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Which regional anesthesia technique is the best for arthroscopic shoulder surgery in terms of postoperative outcomes? A comprehensive literature review

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Abstract. – OBJECTIVE: The literature offers numerous reviews and meta-analyses assessing the different regional anesthesia techniques employed for arthroscopic shoulder surgery (ATS) in terms of diverse outcome parameters. Most have focused on analgesic efficacy in the limited post-operative period as their primary outcome. Indeed, the most up-to-date guidelines are based on the results of comparisons that focus on analgesic efficacy and analgesic drug consumption. However, a correlation has yet to be demonstrated between post-operative analgesia and functional recovery; indeed, the latter has received relatively less research attention concerning the anesthetic technique despite its clinical importance. Here, we aimed to identify the best loco-regional anesthetic technique for ATS, considering all the evaluation parameters considered to date.

MATERIALS AND METHODS: We performed a comprehensive literature review on ATS, searching for all the relative aspects of the regional anesthesia technique employed and the outcome parameters assessed.

RESULTS: From the literature, it is not clear which technique is better than the others. No single technique was revealed as being the absolute best, independent of the outcome parameter considered, which included: post-operative analgesic effect, speed of functional recovery, ease, and safety of execution.

CONCLUSIONS: The choice of anesthetic technique should be tailored to the patient and type of surgery. When comparing one type of loco-regional anesthesia against another, in addition to analgesic efficacy, a whole plethora of aspects need to be considered (i.e., feasibility, complications, contribution to functional recovery, etc.).

Key Words:
Pain, Postoperative, Nerve Block, Ultrasonography.

Introduction

Historically, literature reviews and meta-analyses have addressed the use of various regional anesthesia techniques in arthroscopic shoulder surgery (ATS). Most of these studies focused on analgesic efficacy in the limited post-operative period as their main study outcome. The most current guidelines are based on evidence generated from comparisons of analgesic efficacy and analgesic drug consumption between the different techniques. Based on the analysis of these two parameters only, the superiority of the interscalene approach to brachial plexus block (ISB) has been confirmed, and it is still considered a gold standard in clinical anesthesiology practice. However, the analgesic efficacy of ISB is only better than that achieved by other approaches in the first few post-operative hours[1-3]. Therefore, its supposed superiority has been rightly questioned, but a consensus regarding the best alternative anesthetic technique has yet to be expressed. Until now, however, anesthesiological studies have tended to focus on the purely analgesic aspects of outcome, and generally failed to think in more global terms with regard to patient healing processes. Instead, anesthesiologists' goals should include aspects that go beyond analgesia in the short-term post-operative setting, especially considering the fact that a correlation between post-operative analgesia and functional recovery has yet to be demonstrated. For instance, the most recent review on pain management for rotator cuff repair surgery by Toma et al[1] in 2019 only addressed post-operative analgesia. Thus, a gap in the literature becomes evident, as is the need for an approach to anesthetic appraisal that considers all clinical outcomes/elements, including

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long-term functional aspects. To fill this gap, we performed a comprehensive literature review, searching for all aspects in addition to regional anesthesia technique for ATS.

Materials and Methods

The reviewing method we applied allowed us to group studies together that had reached similar conceptual conclusions but obtained through studies that considered different quantitative and/or qualitative outcomes. We deemed this to be the best way to obtain higher-order evidence, considering that the argument hardly lends itself to unambiguous conclusions due to the various aspects considered.

The few studies that have dealt with the topic are heterogeneous and miss complete and comparable statistical data and qualitative evidence due to the application of different research methods/approaches. Therefore, as explained, we adopted a literature review approach, but were unable to produce a synthesis by means of meta-analysis. In conducting the study, we followed the AMSTAR 2 publication standards for systemic reviews[4].

Search Strategy

We searched the Medline (PubMed) library (2009-2019 period) using the following MeSH-terms: "Interscalene nerve block" AND/OR "Suprascapular nerve block" AND "adverse events" AND/OR "complications" OR "pneumothorax" OR "nerve injury" AND "shoulder arthroscopy" OR "functional outcome" OR "recovery" OR "peripheral nerve block" OR "rebound pain".

Data Extraction

Full-text papers were initially assessed for relevance and subjected to rapid appraisal using the Critical Appraisal Skills Programme (CASP) checklist. We excluded all articles that did not meet the essential criteria for CASP (such as relevance to the review title). We considered a wide range of papers, including randomized controlled trials, brief reports, and observational studies. We excluded non-English language studies, non-human studies, and pre-clinical research. Two authors (MD and DO) recovered the full texts for each of the relevant articles. All related titles and abstracts were retrieved, and the full version articles downloaded. The reference lists of all studies and review articles included were hand-searched to identify any additional relevant studies for analysis.

Quality Appraisal

The quality of each considered article was assessed further using the CASP (Critical Appraisal Skills Programme) checklist.

Two independent trained reviewers (DO and NF) read all papers and scored them according to the CASP checklist. Any discrepancies between assigned scores were discussed between the two reviewers. If no agreement could be reached, a third author (MD) was involved. Agreement between two out of three reviewers was considered sufficient to include the disputed study. All studies passing the reviewers' quality selection were considered in the review. Data pertaining to publication year, type of population, sample size, enrollment and sampling, setting, the primary aim of the research, and the main outcome were reported.

Summarizing the Literature

We undertook a critical evaluation of the literature, interpreted the results, and considered the strengths and limitations of each approach adopted. An argumentative line was developed that incorporates the similarities and differences in perspectives between the different studies.

Results

We screened a total of 2,262 studies, of which 90 were analyzed for the present review (Figure 1). Agreement between the authors was almost 100%. Due to the nature of the studies examined, we chose to divide our treatment into the following seven sections: (1) feasibility, effectiveness, and opioid sparing – in turn, divided into: (a) feasibility of anesthesiological nerve block; (b) effectiveness of anesthesiological nerve block; c) rebound pain control; and d) opioids consumption; (2) safety of anesthesiological nerve block – divided into: a) neurological complications; (b) inflammatory response; c) local anesthetics' systemic toxicity; and (d) respiratory complications; (3) patient satisfaction; (4) impact on length-of-stay; (5) impact on functional outcome and rehabilitation; (6) chronic pain and anesthesia; and (7) intervention technique/basal condition (**Supplementary Table I**).

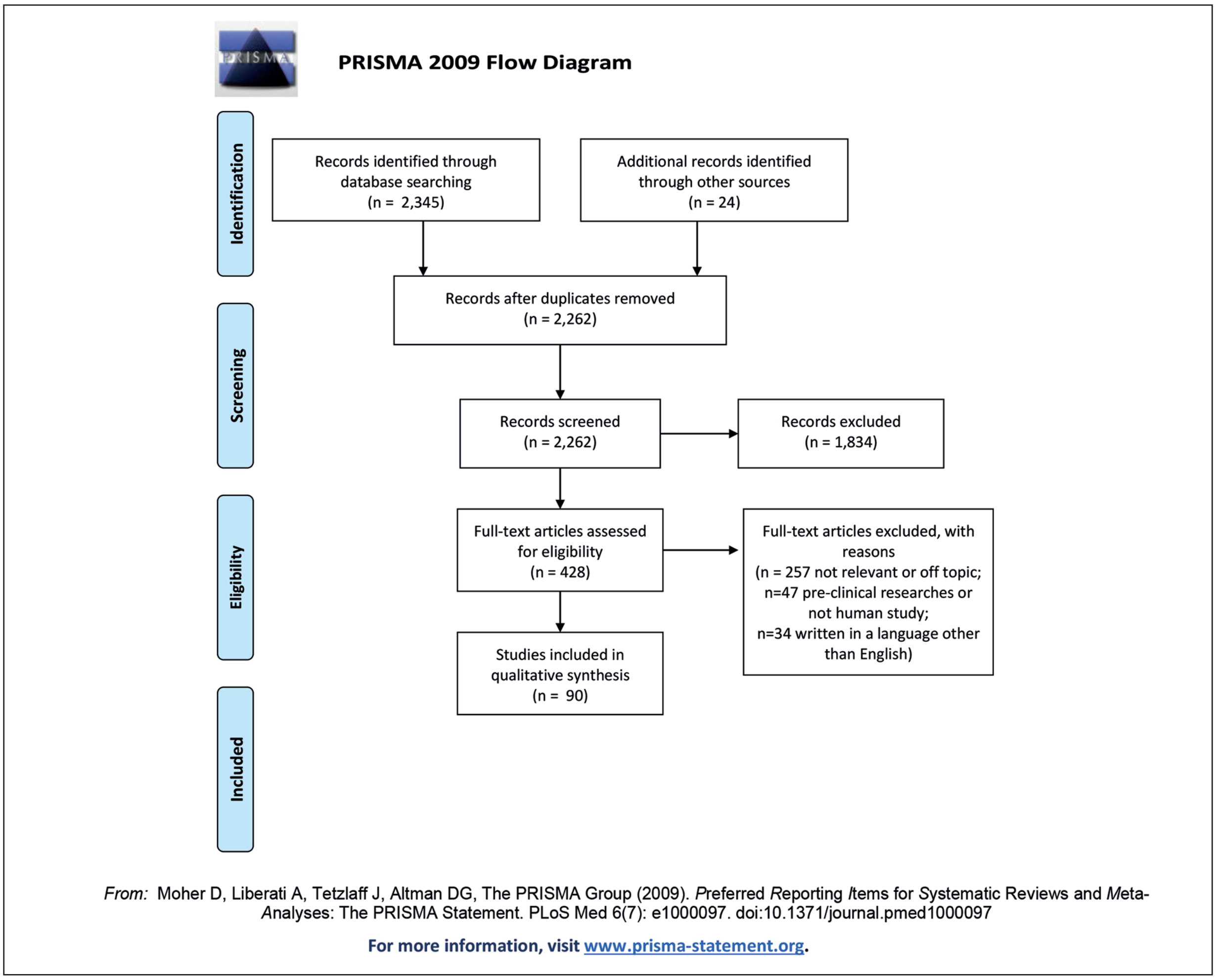

Figure 1. The research and selection process of the studies considered, and the reasons for study exclusion.

1) Feasibility, Effectiveness, and Opioids Sparing

a) The feasibility of Anesthesiological Nerve Block

The reported success rate of ultrasound-guided (US-guided) ISB for ATS is high. Davis et al[5] reported a success rate of 99% (200 US-guided ISBs), and Fredrickson et al[6] a rate of 95% (659 US-guided ISBs). Liu et al[7] reported a success rate of 99.8% for 1169 patients undergoing ATS, of which 515 were performed with ISB, and 654 with supraclavicular nerve block (SCB) and ultrasound (with electrical nerve stimulation [ENS] applied in 6% and 2%, respectively). The percentage of failed procedures was 0% for ISB, and 0.2% for SCB. In a prospective study of 1,319 patients undergoing ambulatory ATS with US-guided ISB performed by expert anesthesiologists, Singh et al[8] recorded a 99.6% success rate. Rohrbaugh et al[9] reported success rate of 11% and 2.7% for ISBs performed with ENS and US-guidance, respectively, on a total of 15,014 outpatient ATSs performed by anesthesia residents. Beals et al[10] examined the effectiveness of ISBs with US performed by emergency medicine residents to reduce shoulder dislocation and revealed a success rate of 78.5%. Thus, considering the above-cited studies, it appears that the operator's level of experience greatly influences the success rate of the nerve block. Blasco et al[11], in a cadaveric study, compared the proximal (near the suprascapular notch) and distal ultrasound-guided approaches (via the supraspinous fossa) to the suprascapular nerve. In essence, they demonstrated both ultrasound-guided methods reach the target effectively. The proximal approach reached more frequently the supra-scapular nerve (13 *vs.*

11) – but also the phrenic nerve (3 *vs.* 0) – than the distal approach. Laumonerie et al[12] compared US-guided and non-US-guided distal suprascapular nerve block (SSB), and concluded that the distal SSB can be performed effectively by the orthopedic surgeon proximal to the suprascapular notch in order to involve the three sensory branches innervating the posterior glenohumeral capsule, subacromial bag, and coracoclavicular and acromioclavicular ligaments.

With regard to the reproducibility of these studies, Taenzer et al[13] highlighted the unjustified variability in the dosages of local anesthetic (LA) used in ISB blocks within the same hospital as well as between different hospitals (the study concerned 21 centers in the USA and Australia over the study period: 2011-2017). Indeed, the dosage has an even more significant variability than age, weight, gender, or type of LA.

b) Effectiveness of Anesthesiological Nerve Block

Warrender et al[3] pointed out that the use of ISB, pregabalin, and etoricoxib before surgery results in less post-operative pain and higher levels of patient satisfaction. A 2018 meta-analysis[14], involving 707 patients undergoing shoulder prosthesis, showed that ISB provides superior analgesia compared with infiltrative local anesthesia with liposomal bupivacaine, but only in the first four post-operative hours. Kim et al[15] highlighted that no overwhelming consensus exists regarding the best technique to use for ATS. According to the Authors, the anesthesiological block would be more effective through the caudal approach to the plexus, rather than via the classic approach that does not guarantee anesthesia of the C8 root. The involvement of the C8 root is essential to cover the back of the shoulder. A meta-analysis by Abdallah et al[16] (23 studies, 1,090 patients), on the analgesic efficacy of ISB *vs.* no block, showed that ISB guarantees better analgesia against movement pain at 6 hours and 8 hours at rest.

As for SSB, Cho et al[17], reviewing the analgesic efficacy of posterior SSB using data from 10 studies, reported that block performed using anatomical references (700 patients, 371 receiving SSB *vs.* 329 receiving no block) provides only modest analgesic benefit in the first six post-operative hours; the Authors found a statistical difference in pain scores in the 24 h post-operative period. Coory et al[18], in a study comparing US-guided SSB and subacromial infiltration (in 42 patients), reported better analgesic efficacy and functional results with SSB at 6 and 12 post-operative weeks. One of the few studies to compare analgesic efficacy between the anterior and posterior approach to SSB is that by Rothe et al[19], who showed the former to be more efficient than the latter.

Kay et al[20] compared the efficacy of post-operative pain control achieved by ISB *vs.* SSB. From the analysis of 14 studies (1382 patients), SSB was found to be significantly more effective than other non-blocking techniques in the first as well as fourth and sixth post-operative hours. The same Authors underlined that SSB is less effective than ISB in the early post-operative hours. Desroches et al[21] conducted a comparison RCT between US-guided ISB and SSB performed using anatomical landmarks during operations to repair the supraspinatus and/or infraspinatus tendon. SSB was as effective as ISB for controlling pain within the first 24 hours, but ISB was more effective at relieving pain in the recovery room. Auyong et al[22] confirmed this result in a study comprising 189 patients. By contrast, a Belgian study[23] of 100 patients found ISB to be superior in analgesic terms compared with SSB in the first four post-operative hours. However, a 2017 meta-analysis[24] (16 studies, 1152 patients) found there to be no clinically significant analgesic differences between ISB and SSB. ISB appears to provide better pain control while the patients remain in the recovery room.

c) Rebound Pain Control

From the literature, it appears that rebound pain occurs in up to 40% of patients following regional anesthesia. However, the incidence of rebound pain is not the same in relation to all forms of blockade[25,26].

DeMarco et al[27], comparing ISB *vs.* placebo (both associated with the subacromial infusion of LA for 72 hours and opioids as rescue therapy), revealed the phenomenon of rebound pain in a considerable percentage (VAS 61.4 *vs.* 48.7) of patients. The first meta-analysis[16] to consider this aspect (23 studies, 1,090 patients) showed rebound pain to be a frequent phenomenon after ISB, occurring between the eighth- and twenty-fourth post-operative hour. Liu et al[7] did not detect a statistically significant difference between ISB and general anesthesia without nerve block. In a comparison between three analgesia treatment groups (ISB single shot; patient-controlled epidural analgesia (PCEA) via catheter; and meperidine as needed), Kim et al[28] reported rebound pain in the ISB single shot group at 12 hours post-operative, whereas it was completely absent in the PCEA group. A recent meta-analysis[29] comparing liposomal bupivacaine and non-liposomal bupivacaine in ISB block showed no difference in pain levels (assessed using the visual analog scale) at 24 and 48 hours.

Park et al[30], comparing intravenous patient-controlled analgesia (PCA IV) alone *vs.* PCA IV associated with SSB with and without axillary block, found that some degree of rebound pain at 12 and 36 hours was recorded in all groups.

In a comparison of SSB associated with axillary block *vs.* SSB alone, Lee et al[31] showed that SSB associated with axillary block reduces the frequency of rebound pain as compared with SSB alone. Three years later, the same group[32] examined ISB associated with SSB *vs.* ISB alone; they found rebound pain to occur in all patients undergoing ISB alone (9.3 h), whereas it occurred in half of the patients in the ISB + SSB group (15.5 h). The pain intensity results were also unfavorable for the ISB-alone group (NRS: 2.5 *vs.* 4). Rhyner et al[33] reported better analgesia in relation to ISB than with SSB. That said, at 24 hours, the difference disappeared, and morphine consumption was similar between the two groups.

Cho et al[17] reviewed the literature on the analgesic efficacy of posterior suprascapular block. They found that this technique was not associated with rebound pain within the first 24 post-operative hours.

d) Opioids Consumption

Sethi et al[34] demonstrated that the use of liposomal bupivacaine in association with either ISB or SSB resulted in a reduction in opioids consumption in the post-operative period. However, other conflicting results are present in the literature regarding the differences between these two approaches to nerve block: Neuts et al[23] found a higher consumption of opioids in the SSB group (*vs.* ISB) in the first 8 hours post-surgery, whereas Auyong et al[22] did not detect any differences. One meta-analysis[16] showed how using ISB correlates with opioid savings in the first twelve hours post-surgery. Moreover, two other meta-analyses conducted after the abovementioned one by Abdallah et al[16], in 2017[24] and 2020[35], found no differences in the post-operative consumption of opioids between ISB *vs.* SSB and SCB, respectively.

In the literature, opioid consumption is considered an indicator of post-operative analgesia, but does it still make sense to use post-operative analgesia as a parameter, since it is also influenced by the frequent and chronic use of NSAIDs and opioids in the preoperative period? Some studies have correlated the (preoperative and chronic) use of NSAIDs with a functional deterioration in recovery[36], although other studies have refuted this hypothesis (showing how a multimodal approach to post-operative pain is related to a better quality of recovery and less opioid consumption)[37]. However, in the literature, the preoperative use of opioids – in the case of ISB – correlates with an increase in opioid consumption (1.91 times greater) in the post-operative period[38].

2) Safety of Anesthesiological Nerve Block

a) Neurological Complications

The complications following arthroscopic shoulder surgery are significant and claims for compensation following brachial plexus injuries associated with ISB make up a considerable part of all claims (up to 40%)[39].

The neurological disorders most frequently incurred after anesthetic nerve block for ATS are transient neurologic symptoms (TNS; 16%), Horner's syndrome, hoarseness, upper limb paresthesia, muscle weakness, both with ISB and with SSB (although in a lower percentage of patients in the latter case)[24]. The prospective study by Singh et al[8] on 1,319 patients undergoing US-guided ISB showed an incidence of adverse events equal to 2.88% (TNS, transient numbness of the ear and/or fingers, and neuropathy of the ulnar nerve resolved at four months). In this study, four cases of permanent brachial plexopathy (0.23%) were reported. Of these four cases, three were secondary to neurological comorbidities, such as transverse myelitis and multiple sclerosis. TNS seems to be the most frequent complication (3.4%)[40]. Davis et al[5] report an incidence of 1% TNS and 6% needle puncture paresthesia. Adams et al[41] reported a case of Harlequin syndrome after ISB (contralateral facial redness and sweating secondary to the inhibition of the ipsilateral sympathetic chain, without miosis or ptosis). Cases of paralysis of the hypoglossal nerve or the association of the laryngeal nerve + hypoglossal + recurrent (Tapia syndrome) have been reported[42].

Cases of transient dysphonia due to upper laryngeal nerve palsy[43], persistent phrenic nerve palsy[44,45], and delayed onset quadriparesis[46] have also been reported.

However, some authors[47] have found that the patient's position during surgery may constitute a confounding factor in the incidence of brachial plexus stretching injuries.

In relation to the use of ultrasound as a guide and the incidence of adverse effects, Orebaugh et al[48] found a difference (albeit not statistically significant) between US-guided ISB *vs.* ISB conducted with ENS only: one case of nerve injury in US-guided ISB *vs.* 4 in ISB with ENS; four cases of seizure toxicity in the ISB with ENS group only. However, the use of ultrasound as a guide seems to reduce the occurrence of complications. In a study in which the patients underwent an examination of the vocal cords before and after the execution of ISB, no alterations occurred[49].

In comparing different types of blockade, Liu et al[7] reported a 31% occurrence of immediate dysphonia and a 11% incidence of delayed dysphonia with SCB *vs.* a 22% occurrence associated with ISB (dyspnea occurred in 10 *vs.* 7% of cases of SCB *vs.* ISB, respectively).

As for the volume of local anesthetic used, Stundner et al[50] highlighted that epidural distribution (and, therefore, the theoretical risk of phrenic nerve blockade) is common for both low volumes (5 ml) and high volumes (10 ml). However, diffusion in the intervertebral foramen seems to be more frequent for high volumes (and, therefore, the frequency of diaphragmatic paralysis).

b) Inflammatory Response

The studies which have tried to verify a relationship between the level of inflammation and pain (and, therefore, analgesic methods) are still few and far between. Liu et al[51] experienced a reduction in insulin levels (used as a stress marker) in patients treated with nerve block compared with a group treated with inhaled anesthetics. In the joints of patients with a rotator cuff tear, Okamura et al[52] found a high level of inflammatory cytokines (such as interleukin 8), which correlated with night-time pain at rest. The authors hypothesized pain to be a marker of inflammatory activation. In this regard, Meja-Terrazas et al[53] evaluated the concentration of some inflammatory stress biomarkers (the erythrocyte sedimentation rate, levels of reactive protein C, and the white blood cell count) after ISB *vs.* general anesthesia. The group of patients treated with ISB showed significantly less inflammation after the first 24 post-operative hours.

c) Local Anesthetic Systemic Toxicity (LAST)

In two recent reviews, the incidence of LAST following ISB was reported to be around 8% in one (for data pertaining to the years 2014 to 2017)[54], whereas the other calculated a rate of 23% (for years 2010 to 2014)[55]. However, according to large-scale retrospective studies, LAST is much rarer. Liu et al[56] reported 3 cases of seizures (of which 1 occurred out of 2,138 patients after non-US-guided ISB, and 1 occurred out of 13,348 patients after US-guided SCB). Morwald et al[57] found a 0.15% incidence of LAST in relation to nerve blocks for shoulder prosthesis (years 2006-2014, retrospective data from a national database). In Rohrbaugh et al[9], the prevalence was even lower (0.053% for a single center, involving 15,014 patients, from 2001 to 2011). Particularly severe cases of LAST with cardiovascular expression have also been reported in the literature. Corey et al[58] reported an incident of seizures, the Brugada phenomenon, and cardiac arrest by ventricular fibrillation after the administration of bupivacaine (0.5%, 30 mL) after non-US-guided ISB. However, the amount of local anesthetic administered does not seem to be linearly correlated with the onset of cardiovascular changes. Indeed, Borgeat et al[59] found that it is not directly associated with elevated plasma peaks for high doses of local anesthetic (30-45 mL). Simultaneously, the QT interval elongation can also occur for plasma concentrations lower than those considered cardiotoxic.

d) Respiratory Complications

After loco-regional anesthesia, the incidence of respiratory complications seems to vary depending on the type of nerve block performed, the technique used, and the anesthetic administered. The meta-analysis by Hussain et al[24] reports dyspnea to be the most frequent respiratory complication, with an occurrence of 34/373 for ISB, and 8/379 for SSB. Moreover, the only case of pneumothorax occurred in the ISB group. ISB appears to have a higher incidence of respiratory complications than SSB[21-23,33].

However, since several types of nerve block appear to be as effective as ISB and less burdened by respiratory complications, some authors have proposed these blocks as an alternative in ATS[60]. Panchamia et al[61,62] used an infraclavicular block associated with a suprascapular block, or a suprascapular nerve block associated with an axillary block. Ferrè et al[63] demonstrated how

ISB could be used with a short-acting local anesthetic associated with the suprascapular block and axillary block with long-lasting local anesthetic for arthroscopic shoulder surgery. A recent review[64] has shown that anterior suprascapular nerve block is just as effective as ISB, but with a lower risk of diaphragmatic paralysis. Furthermore, supraclavicular (SCB) and infraclavicular blockade (ICB) seem worthy of further investigation because they are substantially comparable to ISB but associated with a lower complication rate.

Ghodki et al[65] highlighted how ultrasound decreases the rate of adverse respiratory effects. Some authors[14] have evaluated liposomal bupivacaine, which would appear to produce a lower percentage of respiratory complications.

Patients with a body mass index greater than 25 seem to sustain a higher occurrence of diaphragmatic paralysis following ISB, as highlighted by Melton et al[66] and Marty et al[67]. In the latter study, SSB proved to be safer than ISB.

3) Patient Satisfaction

Regarding the evaluation of patient satisfaction, the literature data are extremely varied: in particular, there is substantial heterogeneity in the scales used to measure patient satisfaction. Some studies[17,23,67,68] found higher satisfaction associated with SSB than with ISB, whereas other studies[24,33] found no difference between the two. Lee et al[31] found that SSB associated with axillary block achieves higher satisfaction levels than single nerve blocks. However, it should be noted that Singh et al[8] even found a very high level of satisfaction with US-guided ISB, highlighting the fact that this type of assessment is very highly difficult, and consists of individual patients rating a single technique, and who have no way of comparing their experience with that obtained from different techniques.

4) Impact on Length-of-Stay (LOS)

In a study comprising almost 60,000 patients, Hamilton et al[69] verified that, compared with general anesthesia alone, peripheral nerve blocks are associated with a lower unplanned admission rate. However, the authors point out that the readmission rate is not lower due to the rebound pain episodes. It should be noted that the same authors found no difference as regards the hospital discharge rate between general anesthesia and peripheral nerve block[70]. Sultan et al[71] analyzed the most frequent causes of unexpected night hospitalization, identifying the most associated factors, which were: age > 65, pain, the oozing of the wound, ASA class, and the repair of the rotator cuff surgery. ISB was not found to be a related factor. Nonetheless, our own group has been able to verify that ISB is associated with a more delayed motor recovery than SSB (5 overnight stays in the ISB group *vs.* 0 in the SSB group), which itself can be a cause of delayed discharge[72]. Kolade et al[29], in their previously mentioned meta-analysis, found no differences in LOS between patients treated with liposomal bupivacaine *vs.* non-liposomal bupivacaine in ISB block.

5) Impact on Functional Outcome and Rehabilitation

Post-operative pain has traditionally been the parameter most frequently used to compare the efficacy of different anesthesia techniques and different anesthetic drugs; however, in recent times, the emphasis has instead been shifted onto functional outcome, i.e., the recovery of joint strength, and thus complete functional recovery[73,74]. The importance of early rehabilitation and restoration of joint function is now widely recognized[75]. Indeed, Li et al[76] note that "anatomical" failure after ATS for rotator cuff repair occurs with an incidence ranging from 20% to 90%. The Authors show that physiotherapy achieves better functional results when applied earlier rather than later. SSB seems to obtain better functional outcomes than just subacromial infiltration[18,67]. Jung et al[77] obtained similar results in patients treated non-surgically in the SSB group compared with intra-articular infiltration alone. In general, loco-regional anesthesia achieves better functional outcomes than infiltration alone[35,78]. Our group[72], in comparing ISB and SSB in 144 patients, observed that the SSB led to faster motor recovery, and, therefore, earlier physiotherapy rehabilitation.

6) Chronic Pain and Anesthesia

The need for opioids in the post-operative period is often used as a parameter of failed post-operative analgesia, and, therefore, as an indirect parameter of chronicization of post-operative pain/chronic post-surgical pain (CPSP). CPSP typically occurs after thoracotomy, mastectomy, and knee and hip replacement surgery, but, as yet, not after shoulder surgery[79].

Epidural analgesia after thoracic surgery and loco-regional anesthesia after knee replacement operations have a preventive effect on CPSP. However, a similar effect was not reported after shoulder surgery, nor with loco-regional techniques nor gabapentinoids[80,81]. However, Syed et al[82] showed that the use of opioids is not linearly related to the intensity of post-operative pain, making this a poor parameter for evaluating the development of chronic pain.

If no single loco-regional anesthesia technique has demonstrated preventive efficacy for CPSP after ATS, it is because the underlying factors responsible for CPSP are so numerous, making it is difficult to identify a clear causal link. Certain psychological aspects (such as depression) also seem to contribute significantly to the manifestation of chronic pain[83-87].

7) Intervention Technique/Basal Condition

Boddapati et al[88] showed that surgical time correlates with wound infection prevalence and the risk of overnight hospitalization. Chen et al[89] found a different prevalence of pain depending on the surgical technique used (double-row *vs.* single row rotator cuff repairs). Calvo et al[90] established a higher intensity of pain after partial repair of the rotator cuff compared with stabilization or subacromial decompression. Coory et al[18] recorded greater efficacy in the SSB group. Full-thickness cuff lesions were most frequent, assuming that this effect is related to the traction that this pathology specifically produces on the suprascapular nerve. This form of neuropathy was demonstrated in 30% of rotator cuff injuries of any entity[90].

For the correct interpretation of the published studies and in order to produce precise and "tailored" guidelines, a detailed characterization of exactly how the type of surgical intervention can act as a confounding factor will be required.

Limitations

In conducting our review, we highlighted the heterogeneous nature of the publications considered, both in terms of study design (prospective *vs.* retrospective) as well as the outcome considered. Therefore, summarizing the results in the form of a meta-analysis is extremely difficult, and the establishment of definitive conclusions is not yet feasible (Table I).

Conclusions

The parameter most frequently considered in the literature as a measure by which to evaluate anesthesiological technique for arthroscopic shoulder surgery is analgesic efficacy. However, the literature also reveals the importance of taking other parameters into consideration, such as functional recovery and the technique's safety. Future guidelines may also consider the variables inherent to the patient (such as age, body mass index, comorbidities, the pathology/dysfunction of the shoulder, the surgical technique, and the type of hospitalization) in order to establish the best anesthesiology strategy to tailor to the patient.

Conflict of Interest
The Authors declare that they have no conflict of interests.

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Table I. Summary representation of the literature divided according to anesthetic techniques employed and parameters used to assess clinical outcome.

Anesthetic technique	Feasibility	Effectiveness	Rebound pain	Analgesic and opioid cons.	Neurologic complications	Inflammatory response	LAST	Respiratory complications	Patient satisfaction	LOS	Functional outcome	Chronicization of pain
ISB	PRO Davis 2009[5] Frederickson 2009[6] Singh 2012[8] CONS Rohrbaugh 2013[9] Beals 2019[10] Taenzer 2019[13]	PRO Sun 2018[14] Kim 2019[15] Abdallah 2015[16] Kay 2018[20] Desroches 2016[21] Auyong 2018[22] Neuts 2018[23] Hussain 2017[24]	PRO Kolade 2019[29] Rhyner 2019[33] CONS DeMarco 2011[27] Kim 2018[28] Lee 2017[32]	PRO Sethi 2019[34]	CONS Saba 2019[39] Fredrickson 2016[40] Adams 2018[41] Kraus 2019[42] Villar 2015[43] Pakala 2013[44] Cohen 2010[45] Arcas-Bellas 2009[46] Ferrero-Mendez 2016[47] Orebaugh 2012[48] Karina 2019[49] Stundner 2016[50]	PRO Liu 2017[51] Mejia-Terrazas 2019[53]	CONS Gitman 2018[54] Vasques 2015[55] Liu 2016[56] Morwald 2017[57] Corey 2017[58] Borgeat 2004[59]	PRO Ferrè 2017[63] Ghodki 2016[65] CONS Melton 2017[66] Marty 2018[67] Tran 2019[64]	PRO Hussain 2017[24]	PRO Hamilton 2019[70] CONS Divella 2019[72] Sultan 2012[71]	PRO Boissard 2018[78]	CONS Adam 2006[80]
ISB + SCB	PRO Liu 2010[7]											
ISB + SSB			PRO Lee 2017[32]									
SSB	PRO Blasco 2019[11] Laumonierie 2019[12]	PRO Cho 2019[17] Coory 2019[18] Rothe 2014[19] Kay 2018[20] Desroches 2016[21] Auyong 2018[22]		PRO Sethi 2019[34]				PRO Hussain 201724 Flaherty 2016[60]	PRO Hussain 2017[24] Jeske 2011[68] CONS Lee 2014[31]	PRO Divella 2019[72]	PRO Salt 2018[73] Coory 2019[18] Jeske 2011[68]	
SSB + ANB			PRO Lee 2014[31]					PRO Panchami 2017[62] Tran 2019[64] Neuts 2018[23]	PRO Ferrè 2017[63] Marty 2018[67] Neuts 2018[23] Lee 2014[31]			

Continued

Table 1 ***(Continued).*** Summary representation of the literature divided according to anesthetic techniques employed and parameters used to assess clinical outcome.

Anesthetic technique	Feasibility	Effectiveness	Rebound pain	Analgesic and opioid cons.	Neurologic complications	Inflammatory response	LAST	Respiratory complications	Patient satisfaction	LOS	Functional outcome	Chronicization of pain
SSB + LIA											PRO Jung 2019[77]	
SCB	PRO Singh 201[28]			PRO Hussain 2020[35]			CONS Liu 2016[56]	PRO Tran 2019[64]				
ICB + SSB								PRO Panchamia 2017[61]				
Gabapentin				PRO Elkassabany 2019[37]							PRO Elkassabany 2019[37]	CONS Hah 2018[81]

Studies are also listed according to whether their results were negative (NEG) or positive (POS) in relation to the outcome parameters assessed.

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