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Review Article

Current Concepts in Regional Analgesia Techniques for Postoperative Pain Management after Total Shoulder Arthroplasty: A Narrative Review

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Abstract

Postoperative pain management after total shoulder arthroplasty (TSA) can be challenging. Interscalene brachial plexus block (ISB), which is administered either as single shot injection (ssISB) or with continuous catheter (ccISB) technique, is the gold standard. Ultrasonography (USG) guidance facilitates a faster, more accurate block with a lower local anaesthetic volume in ssISB. USG also helps for accurate catheter placement in ccISB. Hemi-diaphragmatic palsy is a common complication of ISB. This can be a major concern for patients with a respiratory compromise so it necessitates the administration of diaphragm-sparing nerve blocks. Phrenic nerve sparing block like suprascapular nerve block (SSNB) singly or along with axillary nerve block, subomohyoid anterior suprascapular block, superior trunk block, erector spinae plane block, individually, provide perioperative analgesia non-inferior to ISB. Subacromial or intraarticular infiltration of local anaesthesia (SAIA) is not recommended due to its limited clinical efficacy. Extended analgesic effects have been observed with the continuous catheter (ccISB) technique and liposomal bupivacaine when used as a field block. This article provides an overview of regional anaesthesia techniques for postoperative analgesia following Total shoulder arthroplasty (TSA).

Keywords: Shoulder arthroplasty, Pain management, Regional anaesthesia, Interscalene brachial plexus block

Introduction

Glenohumeral osteoarthritis affects up to 30% of patients aged 60 years. It causes significant functional limitation and disability [1]. The incidence of total shoulder arthroplasty (TSA), an effective lifestyle modification surgery for this painful condition, has increased significantly over the past two decades [2]. This surgery provides long-term clinical results and lasting pain relief [3]. Adequate early postoperative pain control improves the outcome by facilitating early rehabilitation of these elderly patients with associated comorbidities.

Opioids are commonly prescribed to reduce short-term postsurgical pain but their side effects such as nausea, constipation, and respiratory depression are distressing to patients [4]. Enhanced recovery after surgery (ERAS) protocol for shoulder arthroplasty features multidisciplinary collaboration and multimodal analgesia with a mainstay on regional anaesthesia. ERAS has reduced the length of hospital stay and complications, simultaneously improving patient outcomes [5].

In this article, we will provide an overview of regional anaesthesia techniques used to manage postoperative pain following total shoulder arthroplasty.

Anatomy

The shoulder receives sensory innervation from the cervical (C3, 4) and brachial plexuses (C5, 6). The major motor and sensory innervation to the shoulder is from the suprascapular nerve (upper trunk of the brachial plexus) and axillary nerve (posterior cord of the

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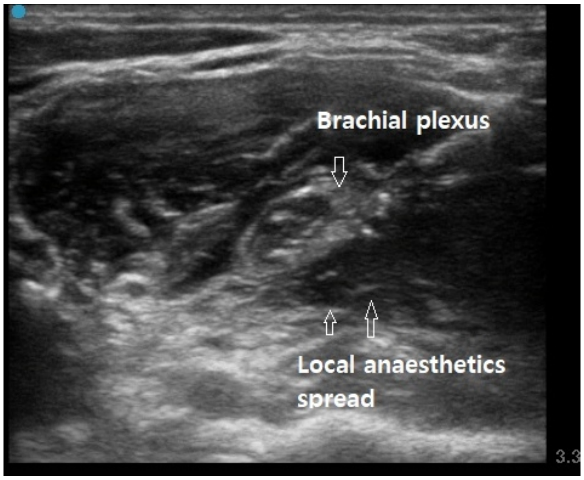

Figure 1: Interscalene block and drug spread

brachial plexus). Minor sensory innervation is from the lateral pectoral, musculocutaneous, and subscapular nerves. The cutaneous supply to the cape of the shoulder, upper thoracic region and a sensory contribution to the acromioclavicular and sternoclavicular joints are from the supraclavicular nerves. (Descending branches of superficial cervical plexus; C3, 4) [6].

Surgery

The standard surgical approach for total shoulder arthroplasty is an anterior skin incision running from the coracoid process along the deltopectoral line towards the deltoid tuberosity of the humerus [7].

Types of Regional Anaesthesia

Interscalene Brachial Plexus Block (ISB)

Interscalene block, the gold standard regional anaesthetic technique for shoulder procedures, is commonly used for all shoulder arthroplasty cases [8]. ISB is administered at the upper border of the cricoid cartilage (the transverse process of C6) in the interscalene groove. Successful blockade achieves analgesia at the lateral two-thirds of the clavicle, the proximal humerus, and the glenohumeral joint [9].

Historically paraesthesia or the peripheral nerve stimulation (PNS) technique has been used to locate and identify the brachial plexus anatomy. In Ultrasonography (USG) guided ISB, using the same landmarks C5 and C6 nerve roots are identified and local anaesthetics is injected (Figure 1).

Use of USG has facilitated accurate identification of the brachial plexus and its branches, blocks performed using USG guidance were more likely to be successful, took less time to perform, had faster onset than those performed with PNS guidance. USG guidance also decreased the risk of a vascular puncture during block performance [10].

Winnie had recommended the use of 40 ml of local anaesthetic for a successful brachial plexus block [9]. However, USG guided block helps to visualize the spread pattern of local anaesthetic in real-time; improves the success rate with a lower local anaesthetic dose than the conventional volume. One study reported that the minimum effective anaesthetic volume (MEAV) required for successful surgical anaesthesia is 5 ml but possibility of a 25% failure rate [11].

ISB may be performed as either a single injection (ssISB) or with a continuous catheter (ccISB). Single shot ISB can provide effective analgesia up to 6 hours on movement and 8 hours at rest after shoulder surgery, with no demonstrable benefits thereafter. Patients who receive an ISB can suffer rebound pain at 24 hrs [12].

Local anaesthetic adjuvants

Various agents such as Clonidine, Dexmedetomidine, Buprenorphine and Dexamethasone have been used as adjuvants with peripheral nerve blocks to increase the duration of analgesia following surgery [13]. Cochrane review has concluded that the addition of Dexamethasone to a peripheral nerve block, prolongs analgesia up to 6-14 hours in upper limb surgery, with similar or better pain relief and lesser narcotic use than plain local anaesthetic [14]. Most adjuncts are safe to use with little or no neurotoxicity and tissue damage [15]. Although extensively used in clinical practice their use as adjuncts is off-label. The assessment of risk and potential benefit must be done while using such an agent [13].

Continuous catheter ISB (ccISB)

To extend the duration of postoperative pain relief after single-shot Interscalene block (ssISB), continuous local anaesthetic infusion into the interscalene groove via a perineural catheter connected to a portable infusion device has been used. Interscalene catheter placement is an advanced technique requiring a skilled operator for block placement. A meta-analysis concluded that, compared with

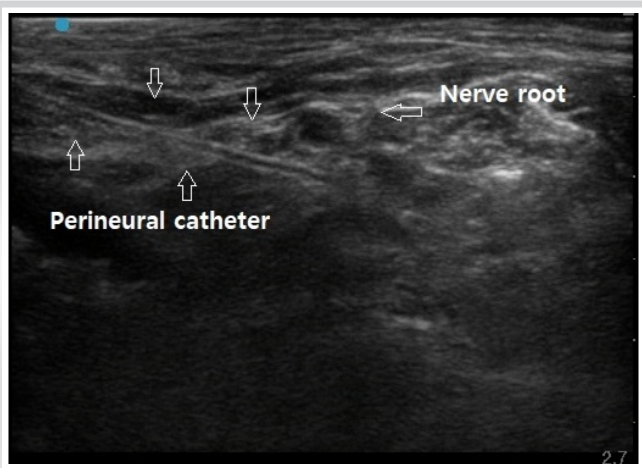

Figure 2: Interscalene perineural catheter

Figure 3: Catheter Fixation device

ssISB, ccISB reduced 24 and 48 hour oral morphine consumption, provided superior rest and dynamic pain control beyond 48 hours, prolonged time-to-first analgesic, enhanced satisfaction, and reduced postoperative nausea and vomiting without complications [16].

USG-guided catheter insertion may be performed either in-plane or out-of-plane according to operator preference. In the out-of-plane technique, the needle tip is adjusted, to lie immediately lateral to the two most superficial brachial plexus roots/trunks. For in-plane needle advancement, the needle is inserted lateral to medial and advanced directly towards the brachial plexus. Needle tip position is determined by injection of local anaesthetic, and view of injectate spread directly posterior and lateral to the target roots/trunks [17] (Figure 2).

The catheter tip position must be verified with ultrasound and a test bolus of local anaesthetic should be administered under clinical supervision. If the catheter and tip is difficult to visualise, small 'boluses of fluid' can be detected using Doppler mode ultrasound. Injection of a tiny volume of air or manual 'wiggling' of the catheter can also help confirm the position [18].

Secure fixation is essential but practically difficult because of shoulder mobility and the proximity of the surgical field to the catheter entry site. Several methods including skin glue, specialist anchor dressings, epidural catheter securing device (Lockit-Plus, Portex) (Figure 3) and tunnelling have all been described to prevent dislodgement with variable success rates [18].

Complications of ISB

Potential complications of ISB are central block with paralysis, brachial plexopathy, phrenic nerve palsy (hemidiaphragmatic paresis), recurrent laryngeal nerve palsy (hoarseness), Horner syndrome, pneumothorax, and cardiac arrhythmias [19].

Phrenic nerve palsy is observed in up to 100% of patients with 20 ml or more local anaesthetic volume and up to 45% with 5-10 ml volume [20]. Hemi-diaphragmatic paresis (HDP), though well tolerated by healthy adults, can cause respiratory compromise due to reduced pulmonary reserve, especially in patients with severe chronic obstructive pulmonary disease, obstructive sleep apnoea and morbid obesity.

Although overall complication rates are low with ccISB, there are concerns regarding the need for additional infrastructure to monitor and troubleshoot the infusion pumps, increased monitoring, risk of catheter migration/pull-out (15%), additional costs and improper placement [17]. Increased adverse effects are seen in ccISB group such as syncope, oversedation, bradycardia, shortness of breath and hypotension compared with ssISB [21].

Considering hemi-diaphragmatic paresis as a major occurrence, phrenic sparing blocks have been described.

Diaphargam Sparing Nerve Blocks

Isolated Suprascapular Nerve Block (SSNB)

The suprascapular nerve (SSN) is a branch of the brachial plexus, which receives contributions mostly from the C5, C6. The motor branch of the SSN supplies the supraspinatus and infraspinatus muscles. SSN provides 70% sensation to the shoulder joint, acromioclavicular joint, coracohumeral ligament, coracoclavicular ligaments, and subacromial bursa [22].

Contrary to the earlier belief [22], recent anatomical studies indicated that SSNs contribution is modest and confined to the posterior superior quadrant of the joint. The subscapular nerve contributes to the anterior superior quadrant, and the inferior half of the joint is innervated by the axillary nerve [23].

The suprascapular nerve branches off the superior trunk of the brachial plexus, close to the anterior and posterior divisions, and runs through the supraclavicular fossa under the inferior belly of the omohyoid and trapezius muscles. It enters the supraspinous fossa under the superior transverse scapular ligament.

USG-guided SSNB via a posterior approach at the suprascapular notch where the suprascapular nerve enters the supraspinous fossa has limited success due to the nerve's depth and inconsistent anatomic variation at the origin of the sensory branches [24].

Axillary nerve block

The axillary nerve may be blocked by imaging the posterior surface of the humerus just distal to the humeral head. The posterior circumflex humeral artery and axillary nerve may be seen at this point, and local anaesthetic is injected deep to the deltoid muscle. A volume of 5-7 ml may be sufficient to travel proximally through the quadrilateral space to block the axillary articular supply to the shoulder [25]. The axillary nerve may also be blocked by an infraclavicular approach also aiming to block the subscapular, musculocutaneous, and lateral pectoral nerves and thus achieve complete shoulder analgesia with a low incidence of phrenic nerve palsy.

A combination of the posterior suprascapular block and axillary nerve block has been found non-inferior to interscalene block for postoperative analgesia for shoulder surgery. It could be an efficient alternative for interscalene block with the additional benefit of avoiding phrenic nerve involvement [26].

Subomohyoid Anterior Suprascapular block

Suprascapular block in the supraclavicular fossa is better than the posterior suprascapular approach owing to its proximity to the superior trunk. This helps in accurate visualization of the suprascapular nerve [27]. In the supraclavicular region before the suprascapular nerve travels through the suprascapular notch, the nerve can be identified more proximally and superficially under the omohyoid muscle (which serves as a landmark) [27]. USG-guided, in-plane needle insertion, and local anaesthetic solution injection in 5 ml incremental doses ensure its spread around the neurovascular bundle.

A multicentric double-blind noninferiority randomized trial concluded that the Subomohyoid anterior Suprascapular block was non-inferior to interscalene block with respect to improvement of postoperative pain control [28].

Superior Trunk Block

Low volume interscalene block was not effective in reducing the incidence of hemidiaphragmatic paralysis [29]. Reductions in the local anaesthetic dose and volume as well as injections away from the C5, and C6 nerve roots have been in focus for minimizing hemidiaphragmatic paralysis associated with interscalene block [30].

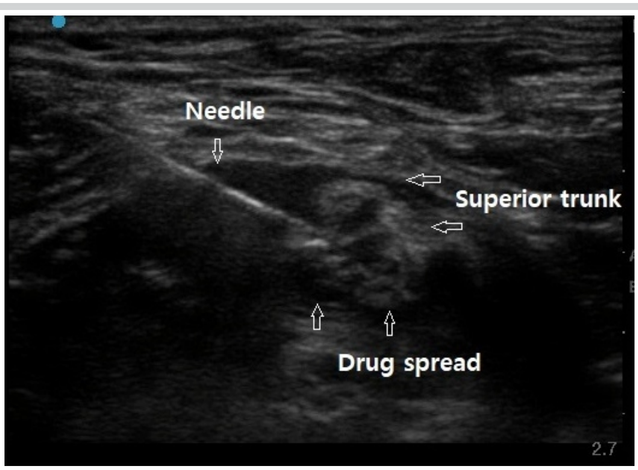

Figure 4: Superior Trunk block

It has been observed that contrary to the misconception of its proximity to the anterior division, the suprascapular nerve is nearer to the posterior division of the superior trunk. This facilitates the spread of a small volume of local anaesthetic deposited proximal to the origin of the suprascapular nerve, to the posterior division of the superior trunk blocking its branches namely, the axillary and subscapular nerves [31]. This results in less spread to the phrenic nerve, inferior trunks of brachial plexus as well as the recurrent laryngeal nerve. So, side effects of ISB like breathing difficulty, hand immobility and hoarseness are reduced [32].

After identifying the cervical roots and scalene muscles with ultrasonography guidance, the probe is moved distally till the suprascapular nerve can be seen branching from the superior trunk. The needle path should avoid the transverse cervical and dorsal scapular arteries which traverse across the brachial plexus and can lie over the superior trunk (Figure 4).

With lateral to medial in-plane needle insertion 10 ml of 0.2% Ropivacaine is injected in the vicinity of SSN. Additional 5 ml is injected anteriorly after directing the needle anterior/superior to the trunk, continuing to be lateral to the trunk [31]. Local anaesthetic injection at the confluence of C5 and C6 ensures adequate blockade of suprascapular nerve, which has a variable origin from the superior trunk.

Superior trunk block causes significantly less hemi-diaphragmatic paresis and provides noninferior analgesia in comparison to interscalene block for initial 24 hours [32].

Erector Spinae Plane Block (ESPB)

The use of erector spinae plane block (ESPB) for chronic shoulder pain aroused interest to use it for shoulder surgery anaesthesia and analgesia [33].

In a case series of five patients undergoing proximal humerus fixation, cervical ESPB was administered with satisfactory pain relief. The spread of drug injected was studied by contrast-enhanced computed tomography. The contrast spread was seen deep to the erector spinae muscle, medially in the retro-laminar region and in the cervical paravertebral space up to C3, and C4 cervical nerve roots. The contrast in the erector spinae plane was also seen to spread along the dorsal rami in a retrograde fashion. The phrenic nerve was spared in these patients. Postoperative analgesia for shoulder surgeries can be an additional indication of cervical ESPB [34].

In a randomized prospective double-blind study for patients undergoing arthroscopic shoulder surgery, it was found that high thoracic ESPB had superior postoperative pain control for the first 48 hours and the VAS score, opioid consumption and rescue analgesia requirement were significantly less

Table 1: Summary of available modalities for postoperative pain management after TSA.		
Modality	**Advantages**	**Limitations**
Single-shot Interscalene nerve block	Gold standard, Simple to perform.	Limited duration, rebound pain, side effects like diaphragmatic palsy, Horner syndrome.
Continuous catheter Interscalene nerve block	Lower pain scores and lower perioperative opioid requirements, longer pain relief (24-48 hours)	Advanced block, risk of catheter dislodgement and logistic issues.
Suprascapular/ Superior trunk	Diaphragm sparing	Need for supplementary axillary Nerve block
Erector spinae	Diaphragm sparing	Advanced block, need more evidence
Liposomal bupivacaine	Comparable pain relief, the opioid-sparing effect, and less adverse effects in the first 48 hours, no extra expertise required	High Cost, insufficient evidence.
Infiltration of the shoulder with local anaesthetic	No additional benefits compared with single-shot or continuous brachial plexus blocks	No proven efficacy

compared with a sham block (NS). The ESPB was administered at T2-3 level under USG guidance. In-plane needle insertion was done in the caudal-cranial direction. A single injection of 30 ml local anaesthetic has been observed to be effective up to C3-5. Insertion of 20G epidural catheter along with local anaesthetic infusion has been found to produce excellent analgesia for up to 48 hours [35]. There was no respiratory depression following this high thoracic, high-volume, single-injection ESPB [35]. Cadaveric injection at the level of T1 resulted in the injectate spread in the dorsal rami path between the medial and lateral erector spinae muscle reaching dorsal to ventral rami [36].

Subacromial or Intraarticular Infiltration of Local Anesthesia (SAIA)

Injection of local anaesthetics into the subacromial or intraarticular (SAIA) space has been well described and can be performed by the surgeon at the end of a case in high volumes of 50 ml to 120 ml, with or without a catheter. However, the literature has failed to demonstrate better pain relief than ISB [37, 38]. Although the implications of chondrolysis may be less relevant in arthroplasty, this modality is not recommended given the limited clinical efficacy [37,39].

Liposomal bupivacaine (LB)

Liposome bupivacaine (LB) is a novel local anaesthetic which uses DepoFoam® as a delivery platform that encapsulates bupivacaine that enables the extended-release of bupivacaine for over 72 hours into surgical sites to extend analgesic effects.

In a recent meta-analysis, liposomal bupivacaine was found to be comparable to non-liposomal local anaesthetic agents with respect to pain relief, the opioid-sparing effect, and adverse effects in the first 48 hours after arthroscopic rotator cuff repair and total shoulder arthroplasty [40, 41].

LB costs 10-100 times more than a standard local anaesthetic agent. The literature suggests the use of LB as a field block rather than periarticular use, in the preoperative setting in conjunction with a standard ISB [42].

Comparative studies

Intraoperative pain management options were compared with each other in a few studies. A study comparing ssISB, ccISB, and SAIA in shoulder arthroplasty patients reported significantly lower pain up to 12 hours and lower narcotic consumption in the ccISB group compared with ssISB alone and SAIA. ISB alone outperformed SAIA [43].

Comparing ssISB, SSNB, and SCB in arthroscopic surgery and ccISB, SSNB, and SCB in arthroplasty resulted in no statistically significant differences in terms of pain scores and oxycodone consumption at 24 hours; however, the authors reported a significantly higher incidence of Horner syndrome, hoarseness, and affected vital capacity in the ISB-only group [44, 45].

Institutional experience

At Deenanath Mangeshkar Hospital, Pune approximately 100-120 total shoulder arthroplasty are performed in a year. We were using ssISB 30 cc of 0.5% Bupivacaine followed by Fentanyl Patch 25 mcg/hr for postoperative analgesia. But we have faced problems of PONV, unilateral diaphragmatic palsy and severe pain after 12 hours. For the last few years, we are using ccISB using 20 ml of 0.5% Levobupivacaine + Dexamethasone 8 mg, followed up by 12 hourly top-up using 10 ml of 0.2% Ropivacaine for the next 48 hours with better pain relief and fewer side effects. With the use of a catheter fixation device, the rate of dislodgement of catheters has been reduced. We are planning to shift towards the use of diaphragm sparing blocks in near future.

Conclusion

Although ISB continues to be the gold standard for postoperative pain relief after TSA, interest in ssISB alternatives is driven by limited duration of analgesia, associated rebound pain and a high incidence of adverse events especially hemidaiphargmatic palsy.

Several options have been evaluated for safer alternatives to ISB, including a combination of suprascapular block and axillary block, Superior trunk block, Erector spinae plane block, Periarticular local anaesthesia infiltration and Liposomal bupivacaine with promising results.

References

1. Chillemi C, Franceschini V. Shoulder osteoarthritis. Arthritis. 2013; 2013:370231.

2. Dillon MT, Chan PH, Inacio MCS, Singh A, Yian EH, Navarro RA. Yearly Trends in Elective Shoulder Arthroplasty, 2005-2013. Arthritis Care Res (Hoboken). 2017 Oct;69(10):1574-1581.

3. Raiss P, Bruckner T, Rickert M, Walch G. Longitudinal observational study of total shoulder replacements with cement: fifteen to twenty-year follow-up. J Bone Joint Surg Am. 2014 Feb 5;96(3):198-205.

4. Benyamin R, Trescot AM, Datta S, Buenaventura R, Adlaka R, Sehgal N, Glaser SE, Vallejo R. Opioid complications and side effects. Pain Physician. 2008 Mar;11(2 Suppl):S105-20.

5. Grosh T, Elkassabany NM. Enhanced Recovery After Shoulder Arthroplasty. Anesthesiol Clin. 2018 Sep;36(3):417-430.

6 Aszmann OC, Dellon AL, Birely BT, McFarland EG. Innervation of the human shoulder joint and its implications for surgery. Clin Orthop Relat Res. 1996 Sep;(330):202-7.

7. Ricchetti ET, Williams Jr GR. Total shoulder arthroplasty—indications, technique, and results. Operative Techniques in Orthopaedics. 2011 Mar 1;21(1):28-38

8. Gabriel RA, Nagrebetsky A, Kaye AD, Dutton RP, Urman RD. The Patterns of Utilization of Interscalene Nerve Blocks for Total Shoulder Arthroplasty. Anesth Analg. 2016 Sep;123(3):758-61.

9.Winnie AP. Interscalene brachial plexus block. Anesth Analg. 1970 May-Jun;49(3):455-66. PMID: 5534420.

10. Abrahams MS, Aziz MF, Fu RF, Horn JL. Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: a systematic review and meta-analysis of randomized controlled trials. Br J Anaesth. 2009 Mar;102(3):408-17.

11. Gautier P, Vandepitte C, Ramquet C, DeCoopman M, Xu D, Hadzic A. The minimum effective anesthetic volume of 0.75% ropivacaine in ultrasound-guided interscalene brachial plexus block. Anesth Analg. 2011 Oct;113(4):951-5.

12. Abdallah FW, Halpern SH, Aoyama K, Brull R. Will the Real Benefits of Single-Shot Interscalene Block Please Stand Up? A Systematic Review and Meta-Analysis. Anesth Analg. 2015 May;120(5):1114-1129.

13. Krishna Prasad GV, Khanna S, Jaishree SV. Review of adjuvants to local anesthetics in peripheral nerve blocks: Current and future trends. Saudi J Anaesth. 2020 Jan-Mar;14(1):77-84.

14. Pehora C, Pearson AM, Kaushal A, Crawford MW, Johnston B. Dexamethasone as an adjuvant to peripheral nerve block. Cochrane Database Syst Rev. 2017 Nov 9;11(11):CD011770.

15. Brummett CM, Williams BA. Additives to local anesthetics for peripheral nerve blockade. Int Anesthesiol Clin. 2011 Fall;49(4):104-16.

16. Vorobeichik L, Brull R, Bowry R, Laffey JG, Abdallah FW. Should continuous rather than single-injection interscalene block be routinely offered for major shoulder surgery? A meta-analysis of the analgesic and side-effects profiles. Br J Anaesth. 2018 Apr;120(4):679-692.

17. Fredrickson MJ, Leightley P, Wong A, Chaddock M, Abeysekera A, Frampton C. An analysis of 1505 consecutive patients receiving continuous interscalene analgesia at home: a multicentre prospective safety study. Anaesthesia. 2016 Apr;71(4):373-9.

18. Hewson DW, Oldman M, Bedforth NM. Regional anaesthesia for shoulder surgery. BJA Educ. 2019 Apr;19(4):98-104.

19. Borgeat A, Ekatodramis G, Kalberer F, Benz C. Acute and nonacute complications associated with interscalene block and shoulder surgery: a prospective study. Anesthesiology. 2001 Oct;95(4):875-80.

20. Riazi S, Carmichael N, Awad I, Holtby RM, McCartney CJ. Effect of local anaesthetic volume (20 vs 5 ml) on the efficacy and respiratory consequences of ultrasound-guided interscalene brachial plexus block. Br J Anaesth. 2008 Oct;101(4):549-56.

21. Hasan SS, Rolf RH, Sympson AN, Eten K, Elsass TR. Single-Shot Versus Continuous Interscalene Block for Postoperative Pain Control After Shoulder Arthroplasty: A Prospective Randomized Clinical Trial. J Am Acad Orthop Surg Glob Res Rev. 2019 Jun 11;3(6):e014.

22. Vorster W, Lange CP, Briët RJ, Labuschagne BC, du Toit DF, Muller CJ, de Beer JF. The sensory branch distribution of the suprascapular nerve: an anatomic study. J Shoulder Elbow Surg. 2008 May-Jun;17(3):500-2.

23. Tran J, Peng PWH, Agur AMR. Anatomical study of the innervation of glenohumeral and acromioclavicular joint capsules: implications for image-guided intervention. Reg Anesth Pain Med. 2019 Jan 11:rapm-2018-100152.

24. Jezierski H, Podgórski M, Stefańczyk L, Kachlik D, Polguj M. The Influence of Suprascapular Notch Shape on the Visualization of Structures in the Suprascapular Notch Region: Studies Based on a New Four-Stage Ultrasonographic Protocol. Biomed Res Int. 2017;2017:5323628.

25. Price DJ. The shoulder block: a new alternative to interscalene brachial plexus blockade for the control of postoperative shoulder pain. Anaesth Intensive Care. 2007 Aug;35(4):575-81.

26. 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 Dec;127(6):998-1013.

27. Siegenthaler A, Moriggl B, Mlekusch S, Schliessbach J, Haug M, Curatolo M, Eichenberger U. Ultrasound-guided suprascapular nerve block, description of a novel supraclavicular approach. Reg Anesth Pain

Med. 2012 May-Jun;37(3):325-8.

28. Abdallah FW, Wijeysundera DN, Laupacis A, Brull R, Mocon A, Hussain N, Thorpe KE, Chan VWS. Subomohyoid Anterior Suprascapular Block versus Interscalene Block for Arthroscopic Shoulder Surgery: A Multicenter Randomized Trial. Anesthesiology. 2020 Apr;132(4):839-853.

29. Tran DQ, Elgueta MF, Aliste J, Finlayson RJ. Diaphragm-Sparing Nerve Blocks for Shoulder Surgery. Reg Anesth Pain Med. 2017 Jan/Feb;42(1):32-38.

30. El-Boghdadly K, Chin KJ, Chan VWS. Phrenic Nerve Palsy and Regional Anesthesia for Shoulder Surgery: Anatomical, Physiologic, and Clinical Considerations. Anesthesiology. 2017 Jul;127(1):173-191.

31. Kim DH, Lin Y, Beathe JC, Liu J, Oxendine JA, Haskins SC, Ho MC, Wetmore DS, Allen AA, Wilson L, Garnett C, Memtsoudis SG. Superior Trunk Block: A Phrenic-sparing Alternative to the Interscalene Block: A Randomized Controlled Trial. Anesthesiology. 2019 Sep;131(3):521-533.

32. Kang R, Jeong JS, Chin KJ, Yoo JC, Lee JH, Choi SJ, Gwak MS, Hahm TS, Ko JS. Superior Trunk Block Provides Noninferior Analgesia Compared with Interscalene Brachial Plexus Block in Arthroscopic Shoulder Surgery. Anesthesiology. 2019 Dec;131(6):1316-1326.

33. Forero M, Rajarathinam M, Adhikary SD, Chin KJ. Erector spinae plane block for the management of chronic shoulder pain: a case report. Can J Anaesth. 2018 Mar;65(3):288-293. English.

34. Diwan S, Nair A. Erector Spinae Plane Block for Proximal Shoulder Surgery: A Phrenic Nerve Sparing Block! Turk J Anaesthesiol Reanim. 2020 Aug;48(4):331-333.

35. Ciftci B, Ekinci M, Gölboyu BE, Kapukaya F, Atalay YO, Kuyucu E, Demiraran Y. High Thoracic Erector Spinae Plane Block for Arthroscopic Shoulder Surgery: A Randomized Prospective Double-Blind Study. Pain Med. 2021 Apr 20;22(4):776-783.

36. Sandeep Diwan; Xavier Sala Blanch; Abhijit Nair; Dipal Shah. Anatomic and radiological correlation of injectate spread from first thoracic costotransverse junction in cervical erector spinae plane. Autopsy and Case Reports, vol 11, e2021275, 2021. Hospital Universitario da Universidade de Sao Paulo.

37. Bjørnholdt KT, Jensen JM, Bendtsen TF, Søballe K, Nikolajsen L. Local infiltration analgesia versus continuous interscalene brachial plexus block for shoulder replacement pain: a randomized clinical trial. Eur J Orthop Surg Traumatol. 2015 Dec;25(8):1245-52.

38. Fredrickson MJ, Krishnan S, Chen CY. Postoperative analgesia for shoulder surgery: a critical appraisal and review of current techniques. Anaesthesia. 2010 Jun;65(6):608-624.

39. Bailie DS, Ellenbecker TS. Severe chondrolysis after shoulder arthroscopy: a case series. J Shoulder Elbow Surg. 2009 Sep-Oct;18(5):742-7.

40. Kolade O, Patel K, Ihejirika R, Press D, Friedlander S, Roberts T, Rokito AS, Virk MS. Efficacy of liposomal bupivacaine in shoulder surgery: a systematic review and meta-analysis. J Shoulder Elbow Surg. 2019 Sep;28(9):1824-1834.

41. Dinges HC, Wiesmann T, Otremba B, Wulf H, Eberhart LH, Schubert AK. The analgesic efficacy of liposomal bupivacaine compared with bupivacaine hydrochloride for the prevention of postoperative pain: a systematic review and meta-analysis with trial sequential analysis. Reg Anesth Pain Med. 2021 Jun;46(6):490-498.

42. Vandepitte C, Kuroda M, Witvrouw R, Anne L, Bellemans J, Corten K, Vanelderen P, Mesotten D, Leunen I, Heylen M, Van Boxstael S, Golebiewski M, Van de Velde M, Knezevic NN, Hadzic A. Addition of Liposome Bupivacaine to Bupivacaine HCl Versus Bupivacaine HCl Alone for Interscalene Brachial Plexus Block in Patients Having Major Shoulder Surgery. Reg Anesth Pain Med. 2017 May/Jun;42(3):334-341.

43. Panchamia JK, Amundson AW, Jacob AK, Sviggum HP, Nguyen NTV, Sanchez-Sotelo J, Sperling JW, Schroeder DR, Kopp SL, Johnson RL. A 3-arm randomized clinical trial comparing interscalene blockade techniques with local infiltration analgesia for total shoulder arthroplasty. J Shoulder Elbow Surg. 2019 Oct;28(10):e325-e338.

44. 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 Jul;129(1):47-57.

45. 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 May/Jun;42(3):302-309.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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