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Continuous interscalene brachial plexus block versus parenteral analgesia for postoperative pain relief after major shoulder surgery (Review)

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[Intervention Review]

Continuous interscalene brachial plexus block versus parenteral analgesia for postoperative pain relief after major shoulder surgery

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ABSTRACT

Background

Postoperative pain may lead to adverse effects on the body, which might result in an increase in morbidity. Its management therefore poses a unique challenge for the clinician. Major shoulder surgery is associated with severe postoperative pain, and different modalities are available to manage such pain, including opioid and non-opioid analgesics, local anaesthetics infiltrated into and around the shoulder joint and regional anaesthesia. All of these techniques, alone or in combination, have been used to treat the postoperative pain of major shoulder surgery but with varying success.

Objectives

The objective of this review was to compare the analgesic efficacy of continuous interscalene brachial plexus block (ISBPB) with parenteral opioid analgesia for pain relief after major shoulder surgery.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (2012, Issue 12), MEDLINE (1950 to December 2012), EMBASE (1980 to December 2012), Web of Science (1954 to December 2012), CINAHL (1982 to December 2012) and bibliographies of published studies.

Selection criteria

We included randomized controlled trials assessing the effectiveness of continuous ISBPB compared with different forms of parenteral opioid analgesia in relieving pain in adult participants undergoing elective major shoulder surgery.

Data collection and analysis

Two review authors independently assessed trial quality and extracted outcome data.

Main results

We included two randomized controlled trials (147 participants). A total of 17 participants were excluded from one trial because of complications related to continuous ISBPB (16) or parenteral opioid analgesia (one). Thus we have information on 130 participants (66 in the continuous ISBPB group and 64 in the parenteral opioid group). The studies were clinically heterogeneous. No meta-analysis was undertaken. However, results of the two included studies showed better pain relief with continuous ISBPB following major shoulder surgery and a lower incidence of complications when interscalene block is performed under ultrasound guidance rather than without it.

Authors' conclusions

Because of the small number of studies (two) relevant to the subject and the high risk of bias of the selected studies, no reasonable conclusion can be drawn.

PLAIN LANGUAGE SUMMARY

Comparison of an upper limb nerve block using local anaesthetic with opioid analgesia for pain relief following major shoulder surgery

Pain following surgical procedures can sometimes increase the incidence of complications in the body. It is important to manage this pain effectively. Major shoulder surgery can cause severe pain. Effectively treating this pain will help reduce complications and will promote early mobilization. A wide range of methods are used to treat pain after major shoulder surgery, including administration of opioid (derived from opium) and non-opioid pain killers and administration of drugs that produce numbness and hence pain relief in and around the shoulder joint or around the nerves supplying the upper limb. We compared the usefulness of a continuous upper limb nerve block performed by injecting local anaesthetic into the neck close to where the nerves originate (interscalene brachial plexus block—ISBPB group) with the administration of opioid pain killers into a vein, into a muscle or under the skin (any route other than by mouth)—the parenteral opioid group.

Evidence obtained is current to December 2012. We included two studies involving 147 participants. Seventeen participants were excluded (16 from the ISBPB group and one from the other), leaving 130 participants: 66 in the ISBPB group and 64 in the parenteral opioid group. The studies were of medium to low quality because of issues with study design, and one of the trials was sponsored by a drug company.

The severity of pain was assessed by the patient using a numerical scale on which zero was considered as no pain and 10 or 100 as the worst imaginable pain for 72 hours in one study and 48 hours in the other. The severity of postoperative pain was significantly less for the ISBPB group at all time points in one study and at all but one time point in the other study.

No concrete conclusions can be drawn because of the small number of studies, which were not of high quality. However, from the available evidence, it can be seen that in one of the trials, the requirement for additional painkiller (piritramide) was significantly higher in the parenteral opioid group, whereas the other trial did not mention this. The incidence of nausea and vomiting was significantly less in the ISBPB group when compared with the parenteral opioid group. Complications related to ISBPB were virtually eliminated when ultrasound was used to perform ISBPB.

BACKGROUND

Description of the condition

The sensation of pain is one of the vital functions of the human body's nervous system that enables protection of an injured area while healing and repair occur. All surgical procedures are followed by pain, which may trigger or amplify endocrine and metabolic responses, autonomic reflexes, nausea, ileus and muscle spasm to increase postoperative morbidity and mortality (Desborough 2000). The current armamentarium of analgesic drugs and techniques for the management of postoperative pain continues to grow at a rapid rate. However, effective treatment of acute postsurgical pain still poses unique challenges for practitioners (White 2005). Major shoulder surgery is often associated with severe postoperative pain, greater than after gastrectomy or thoracotomy, especially within the first 48 hours. One of the characteristics of this pain is its dynamic component (exacerbation on movement); therefore moderate pain at rest can become severe during rehabilitation. Optimal postoperative pain treatment is, therefore, helpful in enabling early mobilization and rehabilitation, enhancing recovery and reducing morbidity (Borgeat 2007).

Description of the intervention

Different options are available for the management of postoperative pain after major shoulder surgery. These include enteral or parenteral administration of opioid and non-opioid (including non-steroidal anti-inflammatory drugs) analgesics, infiltration of local anaesthetics into the joint (intra-articular) or around the joint (bursal or sub-bursal) and use of regional analgesia (Borgeat 2007), including interscalene brachial plexus block (ISBPB), through different techniques. Patient-controlled analgesia (PCA) is a technique that allows patients to have autonomy in controlling their pain by timing the administration of small doses of an analgesic or local anaesthetic drug. PCA can be used with both parenteral and regional analgesic techniques (Macintyre 2001).

How the intervention might work

Traditionally, parenteral analgesia, which is used for postoperative pain relief, includes intravenous, transdermal, subcutaneous and intramuscular routes for administration of opioids and non-opioids, depending on the type of surgery. Opioid analgesics are commonly associated with opioid-related adverse effects such as nausea and vomiting, pruritus, sleep disturbance and constipation. Interscalene block provides effective anaesthesia and analgesia for shoulder surgery (Fredrickson 2010a).

Winnie was the first to describe the single-injection technique of interscalene brachial plexus block (Winnie 1970). ISBPB, alone or in combination with general anaesthesia, is a very suitable technique for shoulder surgery. The catheter technique for ISBPB, which was first described by Tuominen in 1987 (Tuominen 1987), offers many advantages over single-injection ISBPB. These include early and aggressive mobilization, extension of analgesia for prolonged periods and use of smaller doses of local anaesthetics to prevent motor block and reduce opioid requirements and associated side effects (Bishop 2005; Fredrickson 2010a; Russon 2006).

However, ISBPB is an invasive procedure that may lead to serious complications. In addition to commonly associated risks, such as failure, nerve injury, vascular injury, bleeding, phrenic nerve block

and Horner's syndrome, interscalene block is associated with risks of pleural puncture, central neuraxial needle placement, cervical spinal cord damage and permanent paralysis (Benumof 2000). The introduction of ultrasound to locate the brachial plexus has helped to reduce these adverse events.

Why it is important to do this review

This review will attempt to distinguish between the effectiveness of continuous ISBPB and that of parenteral opioid in providing better analgesia with minimal adverse effects in patients undergoing major shoulder surgery. This will help anaesthetists, as well as patients, to choose from the two techniques to obtain better pain control with fewer side effects after major shoulder surgery.

OBJECTIVES

The objective of this review was to compare the analgesic efficacy of continuous interscalene brachial plexus block (ISBPB) with parenteral opioid analgesia for pain relief after major shoulder surgery.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomized controlled trials (RCTs) that compared continuous ISBPB with any form of parenteral opioid analgesia after major shoulder surgery.

Types of participants

We included adult patients (aged over 18 years) undergoing elective major shoulder surgery (shoulder arthroplasty or total shoulder replacement, open rotator cuff repair and internal fixation of shoulder fractures) who received either continuous ISBPB or any form of parenteral opioid analgesia for postoperative pain relief.

We excluded patients undergoing arthroscopic procedures, those who had undergone previous shoulder surgery and those coming in for daycare surgery.

Types of interventions

We included any RCT that compared continuous ISBPB with any form of parenteral opioid analgesia after major shoulder surgery with a minimum duration of follow-up of 12 hours postoperatively (Table 1).

We included studies with:

1. any method of localization of the brachial plexus by an interscalene approach.
2. any local anaesthetic, in any concentration with or without any other drug(s), given by the ISBPB technique.
3. any form(s) of parenteral (intravenous, intramuscular, subcutaneous) opioid analgesia technique.
4. any parenteral opioid analgesic drug(s), given in any dosage.

Types of outcome measures

Primary outcomes

1. The effectiveness of pain relief after major shoulder surgery using continuous ISBPB or parenteral opioid analgesia for the entire follow-up period (minimum 12 hours).
2. Complications related to ISBPB including those related to technique (failure, pneumothorax, nerve injury, Horner's syndrome, vascular injury, haematoma, bleeding, catheter dislocation, infection, facial nerve palsy) and those related to drugs (nausea, vomiting, pruritus, metallic taste, motor block, sedation, respiratory depression, central nervous system excitation).
3. Complications related to parenteral analgesia (nausea, vomiting, pruritus, sedation, respiratory depression).

Secondary outcomes

1. Effectiveness of pain relief at mobilization.
2. Supplemental analgesia, if used.
3. Time to mobilization.
4. Participant satisfaction.
5. Length of stay in postanaesthesia care unit (PACU).
6. Length of stay in hospital.

Search methods for identification of studies

Electronic searches

We searched the following databases.

1. The Cochrane Central Register of Controlled Trials (CENTRAL) (2012, Issue 12) ([Appendix 1](#)).
2. MEDLINE (via PubMed) (1950 to December 2012) ([Appendix 2](#)).
3. EMBASE (1980 to December 2012) ([Appendix 3](#)).
4. ISI Web of Science (1954 to December 2012) ([Appendix 4](#)).
5. CINAHL (EBSCO host) (1982 to December 2012) ([Appendix 5](#)).

We imposed no language restrictions.

Searching other resources

We included all relevant studies irrespective of the language of publication. We manually checked the reference lists of relevant studies to identify trials missed by the electronic search strategy.

We contacted primary authors of identified trials to ask for more information, if required.

We searched for ongoing trials on the following websites.

1. <http://www.controlled-trials.com>.
2. <http://www.clinicaltrials.gov>.

Data collection and analysis

Selection of studies

We (HU and KS) independently reviewed the titles and abstracts identified by the searches. We obtained full copies of potentially relevant trials and assessed all full copies according to the parameters outlined in [Criteria for considering studies for this review](#). We assessed only trials meeting these criteria

for methodological quality. No disagreement arose during this process; therefore we did not consult the third review author (FK).

Data extraction and management

Two review authors (HU and KS) independently extracted data using a data extraction form ([Appendix 6](#)) modified from one developed by the Cochrane Anaesthesia Review Group (CARG). We resolved discrepancies by discussion. We extracted data (as far as was possible) on the basis of an intention-to-treat (ITT) analysis. We contacted primary investigators to ask for missing data. Two review authors (HU and KS) independently entered all data into Review Manager ([RevMan 5.1](#)).

Assessment of risk of bias in included studies

We assessed trial quality using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011](#)). We observed whether inclusion and exclusion criteria were clearly defined in the text. Criteria included the following.

1. Random sequence generation.
2. Allocation concealment.
3. Blinding of participants, personnel and outcome assessors.
4. Incomplete outcome data.
5. Selective reporting.

Based on the above, we rated study validity as follows.

1. Low risk of bias: if most of the above criteria are met.
2. High risk of bias: if most of the above criteria are not met.
3. Unclear risk of bias: if criteria are expressed in an unclear manner.

We (HU and KS) resolved any disagreements regarding the assessment by discussion and by coming to consensus.

Measures of treatment effect

We planned to express the treatment effect as a pooled risk ratio and 95% confidence interval (CI) for dichotomous data, and as a mean difference and 95% CI for continuous data. We planned to use a fixed-effect model when minimal heterogeneity existed; otherwise a random-effects model was planned. In cases in which such data combination was not possible or was inappropriate (in the presence of significant clinical heterogeneity or for other reasons), we provided a narrative synthesis.

Unit of analysis issues

In the studies included in the review, participants were randomly assigned to either group (ISBPB or parenteral opioid), and a measurement for each outcome from each participant was recorded and analysed. In cases of multiple observations for the same outcome, we computed the effect measure for each individual participant that incorporated all time points.

Dealing with missing data

Intention-to-treat analysis is recommended to minimize bias. No consensus has been reached on how to handle missing data in ITT analysis in systematic reviews ([Higgins 2011](#)). We excluded all participants for whom outcome data were missing.

Assessment of heterogeneity

We planned statistical heterogeneity using the Chi² test (significant at $P < 0.1$) before considering the appropriateness of pooling the data and proceeding with a meta-analysis.

Assessment of reporting biases

We looked at the number of outcomes presented in the methods section of the included studies and confirmed this number in the results section of the trial. We planned to provide a funnel plot to detect publication bias or a difference between smaller and larger studies expressed by asymmetry (Egger 1997). However, as recommended by the *Cochrane Handbook for Systematic Reviews of Interventions*, Chapter 10 (Higgins 2011), at least 10 studies are needed to create a funnel plot.

Data synthesis

We planned to enter the data extracted from the studies into Review Manager 5.1.

We also planned to:

1. pool the data from various trials, when appropriate, and perform analysis in both groups;
2. record either the means of an event or the number of participants experiencing an event in each group;
3. express the treatment effect as a pooled risk ratio and 95% CI for dichotomous data, and as a mean difference and 95% CI for continuous data;
4. use a fixed-effect model when minimal heterogeneity existed, otherwise a random-effects model; and
5. generate forest plots when only a single study was available for a particular outcome. In situations in which variables were presented differently, we planned to equate each variable by methods prescribed by the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Subgroup analysis and investigation of heterogeneity

If appropriate data were found, we planned subgroup analysis based on:

1. the type of local anaesthetic used;
2. the type of analgesic drug used;
3. a combination of drugs in either technique;
4. any technique for localization of brachial plexus; and
5. the type of surgery performed (in cases of multiple surgical procedures, we will subanalyse each procedure).

Heterogeneity was assessed as mentioned in the section [Assessment of heterogeneity](#).

Sensitivity analysis

We planned a sensitivity analysis if methodological quality or characteristics of participants in the studies differed significantly and adequate data were available.

RESULTS

Description of studies

Results of the search

We identified 122 abstracts from the 2774 results obtained by searching according to the methods mentioned in [Search methods for identification of studies](#). The details are presented in [Figure 1](#). Of these, 47 abstracts qualified for full-paper analysis after mutual discussion. We accessed all 47 full-text papers, and 45 were excluded because of inappropriate participants or comparison groups. Thus two studies (Hofmann-Kiefer 2008; Wei 2012) qualified to be included in the final analysis, of which one study was written in Chinese and required translation for extraction of data.

Figure 1. Abstracts search flow diagram.

Included studies

We included two studies in the review. The sample size was 147 participants (87 in [Hofmann-Kiefer 2008](#) and 60 in [Wei 2012](#)). See [Characteristics of included studies](#) for details. Because of the small number of studies included in the review and significant clinical heterogeneity among them, we were unable to perform meta-analysis in this review.

Excluded studies

Upon the advice of Dr Mathew Zacharia and Professor Nathan Pace, we have listed in the [Excluded studies](#) section all studies that we retrieved as full-text papers from literature searches that did not

meet the eligibility criteria for inclusion in the review. Forty-five studies have been excluded, and the reasons for their exclusion are mentioned in the [Characteristics of excluded studies](#). These studies did not include appropriate interventions or appropriate participants, as mentioned in the [Criteria for considering studies for this review](#).

Risk of bias in included studies

The overall quality of each study was evaluated according to the methodology mentioned in [Assessment of risk of bias in included studies](#). The different bias domains are presented in [Characteristics of included studies](#). A graph and a summary of the risk of bias of included studies are presented in [Figure 2](#) and [Figure 3](#).

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)
Hofmann-Kiefer 2008
Wei 2012

Effects of interventions

[Hofmann-Kiefer 2008](#) enrolled 87 participants. In all, 17 participants were excluded for reasons mentioned in [Characteristics of included](#)

[studies](#), and they were removed from the analysis. A total of 16 participants received continuous ISBPB as postoperative analgesia, and one was given parenteral opioids. The authors of the study used a nerve stimulator to locate the brachial plexus.

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[Wei 2012](#) enrolled 60 participants, all of whom completed the study. Four participants were excluded according to exclusion criteria. Investigators used ultrasound technique to perform brachial plexus block.

Outcomes

Primary outcomes

Effectiveness of pain relief

The effectiveness of pain relief was assessed by visual analogue scale (VAS) ([Hofmann-Kiefer 2008](#)) and numerical rating pain scale (NRPS) ([Wei 2012](#)). Study authors reported observations at different time points ([Hofmann-Kiefer 2008](#) reported at four time points and [Wei 2012](#) at three time points). Because only two studies qualified for inclusion in the review and because significant clinical heterogeneity was present among the studies, we did not perform the meta-analysis; hence, the results are reported in a narrative form.

One hundred thirty participants received continuous ISBPB (66) or parenteral opioid analgesia (64). [Hofmann-Kiefer 2008](#) followed participants for 72 hours postoperatively, whereas [Wei 2012](#) followed participants for 48 hours postoperatively.

[Hofmann-Kiefer 2008](#) reported pain scores at six, 24, 48 and 72 hours after surgery, and pain scores were significantly lower at six, 24 and 72 hours in the ISBPB group than in the group given parenteral opioids. However, pain scores were similar at 48 hours among the two groups. In the [Wei 2012](#) study, pain scores were reported at arrival to the PACU and 24 and 48 hours after surgery; scores were significantly lower in the ISBPB group at all time points.

Adverse effects

Incomplete block did not occur in any participant; therefore, no participants were excluded before surgery. Postoperatively, 17 participants were withdrawn ([Hofmann-Kiefer 2008](#)) because of one or another adverse event (see [Risk of bias in included studies](#)) and were not included in the analysis. Of these, 16 were from the ISBPB group (one for no C5 block, nine for catheter dislocations, one for Horner's syndrome, four for diaphragmatic paresis leading to dyspnoea and one on the participant's choice) and one from the parenteral opioid group (pruritus). Four participants were excluded from the [Wei 2012](#) study, according to exclusion criteria.

Secondary outcomes

Of the secondary outcomes listed in the [Types of outcome measures](#), only the following have been found to be reported in the included studies. The remaining are not reported at all or are mentioned only in narrative rather than numerical form.

[Hofmann-Kiefer 2008](#) mentions that VAS scores were lower in the ISBPB group during physiotherapy at day two ($P = 0.016$) but were similar at day three. Investigators used piritramide boluses (3.75 to 7.5 mg intravenously) when the pain score exceeded 40 on a scale of 100. Six of 36 participants (16.6%) in the ISBPB group and 11 of 34 (32.3%) in the parenteral opioid group required boluses of piritramide; this was statistically significant ($P < 0.01$). Regarding nausea and/or vomiting, two of 36 (5.5%) participants in the continuous ISBPB group versus nine of 34 (26.4%) in the parenteral opioid group developed nausea and/or vomiting during the study; this again was statistically significant. No catheter infections were reported.

[Wei 2012](#) looked at participant satisfaction, which was significantly greater ($P < 0.01$) in the ISBPB group. This study also reported nausea and/or vomiting as an adverse event that was significantly more frequent in the parenteral opioid group (one of 30 (3.3%) in the ISBPB group vs eight of 30 (26.6%) in the parenteral opioid group). The drug used for postoperative analgesia was sufentanil.

DISCUSSION

Summary of main results

The primary focus of this review was to look at clinically and statistically significant differences in postoperative pain management following major shoulder surgery when continuous ISBPB is compared with parenteral opioids. We also looked at adverse effects related to both techniques, use of supplemental analgesia, participant satisfaction and length of hospital stay.

We included two randomized controlled trials ([Hofmann-Kiefer 2008](#); [Wei 2012](#)) consisting of 147 participants, of whom 17 were excluded from analysis—all from the [Hofmann-Kiefer 2008](#) study. Of these 17, 16 had complications related to continuous ISBPB (one no C5 block, nine catheter dislocation, one Horner's syndrome, four diaphragmatic paresis leading to dyspnoea and one poor choice by the participant) and one had complications related to parenteral opioid analgesia (pruritus). Therefore 130 participants were included in the analysis (66 in the continuous ISBPB group and 64 in the parenteral opioid group). The included studies carried a high risk of bias, mainly for the reasons of absence of allocation concealment, lack of blinding and large numbers of dropouts. Both mentioned primary outcomes and several secondary outcomes. A nerve stimulator was used to locate the brachial plexus in all participants in the [Hofmann-Kiefer 2008](#) study, and [Wei 2012](#) used ultrasound to perform brachial plexus block, which may be the reason why no complications related to ISBPB were reported in this study. Because of the small number of studies included in the review, high risk of bias and significant clinical heterogeneity, no concrete conclusions can be drawn. However, following is the summary reported by these two studies.

Effectiveness of pain relief was assessed at different time points for up to 72 hours by [Hofmann-Kiefer 2008](#), and up to 48 hours by [Wei 2012](#). [Hofmann-Kiefer 2008](#) used VAS and [Wei 2012](#) used NRPS to evaluate postoperative pain. Pain scores were significantly lower in the ISBPB group at six, 24 and 72 hours, whereas they were similar at 48 hours in the [Hofmann-Kiefer 2008](#) study. Pain scores were significantly lower in the ISBPB group, as reported by [Wei 2012](#), at all time points (upon arrival to PACU and 24 and 48 hours postoperatively).

Supplemental analgesia was used in the [Hofmann-Kiefer 2008](#) study; the drug used was piritramide, whereas [Wei 2012](#) used sufentanil as supplemental analgesia. The number of boluses was significantly greater in the parenteral opioid group. Adverse effects mentioned included nausea and vomiting, which was significantly more frequent in the parenteral opioid group, as reported by both studies ([Hofmann-Kiefer 2008](#); [Wei 2012](#)).

Overall completeness and applicability of evidence

Both studies included in this review had participants, interventions and outcomes that were appropriate to our objectives and outcomes, both primary and secondary. The main issues with the applicability of this evidence include the small number of studies,

the high risk of bias in these studies and the presence of significant clinical heterogeneity. Another important point is the method used to perform brachial plexus block. It is evident that ISBPB-related complications were significantly more frequent when a nerve stimulator was used when compared with ultrasound technique. Another aspect worth mentioning is the usual current practice of using ultrasound for performing brachial plexus block; one study in this review did not use ultrasound and may not represent usual current practice.

Quality of the evidence

Generally, the quality of evidence included in our review was limited by a high risk of bias of the included studies, as evaluated from the information provided by the papers. The included studies were prospective randomized clinical trials in which randomization was done by computer or by random number tables. These studies were not placebo-controlled, and sham catheters were not used for ethical reasons, thus making the studies unblinded. These studies were heterogeneous clinically, as different methods were used to perform ISBPB. We were unable to retrieve the protocol and thus were unable to compare published outcomes versus proposed ones.

Potential biases in the review process

We strictly followed the protocol to perform the review and could think of no source of potential bias in the review process.

Agreements and disagreements with other studies or reviews

We found only one review article, which is actually a critical appraisal of current techniques ([Fredrickson 2010a](#)), that reviewed the postoperative analgesic techniques used for shoulder surgery. The results of this review are similar to those reported in our review. This review also does not include a meta-analysis.

AUTHORS' CONCLUSIONS

Implications for practice

Based on the evidence generated by this review, no reasonable conclusions can be drawn. Because of the presence of significant clinical heterogeneity among the two included studies, meta-analysis could not be performed. Current practice is to perform single-shot ISBPB as well as placement of ISBPB catheters by using ultrasound assistance; for this reason, the study by [Hofmann-Kiefer 2008](#) is unlikely to be performed again.

Implications for research

Further randomized controlled trials with low risk of bias are needed to generate good-quality evidence on the topic. Future research should focus on blinding studies to make them stronger and using ultrasound to perform ISBPB.

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We are grateful to Dr Xiaoli Ge for extracting data from the Chinese study ([Wei 2012](#)).

REFERENCES

References to studies included in this review

Hofmann-Kiefer 2008 {published data only}

Hofmann-Kiefer K, Eiser T, Chappell D, Leuschner S, Conzen P, Schwender D. Does patient-controlled continuous interscalene brachial plexus block improve early functional rehabilitation after open shoulder surgery?. *Anesthesia and Analgesia* 2008;**106**:991-6.

Wei 2012 {published data only}

Wei Y, Guo X-Y, Yang L, Rong Y-L, Xu CY, Li M. Effects of continuous interscalene brachial plexus block plus general anesthesia versus general anesthesia alone on perioperative management of arthroscopic rotator cuff repair surgery. *National Medical Journal of China* 2012;**92**:2327-30.

References to studies excluded from this review

Al-Kaisy 1998 {published data only}

Al-Kaisy A, McGuire G, Chan VWS, Bruin G, Peng P, Miniaci A, et al. Analgesic effect of interscalene block using low-dose bupivacaine for outpatient arthroscopic shoulder surgery. *Regional Anesthesia and Pain Medicine* 1998;**23**:469-73.

Bain 2001 {published data only}

Bain GI, Rudkin G, Comley AS, Heptinstall RJ, Chittleborough M. Digitally assisted acromioplasty: the effect of interscalene block on this new surgical technique. *Arthroscopy* 2001;**17**:44-9.

Barber 2002 {published data only}

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

Beaudet 2008 {published data only}

Beaudet V, Williams SR, Tétreault P, Perrault MA. Perioperative interscalene block versus intra-articular injection of local anesthetics for postoperative analgesia in shoulder surgery. *Regional Anesthesia and Pain Medicine* 2008;**33**:134-8.

Birnbaum 2007 {published data only}

Birnbaum J, Kip M, Spies CD, Hein OV, Labs K, Moeckel G, et al. The effect of stimulating versus nonstimulating catheters for continuous interscalene plexus blocks in short-term pain management. *Journal of Clinical Anesthesia* 2007;**19**:434-9.

Blumenthal 2005 {published data only}

Blumenthal S, Dullenkopf A, Rentsch K, Borgeat A. Continuous infusion of ropivacaine for pain relief after iliac crest bone grafting for shoulder surgery. *Anesthesiology* 2005;**102**:392-7.

Borgeat 1997 {published data only}

Borgeat A, Schäppi B, Biasca N, Gerber C. Patient-controlled analgesia after major shoulder surgery: patient-controlled interscalene analgesia versus patient-controlled analgesia. *Anesthesiology* 1997;**87**:1343-7.

Borgeat 1998 {published data only}

Borgeat A, Tewes E, Biasca N, Gerber C. Patient-controlled interscalene analgesia with ropivacaine after major shoulder surgery: PCIA vs PCA. *British Journal of Anaesthesia* 1998;**81**:603-5.

Borgeat 2000 {published data only}

Borgeat A, Perschak H, Bird P, Hodler J, Gerber C. Patient-controlled interscalene analgesia with ropivacaine 0.2% versus patient-controlled intravenous analgesia after major shoulder surgery: effects on diaphragmatic and respiratory function. *Anesthesiology* 2000;**92**:102-8.

Ciccione 2008 {published data only}

Ciccione WJ II, Busey TD, Weinstein DM, Walden DL, Elias JJ. Assessment of pain relief provided by interscalene regional block and infusion pump after arthroscopic shoulder surgery. *Arthroscopy* 2008;**24**:14-9.

Contreras-Domínguez 2008 {published data only}

Contreras-Domínguez V, Carbonell-Bellolio P, Sanzana ES, Ojeda-Greciet A, Orrego-Santos A. Efficacy of a continuous interscalene block vs intra-articular analgesia for postoperative pain in arthroscopic acromioplasty. *Revista Española de Anestesiología y Reanimación* 2008;**55**:475-80.

Culebras 2001 {published data only}

Culebras X, Van Gessel E, Hoffmeyer P, Gamulin Z. Clonidine combined with a long acting local anesthetic does not prolong postoperative analgesia after brachial plexus block but does induce hemodynamic changes. *Anesthesia and Analgesia* 2001;**92**:199-204.

Delaunay 2005 {published data only}

Delaunay L, Souron V, Lafosse L, Marret E, Toussaint B. Analgesia after arthroscopic rotator cuff repair: subacromial versus interscalene continuous infusion of ropivacaine. *Regional Anesthesia and Pain Medicine* 2005;**30**:117-22.

Deweese 2006 {published data only}

Deweese JL, Schultz CT, Wilkerson FK, Kelly JA, Biegner AR, Pellegrini JE. Comparison of two approaches to brachial plexus anesthesia for proximal upper extremity surgery: interscalene and intersternocleidomastoid. *American Association of Nurse Anesthetists* 2006;**74**:201-6. [16786913]

Esteves 2002 {published data only}

Esteves S, Sá P, Figueiredo D, Pêrez Souto A. Duration and quality of postoperative analgesia after brachial plexus block for shoulder surgery: ropivacaine 0.5% versus ropivacaine 0.5% plus clonidine. *Revista Española de Anestesiología y Reanimación* 2002;**49**:302-5.

Fontana 2009 {published data only}

Fontana C, Di Donato A, Di Giacomo G, Costantini A, De Vita A, Lancia F, et al. 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. *European Journal of Anaesthesiology* 2009;**26**:689-93.

Fredrickson 2010 {published data only}

Fredrickson MJ, Ball CM, Dalglish AJ. Analgesic effectiveness of a continuous versus single-injection interscalene block for minor arthroscopic shoulder surgery. *Regional Anesthesia and Pain Medicine* 2010;**35**:28-33.

Fredrickson 2011 {published data only}

Fredrickson MJ, Abeysekera A, Price DJ, Wong AC. Patient-initiated mandatory boluses for ambulatory continuous interscalene analgesia: an effective strategy for optimizing analgesia and minimizing side-effects. *British Journal of Anaesthesia* 2011;**106**:239-45.

Goebel 2010 {published data only}

Goebel S, Stehle J, Schwemmer U, Reppenhagen S, Rath B, Gohlke F. Interscalene brachial plexus block for open-shoulder surgery: a randomized, double-blind, placebo-controlled trial between single-shot anesthesia and patient-controlled catheter system. *Archives of Orthopaedic and Trauma Surgery* 2010;**130**:533-40.

Gohl 2001 {published data only}

Gohl MR, Moeller RK, Olson RL, Vacchiano CA. The addition of interscalene block to general anesthesia for patients undergoing open shoulder procedures. *American Association of Nurse Anesthetists* 2001;**69**:105-9.

Gonano 2009 {published data only}

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. *British Journal of Anaesthesia* 2009;**103**:428-33.

Grossi 1998 {published data only}

Grossi P, Calliada S, Braga A, Caldara P, D'Aloia A, Coluccia R. Interscalene brachial plexus block combined with total intravenous anaesthesia and laryngeal mask airway for shoulder surgery. *Anaesthesia* 1998;**53**:20-1.

Hadzic 2005 {published data only}

Hadzic A, Williams BA, Karaca PE, Hobeika P, Unis G, Dermksian J, et al. For outpatient rotator cuff surgery, nerve block anesthesia provides superior same-day recovery over general anesthesia. *Anesthesiology* 2005;**102**:1001-7.

Ilfeld 2003 {published data only}

Ilfeld BM, Morey TE, Wright TW, Chidgey LK, Enneking FK. Continuous interscalene brachial plexus block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. *Anesthesia and Analgesia* 2003;**96**:1089-95.

Ilfeld 2006 {published data only}

Ilfeld BM, Vandenborne K, Duncan PW, Sessler DI, Enneking FK, Shuster JJ, et al. Ambulatory continuous interscalene nerve blocks decrease the time to discharge readiness after total shoulder arthroplasty: a randomized, triple-masked, placebo-controlled study. *Anesthesiology* 2006;**105**:999-1007.

Iskandar 2003 {published data only}

Iskandar H, Benard A, Ruel-Raymond J, Cochard G, Manaud B. The analgesic effect of interscalene block using clonidine as an analgesic for shoulder arthroscopy. *Anesthesia and Analgesia* 2003;**96**:260-2.

Kean 2006 {published data only}

Kean J, Wigerowitz CA, Coventry DM. Continuous interscalene infusion and single injection using levobupivacaine for analgesia after surgery of the shoulder. A double-blind, randomised controlled trial. *The Journal of Bone and Joint Surgery. British volume* 2006;**88**:1173-7.

Kinnard 1994 {published data only}

Kinnard P, Truchon R, St-Pierre A, Montreuil J. Interscalene block for pain relief after shoulder surgery. A prospective randomized study. *Clinical Orthopaedics and Related Research* 1994;**304**:22-4.

Klein 2000 {published data only}

Klein SM, Grant SA, Greengrass RA, Nielsen KC, Speer KP, White W, et al. Interscalene brachial plexus block with a continuous catheter insertion system and a disposable infusion pump. *Anesthesia and Analgesia* 2000;**91**:1473-8.

Klein 2001 {published data only}

Klein SM, Nielsen KC, Martin A, White W, Warner DS, Steele SM, et al. Interscalene brachial plexus block with continuous intraarticular infusion of ropivacaine. *Anesthesia and Analgesia* 2001;**93**:601-5.

Klein 2003 {published data only}

Klein SM, Steele SM, Nielsen KC, Pietrobon R, Warner DS, Martin A, et al. The difficulties of ambulatory interscalene and intra-articular infusions for rotator cuff surgery: a preliminary report. *Canadian Journal of Anaesthesia* 2003;**50**:265-9.

Laurila 2002 {published data only}

Laurila PA, Löppönen A, Kangas-Saarela T, Flinkkilä T, Salomäki TE. Interscalene brachial plexus block is superior to subacromial bursa block after arthroscopic shoulder surgery. *Acta Anaesthesiologica Scandinavica* 2002;**46**:10031-6.

Le 2008 {published data only}

Le LT, Loland VJ, Mariano ER, Gerancher JC, Wadhwa AN, Renehan EM, et al. Effects of local anesthetic concentration and dose on continuous interscalene nerve blocks: a dual-center, randomized, observer-masked, controlled study. *Regional Anesthesia and Pain Medicine* 2008;**33**:518-25.

Lehtipalo 1999 {published data only}

Lehtipalo S, Koskinen LO, Johansson G, Kolmodin J, Biber B. Continuous interscalene brachial plexus block for postoperative analgesia following shoulder surgery. *Acta Anaesthesiologica Scandinavica* 1999;**43**:258-64.

Mahmoodpoor 2011 {published data only}

Mahmoodpoor A, Abedini N, Parish M, Jannati A, Baradaran R. Efficacy of low dose interscalene brachial plexus block on post anesthesia recovery parameters after shoulder surgery. *Pakistan Journal of Medical Sciences* 2011;**27**:265-8.

Mariano 2009 {published data only}

Mariano ER, Afra R, Loland VJ, Sandhu NS, Bellars RH, Bishop ML, et al. Continuous interscalene brachial plexus block via an ultrasound-guided posterior approach: a randomized, triple-masked, placebo-controlled study. *Anesthesia and Analgesia* 2009;**108**:1688-94.

Muittari 1998 {published data only}

Muittari P, Kirvelä O. The safety and efficacy of intrabursal oxycodone and bupivacaine in analgesia after shoulder surgery. *Regional Anesthesia and Pain Medicine* 1998;**23**:474-8.

Nisar 2008 {published data only}

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. *Journal of Shoulder and Elbow Surgery / American Shoulder and Elbow Surgeons* 2008;**17**:78-84.

Patacsil 2008 {published data only}

Patacsil JA, Wemette JP, Eborn TW, Daniel CA, Pellegrini JE. Intraarticular infusion pump vs an interscalene brachial plexus block for improved pain control in arthroscopic shoulder surgery. *American Association of Nurse Anesthetists* 2008;**76**:386.

Pennekamp 2004 {published data only}

Pennekamp PH, Pless V, Kraft CN, Stütz A, Schmitt O, Diedrich O. Effectiveness of interscalene plexus block for open subacromion decompression. *Deutsche Gesellschaft für Orthopädie und Orthopädische Chirurgie* 2004;**142**:598-602.

Pere 1993 {published data only}

Pere P. The effect of continuous interscalene brachial plexus block with 0.125% bupivacaine plus fentanyl on diaphragmatic motility and ventilatory function. *Regional Anesthesia* 1993;**18**:93-7.

Sia 2003 {published data only}

Sia S, Sarro F, Lepri A, Bartoli M. The effect of exogenous epinephrine on the incidence of hypotensive/bradycardic events during shoulder surgery in the sitting position during interscalene block. *Anesthesia and Analgesia* 2003;**97**:583-8.

Singelyn 1999 {published data only}

Singelyn FJ, Seguy S, Gouverneur JM. Interscalene brachial plexus analgesia after open shoulder surgery: continuous versus patient-controlled infusion. *Anesthesia and Analgesia* 1999;**89**:1216-20.

Singelyn 2004 {published data only}

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. *Anesthesia and Analgesia* 2004;**99**:589-92.

Tamosiūnas 2004 {published data only}

Tamosiūnas R, Gudas R, Karbonskiene A, Marchertiene I. Bupivacaine for continuous interscalene brachial plexus analgesia after shoulder surgery. *Medicina* 2004;**40**:351-7.

Additional references
Benumof 2000

Benumof JL. Permanent loss of cervical spinal cord function associated with interscalene block performed under general anesthesia. *Anesthesiology* 2000;**93**:1541-4. [MEDLINE: 11149455]

Bishop 2005

Bishop JY, Sprague M, Gelber J, Krol M, Rosenblatt MA, Gladstone J, et al. Interscalene regional anaesthesia for shoulder surgery. *The Journal of Bone and Joint Surgery. American volume* 2005;**87**(5):974-9. [MEDLINE: 15866958]

Borgeat 2007

Borgeat A. New insights of anesthesia for shoulder surgery. *Journal of Medical Science* 2007;**27**:47-54.

Desborough 2000

Desborough JP. The stress response to trauma and surgery. *British Journal of Anaesthesia* 2000;**85**(1):109-17. [MEDLINE: 10927999]

Egger 1997

Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;**315**(7109):629-34. [MEDLINE: 9310563]

Fredrickson 2010a

Fredrickson MJ, Krishnan S, Chen CY. Postoperative analgesia for shoulder surgery: a critical appraisal and review of current techniques. *Anaesthesia* 2010;**65**:608-24. [MEDLINE: 20565394]

Higgins 2011

Higgins JPT, Green S. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2008.

Macintyre 2001

Macintyre 2001. Safety and efficacy of patient-controlled analgesia. *British Journal of Anaesthesia* 2001;**87**:36-46. [MEDLINE: 11460812]

RevMan 5.1 [Computer program]

Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan) [Computer program]. Version 5.1. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011.

Russon 2006

Russon K, Sardesai AM, Ridgway S, Whitear J, Sildown D, Boswell S, et al. Postoperative shoulder surgery initiative (POSSI): an interim report of major shoulder surgery as a day case procedure. *British Journal of Anaesthesia* 2006;**97**(6):869-73. [MEDLINE: 17065168]

Tuominen 1987

Tuominen M, Pitkanen M, Rosenberg PH. Postoperative pain relief and bupivacaine plasma levels during continuous

interscalene brachial plexus block. *Acta Anaesthesiologica Scandinavica* 1987;**31**(4):276-8. [MEDLINE: 3591249]

White 2005

White PF. The changing role of non-opioid analgesic techniques in the management of postoperative pain. *Anesthesia and Analgesia* 2005;**101**(5 Suppl):5-22. [MEDLINE: 16334489]

Winnie 1970

Winnie AP. Interscalene brachial plexus block. *Anesthesia and Analgesia* 1970;**49**(3):455-66. [MEDLINE: 5534420]

References to other published versions of this review

Ullah 2008

Ullah H, Samad K, Khan FA. Continuous interscalene brachial plexus block versus parenteral analgesia for postoperative pain relief after major shoulder surgery. *Cochrane Database of Systematic Reviews* 2008, Issue 2. [DOI: [10.1002/14651858.CD007080](https://doi.org/10.1002/14651858.CD007080)]

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Hofmann-Kiefer 2008

Methods	Prospective, randomized, clinical trial
Participants	87, ASA one to three, adult patients undergoing open rotator cuff repair or acromioplasty
Interventions	<p>Group one: ISBPB with 40 mL of 0.75% ropivacaine, followed by patient-controlled continuous ISBPB using 0.2% ropivacaine infusion at the rate of 10 mg/h plus a bolus of 8 mg with a lockout of 20 minutes up to a maximum of 450 mg in 24 hours</p> <p>Group two: Patient-controlled opioid analgesia with piritramide bolus of 2 mg and a lockout of 10 minutes with no background infusion. Maximum: four-hour dose: 30 mg</p> <p>Duration of study observations was 72 hours; however, the infusion of analgesic solutions was continued for up to about 80 hours postoperatively</p>
Outcomes	Pain intensity Consumption of opioids Nausea and vomiting
Notes	Protocol violation occurred three times in each group during the study period This study was supported by AstraZeneca International

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization table
Allocation concealment (selection bias)	High risk	No mention in the methodology
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unblinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Pain was evaluated by an unblinded investigator

Hofmann-Kiefer 2008 (Continued)

Incomplete outcome data (attrition bias) All outcomes	High risk	17 participants were excluded for various reasons. Of these, 16 were from group one (one for no C5 block, nine for catheter dislocations, one for Horner's syndrome, four for diaphragmatic paresis leading to dyspnoea and one on participant's choice) and one from Group two (pruritus). Thus, 70 participants completed the study and remained in the final analysis
Selective reporting (reporting bias)	Low risk	All outcomes mentioned are reported

Wei 2012

Methods	Prospective, randomized clinical trial
Participants	60 patients undergoing rotator cuff surgery
Interventions	<p>Group ISB + GA—30 participants received preoperative ISBPB (ultrasound guided) with 20 mL of 0.5% ropivacaine along with general anaesthesia. This was followed postoperatively by continuous ISBPB with a PCA device programmed to deliver 0.2% ropivacaine infusion at 4 mL per hour and a bolus of 5 mL on demand with a lock-out interval of one hour</p> <p>Group GA—30 participants received general anaesthesia, followed postoperatively by patient-controlled intravenous analgesia with a PCA device programmed to deliver 1 µg/mL sufentanil infusion at 2 mL per hour and a bolus of 1 mL on demand with a lock-out interval of 15 minutes</p> <p>Duration of study observations was 48 hours. The duration of injection of analgesic infusions was not mentioned</p>
Outcomes	<p>Haemodynamic variables</p> <p>Numerical pain rating scores</p> <p>Participant satisfaction</p>
Notes	Article in Chinese. Data extracted with the help of Dr Xiaoli Ge. Inclusion and exclusion criteria are not clearly mentioned. Four participants were excluded according to exclusion criteria

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table
Allocation concealment (selection bias)	High risk	No concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unblinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unclear

Wei 2012 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Following eligibility, four participants were excluded based on exclusion criteria: One could not understand the PCA device, one refused ISB, two were using long-term analgesic drugs
Selective reporting (reporting bias)	Low risk	All outcomes mentioned are reported

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Al-Kaisy 1998	Not appropriate participants (arthroscopic surgery). Not appropriate intervention. Single-shot ISBPB
Bain 2001	Not appropriate intervention. Single-shot ISBPB. Both groups received postoperative pethidine PCA
Barber 2002	Not appropriate intervention. None of the groups underwent ISBPB
Beaudet 2008	Not appropriate intervention. ISBPB compared with intra-articular analgesia with no parenteral opioid group
Birnbbaum 2007	Not appropriate intervention. All three groups had ISBPB with no parenteral opioid group
Blumenthal 2005	Not appropriate intervention. Both groups received morphine PCA
Borgeat 1997	Not appropriate intervention. Both groups had ISBPB
Borgeat 1998	Not appropriate intervention. Both groups had ISBPB
Borgeat 2000	Not appropriate intervention. Both groups had ISBPB
Ciccone 2008	Not appropriate intervention. All participants had single-shot ISBPB. No continuous parenteral opioid group for postoperative analgesia
Contreras-Domínguez 2008	Not appropriate intervention. Single-shot ISBPB or intra-articular block followed by continuous ISBPB or intermittent morphine
Culebras 2001	Not appropriate intervention. Single-shot ISBPB in all three groups
Delaunay 2005	Not appropriate intervention. Single-shot ISBPB in all participants with continuous ISBPB compared with continuous subacromial analgesia
Deweese 2006	Not appropriate intervention. Single-shot ISBPB
Esteves 2002	Not appropriate intervention. Single-shot ISBPB in both groups
Fontana 2009	Not appropriate intervention. Single-shot ISBPB, no continuous parenteral opioid given postoperatively. Not appropriate participants, participants undergoing arthroscopy
Fredrickson 2010	Not appropriate participants. Minor arthroscopic shoulder surgery was included
Fredrickson 2011	Not appropriate intervention. No parenteral opioid group

Study	Reason for exclusion
Goebel 2010	Not appropriate intervention. Both groups had ISBPB with no postoperative continuous infusion in either group
Gohl 2001	Not appropriate intervention. Single-shot ISBPB. No parenteral opioid group
Gonano 2009	Not appropriate intervention. Single-shot ISBPB
Grossi 1998	Not appropriate intervention. Single-shot ISBPB
Hadzic 2005	Not appropriate intervention. Single-shot ISBPB
Ilfeld 2003	Not appropriate intervention. Both groups had single-shot ISBPB followed by continuous ISBPB compared with oral opioids
Ilfeld 2006	Not appropriate intervention. Continuous ISBPB in both groups until 0600 hours of postoperative day one. No continuous parenteral opioid group in the study
Iskandar 2003	Not appropriate intervention. Both groups received continuous ISBPB. No continuous parenteral opioid group
Kean 2006	Not appropriate intervention. Both groups had ISBPB
Kinnard 1994	Not appropriate intervention. Single-shot ISBPB
Klein 2000	Not appropriate intervention. Both groups had ISBPB. No continuous parenteral opioid group
Klein 2001	Not appropriate intervention. Continuous ISBPB compared with continuous intra-articular infusion. No continuous parenteral opioid group
Klein 2003	Not appropriate intervention. Single-shot ISBPB followed by continuous ISBPB or intra-articular infusion. No parenteral opioid group
Laurila 2002	Not appropriate participants (arthroscopic surgery). Not appropriate intervention. Single-shot ISBPB
Le 2008	Not appropriate intervention. Both groups had continuous ISBPB with different concentrations of local anaesthetic. No parenteral opioid group
Lehtipalo 1999	Not appropriate participants. Participants were not of major shoulder surgery
Mahmoodpoor 2011	Not appropriate intervention. Single-shot ISBPB
Mariano 2009	Not appropriate intervention. Single-shot ISBPB followed by continuous ISBPB compared with oral opioids. No parenteral opioid group
Muittari 1998	Not appropriate intervention. Single-shot intrabursal or ISBPB with all participants receiving post-operative fentanyl PCA
Nisar 2008	Not appropriate intervention. Single-shot ISBPB
Patacsil 2008	Not appropriate intervention. ISBPB compared with intra-articular analgesia
Pennekamp 2004	Not appropriate intervention. Single-shot ISBPB
Pere 1993	Not appropriate participants. Control group (without ISBPB) included participants with minor shoulder surgery who did not require ISBPB

Study	Reason for exclusion
Sia 2003	Not appropriate intervention. All participants received ISBPB with or without epinephrine
Singelyn 1999	Not appropriate intervention. All three groups received ISBPB with no parenteral opioid group
Singelyn 2004	Not appropriate intervention. Intra-articular, supracapsular ISBPB and a no-block group were compared. Postoperative analgesia consisted of paracetamol and morphine
Tamosiūnas 2004	Not appropriate intervention. Both groups had ISBPB. No continuous parenteral opioid group

ADDITIONAL TABLES

Table 1. Table of comparison

Continuous ISBPB group	Parenteral opioid analgesia group
Continuous infusion of any local anaesthetic, in any concentration with or without any other drug, in ISBPB achieved by any technique	Any opioid drug in any dose given via the intravenous (IV), intramuscular (IM) or subcutaneous (SC) route, whether given as boluses or as continuous infusion

APPENDICES

Appendix 1. CENTRAL search strategy

Search terms
#1 (shoulder or rotator cuff):ti,ab
#2 MeSH descriptor Shoulder, this term only
#3 MeSH descriptor Shoulder Joint explode all trees
#4 MeSH descriptor Rotator Cuff explode all trees
#5 MeSH descriptor Arthroplasty, this term only
#6 MeSH descriptor Arthroplasty, Replacement explode all trees
#7 (#1 OR #2 OR #3 OR #4 OR #5 OR #6)
#8 MeSH descriptor Analgesia, Patient-Controlled explode all trees
#9 MeSH descriptor Anesthetics, Intravenous, this term only
#10 MeSH descriptor Anesthesia, Intravenous, this term only
#11 MeSH descriptor Nerve Block explode all trees
#12 (intravenous or intramuscular or transdermal or subcutaneous):ti,ab
#13 (ISBPB or ISNB or (interscalene near (block or an?esth* or analg* or continuous)))
#14 (#8 OR #9 OR #10 OR #11 OR #12 OR #13)

(Continued)

#15 (#7 AND #14)

Appendix 2. MEDLINE (via PubMed) search strategy

Search terms

```
#1 shoulder in TI, AB
#2 shoulder near (surg* or replac* or arthroplasty)
#3 rotator cuff in TI, AB
#4 explode Shoulder / all subheadings
#5 explode Shoulder Joint/ all subheadings
#6 explode Rotator Cuff/ all subheadings
#7 "Arthroplasty-" / all SUBHEADINGS in MIME,MJME,PT
#8 "Arthroplasty-Replacement" / all SUBHEADINGS in MIME,MJME,PT
#9 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8
#10 interscalene near block
#11 Patient control* near analgesia
#12 interscalene near (block or an?esth* or analg* or continuous or (brachial plexus)
#13 explode "Analgesia-Patient-Controlled" / all SUBHEADINGS in MIME,MJME,PT
#14 (explode "Anesthetics-Intravenous" / all SUBHEADINGS in MIME,MJME,PT) or (explode "Anesthesia-Intravenous" / all SUBHEAD-
INGS in MIME,MJME,PT)
#15 interscalene
#16 explode Injections-Intramuscular/ all subheadings
#17 explode Administration-Cutaneous/ all subheadings
#18 explode Injections-Subcutaneous/ all subheadings
#19 explode Infusions-Intravenous/ all subheadings
#20 parenteral near (an?esth* or analg*)
#21 ISBPB or ISNB
#22 explode nerve block/ all subheadings
#23 (parenteral or intravenous or intramuscular or transdermal or subcutaneous) in TI, AB
#24 #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23
#25 #9 and #24
```

Appendix 3. EMBASE search strategy

Search terms

```
1 shoulder/ or exp rotator cuff/ or exp shoulder arthroplasty/ or arthroplasty/ or (shoulder or rotator cuff).ti,ab. (32445)
2 exp patient controlled analgesia/ or intravenous anesthetic agent/ or intravenous anesthesia/ or exp nerve block/ or postop-
erative pain/ or brachial plexus anesthesia/ or local anesthetic agent/ or (intravenous or intramuscular or transdermal or subcuta-
neous).ti,ab. or (ISBPB or ISNB or (interscalene adj3 (block or an?esth* or analg* or continuous))).mp. (274975)
3 1 and 2 (1699)
4 (randomized-controlled-trial/ or randomisation/ or controlled-study/ or multicenter-study/ or phase-3-clinical-trial/ or phase-4-
clinical-trial/ or double-blind-procedure/ or single-blind-procedure/ or (random* or cross?over* or factorial* or placebo* or volun-
teer* or ((singl* or doubl* or trebl* or tripl*) adj3 (blind* or mask*))).ti,ab.) not (animals not (humans and animals)).sh. (3269130)
5 4 and 3 (659)
6 from 5 keep 1-659 (659)
```

Appendix 4. ISI Web of Science search strategy

Search terms

- 1 shoulder/ or exp rotator cuff/ or exp shoulder arthroplasty/ or arthroplasty/ or (shoulder or rotator cuff).ti,ab. (32445)
- 2 exp patient controlled analgesia/ or intravenous anesthetic agent/ or intravenous anesthesia/ or exp nerve block/ or postoperative pain/ or brachial plexus anesthesia/ or local anesthetic agent/ or (intravenous or intramuscular or transdermal or subcutaneous).ti,ab. or (ISBPB or ISNB or (interscalene adj3 (block or an?esth* or analg* or continuous))).mp. (274975)
- 3 1 and 2 (1699)
- 4 (randomized-controlled-trial/ or randomisation/ or controlled-study/ or multicenter-study/ or phase-3-clinical-trial/ or phase-4-clinical-trial/ or double-blind-procedure/ or single-blind-procedure/ or (random* or cross?over* or factorial* or placebo* or volunteer* or ((singl* or doubl* or trebl* or tripl*) adj3 (blind* or mask*))).ti,ab.) not (animals not (humans and animals)).sh. (3269130)
- 5 4 and 3 (659)
- 6 from 5 keep 1-659 (659)

Appendix 5. CINAHL (EBSCO host) search strategy

Search terms

- S1 TX (shoulder or rotator cuff) and AB (shoulder or rotator cuff)
- S2 (MH "Shoulder")
- S3 (MH "Shoulder Joint+")
- S4 (MH "Rotator Cuff+")
- S5 (MH "Arthroplasty") or (MH "Arthroplasty, Replacement+")
- S6 S1 or S2 or S3 or S4 or S5
- S7 (MH "Patient-Controlled Analgesia")
- S8 (MH "Anesthetics, Intravenous") or (MH "Anesthesia, Intravenous")
- S9 (MM "Nerve Block")
- S10 AB intravenous or intramuscular or transdermal or subcutaneous
- S11 TX ISBPB or ISNB
- S12 TX interscalene and TX (block or an?esth* or analg* or continuous)
- S13 S7 or S8 or S9 or S10 or S11 or S12
- S14 S6 and S13
- S15 TX (random* or placebo* or clinical trial*) or TX ((single or double or triple) and (blind* or mask*))
- S16 TX animal* not TX ((animal* and human*))
- S17 S15 not S16

(Continued)

S18 S14 and S17

Appendix 6. Data extraction form

Continuous interscalene blockade versus parenteral analgesia for postoperative pain relief after major shoulder surgery

Study ID:

Authors:

MEDLINE journal ID:

Year of publication:

Language:

RCT

CCT

Observational

Type of study:

Comments on study design:

Quality of concealment of random allocation

Allocation was not concealed

(e.g. quasi-randomization)

Allocation concealment was inadequate

Methods of concealment were unclear or were not stated

Concealment was adequate

(e.g. numbered, sealed opaque envelopes; central assignment by co-ordinating centre)

Inclusion and exclusion criteria were not clearly defined in the text

Outcomes of participants who withdrew or were excluded after allocation were NEITHER detailed separately NOR included in an intention-to-treat analysis

Outcomes of participants who withdrew or were excluded after allocation were EITHER detailed separately OR included in an intention-to-treat analysis

OR the text stated there were no withdrawals

Treatment and control groups were NOT adequately described at entry

Treatment and control groups were adequately described at entry

A minimum of four admission details were described

Methods

	Low risk of bias	High risk of bias	Unclear
Subject-blinded			
Physician type one-blinded			
Physician type two-blinded			
Outcome assessor-blinded			

Participants

Number of eligible participants	Number enrolled in study
Number of males	Number of females

Intervention	Drugs (specify)	Dose	Duration	Route
Interscalene group				

(Continued)

Parenteral group

Comment on treatment

	Interscalene group n	Parenteral group n
Withdrawals		
Lost to follow-up		

Primary outcome	Effectiveness of pain relief # (%)	Total participants n
Interscalene group		
Parenteral group		

Secondary outcome	Interscalene group		Parenteral group	
complications	n	(%)	n	(%)
Block failure				
Pneumothorax				
Nerve injury				
Horner's syndrome				

(Continued)

Vascular injury

Haematoma

Bleeding

Catheter dislocation

Infection

Metal taste

Motor block

Cardiovascular depression

Central nervous system excitation

Nausea and vomiting

Pruritus

Sedation

Respiratory depression

Others

Secondary outcome

Interscalene group

Parenteral group

n

(%)

(%)

n

Duration of analgesia (hours)

LOS PACU (hours)

Continuous outcomes:
LOS hospital (days)

Participant satisfaction

Supplemental analgesia

Changes in protocol:

Contact with author:

Other comments on the study:

CONTRIBUTIONS OF AUTHORS

Conceiving of the review: Hameed Ullah (HU).
Co-ordinating the review: HU.
Undertaking manual searches: HU, Khalid Samad (KS).
Screening search results: HU, KS.
Organizing retrieval of papers: HU, KS.
Screening retrieved papers against inclusion criteria: HU, KS.
Appraising quality of papers: HU, KS.
Abstracting data from papers: HU.
Writing to authors of papers to ask for additional information: KS.
Providing additional data about papers: HU, KS.
Obtaining and screening data on unpublished studies: HU, KS.
Managing data for the review: HU, KS.
Entering data into Review Manager ([RevMan 5.1](#)): HU.
Handling RevMan statistical data: HU, KS.
Performing other statistical analyses not using RevMan: HU, KS.
Entering data double: data entered by person one, HU; data entered by person two, KS.
Interpreting data: HU, KS, Fauzia A Khan (FK).
Making statistical inferences: HU, KS, FK.
Writing the review: HU.
Securing funding for the review: not applicable.
Performing previous work that was the foundation of the present study: HU.
Serving as guarantor for the review (one author): HU.
Taking responsibility for reading and checking the review before submission: KS, FK,

DECLARATIONS OF INTEREST

Hameed Ullah: none known.

Khalid Samad: none known.

Fauzia A Khan: none known.

SOURCES OF SUPPORT

Internal sources

- Department of Anaesthesiology, Aga Khan University, Karachi, Pakistan.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

1. The title has undergone a minor change. "Continuous interscalene blockade" has been changed from the protocol (Ullah 2008) to "Continuous interscalene brachial plexus block" in the review.
2. In the review, we searched CENTRAL, MEDLINE, EMBASE, CINAHL and ISI Web of Science, whereas we mentioned only the first three databases in the protocol.
3. The risk of bias tool has been updated and the methods amended to reflect this.

INDEX TERMS

Medical Subject Headings (MeSH)

*Brachial Plexus; Analgesics, Opioid [*administration & dosage]; Anesthesia, Local [*methods]; Nerve Block [*methods]; Pain, Postoperative [*therapy]; Pirinitramide [administration & dosage]; Randomized Controlled Trials as Topic; Shoulder [*surgery]; Sufentanil [administration & dosage]

MeSH check words

Humans