7-17-2013

Interscalene brachial plexus block for arthroscopic shoulder surgery: a systematic review

Michael S. Hughes
Washington University School of Medicine in St. Louis

Matthew J. Matava
Washington University School of Medicine in St. Louis

Rick W. Wright
Washington University School of Medicine in St. Louis

Robert H. Brophy
Washington University School of Medicine in St. Louis

Matthew V. Smith
Washington University School of Medicine in St. Louis

Interscalene Brachial Plexus Block for Arthroscopic Shoulder Surgery

A Systematic Review

Michael S. Hughes, MD, Matthew J. Matava, MD, Rick W. Wright, MD, Robert H. Brophy, MD, and Matthew V. Smith, MD

Investigation performed at the Department of Orthopedic Surgery, Washington University, Chesterfield, Missouri

Shoulder arthroscopy is currently one of the more common orthopaedic procedures, with an estimated 1.4 million procedures performed per year worldwide[1]. Many of these procedures are being performed on an outpatient basis and present substantial postoperative pain control challenges to the surgeon and anesthesiologist. An integral component of successful ambulatory surgical treatment is achieving and maintaining adequate pain management during the early postoperative course.

The pain during the first twenty-four to forty-eight hours after arthroscopic shoulder surgery is often equivalent to that after open surgery, with 30% of patients reporting severe pain on the first postoperative day[2]. In a study of more than 15,000 outpatient surgical procedures from nine different surgical specialties, pain was responsible for 12% of the unplanned postoperative hospital admissions[3]. A retrospective review of 222 shoulder arthroscopy cases revealed a 2% rate of unplanned overnight admission because of pain symptoms[4]. Additionally, postoperative pain may instigate endocrine and metabolic responses, autonomic reflexes, nausea, and constipation that potentially lead to delayed postoperative rehabilitation, adhesive capsulitis, hospital admission, and loss of work days[5-7]. As a result, many different modalities have been described in both the orthopaedic and anesthesiology literature to minimize postoperative pain following ambulatory surgery[8].

Traditionally, these surgical procedures were performed under general anesthesia with infiltration of local anesthetic and parenteral administration of opioids to achieve early postoperative pain relief. Over forty years ago, Winnie reported the results of an interscalene brachial plexus block involving a single anesthetic injection for pain control following shoulder surgery[9]. Nearly two decades later, Tuominen et al. described an interscalene block technique involving the placement of an indwelling catheter to provide continuous infusion of anesthetic for two to three days of pain relief[10]. A third modality includes continuous anesthetic administration via a pump catheter placed into the subacromial or intra-articular space[11-13].

There is a relative paucity of high-level randomized controlled studies addressing the benefits and potential complications associated specifically with interscalene brachial plexus blocks. The purpose of the present systematic review was to evaluate the available Level-I and II randomized controlled trials comparing interscalene blocks in arthroscopic shoulder surgery with placebo or noncontinuous infusion of anesthetic, with the primary outcome being analgesic efficacy. Secondary outcomes included use of narcotic and non-narcotic medication, side effects of opioid use, cost-effectiveness, and complications of the interscalene block. We hypothesized that the interscalene block would be at least as effective as general anesthesia alone or other regional anesthetic techniques for decreasing postoperative pain, the need for supplemental analgesics, and episodes of nausea and vomiting, and that the associated complication rate would be low.

Materials and Methods

We performed an electronic search of PubMed (1950 to present), Embase (1966 to present), and the Cochrane databases with use of the following search terms: "shoulder arthroscop* AND (block OR regional anesthesia)," "rotator cuff AND (block OR regional anesthesia)," and "interscalene." This search was performed on May 28, 2012, and identified 1049 articles in PubMed, 1630 articles in Embase, and no articles in the Cochrane library database. The search results represented a total of 1350 unique articles after removal of

Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. One or more of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article.

duplicates. The abstracts of these articles were reviewed for inclusion in the systematic review. Thirty-five of the articles subsequently underwent full-text review, and ten were ultimately found to satisfy the inclusion and exclusion criteria. The systematic review included published Level-I or II randomized controlled trials analyzing the effectiveness of interscalene brachial plexus blockade for shoulder arthroscopy procedures, assessed on the basis of pain relief and/or usage of narcotic medication, compared with either placebo or noncontinuous infusion of anesthetic via a pump. Non-English-language articles, abstracts, proceedings from meetings, and studies that included open shoulder procedures, surgical procedures on other parts of the upper extremity, or a continuous subacromial or intra-articular pump analgesic modality were excluded. Two authors (M.S.H. and M.V.S.) independently executed the search protocol to identify studies for inclusion, evaluate homogeneity, and appraise study quality.

The bibliographies of the ten eligible articles and a manual review of articles published between January 2012 and June 2012 in *Acta Anaesthesiologica Scandinavica, Anesthesia & Analgesia, Arthroscopy, The American Journal of Sports Medicine, European Journal of Anesthesiology, The Journal of Bone and Joint Surgery* (American and British Volumes), *Journal of Shoulder and Elbow Surgery,* and *Regional Anesthesia and Pain Medicine* did not identify any additional articles for inclusion. Thus, ten studies were included in the final analysis. The CONSORT (Consolidated Standards of Reporting Trials) guidelines were used to help evaluate study quality[14].

Source of Funding

There was no external funding source for this study.

Results

Tables I and II summarize the study demographics, including the outcome measures used and potential sources of bias. Table III summarizes the study randomization and blinding process and power analysis. Table IV summarizes the analgesia protocols, which included oral and parenteral administration of narcotics and non-narcotics and local infiltration of anesthetics. A meta-analysis was not believed to be appropriate because of the wide variations in the nature of the control and treatment groups across the studies and the heterogeneity of the outcome measures used.

Use of an interscalene block was associated with a significant reduction in the pain level, as measured with use of a visual analog scale (VAS) or a visual eleven-point box scale (BS-11), at various time points up to twenty-four hours after surgery in each of the ten studies included in the systematic review[15-24]. VAS and BS-11 pain scores were significantly lower than those in the controls at twenty-four hours after surgery in three of the seven studies that included this time point[17,21,24]. Lee et al. and Nisar et al. reported significantly lower VAS scores at all time points less than twelve hours after surgery but not at twenty-four hours[20,22]. Oh et al. reported lower VAS scores at one hour and eight hours after surgery in the group that received a single-injection interscalene block compared with the control group that received intravenous pain medication[23]. Laurila et al. found that use of an interscalene block significantly lowered the BS-11 score at rest during the first four hours after surgery as well as the score when the patient moved the arm during the first six hours[19]. DeMarco et al. conducted a double-blind study of fifty-three patients who received a subacromial continuous infusion of bupivacaine combined with an interscalene injection of either 0.5% ropivacaine or a saline solution control. The VAS score in the patients who received the ropivacaine interscalene block was significantly lower during the first six hours but not at subsequent time points (up to eighty hours)[16].

In addition, the amount of supplemental analgesia required was significantly less in the interscalene block group compared with the control group at various postoperative time points in eight of the nine studies that examined this outcome[15,17,19-24]. The type of supplemental analgesia varied across the studies. Only the study by Gonano et al. did not record the administration of supplemental medication in the treatment and control groups[18]. It should be noted that both the VAS and supplemental analgesic outcomes could be susceptible to subject bias as the patients in most of the studies were aware of whether they had received an interscalene block or another form of treatment. Only the studies by Al-Kaisy et al. and DeMarco et al. had true double-blinding between the control and treatment groups[15,16]. In both of those studies, the VAS score was approximately 50% lower in the group that received an interscalene block with anesthetic compared with the group that received saline solution. In the study by Al-Kaisy et al., the amount of supplemental analgesia needed was approximately one-third as great in the group that received an interscalene block with anesthetic compared with the group that received saline solution[15]. The study by DeMarco et al. revealed a trend toward lower oral narcotic usage in the interscalene block group, although the difference did not reach significance[16].

One of the proposed benefits of regional anesthesia is a decrease in systemic complications such as nausea and vomiting. The prevalence of nausea and vomiting was reported in eight of the ten studies included in this review[15,17,19-24]. Only two of the eight studies revealed a significant difference between the interscalene block and control groups, with less nausea and vomiting reported in the interscalene block group in each case[15,24]. It is possible that the remaining six studies failed to reveal a significant difference because of a type-II sampling error, as each of the studies that included a power analysis was designed to achieve adequate power for the VAS score or supplemental analgesic usage rather than the prevalence of nausea and vomiting.

The overall complication rate attributable to the interscalene block was low. Horner syndrome was noted in six patients in the included studies, with five of these being in one study[18,21]. Only one hematoma was reported[21], and one case of persistent hand paresthesia resolved after twenty-four hours[15]. Four cases of mild dyspnea and two cases of dysphonia were noted in the interscalene block group in one study[17]. A potential observer bias for these blinded-evaluator studies resulted from the inability of the evaluator to definitively determine failure or success of the block as the allocation group was not known at the time of the evaluation.

Discussion

This systematic review was performed to analyze the available evidence from high-quality studies in order to evaluate our hypothesis that an interscalene block was at least as effective as general anesthesia alone or other regional anesthetic

TABLE I Study Treatment Demographics*

Study	Surgery†	Treatment Group‡	Treatment Injection Solution§
Al-Kaisy et al.[15]	SAD, RCR, cap	ISBP	0.125% bupi with 1:400,000 epi (10 mL)
DeMarco et al.[16]	SAD, RCR, biceps tenotomy, SLAP, DCE	ISBP	0.5% ropi (30 mL)
Fontana et al.[17]	SAD, RCR, debridement	(1) ISBP, (2) subacromial preop., (3) intra-articular preop., (4) subacromial + intra-articular preop.	0.5% levo with 1:200,000 epi (30 mL)
Gonano et al.[18]	NM, shoulder arthroscopy	ISBP	0.75% ropi (20 mL)
Laurila et al.[19]	Debridement, labral, RCR, SAD	(1) ISBP, (2) subacromial bursal injection	(1) 0.5% ropi (15 mL), (2) 0.5% ropi (15 mL)
Lee et al.[20]	RCR	ISBP	0.5% ropi (10 mL)
Lehtipalo et al.[21]	SAD	(1) ISBP, (2) IV PCA	(1) 0.5% bupi (1.25 mg/kg of a 5 mg/ml solution), (2) 1 mg morphine every 6 min
Nisar et al.[22]	SAD, DCE, clavicle coplaning	(1) ISBP, (2) subacromial bursal injection	(1) 0.5% bupi (20 mL), (2) 0.5% bupi (10 mL) and 1% pril (20 mL)
Oh et al.[23]	RCR, SLAP, labral	(1) ISBP + IV PCA, (2) intra-articular pump, (3) ISBP + intra-articular pump	(1) 0.25% ropi (20 mL) + fentanyl, ketorolac, ondansetron on PCA, (2) 0.75% ropi (10 mL) and 0.5% ropi (96 mL) infused at 2 mL/hr, (3) 0.25% ropi (20 mL) and 0.75% ropi (96 mL) infused at 2 mL/hr
Singelyn et al.[24]	SAD	(1) Suprascapular nerve block, (2) intra-articular injection, (3) ISBP	(1) 0.25% bupi (10 mL) with 1:200,000 epi, (2) 0.25% bupi (20 mL) with 1:200,000 epi, (3) 0.25% bupi (20 mL) with 1:200,000 epi

*IV = intravenous, PCA = patient-controlled analgesia, and VAS = visual analog pain scale. †SAD = subacromial decompression, RCR = rotator cuff repair, cap = capsulorraphy, SLAP = repair of SLAP (superior labrum anterior and posterior) tear, DCE = distal clavicular excision, and NM = not mentioned. ‡ISBP = interscalene brachial plexus block. §Bupi = bupivacaine, epi = epinephrine, ropi = ropivacaine, levo = levobupivacaine, and pril = prilocaine.

techniques in decreasing postoperative pain, the need for supplemental analgesics, and episodes of nausea and vomiting. Additionally, we attempted to document the prevalence of complications associated with the interscalene block. Our evaluation of the available Level-I and II evidence indicates that use of an interscalene block in shoulder arthroscopy resulted in a significant reduction in the pain level and the need for supplemental analgesics compared with general anesthesia and other regional anesthetic techniques. Nausea and vomiting may have been reduced by the interscalene block in two studies, but the remaining six studies did not support this claim. There were relatively few reported complications in the included studies, and most of these complications were transient.

An interscalene block can be performed by means of a single injection of anesthetic or by placement of an indwelling catheter and anesthetic pump. We decided to limit this review to include only comparisons between an interscalene block and a placebo or noncontinuous infusion of anesthetic for two reasons: (1) interscalene blocks are one of the most common regional anesthesia techniques utilized, and (2) such a restriction limits the heterogeneity of the interventions reviewed[25]. We also decided to exclude studies that utilized intra-articular anesthetic delivery devices as use of such devices has been associated with the development of glenohumeral joint chondrolysis after arthroscopy[26-28].

This review did not include articles that compared a single-injection interscalene block with a continuous interscalene block. However, such a comparison has been made in a randomized study by Fredrickson et al. involving sixty-one patients undergoing subacromial decompression, distal clavicular excision, or labral repair. Patients were randomized by computer to either an intraoperative interscalene block with 0.5% ropivacaine or a continuous interscalene block for a total of forty-eight hours. Those authors found that the continuous interscalene block resulted in significantly lower levels of pain and supplemental analgesic usage during the first postoperative day compared with the single-injection interscalene block[29].

An identified weakness of this systematic review is the heterogeneity in the preoperative and postoperative protocols and in the shoulder pathology that was being treated. None of the ten studies exactly matched another study with regard to the anesthetic medication, medication concentration, or volume infused.

TABLE I (*continued*)

Control Group†	Control Injection Solution§	Continuous Infusion (Duration)	No. of Patients in Control Group	No. of Patients in Treatment Group
ISBP	Saline (10 mL)	No	15	15
ISBP	Saline (10 mL)	Yes (2 day)	25	28
No intervention	—	No	20	(1) 20, (2) 21, (3) 19, (4) 23
General anesthesia	—	No	20	20
Subacromial bursal injection	Saline (15 mL)	No	15	(1) 15, (2) 15
ISBP	Saline (10 mL)	No	25	25
IV bolus	Morphine (2 mg if VAS > 3)	Yes (24 hr)	10	(1) 10, (2) 10
No intervention	—	No	15	(1) 19, (2) 19
IV PCA	Weight-based protocol of 0.3-0.5 mg/kg fentanyl, 0.03 mg/kg ketorolac, and 0.08 mg ondansetron infused at 1 mL/hr	Yes for intra-articular pump only (48 hr)	21	(1) 20, (2) 20, (3) 21
No intervention	—	No	30	(1) 30, (2) 30, (3) 30

TABLE II Study Outcome Demographics*

Study	Follow-up	Pain Outcome Measure	Medication Outcome Measure	Other Outcome Measures
Al-Kaisy et al.[15]	24 hr	Verbal analog scale	Yes	Discharge readiness, nausea, time to first narcotic, time to discharge, readmission, patient satisfaction
DeMarco et al.[16]	48 hr	VAS	Yes	Supplemental medication
Fontana et al.[17]	24 hr	VAS	Yes	Patient satisfaction, nausea
Gonano et al.[18]	24 hr	VAS	Yes	Nausea, time from PACU to discharge, total cost per case
Laurila et al.[19]	20 hr	Visual 11-point box scale (BS-11)	Yes	Time to first PCA bolus, hourly oxycodone consumption, nausea, satisfaction scale, vital signs
Lee et al.[20]	24 hr	VAS	Yes	Blood pressure, pulse, nausea
Lehtipalo et al.[21]	24 hr	VAS	Yes	Headache, nausea
Nisar et al.[22]	24 hr	VAS	Yes	Nausea sickness score, time spent in hospital, time to first bolus of morphine, sedation score
Oh et al.[23]	48 hr	VAS	Yes	Nausea, urinary retention, dizziness
Singelyn et al.[24]	24 hr	VAS	Yes	Patient satisfaction, nausea

*VAS = visual analog pain scale, PACU = post-anesthesia care unit, and PCA = patient-controlled anesthesia.

TABLE III Study Statistics*

Study	Randomization	Blinding	Power Analysis	Bias
Al-Kaisy et al.[15]	Computer	Yes: observer & patient	NM	Prevalence of failed block unknown because no function assessment prior to surgery
DeMarco et al.[16]	Computer	Yes: observer & patient	Sample size of 25 patients needed for 30% difference in VAS pain score and 50% difference in narcotic tablet use	Transfer or exclusion bias as 6 patients disqualified for nonfunctional subacromial pain pump
Fontana et al.[17]	Computer	Yes: observer only	Clinical difference of 1.5 boluses with SD of 0.5. Sample size of 24 patients for each group provided 5% alpha level and 80% power	Subject bias as patients were not blinded to their group allocation, and type-II error as group sizes were less than called for by the power analysis. Exclusion or transfer bias as 17 patients were excluded post hoc because their VAS pain score would ''notably alter the evaluation''
Gonano et al.[18]	Sealed envelope	Yes: observer only	25% difference in cost in euros (difference, 10κ; within-group SD, 10κ). Sample size of 20	Selection bias as no mention of shoulder arthroscopy procedures and sealed envelope randomization; subject bias as patients were not blinded to their group allocation
Laurila et al.[19]	Sealed envelope	Yes: observer and subacromial bursa group only	50% difference in mean oxycodone consumption in the SUB and ISBP groups compared with the placebo group during the first 6 hr postop.	Selection bias as sealed envelope randomization; subject bias as patients were not blinded to their group allocation
Lee et al.[20]	Random number table	Yes	NM	Anesthesiologist/surgeon not blinded to treatment group allocation
Lehtipalo et al.[21]	NM	Yes: observer only	NM	Randomization process not described. Subject bias due to presence of a continuous ISBP, PCA, or IV boluses. Randomization resulted in an uneven distribution between male and female patients among groups. 30% of the ISBP patients had a ''visually obvious dislocation of the plexus catheter''
Nisar et al.[22]	Computer	Yes: observer only	1 SD difference in PCA consumption between the 2 treatment groups. Sample size of 17 patients	Subject bias
Oh et al.[23]	NM	Yes: observer only	NM	Subject bias as patients were not blinded to their group allocation; selection bias as the randomization process was not described
Singelyn et al.[24]	Computer	Yes: observer only	50% difference in VAS with 25 in ISBP group and 50 in control group with SD of 15	Subject bias as patients as patients were not blinded to their group allocation since controls received no placebo injection

*NM = not mentioned, VAS = visual analog scale, SD = standard deviation, ISBP = interscalene brachial plexus block, SUB = subacromial bursa blockade, PCA = patient-controlled analgesia, and IV = intravenous.

TABLE IV Study Analgesia Protocol*

Study	Anesthesia Type	Narcotic, IV/IM/Subq.	Other, IV/IM/Subq.
Al-Kaisy et al.[15]	General	Morph	NM
DeMarco et al.[16]	General	NM	NM
Fontana et al.[17]	General	Fentanyl PCA	NM
Gonano et al.[18]	General or ISBP	Piritramid	Acetaminophen
Laurila et al.[19]	General	Oxycodone	Oxycodone
Lee et al.[20]	General	NM	Tramadol
Lehtipalo et al.[21]	General	Morphine	none
Nisar et al.[22]	General	Morphine PCA	NM
Oh et al.[23]	General	Meperidine	Ketorolac
Singelyn et al.[24]	General	Morphine	NM

*IV = intravenous, IM = intramuscular, subq. = subcutaneous, NM = not mentioned, bupi = bupivacaine, ISBP = interscalene brachial plexus block, and PCA = patient-controlled analgesia.

TABLE IV (*continued*)

Narcotic, Oral	Other, Oral	Subacromial Injection	Intra-articular Injection	Local Anesthetic to Incision
Tylenol 3	Toradol	NM	NM	NM
Percocet	NM	Subacromial pump 5-mL priming bolus of 0.5% bupi followed by 0.5% bupi at 2 mL/hr for 72 hr	NM	NM
NM	NM	NM	NM	NM
NM	NM	NM	NM	NM
NM	Ketoprofen	NM	NM	NM
NM	NM	NM	NM	NM
NM	NM	NM	NM	NM
Paracetamol, codeine	Diclofenac	NM	NM	NM
NM	NM	NM	NM	NM
Propacetamol	NM	NM	NM	NM

Fortunately, the interscalene block in all ten studies was performed with use of a neurostimulator for guidance, thus avoiding a further source of heterogeneity; however, the use of ultrasonographically guided interscalene blocks is becoming increasingly popular[30,31].

Finally, a power analysis was not mentioned as a part of the design of four of the ten studies in this review. The remaining six studies that did include a power analysis varied with regard to the variable on which the power analysis was based[16-19,22,24]. This heterogeneity introduces the potential for type-II (beta) errors for variables for which no statistically significant difference was found (i.e., the need for supplemental medication[16] and the occurrence of nausea[17,19-23]).

Since arthroscopic shoulder procedures are now often performed on an outpatient basis, interventions such as regional anesthesia, which decrease postoperative pain as well as nausea and vomiting and have a low complication rate[32-36], can potentially decrease the need for unexpected hospital admission, unwanted medical complications related to surgery, and overall health-care costs. Use of an interscalene block can also increase patient satisfaction after arthroscopic shoulder surgery[15,17,24]. Lastly, Gonano et al. found that use of an interscalene block for patients undergoing arthroscopic shoulder surgery reduced total costs, improved the anesthesia-related work flow, decreased the time spent in the post-anesthesia care unit, and decreased the time spent in the operating room[18]. These factors will become more important with the implementation of performance benchmarks as part of the Patient Protection and Affordable Care Act[37].

In conclusion, use of an interscalene brachial plexus block resulted in significant decreases in postoperative pain scores and in the amount of supplemental analgesia required in patients undergoing arthroscopic procedures involving the shoulder. The interscalene block had no clear benefit with regard to decreasing nausea. The overall complication rate attributable to the block was negligible. Interscalene brachial plexus blocks were cost-effective compared with general anesthesia alone. ■

Michael S. Hughes, MD
Matthew J. Matava, MD
Rick W. Wright, MD
Robert H. Brophy, MD
Matthew V. Smith, MD
Department of Orthopedic Surgery,
Washington University,
14532 South Outer Forty Drive,
Chesterfield, MO 63017.
E-mail address for M.S. Hughes: michaelhughesmd@gmail.com

References

1. American Orthopaedic Society for Sports Medicine. Arthroscopy. 2008. http://www.sportsmed.org/uploadedFiles/Content/Patient/Sports_Tips/ST%20Arthroscopy%2008.pdf. Accessed 2012 Dec 27.

2. Wilson AT, Nicholson E, Burton L, Wild C. Analgesia for day-case shoulder surgery. Br J Anaesth. 2004 Mar;92(3):414-5.

3. Fortier J, Chung F, Su J. Unanticipated admission after ambulatory surgery—a prospective study. Can J Anaesth. 1998 Jul;45(7):612-9.

4. Sultan J, Marflow KZ, Roy B. Unplanned overnight admissions in day-case arthroscopic shoulder surgery. Surgeon. 2012 Feb;10(1):16-9.

5. Desborough JP. The stress response to trauma and surgery. Br J Anaesth. 2000 Jul;85(1):109-17.

6. Wolf AR. Stress response in orthopaedics and trauma in paediatrics: general versus regional anaesthesia. Anaesthesia. 1998 May;53(Suppl 2):76-8.

7. Weissman C. The metabolic response to stress: an overview and update. Anesthesiology. 1990 Aug;73(2):308-27.

8. Bruce BG, Green A, Blaine TA, Wesner LV. Brachial plexus blocks for upper extremity orthopaedic surgery. J Am Acad Orthop Surg. 2012 Jan;20(1):38-47.

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

10. Tuominen M, Pitkänen M, Rosenberg PH. Postoperative pain relief and bupivacaine plasma levels during continuous interscalene brachial plexus block. Acta Anaesthesiol Scand. 1987 May;31(4):276-8.

11. Barber FA, Herbert MA. The effectiveness of an anesthetic continuous-infusion device on postoperative pain control. Arthroscopy. 2002 Jan;18(1):76-81.

12. Mallon WJ, Thomas CW. Patient-controlled lidocaine analgesia for acromioplasty surgery. J Shoulder Elbow Surg. 2000 Mar-Apr;9(2):85-8.

13. Savoie FH, Field LD, Jenkins RN, Mallon WJ, Phelps RA 2nd. The pain control infusion pump for postoperative pain control in shoulder surgery. Arthroscopy. 2000 May-Jun;16(4):339-42.

14. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, Elbourne D, Egger M, Altman DG; Consolidated Standards of Reporting Trials Group. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. J Clin Epidemiol. 2010 Aug;63(8):e1-37.

15. Al-Kaisy A, McGuire G, Chan VW, Bruin G, Peng P, Miniaci A, Perlas A. Analgesic effect of interscalene block using low-dose bupivacaine for outpatient arthroscopic shoulder surgery. Reg Anesth Pain Med. 1998 Sep-Oct;23(5):469-73.

16. DeMarco JR, Componovo R, Barfield WR, Liles L, Nietert P. Efficacy of augmenting a subacromial continuous-infusion pump with a preoperative interscalene block in outpatient arthroscopic shoulder surgery: a prospective, randomized, blinded, and placebo-controlled study. Arthroscopy. 2011 May;27(5):603-10.

17. Fontana C, Di Donato A, Di Giacomo G, Costantini A, De Vita A, Lancia F, Caricati A. Postoperative analgesia for arthroscopic shoulder surgery: a prospective randomized controlled study of intraarticular, subacromial injection, interscalenic brachial plexus block and intraarticular plus subacromial injection efficacy. Eur J Anaesthesiol. 2009 Aug;26(8):689-93.

18. Gonano C, Kettner SC, Ernstbrunner M, Schebesta K, Chiari A, Marhofer P. Comparison of economical aspects of interscalene brachial plexus blockade and general anaesthesia for arthroscopic shoulder surgery. Br J Anaesth. 2009 Sep;103(3):428-33.

19. Laurila PA, Löppönen A, Kanga-Saarela T, Flinkkilä T, Salomäki TE. Interscalene brachial plexus block is superior to subacromial bursa block after arthroscopic shoulder surgery. Acta Anaesthesiol Scand. 2002 Sep;46(8):1031-6.

20. Lee HY, Kim SH, So KY, Kim DJ. Effects of interscalene brachial plexus block to intra-operative hemodynamics and postoperative pain for arthroscopic shoulder surgery. Korean J Anesthesiol. 2012 Jan;62(1):30-4.

21. Lehtipalo S, Koskinen LO, Johansson G, Kolmodin J, Biber B. Continuous interscalene brachial plexus block for postoperative analgesia following shoulder surgery. Acta Anaesthesiol Scand. 1999 Mar;43(3):258-64.

22. Nisar A, Morris MW, Freeman JV, Cort JM, Rayner PR, Shahane SA. Subacromial bursa block is an effective alternative to interscalene block for postoperative pain control after arthroscopic subacromial decompression: a randomized trial. J Shoulder Elbow Surg. 2008 Jan-Feb;17(1):78-84.

23. Oh JH, Kim WS, Kim JY, Gong HS, Rhee KY. Continuous intralesional infusion combined with interscalene block was effective for postoperative analgesia after arthroscopic shoulder surgery. J Shoulder Elbow Surg. 2007 May-Jun;16(3):295-9.

24. Singelyn FJ, Lhotel L, Fabre B. Pain relief after arthroscopic shoulder surgery: a comparison of intraarticular analgesia, suprascapular nerve block, and interscalene brachial plexus block. Anesth Analg. 2004 Aug;99(2):589-92.

25. Klein SM, Evans H, Nielsen KC, Tucker MS, Warner DS, Steele SM. Peripheral nerve block techniques for ambulatory surgery. Anesth Analg. 2005 Dec;101(6):1663-76.

26. Provencher MT, Navaie M, Solomon DJ, Smith JC, Romeo AA, Cole BJ. Joint chondrolysis. J Bone Joint Surg Am. 2011 Nov 2;93(21):2033-44.

27. Solomon DJ, Navaie M, Stedje-Larsen ET, Smith JC, Provencher MT. Glenohumeral chondrolysis after arthroscopy: a systematic review of potential contributors and causal pathways. Arthroscopy. 2009 Nov;25(11):1329-42.

28. Busfield BT, Romero DM. Pain pump use after shoulder arthroscopy as a cause of glenohumeral chondrolysis. Arthroscopy. 2009 Jun;25(6):647-52.

29. Fredrickson MJ, Ball CM, Dalgleish AJ. Analgesic effectiveness of a continuous versus single-injection interscalene block for minor arthroscopic shoulder surgery. Reg Anesth Pain Med. 2010 Jan-Feb;35(1):28-33.

30. Fredrickson MJ, Ball CM, Dalgleish AJ. A prospective randomized comparison of ultrasound guidance versus neurostimulation for interscalene catheter placement. Reg Anesth Pain Med. 2009 Nov-Dec;34(6):590-4.

31. Koscielniak-Nielsen ZJ, Dahl JB. Ultrasound-guided peripheral nerve blockade of the upper extremity. Curr Opin Anaesthesiol. 2012 Apr;25(2):253-9.

32. Arciero RA, Taylor DC, Harrison SA, Snyder RJ, Leahy KE, Uhorchak JM. Interscalene anesthesia for shoulder arthroscopy in a community-sized military hospital. Arthroscopy. 1996 Dec;12(6):715-9.

33. Bishop JY, Sprague M, Gelber J, Krol M, Rosenblatt MA, Gladstone J, Flatow EL. Interscalene regional anesthesia for shoulder surgery. J Bone Joint Surg Am. 2005 May;87(5):974-9.

34. D'Alessio JG, Rosenblum M, Shea KP, Freitas DG. A retrospective comparison of interscalene block and general anesthesia for ambulatory surgery shoulder arthroscopy. Reg Anesth. 1995 Jan-Feb;20(1):62-8.

35. Wu CL, Rouse LM, Chen JM, Miller RJ. Comparison of postoperative pain in patients receiving interscalene block or general anesthesia for shoulder surgery. Orthopedics. 2002 Jan;25(1):45-8.

36. Brown AR, Weiss R, Greenberg C, Flatow EL, Bigliani LU. Interscalene block for shoulder arthroscopy: comparison with general anesthesia. Arthroscopy. 1993;9(3):295-300.

37. Enquist M, Bosco JA 3rd, Pazand L, Habibi KA, Donoghue RJ, Zuckerman JD. Managing episodes of care: strategies for orthopaedic surgeons in the era of reform. J Bone Joint Surg Am. 2011 May 18;93(10):e55.