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NARRATIVE REVIEW

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

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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]

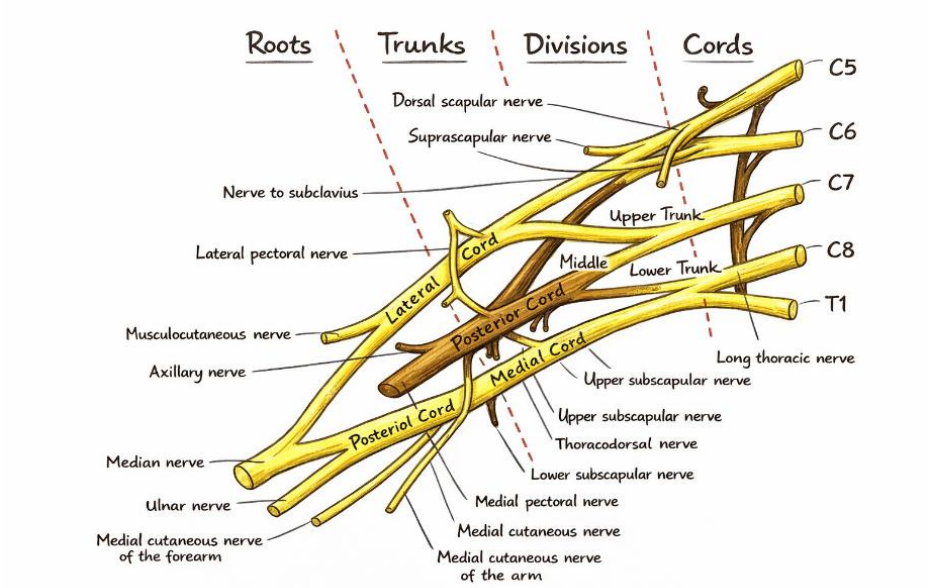

Figure 1. Brachial Plexus Anatomy.[11]

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.

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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