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Guidelines

# PROSPECT guideline for rotator cuff repair surgery: systematic review and procedure-specific postoperative pain management recommendations

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## Summary

Rotator cuff repair can be associated with significant and difficult to treat postoperative pain. We aimed to evaluate the available literature and develop recommendations for optimal pain management after rotator cuff repair. A systematic review using procedure-specific postoperative pain management (PROSPECT) methodology was undertaken. Randomised controlled trials published in English from 1 January 2006 to 15 April 2019 assessing postoperative pain after rotator cuff repair using analgesic, anaesthetic or surgical interventions were identified from MEDLINE, Embase and Cochrane Databases. Out of 322 eligible studies identified, 59 randomised controlled trials and one systematic review met the inclusion criteria. Pre-operative and intra-operative interventions that improved postoperative pain were paracetamol, cyclo-oxygenase-2 inhibitors, intravenous dexamethasone, regional analgesia techniques including interscalene block or suprascapular nerve block (with or without axillary nerve block) and arthroscopic surgical technique. Limited evidence was found for pre-operative gabapentin, perineural adjuncts (opioids, glucocorticoids, or α-2-adrenoceptor agonists added to the local anaesthetic solution) or postoperative transcutaneous electrical nerve stimulation. Inconsistent evidence was found for subacromial/intra-articular injection, and for surgical technique-linked interventions, such as platelet-rich plasma. No evidence was found for stellate ganglion block, cervical epidural block, specific postoperative rehabilitation protocols or postoperative compressive cryotherapy. The analgesic regimen for rotator cuff repair should include an arthroscopic approach, paracetamol, non-steroidal anti-inflammatory drugs, dexamethasone and a regional analgesic technique (either interscalene block or suprascapular nerve block with or without axillary nerve block), with opioids as rescue analgesics. Further randomised controlled trials are required to confirm the influence of the recommended analgesic regimen on postoperative pain relief.

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[#]See Appendix

## Recommendations

1 Whenever possible, rotator cuff repair should be performed using an arthroscopic approach, as it is associated with reduced postoperative pain.
2 Systemic analgesia should include paracetamol and non-steroidal anti-inflammatory drugs (NSAID) administered pre-operatively or intra-operatively and continued postoperatively.
3 Interscalene brachial plexus blockade is recommended as the first-choice regional analgesic technique. Suprascapular nerve block, with or without axillary nerve block, may be used as an alternative to interscalene block.
4 A single dose of intravenous (i.v.) dexamethasone is recommended for its ability to increase the analgesic duration of interscalene brachial plexus block, decrease analgesic use and anti-emetic effects.
5 Opioids should be reserved as rescue analgesia in the postoperative period.

## Why was this guideline developed?

Rotator cuff repair surgery is associated with significant postoperative pain and effective pain control can improve early postoperative rehabilitation. The aim of this guideline is to provide clinicians with an evidence-based approach to pain management after rotator cuff repair which should improve postoperative pain relief.

## What other guidelines are available on this topic?

There are no previously published formal guidelines for pain management after rotator cuff repair surgery, although there are systematic reviews assessing analgesic interventions after shoulder surgery.

## How does this guideline differ from other guidelines?

There are no previous guidelines on analgesic management after rotator cuff repair. Nevertheless, the procedure-specific postoperative pain management (PROSPECT) approach to developing guidelines is unique such that the available evidence is critically assessed for current clinical relevance and the use of simple, non-opioid analgesics, such as paracetamol and NSAIDs, as baseline analgesics is considered. This approach reports true clinical effectiveness by balancing the invasiveness of the analgesic interventions and the degree of pain after surgery, as well as balancing efficacy and adverse effects.

## Introduction

Rotator cuff repair improves long-term pain and quality of life in patients with symptomatic rotator cuff disease [1]. However, rotator cuff repair is associated with significant postoperative pain, and effective pain control can affect early postoperative rehabilitation [2] and long-term outcomes [1]. Pain continues to be a significant concern after rotator cuff repair as it may result in prolonged admission or re-admission to hospital [3]. With significant variations in analgesic protocols, a unified approach is necessary to provide standardised interventions to reduce pain. A systematic review [4] assessed the evidence for the effectiveness of commonly used regional anaesthesia techniques for postoperative analgesia after shoulder surgery and made recommendations for management. That review was not specific to rotator cuff repair and it focused on regional analgesic techniques only. Moreover, the authors did not assess non-opioid analgesics like paracetamol and NSAIDs. A narrative review [5] examined modalities for pain relief after arthroscopic rotator cuff repair, however, no specific recommendations were provided except to state that a multimodal analgesia approach is preferred.

The PROSPECT Working Group is a collaboration of surgeons and anaesthetists working to formulate procedure-specific recommendations for pain management after common but potentially painful operations [6]. The recommendations are based on a procedure-specific systematic review of randomised controlled trials (RCT). The methodology considers clinical practice, efficacy and adverse effects of analgesic techniques [7].

The aim of this systematic review was to evaluate the available literature on the effects of analgesic and surgical interventions on pain after rotator cuff repair. The primary outcomes sought were postoperative pain scores and analgesic requirements. Other recovery outcomes, including adverse effects, were also assessed when reported and the limitations of the data were reviewed. The ultimate aim was to develop recommendations for pain management after rotator cuff repair.

## Methods

The methods of this review adhered to PROSPECT methodology as previously reported [8]. Specific to this study, the Embase, MEDLINE, PubMed and Cochrane Databases (Cochrane Central Register of Controlled Trials, Cochrane Database of Abstracts or Reviews of Effects, Cochrane Database of Systematic Reviews) were searched for RCTs published between 1 January 2006 and 15 April

 

**Table 1** Overall recommendations for pain management in patients undergoing rotator cuff repair surgery.

| |
|---|
| Pre-operative and intra-operative |
| Paracetamol (Grade D) |
| COX-2-specific inhibitor (Grade D) |
| Dexamethasone i.v. (Grade B) |
| Regional analgesia |
| Interscalene brachial plexus block, continuous (Grade A) |
| Interscalene brachial plexus block, single-shot (Grade A) |
| Suprascapular nerve block with or without axillary nerve block (but not as the first choice, Grade B) |
| Postoperative |
| Paracetamol (Grade D) |
| COX-2-specific inhibitor/NSAID (Grade D) |
| Opioid for rescue (Grade D) |
| Surgical technique |
| Arthroscopic technique (Grade B) |

COX, cyclo-oxygenase; NSAID, non-steroidal anti-inflammatory drugs.

2019. The search terms used included pain OR analgesia OR anaesthesia OR visual analogue scale (VAS) OR peripheral nerve OR peripheral block OR interscalene block OR brachial plexus anaesthesia OR supraclavicular block OR nonsteroidal anti-inflammatory agent OR paracetamol OR gabapentin OR pregabalin OR clonidine OR opiate OR ketamine OR corticosteroid OR intra articular drug administration OR cryotherapy AND rotator cuff repair OR arthroscopic rotator cuff repair OR rotator cuff surgery.

Quality assessment, data extraction and data analysis adhered to PROSPECT methodology [8]. Pain intensity scores were used as the primary outcome measure. In this study, we defined a change of more than 10 mm on the VAS or numerical rating score as clinically relevant. The effectiveness of each intervention for each outcome was evaluated qualitatively by assessing the number of studies showing a significant difference between treatment arms ($p < 0.05$ as reported in the study publication). A meta-analysis was not performed due to heterogeneity in study design and result reporting, restricting pooled analysis.

Recommendations were made according to PROSPECT methodology [8]. In brief, this involved a grading of A–D according to the overall level of evidence, as determined by the quality of studies included, consistency of evidence and study design. The proposed recommendations were sent to the PROSPECT Working Group for review and comments and a modified Delphi approach was utilised as previously described [8]. Once a consensus was achieved, the lead authors drafted the final document, which was ultimately approved by the Working Group.

## Results

The PRISMA flow chart demonstrating the search data are presented in Fig. 1. The methodological quality assessments of the 59 RCTs and one systematic review included for the final qualitative analysis are summarised in Table S1. The characteristics of the included studies are shown in Tables S2 and S3.

### *Systemic non-opioid analgesics*

In a placebo-controlled study, Takada et al. looked into the pre-operative use of a single dose of i.v. flurbiprofen 1 $mg.kg^{-1}$ in patients receiving intra-articular ropivacaine at the end of the procedure [9]. Pain scores were significantly lower at 0.5 h, 1 h, 2 h, 4 h and 6 h post-surgery and buprenorphine consumption was lower within the first 2 h post-surgery for flurbiprofen vs. placebo.

In patients receiving patient-controlled analgesia (PCA) for the first 48 postoperative hours, Oh et al. [10] compared celecoxib, ibuprofen or tramadol for 2 weeks after surgery. Pain scores and rescue opioids were similar in the three groups at 3 days and 2 weeks after surgery. However, the 'tear' rates were higher in the celecoxib group, 24 months after surgery.

Cho et al. compared a multimodal pain regimen including pre-operative oral oxycodone, acetaminophen, intra-operative intra-articular morphine, methylprednisolone acetate, ropivacaine 0.75%, and postoperative oral oxycodone, acetaminophen and celecoxib vs. postoperative oral celecoxib added to i.v. PCA with fentanyl and ketorolac [11]. The multimodal pain regimen reduced pain scores immediately after surgery on postoperative days (POD) 3, 4

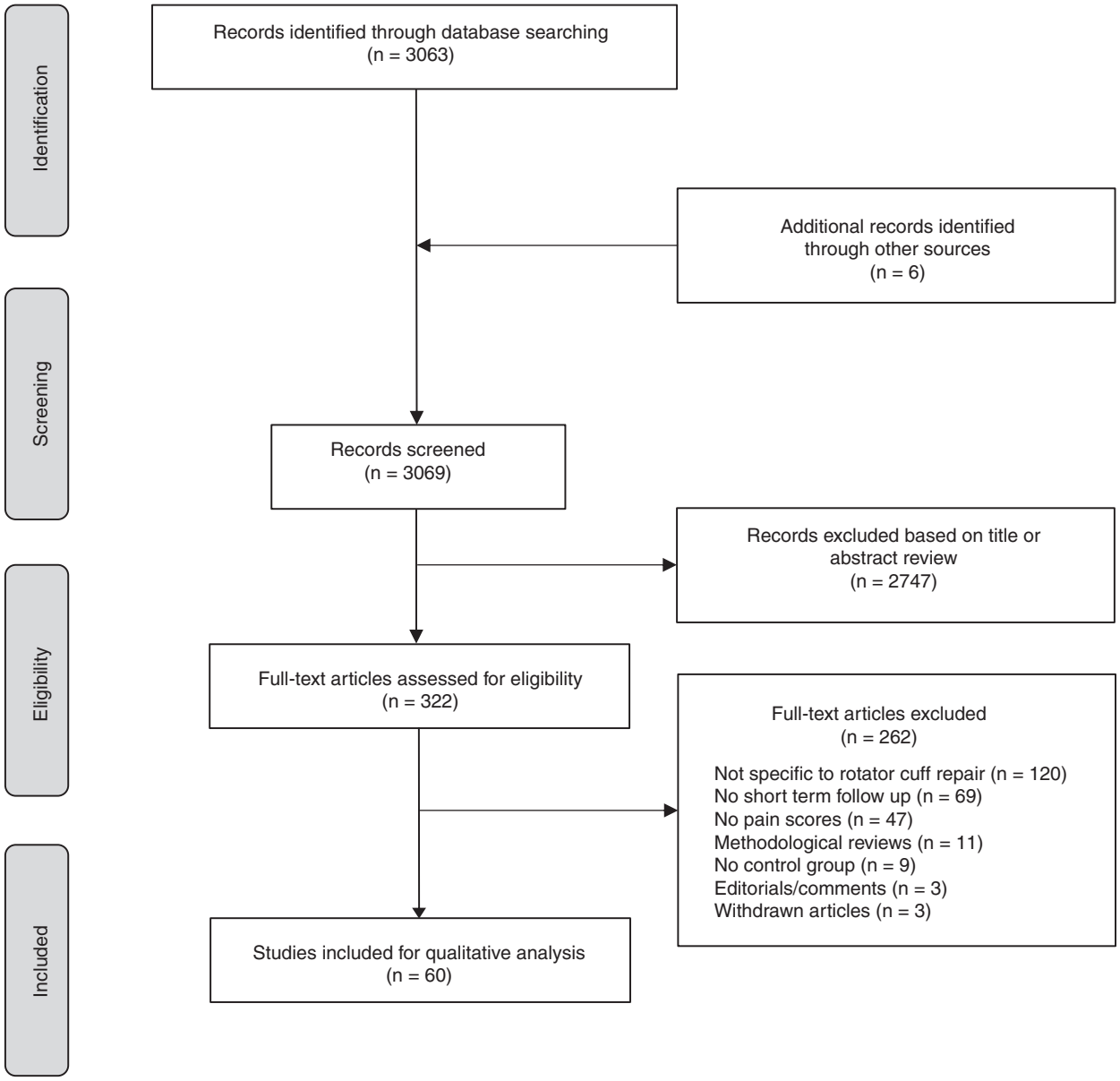


**Figure 1** PRISMA flow diagram of studies.

and 5. The multimodal protocol also reduced the likelihood for additional postoperative analgesia in the form of intramuscular (i.m.) diclofenac.

Bang et al. investigated in a placebo-controlled manner the analgesic effects of oral gabapentin 300 mg administered 2 h pre-operatively [12]. Pain scores were significantly lower at 2 h, 6 h and 12 h after surgery, although fentanyl consumption did not differ between the gabapentin and placebo groups.

Desmet et al. conducted a placebo-controlled study evaluating the effect of three different doses of i.v. dexamethasone on the duration of interscalene blockade [13]. Postoperative pain scores and analgesic consumption were not significantly different between the groups, but dexamethasone 2.5 mg and 10 mg produced a significantly longer duration of analgesia.

***Regional analgesic interventions***

Choi et al. [14] evaluated the efficacy of stellate ganglion block vs. no block in the rotator cuff repair setting. Neither postoperative pain scores nor opioid consumption was significantly different between the groups.

Liu et al. [15] compared analgesia provided by a single-shot interscalene brachial plexus block with placebo and

 

found that pain scores were lower at 1 h, 6 h and 12 h after surgery in the block group, and postoperative opioid use was lower at 6 h after surgery. Wong et al. [16] assessed the analgesic effects of two different concentrations of ropivacaine (0.2% vs. 0.1%) for single-shot interscalene block and found that, although pain scores were similar, postoperative opioid consumption was reduced for the first 72 h after surgery by ropivacaine 0.2%. In a study with a similar design, Lee et al. [17] compared different volumes of ropivacaine 0.75% (5 ml vs. 10 ml) for a single-shot interscalene block and did not find any differences either for pain scores or for opioid consumption.

Watanabe et al. [18] found that, compared with placebo, betamethasone 4 mg added perineurally to ropivacaine 0.375% reduced pain scores at 12 h after surgery and on POD 1 and 7, and also reduced opioid consumption. Desmet et al. compared perineural placebo, perineural dexamethasone 10 mg and i.v. dexamethasone 10 mg in patients receiving single-shot interscalene block with ropivacaine 0.5%. Both dexamethasone groups had lower pain scores compared with perineural placebo as well as lower paracetamol and diclofenac use for the first 48 h after surgery [19] ($p = 0.03$). There were no differences in pain scores or opioid consumption between perineural and i.v. dexamethasone.

Behr et al. [20] compared placebo, perineural buprenorphine 150 μg and i.m. buprenorphine 150 μg. Compared with placebo, both perineural and i.m. buprenorphine increased the duration of analgesia and reduced opioid consumption. Perineural buprenorphine provided a longer duration of analgesia compared with i.m. buprenorphine. With a similar study design, Allemano et al. [21] compared placebo, perineural tramadol 1.5 $mg.kg^{-1}$ and i.m. tramadol 1.5 $mg.kg^{-1}$. Perineural and i.m. tramadol increased the duration of analgesia when compared with placebo. Also, perineural tramadol was more effective in increasing the duration of analgesia when compared with i.m. tramadol. In a placebo-controlled study, Faria-Silva et al. [22] reported that perineural clonidine 150 μg did not influence pain scores or opioid consumption. Lee et al. [23] found that 2 ml of perineural magnesium sulphate 10% added to interscalene block reduced the pain scores at 12 h postoperatively compared with placebo, but did not reduce opioid consumption.

Salviz et al. [24] compared three groups: continuous interscalene block; single-shot interscalene block; and general anaesthesia with no block. The continuous interscalene block group had lower pain scores on POD 1, 2 and 7, and lower opioid consumption on POD 1 and 2. Malik et al. [25] compared continuous interscalene block with single-shot interscalene block and found that the continuous interscalene block group had lower pain scores as well as opioid consumption on POD 1, 2 and 3. Gomide et al. [26] compared continuous interscalene block with single-shot interscalene block and found that the continuous interscalene block group had significantly lower pain scores and rescue analgesic consumption on POD 1, 2 and 3. Kim et al. [27] compared three groups: single-shot interscalene block, continuous interscalene block and no block (i.v. meperidine as needed). Lower pain scores were found for continuous interscalene block 24 h postoperatively, whereas the use of single-shot interscalene block was associated with higher pain scores 24 h postoperatively.

Hofmann-Kiefer et al. [28] found that, compared with i.v. PCA piritramide, continuous interscalene block reduced resting pain scores at 6 h, 24 h and 72 h as well pain scores during physiotherapy on POD 2 and intra-operative opioid consumption. Shin et al. [29] compared three groups: one group with continuous interscalene block with a fixed-rate infusion; another with patient-administered bolus; and a third group with no block, but with i.v. morphine PCA and ketorolac. Compared with i.v. PCA, both continuous interscalene block groups had lower pain scores at 1 h, 4 h, 8 h, 16 h, 24 h, 32 h and 40 h after surgery and needed less supplementary opioid analgesia.

Thackeray et al. [30] compared bupivacaine 0.125% with 0.25% for continuous interscalene block and found lower pain scores in the 0.25% group without a significant reduction in opioid use. Kim et al. [31] compared three groups: two groups with continuous interscalene block (initial injection ropivacaine 0.75% or 0.2%, but both groups receiving continuous ropivacaine 0.2% postoperatively), and one group with cervical epidural block. The groups with continuous interscalene block had lower pain scores at all recorded time-points compared with the cervical epidural group. Pain scores between the two continuous interscalene block groups were similar. Postoperative opioid consumption was not reported. Borgeat et al. [32] evaluated ropivacaine 0.2% vs. ropivacaine 0.3% for continuous interscalene block and found no differences in pain scores with lower opioid consumption in the 0.3% group at all time-points during the first 48 h after surgery.

Auyong et al. [33] evaluated three groups with continuous blocks: interscalene brachial plexus block; supraclavicular brachial plexus block; and suprascapular nerve block. Pain scores were lower in the continuous interscalene block group without a significant reduction in opioid use.

Borgeat et al. [34] assessed the efficacy of continuous interscalene block with a catheter placed using neurostimulation

posterior to the superior trunk of the brachial plexus vs. the anterior to the superior trunk of the brachial plexus. Pain scores were not reported but opioid consumption after surgery was not significantly different.

Fredrickson et al. [35] evaluated two different settings for continuous interscalene block: 2 $ml.h^{-1}$ ropivacaine 0.2% with mandatory 5-ml boluses 6-hourly vs. 5 $ml.h^{-1}$ ropivacaine 0.2% plus patient-controlled 5-ml boluses. They reported that both postoperative pain scores and opioid consumption were similar between groups.

In a placebo-controlled study, Lee et al. [36] investigated the effects of adding an axillary nerve block to a suprascapular nerve block. As compared with saline, when ropivacaine 0.75% was used for performing the axillary nerve block, pain scores were lower at 1 h, 3 h, 6 h, 12 h, 18 h and 24 h after surgery. Opioid consumption was not reported. Park et al. [37] assessed combined axillary nerve block and suprascapular nerve block vs. suprascapular nerve block only vs. no block and found lower pain scores for the treatment groups vs. no block at 1 h, 6 h, 12 h and 36 h after surgery. Lower pain scores were also identified up to 48 h after surgery for the combined group vs. suprascapular nerve block-only group. Desroches et al. [38] found that, compared with suprascapular nerve block, interscalene block provided lower pain scores and opioid consumption at 2 h after surgery. Lee et al. [39] added a suprascapular nerve block to an interscalene block in a placebo-controlled study and identified lower pain scores for the group that received the suprascapular nerve block at 3 h, 6 h, 12 h, 18 h and 24 h after surgery. Opioid consumption was not reported. Lee et al. [40] found that, compared with placebo, arthroscopic suprascapular nerve block reduced the i.v. fentanyl PCA consumption. Pain scores were not significantly different.

***Intra-operative interventions***

Kim et al. assessed the effects of intra-operative hypotension, induced by either remifentanil, nicardipine or their combination, on pain after rotator cuff repair [41]. Pain scores after surgery were lower for nicardipine only and nicardipine plus remifentanil as compared with remifentanil only. Opioid use after surgery was not recorded.

Khashan et al. [42] compared the analgesic effects of three different intra-articular injections: morphine 20 mg; morphine 10 mg plus ketamine 50 mg; or saline. There was no difference in postoperative pain scores and opioid consumption between the three groups. In a placebo-controlled study, Perdreau et al. [43] reported that subacromial injection of morphine, ropivacaine and methylprednisolone reduced both pain scores and opioid consumption at 0.5 h, 1 h, 4 h, 6 h, 12 h, 18 h and 24 h after surgery. Jo et al. [44] compared a subacromial and intra-articular injection of ropivacaine and morphine to saline injection and found lower pain scores 5 h postoperative and on POD 4 and a reduction in 24-h opioid consumption in the intervention group. Han et al. [45] compared subacromial injection of ropivacaine and morphine to i.v. fentanyl PCA and ketorolac. They reported that pain scores were lower at 2 h postoperatively in the subacromial group, but that opioid consumption was lower in the i.v. PCA group12–48 h postoperatively. Lee et al. [46] compared an intra-articular injection of a mixture of bupivacaine and lidocaine with subacromial injection and with a combination of intra-articular and subacromial injections. There were no significant differences between the three groups with regard to pain scores or opioid consumption.

Merivirta et al. [47] compared subacromial bupivacaine and placebo patch with subacromial saline and fentanyl patch and found no significant difference in pain scores or opioid consumption between the two groups. Yun et al. [48] compared patient-controlled subacromial ropivacaine administration with i.v. PCA comprising fentanyl, ketorolac and ondansetron, and found lower pain scores for subacromial infusion at 1 h after surgery and no difference in opioid consumption. Schwartzberg et al. reported lower pain scores in the control group (no subacromial catheter) compared with subacromial infusion with bupivacaine in the immediate postoperative period, also finding no difference in opioid consumption [49]. Merivirta et al. reported lower pain scores at 18 h postoperatively and lower opioid consumption on POD 0, 1 and 2 with subacromial bupivacaine 0.5% infusion compared with saline infusion [50]. Coghlan et al. found that compared with saline infusion, subacromial infusion with ropivacaine 0.75% provided lower pain scores for the first 12 h, but no difference in opioid consumption [51]. Banerjee et al. found no difference in pain scores or opioid consumption between subacromial bupivacaine 0.25% infusion at a rate of 2 $ml.h^{-1}$, 5 $ml.h^{-1}$ or saline infusion [52].

After performing an interscalene block with levobupivacaine 0.5%, Koltka et al. [53] compared subacromial vs. interscalene continuous postoperative levobupivacaine 0.125% infusion. Better pain scores and less opioid consumption were found in the interscalene group. Sethi et al. [54] added intra-operative injections of liposomal bupivacaine into the surgical site (with a 10 ml bolus injection as a suprascapular nerve block) to an interscalene block performed with bupivacaine 0.5%. They found significantly lower pain scores on POD 1 and 2 and significantly lower postoperative opioid consumption on

 

POD 0–5 in the liposomal bupivacaine group. Oh et al. compared subacromial ropivacaine 0.5% infusion to interscalene ropivacaine 0.125% infusion; there were lower pain scores in the subacromial group but no significant difference in opioid consumption [55]. Cho et al. compared subacromial infusion with bupivacaine 0.5% to i.v. PCA with fentanyl and ketorolac and found no significant difference in pain scores or opioid consumption between the two groups [56].

***Postoperative interventions***

Mazzocca et al. compared early (POD 2–3) vs. delayed (POD 28) motion rehabilitation protocols after rotator cuff repair and did not find any difference in pain scores 7–10 days postoperatively [57]. Opioid consumption was not recorded. Hollman et al. assessed an abduction brace vs. an antirotation sling as a way to immobilise the shoulder after surgery [58]. Neither pain scores nor opioid use after surgery were different between the techniques. Mahure et al. performed a placebo-controlled study investigating postoperative transcutaneous electrical nerve stimulation (TENS) and found lower pain scores at 12 h and on POD 7 [59]. Opioid consumption after surgery also favoured TENS. Kraeutler et al. compared compressive cryotherapy vs. standard ice wrap and found neither pain scores nor opioid use after surgery was significantly different [60]. Cho et al. compared the addition of zolpidem as a sleep aid to multimodal analgesia with multimodal analgesia only [61]. Pain scores after surgery were not significantly different; the zolpidem group had lower rescue analgesic requirements.

***Surgical technique***

Capito et al. compared isotonic to hyperosmolar irrigation arthroscopy and found lower pain scores after hyperosmolar irrigation at the end of surgery [62]. Opioid use was not reported. Randelli et al. compared single-row anchor fixation to transosseous hardware-free suture repair and found that the transosseous technique provided lower pain scores on week 3 and 4 after surgery [63]. Opioid consumption was not reported. Liu et al. reported that an arthroscopic approach had lower pain scores on POD 1 compared with a mini-incision [64]. In a similar study, Cho et al. reported that an arthroscopic approach provided lower pain scores on POD 1 and 2 with a reduction in postoperative analgesic consumption [65].

D'Ambrosi et al. compared the use of platelet-rich plasma with standard arthroscopic rotator cuff repair and found lower pain scores with platelet-rich plasma in the first week after surgery [66]. Opioid consumption was not recorded. Flury et al. compared platelet-rich plasma injection at the supraspinatus attachment with subacromial injection of ropivacaine 1% and did not find significant differences in pain scores and opioid use after surgery [67]. Weber et al. compared platelet-rich fibrin matrix with standard arthroscopic rotator cuff repair and did not find any significant difference in pain scores or opioid use after surgery [68]. Yang et al. performed a meta-analysis of RCTs and found that platelet-rich plasma reduced pain scores 7 days after surgery. Opioid consumption after surgery was not reported [69].

## Discussion

Based on available evidence and the PROSPECT approach to providing recommendations, combinations of paracetamol and an NSAID or a cyclo-oxygenase-2 (COX-2)-specific inhibitor are recommended pre-operatively or intra-operatively, and should be continued into the postoperative period, unless there are contra-indications. The analgesic benefits and opioid-sparing effects of these simple analgesics are well described [6, 70, 71]. Although there is limited procedure-specific evidence, i.v. dexamethasone is recommended for its ability to increase the analgesic duration of interscalene block and decrease supplemental analgesia use, as well as for its antiemetic effects. Limited procedure-specific evidence was found for pre-operative gabapentin, which was not demonstrated to have opioid-sparing effects in this setting. Further evidence is, therefore, needed to support peri-operative use of gabapentin for rotator cuff repair. Intra-operative controlled hypotension is not recommended as there is insufficient procedure-specific evidence regarding its analgesic benefits. Moreover, there is a concern that hypotension may increase the risk of a reduction in cerebral perfusion and oxygenation [72, 73].

The use of a regional analgesic technique as a component of multimodal analgesia is recommended. A continuous interscalene block is favoured over a single-shot interscalene block. A systematic review with meta-analysis of RCTs assessing analgesic effects of single-shot interscalene block in patients undergoing shoulder surgery including rotator cuff repair found that interscalene block was more effective compared with placebo or systemic analgesia [74]. However, the duration of analgesia was short (6 h and 8 h with motion and at rest, respectively) and there was rebound pain at 24 h. Therefore, it is imperative that patients receive paracetamol and NSAID or a COX-2-specific inhibitor regularly to avoid a significant increase in pain after the regional block has resolved. If an interscalene block is not possible, an axillary nerve block with or without suprascapular nerve block is favoured over no block or over a suprascapular nerve block alone. Additionally, a

suprascapular nerve block reduces pain scores and/or opioid use after surgery but does not seem to have analgesic advantages over interscalene block.

In an effort to prolong the duration of a single-shot interscalene block, several analgesic adjuncts are administered perineurally combined with a local anaesthetic. There is limited procedure-specific evidence regarding perineural benefits of buprenorphine, tramadol or magnesium sulphate. Procedure-specific evidence is lacking for perineural clonidine. Limited procedure-specific evidence was also identified for perineural glucocorticoids (betamethasone and dexamethasone). Nevertheless, we recommend using i.v. dexamethasone over perineural administration.

Several studies investigated subacromial injection or infusion in the rotator cuff repair setting. However, the data concerning analgesia are inconsistent and therefore hinder recommendation. Only a few studies found beneficial effects for both pain scores and opioid consumption, whereas some demonstrated reductions in pain scores with no effect on postoperative opioid consumption. Most studies found insignificant differences in both pain scores and opioid consumption. In addition, the technique and timing of the subacromial injections or infusions were heterogeneous – some blocks were performed intra-operatively whereas others were performed at the end of surgery. Stellate ganglion block or cervical epidural block cannot be recommended in the rotator cuff repair setting due to a lack of procedure-specific evidence and increased risk of complications. Various postoperative interventions studied lack procedure-specific evidence (early vs. delayed motion protocols, compressive cryotherapy, use of specific shoulder immobilisation device) or have limited procedure-specific evidence (TENS, zolpidem as a sleep aid) and are, therefore, not recommended.

From a range of surgical interventions, an arthroscopic approach is recommended as it reduces postoperative pain. However, there is limited evidence to recommend hyperosmotic vs. isotonic irrigation during arthroscopy. Single-row anchor fixation as compared with transosseous hardware-free suture repair has limited procedure-specific evidence and this approach is, therefore, not recommended. Additionally, there is inconsistent procedure-specific evidence to support the use of platelet-rich plasma supplementation in the rotator cuff repair setting.

The limitations of this review are related to those of the included studies. There was considerable heterogeneity

**Table 2** Analgesic interventions that are not recommended for pain management in patients undergoing rotator cuff repair surgery.

| Intervention | Reason for not recommending |
|---|---|
| Pre-operative | |
| Gabapentin | Limited procedure-specific evidence |
| Subacromial/intra-articular injection | Inconsistent procedure-specific evidence |
| Stellate ganglion block | Lack of procedure-specific evidence and increased risks |
| Cervical epidural block | Lack of procedure-specific evidence and increased risks |
| Perineural adjuncts: opioid (buprenorphine or tramadol), glucocorticoid (betamethasone or dexamethasone), α-2-adrenoceptor agonist (clonidine) added to the local anaesthetic solution | Limited procedure-specific evidence |
| Intra-operative | |
| Hypotension | Limited procedure-specific evidence and increased risks |
| Postoperative | |
| Early motion protocols vs. delayed motion protocols | Lack of procedure-specific evidence |
| Specific postoperative shoulder immobilisation device | Lack of device-specific evidence |
| TENS | Limited procedure-specific evidence |
| Compressive cryotherapy or ice wrapping | Lack of procedure-specific evidence |
| Zolpidem as a sleep aid | Limited procedure-specific evidence |
| Surgical technique | |
| Hyperosmotic irrigation arthroscopy | Limited of procedure-specific evidence |
| Single-row anchor fixation vs. transosseous hardware-free suture repair | Limited procedure-specific evidence |
| Platelet-rich plasma supplementation | Limited and inconsistent procedure-specific evidence |

TENS, transcutaneous electrical nerve stimulation.

 

between studies such as variable dosing regimens, methods of administration and control groups as well as inconsistency in the time-points of pain assessments. Many of the included studies suffered from small sample sizes and might not have been adequate to draw valid conclusions from concerning the safety profile of analgesic interventions. In addition, many of the analgesic interventions were not evaluated against a control group that included an optimised multimodal analgesic regimen such as paracetamol and NSAIDs. Future adequately powered studies should assess the effects of analgesic interventions not only on time to ambulation and length of hospital stay but also other patient-related outcome measures such as chronic pain and long-term opioid consumption.

In summary, this review has identified the analgesic regimen for optimal pain management after rotator cuff repair (Table 1). We have also identified analgesic interventions that are not recommended for pain management in patients undergoing rotator cuff repair surgery (Table 2). Peri-operative pain management after rotator cuff repair should include unless contraindicated, paracetamol and NSAIDs administered pre-operatively or intra-operatively that should be continued into the postoperative period. Intravenous dexamethasone is recommended for its ability to increase the analgesic duration of interscalene block, decrease analgesic use and its antiemetic effects. Interscalene brachial plexus blockade is recommended as the first-choice regional analgesic technique. Suprascapular nerve block with or without axillary nerve block may be administered as an alternative to interscalene block. Opioids should be reserved for rescue postoperative analgesia. Whenever possible, rotator cuff repair should be performed using an arthroscopic approach, as it is associated with reduced postoperative pain.

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## Appendix

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## Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Table S1.** Quality assessment and level of evidence assigned to the randomised trials included in the review for analgesia after rotator cuff repair surgery.

**Table S2.** Summary of key results from studies evaluating systemic analgesics, systemic analgesic adjuncts, regional analgesia and surgical procedures used to support the recommended interventions in patients after rotator cuff repair surgery.

**Table S3.** Summary of key results from studies evaluating systemic analgesics, regional analgesia, perineural analgesic adjuncts and surgical procedures used to support interventions that are not recommended for analgesic benefit in patients having rotator cuff repair surgery.