apm ANESTHESIA & PAIN MEDICINE

Anesth Pain Med 2025;20:175-182
https://doi.org/10.17085/apm.24142
pISSN 1975-5171 • eISSN 2383-7977

Original Article

Pathway from anterior suprascapular nerve block to the phrenic nerve: a cadaveric dye study

Sandeep Diwan[1], Deepika Sathe[2], Anjali Sabnis[3], Prakash Mane[3], and Anju Gupta[4]

[1]Department of Anesthesiology, Sancheti Hospital, Pune, [2]Department of Anesthesia, MGM Hospital, [3]Department of Anatomy, MGM Hospital, Navi Mumbai, [4]Department of Anesthesiology, Critical Care and Pain Medicine, All India Institute of Medical Sciences, New Delhi, India

Received October 10, 2024
Revised November 18, 2024
Accepted December 7, 2024

Corresponding author
Anju Gupta, M.D., DNB, IDRA, EDRA
Department of Anesthesiology, Critical Care and Pain Medicine, All India Institute of Medical Sciences, R.No. 6, Porta Cabin, Teaching block, New Delhi-110029, India
Tel: 91-9911573371
Fax: 91-11-26588663
E-mail: dranjugupta2009@rediffmail.com

Background: Anterior suprascapular nerve block is widely used for postoperative shoulder pain management. Although cadaveric studies show the spread and smudging of the phrenic nerve, our cadaveric injection investigation was conducted to investigate the pathway of diffusion of the dye toward the phrenic nerve from a more distal injection at the suprascapular nerve.

Methods: We injected 5 ml of 0.1% methylene blue dye into the proximal portion of the suprascapular nerve (infra-omohyoid in the posterior triangle) in 12 neck specimens from six cadavers. Following meticulous dissection, we assessed the spread of the dye along the brachial plexus to the nerve roots and traced the phrenic nerve for staining.

Results: The phrenic nerve was stained in 41.7% of the cases, the inferior trunk of the brachial plexus was unstained in all cases (100%), and the posterior division and suprascapular nerve were stained in all cases (100%). The nerves to the subclavius, dorsal aspect of the superior trunk, and C5 and C6 roots were stained in all cases. Anterior division of the superior trunk was observed in 75% of the specimens. The dye-spread pathway along the brachial plexus was dorsal, sparing the ventral aspect.

Conclusions: Our study demonstrated that the dye-spread pathway from the suprascapular nerve at the infra-omohyoid level to the phrenic nerve is dorsal to the brachial plexus.

Keywords: Brachial plexus; Cadaver; Methylene blue; Pain management; Phrenic nerve; Shoulder.

KSRA

INTRODUCTION

Significant effort has been devoted to mitigating pulmonary dysfunction associated with regional anesthesia of the brachial plexus [1-6]. An ultrasound study illustrated that the phrenic nerve was indistinguishable at the fifth cervical rami (C5) level. However, for every 1-cm caudal descent of the phrenic nerve, there is a 3-mm separation from the brachial plexus [7]. Therefore, it is prudent to implement distal brachial plexus blocks to avoid hemidiaphragmatic paresis (HDP). Previously, a superior trunk block was described as non-inferior to an interscalene block in terms of block efficacy. However, the HDP incidence was 76.3% (complete palsy in 5.3%) compared to 97.5% (complete palsy in 72.5%) with an interscalene block [8].

The suprascapular nerve provides the majority of the sensory supply to the shoulder joint, and its block can provide effective analgesia for shoulder surgeries. Posterior suprascapular nerve block in the suprascapular notch has been proposed as an alternative that spares the phrenic nerve. However, several randomized clinical trials have concluded that it is inferior to the interscalene block for pain control, at least in the first 4 h after shoulder surgery, which can delay discharge after outpatient shoulder surgery [5,9,11].

An anterior approach to a selective suprascapular nerve block guided by ultrasound and performed beneath the omohyoid muscle was described by Siegenthaler et al. [11]. The anterior approach targets the suprascapular nerve proximally, lateral to the supraclavicular brachial plexus, and below the omohyoid muscle, as it branches off the superior trunk. When comparing interscalene, supraclavicular, and anterior suprascapular nerve blocks, the latter can alleviate phrenic nerve paresis without compromising sufficient analgesia [12]. However, upon closer examination of the aforementioned study, it is evident that a continuous anterior suprascapular nerve block reduces diaphragmatic excursion during a vital capacity inhalation by a mean (95% confidence interval) of 2.1 cm (1.3–2.9 cm) as compared to baseline [12]. According to a subsequent cadaveric percent of ultrasound-guided anterior suprascapular nerve blocks exhibit methylene blue dye diffusion to the phrenic nerve [13]. Furthermore, a recent clinical study demonstrated that an anterior suprascapular nerve block was associated with a 40% incidence of partial or complete HDP [14]. With a high incidence of phrenic nerve involvement reported in both cadaveric and clinical studies for the anterior suprascapular nerve block, the aim of the present study was to assess the dissemination of the injected dye as it travelled from the injection site (beneath the omohyoid and lateral to the suprascapular nerve) and the prevalence of phrenic nerve stain.

MATERIALS AND METHODS

Six unembalmed (fresh) cadavers aged 67–78 years were recruited for scientific research to examine the diffusion of methylene blue dye injected at the level of the anterior suprascapular nerve block under ultrasound guidance (Fig. 1). Anatomical dissection was performed by an anatomist (PM) with > 15 years of experience, and injections were administered by a single anesthesiologist (SD) with > 17 years of ultrasound experience. A team of regional anesthesiologists with > 10 years of combined experience observed the real-time ultrasound images and open dissections. The anesthesiologist who administered the injections (SD) was blinded to the dissection results. Following the administration of 12 injections (in six cadavers), anatomical dissection was performed by an anatomist who was unfamiliar with the injection techniques. Dissection commenced 30 min post-block for each cadaver. Detailed observations were made with particular attention given to specific areas of interest.

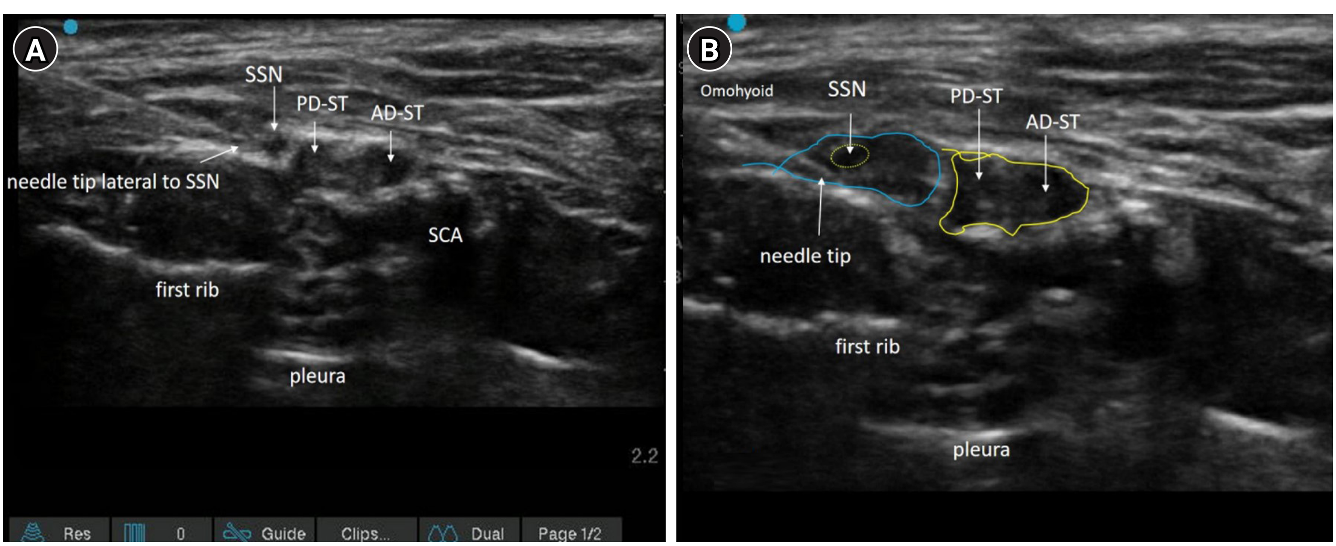

Fig. 1. Ultrasound-guided anterior suprascapular nerve block. (A) Needle tip approaching the suprascapular nerve, (B) following injection of methylene blue dye around the suprascapular nerve. Yellow line represents the anterior and posterior divisions of superior trunk, blue line shows the dye spread around the suprascapular nerve. SSN: suprascapular nerve, AD-ST: anterior division of superior trunk, PD-ST: posterior division of superior trunk, SCA: subclavian artery.

Technique

1. Ultrasound-guided anterior suprascapular nerve block

A real-time ultrasound scan of the anterolateral neck (Fuji-Sonosite EDGE 2, FUJIFILM Sonosite, Inc.) was conducted on every cadaver. The superior trunk was visualized in the short axis by placing a linear array transducer probe (6–13 MHz, Sonosite M-Turbo, Sonosite) in the transverse plane in the supraclavicular fossa, which obtained a classic supraclavicular view with the subclavian artery medial and brachial plexus posterolateral. Based on the standard supraclavicular view of the brachial plexus, the suprascapular nerve is located in the most lateral and posterior parts of the brachial plexus. As the plexus was imaged laterally, the suprascapular nerve separated from the brachial plexus and coursed under the inferior belly of the omohyoid muscle. At this point, the nerves can be visualized in a 'SPA' arrangement (formed by suprascapular nerve, posterior division of the superior trunk, and anterior division of the superior trunk) with suprascapular nerve being the lateral-most (Fig. 1). The suprascapular nerve diverged from the superior trunk and was identified at this point. A 5-cm 22-gauge insulated needle (B. Braun Medical Inc.) was inserted in a lateral-to-medial orientation toward the suprascapular nerve in alignment with the probe. With the needle tip immediately lateral to the suprascapular nerve at the level where it begins to branch off from the superior trunk, 5 ml (0.05 %) of methylene blue dye (non-viscous) was injected to accomplish circumferential spread around the neurovascular bundle [11].

2. Open dissection

Stratified dissection was performed on the anterior neck until the blue dye began to manifest at the level of the prevertebral fascia. The supraclavicular nerve located superficial to the prevertebral fascia was confirmed to be unstained, and the fascia was carefully dissected to access the trunks of the brachial plexus beneath it. By delicately dissecting the fascia, the cervical rami comprising the trunk were exposed. With an incision extending from the mentum to the sternal notch, the skin was reflected medially to laterally over the posterior triangle, along with the platysma and deep cervical fascia. Notably, the sternocleidomastoid and inferior belly of the omohyoid were also identified. The floor of the posterior triangle was identified as the anterior and medial scales. Between the scalene muscles, the 5th and 6th cervical rami emerged. The two cervical ramids were traced caudally to form the superior trunk. The superior trunk is divided into the lateral-most suprascapular, middle-posterior, and innermost anterior divisions. The suprascapular nerve was traced from the point of diversion from the superior trunk to the point at which it disappeared from the suprascapular notch.

Upon dissection, if the stained nerves were dark blue, they were designated as heavy (+3); if they were stained light blue, they were designated as moderate (+2); if they were stained very light blue, they were designated as mild (+1); and if there was no staining, they were designated as none (0) (Fig. 2).

RESULTS

Together, C5 and C6 form the superior trunk. When the superior trunk was traced caudally, it was divided into three divisions: the innermost anterior division, middle posterior division, and lateral-most suprascapular nerves (Figs. 3–5). Superior visualization of the phrenic nerve was achieved in relation to C5 (Figs. 4, 5). It was possible to locate the middle trunk, which originated from the anterior division medial to the anterior division of the superior trunk (Figs. 3, 4).

The middle trunk, anterior and posterior divisions of the superior trunk, and suprascapular nerve were stained blue beneath the prevertebral fascia (Figs. 2–4).

By dividing the epineurium of the superior trunk, the dye can be exposed along the lateral edge of the superior trunk and C5 rami. The posterior division of the superior trunk was stained in all (100%) cases, whereas the anterior division was stained in 75% (8/12) specimens. However, the ventral region of the superior trunk, as well as the C6 and C5 rami, exhibited no staining (Figs. 2–5). The nerve to the subclavius was stained in seven specimens. Gentle dissection of the dorsal aspect of the brachial plexus was performed by desheathing the superior trunk and advancing the cephalad toward the dorsal C6 and C5 rami, reflecting the pathway of the dye in this specific manner (Figs. 3–5). In addition, after staining the suprascapular nerve, the dye travelled dorsally and laterally to the brachial plexus divisions C6 and C5. Turning around C5, the dye appeared on the ventral aspect, soaking the phrenic nerve. The phrenic nerve was stained for a short distance in the proximal region in five of the 12 specimens (41.7%) (Figs. 2, 4). The pattern of staining for neural components of the brachial plexus would have no color for no staining (0), light (+1), moderate (+2), and heavy (+3) blue stains, as illustrated in the box in Fig. 2 as well as in Figs. 3–5.

CAD	SIDE	ASSN 100%	PD-ST 100%	AD-ST 75%	NtSUB 58.3%	MT 58.3%	IT	VtST 25%	DtST 100%	C6 41.6%	C5 66.32%	PN 41.67%
1	L	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y
	R	Y	Y	Y	Y	Y	N	N	Y	N	Y	N
2	L	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
	R	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y
3	L	Y	Y	N	N	N	N	N	Y	N	N	N
	R	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y
4	L	Y	Y	N	Y	N	N	N	Y	N	Y	N
	R	Y	Y	Y	N	Y	N	Y	Y	Y	N	N
5	L	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y
	R	Y	Y	Y	Y	N	N	N	Y	N	N	N
6	L	Y	Y	N	N	N	N	N	Y	N	N	N
	R	Y	Y	Y	N	Y	N	N	Y	N	Y	Y

+3 Heavy +2 Moderate +1 Light 0 No stain

Fig. 2. Stain pattern of nerve elements after injection of methylene blue dye at the isolated suprascapular nerve block. L: left, R: right, Y: Yes, N: No, CAD: cadaver, SSN: suprascapular nerve, PD-ST: posterior division of superior trunk, AD-ST: anterior division of superior trunk, MT: middle trunk, IT: inferior trunk, VtST: ventral to superior trunk, DtST: dorsal to superior trunk, NtSUB: nerve to subclavius, C5: 5th cervical rami, C6: 6th cervical rami, PN: phrenic nerve.

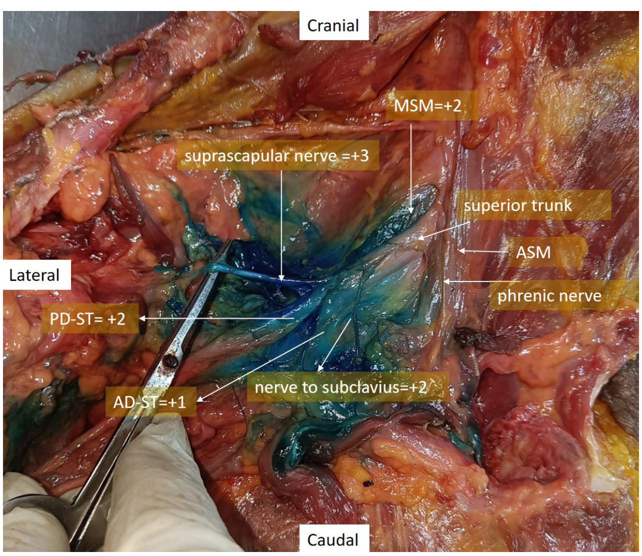

Fig. 3. Anatomic dissection showing the three divisions of the superior trunk and the stain pattern of the suprascapular, posterior, and anterior divisions of the superior trunk. PD-ST: posterior division of superior trunk, AD-ST: anterior division of superior trunk, ASM: anterior scalene muscle, MSM: middle scalene muscle, +3: +2, and +1 represent staining intensities.

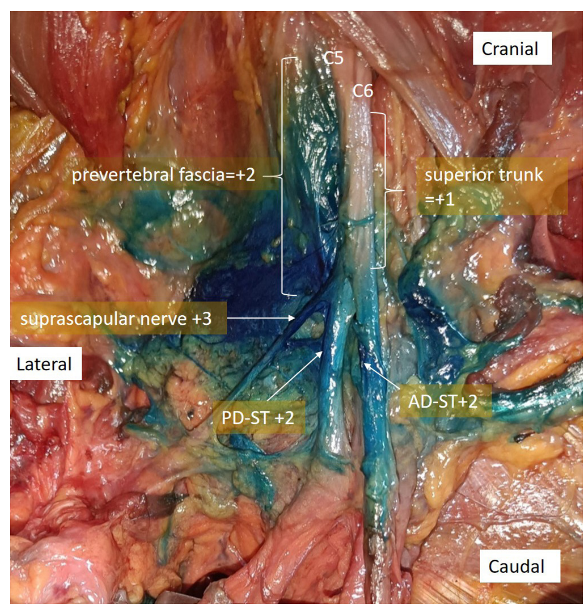

Fig. 4. Staining pattern of the anterior and posterior divisions of the superior trunk illustrating the stained anterior and posterior divisions of the superior trunk as well as the connective tissue and sheath dorsal to brachial plexus. PD-ST: posterior division of superior trunk, AD-ST: anterior division of superior trunk, +3: +2, and +1 represent the staining intensities.

Briefly, the suprascapular nerve was heavily stained (+3) at the point of injection, as it branched away from the superior trunk. Proximal and distal to the injection point on the suprascapular nerve, it was moderately stained (+2). As the dye travelled through the cephalad, the superior trunk was highlighted with a light (+2) to very light (+1) stain. The divisions of the superior trunk were stained +2 to +1, and the phrenic nerve was stained from +2 to +1 (Fig. 2).

DISCUSSION

By administering a single dye injection of 5 ml in the region of the anterior suprascapular nerve block in the infra-omohyoid plane, our cadaver injection study demonstrated that in five of the 12 specimens (41.7%), the propagation trajectory entailed traversing the dorsal aspect of the superior trunk, the C6 and C5 rami, and ultimately reaching the ventral aspect, staining the phrenic nerve. In addition, staining of the posterior and anterior divisions of the superior and middle trunks were significant. Thus, an isolated anterior suprascapular nerve block should be performed via the superior trunk. Based on our cadaveric injection study, we concluded that the diaphragm-sparing effect cannot be guaranteed with anterior suprascapular nerve injections.

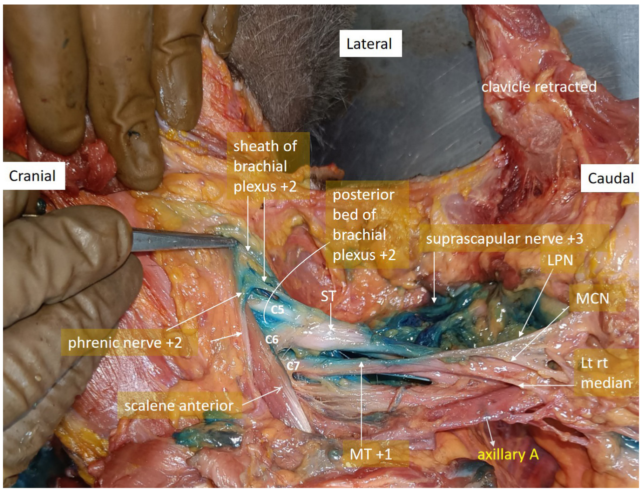

Fig. 5. Dye pathway reflected on dissection on the posterior or dorsal aspect by de-sheathing the superior trunk and advancing cephalad toward the dorsal/posterior of C6 and C5 rami. The phrenic nerve is stained in the proximal region. ST: superior trunk, MT: middle trunk, LPN: lateral pectoral nerve, MCN: musculocutaneous nerve, Lt rt median: lateral root of median nerve, +3: +2, and +1 represent the staining intensities.

Multiple layers of the mesoneurium envelope the suprascapular nerve along its length, proximally encompassing the superior trunk and the C5 rami. Its topographical origin differs from its fascicular origin. Its topographical origin is the separation of the suprascapular nerve from the superior trunk, which is visible through an intact mesoneurium (Fig. 6). However, only after the epineurium was removed was the fascicular arrangement at the C5 level visible, indicating a fascicular origin. In addition, this anatomical configuration accounts for dye dispersion from caudal to cranial [15]. Notably, 80% of the time when the fifth cervical rami was divided into four quadrants, the suprascapular nerve was located near the phrenic nerve in the ventral quadrants [16]. This topography may account for the staining of the phrenic nerves (41.7%) in our study. Based on an anatomical treatise, there is a 3% possibility of 'phrenicosuprascapular connections,' which could lead to dye tracking to the phrenic nerve [17]. Our study plausibly establishes the 'phrenicosu-

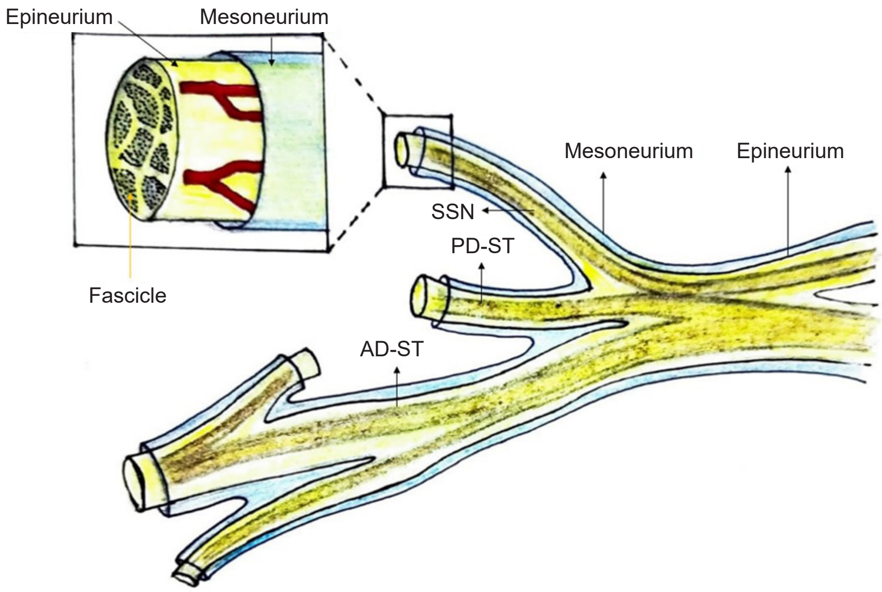

Fig. 6. Topographic origin and fascicular arrangement of the suprascapular nerve within the superior trunk. PD-ST: posterior division of superior trunk, AD-ST: anterior division of superior trunk, SSN: suprascapular nerve.

KSRA

prascapular connections.'

Several clinical investigations have focused on distal nerve blocks to prevent HDP during shoulder surgery [18]. Shoulder innervation is complex, with 30% of its supply originating from the brachial plexus neural tissue [19]. The articular branches of the suprascapular and axillary nerves penetrate the glenohumeral joint capsule. The articular branches of the lateral pectoral nerve innervate the anterior shoulder [20]. A meta-analysis identified interscalene block as the sole analgesic technique with clinical significance, indicating that it provides more effective pain management for patients during their recovery room stay [18]. In contrast, the suprascapular block is characterized by fewer adverse effects. Based on the findings of this meta-analysis, the suprascapular block may be a feasible and reliable alternative to the interscalene block for shoulder surgery. A subsequent randomized controlled trial determined that the anterior suprascapular block provided analgesic effects comparable to those of the interscalene block during major arthroscopic shoulder surgery [21]. Effective preservation of the pulmonary function was achieved when the anterior suprascapular nerve was blocked at the subomohyoid level. However, subsequent cadaveric and clinical studies have yielded contradictory results, with 20% staining of the phrenic nerve in a cadaveric study [11], and 40% involvement of the phrenic nerve in a clinical investigation [14]. In contrast, a recent cadaver study identified 4.2 ml as a phrenic-sparing injection technique volume [22], and a clinical study identified 6 ml [23]. Our cadaveric study showed similar results (41.7%) to those of a clinical study [14].

A 5-ml injection of methylene blue dye was administered to gain a better understanding of the pathway of the dye from its most distant point, where the suprascapular nerve exits the superior trunk, in the anterior supraclavicular fossa beneath the inferior belly of the omohyoid, to its most proximal location on the C5 nerve root. Dissection revealed that the dye travelled from its point of injection at the anterior suprascapular nerve block and along the dorsal area of the brachial plexus up to C5, and then curled over C5 from dorsal to ventral to stain the proximal portion of the phrenic nerve (5/12 = 41.7%) of its ventral aspect. The posterior sheath of the brachial plexus is supple and comprises of flexible connective tissue that provides minimal resistance to the injected dye. This facilitates swift and effortless dissemination of the dye from the caudal to the cephalad direction through the dorsal pathway.

Furthermore, it has been hypothesized that local anesthetic blockade of the superior trunk is the mechanism by which the anterior suprascapular block exerts its effect [24]. An anterior suprascapular nerve block results in a partial brachial plexus block [14]. Our real-time dissection at the level of the isolated anterior suprascapular nerve block after methylene blue injection demonstrated dye staining of the posterior (100%) and anterior (75%) divisions and nerves to the subclavius (58.3%) and middle trunk (58.3%). This finding indicates the possibility of developing a supraclavicular brachial plexus block (partial) by injecting 5 ml at the isolated anterior suprascapular nerve block area. This is anatomically plausible because the distance between the plexus and the suprascapular nerve in the supraclavicular fossa was 8 mm in cadavers and 9 mm in volunteers [11]. Based on our cadaveric injection study, we attempted to establish a dorsal pathway from the caudal level of the isolated anterior suprascapular nerve block to the proximal level of the fifth cervical ramus. In addition, there was a high likelihood of phrenic nerve staining and brachial plexus involvement in the supraclavicular region without inferior trunk involvement.

However, the interscalene block is the recommended regional anesthesia technique for shoulder surgery with 100% phrenic paresis, especially at higher volumes. With regards to phrenic sparing capacity, the anterior suprascapular nerve block has been shown to be a promising alternative analgesic block for shoulder surgery. However, our cadaver injection study demonstrated otherwise, with phrenic staining detected in 41.7% of specimens, even at a volume of 5 ml. Therefore, we strongly recommend further dose-finding, anatomical, and clinical studies to determine the efficacy of an isolated anterior suprascapular nerve block and its phrenic-sparing ability.

Limitations of the current study include its small sample size, which may not be representative of the entire population. Dye spread in cadaveric studies may not precisely replicate the spread of local anesthetic patterns among patients. Facial resistance to methylene blue and the effectiveness of local anesthetic diffusion may vary between cadavers and healthy patients. Different results may be observed when the suprascapular nerve separates from the superior trunk and subsequently from the injection points (such as at the point of separation, complete separation beneath the omohyoid, and more distal as it courses laterally and posteriorly to the suprascapular notch). However, in our study, we performed all injections at the point of nerve diversion from the superior trunk to maintain homogeneity. Furthermore, pressure-monitoring equipment was not employed to gauge the injection pressures owing to unavailability. However, the minimal effective dosage in the current investigation was nearly identical to the values reported for cadavers and living patients in clinical studies. Notably, we used fresh cadavers that had minimal tissue distortion and were similar to those of actual patients.

In conclusion, the results of this cadaveric study revealed a high incidence of phrenic nerve staining with a 5-ml dye injection at the level of the suprascapular nerve beneath the omohyoid muscle. The brachial plexus was partially soaked and the inferior trunk was excluded. The pathways of dye spread were deduced to be dorsal and craniocaudal from the point of injection.

FUNDING

None.

ACKNOWLEDGMENTS

The authors acknowledge and thank Dr. Shweta Puntambekar for contributing an illustration in the manuscript.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

Writing - original draft: Sandeep Diwan, Anju Gupta. Writing - review & editing: Sandeep Diwan, Deepika Sathe, Anjali Sabnis, Prakash Mane. Conceptualization: Sandeep Diwan, Deepika Sathe, Prakash Mane, Anju Gupta. Data curation: Anjali Sabnis. Methodology: Sandeep Diwan. Project administration: Sandeep Diwan, Anjali Sabnis. Funding acquisition: Sandeep Diwan, Anjali Sabnis. Visualization: Sandeep Diwan, Deepika Sathe, Anjali Sabnis, Prakash Mane, Anju Gupta. Investigation: Deepika Sathe, A Sabnis, Anju Gupta. Resources: Sandeep Diwan, Prakash Mane, Anju Gupta. Software: Sandeep Diwan, Prakash Mane. Supervision: Sandeep Diwan, Prakash Mane. Validation: Sandeep Diwan, Prakash Mane.

ORCID

Sandeep Diwan, https://orcid.org/0000-0001-7950-070X
Deepika Sathe, https://orcid.org/0009-0000-0491-1133
Anjali Sabnis, https://orcid.org/0000-0003-3997-4980
Prakash Mane, https://orcid.org/0009-0001-7588-7182
Anju Gupta, https://orcid.org/0000-0003-1726-1488

REFERENCES

1. Rhyner P, Kirkham K, Hirotsu C, Farron A, Albrecht E. A randomised controlled trial of shoulder block vs. interscalene brachial plexus block for ventilatory function after shoulder arthroscopy. Anaesthesia 2020; 75: 493-8.
2. Riazi S, Carmichael N, Awad I, Holtby RM, McCartney CJL. Effect of local anesthetic volume (20 vs 5 mL) on the efficacy and respiratory consequences of ultrasound-guided interscalene brachial plexus block. Br J Anaesth 2008; 101: 549-56.
3. Kim KS, Ahn JH, Yoon JH, Ji HT, Kim IS. Hemidiaphragmatic paresis following interscalene brachial plexus block with 2-point injection technique. Pain Physician 2021; 24: 507-15.
4. Verelst P, Van Zundert A. Respiratory impact of analgesic strategies for shoulder surgery. Reg Anesth Pain Med 2013; 38: 50-3.
5. Dhir S, Sondekoppam RV, Sharma R, Ganapathy S, Athwal GS. A comparison of combined suprascapular and axillary nerve blocks to interscalene nerve block for analgesia in arthroscopic shoulder surgery: an equivalence study. Reg Anesth Pain Med 2016; 41: 564-71.
6. Tran DQ, Elgueta MF, Aliste J, Finlayson RJ. Diaphragm sparing nerve blocks for shoulder surgery. Reg Anesth Pain Med 2017; 42: 32-8.
7. Kessler J, Schafhalter-Zoppoth I, Gray AT. An ultrasound study of the phrenic nerve in the posterior cervical triangle: Implications for the interscalene brachial plexus block. Reg Anesth Pain Med 2008; 33: 545-50.
8. 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; 131: 1316-26.
9. Lee SM, Park SE, Nam YS, Han SH, Lee KJ, Kwon MJ, et al. Analgesic effectiveness of nerve block in shoulder arthroscopy: comparison between interscalene, suprascapular and axillary

nerve blocks. Knee Surg Sports Traumatol Arthrosc 2012; 20: 2573-89.

10. Neuts A, Stessel B, Wouters PF, Dierickx C, Cools W, Ory JP, et al. Selective suprascapular and axillary nerve block versus interscalene plexus block for pain control after arthroscopic shoulder surgery: a noninferiority randomized parallel-controlled clinical trial. Reg Anesth Pain Med 2018; 43: 738-44.
11. Siegenthaler A, Moriggl B, Mlekusch S, Schliessbach J, Haug M, Curatolo M, et al. Ultrasound-guided suprascapular nerve block, description of a novel supraclavicular approach. Reg Anesth Pain Med 2012; 37: 325-8.
12. Auyong DB, Yuan SC, Choi DS, Pahang JA, Slee AE, Hanson NA. A double-blind randomized comparison of continuous interscalene, supraclavicular, and suprascapular blocks for total shoulder arthroplasty. Reg Anesth Pain Med 2017; 42: 302-9.
13. Laumonerie P, Ferré F, Cances J, Tibbo ME, Roumiguié M, Mansat P, et al. Ultrasound-guided proximal suprascapular nerve block: a cadaveric study. Clin Anat 2018; 31: 824-9.
14. Ferré F, Pommier M, Laumonerie P, Ferrier A, Menut R, Bosch L, et al. Hemidiaphragmatic paralysis following ultrasound-guided anterior vs. posterior suprascapular nerve block: A double-blind, randomized control trial. Anesthesia 2020; 75: 499-508.
15. Arad E, Li Z, Sitzman TJ, Agur AM, Clarke HM. Anatomic sites of origin of the suprascapular and lateral pectoral nerves within the brachial plexus. Plast Reconstr Surg 2014; 133: 20e-7e.
16. Siqueira MG, Foroni LH, Martins RS, Chadi G, Malessy MJ. Fascicular topography of the suprascapular nerve in the C5 root and upper trunk of the brachial plexus: A microanatomic study from a nerve surgeon's perspective. Neurosurgery 2010; 67(2 Suppl): 402-6.
17. Kodama K, Kawai K, Okamoto K, Yamada M. The suprascapular nerve as re-interpreted by its communication with the phrenic nerve. Acta Anat (Basel) 1992; 144: 107-13.
18. Hussain N, Goldar G, Ragina N, Banfield L, Laffey JG, Abdallah FW. Suprascapular and interscalene nerve block for shoulder surgery: a systematic review and meta-analysis. Anesthesiology 2017; 127: 998-1013.
19. Slingluff Jr CL, Terzis JK, Edgerton MT. The quantitative microanatomy of the brachial plexus in man: Reconstructive relevance. In: Micro reconstruction of Nerve Injuries. Edited by Terzis JK: Micro reconstruction of Nerve Injuries. Philadelphia, WB Saunders. 1987, pp 285–324.
20. Eckmann MS, Bickelhaupt B, Fehl J, Benfield JA, Curley J, Rahimi O, et al. Cadaveric study of the articular branches of the shoulder joint. Reg Anesth Pain Med 2017; 42: 564-70.
21. Auyong DB, Hanson NA, Joseph RS, Schmidt BE, Slee AE, Yuan SC. Comparison of anterior suprascapular, supraclavicular, and interscalene nerve block approaches for major outpatient arthroscopic shoulder surgery: a randomized, double-blind, noninferiority trial. Anesthesiology 2018; 129: 47-57.
22. Maikong N, Kantakam P, Sinthubua A, Mahakkanukrauh P, Tran Q, Leurcharusmee P. Cadaveric study investigating the phrenic-sparing volume for anterior suprascapular nerve block. Reg Anesth Pain Med 2021; 46: 769-72.
23. Coşarcan SK, Doğan AT, Koyuncu Ö, Gurkan Y, Erçelen Ö. The minimum effective analgesic volume of 0.5% bupivacaine for ultrasound-guided anterior suprascapular nerve block. Cureus 2022; 14: e31350.
24. Coşarcan SK, Gürkan Y, Doğan AT, Erçelen Ö. Anterior suprascapular block may not avoid diaphragmatic paralysis. Reg Anesth Pain Med 2021; 46: 461-2.