request compared with the lateral TAP block; and opioid consumption was significantly reduced (specific values not reported).	A prospective study with detailed documentation of analgesic distribution; an innovative technique (linea semilunaris) that has not been extensively evaluated previously; and measured VAS scores and opioid consumption.	There was no control group; the single-arm design limited direct comparisons; and the duration of analgesia follow-up was restricted to the early postoperative period.

10.24843/qg4fmv98

3.	Sun et al. (2017)	Postoperative Analgesia by a Transversus Abdominis Plane Block Using Different Concentrations of Ropivacaine for Abdominal Surgery: A Meta-Analysis	To analyze the effects of TAP block using different concentrations of ropivacaine on postoperative analgesia after abdominal surgery.	Meta-analysis	TAP Block with ropivacaine 0,25–0,5%	The TAP block, particularly with 0.375% ropivacaine, significantly reduces pain scores and opioid consumption within the first 24 hours postoperatively.	A meta-analysis including a large number of studies and patients; comparing different concentrations of ropivacaine; and providing standardized analyses of pain outcomes and opioid consumption.	The quality of the included studies varied; heterogeneity was high; and most studies had short follow-up periods.
4.	Uppal et al. (2019)	Transversus Abdominis Plane (TAP) and Rectus Sheath Blocks: A Technical Description and Evidence Review.	To describe TAP block and rectus sheath block techniques and review the evidence for their effectiveness.	Narrative Review	TAP block using various approaches (lateral, posterior, subcostal, and linea semilunaris).	Evidence indicates that TAP approaches providing wider coverage (e.g., linea semilunaris and posterior approaches) offer better pain control and reduce opioid requirements compared with the lateral approach, particularly for extensive incisions.	A comprehensive narrative review that discusses TAP and rectus sheath block techniques in detail and compares different approaches and their analgesic coverage.	Did not perform quantitative analysis; some evidence was derived from small or non-RCT studies; and there was potential publication bias.

Research Gap

Although TAP block has been extensively investigated in various abdominal procedures, direct scientific evidence comparing the linea semilunaris and lateral approaches specifically in the context of CS remains limited. Most of the existing literature compares a single TAP block technique with a control group or contrasts TAP blocks with other regional analgesia techniques, such as the quadratus lumborum block or epidural analgesia.[9,10] Consequently, specific data delineating the relative advantages of the linea semilunaris versus lateral approach for caesarean delivery are still scarce.

Several findings suggest that the linea semilunaris approach may provide broader dermatomal coverage and longer analgesic duration; however, this argument is largely supported by non–head-to-head studies, single-arm study designs, or investigations conducted in non-CS populations evaluating the umbilical paramedian semilunaris approach in open abdominal surgery. Meanwhile, available studies in CS populations have primarily compared posterior versus lateral TAP approaches rather than linea semilunaris versus lateral techniques. This indicates that current evidence suggesting the superiority of the linea semilunaris approach over the lateral approach in CS patients remains inferential, derived from anatomical extrapolation, physiological rationale, and cross-population data that have not been directly tested.[4,5]

Furthermore, existing studies demonstrate substantial heterogeneity in study design, inclusion criteria, and outcome measures. Variations in dosing (20–30 mL versus 15–20 mL per side), type and concentration of local anesthetics (0.25% bupivacaine versus 0.375% ropivacaine), timing of block administration (preoperative before incision versus postoperative before wound closure), and inconsistent use of ultrasound guidance may all influence study outcomes and complicate meta-analyses in drawing robust conclusions.[9–11]

In other words, well-designed randomized controlled trials with standardized dosing and techniques, homogeneous populations (elective and emergency caesarean sections), and comprehensive outcomes encompassing pain, functional recovery, safety, and cost are still required. Only through such studies can scientific evidence provide a strong foundation for clinical practice recommendations specific to the obstetric population.

Conclusion

TAP block is an effective regional analgesia technique for reducing postoperative pain after caesarean section, and the linea semilunaris approach offers both theoretical and practical advantages over the lateral approach through a wider distribution of local anesthetic. Available data suggest that the linea semilunaris approach tends to provide better pain control in the early postoperative period, prolong pain-free duration, and reduce opioid requirements, which collectively contribute to faster recovery and a lower risk of opioid-related adverse effects.

However, direct head-to-head evidence comparing the linea semilunaris and lateral approaches in caesarean section patients remains very limited. The advantages reported to date are largely derived from anatomical extrapolation and findings from studies conducted in non-caesarean populations or using non-comparative study designs, and therefore cannot be regarded as definitive clinical superiority. Consequently, large-scale randomized

controlled trials with standardized protocols—particularly regarding dosing, ultrasound technique, local anesthetic volume, and both short- and long-term pain outcomes—are needed to establish the effectiveness and safety of the linea semilunaris approach in the obstetric population. Until such evidence is available, this technique should be considered a promising yet still investigational approach rather than a definitive standard of care.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

No new data were generated or analysed in this study.

Author's Contributions

Conseptualization: LROR, PK. Methodology: LROR. Literature search: LROR. Data curation: LROR. Writing – original draft: LROR. Writing – review & editing: PK. Supervision: PK. All authors have read and approved the final version of the manuscript.

References

1. Vrooman BM, Youngren KM. Chronic pain management. In: Butterworth JF IV, Mackey DC, Wasnick JD, editors. Morgan & Mikhail's Clinical Anesthesiology. 7th ed. New York: McGraw-Hill Education; 2022. p. 1069-1134.
2. Raja SN, Carr DB, Cohen M, Finnerup NB, Flor H, Gibson S, et al. The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. Pain. 2020 Sep 1;161(9):1976–82. doi:10.1097/j.pain.0000000000001939
3. Tsai HC, Yoshida T, Chuang TY, Yang SF, Chang CC, Yao HY, et al. Transversus Abdominis Plane Block: An Updated Review of Anatomy and Techniques. Biomed Res Int. 2017 Jan 1;2017(1):8284363. doi:10.1155/2017/8284363
4. Tran DQ, Bravo D, Leurcharusmee P, Neal JM. Transversus abdominis plane block: A narrative review. Anesthesiology. 2019 Nov 1;131(5): 1166–90. doi:10.1097/ALN.0000000000002842
5. John M, Guys IA, Thomas' Nhs S. TAP block nomenclature. Anaesthesia. 2015 Jan 1;70(1):112–3. doi:10.1111/anae.12970
6. Mallan D, Sharan S, Saxena S, Singh TK, Faisal. Anesthetic techniques: focus on transversus abdominis plane (TAP) blocks. Local Reg Anesth. 2019 Sep 5;12:81–8. doi:10.2147/LRA.S138537
7. Xu C, Wang Z, Wang C, Lu J, Zhou Q. Effectiveness and safety of new umbilical paramedian semilunaris approach for transverse abdominis plane block: a prospective, single-arm, observational, evaluation study. Quant Imaging Med Surg. 2023 Jul 1;13(7):4641–7. doi:10.21037/qims-23-245
8. Faiz SHR, Alebouyeh MR, Derakhshan P, Imani F, Rahimzadeh P, Ashtiani MG. Comparison of ultrasound-guided posterior transversus abdominis plane block and lateral transversus abdominis plane block for postoperative pain management in patients undergoing cesarean section: a randomized double-blind clinical trial study. J Pain Res. 2017 Dec 19;11:5–9. doi:10.2147/JPR.S146970
9. Uppal V, Sancheti S, Kalagara H. Transversus Abdominis Plane (TAP) and Rectus Sheath Blocks: a Technical Description and Evidence Review. Curr Anesthesiol Rep. 2019 Dec 1;9(4):479–87. doi:10.1007/s40140-019-00351-y
10. Sun N, Wang S, Ma P, Liu S, Shao A, Xiong L. Postoperative analgesia by a transversus abdominis plane block using different concentrations of ropivacaine for abdominal surgery a meta-analysis. Clinical Journal of Pain. 2016 Dec 19; 33(9): 853–63. doi:10.1097/AJP.0000000000000468
11. Sahu S, Sayeed Z, Singh TK, Srivastava D, Aneesh, Bhadauria D. Comparison of Analgesic Efficacy of Ropivacaine and Levobupivacaine in Ultrasound-Guided Transversus Abdominis Plane Block and Port Site Infiltration in Laparoscopic Live-Donor Nephrectomy, a Double-Blind Randomized Parallel Group Trial. Bali Journal of Aneshtesiology. 2020 Oct; 4(4): 188-193. doi: 10.4103/BJOA.BJOA_157_2

JATI

ISSN 3090-3580

NARRATIVE REVIEW

Single versus Double Injection Techniques in Supraclavicular Brachial Plexus Block and the Role of Perfusion Index: A Narrative Review

Fransiscus Braveno Rapa*, I Made Gede Widnyana, Made Agus Kresna Sucandra

Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Fransiscus Braveno Rapa, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
enobius2021@gmail.com

Submitted: 19-Aug-2025
Revised: 09-Sep-2025
Accepted: 24-Dec-2025
Published: 05-Apr-2026

How to cite this article:
Rapa FB, Widnyana IMG, Sucandra MAK. Single versus double injection techniques in supraclavicular brachial plexus block and the role of perfusion index: a narrative review. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):25-32. doi:10.24843/eszj4f98.

Abstract

Ultrasound-guided supraclavicular brachial plexus block (SCBPB) is a widely used regional anesthesia technique for upper extremity surgery; however, variability in block onset and success remains a clinical concern. Differences in injection strategies, particularly single versus double injection techniques, have been proposed to improve anesthetic spread and block reliability. In parallel, the perfusion index (PI), derived from pulse oximetry, has emerged as a potential objective and non-invasive indicator for early assessment of block success. This narrative review aims to synthesize current evidence comparing single and double injection techniques in supraclavicular brachial plexus block and to evaluate the clinical value of the perfusion index as an objective monitoring tool. A narrative literature search was conducted using PubMed, ScienceDirect, and Google Scholar with keywords related to supraclavicular brachial plexus block, injection techniques, and perfusion index, focusing on studies published between 2015 and 2025. The reviewed literature suggests that the double injection technique is generally associated with faster sensory and motor onset, longer block duration, and higher block success rates compared with the single injection approach, although it requires longer procedural time and may slightly increase the incidence of transient neurological symptoms. Studies assessing perfusion index consistently demonstrate a significant increase following successful blocks, often preceding conventional sensory and motor assessments, with reported threshold values showing high sensitivity and specificity despite variability among studies. Overall, double injection supraclavicular brachial plexus block appears to offer improved block characteristics, while perfusion index monitoring represents a promising, rapid, and objective adjunct for early block evaluation. Further studies integrating injection techniques with standardized perfusion index assessment are required to optimize clinical application.

Keywords: Brachial Plexus Block; Injections; Perfusion Index; Supraclavicular Region; Ultrasonography

Introduction

Supraclavicular brachial plexus block (SCBPB) is an effective and relatively safe regional anesthesia technique for upper extremity surgery; however, it requires adequate onset time and reliable assessment of block success. Prolonged onset or partial block may compromise operating room efficiency, increase surgical team stress, and negatively affect healthcare delivery as well as hospital financial outcomes.[1,2] SCBPB is commonly performed under ultrasound guidance to accelerate onset,

improve block success, and reduce complications.[3] The double injection (DI) technique, involving anesthetic deposition at two strategic locations, has been shown to produce faster sensory and motor onset and higher block success rates compared with the single injection (SI) technique.[4-6] Nevertheless, several studies have reported a higher incidence of transient paresthesia associated with the DI technique compared with SI.[7]

Block success is traditionally evaluated using pinprick testing and the modified Bromage scale; however, these methods are subjective, time-consuming, and dependent on patient cooperation. The perfusion index (PI) represents an objective, non-invasive, and rapid parameter for predicting SCBPB success by detecting perfusion changes that may occur within the first minute and up to 10 minutes after block placement.[8-10]

The literature for this narrative review was identified through searches of PubMed, ScienceDirect, and Google Scholar using keywords related to "supraclavicular block," "perfusion index," and injection techniques. Publications from 2015 to 2025 that discussed injection strategies and the role of perfusion index in predicting supraclavicular brachial plexus block success were considered. Articles were selected based on relevance to the clinical topic and clarity of methodology, and the included literature was appraised narratively to support a structured and critical synthesis.

Despite increasing interest in both injection strategies and objective monitoring, studies directly comparing SI and DI techniques in relation to perfusion index changes, sensory onset, and motor onset remain limited. Therefore, this narrative review aims to synthesize and critically appraise the available literature regarding single and double injection supraclavicular brachial plexus block techniques and to evaluate the role of the perfusion index as an objective indicator of block success in upper extremity surgery.

Anatomy of the Brachial Plexus

The brachial plexus is a complex neural network originating from the cervical spine that provides sensory, motor, and sympathetic innervation to the upper extremity.[11,12] It is anatomically organized into five sequential components, beginning with the roots and extending to the terminal branches. These structures arise from the ventral rami of the C5–T1 spinal nerves, which combine to form five roots, three trunks, six divisions, three cords, and five terminal branches.[11]

The brachial plexus is enclosed within a neurovascular sheath, a fascial structure derived from the prevertebral fascia, which also surrounds the subclavian artery. Several anatomical studies have demonstrated the presence of internal fascial septations within this sheath. These septa may consist of thin connective tissue partitions that partially separate trunks or individual nerve fascicles from one another, potentially influencing the spread of local anesthetic during regional anesthesia techniques.[13]

Supraclavicular Brachial Plexus Block

Brachial plexus block can be performed at different anatomical levels, including the interscalene, supraclavicular, infraclavicular, and axillary approaches. Among these, the supraclavicular approach is the most commonly used for upper extremity surgery because the brachial plexus at this level lies relatively superficial

and appears as a compact cluster, allowing for a dense block with rapid onset.[6,14,15]

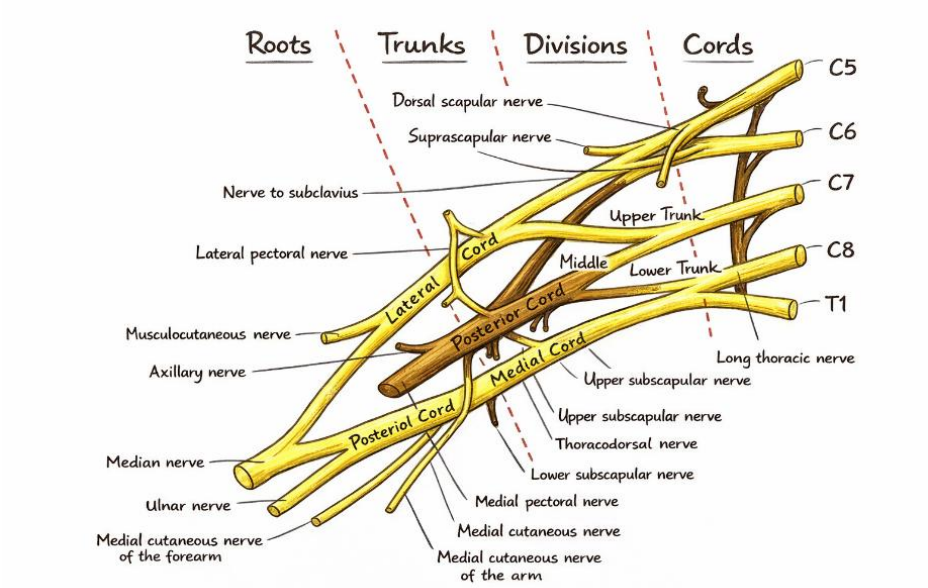


Figure 1. Brachial Plexus Anatomy.[11]

Various techniques may be used to deposit local anesthetic around the brachial plexus, including single, double, and multiple injection approaches. An increased number of needle passes is associated with a higher risk of paresthesia and other transient neurological complications.[7,15] This risk can be reduced by limiting injections using the single injection (SI) technique; however, SI is more frequentlyassociated with partial block and delayed onset. Internal fascial septations within the brachial plexus sheath may restrict local anesthetic spread, resulting in non-uniform blockade or prolonged onset. The double injection (DI) technique, which distributes local anesthetic into two strategic locations, is intended to enhance anesthetic spread throughout the plexus, thereby reducing partial block and accelerating onset, although it requires a longer procedural time.[4,5,16]

The onset of supraclavicular brachial plexus block is influenced by multiple factors affecting the distribution and penetration of local anesthetics into the target nerves. These factors include injection technique (number of injections and guidance modality), properties of the local anesthetic (volume, concentration, and type), and patient-related variables such as anatomy, age, and body mass index.[3-5,13,17,18] Ultrasound-guided supraclavicular block offers several advantages over nerve stimulator guidance, including direct visualization of anesthetic spread, faster onset, and prolonged block duration.[3]

In the SI technique, the entire volume of local anesthetic is injected at the junction between the first rib and the subclavian artery, commonly referred to as the "corner pocket." In contrast, the DI technique involves injecting half of the anesthetic volume into the corner pocket and the remaining half into the superior-lateral aspect of the subclavian artery.[4-6]

Pulse Oximetry and Perfusion Index

Finger-clip pulse oximetry uses light-emitting diodes and photodetectors to measure arterial oxygen saturation (SpO_2) based on differential light absorption by

oxyhemoglobin (O_2Hb) and deoxyhemoglobin (HHb). Oxyhemoglobin absorbs more infrared light, whereas deoxyhemoglobin absorbs more red light, and these absorption patterns fluctuate with the cardiac cycle. The pulsatile component (AC) represents arterial blood flow and is variable, while the non-pulsatile component (DC) reflects relatively stable tissues such as venous blood, capillaries, bone, fat, and skin. Variations in light absorption over time form the photoplethysmographic waveform (PPG).[19]

The perfusion index (PI) is derived from the ratio of the pulsatile to non-pulsatile components of the PPG signal and reflects peripheral perfusion. PI decreases during hypoperfusion and is influenced by patient-related factors such as age, body temperature, anxiety, and vasopressor use, as well as external conditions including ambient light, nail polish, and probe movement.[9,10,20] Normal PI values generally range from 0.02 to 20.[10]

Perfusion Index and Supraclavicular Brachial Plexus Block

The success of peripheral nerve blocks is traditionally assessed using sensory and motor function tests. Common sensory evaluation includes the pinprick test, graded as 0 (no block), 1 (presence of sensation without pain), and 2 (absence of sensation).[4,8] Motor function is commonly assessed using the Modified Bromage Scale (MBS), where 0 indicates no motor block, 1 indicates inability to lift the arm with preserved wrist movement, 2 indicates inability to move the wrist with preserved finger movement, and 3 indicates complete inability to move the arm and fingers.[4,5] A block is generally considered successful when the patient does not respond to sensory stimulation.[10,12]

The perfusion index represents an objective, rapid, non-invasive, and patient-independent method for assessing vasomotor tone. Supraclavicular brachial plexus block results in sympathetic nerve fiber blockade, leading to regional vasodilation, increased blood flow, and a subsequent rise in perfusion index. PI values measured at 10 minutes after block placement have demonstrated high sensitivity and specificity for predicting block success and appear superior to conventional pinprick testing or temperature response.[10,21–23] Reported threshold values, including absolute PI >3.3 or PI ratios ranging from 2.8 to 3.0, have been associated with high diagnostic accuracy for successful supraclavicular brachial plexus block.[8,9,20]

Critical Analysis of the Current Evidence

Although the available literature provides valuable insights into supraclavicular brachial plexus block techniques and perfusion index monitoring, several methodological and conceptual limitations must be acknowledged. Most randomized controlled trials comparing single and double injection techniques demonstrate favorable onset and block quality with the double injection approach; however, these studies are frequently limited by small sample sizes and incomplete reporting of blinding procedures. In several trials, operator blinding was not feasible, potentially introducing performance bias, while outcome assessors were not consistently blinded, which may influence subjective assessments of sensory and motor block.

Another important limitation relates to heterogeneity in block technique execution. Variations in local anesthetic type, volume, concentration, and injection sites limit direct comparability across studies. In addition, adjunctive maneuvers such as hydrodissection were inconsistently applied, particularly in the double injection groups, which may independently enhance anesthetic spread and confound interpretation of technique superiority.

Evidence supporting the perfusion index as an objective marker of block success is largely derived from observational studies. Although these studies consistently report high sensitivity and specificity, their non-randomized design limits causal inference. Furthermore, perfusion index measurement protocols vary substantially across studies with respect to sensor location, timing of measurements, and calculation of absolute versus ratio values. The lack of standardized cut-off thresholds reduces external validity and limits immediate clinical generalizability.

Importantly, the existing literature evaluates injection techniques and perfusion index largely in isolation. Studies directly correlating injection strategy with perfusion index dynamics are scarce, leaving uncertainty regarding whether observed improvements in block characteristics with double injection are reliably reflected by objective perfusion changes. These limitations highlight the need for cautious interpretation of current findings and underscore the importance of integrating anatomical, physiological, and methodological considerations in future investigations.

Clinical Implications and Future Research Directions

From a clinical perspective, the double injection technique for supraclavicular brachial plexus block appears advantageous in situations where rapid onset and high block reliability are prioritized, such as high-throughput operating rooms or procedures with limited tolerance for block failure. However, the increased procedural time and slightly higher incidence of transient neurological symptoms emphasize the importance of operator expertise and careful patient selection. Single injection techniques may remain appropriate in settings where simplicity, speed, and minimal needle manipulation are preferred.

Perfusion index monitoring offers a practical and objective adjunct for early block assessment, particularly in sedated, anxious, or non-cooperative patients where conventional sensory testing is unreliable. Incorporating perfusion index into routine practice may allow earlier identification of block failure and facilitate timely corrective interventions, potentially improving operating room efficiency and patient safety.

Future research should focus on well-designed randomized controlled trials that simultaneously compare injection techniques and perfusion index responses using standardized protocols. Establishing uniform measurement timing, sensor placement, and validated cut-off values for perfusion index is essential to enhance reproducibility and clinical applicability. Additionally, broader patient populations, including pediatric, geriatric, and vascular-compromised patients, should be studied to determine the generalizability of perfusion-based assessment.

Finally, integrating objective perfusion monitoring with ultrasound-guided injection strategies represents a promising

avenue toward precision regional anesthesia, where technique selection and block evaluation are guided by both anatomical visualization and real-time physiological feedback.

Table 1. Comparison of Injection Techniques and Perfusion Index Assessment in Supraclavicular Brachial Plexus Block

Aspect	Single Injection (SI)	Double Injection (DI)	Perfusion Index (PI)
Injection strategy	Entire local anesthetic volume injected at a single site (corner pocket)	Local anesthetic divided into two injections at strategic locations around the plexus	Not an injection technique; monitoring parameter derived from pulse oximetry
Anesthetic spread	May be limited by internal fascial septations, leading to non-uniform distribution	Improved circumferential spread, potentially overcoming fascial barriers	Reflects physiological response to sympathetic blockade rather than drug distribution
Onset of block	Generally slower sensory and motor onset	Faster sensory and motor onset reported in most studies	PI increases early after successful block, often preceding sensory and motor signs
Block success	Higher incidence of partial or delayed block	Higher and more consistent block success rates	High sensitivity and specificity for predicting block success
Procedure time	Shorter procedural time	Longer procedural time due to additional needle manipulation	No additional procedural time required
Neurological complications	Lower risk of transient paresthesia	Slightly higher incidence of transient paresthesia	Non-invasive and not associated with neurological risk
Assessment characteristics	Relies on subjective sensory and motor testing	Relies on subjective sensory and motor testing	Objective, rapid, non-invasive, and independent of patient cooperation
Clinical role	Suitable for simple cases prioritizing speed and minimal needle passes	Preferred when rapid onset and reliable block are critical	Useful adjunct for early block assessment and decision-making

Conclusion

This narrative review aimed to synthesize current evidence on single and double injection techniques in supraclavicular brachial plexus block and to examine the role of perfusion index as an objective marker of block success. The analysis indicates that the double injection technique generally provides faster onset and more reliable block characteristics, while perfusion index monitoring offers a rapid, non-invasive, and patient-independent method for early block assessment. A key insight emerging from this synthesis is the potential complementary role of optimized injection

strategies and objective perfusion-based monitoring in enhancing both technical precision and clinical efficiency in regional anesthesia. From a practical perspective, these findings support more individualized technique selection and earlier identification of block failure, while theoretically they highlight the value of integrating anatomical, physiological, and monitoring-based approaches. Future research should prioritize standardized protocols that jointly evaluate injection techniques and perfusion index dynamics, establish validated cut-off values, and assess broader patient populations to inform evidence-based guidelines and policy development in regional anesthesia practice.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

No new data were generated or analysed in this study.

Author's Contributions

Conceptualization: FBR, IMGW. Methodology: MAKS. Literature search: FBR, MAKS. Data curation: FBR, IMGW. Writing – original draft: FBR. Writing – review & editing: FBR, MAKS, IMGW. Supervision: MAKS, IMGW. All authors have read and approved the final version of the manuscript.

References

1. Kamande S, Sarpong K, Murray J, Ajayi A, Dowlati E, Nair MN. Turnover Time Between Elective Operative Cases: Does the Witching Hour Exist for the Operating Room? World J Surg [Internet]. 2022;46(12):2939–45. Available from: https://doi.org/10.1007/s00268-022-06724-5
2. Pasquer A, Cordier Q, Lifante JC, Poncet G, Polazzi S, Duclos A. Influence of a surgeon's exposure to operating room turnover delays on patient outcomes. BJS Open [Internet]. 2024;8(5):1–9. Available from: https://doi.org/10.1093/bjsopen/zrae117
3. Surendran S, Rajeev D, Rajan R. Supraclavicular Brachial Plexus Block by Nerve Stimulator or Ultrasound: An Observational Cross-sectional Study. J Clin Diagnostic Res. 2022;16(11):9–12.
4. Choudhary N, Kuma A, Kohli A, Wadhawan S, Siddiqui TH, Bhadoria P, et al. Single-point versus double-point injection technique of ultrasound-guided supraclavicular block: A randomized controlled study. J Anaesthesiol Clin Pharmacol. 2019;35:373–8.
5. Vallapureddy SK, Fultambkar G, Rajeswar Rao V, Kukreja V, Gurram R, Nair A. Comparison between single And double injection technique for ultrasound-guided supraclavicular block: A randomized controlled study. Dubai Med J. 2021;4(3):198–203.
6. Thiruchelvan V, Sundar AA, Arivazhagan S, Jayadevi C. Comparison Between SinglePoint and DoublePoint Injection Techniques in Supraclavicular Brachial Plexus Block. Int J Acad Med Pharm. 2023;5(2):140–4.
7. Albrecht E, Mermoud J, Fournier N, Kern C, Kirkham KR. A systematic review of ultrasound-guided methods for brachial plexus blockade. Anaesthesia. 2016;71(2):213–27.
8. Lal J, Bhardwaj M, Malik A, Bansal T. A study to evaluate the change in perfusion index as an indicator of successful ultrasound-guided supraclavicular block. Indian J Anaesth. 2021;65:738–43.
9. E Koca MÖ. Are The Perfusion İndex And Pleth Variability Index Title an Early İndicator of Brachial Plexus Block? Niger J Clin Pract. 2022;25:1710–6.
10. Bozdağ A, Doğukan M, Bıçakçıoğlu M, Nakır H, Duran M, Uludağ Ö. Perfusion index (PI) measured in the brachial plexus blocks performed by ultrasonography: investigation of correlation with block success. Ain-Shams J Anesthesiol [Internet]. 2023;15(1). Available from: https://doi.org/10.1186/s42077-023-00321-x

11. Desai N, Russon K. Anatomical Variation of the Brachial Plexus and Its Clinical Implications. In: Regional Anaesthesia. 2016. p. 1–9.
12. Simpson AI, Vaghela KR, Brown H, Adams K, Sinisi M, Fox M, et al. Reducing the Risk and Impact of Brachial Plexus Injury Sustained From Prone Positioning—A Clinical Commentary. J Intensive Care Med. 2020;35(12):1576–82.
13. Bottomley T, Gadsden J, West S. The failed peripheral nerve block. BJA Educ [Internet]. 2023;23(3):92–100. Available from: https://doi.org/10.1016/j.bjae.2022.12.002
14. Seylanı I, Duran M, Yılmaz N, Nakır H, Do˘gukan M, Uluda Ö. Investigation of infraclavicular block success using the perfusion index: A randomized clinical trial. Biomol Biomed. 2022;23(3):496–501.
15. Raw RM. The Supraclavicular Brachial Plexus Block. J Reg. 2018;1–14.
16. Shah DP, Patel DH, Macwan D sharmy. ultrasound guided supraclavicular block-comparison between single point and double point injection technique : a prospective randomised double blind clinical study. Int J Sci Res. 2023;12(08):21–4.
17. Šarić JP, Zenko J, Vončina V, Lupis T, Paklar N, Dvorščak MB. Effects of age on onset time and duration of sensory blockade in ultrasound guided supraclavicular block. Period Biol. 2015;117(2):287–90.
18. Taylor A, McLeod G. Basic pharmacology of local anaesthetics. BJA Educ [Internet]. 2020;20(2):34–41. Available from: https://doi.org/10.1016/j.bjae.2019.10.002
19. Coutrot M, Dudoignon E, Md JJ, Gayat E, Vallee F, Depret F. Perfusion Index: Physical Principles, Physiological Meanings and Clinical Implications in Anaesthesia and Critical Care [Internet]. Anaesthesia Critical Care & Pain Medicine. Available from: https://inria.hal.science/hal-03475091
20. Abdelnasser A, Abdelhamid B, Elsonbaty A, Hasanin A, Rady A. Predicting successful supraclavicular brachial plexus block using pulse oximeter perfusion index. Br J Anaesth. 2017;119(2):276–80.
21. Chatterjee S, Majumdar U, Gupta D, Sarkar C, Chatterjee S. Predictive Value of Perfusion Index for Assessing Success of Supraclavicular Brachial Plexus Block: A Prospective Observational Study. 2024;38(1):51–5.
22. Singh RB, Kumar A, Singh AK, Rathore VS, Kumar A. Comparative Study of Cold Sensation, Pinprick , and Perfusion Index in Evaluating the Quality of Ultrasound-Guided Supraclavicular Brachial Plexus Block : An Observational Study. Cureus. 2025;17(3):1–8.
23. Sarkar S, Doshi SM. A comparative study between supraclavicular brachial plexus block and Infraclavicular brachial plexus block for upper limb orthopedic surgeries: A prospective, randomized, double-blind study. Bali Journal of Anesthesiology. 2019 Jan; 3(1):82-87.doi: 10.15562/bjoa.v3i1.123

JATI

ISSN 3090-3580

NARRATIVE REVIEW

Supportive Care for Severe Tetanus in the Intensive Care Unit: A Narrative Review

Michael Jaya*, Cynthia Dewi Sinardja, I Putu Fajar Narakusuma

Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Michael Jaya, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
mjybius2024@gmail.com

Submitted: 10-Nov-2025
Revised: 06-Dec-2025
Accepted: 15-Dec-2025
Published: 05-Apr-2026

How to cite this article:
Jaya M, Sinardja CD, Narakusuma IPF. Supportive care for severe tetanus in the intensive care unit: a narrative review. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):33-43. doi:10.24843/v0ftgb42.

Abstract

Tetanus is an acute infectious disease caused by Clostridium tetani and remains associated with high mortality, particularly in severe cases requiring intensive care unit (ICU) admission. The neurotoxin tetanospasmin induces persistent muscle spasms, autonomic dysfunction, and respiratory failure, rendering ICU management complex and resource-intensive. This narrative review aims to synthesize current evidence on multimodal supportive care strategies that improve clinical outcomes in patients with severe tetanus managed in the ICU. This literature review identifies several interrelated components as central to successful management, including early airway control and mechanical ventilation, optimized sedation and spasm control using benzodiazepines, magnesium sulfate, and selected adjuvant agents, targeted nutritional and metabolic support through early enteral feeding, prevention of ICU-related complications, and early rehabilitation to mitigate ICU-acquired weakness. Collectively, evidence indicates that a comprehensive, evidence-based supportive care approach improves hemodynamic stability, reduces complication rates, and facilitates functional recovery in patients with severe tetanus.

Keywords: Tetanus; Intensive Care Units; Supportive Care; Mechanical Ventilation; Sedation

Introduction

Tetanus is a life-threatening acute infectious disease caused by Clostridium tetani, which produces a potent neurotoxin known as tetanospasmin. Despite being preventable through immunization, tetanus continues to occur frequently in low and middle income countries, including Indonesia, and remains associated with high mortality, particularly in patients with severe disease requiring intensive care unit (ICU) admission.[1] Global vaccination programs have substantially reduced the incidence of tetanus; however, the disease continues to impose a significant burden in resource-limited settings, where severe complications and poor outcomes are more commonly encountered.[1–3] The epidemiology of tetanus has also shifted in recent decades. An increasing proportion of cases is now observed among older adults, especially in countries that have successfully eliminated neonatal tetanus.[1,4] Age-related immunodeficiency has emerged as an important risk factor contributing to this demographic transition.[1,5] In settings with

limited access to advanced critical care, mortality rates among patients with severe tetanus may still range between 20% and 50% in the absence of adequate intensive care support.[6,7] In addition, recent observational data have highlighted a substantial burden of autonomic and respiratory complications in this population, underscoring the importance of early risk stratification and comprehensive ICU management.[5,7]

The pathogenesis of tetanus is primarily mediated by disruption of inhibitory neurotransmitter release, particularly gamma-aminobutyric acid (GABA) and glycine, resulting in sustained muscle spasms, rigidity, and autonomic dysfunction. These complex pathophysiological processes necessitate a comprehensive approach to care in the ICU that extends beyond antimicrobial therapy and toxin neutralization. Effective management requires multimodal supportive strategies, including airway stabilization, control of muscle spasms, adequate nutritional support, and prevention of complications related to prolonged immobilization and mechanical ventilation.[2]

The objective of this narrative review is to identify, synthesize, and summarize evidence-based multimodal supportive care strategies that improve clinical outcomes in patients with severe tetanus requiring intensive care. The discussion focuses on four key components of supportive management: airway and ventilatory support, sedation and spasm control, nutritional and metabolic support, and prevention of complications. This review aims to provide a scientific foundation for the development of evidence-based clinical protocols to optimize the management of severe tetanus in the ICU.

Theoretical Basis and Pathophysiology

Tetanus is an acute infectious disease caused by the neurotropic toxin tetanospasmin, produced by Clostridium tetani, a gram-positive, anaerobic, spore-forming bacillus capable of long-term survival in the environment. Infection occurs when bacterial spores enter the body through an open wound, where anaerobic conditions facilitate germination into the vegetative form. The organism subsequently produces two principal toxins, tetanospasmin and tetanolysin, of which tetanospasmin is primarily responsible for the characteristic clinical manifestations of tetanus. Following local production, the toxin disseminates via lymphatic and perineural pathways to the central nervous system, particularly the brainstem and spinal cord.[6]

From a pathophysiological perspective, tetanospasmin exerts its effects by inhibiting the release of inhibitory neurotransmitters, specifically GABA and glycine, at inhibitory interneurons within the spinal cord and brainstem. This inhibition results in the loss of inhibitory control over alpha motor neurons, leading to sustained muscle rigidity and recurrent spasms. Concurrently, continuous stimulation of the autonomic nervous system induces sympathetic hyperactivity, manifesting as blood pressure lability, tachycardia, cardiac arrhythmias, and an increased risk of sudden cardiovascular collapse.[2,3]

The severity of tetanus is influenced by several factors, including the incubation period, the speed of symptom onset, and the anatomical location of the primary

wound. Injuries located closer to the central nervous system, such as those involving the head or neck, are typically associated with a shorter incubation period and more severe clinical manifestations. Disease severity has traditionally been assessed using the Ablett classification, which grades tetanus based on the frequency and duration of muscle spasms, respiratory involvement, and autonomic stability. In addition, the Dakar scoring system has been developed to provide a more objective prognostic assessment by incorporating patient age, incubation period, time to symptom onset, spasm frequency, and the presence of autonomic dysfunction.[5]

Airway and Ventilatory Management

Respiratory failure remains one of the leading causes of mortality in patients with severe tetanus, making airway management a central priority in intensive care. Respiratory compromise in tetanus may result from multiple mechanisms, including sustained spasms of the respiratory muscles, laryngospasm, upper airway obstruction due to excessive secretions, and respiratory depression secondary to sedative or muscle relaxant therapy. Consequently, early airway control is essential to prevent hypoxemia, aspiration, and sudden respiratory collapse.[2]

Tracheostomy is generally preferred over prolonged endotracheal intubation in patients with severe tetanus, as it provides greater airway stability, reduces the risk of laryngeal spasm, facilitates secretion clearance, and enables prolonged mechanical ventilation. In addition, tracheostomy minimizes repetitive mechanical stimulation of the larynx, which can precipitate reflex spasms which could potentially be fatal in this patient population.[8] Early consideration of tracheostomy is therefore recommended in patients anticipated to require extended ventilatory support.[7]

Mechanical ventilation is indicated in cases of refractory respiratory muscle spasm despite adequate sedation, as well as in patients who develop respiratory depression related to sedative or neuromuscular blocking agents. Ventilatory modes should be individualized based on the patient's hemodynamic status and severity of muscle spasms, with particular attention to patient–ventilator synchrony to avoid excessive stimulation. Continuous monitoring of oxygenation, airway pressures, and arterial blood gas parameters is essential to assess ventilatory effectiveness and guide ongoing management.[9]

In addition to invasive airway interventions, supportive care measures include regular chest physiotherapy and aggressive secretion management to maintain airway patency. Environmental modification within the ICU—such as reduced lighting, noise control, and minimization of sensory stimulation—plays an important role in preventing stimulus-induced spasms.[10,11] A multimodal approach integrating early airway stabilization, appropriate ventilatory support, effective spasm control, and a low-stimulation environment has been associated with reduced mortality and improved outcomes in patients with severe tetanus requiring intensive care.[2]

Sedation and Spasm Control

Sedation and spasm control represent core components of supportive management in severe tetanus, as intense muscle spasms not only cause severe pain but also interfere

with ventilation and may precipitate life-threatening complications, including respiratory failure and malignant arrhythmias secondary to autonomic overstimulation. The primary objectives of sedative therapy are to suppress excessive neuromuscular activity, attenuate sympathetic stress responses, and enable safe mechanical ventilation and patient rest in the intensive care setting.[2]

Benzodiazepines, such as diazepam and midazolam, are considered first-line agents for spasm control due to their action as GABA-A receptor agonists. By enhancing inhibitory neurotransmission within the central nervous system, these agents reduce motor neuron excitability, thereby alleviating muscle rigidity and spasms while providing anxiolytic and sedative effects. Benzodiazepines are commonly administered as continuous infusions with dose titration based on clinical response, with careful monitoring for respiratory depression and hemodynamic instability.[2,12]

Adjunctive use of α_2-adrenergic agonists, including dexmedetomidine and clonidine, has been employed to mitigate sympathetic hyperactivity, reduce sedative requirements, and stabilize heart rate and blood pressure. Dexmedetomidine offers sedative and analgesic effects with minimal respiratory depression, making it a potentially valuable option in patients with severe autonomic dysfunction. However, current evidence supporting its routine use in tetanus remains limited, and close hemodynamic monitoring is essential during therapy.[11,12]

Magnesium sulfate plays an important adjunctive role in the management of severe tetanus by exerting muscle relaxant properties, reducing acetylcholine release at the neuromuscular junction, and inhibiting catecholamine release from sympathetic nerve terminals and the adrenal medulla. Magnesium therapy may enhance spasm control and contribute to autonomic stabilization, particularly in patients with refractory symptoms. Opioids, such as morphine, may also be administered to alleviate pain and blunt sympathetic responses associated with recurrent muscle spasms.[2,12]

In patients with severe tetanus who develop refractory spasms causing ventilatory compromise despite maximal sedative therapy, the use of neuromuscular blocking agents (NMBAs) becomes a definitive intervention. Agents such as vecuronium, rocuronium, atracurium, and pancuronium have been utilized for this purpose. Pancuronium possesses sympathomimetic properties that may exacerbate tachycardia and should be used with caution in patients with autonomic instability. In contrast, vecuronium and rocuronium are often preferred due to their more stable hemodynamic profiles.[1,2,13]

A multimodal strategy combining benzodiazepines, magnesium sulfate, and selected adjuvant agents such as dexmedetomidine or clonidine has been shown to provide more effective spasm control, reduce spasm frequency, and improve cardiovascular stability. This approach requires close ICU monitoring to prevent adverse effects related to drug synergy, including respiratory depression, hypotension, and bradycardia.[14]

Nutritional and Metabolic Support

Nutritional and metabolic support is a critical component of supportive management in patients with severe tetanus requiring intensive care. The disease is associated with a hypermetabolic state and

accelerated protein catabolism resulting from persistent muscle spasms, fever, and severe physiological stress. These factors markedly increase energy and protein requirements, while dysphagia, aspiration risk, and the need for deep sedation further compromise nutritional intake. Adequate and timely nutritional support is therefore essential to preserve lean body mass, promote tissue repair, and improve overall clinical outcomes.[2]

Early enteral nutrition is recommended once hemodynamic stability has been achieved, preferably via a nasogastric or nasoduodenal tube, as the enteral route helps maintain gut mucosal integrity and reduces the risk of nosocomial infections. In patients with severe spasms or a high risk of aspiration, partial or total parenteral nutrition may be considered temporarily until a safe transition to enteral feeding is feasible. Energy requirements typically range from 30 to 35 kcal/kg/day, while protein needs may reach 1.5–2.0 g/kg/day, depending on the severity of muscle spasms and the degree of catabolic stress. Balanced provision of carbohydrates and lipids is necessary to optimize metabolic efficiency and prevent complications such as hyperglycemia.[15]

Close metabolic monitoring is required to prevent and promptly address common disturbances, including electrolyte imbalances such as hypokalemia, hypomagnesemia, and hypophosphatemia, which may be exacerbated by increased metabolic demands and the use of magnesium sulfate therapy. Regular assessment of blood glucose levels, electrolyte profiles, and fluid balance is essential to guide nutritional adjustments and minimize metabolic complications. In addition to macronutrients, micronutrient supplementation—including B-complex vitamins, vitamin C, and zinc—plays an important role in supporting energy metabolism, tissue regeneration, and immune function Careful attention to hydration status and fluid balance is also necessary, particularly in patients experiencing profuse diaphoresis or increased insensible fluid losses due to sustained muscle spasms.[2,15]

Prevention of Complications and Early Rehabilitation

Prevention of complications is an essential component of supportive management in patients with severe tetanus requiring intensive care, given the prolonged disease course, extended immobilization, and frequent need for deep sedation and long-term mechanical ventilation. These factors substantially increase the risk of secondary morbidity, with commonly reported complications including ventilator-associated pneumonia (VAP), venous thromboembolism, stress-related gastrointestinal bleeding, and pressure injuries. Systematic and proactive preventive strategies are therefore critical to reducing mortality and facilitating recovery.[6]

Ventilator-associated pneumonia represents one of the most frequent complications associated with prolonged mechanical ventilation and excessive airway secretions in patients with tetanus. Preventive measures should adhere to established ventilator care bundles, including elevation of the head of the bed to 30–45 degrees, regular oral hygiene with antiseptic agents, scheduled airway suctioning, and routine reassessment of ventilatory requirements. Early tracheostomy, when indicated, may further reduce pulmonary infection risk compared with prolonged endotracheal intubation by

improving secretion clearance and minimizing airway irritation.[16]

The risk of venous thromboembolism is increased as a result of prolonged immobilization and heightened sympathetic activity. Pharmacological prophylaxis with low-dose unfractionated heparin or low–molecular weight heparin is recommended, complemented by nonpharmacological measures such as passive limb mobilization and the use of elastic compression stockings to promote venous return. Stress-related gastrointestinal ulcers may occur due to severe systemic stress and increased gastric acid secretion; therefore, prophylactic administration of proton pump inhibitors or histamine H_2-receptor antagonists is warranted to reduce the risk of upper gastrointestinal bleeding.[17]

Pressure injuries and musculoskeletal complications, including joint stiffness and muscle contractures, can be mitigated through regular repositioning, use of pressure-relieving mattresses, and early initiation of passive physiotherapy. These interventions help preserve skin integrity, improve peripheral circulation, and prevent long-term functional impairment. Adequate skin care, hydration, and nutritional support further contribute to wound healing and reduce susceptibility to infection, particularly in patients with prolonged critical illness.[18]

Following prolonged ICU stays, patients with severe tetanus are at risk of developing ICU-acquired weakness as a consequence of extended immobilization and prolonged exposure to neuromuscular blocking agents. Early rehabilitation strategies are therefore crucial and should be initiated during ICU care, beginning with passive mobilization and progressing gradually to active exercises as clinical stability permits. Early physiotherapy has been shown to improve functional outcomes, shorten recovery time, and enhance the ability to resume independent activities after critical illness.[9–11] Overall, effective prevention of complications in severe tetanus requires an integrated, multidisciplinary approach involving medical management, nursing care, and rehabilitation to ensure long-term stability and optimal functional recovery in the intensive care setting.[19]

Evidence and Recent Research Trends in Supportive Management of Tetanus in the ICU

Recent literature increasingly emphasizes the importance of multimodal supportive strategies in the management of severe tetanus in the intensive care unit (Table 1). Contemporary narrative syntheses have highlighted that the implementation of modern ICU-based care—including early mechanical ventilation, effective spasm control, and integrated supportive management—has been associated with a substantial reduction in mortality, from approximately 50% in settings without intensive care facilities to 10–20% in hospitals equipped with advanced airway management and invasive hemodynamic monitoring. These findings underscore the critical role of early tracheostomy, continuous monitoring, and coordinated ICU care in improving survival outcomes. However, as these conclusions are largely derived from narrative syntheses, the absence of pooled quantitative analyses limits the strength of causal inference.[1]

Observational studies conducted in resource-limited settings have demonstrated that autonomic dysfunction is a frequent complication in patients with severe tetanus and is strongly associated

with prolonged ICU stay and extended duration of mechanical ventilation. Mean ICU lengths of stay exceeding two weeks and ventilator dependence averaging more than 16 days have been reported in patients with significant autonomic instability, with worse overall prognostic outcomes observed in this subgroup.[9] These findings highlight autonomic dysfunction as a key determinant of disease severity and resource utilization in the ICU.[20]

More recent retrospective data from high-income settings indicate a shifting demographic pattern, with an increasing proportion of tetanus cases occurring in elderly populations. Although mortality rates in these cohorts are relatively low when comprehensive ICU care is available, survivors frequently experience significant declines in physical function and prolonged hospitalization, with reported mean lengths of stay exceeding two months.[5] These observations suggest that improved survival does not necessarily translate into favorable functional outcomes, particularly among older patients.[19,20]

Prospective observational evidence has further demonstrated that structured, protocol-based multimodal supportive management—encompassing airway control, sedation, and nutritional support—can shorten ICU length of stay, reduce the incidence of refractory spasms, and improve survival in patients with severe tetanus. The principal strength of this approach lies in its real-world applicability and comprehensive integration of ICU interventions. Nevertheless, the absence of control groups and multivariate analyses in such studies limits definitive conclusions regarding causality and introduces potential selection bias.[2]

Additional exploratory evidence has examined the role of advanced monitoring and adjunctive therapies. Case-based reports have suggested that the use of α_2-adrenergic agonists may contribute to rapid stabilization of heart rate and blood pressure in patients with severe autonomic dysfunction, without significant respiratory depression. While these findings provide a plausible physiological rationale for their use as sedative adjuncts, the lack of comparative data precludes generalization.[20] Similarly, prospective studies evaluating heart rate variability as a marker of autonomic function have identified abnormal variability patterns as potential predictors of poor prognosis. Although innovative, these studies are limited by small sample sizes and the absence of interventional evaluation, and therefore should be interpreted as hypothesis-generating rather than definitive.[21]

Practice-based clinical guidelines derived from modern ICU experience consistently emphasize the importance of early spasm control, adequate ventilatory support, structured nutritional management, and systematic prevention of complications such as pneumonia and autonomic instability. These guidelines advocate a multidisciplinary and coordinated ICU approach to severe tetanus management. However, many recommendations remain based on expert consensus rather than high-quality controlled trials, underscoring the need for further empirical validation.[13]

Collectively, current evidence supports the concept that supportive management of severe tetanus in the ICU must be comprehensive and multimodal, integrating early airway and ventilatory support, effective spasm control, autonomic stabilization, and adequate nutritional

therapy. Although individual studies exhibit methodological limitations, together they contribute meaningful insights into contemporary ICU management of tetanus.[19-21] A synthesis of recommended supportive management strategies for severe tetanus in the ICU is summarized in Table 1.

Table 1. Recommended Multimodal Supportive Strategies for Severe Tetanus in the Intensive Care Unit

Intervention Domain	Recommendations
A. Airway and Ventilatory Management	• Perform early airway control to prevent hypoxemia and aspiration. • Tracheostomy is preferred over prolonged endotracheal intubation to improve airway stability and secretion management. • Initiate mechanical ventilation in cases of refractory respiratory muscle spasms or sedative-induced respiratory depression; ventilatory modes should be individualized according to hemodynamic status. • Monitor arterial blood gases and airway pressures regularly to assess ventilatory effectiveness. • Maintain a low-stimulation ICU environment (reduced noise and lighting) to minimize reflex spasms.
B. Sedation and Spasm Control	• Use benzodiazepines (e.g., diazepam, midazolam) as first-line agents to suppress muscle spasms. • Consider α_2-adrenergic agonists (dexmedetomidine or clonidine) for autonomic dysfunction control and to reduce ventilatory requirements. • Add magnesium sulfate for muscle relaxation and autonomic stabilization. • Administer opioids (e.g., morphine) for analgesia and attenuation of sympathetic stress responses. • Titrate sedative doses carefully with close monitoring for respiratory depression, hypotension, and bradycardia.
C. Nutritional and Metabolic Support	• Initiate early enteral nutrition via nasogastric or nasoduodenal tube once hemodynamic stability is achieved to preserve gut integrity. • Consider partial or total parenteral nutrition in patients with high aspiration risk or intolerance to enteral feeding. • Target energy intake of 30–35 kcal/kg/day and protein intake of 1.5–2.0 g/kg/day. • Perform regular monitoring of blood glucose, electrolytes (potassium, magnesium, phosphate), and fluid balance. • Ensure adequate micronutrient supplementation, including B-complex vitamins, vitamin C, and zinc, to support metabolism and immune function.

D. Complication Prevention	• Apply ventilator care bundles to prevent ventilator-associated pneumonia (head-of-bed elevation, oral hygiene, routine suctioning). • Provide venous thromboembolism prophylaxis using low-dose unfractionated heparin or low–molecular weight heparin, combined with passive mobilization • Administer proton pump inhibitors or H_2-receptor antagonists for stress ulcer prophylaxis. • Implement regular repositioning, use pressure-relieving mattresses, and initiate early passive physiotherapy to prevent pressure injuries and contractures. • Maintain skin hygiene, hydration, and adequate nutritional status to promote wound healing and reduce secondary infections.
E. Rehabilitation	• Initiate passive mobilization as early as possible, even during deep sedation, to prevent joint stiffness and muscle contractures. • Progress to active mobilization once sedation is reduced or discontinued and clinical stability permits. • Perform regular functional assessments to enable early detection and prevention of ICU-acquired weakness.

Limitations and Future Research Directions

The primary limitation of this narrative review lies in its descriptive nature, as the synthesis is largely based on observational studies, case series, and case reports with varying levels of evidence. Consequently, the strength of generalizability to broader clinical practice remains limited. In addition, most of the included studies originate from intensive care settings with heterogeneous resource availability, which may influence clinical outcomes through differences in sedation protocols, ventilatory strategies, and nutritional support. Variability in drug dosing, combination regimens, and duration of supportive interventions further complicates direct comparison across studies and underscores the absence of universally accepted standards for the management of severe tetanus in the ICU. These limitations highlight existing evidence gaps in defining optimal strategies for spasm control, timing of tracheostomy, and effective nutritional interventions in this patient population.

To strengthen the evidence base, future research should prioritize well-designed prospective studies with controlled methodologies to objectively evaluate the impact of multimodal supportive care on mortality, ICU length of stay, and hemodynamic stability. Multicenter studies employing standardized protocols are particularly needed to identify prognostic factors associated with treatment success and to reduce variability in clinical practice. In addition, the incorporation of physiological biomarkers, such as heart rate variability, may offer a promising approach for early detection of autonomic dysfunction and for monitoring therapeutic response in patients with severe tetanus. Collectively, these research directions may contribute to the development of more

robust, evidence-based guidelines and improve the consistency and effectiveness of supportive care strategies in the intensive care setting.

Conclusions

This narrative review highlights that multimodal supportive management in the intensive care unit is a decisive factor in improving outcomes of patients with severe tetanus. The synthesis indicates that the primary contribution of supportive care lies in coordinated airway stabilization, effective spasm control, metabolic and nutritional optimization, and systematic prevention of ICU-related complications, rather than reliance on any single therapeutic intervention. A key insight emerging from this review is that the effectiveness of tetanus management is strongly determined by the integration and timing of supportive strategies, particularly in addressing autonomic instability and prolonged critical illness.

From a practical perspective, these findings reinforce the need for structured, multidisciplinary ICU protocols that prioritize early airway control, individualized sedation strategies, and proactive complication prevention. At a theoretical level, the review underscores the importance of viewing severe tetanus as a complex neurocritical condition in which supportive care directly influences survival and functional recovery. Future research should focus on prospective, multicenter studies with standardized protocols to define optimal combinations of supportive interventions, establish objective prognostic markers, and inform evidence-based policy and guideline development for the management of severe tetanus in the intensive care setting.

Acknowledgement

None.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

No new data were generated or analysed in this study.

Author's Contributions

Conceptualization: CDS, MJ. Methodology: CDS. Literature search: CDS, MJ. Data collection, analysis, and interpretation: CDS, MJ. Writing – original draft: CDS, MJ. Writing – critical review & editing: IPFN, MJ. Supervision: CDS, IPFN. All authors have read and approved the final version of the manuscript

References

1. Yen LM, Thwaites CL. Tetanus. Lancet. 2019;393(10181):1657–1668. doi:10.1016/S0140-6736(18)33131-3
2. Karnad DR, Gupta V. Intensive care management of severe tetanus. Indian J Crit Care Med. 2021;25(suppl 2):S155. doi:10.5005/JP-JOURNALS-10071-23829
3. Karna P, Thakur AK. Tetanus: a lethal and neglected infectious disease. Ann Med Surg. 2025;87(7):4567–4569. doi:10.1097/MS9.0000000000003407
4. Sudarshan R, Sayo AR, Renner DR, et al. Tetanus: recognition and management. Lancet Infect Dis. 2025;25(11):e645–e657. doi:10.1016/S1473-3099(25)00292-0
5. Yamamoto T, Sada RM, Yamamoto S, Osawa R, Hosokawa N, Kutsuna S. Functional prognosis of older adults with tetanus in Japan: a single-center retrospective study. BMC Infect Dis. 2025;25(1):1433. doi:10.1186/s12879-025-11877-4
6. Almas T, Niaz MA, Zaidi SMJ, et al. The spectrum of clinical characteristics and complications of tetanus: a retrospective cross-sectional study from a developing nation. Cureus. 2021;13(6):e15484. doi:10.7759/cureus.15484
7. Utami IN, Arifin, Susilo RSB, Redhono D, Sumandjar T. Respiratory failure in tetanic patient: maintenance of airway problem in

intensive care unit setting. IOP Conf Ser Earth Environ Sci. 2018;125(1):012153. doi:10.1088/1755-1315/125/1/012153
8. Goubrial D, Roman C, Ashok A, Mitra B. Tetanus management in a high-resource emergency department: a case report. Clin Case Rep. 2024;12(7):e9073. doi:10.1002/ccr3.9073
9. Davies-Foote R, Trung TN, Duoc NVT, et al. Risk factors associated with mechanical ventilation, autonomic nervous dysfunction, and physical outcome in Vietnamese adults with tetanus. Trop Med Health. 2021;49(1):50. doi:10.1186/s41182-021-00336-w
10. Fafolahan AO, Sodipo OP, Adeoye KK, et al. The role of physiotherapy in recovery from generalized tetanus: two case reports. Egypt Pediatr Assoc Gaz. 2023;71(1):23. doi:10.1186/s43054-023-00169-8
11. Seki M, Sugiyama M, Maeda T, Kasai F. Challenges in rehabilitation of a tetanus patient with severe complications. Cureus. 2024;16(12):e76494. doi:10.7759/cureus.76494
12. Boer M, de Voogd M, Niemeijer ND, van Hoeven L. Tetanus: a case report highlighting the challenges in diagnosis and treatment. Trop Dis Travel Med Vaccines. 2024;10(1):10. doi:10.1186/s40794-024-00220-5
13. Lipman J. Tetanus. In: Bersten AD, Handy JM, eds. Oh's Intensive Care Manual. 8th ed. Elsevier; 2019:692–696.
14. Laksamana Jaya H, Aditya R. Pengelolaan pasien tetanus di intensive care unit. Anesth Crit Care. 2018;36(3).
15. Burgos R, Bretón I, Cereda E, et al. ESPEN guideline on clinical nutrition in neurology. Clin Nutr. 2018;37(1):354–396. doi:10.1016/j.clnu.2017.09.003
16. Klompas M, Branson R, Cawcutt K, et al. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 update. Infect Control Hosp Epidemiol. 2022;43(6):687–713. doi:10.1017/ice.2022.88
17. Onwuzo C, Olukorode J, Sange W, et al. A review of the preventive strategies for venous thromboembolism in hospitalized patients. Cureus. 2023;15(11):e48421. doi:10.7759/cureus.48421
18. Mervis JS, Phillips TJ. Pressure ulcers: prevention and management. J Am Acad Dermatol. 2019;81(4):893–902. doi:10.1016/j.jaad.2018.12.068
19. Karnad DR. Tetanus. In: Kellerman RD, Rakel DP, eds. Conn's Current Therapy. Elsevier; 2021:660–663.
20. Seo SW, Lee J, Yoo BG, Kim J, Huh SY. Autonomic instability in severe tetanus: a case report. Ann Clin Neurophysiol. 2021;23(2):117–120. doi:10.14253/ACN.2021.23.2.117
21. Duong HTH, Tadesse GA, Nhat PTH, et al. Heart rate variability as an indicator of autonomic nervous system disturbance in tetanus. Am J Trop Med Hyg. 2019;102(2):403–407. doi:10.4269/AJTMH.19-0720
22. Suyasa IK, Ryalino C, Pradnyani NPN. Dexmedetomidine Provides Better Hemodynamic Stability Compared To Clonidine In Spine Surgery. Bali Journal of Aneshtesiology. 2018;2(3):90-94. doi:10.15562/bjoa.v2i3.100

JATI

ISSN 3090-3580

CASE SERIES

Rotational Thromboelastometry-guided Transfusion in Major Obstetric Hemorrhage: A Case Series

David*, Tjahya Aryasa EM, Marilaeta Cindryani Ra Ratumasa

Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
David, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
david.24006@student.unud.ac.id

Submitted: 03-Nov-2025
Revised: 27-Nov-2025
Accepted: 23-Dec-2026
Published: 05-Apr-2026

How to cite this article:
David D, Aryasa T, Ratumasa MCR. Rotational thromboelastometry-guided transfusion in major obstetric hemorrhage: a case series. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):44-50. doi:10.24843/7nf7vg96.

Abstract

Major obstetric hemorrhage remains a critical cause of maternal morbidity and mortality, requiring rapid yet precise transfusion management to prevent coagulopathy and adverse outcomes. We report a case series of seven obstetric patients with major perioperative hemorrhage managed using rotational thromboelastometry (ROTEM) guided transfusion at a tertiary referral center. The patients, predominantly with placenta accreta spectrum disorders, placenta previa, uterine atony, and one case of idiopathic thrombocytopenic purpura, experienced a wide range of estimated blood loss from 200 to 4500 mL. ROTEM assessment using EXTEM and FIBTEM parameters was performed during active bleeding to identify specific coagulation abnormalities and guide transfusion decisions. All patients received packed red cell transfusion, while fibrinogen replacement, fresh frozen plasma, platelet concentrates, and tranexamic acid were administered selectively based on viscoelastic findings rather than estimated blood loss alone. Four patients received tranexamic acid due to evidence of impaired clot stability, whereas others with preserved clot firmness were managed without empiric plasma or antifibrinolytic therapy despite significant hemorrhage. One patient with minimal bleeding required platelet transfusion after ROTEM detected qualitative platelet dysfunction. All patients achieved hemodynamic stabilization without major transfusion-related complications or need for reoperation. This case series highlights the clinical value of ROTEM in enabling goal-directed, individualized transfusion strategies in obstetric hemorrhage, emphasizing that viscoelastic-guided management may optimize hemostasis while limiting unnecessary blood product exposure..

Keywords: Antifibrinolytic Agents, Hemostasis, Platelet Transfusion, Thromboelastography, Tranexamic Acid

Introduction

Obstetric hemorrhage remains one of the leading causes of maternal morbidity and mortality worldwide, accounting for a substantial proportion of preventable maternal deaths.[1] Rapid blood loss during obstetric surgery or postpartum hemorrhage may lead to acute coagulopathy, hemodynamic instability, and multiorgan dysfunction if not promptly and appropriately managed. Early recognition of coagulation abnormalities and

timely, targeted transfusion therapy are therefore essential components of modern obstetric critical care.

Massive obstetric hemorrhage is commonly defined as blood loss exceeding 1500 mL, a decrease in hemoglobin greater than 4 g/dL, or the need for transfusion of four or more units of packed red cells (PRC) within a short time frame.[1] Traditionally, massive transfusion protocols (MTPs) employ fixed-ratio strategies, most commonly PRC, fresh frozen plasma (FFP), and platelet concentrates in a 1:1:1 ratio to rapidly restore circulating volume and coagulation factors.[2] Although this approach is widely adopted, it does not account for individual variations in coagulation status and may result in unnecessary transfusion of blood products, increasing the risk of transfusion-related complications such as transfusion-associated circulatory overload (TACO) and transfusion-related acute lung injury (TRALI).

Conventional coagulation tests (CCTs), including prothrombin time (PT) and activated partial thromboplastin time (aPTT), have limited utility in acute obstetric hemorrhage due to delayed turnaround times and their inability to reflect the dynamic process of clot formation and fibrinolysis.3 In contrast, viscoelastic testing using Rotational thromboelastometry (ROTEM) provides a real-time, global assessment of hemostasis, allowing clinicians to identify specific coagulation deficits and guide targeted transfusion therapy at the bedside. Key parameters such as EXTEM and FIBTEM amplitudes enable differentiation between fibrinogen deficiency, platelet dysfunction, and impaired clot kinetics, thereby facilitating individualized, goal-directed transfusion strategies.4 Increasing evidence supports the use of ROTEM-guided algorithms in obstetric hemorrhage to reduce unnecessary plasma and platelet transfusion while maintaining effective hemostasis.5 This approach is particularly relevant in obstetric patients, where early hypofibrinogenemia and qualitative platelet dysfunction may occur even before classical thresholds for massive transfusion are met.6

This case series aims to describe the clinical characteristics, ROTEM findings, transfusion strategies, and outcomes of seven obstetric patients with major perioperative hemorrhage managed using ROTEM-guided transfusion. By presenting a series of cases with varying degrees of blood loss and distinct coagulation profiles, this report highlights the practical role of ROTEM in tailoring transfusion therapy and optimizing hemostatic management in complex obstetric hemorrhage.

Case Presentation

This case series included seven obstetric patients who experienced major perioperative hemorrhage and were managed using ROTEM-guided transfusion strategies. All cases were treated at a tertiary referral hospital, and clinical data were collected retrospectively from medical records following patient consent. The indications for surgery and transfusion, estimated blood loss, ROTEM parameters, transfusion components, and clinical outcomes were analyzed descriptively.

Patient Characteristics and Surgical Context

The patients comprised six multiparous women with high-risk obstetric conditions, primarily placenta accreta spectrum disorders and placenta previa, who underwent cesarean delivery followed by

hysterectomy. One patient was diagnosed with idiopathic thrombocytopenic purpura (ITP) and underwent cesarean delivery without hysterectomy. General anesthesia with orotracheal intubation was used in four cases, while three patients received regional anesthesia via subarachnoid block. Estimated blood loss (EBL) ranged widely from 200 mL to 4500 mL, reflecting the heterogeneity of clinical severity within the series.

ROTEM Findings and Transfusion Strategy

ROTEM analysis was performed intraoperatively or immediately following the onset of significant bleeding. The primary parameters assessed were EXTEM clotting time (CT) and amplitude at 5 minutes (A5), as well as FIBTEM A5, to evaluate clot initiation, clot firmness, and fibrinogen contribution.

All patients received packed red cell (PRC) transfusion, with requirements ranging from 1 to 4 units (approximately 254–759 mL). Transfusion decisions were guided by ROTEM findings rather than estimated blood loss alone. Patients with preserved clot firmness (FIBTEM A5 ≥12 mm and EXTEM A5 ≥35 mm) were managed with PRC transfusion alone, without empiric administration of plasma or antifibrinolytic therapy, despite blood loss exceeding 1500–2000 mL in some cases.

In contrast, patients demonstrating hypofibrinogenemia on ROTEM (FIBTEM A5 <12 mm) received fibrinogen replacement in the form of cryoprecipitate. Two patients with severe reductions in clot amplitude (FIBTEM A5 ≤9 mm) received 5 units of cryoprecipitate in addition to PRC transfusion. Fresh frozen plasma (FFP) was administered selectively in cases with prolonged EXTEM CT or ongoing bleeding despite initial correction.

Use of Antifibrinolytic Therapy

Tranexamic acid (TXA) was administered to four of the seven patients based on ROTEM evidence of impaired clot stability and clinical assessment of bleeding severity. TXA use was not routine and was avoided in patients with preserved viscoelastic parameters, even when estimated blood loss exceeded traditional thresholds for massive transfusion. This selective approach underscored the role of ROTEM in preventing unnecessary antifibrinolytic exposure.

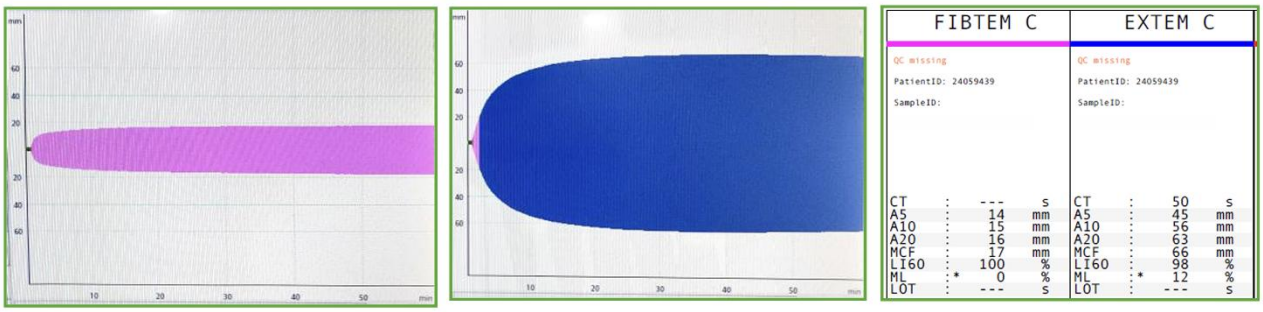


Figure 1. Normal ROTEM

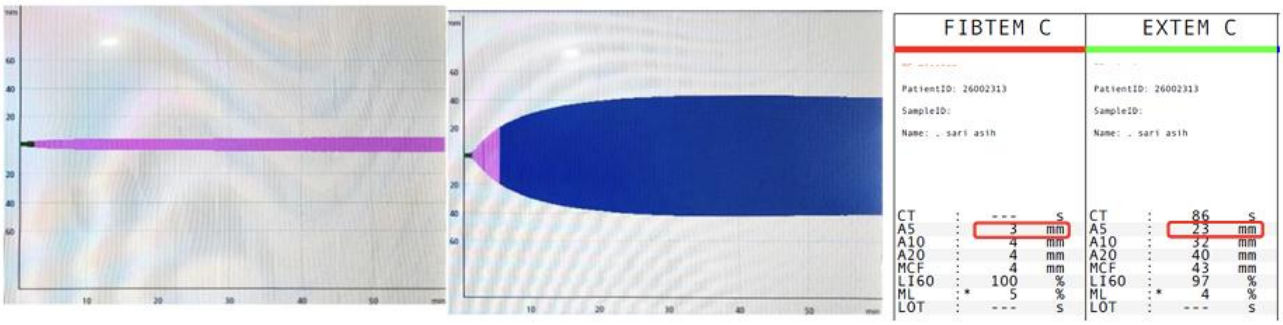


Figure 2. Postoperative FIBTEM C rotational thromboelastometry showing reduced clot amplitude, indicating impaired fibrin-based clot formation

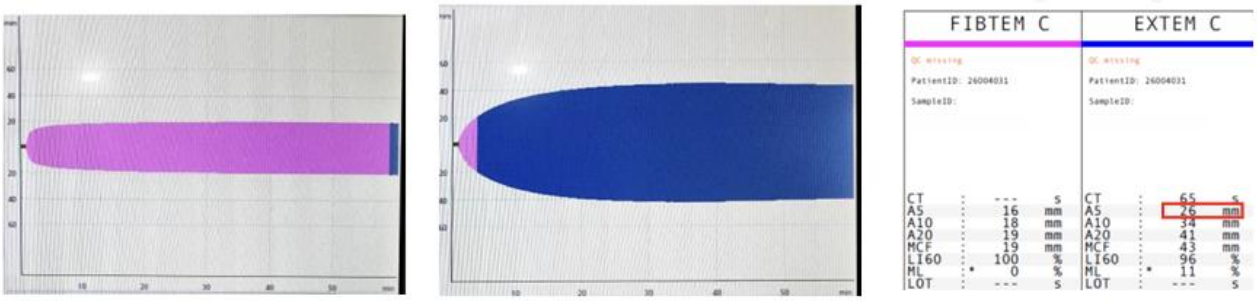


Figure 3. Postoperative EXTEM C rotational thromboelastometry demonstrating abnormal clotting kinetics with altered clot amplitude.

Representative Clinical Scenario

One patient with placenta accreta experienced massive hemorrhage with an estimated blood loss of 4500 mL. ROTEM demonstrated marked hypofibrinogenemia (FIBTEM A5 9 mm) and reduced clot firmness (EXTEM A5 41 mm). Management included transfusion of 3 units of PRC, 5 units of FFP, 5 units of cryoprecipitate, and TXA, resulting in hemodynamic stabilization and cessation of bleeding.

Conversely, another patient with an estimated blood loss of 2000 mL showed preserved coagulation profiles (FIBTEM A5 14 mm; EXTEM A5 45 mm) and was successfully managed with PRC transfusion alone, without plasma, cryoprecipitate, or TXA.

The patient with idiopathic thrombocytopenic purpura exhibited minimal blood loss (200 mL); however, OTEM revealed reduced clot amplitude suggestive of qualitative platelet dysfunction. Based on these findings, platelet concentrate transfusion was administered despite the low volume of bleeding, highlighting the sensitivity of ROTEM in detecting clinically relevant coagulopathy not apparent from blood loss estimation alone.

Outcome

All patients achieved hemodynamic stability following ROTEM-guided transfusion. No major transfusion-related complications, including transfusion-associated circulatory overload or transfusion reactions, were observed. None of the patients required reoperation for bleeding, and all survived to hospital discharge

.

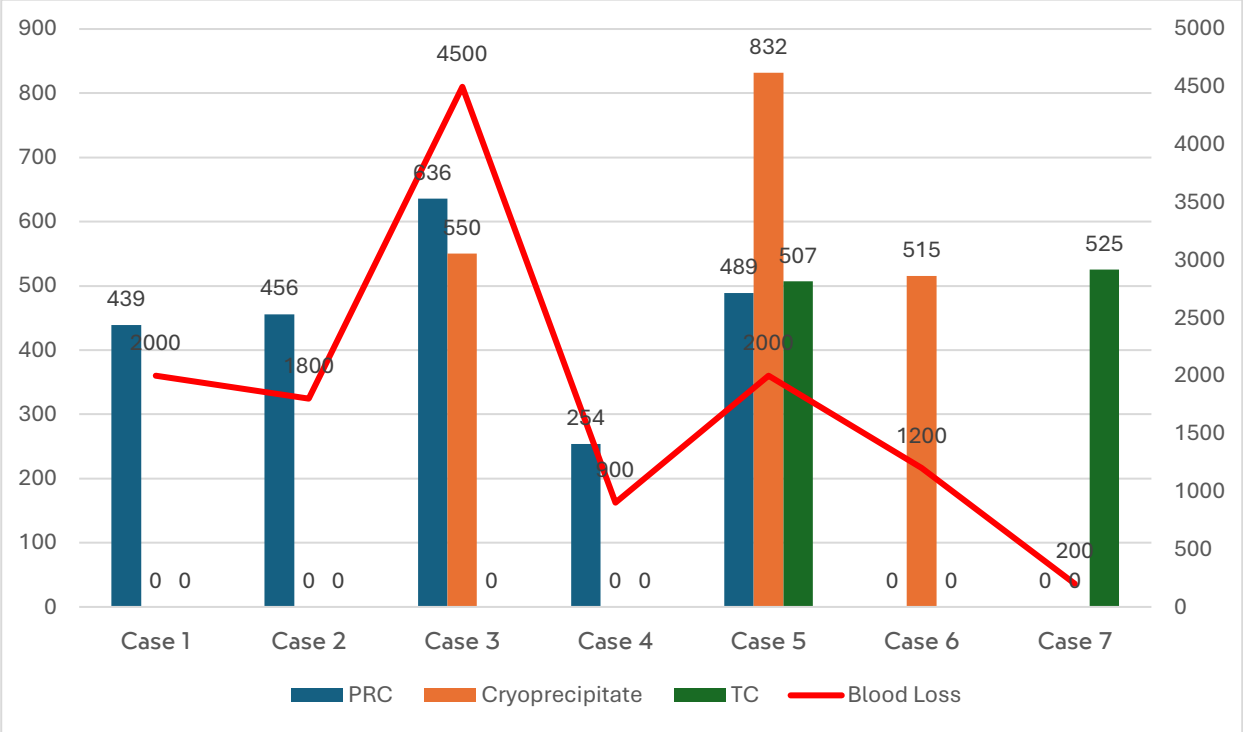


Figure 4. Total Blood Loss and Transfusion Given

Discussion

This case series demonstrates the practical value of rotational thromboelastometry (ROTEM) in guiding transfusion management during major obstetric hemorrhage. Across seven heterogeneous cases with estimated blood loss ranging from 200 to 4500 mL, ROTEM enabled individualized correction of coagulation abnormalities, rather than reliance on fixed-ratio massive transfusion protocols. The findings highlight how viscoelastic testing can refine transfusion decisions even when classical thresholds for massive transfusion are approached or exceeded.

Obstetric hemorrhage is frequently complicated by early hypofibrinogenemia, which has been identified as an independent predictor of severe postpartum hemorrhage and adverse maternal outcomes.[1] In this series, reduced FIBTEM A5 values (<12 mm) consistently guided fibrinogen supplementation using cryoprecipitate. This targeted approach aligns with current evidence suggesting that early fibrinogen replacement improves hemostasis and may reduce overall transfusion requirements.[4] Importantly, not all patients with large-volume blood loss exhibited fibrinogen deficiency, underscoring the limitation of estimated blood loss as a sole trigger for empiric plasma or cryoprecipitate administration.

Traditional massive transfusion protocols are designed to rapidly correct coagulopathy using fixed ratios of PRC, plasma, and platelets. While effective in trauma settings, such protocols may result in over-transfusion in obstetric patients, particularly when coagulation deficits are selective rather than global.[2,5] In the present case series, ROTEM-guided management limited the use of fresh frozen plasma and platelet concentrates to cases with demonstrable abnormalities in EXTEM clotting time or clot amplitude. This selective strategy may reduce the risk of transfusion-related complications such as TACO and TRALI, which are of particular concern in peripartum patients.[6]

The role of antifibrinolytic therapy in obstetric hemorrhage has been well established, particularly following the results of large trials supporting early TXA administration. However, indiscriminate use of TXA may expose patients to unnecessary thrombotic risk. In this series, TXA was administered to four patients based on ROTEM evidence of impaired clot stability and clinical bleeding severity. Patients with preserved viscoelastic parameters did not receive TXA, even in the presence of significant blood loss. This approach supports the concept that viscoelastic testing may help refine antifibrinolytic therapy, complementing clinical judgment rather than replacing it.[4]

An important observation from this case series is the ability of ROTEM to identify clinically relevant coagulopathy independent of bleeding volume. The patient with idiopathic thrombocytopenic purpura experienced minimal blood loss but demonstrated reduced clot amplitude on EXTEM, prompting platelet transfusion. This finding illustrates the advantage of viscoelastic assays in detecting qualitative platelet dysfunction that may not be apparent from standard laboratory values or clinical estimation alone.[3]

Several studies have reported favorable outcomes associated with viscoelastic-guided transfusion in obstetric hemorrhage. One study demonstrated reduced plasma transfusion and improved hemostatic control using a ROTEM-guided algorithm in postpartum hemorrhage, while a recent meta-analysis found that viscoelastic-guided strategies were associated with lower transfusion requirements and reduced rates of emergency hysterectomy.[4,7] Although the present case series is descriptive and not designed to establish causality, the observed hemodynamic stabilization and absence of major transfusion-related complications are consistent with these reports.

This study has several limitations. The small sample size and retrospective design limit generalizability and preclude statistical comparison with conventional transfusion strategies. The heterogeneity of underlying obstetric conditions and surgical interventions may also influence transfusion requirements and outcomes. Additionally, the availability of ROTEM and institutional expertise may limit the applicability of this approach in resource-limited settings. Nevertheless, the strength of this case series lies in its detailed clinical characterization and real-world demonstration of ROTEM-guided transfusion across a spectrum of obstetric hemorrhage severity.

In conclusion, this case series supports the role of ROTEM as a valuable adjunct in the management of major obstetric hemorrhage. By enabling real-time identification of specific coagulation deficits, ROTEM facilitates goal-directed transfusion, minimizes empiric blood product use, and may enhance patient safety. Larger prospective studies are warranted to further define standardized ROTEM-guided algorithms and to clarify their impact on maternal outcomes in obstetric hemorrhage

Acknowledgement

None.

Declaration of Patient Consent

The authors confirm that all necessary patient consent forms have been obtained. In these forms, the patient(s) provided

informed consent for the publication of their images and relevant clinical information in the journal. The patients have been informed that while their names and initials will not be published and reasonable efforts will be made to protect their identity, complete anonymity cannot be guaranteed.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author's Contributions

Conceptualization: DD, TA, and MCR. Data curation: DD. Investigation: DD, TA and MCR. Writing – original draft: DD. Writing – review & editing: TA, MCR. Supervision: IKW, MCR. All authors have read and approved the final version of the manuscript.

References

1. Collis R, French L. Massive obstetric haemorrhage. In: Fernando R, Sultan P, Phillips S, editors. Quick Hits in Obstetric Anesthesia. Cham: Springer; 2022. p. 121-9. doi:10.1007/978-3-030-72487-0_21.
2. Moore SA, Raval JS. Massive transfusion: a review. Ann Blood. 2022;7:15. doi:10.21037/aob-22-3.
3. Hutspardol S, Borja T, Kroeker J, Wang XQ, Mi J, Zamar D, et al. Comparison of conventional coagulation tests and ROTEM in identifying trauma-induced coagulopathy for massive haemorrhage protocol activation. Transfus Med. 2025;35(3):266-74. doi:10.1111/tme.13128.
4. Jokinen S, Kuitunen A, Uotila J, Yli-Hankala A. Thromboelastometry-guided treatment algorithm in postpartum haemorrhage: a randomised, controlled pilot trial. Br J Anaesth. 2023;130(2):165-74. doi:10.1016/j.bja.2022.10.031.
5. Setyawan NH, Permana SA. Massive transfusion in cesarean section patients with placenta accreta: a case series. Bali J Anaesthesiol. 2021;5:191-4.
6. Khanna P, Sinha C, Singh AK, Kumar A, Sarkar S. The role of point-of-care thromboelastography (TEG) and thromboelastometry (ROTEM) in management of primary postpartum haemorrhage: a meta-analysis and systematic review. Saudi J Anaesth. 2023;17(1):23-32. doi:10.4103/sja.sja_529_22.
7. Ronenson AM, Shifman EM, Kulikov AV, Raspopin YS, Gösrlinger K, Ioscovich AM, et al. Rotational thromboelastometry reference range during pregnancy, labor and postpartum period: a systematic review with meta-analysis. J Obstet Anaesth Crit Care. 2022;12(2):105. doi:10.4103/JOACC.JOACC_21_22

JATI

ISSN 3090-3580

CASE REPORT

Ultrasound-Guided PENG Block for Analgesia in Early Pregnancy with Femoral Head Fracture and Hip Dislocation: A Case Report

Made Agus Cahya Nugraha Koriawan*, I Gusti Agung Gede Utara Hartawan

Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar, Indonesia

Corresponding Author
Made Agus Cahya Nugraha Koriawan, MD
Department of Anesthesiology and Intensive Therapy, Udayana University, Denpasar 80113, Indonesia
nugbius2024@gmail.com

Submitted: 03-Nov-2025
Revised: 22-Nov-2025
Accepted: 31-Dec-2025
Published: 05-Apr-2026

How to cite this article:
Koriawan MACN, Hartawan IGAGU. Ultrasound-guided PENG block for analgesia in early pregnancy with femoral head fracture and hip dislocation: a case report. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):51-57. doi:10.24843/3eb6hh34.

Abstract

Femoral head fracture accompanied by hip dislocation during pregnancy is an uncommon clinical event that presents significant challenges in maternal analgesia and fetal safety. Traumatic hip dislocations account for a small proportion of joint dislocations, while their occurrence during pregnancy is rarely reported, particularly when associated with femoral head fractures. Management becomes more complex because timely reduction and defenitive orthopedic fixation must be achieved while ensuring adequate analgesia and minimizing systemic drug exposure. We describe the case of a 32-year-old woman in early pregnancy (11 weeks of gestation) who presented with a posterior dislocation of the left hip accompanied by a Pipkin type I femoral head fracture following a traffic accident. To provide effective analgesia and reduce fetal risk, a pericapsular nerve group (PENG) block was selected as part of the anesthetic strategy. This regional technique enabled optimal positioning for reduction, minimized the requirement for systemic opioids, and supported early mobilization. Maternal hemodynamics and fetal parameters remained stable throughout the perioperative period. This case highlights the potential role of the PENG block as a focused regional analgesic technique in pregnant trauma patients, particularly during early gestation, where minimizing systemic drug exposure is a critical priority.

Keywords: Case Reports; Femoral Fractures; Hip Dislocation; Nerve Block; Pregnancy

Introduction

Pain control in pregnant trauma patients represents a complex clinical dilemma, particularly in the first trimester when fetal susceptibility to teratogenic influences is highest. Systemic analgesic such as opioids and NSAIDs have been associated with adverse fetal outcomes, making regional anesthesia techniques an attractive alternative.[1,2]

Hip dislocation occurring during pregnancy is an exceptionally uncommon orthopedic condition and poses substantial challenges in selecting safe and effective analgesic strategies.[3] Although hip dislocations constitute approximately 2–5% of all joint dislocations,[4] their incidence in pregnant patients is exceedingly rare and only sporadically documented in the literature.[5] The presence of a Pipkin type I femoral head fracture combined with a posterior hip dislocation further

complicates management, as prompt reduction and adequate analgesia are essential, yet must be achieved without compromising fetal safety.

In this report, we describe the case of a 32-year-old woman in early pregnancy (11 weeks of gestation) who sustained a Pipkin type I fracture of the femoral head associated with a posterior dislocation of the left hip following a traffic-related injury. Given the need to control severe pain while avoiding systemic medications with known teratogenic potential, PENG block was selected as the primary analgesic technique. The PENG block is a relatively recent regional anesthesia approach that targets the articular sensory branches of the femoral nerve and the accessory obturator nerve.[7] When performed under ultrasound (USG) guidance, this technique delivers localized analgesia with minimal systemic drug absorption, making it particularly suitable for trauma management in early pregnancy.[3] To our knowledge, reports describing the use of ultrasound-guided PENG block for analgesia in pregnant trauma patients remain extremely limited.

Case Presentation

A 32-year-old woman, gravida 3, was transferred from a secondary hospital to a tertiary referral center, after being involved in a traffic-related accident. She had been seated as a passenger in a car and was propelled forward during the collision, causing her left knee to impact the front passenger seat. The patient experienced acute, severe pain localized to the left groin, with onset seven hours prior to admission. There was no loss of consciousness, shortness of breath, chest pain, abdominal pain, or vaginal bleeding. There was no history of head, thoracic, or abdominal trauma.

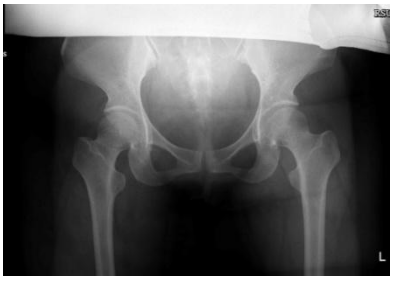
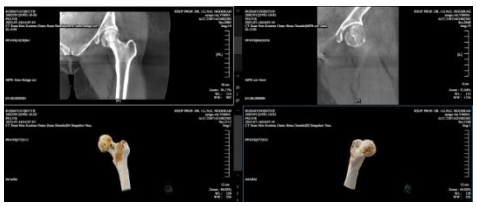
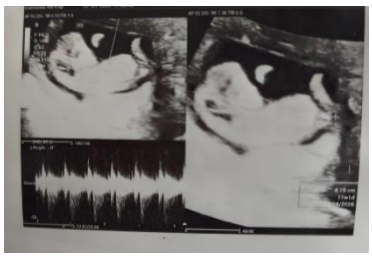
The patient was in her third pregnancy at 11–12 weeks of gestation and had been receiving routine antenatal care without prior complaints. She had no significant past medical or surgical history, no known drug or food allergies, smoking, or alcohol use. Preoperative examination showed a cooperative patient with stable vital signs and no signs of acute illness. On arrival, pain assessment using the Numerical Rating Scale (NRS) revealed severe pain (8/10). Following administration of 750 mg intravenous paracetamol, the pain partially improved to 3/10 at rest but remained significant during movement (6/10), limiting optimal positioning for reduction.

Figure 1. USG Guided PENG Block

Routine laboratory tests, including complete blod count, clinical chemistry, and coagulation profile, were within acceptable limits (Table 1). Initial pelvic radiography did not demonstrate evidence of hip dislocation or fracture. However, due to persistent and unrelieved severe left groin pain despite initial management, further imaging was pursued. Pelvic CT scan was obtained, which revealed a displaced left femoral head fracture with surrounding soft tissue swelling. CT Scan imaging was carefully considered and justified following

multidisciplinary discussion; when performed, radiation exposure from pelvic CT imaging was minimized using shielding and optimized protocols, keeping exposure well below threshold associated with fetal harm.

Table 1. Laboratory Findings and Imaging Studies

Test	Result	Normal Range / Notes
Hemoglobin (Hb)	11.7 g/dL	12–16 g/dL (female)
Leukocytes	11.560/µL	4.000–11.000/µL
Platelets	237.000/µL	150.000–450.000/µL
SGOT (AST)	68 U/L	< 40 U/L
SGPT (ALT)	62 U/L	< 41 U/L
Creatinine	0.53 mg/dL	0.5–1.1 mg/dL (female)
eGFR	125 mL/min/1.73m²	≥ 90 mL/min/1.73m²
APTT	28.9 seconds	25–35 seconds
PT	13.6 seconds	10–13 seconds
INR	1.03	0.9–1.2
Radiology (X-ray)	No active dislocation observed 	Pre reduction pelvic condition (10 July 2025)
Pelvic CT Scan	Displaced left femoral head fracture 	Consistent with Pipkin Type I fracture (14 July 2025)
Obstetric USG	Single viable intrauterine pregnancy with an estimated gestational age of 11–12 weeks, consistent with biometric measurements 	No fetal abnormalities detected

The patient was scheduled for ORIF (Open Reduction Internal Fixation) Screwing of the left femoral head. This case was managed by using a combined approach, with an ultrasound-guided PENG block, followed by a subarachnoid block. A

unilateral left PENG Block was performed under ultrasound guidance low-frequency curvilinear probe. Local anesthetic (20 mL of 0.25% bupivacaine combined with 5 mg of dexamethasone) was injected into the pericapsular plane between the superior pubic ramus and the psoas tendon. Afterward, that the patient was placed in the left lateral decubitus position, spinal anesthesia was performed at L4–L5 using a 27G Quincke needle, injecting 10 mg of 0.5% hyperbaric bupivacaine, followed by lateral positioning for 15 minutes The procedure lasted 2 hours and 32 minutes, during which hemodynamic parameters remained stable, with an estimated blood loss of 50 mL; detailed intraoperative hemodynamic data are presented in Figure 2.

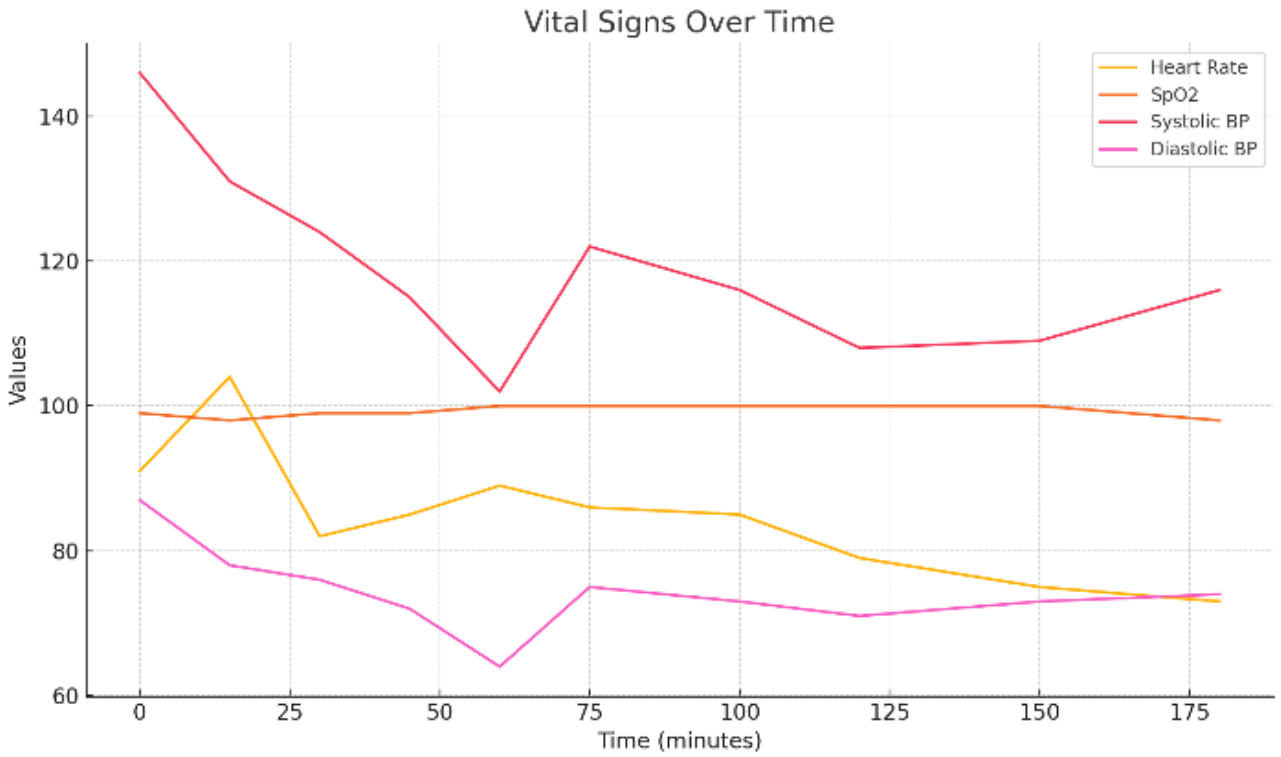


Figure 2. Intraoperative Hemodynamic

Figure 3. Postoperative NRS Score

Postoperatively, the patient remained hemodynamically stable and was transferred to the general ward for continued multidisciplinary monitoring. Analgesia was effective, with NRS scores of 1/10 at rest and 2/10 during movement, maintained with oral paracetamol 500 mg every 6 hours. Importantly, the patient was able to tolerate gentle passive and active-assisted hip flexion without significant pain, facilitating early sitting and bedside mobilization on the first postoperative day. No motor weakness of the quadriceps was observed. Maternal and fetal conditions remained stable throughout hospitalization. She was discharged 2 days after the surgery without any complications. The clinical course of the patient is summarized in Figure 4.

Discussion

The PENG block has recently gained recognition as a targeted regional anesthesia technique for managing pain in femoral head fractures and pelvic trauma. Since its introduction in 2018, clinical reports and observational studies have consistently demonstrated its ability to reduce hip-related pain while preserving motor function.[7]

Evidence on the use of PENG block in pregnant patients remains scarce. Nonetheless, within the broader context of regional anesthesia and concerns about systemic drug exposure in early pregnancy, its application appears justified.

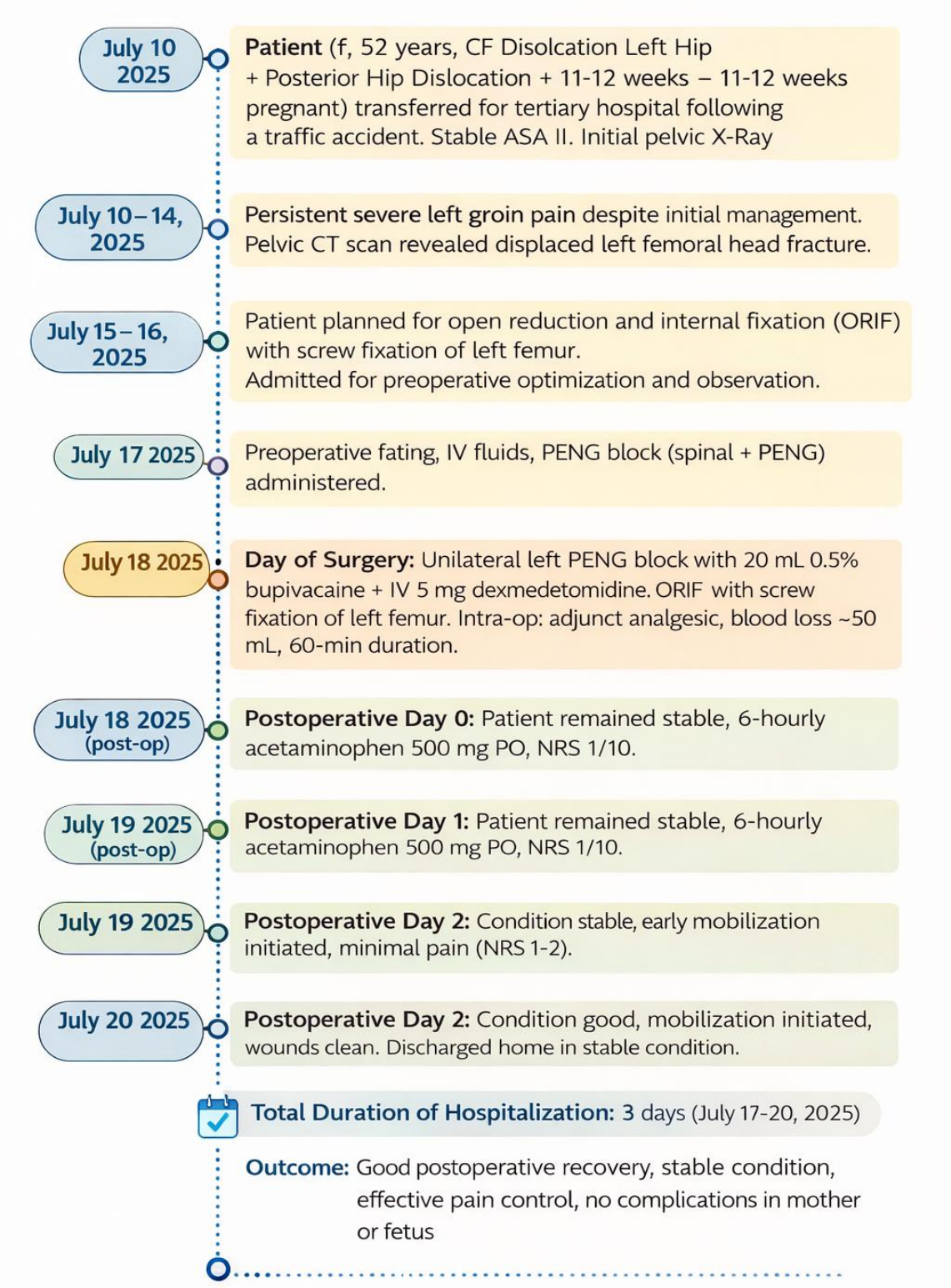


Figure 4. Case Timeline

Observational studies have linked first-trimester NSAID use to increased miscarriage risk, while data suggest opioid exposure may negatively affect fetal neurodevelopment.[1,2] These findings reinforce the importance of minimizing systemic analgesics during this critical stage. Bupivacaine is commonly used in regional anesthesia during pregnancy due to its relatively limited placental transfer when administered in appropriate doses.[8]

Studies in non-pregnant populations further support these benefits. In elderly patients with femoral neck fractures, the PENG block provided faster analgesia, longer pain-free intervals, and reduced opioid use compared with the fascia iliaca compartment block.[9] Similarly, a randomized trial in hip fracture patients showed that ultrasound-guided PENG block with ropivacaine reduced morphine consumption compared with standard care, though analgesia was limited to the early post-block period.[10] In contrast, the present case achieved prolonged pain control with bupivacaine plus dexamethasone, suggesting that adjuvant use may extend block duration—a particularly valuable effect in pregnancy, where systemic drug avoidance is paramount Mechanistically, femoral head fracture pain arises from sensory input via the femoral, obturator, and quadratus femoris nerves. The PENG block targets the interfascial plane between the psoas tendon and superior pubic ramus, and ultrasound-guided deposition of local anesthetic in this space effectively interrupts nociceptive transmission while minimizing systemic absorption. This makes the technique especially suitable for vulnerable populations such as pregnant women.[7] The advantages of this approach include effective analgesia with minimal fetal drug exposure, avoidance of general anesthesia, and facilitation of early mobilization, which reduces postoperative complications such as aspiration pneumonia and thromboembolism.[11] However, limitations include the need for advanced operator skill and ultrasound equipment, as well as the lack of high-quality evidence specifically in pregnant patients. Multidisciplinary collaboration and close fetal monitoring were essential to the favorable outcome in this case.

Supporting evidence from a randomized clinical trial further reinforces the utility of the PENG block. In geriatric patients with proximal femoral fractures, this technique was associated with superior analgesia compared with femoral nerve block during positioning for spinal anesthesia, reflected by significantly lower pain scores and improved patient comfort. Although pregnant individuals were not included, these findings highlight the practical advantage of the PENG block in facilitating regional anesthesia in orthopedic trauma settings.[12]

In conclusion, the PENG block represents a highly effective and appropriate analgesic strategy for pregnant patients with pelvic or hip trauma. Its opioid-sparing and motor-sparing properties, combined with its role in supporting early mobilization, make it particularly valuable when systemic analgesics pose significant fetal risks.

This report has several limitations. As a single case report, the findings cannot be generalized. In addition, long-term maternal and neonatal outcomes were not evaluated.

Acknowledgement

None.

Declaration of Patient Consent

The authors confirm that all necessary patient consent forms have been obtained.

In these forms, the patient(s) provided informed consent for the publication of their images and relevant clinical information in the journal. The patients have been informed that while their names and initials will not be published and reasonable efforts will be made to protect their identity, complete anonymity cannot be guaranteed.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

Deidentified patient data from this case report/series will be made available upon reasonable request to the corresponding author following publication, subject to institutional data-sharing policies and ethics approval.

Author's Contributions

Conceptualization: MAC., IGAGUH. Data curation: MAC. Investigation: MAC. Writing – original draft: MAC. Writing – review & editing: MAC. Supervision: IGAGUH. All authors have read and approved the final version of the manuscript.

References

1. Allegaert K, van den Anker JN. Perinatal and neonatal use of analgesic drugs. Arch Dis Child Fetal Neonatal Ed. 2016;101(5):F462–6, doi: 10.1016/j.siny.2017.07.006.
2. Nielsen GL, Sørensen HT, Larsen H, Pedersen L. Risk of adverse birth outcome and miscarriage in pregnant users of NSAIDs. Am J Obstet Gynecol. 2001;184(1):163–9. doi: 10.1136/bmj.322.7281.266
3. Santos AC, Pedersen H. Regional anesthesia for obstetrics. Dalam: Hadzic A, editor. Hadzic's Textbook of Regional Anesthesia and Acute Pain Management. Edisi ke-2. New York: McGraw-Hill; 2017. hlm. 773–798. ISBN 978-0071741224 / 978-0071717595.
4. Epstein HC. Traumatic dislocations of the hip. Clin Orthop Relat Res. 1973;(92):116–42. doi: 10.1097/00003086-197305000-00011
5. Tomer D, Tupe R, Bartakke G, Bhoi K. Management of Pelvic Fractures and Hip Dislocation in Pregnancy: A Case Report and Review of Literature. J Orthop Case Rep. 2022 Oct;12(10):5-9. DOI: 10.13107/jocr.2022.v12.i10.3342. PMID: 36874880; PMCID: PMC9983384.
6. PIPKIN G. Treatment of grade IV fracture-dislocation of the hip. J Bone Joint Surg Am. 1957 Oct;39-A(5):1027-42 passim. PMID: 13475403.
7. Girón-Arango L, Peng PWH, Chin KJ, Brull R, Perlas A. Pericapsular Nerve Group (PENG) Block for Hip Fracture. Reg Anesth Pain Med. 2018 Nov;43(8):859-863. doi: 10.1097/AAP.0000000000000847. PMID: 30063657.
8. Wundiawan KF, Panji PAS, Suranadi W, Widnyana MG, Dewi DAMS, Hartawan IGAGU, et al. Comparison of hemodynamic profiles and onset and offset of motor and sensory blockade between 2% hyperbaric prilocaine and 0.5% hyperbaric bupivacaine for spinal anesthesia in scheduled cesarean sections: a double-blind, randomized clinical trial. Bali J Anaesthesiol. 2025;9(1):35-41. doi:10.4103/bjoa.bjoa_17_25.
9. Andrade PP, Lombardi RA, Marques IR, Braga ACDNAE, Isaias BRS, Heiser NE. Pericapsular Nerve Group (PENG) block versus fascia iliaca compartment (FI) block for hip surgery: a systematic review and meta-analysis of randomized controlled trials. Braz J Anesthesiol. 2023 Nov-Dec;73(6):794-809. doi: 10.1016/j.bjane.2023.07.007. Epub 2023 Jul 26. PMID: 37507071; PMCID: PMC10625158.
10. Calati P, Lenoir C, Kamel LC, Contie N, Firoloni JD, Sichez A, Sebai A, Chelly J, Caumon L. Effectiveness of pericapsular nerve group block for hip fracture pain management in the emergency department: results of the ED-PENG-B randomised controlled trial. BMC Emerg Med. 2025 Nov 26;25(1):245. doi: 10.1186/s12873-025-01401-x. PMID: 41299315; PMCID: PMC12659107.

11. Horlocker TT, Wedel DJ. Regional anesthesia in the patient receiving antithrombotic and antiplatelet therapy. Reg Anesth Pain Med. 2010;35(1):64–101.s doi: 10.1097/AAP.0b013e3181c15c70
12. Erten E, Kara U, Şimşek F, Eşkin MB, Bilekli AB, Öcal N, Şenkal S, Ozdemirkan İ. Comparison of pericapsular nerve group block and femoral nerve block in spinal anesthesia position analgesia for proximal femoral fractures in geriatric patients: a randomized clinical trial. Ulus Travma Acil Cerrahi Derg. 2023 Dec;29(12):1368-1375. doi: 10.14744/tjtes.2023.33389. PMID: 38073453; PMCID: PMC10767289.

JATI

ISSN 3090-3580

CASE SERIES

Wound Infiltration for Enhanced Recovery After Cesarean Surgery in Rural Hospital: A Case Series

Roy Sando*, Jimmy Wongkar

Department of Anesthesiology and Intensive Therapy, Santo Damian Hospital, Lewoleba, Indonesia

Corresponding Author
Roy Sando, MD
Department of Anesthesiology and Intensive Therapy, Santo Damian Hospital , Lewoleba 86611, Indonesia
roysandoo@gmail.com

Submitted: 03-Nov-2025
Revised: 21-Dec-2025
Accepted: 29-Jan-2026
Published: 05-Apr-2026

How to cite this article:
Sando R, Wongkar J. Wound infiltration for enhanced recovery after cesarean surgery in rural hospital: a case series. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):58-63. doi:10.24843/t9an4z51

Abstract

Cesarean section is a major surgical procedure frequently associated with significant postoperative pain, which may delay mobilization and prolong hospital stay, particularly in rural hospitals with limited healthcare resources. Wound infiltration with local anesthetic represents a simple and practical analgesic component within the multimodal pain management strategy of the Enhanced Recovery After Cesarean Surgery (ERACS) pathway. This case series describes ten parturients scheduled for elective cesarean section with American Society of Anesthesiologists (ASA) physical status II and body mass index (BMI) < 30 kg/m2. All patients received regional anesthesia using subarachnoid block without intrathecal adjuvants. Local wound infiltration was performed before skin closure using 0.2% isobaric bupivacaine with adrenaline (1:200,000) along the incision margins. Postoperative outcomes included pain intensity was assessed by the Visual Analog Scale (VAS) at 2, 4, and 6 hours, as well as postoperative nausea and vomiting, early ambulation, early initiation of breastfeeding and length of hospital stay. Across all cases, low early postoperative pain scores were observed, with VAS score ≤ 2 during the first 4 hours and decreasing to 1 at 6 hours postoperatively. Eight patients achieved early ambulation and successfully initiated breastfeeding within 24 hours. Two patients experienced postoperative nausea and vomiting, which delayed mobilization and prolonged hospital stay beyond 24 hours. No wound complications or signs of local anesthetic systemic toxicity were observed. In this rural hospital setting, wound infiltration with bupivacaine and adrenaline was associated with favorable early postoperative outcomes and appears to be feasible, low-resource adjunct within ERACS protocols to support early recovery after cesarean delivery.

Keywords: Anesthesia, Local; Cesarean Section; Pain, Postoperative; Rural Health Service; Wound Infiltration.

Introduction

Cesarean section is one of the most frequently performed obstetric surgical procedures worldwide, with global rate increasing from approximately 7% in 1990 to 21% in 2021.1 Women undergoing cesarean delivery frequently experience moderate to severe postoperative pain during the first 48 hours,[2] which may impede early mobilization, delay mother-infant bonding, and prolong hospital stay. These challenges are particularly pronounced in rural healthcare settings, where limited resources may restrict comprehensive perioperative care and access to advanced analgesic techniques.[1] Postoperative pain management after cesarean section

commonly relies on multimodal analgesia combining non-opioid and opioid medications. However, opioid-based regimens may be insufficient to achieve optimal pain control and are associated with adverse effects such as postoperative nausea and vomiting, delayed recovery, and impaired maternal function.[3]

Local anesthetic wound infiltration has been reported to reduce postoperative pain intensity and opioid requirements, offering a simple and affordable adjunct to multimodal analgesia, particularly in resource-limited settings.[2,4]

ERACS is a standardized perioperative care pathway encompassing preoperative, intraoperative, and postoperative elements aimed at optimizing maternal recovery and improving patient-centered outcomes.[5] Although international guidelines support the use of wound infiltration as part of multimodal analgesia, evidence describing its practical implementation within ERACS frameworks in rural and resource-limited hospitals remains limited. This case series describes early postoperative outcomes associated with wound infiltration using local anesthetic as part of an ERACS-oriented approach in a rural hospital setting.

Case Presentation

This case series includes ten consecutive elective cesarean deliveries that met the inclusion criteria during the observation period at this rural hospital. The ten parturients were women in their early 20s to late 30s, all with a body mass index (BMI) below 30 kg/m2 and classified as American Society of Anesthesiologists (ASA) physical status II. Obstetric indication included previous cesarean section (PCS), transverse fetal lie and fetal macrosomia. Preoperative assessment showed stable maternal conditions without clinically relevant abnormalities.

All patients received subarachnoid block without intrathecal adjuvants. Following fetal delivery and before skin closure, local wound infiltration was performed as part of multimodal analgesia. The anesthetic solution was prepared by diluting adrenaline in normal saline and combining it with isobaric bupivacaine to obtain 20 mL 0.2% bupivacaine with adrenaline (1:200,000). The infiltration was administered in a standardized manner along the subfascial and subcutaneous layers on both margins of the Pfannenstiel incision. Postoperative analgesia consisted of scheduled paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs), with opioids reserved for rescue therapy.

Pain intensities were assessed using the Visual Analog Scale (VAS) at 2, 4, and 6 hours postoperatively. Additional observed outcomes included postoperative nausea and vomiting (PONV), early ambulation, early initiation of breastfeeding (EIBF), and length of hospital stay. Individual patient characteristics and postoperative outcomes are summarized in Table 1.

Across all ten cases, low early pain scores were observed, with VAS values ≤ 2 during the first four postoperative hours and decreasing to 1 by six hours postssssssssssoperatively. None of the patients required opioid rescue within the first six postoperative hours. Eight patients achieved progressive early ambulation and initiated breastfeeding within 24 hours. Two patients experienced PONV, which was associated with delayed mobilization and prolonged hospital stay beyond 24 hours.

Table 1. Clinical characteristics and postoperative outcomes of parturients of undergoing wound infiltration analgesia.

Case	Age	Parity	BMI (kg/m²)	ASA	Indication / History	VAS 2h/4h/ 6h	PONV	Ambulation Level 2h /4h /6h	EIBF	Hospital Stay >24h
1	Mid 30s	G2P1	28	II	PCS	1/1/0	Yes	2→2→3	No	Yes
2	Late 20s	G2P1	23	II	PCS	2/1/0	No	3→4→4	Yes	No
3	Early 20s	G1P0	24	II	Transverse lie	1/0/0	No	3→4→4	Yes	No
4	Mid 30s	G3P2	28	II	PCS	1/1/0	No	3→4→4	Yes	No
5	Early 20s	G1P0	27	II	Transverse lie	1/1/0	Yes	2→2→3	No	Yes
6	Late 30s	G2P1	23	II	PCS	1/0/0	No	3→4→4	Yes	No
7	Early 20s	G1P0	25	II	Macrosomia	1/1/0	No	3→4→4	Yes	No
8	Mid 30s	G3P2	29	II	Transverse lie	2/1/0	No	3→4→4	Yes	No
9	Late 20s	G1P0	25	II	Macrosomia	1/1/0	No	3→4→4	Yes	No
10	Mid 20s	G2P1	28	II	PCS	1/1/0	No	3→4→4	Yes	No

**Age presented in de-identified categories (early/mid/late)*

***Ambulation level: Level 1 = sitting upright, Level 2 = sitting at bed edge, Level 3 = standing next to bed, Level 4 = walking ambulation.*

Abbreviations: VAS = Visual Analog Scale; PONV= postoperative nausea and vomiting; EIBF = early initiation of breastfeeding; PCS = previous ceaseran section.

No wound complications, surgical site infections, or clinical signs of local anesthetic systemic toxicity were observed.

Discussion

Postoperative pain control is a central component of the ERACS pathway, particularly in resource-limited rural hospitals where access to advanced regional analgesic techniques may be restricted. Simple and feasible analgesic strategies are therefore essential to support early postoperative recovery. In this descriptive case series, patients had comparable preoperative characteristics, which reduced variability in analgesic response and allowed a clearer description of early postoperative outcomes associated with wound infiltration as part of multimodal analgesia.[6,7]

Local wound infiltration using bupivacaine combined with adrenaline was applied as an intraoperative ERACS-aligned analgesic strategy. Low early postoperative pain scores were observed during the first six postoperative hours, findings that are consistent with previous studies demonstrating reduced postoperative pain following wound infiltration in cesarean delivery.[2,4]

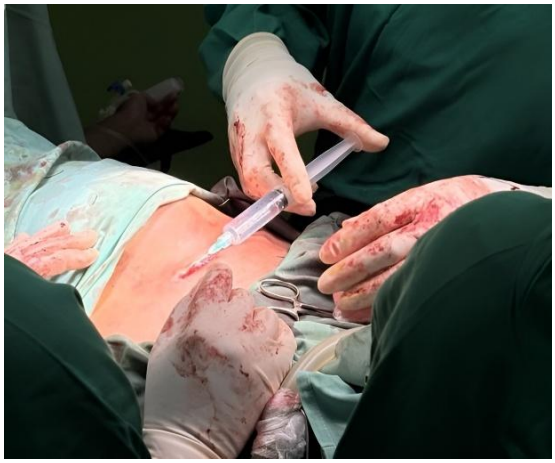


Figure 1. Wound Infiltration with Local Anesthetic

The dosing regimen used in this series was selected with particular attention to safety considerations. A total dose of 40 mg bupivacaine (0.2%, 20 mL) combined with adrenaline (1:200,000) was administered following fetal delivery and prior to skin closure. For adult parturients with an estimated body weight range of approximately 50-80 kg, this corresponds to a dose of approximately 0.5-0.8 mg/kg, which remains well below the commonly accepted maximum recommended dose of bupivacaine with adrenaline (3 mg/kg). This conservative dosing strategy was intentionally chosen to maintain a wide safety margin, which is especially relevant in rural healthcare settings with limited monitoring resources.[3]

Although the concentration of bupivacaine used in this series (0.2%) was slightly lower than that commonly described in ERACS guidance (0.25%),[6] favorable early pain scores were still observed. This may be related to the timing of administration immediately after fetal delivery and before skin closure, allowing the local anesthetic to act during peak nociceptive activation. The combined subfascial and subcutaneous infiltration technique likely facilitated adequate distribution of the anesthetic across somatic pain pathways. The addition of adrenaline further enhanced the local anesthetic effect by reducing systemic absorption through vasoconstriction.[3] Pain assessment was intentionally focused on the early postoperative period, which corresponds to the expected analgesic window of wound infiltration and the critical recovery phase emphasized in ERACS pathways.

From a physiological perspective, wound infiltration with local anesthetics primarily attenuates somatic incisional pain by blocking voltage-gated sodium channels in peripheral nerve endings. Surgical tissue injury induces the release of inflammatory mediators such as prostaglandins and bradykinin, which increase nociceptor sensitivity at the incision site. By interrupting nociceptive signal transmission during the early phases of pain processing, wound infiltration contributes to reduced pain perception during the immediate postoperative period.[3,7]

Pharmacologically, while the duration of analgesia provided by wound infiltration is generally shorter than that achieved with interfascial plane blocks such as the transversus abdominis plane (TAP) block, wound infiltration remains a simple and cost-effective option.[2] In resource-limited rural facilities where ultrasound-guided regional techniques may not be available, this approach represents a pragmatic component of multimodal analgesia.[2,4]

Previous studies demonstrate reduced opioid requirements following wound infiltration,[4] and ERACS postoperative guidelines emphasize opioid minimization as an important strategy to reduce PONV.8 In this series, two patients experienced PONV, which was likely influenced by

multifactorial contributors such as spinal anesthesia-related hypotension and individual susceptibility rather than inadequate analgesia.[3] These events were associated with delayed ambulation and prolonged hospitalization. In contrast, adequate early somatic analgesia supported early ambulation and early initiation of breastfeeding in most patients, in line with ERACS principles aimed at optimizing maternal recovery.[8]

In this descriptive case series, wound infiltration using bupivacaine combined with adrenaline was feasible and associated with low early postoperative pain scores after cesarean delivery in a rural hospital setting, supporting early ambulation and early initiation of breastfeeding as part of an ERACS-oriented multimodal approach. However, these findings are limited by the small sample size, absence of a control group, and the short observation period restricted to the first six postoperative hours, as well as the single-center design, which may limit generalizability to other patient populations and healthcare settings.

Acknowledgement

None.

Declaration of Patient Consent

The authors confirm that all necessary patient consent forms have been obtained. In these forms, the patient(s) provided informed consent for the publication of their images and relevant clinical information in the journal. The patients have been informed that while their names and initials will not be published and reasonable efforts will be made to protect their identity, complete anonymity cannot be guaranteed.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

De-identified patient data from this case report/series will be made available upon reasonable request to the corresponding author following publication, subject to institutional data-sharing policies and ethics approval.

Author's Contributions

Conceptualization: RS, JW. Data curation: R.S.
Investigation: RS. Writing – original draft: RS. Writing – review & editing: JW. Supervision: JW. All authors have read and approved the final version of the manuscript.

References

1. Angolile CM, Max BL, Mushemba J, Mashauri HL. Global increased cesarean section rates and public health implications: a call to action. Health Sci Rep. 2023;6(5). doi:10.1002/hsr2.1274.
2. Zewdu D, Tantu T, Olana M, Teshome D. Effectiveness of wound site infiltration for parturients undergoing elective cesarean section in an Ethiopian hospital: a prospective cohort study. Ann Med Surg (Lond). 2021;64. doi:10.1016/j.amsu.2021.102255.
3. Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's clinical anesthesiology. 7th ed. New York: McGraw Hill; 2022.
4. Garmi G, Parasol M, Zafran N, Rudin M, Romano S, Salim R. Efficacy of single wound infiltration with bupivacaine and adrenaline during cesarean delivery for reduction of postoperative pain. JAMA Netw Open. 2022;5(11):e2242203. doi:10.1001/jamanetworkopen.2022.42203.
5. Wilson RD, Monks DT, Sharawi N, et al. Guidelines for antenatal and preoperative care

in cesarean delivery: Enhanced Recovery After Surgery Society recommendations (part 1)-2025 update. Am J Obstet Gynecol. 2025 Apr. doi:10.1016/j.ajog.2025.01.014.

6. Caughey AB, Sultan P, Monks DT, et al. Guidelines for intraoperative care in cesarean delivery: Enhanced Recovery After Surgery Society recommendations (part 2)-2025 update. Am J Obstet Gynecol. 2025 Apr. doi:10.1016/j.ajog.2025.02.040.
7. Nived M, Raghu K. Transverse Abdominis Plane Block Versus Sodium Diclofenac-Acetaminophen Combination for Postoperative Analgesia Following Cesarean Section. Bali Journal of Anesthesiology. 2020 Apr; 4(2):39-41. doi:10.4103/BJOA.BJOA_4_20
8. Macones GA, Caughey AB, Wood SL, et al. Guidelines for postoperative care in cesarean delivery: Enhanced Recovery After Surgery (ERAS) Society recommendations (part 3). Am J Obstet Gynecol. 2019;221(3):247.e1-247.e9. doi:10.1016/j.ajog.2019.04.012.

JATI

ISSN 3090-3580

CASE REPORT

Supraclavicular Block for ORIF of Distal Humerus Fracture in End-Stage Renal Disease: A Case Report

Dessy Kusumadewi*, Taufiq Agus Siswagama

Departement of Anesthesiology and Intensive Care, University of Brawijaya, Malang, Indonesia

Corresponding Author
Dessy Kusumadewi, MD
Department of Anesthesiology and Intensive Care, University of Brawijaya, Malang 65145, Indonesia
dessyaiful@gmail.com

Submitted: 08-Nov-2026
Revised: 26-Nov-2026
Accepted: 21-Dec-2026
Published: 05-Apr-2026

How to cite this article:
Kusumadewi D, Siswagama TA. Supraclavicular block for ORIF of distal humerus fracture in end-stage renal disease: a case report. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):64-69. doi:10.24843/vk6kyr32.

Abstract

Supraclavicular block (SCB) is a well-established regional anesthesia technique for upper limb surgery; however, its application in patients with end-stage renal disease (ESRD) receiving antiplatelet therapy presents distinct clinical challenges. This case is noteworthy because of the coexistence of ESRD, ongoing clopidogrel therapy, anemia, and potential respiratory compromise, all of which complicate anesthetic decision-making. We report a 44-year-old female with ESRD on regular hemodialysis who sustained a comminuted intra-articular distal humerus fracture and underwent open reduction and internal fixation under ultrasound-guided SCB. The block was performed using 15 mL of 0.75% ropivacaine with dexamethasone as an adjuvant, following careful consideration of bleeding risk, local anesthetic dosing, and pneumothorax prevention. The procedure provided effective intraoperative anesthesia and prolonged postoperative analgesia without neurological, respiratory, or bleeding complications. Postoperative pain scores remained low, opioid consumption was minimal, and motor function recovered uneventfully. This case highlights that ultrasound-guided SCB can be safely and effectively performed in carefully selected ESRD patients receiving antiplatelet therapy when meticulous technique, dose justification, and risk mitigation strategies are applied. The key learning point is the importance of individualized anesthetic planning rather than a generalized preference for regional over general anesthesia.

Keywords: Anesthesia, Regional; Chronic Kidney Disease; Fracture Fixation, Internal; Nerve Block; Ultrasonography

Introduction

Supraclavicular block (SCB) is a widely used regional anesthesia technique for upper extremity surgery because it provides rapid onset, dense sensory and motor blockade, and effective postoperative analgesia. The introduction of ultrasound guidance has significantly improved the safety and accuracy of SCB by allowing real-time visualization of the brachial plexus, surrounding vascular structures, and pleura.[1,2] The subsequent incorporation of ultrasound technology resulted in notable improvements in both procedural safety and effectiveness. By using real-time imaging, anesthesiologists can visualize the brachial plexus and surrounding anatomy, guiding the needle with precision while avoiding critical structures. This advancement has made SCB more accurate, efficient, and much safer, particularly for patients with complex medical conditions.[2,3]

Patients with end-stage renal disease (ESRD) present unique challenges in anesthetic management. Impaired drug clearance, fluid and electrolyte imbalance, and multiple comorbidities increase the risk associated with general anesthesia, including cardiovascular instability, prolonged recovery, and respiratory complications.[4]

Regional anesthezsia techniques such as ultrasound-guided SCB offer a valuable alternative by minimizing systemic drug exposure, reducing opioid requirements, and providing effective analgesia with fewer systemic side effects.[1,3,4]

This report describes a 44-year-old woman with ESRD undergoing regular hemodialysis who sustained a comminuted distal humerus fracture. Considering her multiple comorbidities, including hypertension and type 2 diabetes mellitus, ultrasound-guided SCB was selected as the primary anesthetic technique. The block provided effective intraoperative anesthesia and prolonged postoperative analgesia without complications, supporting its role as a safe and practical option in high-risk patients.

This case highlights how ultrasound-guided SCB can be a safe, effective, and practical anesthetic choice for high-risk patients, supporting its role as a preferred technique in modern anesthesia practice.

Case Presentation

A 44-year-old female with end-stage renal disease (ESRD) on regular maintenance hemodialysis presented with left elbow pain following a fall. Imaging studies confirmed a comminuted intra-articular distal humerus fracture, and open reduction and internal fixation (ORIF) was planned. The clinical course and the radiographic findings are illustrated in **Figures 1** and **2.**

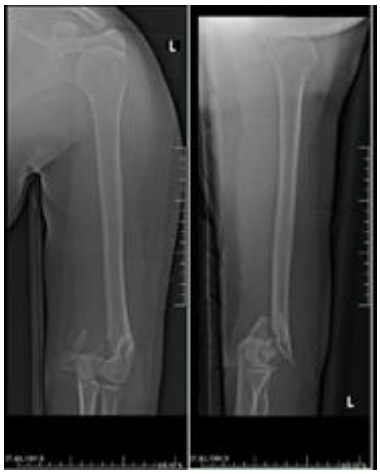


Figure 1. X-ray examination of the left humerus (anteroposterior and lateral views)

The patient had been undergoing scheduled hemodialysis three times per week for several years. She was on long-term antiplatelet therapy with clopidogrel for cardiovascular risk reduction.

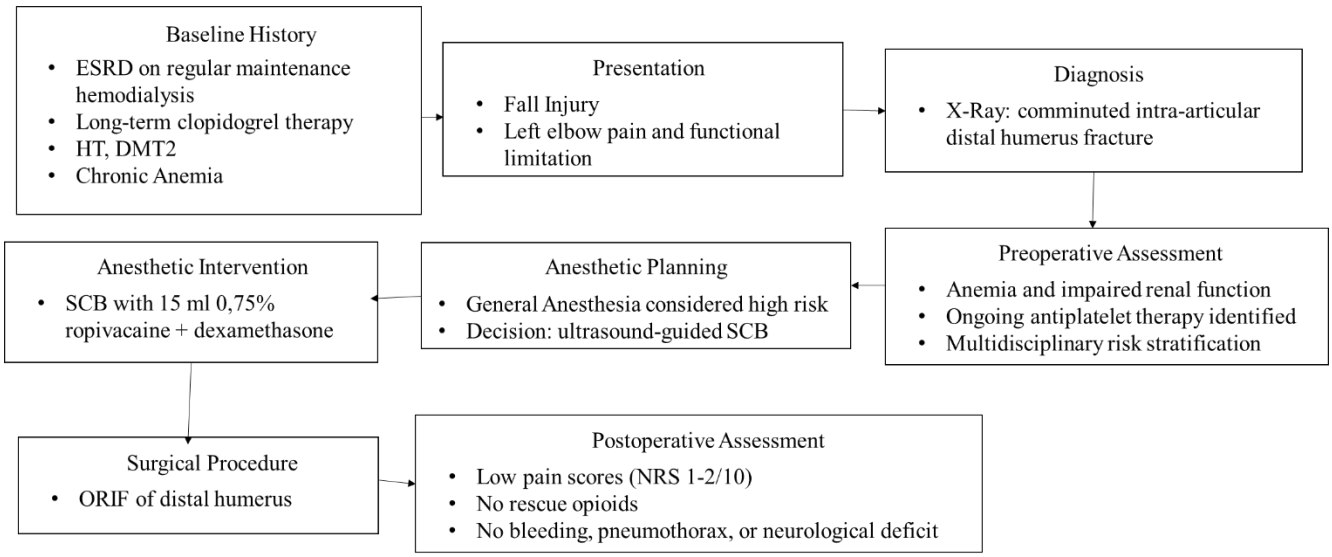
Table 1. Preoperative Laboratory Values

Parameter	Value	Reference Range
Hemoglobin	9.5 g/dL	11.4-15.1
MCV	81.7 fL	80-93
MCH	28.4 pg	27-31
Platelet Count	389 x 10^3/mL	142-424
Random Blood Glucose	157 mg/dL	<180

Pain related to the fracture had been managed conservatively with oral non-opioid analgesics prior to admission, with inadequate relief. No prior surgical procedures or regional anesthetic interventions were documented. Relevant comorbidities included poorly controlled hypertension, type 2 diabetes mellitus treated with insulin, and chronic anemia

related renal disease. Preoperative laboratory evaluation demonstrated anemia and impaired renal function without severe thrombocytopenia or clinically significant coagulation abnormalities. Preoperative laboratory values are summarized in **Table 1**.

Figure 1. Clinical Course of The Patient



Several factors complicated anesthetic planning in this patient. Ongoing clopidogrel therapy increased the risk of bleeding and hematoma formation associated with deep peripheral nerve blocks. ESRD-related anemia and altered drug pharmacokinetics raised concerns regarding systemic anesthetic exposure and delayed drug clearance. In addition, supraclavicular block carries an inherent risk of pneumothorax due to the proximity of the pleura, a concern that may be amplified in ESRD patients who are prone to fluid overload and reduced pulmonary reserve. These considerations necessitated careful risk–benefit evaluation and meticulous procedural planning.

Given the elevated perioperative risk associated with general anesthesia, an ultrasound-guided supraclavicular brachial plexus block was selected. The block was performed using 15 mL of 0.75% ropivacaine combined with dexamethasone as an adjuvant. This reduced yet clinically effective volume was chosen to provide adequate neural coverage while minimizing total local anesthetic exposure, which is particularly important in patients with ESRD because of altered pharmacokinetics and increased susceptibility to systemic toxicity. Continuous real-time ultrasound visualization allowed identification of the brachial plexus, subclavian vessels, and pleura, enabling precise needle placement and reducing the risk of vascular puncture and pneumothorax. The block was completed with a single needle insertion and without immediate complications. The supraclavicular block provided complete sensory and motor blockade of the operative limb, allowing ORIF to proceed without supplemental general anesthesia. Postoperative outcomes were assessed

using standardized measures and are summarized in **Table 2**.

Table 2. Postoperative Outcome Assessment

Outcome Parameter	Result
Pain Score in PACU (NRS)	1/10
Pain Score at 24 hours (NRS)	2/10
Duration of sensory block	Approximately 18 hours
Motor function recovery	Complete within 24 hours
Rescue opioid requirement	None

No adverse events were observed during or after the procedure. There were no signs of bleeding or hematoma at the injection site, no neurological deficits, no respiratory complications including pneumothorax, and no evidence of local anesthetic systemic toxicity. These potential complications were anticipated and actively monitored due to the patient's antiplatelet therapy, renal impairment, and the anatomical risks associated with supraclavicular block.

The patient reported high satisfaction with the anesthetic technique. She expressed relief at avoiding general anesthesia and described minimal postoperative pain, which facilitated comfort during recovery. She did not experience nausea, respiratory discomfort, or other distressing symptoms following the procedure.

Discussion

This case demonstrates the successful use of ultrasound-guided supraclavicular block as the primary anesthetic technique for distal humerus fracture surgery in a patient with ESRD receiving ongoing antiplatelet therapy. Anesthetic management was challenging due to ESRD-related physiological alterations, chronic anemia, clopidogrel use, and the anatomical risks associated with supraclavicular block.[1-3]

In patients with ESRD, anesthetic planning must consider altered pharmacokinetics, impaired drug clearance, fluid balance instability, and increased sensitivity to opioids and sedatives. In this patient, these factors raised concerns regarding general anesthesia, particularly the risks of prolonged recovery, respiratory compromise, and hemodynamic instability. The decision to use SCB was therefore based on individualized risk assessment rather than a generalized preference for regional anesthesia.[4,5]

The distal humerus fracture required a dense and reliable block extending to the elbow joint. Ultrasound-guided SCB was selected because it provides consistent anesthesia for surgeries at and below the distal humerus while allowing precise visualization of neural and non-neural structures.[1,5,6]

A total volume of 15 mL of 0.75% ropivacaine was deliberately chosen to balance efficacy and safety. Ultrasound guidance enables effective blockade with lower volumes of local anesthetic compared with landmark-based techniques. In patients with ESRD, minimizing total local anesthetic dose is particularly important due to altered drug distribution and clearance, which may increase the risk of systemic toxicity. The addition of dexamethasone as an adjuvant was intended to prolong block duration and reduce postoperative analgesic requirements, contributing to minimal opioid use in this case.[7-10]

Ongoing clopidogrel therapy represented a significant consideration because

supraclavicular block is classified as a deep peripheral nerve block with potential bleeding risk. In this case, the absence of severe coagulopathy, careful ultrasound-guided needle placement, avoidance of vascular puncture, and use of a single-insertion technique supported the decision to proceed. Continuous postoperative monitoring allowed early detection of potential complications, none of which occurred.[9,10]

Pneumothorax is a recognized complication of supraclavicular block due to the proximity of the pleura. This risk may be heightened in patients with ESRD because of reduced pulmonary reserve related to fluid overload or anemia. In this case, real-time ultrasound visualization of the pleura and continuous needle tracking were critical in minimizing this risk. No respiratory complications occurred during or after the procedure, underscoring the importance of ultrasound guidance in high-risk patients.[11-13]

The block provided effective intraoperative anesthesia and prolonged postoperative analgesia, as reflected by low postoperative pain scores, absence of rescue opioid requirements, and complete motor recovery within 24 hours. These outcomes highlight the value of systematic outcome assessment rather than descriptive reporting alone. Importantly, no neurological, respiratory, or bleeding complications were observed, despite the patient's elevated baseline risk.[12-14]

This case emphasizes that ultrasound-guided SCB can be safely performed in carefully selected ESRD patients receiving antiplatelet therapy when meticulous technique, appropriate dose selection, and vigilant monitoring are applied. The key clinical lesson is the importance of individualized anesthetic decision-making based on patient-specific risks, rather than broad assumptions regarding the superiority of regional versus general anesthesia.[14,15]

Acknowledgement

None.

Declaration of Patient Consent

The authors confirm that all necessary patient consent forms have been obtained. In these forms, the patient(s) provided informed consent for the publication of their images and relevant clinical information in the journal. The patients have been informed that while their names and initials will not be published and reasonable efforts will be made to protect their identity, complete anonymity cannot be guaranteed.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

The individual patient data collected in this Case Report/Series are not publicly available due to ethical, legal, and institutional restrictions. For further information, please contact the corresponding author.

.

Author's Contributions

Conceptualization: DK, TAS. Data curation: DK. Investigation: DK. Writing – original draft: DK. Writing – review & editing: DK., TAS. Supervision: TAS. All authors have read and approved the final version of the manuscript.

References

1. D'Souza RS, Johnson RL. Supraclavicular Block. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Oct 21]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK519056/
2. Xu G, Su P, Cai B, Liu Y, Jiang D, He Y, et al. Ultrasound-guided superficial cervical plexus block combined with clavipectoral fascial plane block or interscalene brachial plexus block in clavicle surgery: a single-centre, double-blind, randomized controlled trial. J Clin Monit Comput. 2023 Jan 10;37:985–92.
3. Pester JM, Hendrix JM, Varacallo MA. Brachial Plexus Block Techniques. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Oct 21]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK470213/
4. Ramanujam V, Kirk PV. Anatomy variation of brachial plexus trunks during supraclavicular nerve block: clinical image. Braz J Anesthesiol Engl Ed. 2022 Nov;72(6):834–5.
5. Lee B, Jang J, Lim JR, Kim EJ, Kim D, Chun YM, et al. Continuous Superior Trunk Block versus Single-Shot Superior Trunk Block with Intravenous Dexmedetomidine for Postoperative Analgesia in Arthroscopic Shoulder Surgery: A Prospective Randomized Controlled Trial. J Clin Med. 2024 Mar 22;13(7):1845.
6. Tarıkçı Kılıç E, Akdemir MS. Comparison of Supraclavicular, Infraclavicular, and Axillary Approaches for Ultrasound-Guided Brachial Plexus Block for Upper Limb Surgeries: A Retrospective Analysis of 182 Blocks. Dubai Med J. 2018 Dec 21;1(1–4):33–7.
7. Tintinalli JE, Stapczynski JS, Cline D, Ma OJ, Meckler GD, Yealy DM, editors. Tintinalli's emergency medicine: a comprehensive study guide. 8th ed. New York, N.Y: McGraw-Hill Education LLC; 2016. 1 p. (McGraw-Hill's AccessMedicine).
8. Hadzic A, New York School of Regional Anesthesia, editors. Hadzic's textbook of regional anesthesia and acute pain management. Second edition. New York: McGraw-Hill Education; 2017. 1506 p.
9. Shanthanna H. Ultrasound guided selective cervical nerve root block and superficial cervical plexus block for surgeries on the clavicle. Indian J Anaesth. 2014;58(3):327.
10. Tran DQH, Elgueta MF, Aliste J, Finlayson RJ. Diaphragm-Sparing Nerve Blocks for Shoulder Surgery: Reg Anesth Pain Med. 2017;42(1):32–8.
11. Bian WG, Zhou RH, Liu HL, Luo HG. Elevated cervical shoulder position and traditional supine position in the ultrasound-guided brachial plexus block: A randomized controlled trial. Asian J Surg. 2022 Nov;45(11):2300–1.
12. Kang R, Jeong JS, Chin KJ, Yoo JC, Lee JH, Choi SJ, et al. Superior Trunk Block Provides Noninferior Analgesia Compared with Interscalene Brachial Plexus Block in Arthroscopic Shoulder Surgery. Anesthesiology. 2019 Dec;131(6):1316–26.
13. Sivashanmugam T, Areti A, Selvum E, Diwan S, Pandian A. Selective blockade of supraclavicular nerves and upper trunk of brachial plexus "The SCUT block" towards a site-specific regional anaesthesia strategy for clavicle surgeries - A descriptive study. Indian J Anaesth. 2021 Sep;65(9):656–61.
14. Maybin J, Townsley P, Bedforth N, Allan A. Ultrasound guided supraclavicular nerve blockade: first technical description and the relevance for shoulder surgery under regional anaesthesia. Anaesthesia. 2011 Nov;66(11):1053–5.

JATI

ISSN 3090-3580

CASE REPORT

Scalp Nerve Block for External Ventricular Drain in a Geriatric Patient with Anticipated Difficult Airway: A Case Report

Komang Adi Widayana*, Andika Metrisiawan

Department of Anesthesiology and Intensive Therapy, Buleleng General Hospital, Singaraja, Indonesia

Corresponding Author
Komang Adi Widayana, MD
Department of Anesthesiology and Intensive Therapy, Buleleng General Hospital, Singaraja 81113, Indonesia ,
ady.widayana@gmail.com

Submitted: 07-Dec-2025
Revised: 30-Dec-2025
Accepted: 09-Mar-2026
Published: 05-Apr-2026

How to cite this article:
Widayana KA, Metrisiawan A. Scalp nerve block for external ventricular drain in a geriatric patient with anticipated difficult airway: a case report. Jurnal Anestesiologi dan Terapi Intensif. 2026;2(1):70-76. doi:10.24843/zfaszb91

Abstract

Emergency neurosurgical procedures in geriatric patients with an anticipated difficult airway pose major anesthetic challenges due to limited physiological reserve and the risk of hemodynamic instability during general anesthesia. We report the use of a scalp nerve block (SNB) as the primary anesthetic technique for urgent external ventricular drain (EVD) placement in a female patient in her mid-70s with intracerebral hemorrhage and obstructive hydrocephalus. She presented with decreased consciousness and a LEMON score of 6, indicating a high likelihood of difficult airway, and was classified as American Society of Anesthesiologists (ASA) physical status IIIE. Given the elevated intracranial pressure and anticipated difficulty in airway management, SNB with lidocaine and dexmedetomidine as an adjuvant was performed under standard monitoring. The procedure was completed uneventfully, with stable hemodynamics and adequate analgesia, without the need for airway manipulation or conversion to general anesthesia. This case highlights that SNB may be a feasible alternative anesthetic approach for selected high-risk geriatric patients undergoing EVD placement, particularly when airway intervention may be hazardous or when advanced airway and critical care resources are limited. Further reports and larger studies are required to determine safety and generalizability.

Keywords: Diaphragm; Intensive Care Units; Mechanical Ventilation; Ultrasonography; Ventilator Weaning

Introduction

Emergency neurosurgical procedures in geriatric patients are associated with increased anesthetic risk because of age-related physiological changes, reduced cardiopulmonary reserve, and increased sensitivity to anesthetic agents. The presence of an anticipated difficult airway further complicates anesthetic management, as airway manipulation during induction and emergence from general anesthesia may precipitate hypoxia, hemodynamic fluctuations, and secondary increases in intracranial pressure.[1,2]

External ventricular drain (EVD) placement is a critical intervention for managing elevated intracranial pressure in

conditions such as obstructive hydrocephalus, intraventricular hemorrhage, and intracerebral hemorrhage.[3] In selected high-risk patients, general anesthesia may not be the optimal approach. Scalp nerve block (SNB) provides scalp analgesia by blocking sensory input from multiple cranial nerve branches, thereby attenuating sympathetic responses to surgical stimulation.[4] Evidence from systematic reviews and meta-analyses suggests that SNB may improve hemodynamic stability during neurosurgical procedures.[3]

Although SNB has been widely studied as an adjunct to general anesthesia and in awake craniotomy, reports describing its use as the sole anesthetic technique for emergency EVD placement in geriatric patients with an anticipated difficult airway remain limited. Evidence regarding its application in resource-limited settings is also scarce. This gap highlights the need for clinical reports exploring alternative anesthetic strategies for high-risk patients. This report describes the anesthetic management and clinical outcome of a geriatric patient with an anticipated difficult airway who underwent urgent EVD placement under SNB as the primary anesthetic technique.

Case Presentation

A female patient in her mid-70s was admitted with a sudden decrease in consciousness approximately 8 hours before presentation. There was no history of trauma or fever. Her medical history was notable for long-standing uncontrolled hypertension.

On examination, the vital signs were stable: blood pressure 130/80 mmHg, heart rate 90 beats/min, respiratory rate 18 breaths/min, oxygen saturation 96% on room air, and axillary temperature 36.8°C. Neurological examination revealed a Glasgow Coma Scale score of E2V2M5, isocoric pupils, and neck stiffness. Thyroid enlargement was noted. There was no audible stridor or orthopnea before the deterioration in consciousness. Chest radiography showed no significant tracheal deviation. However, a detailed dynamic airway assessment was limited by the patient's neurological status. Cardiopulmonary and abdominal examinations were otherwise unremarkable.

Table.1 Laboratory Findings

Laboratory Examination	Result	Laboratory Examination	Result
Hemoglobin	13.8 g/dL	Urea	32.1 mg/dL
Hematocrit	42.3 %	Serum Creatine	0.45 mg/dL
Leukocyte count	11.670 /µL	Aspartate aminotransferase (AST)	22.9 U/L
Platelet count	136,000 /µL	Alanine aminotransferase (ALT)	13.9 U/L
Blood Glucose	171 mg/dL	Potassium (K)	3.97 mmol/L
Bleeding Time (BT)	3 minutes	Sodium (Na)	136.6 mmol/L
Clotting Time (CT)	12 minutes	Chloride (Cl)	100.1 mmol/L
		Ionized Calsium (Ca ion)	1.094 mmol/L

Head computed tomography demonstrated intracerebral hemorrhage with obstructive hydrocephalus. Chest radiography also revealed cardiomegaly. Laboratory investigations were largely within normal limits (Table 1).

The patient was diagnosed with decreased consciousness due to intracerebral hemorrhage with obstructive hydrocephalus and was scheduled for urgent EVD insertion. Preanesthetic airway evaluation indicated a high likelihood of difficult airway, with a LEMON score of 6, which consisted of a large tongue on external inspection, an abnormal 3-3-2 rule indicating reduced inter-incisor distance and thyromental space, Mallampati class III, and limited neck mobility. These findings suggested a high probability of difficult laryngoscopy and tracheal intubation. The patient was classified as American Society of Anesthesiologists (ASA) physical status IIIE.

Given the elevated intracranial pressure, anticipated difficult airway, and limited resources, SNB was selected as the primary anesthetic technique. The team agreed to convert immediately to general anesthesia with airway control if the block proved inadequate, the patient became uncooperative, or clinical deterioration occurred. Therefore, an airway rescue plan was established prior to the procedure, despite a noted lack of advanced airway devices. This limitation further supported the decision to avoid primary general anesthesia and intubation in this high-risk patient.

Standard ASA monitoring was applied, including continuous noninvasive blood pressure monitoring, electrocardiography, pulse oximetry, and observation of respiratory rate. Premedication included intravenous midazolam 3 mg, ketorolac 30 mg, and fentanyl 25 μg. Midazolam was titrated incrementally in 0.5-1 mg with continuous reassessment of respiratory effort and level of consciousness. Supplemental oxygen was delivered through a non-rebreathing mask (NRM). Neurological responsiveness was reassessed after sedation to ensure preservation of spontaneous ventilation and protective airway reflexes.

SNB was performed using a landmark-based technique because of the limited availability of ultrasound guidance. Anatomical landmarks were identified before injection. The supraorbital, supratrochlear, and zygomaticotemporal nerves were selectively blocked to provide analgesia to the frontal scalp corresponding to the site of EVD insertion. Because the surgical field was confined to the anterior frontal region, posterior scalp nerves were not included. The procedure included supine positioning, sterile preparation of the injection sites, identification of anatomical landmarks, incremental aspiration before injection, slow infiltration of the anesthetic solution, and assessment of analgesic adequacy before incision. A 25-gauge needle was used for infiltration. A total of 10 mL of 2% lidocaine (200 mg) combined with dexmedetomidine 20 μg (0.2 mL) was administered incrementally, with careful aspiration before each injection. The total lidocaine dose was 2.5 mg/kg, which remained below the recommended maximum dose of 4.5 mg/kg without epinephrine. To improve reproducibility, the anesthetic solution was distributed according to anatomical landmarks: approximately 4 mL around the supraorbital nerve at the supraorbital notch

along the superior orbital rim, 3 mL around the supratrochlear nerve at the medial aspect of the supraorbital ridge near the midline, and 3 mL around the zygomaticotemporal nerve in the temporal region posterior to the lateral orbital rim. Continuous hemodynamic monitoring was maintained to detect any signs of local anesthetic systemic toxicity or dexmedetomidine-related bradycardia. No adverse events were observed during or after the procedure.

EVD placement was completed in approximately 30 minutes. Hemodynamic parameters remained stable throughout the procedure, with no significant fluctuations. Systolic blood pressure ranged from 120 to 130 mmHg and heart rate from 85 to 100 beats/min during block placement, skull puncture, and catheter insertion. No airway intervention was required and peripheral saturation remained stable within 97-98% on NRM 10 liter per minute. The patient was transferred to the recovery unit in stable condition. On the first postoperative day, vital signs remained stable, and analgesia was adequately maintained with intravenous ketorolac 30 mg every 8 hours and intravenous paracetamol 1000 mg every 8 hours.

Discussion

SNB provides significant advantages in neurosurgical procedures by blocking the major sensory nerve branches of the scalp and effectively attenuating sympathetic responses associated with cranial tissue manipulation.4 This effect is particularly relevant in geriatric patients, who are more vulnerable to hemodynamic fluctuations and complications related to general anesthesia. Although most available evidence concerns elective craniotomy performed under general anesthesia with adjunctive SNB, extrapolation to emergent EVD placement in geriatric patients should be made cautiously because of differences in clinical urgency and physiological status.[3]

In the present case, avoidance of airway manipulation was especially important because of the anticipated difficult airway, reflected by a LEMON score of 6, and the presence of elevated intracranial pressure. The stable intraoperative hemodynamic profile observed during EVD insertion is consistent with the reported benefits of SNB in attenuating sympathetic responses. Unlike its more common use as an adjunct to general anesthesia, SNB in this case served as the primary anesthetic technique, suggesting its feasibility in carefully selected high-risk geriatric patients. Immediate availability of airway rescue equipment and a predefined rescue strategy remained essential, given the anticipated difficult airway and decreased level of consciousness.[3,4]

A previous report described the successful use of SNB as the primary anesthetic technique in a 32-week pregnant patient undergoing EVD placement for acute hydrocephalus. The procedure was completed without endotracheal intubation, respiratory depression, or significant hemodynamic instability.[1] These findings are consistent with the present case, in which induction of general anesthesia was considered high risk because of the anticipated difficult airway and unstable neurological condition.

SNB has been shown to significantly reduce sympathetic responses and provide better blood pressure stability during craniotomy.[2] This is supported by a meta-

analysis demonstrating reductions in mean arterial pressure of up to 14 mmHg and in heart rate of approximately 11 beats per minute during cranial pinning.3 These findings suggest that SNB may help prevent acute increases in intracranial pressure triggered by nociceptive stimuli.

SNB has also been associated with reduced intraoperative fentanyl requirements, supporting its role in multimodal analgesia.[4] Opioid reduction is particularly important in geriatric patients to minimize adverse effects such as respiratory depression, postoperative nausea and vomiting, and delirium.

Beyond its use with general anesthesia, SNB has also been shown to be effective in awake craniotomy. When combined with light sedation, it may allow adequate patient comfort, intraoperative communication, and hemodynamic stability.[5] Within the framework of Enhanced Recovery After Surgery (ERAS), opioid-sparing anesthetic techniques, including SNB, may contribute to faster recovery and a lower incidence of postoperative nausea and vomiting.[6] This may be particularly beneficial in patients with significant comorbidities.

The effectiveness of SNB has also been reported in pediatric patients. Two randomized controlled trials demonstrated reduced postoperative pain, lower additional analgesic requirements, and a favorable safety profile.[7,8] Although pediatric physiology differs from that of geriatric patients, these findings support the consistency of the analgesic mechanism across age groups.

In the present case, dexmedetomidine was used as an adjuvant to lidocaine. Previous studies have shown that dexmedetomidine may prolong analgesia, provide sympatholytic effects, and reduce systemic anesthetic requirements without significant adverse effects.[9,10] These properties may be advantageous in geriatric patients with increased cardiovascular risk.[11] Intraoperative neurological status was intermittently assessed through spontaneous movement, respiratory pattern, and response to verbal stimuli, allowing a balance between patient comfort and preservation of airway protective reflexes.

From an economic perspective, regional anesthesia techniques may offer lower costs than general anesthesia in selected settings.12 However, this report did not include a direct economic analysis, and any conclusion regarding cost-effectiveness should therefore be interpreted cautiously.

This report has several limitations. It describes a single case without comparison with general anesthesia, which limits conclusions regarding superiority and broader applicability. Selection bias may also be present, as the anesthetic approach was chosen on the basis of specific clinical considerations. In addition, the success of SNB may depend on operator expertise and familiarity with regional techniques, which may limit generalizability across centers. Further prospective studies and larger case series are needed to evaluate the reproducibility, safety, and effectiveness of SNB as a primary anesthetic technique for EVD placement.

Conclusion

SNB may be considered as an alternative anesthetic technique for selected geriatric patients undergoing emergent EVD placement when general anesthesia poses substantial risk. Careful patient selection, preparation for airway rescue, and familiarity with the technique are essential.

Acknowledgement

None.

Funding

None reported.

Conflict of Interest

The author(s) report no conflict of interest.

Data Availability Statement

The individual patient data collected in this Case Report/Series are not publicly available due to ethical, legal, and institutional restrictions. For further information, please contact the corresponding author.

Author's Contributions

Conceptualization: KAW. Data curation: KAW, AM. Investigation: KAW, AM. Writing – original draft: KAW, AM. Writing – review & editing: KAW, AM. Supervision: AM. All authors have read and approved the final version of the manuscript.

References

1. Arshad M, Yulianti Bisri D, Rahardjo S. Anestesi Scalp Block dan Occipital Block pada Tindakan External Ventricular Drainage (EVD) pada Kehamilan 32 Minggu Scalp Block and Occipital Block Anesthesia for External Ventricular Drainage (EVD) in 32-Week Pregnancy. Jurnal Neuroanestesi Indonesia. 2020;9(2):102-107. doi:10.24244/jni.v9i2.243
2. Rahardjo S, Mahmud. Scalp Blok untuk Kraniotomi dan Penanganan Nyeri Membandel Pasca Kraniotomi. Jurnal Neuroanestesi Indonesia. 2020;9(1):51-59. doi:10.24244/jni.v9i1.255
3. Luo M, Zhao X, Tu M, Yang X, Deng M, Wang Y. The effectiveness of scalp nerve block on hemodynamic response in craniotomy: a systematic review and meta-analysis of randomized trials. Minerva Anestesiol. Edizioni Minerva Medica. 2023;89(1-2):85-95. doi:10.23736/S0375-9393.22.16775-1
4. Iskandar Suryadani R, Margarita Rehatta N, Utariani A. Comparison General Anesthesia and Combined Scalp Block with Ropivacaine 0,5% on Mean Arterial Pressure, Heartrate, and Fentanyl Consumption During Craniotomy. Jurnal Widya Medika. 2020;6(1). doi:10.33508/jwm.v6i1.2499
5. Chen Y jun, Nie C, Lu H, et al. Monitored Anesthetic Care Combined with Scalp Nerve Block in Awake Craniotomy: An Effective Attempt at Enhanced Recovery After Neurosurgery. World Neurosurg. 2021;154:e509-e519. doi:10.1016/j.wneu.2021.07.069
6. Setiadi I, Rezanda Alifahna M, Halimi RA, Bisri DY, Alifahna MR. Opioid-free anesthesia in enhanced recovery after supratentorial craniotomies: a case series. JOURNAL of MEDICINE and LIFE 1061 JOURNAL of MEDICINE and LIFE. 2024;17:12. doi:10.25122/jml-2024-0280
7. Xiong W, Wang Y, Li L, et al. Effect of scalp nerve block on postcraniotomy analgesia in children: a randomized, controlled trial. BMC Anesthesiol. 2024;24(1). doi:10.1186/s12871-024-02822-0
8. Ning L, Jiang L, Zhang Q, Luo M, Xu D, Peng Y. Effect of scalp nerve block with ropivacaine on postoperative pain in pediatric patients undergoing craniotomy: A randomized controlled trial. Front Med (Lausanne). 2022;9:952064. doi:10.3389/fmed.2022.952064
9. Eka Nantha Kusuma P, I Putu Pramana Suarjaya, Parami P, et al. Dexmedetomidine as Adjuvant in Scalp Nerve Block for Craniotomy: A Double-Blind Randomized Clinical Trial. Jurnal Anestesi dan Terapi Intensif Udayana. 2025;1(3):102-111. doi:10.24843/q23wyc88
10. Stachtari C, Stergiouda Z, Koraki E, Sifaki F, Bagntasarian S, Chatzopoulos S. Dexmedetomidine as an adjuvant to scalp block in patients undergoing elective craniotomy: A prospective randomized controlled trial. Clin Neurol Neurosurg. 2023;227:107669. doi:10.1016/J.CLINEURO.2023.107669
11. Govil N. Enhanced recovery after surgery in geriatric patients: a need to fly in the face of convention. Bali J Anaesthesiol. 2023;7(1):1–2. doi:10.4103/bjoa.bjoa_3_23.
12. Wicaksono GS, Sudadi, Uyun Y. Cost Effectiveness General Anesthesia Combined with Scalp Block Compared to General

Anesthesia in Patients Undergoing Removal Tumor Craniotomy in Dr. Sardjito Hospital. Jurnal Komplikasi Anestesi. 2023;11(1):11-16. doi:10.22146/jka.v11i1.10199 10.24843/zfaszb91