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Guidelines

Evidence-Based Orthopaedic Post-Operative Opioid Prescribing Recommendations Following Shoulder Surgery

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Orthopaedic surgeons, the third-highest prescribers, have a crucial impact on the opioid epidemic, underscoring the urgency for safer prescribing protocols. To tackle this issue, ongoing research is dedicated to enhancing pain management and establishing evidence-based prescribing guidelines for shoulder surgeries. The literature on shoulder and elbow procedures provides vital foundational data for developing evidence-based opioid prescribing guidelines. Our strategy involves dispensing reduced quantities of opioids after surgery and prioritizing prescription refill requests over potentially excessive initial prescriptions. Recommendations are as follows: 1. collaborate with the anesthesiology team for perioperative nerve blocks 2. Use interscalene block for low-risk patients 3. Consider alternatives for high-risk patients 4. Utilize liposomal bupivacaine for postoperative pain control as an alternative to interscalene block.

INTRODUCTION

Since 2000, there has been a fourfold increase in narcotics-related fatalities.[1–3] Despite adhering to the guidelines set by medical boards, more than 50% of deaths attributed to opioids still occur.[4–6] The estimated annual societal cost resulting from the misuse of prescription opioids amounts to more than $75 billion.[1,7–10] Postoperative opioid prescriptions significantly influence the opioid epidemic. Studies show that three to eight percent of patients with no prior exposure to opioids continue to use these medications one year after surgery.[11,12] Among physicians from various specialties, orthopaedic surgeons ranked as the third-highest prescribers of opioid medications.[13–15] With the escalating severity of the opioid epidemic, it is of utmost importance for orthopaedic surgeons to adopt safer prescribing practices or explore alternative approaches to pain management.[10–15]

The achievement of optimal pain management for patients with shoulder disorders or those who have undergone surgical interventions remains a subject of ongoing research.[13,14,16,17] Presently, orthopaedic surgeons employ widely diverse approaches, with opioids frequently being relied upon or prescribed without tailoring them to meet the specific needs of individual patients.[12–17] There is a lack of comprehensive data regarding the extent of post-operative pain medication usage after orthopaedic shoulder surgery. Orthopaedic shoulder surgeons perform many surgeries, from open procedures such as total shoulder arthroplasty to minimally invasive arthroscopic debridements and repairs. Many of these patients are prescribed opioids postoperatively. Postoperative overprescribing of opioids is a well-documented contributor to the opioid epidemic. Recent studies have shown that shoulder surgeons are susceptible to overprescribing opioids, which can lead to opioid abuse and diversion in the community.[7,18] We aimed to establish simple, standardized, evidence-based postoperative opioid prescribing recommendations for common shoulder surgeries while providing satisfactory analgesia for patients through multimodal strategies.

STRATEGIES

The principles of pain management can be stratified into the following categories: acute pain, post-operative pain, and chronic pain. The present review aims to address post-operative pain. An overview of basic analgesic principles is outlined in this section. Additional specific, evidenced-based analgesia recommendations will be detailed in subsequent sections.

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1. Risk factors for potential opioid abuse should be considered before prescribing an opioid.
2. All patients receiving an opioid prescription should also receive preoperative counseling and educational materials.[19–21]
3. Non-pharmacologic treatment strategies should be utilized whenever possible.
4. Non-opioid analgesics should be considered the first-line pain management prescription(s) and are best ordered using a standing, around-the-clock dosing regimen vs. an as-needed basis.
5. In the majority of shoulder surgeries, we recommend the use of interscalene nerve block (ISNB) to reduce perioperative opioid consumption for patients who are at low risk for respiratory compromise in the event of phrenic nerve palsy. All decisions should be reached in collaboration with the anesthesiology team, and patients should be counseled regarding rebound pain.
6. In the majority of shoulder surgeries, we recommend a single dose of intra-operative IV glucocorticoids, administered at the discretion of the anesthesia team
7. Postoperative local infiltration with liposomal bupivacaine is a viable alternative instead of, NOT in addition to, ISNB for multimodal pain control.
8. Opioids should be provided for breakthrough pain as needed at the lowest effective dose for the shortest possible duration.
9. It is advisable to tailor pain regimens individually as needed based on pertinent medical history.

Perioperative pain management following shoulder surgery can be challenging and requires close communication between the orthopaedic, anesthesiology, and patient. Non-pharmacologic treatment strategies should be applied whenever possible. These strategies include but are not limited to rest, cryotherapy, and elevation of the upper extremity.[22,23] Non-opioid analgesics should form the foundation of a multimodal pain management strategy. We recommend the use of a standing dosing regimen for these medications. Specifically, acetaminophen (i.e., Tylenol) and non-steroidal anti-inflammatory drugs (NSAIDs) have shown remarkable effectiveness in multimodal analgesia studies.[5,7,12,19,24–38] We recommend against using opioid-acetaminophen combination medications to avoid confusion and minimize possible accidental acetaminophen overdose. Tramadol, a synthetic analog of codeine, can be an effective alternative to traditional opioids for mild-moderate postoperative pain.[39]

Risk factors for opioid misuse, including certain psychiatric conditions or a history of substance abuse, should be considered before prescribing opioid analgesics.[40–42] Screening tools such as the Medical Outcomes Study 36-Item (SF-36) Mental Component Summary and Beck Depression Inventory (BDI) can aid in identifying patients at risk for opioid misuse.[43,44] Additionally, surgeons should review state Prescription Drug Monitoring Programs (PDMP) data for each patient before prescribing narcotic analgesics. Ideally, all patients already under the care of a pain management physician preoperatively should continue to have their opioid prescriptions managed by the same provider postoperatively. Communication with this physician during the peri-operative period is essential to avoid double-prescribing opioids.[45]

Prior to prescribing an opioid, it is the surgeon's responsibility to provide the patient with counseling on safe opioid-use practices. Preoperative opioid education has been associated with significantly decreased total opioid consumption and earlier overall opioid cessation postoperatively after upper extremity surgery.[19,21,46] Opioid counseling should include education on side effects, signs of opioid misuse, and/or dependence, and establish the duration of these as-needed medications, with a maximum of up to 6 weeks postoperatively. If an opioid analgesic is provided, a low dose for the shortest possible duration is preferred. An "opioid contract" between the patient and their surgeon can help establish an appropriate opioid analgesic regimen and increase compliance.[47,48] Additionally, patients should be educated on safe storage and disposal practices to avoid potential narcotic diversion and abuse.[49] Finally, a key component of preoperative counseling is setting reasonable patient expectations regarding analgesia. While we strive to provide the safest and most effective pain management strategies, pain is a "normal" aspect of recovery from shoulder surgery. Patients can greatly benefit from having realistic expectations before undergoing their procedure.[50]

MEDICATIONS

ACETAMINOPHEN

Acetaminophen (i.e., Tylenol) is an analgesic and antipyretic medication common in many postoperative multimodal pain management regimens. Acetaminophen works through multiple, incompletely understood mechanisms of action.[51] In healthy adults with normal liver function who consume less than two alcoholic drinks daily, the FDA recommends a maximum of 4000 mg daily PO for less than ten days.[52] Patients with abnormal liver function tests, active hepatitis, cirrhosis, or other active hepatic disease should consume a maximum of 2000 mg daily. In November 2010, intravenous (IV) acetaminophen received FDA approval.[53] There is no consensus for the use of IV instead of PO acetaminophen in the orthopaedic literature.[54–56]

While acetaminophen is one of the most common medications used in a multimodal approach following shoulder and surgery, few studies have sought to isolate its effects on opioid consumption alone without confounders. Singh et al. designed an unblinded, randomized controlled trial (RCT) evaluating opioid consumption in patients undergoing arthroscopic rotator cuff repair (ARCR) with a standardized interscalene liposomal bupivacaine nerve block.[25] A total of 57 patients were randomized to one of three groups. Patients, who were randomized to receive standing preoperative acetaminophen one day prior to surgery (1000mg every 6 hours) in addition to post-operative days 2-5 (1000mg every 8 hours), consumed significantly fewer MMEs (67.1) over the first post-operative week when compared to patients without acetaminophen ordered (141.6)

or with it ordered postoperatively on an as-needed basis only (97.3).

Standard precautions and contraindications should be considered. There should be a low threshold to consult the pharmacist and/or medical teams regarding dosing or drug-drug interactions in unclear cases.

NON-STEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS)

Non-steroidal anti-inflammatory drugs (NSAIDs) represent an additional cost-effective class of drugs that are a mainstay in multimodal analgesia after shoulder surgery. The mechanism of action through which these medications diminish inflammation and provide pain relief is the inhibition of cyclooxygenase (COX), resulting in decreased synthesis of prostaglandins.[57,58] Non-selective NSAIDs, such as ibuprofen, naproxen, ketorolac, diclofenac, meloxicam, and indomethacin, act on both the COX-1 and COX-2 isoenzymes. COX-1 has a role in maintaining the gastrointestinal mucosal lining, and COX-2 is typically expressed during an inflammatory response. Selective COX-2 inhibitors such as celecoxib and etoricoxib are more specific to the inflammatory response and confer a lower risk of gastrointestinal bleeding compared to non-selective NSAIDs.[57,58]

Multiple studies in the shoulder literature have demonstrated associations between the use of NSAIDs and decreased opioid consumption post-operatively (Tables 1-3). Thompson et al. performed a prospective RCT comparing ibuprofen (600mg every 6 to 8 hours as needed) as the primary postoperative analgesic vs. standard oxycodone/acetaminophen (5/325mg every 6 hours as needed) after arthroscopic Bankart repair. They noted significantly less opioid consumption in the experimental group after one week.[29] Tangtiphaiboontana and colleagues performed a double-blinded RCT comparing opioid consumption and tendon healing after arthroscopic rotator cuff repair (ARCR) between a group receiving ibuprofen (400mg every 8 hours for 14 days) versus a placebo. Opioid consumption was significantly higher in the placebo group (211 MME) vs. the ibuprofen group (168 MME) after one week. No difference in retear rates was noted on musculoskeletal ultrasound one year after surgery.[28]

Selective COX-2 inhibitors have also been an area of research interest in shoulder surgery. Burns et al. performed a double-blinded RCT in patients undergoing ARCR or total shoulder arthroplasty (TSA), comparing celecoxib (400mg once preoperatively, 200mg twice daily for three weeks postoperatively) vs. placebo for peri-operative analgesia.[27] TSA patients in the celecoxib group consumed significantly fewer opioids over six weeks. Patients in the celecoxib arm of the ARCR cohort consumed less opioids than the placebo group. However, this did not reach statistical significance. A major concern regarding COX-2 inhibitors, particularly in ARCR, is the potential for adverse effects on tendon-to-bone healing. The administration of COX-2 selective NSAIDs has been associated with a poor healing response at the osteotendinous junction in rat patellar tendon.[59] Oh and colleagues performed a double-blinded RCT comparing celecoxib (200mg twice each day), ibuprofen (385mg three times per day), and tramadol (50mg twice each day) for pain control after ARCR.[60] After a minimum of 24 months, the integrity of the repaired rotator cuff tendon(s) was assessed via magnetic resonance imaging (MRI) or dynamic ultrasonography. Rotator cuff tendon retear rates were significantly higher in patients who received celecoxib (37%) compared to ibuprofen (7%) or tramadol (4%). Burns et al. performed an additional double-blind, placebo-controlled RCT comparing tendon healing one-year status post-ARCR using MRI in patients receiving celecoxib (400mg once preoperatively, 200mg twice daily for three weeks postoperatively) vs. placebo.[61] Only 50% of celecoxib patients were found to have an intact repair compared to 70% in the placebo group at one year. While this did not reach significance statistically due to the small sample size (20 patients per group), the authors advised against using celecoxib for post-operative analgesia after ARCR. In aggregate, these findings are concerning, and we recommend against using COX-2 inhibitors in ARCR, given the available evidence.

Standard precautions and contraindications should be considered prior to prescribing NSAIDs. These medications should be used cautiously in patients with a history of renal disease, cardiovascular disease, gastrointestinal bleeding, or current anticoagulation and/or antiplatelet therapies. There should be a low threshold to consult pharmacy and/or medical teams. A concomitant proton pump inhibitor (PPI), such as omeprazole 20 mg BID or pantoprazole 40 mg daily, can be used in patients over 50 and/or with gastric ulcer risk factors while taking NSAIDs. Daily ibuprofen dose should not exceed 2400 mg, and daily naproxen dose should not exceed 1100 mg.[62]

GABAPENTINOIDS

Gabapentin and pregabalin were initially developed as anticonvulsants to treat chronic neuropathic pain.[63,64] Both gabapentin and pregabalin work through inhibition of the $\alpha 2\delta$ subunit on voltage-gated calcium channels necessary for membrane depolarization and neurotransmitter release.[65] More recently, these medications have gained traction as supplemental agents for peri-operative pain management. While there is no consensus on their clinical efficacy in this capacity, gabapentinoids are commonly prescribed to decrease concomitant opioid use.[63,66] Administration of gabapentin approximately two hours prior to surgery has been used in past studies to achieve maximum plasma concentrations while in the operating room.[67]

A limited number of studies in the shoulder literature investigating the off-label use of gabapentinoids on post-operative opioid consumption (Table 2). Some studies have shown significantly less opioid consumption after single doses of gabapentin or pregabalin preoperatively in ARCR and Bankart repair surgery, while others have not demonstrated any significant impact.[68–70] The side effect profile of these medications includes dizziness, somnolence, ataxia, headache, and edema. For this reason, gabapentinoids may not be desirable in some patient populations, particularly the elderly or those with renal disease.

Table 1. Total Shoulder Arthroplasty Opioid Consumption

Table 1: Total Shoulder Arthroplasty Opioid Consumption									
Author (Ref #)	**Journal**	**Publication Year**	**LoE**	**Procedure & Group (n)**	**Pill Consumption**	**MME**	**Multimodal Meds?**	**Nerve Block?**	**Comments**
Griswold (65)	Eur J Orthop Surg Traumatol	2021	III	Primary TSA w/ Nerve Block (281)	N/a	141.3	No	Yes	Single-surgeon; Consumption reported during inpatient stay only; Authors recommend managing pain similarly for primary and revision TSA
				Primary TSA w/ Nerve Block Catheter (47)	N/a	96	No	Yes	
				Primary TSA w/o Nerve Block (12)	N/a	136.2	No	No	
				Revision TSA w/ Nerve Block (58)	N/a	73	No	Yes	
				Revision TSA w/ Nerve Block Catheter (13)	N/a	71.7	No	Yes	
				Revision TSA w/o Nerve Block (4)	N/a	17.2	No	No	
Jolissaint (24)	J Shoulder Elbow Surg	2022	II	TSA Multimodal (35)	N/a	0.4 inpatient; 0.1 outpatient	Yes	Yes	Multimodal arm included: gabapentin, meloxicam, IV acetaminophen, ketorolac,, dexamethasone, peri-articular bupivacaine; both groups received interscalene block; outpatient consumption reported at 2 weeks post-op
				TSA Opioid (32)	N/a	20.9 inpatient; 133.3 outpatient	Yes, to a lesser degree	Yes	
Kopechek (66)	JSES Int	2021	III	aTSA (50)	67 pills (median) (prescribed)	502.5 (prescribed)	Yes	Yes	Reported opioid prescribing habits not consumption; 25% of patients using opioids pre-op; 40% required refills; significantly greater use in patients under 65
				rTSA (50)	72 pills (median) (prescribed)	540 (prescribed)	Yes	Yes	
Namdari (69)	J Bone Joint Surg Am	2017	II	aTSA w/ ISNB (standard Ropivacaine) (44)	N/a	14.8	No	Yes	4 S&E surgeons; Consumption (Hydromorphone PCA) reported over first 24 hours post-op
				rTSA w/ ISNB (standard Ropivacaine) (34)			No	Yes	
				aTSA w/ Local infiltration (LB) (51)	N/a	14.1	No	No	
				rTSA w/ Local infiltration (LB) (27)			No	No	

Table 1: Total Shoulder Arthroplasty Opioid Consumption									
Namdari (71)	J Bone Joint Surg Am	2018	II	aTSA w/ ISNB (standard Ropivacaine) (26)	N/a	18.9	No	Yes	4 S&E surgeons; Consumption (Hydromorphone PCA) reported over first 24 hours post-op; No apparent benefit to adding Local LB to standard ISNB
				rTSA w/ ISNB (standard Ropivacaine) (13)			No	Yes	
				aTSA w/ ISNB (standard Ropivacaine) + Local infiltration (LB) (25)	N/a	35.3	No	Yes	
				rTSA w/ ISNB (standard Ropivacaine) + Local infiltration (LB) (14)			No	Yes	
Sethi (72)	JSES Int	2021	III	rTSA w/ ISNB (Bupivacaine) (29)	13.6 pills	109.4	Yes	Yes	Non-randomized group allocation; Consumption reported over 14 days post-op; Author conflict of interest
				rTSA w/ ISNB (LB) (24)	3.1 pills	20.8	Yes	Yes	
				rTSA w/ Local (LB) (10)	13.2 pills	98.6	Yes	No	
Hattrup (74)	J Shoulder Elbow Surg	2021	II	aTSA w/ ISNB (plain Bupivacaine) (33)	N/a	114.5	Yes	Yes	Consumption includes outpatient total inpatient through 3 weeks post-op
				rTSA w/ ISNB (plain Bupivacaine) (19)			Yes	Yes	
				aTSA w/ ISNB (LB) (23)	N/a	103.5	Yes	Yes	
				rTSA w/ ISNB (LB) (29)			Yes	Yes	
Burns (27)	J Shoulder Elbow Surg	2021	II	aTSA Placebo (14)	N/a	N/a	No	Yes	Celecoxib group dosing: 400mg once pre-op & 200mg BID x3 weeks post op; Consumption recorded through 6 weeks post-op
				rTSA Placebo (25)			No	Yes	
				aTSA Celecoxib (13)	N/a	270 less than placebo	Yes	Yes	
				rTSA Celecoxib (26)			Yes	Yes	
				ARCR Placebo (39)	N/a	N/a	No	Yes	
				ARCR Celecoxib (39)	N/a	94.5 less than placebo	Yes	Yes	
Bjørnholdt (96)	Eur J Orthop Surg Traumatol	2015	II	aTSA w/ ISNB catheter (Ropivacaine) (31)	N/a	40 (median)	Yes	Yes	Consumption recorded at 24hrs post-op; One rescue single-shot ISNB given in the local infiltration group post-op

Table 1: Total Shoulder Arthroplasty Opioid Consumption									
				aTSA w/ Local infiltration (30)	N/a	95 (median)	Yes	No	
Weller (97)	J Arthroplasty	2017	III	aTSA ISNB catheter (84)	N/a	64	N/a	Yes	Consumption reported at 24hrs post-op; Higher "major" complication rate in catheter group (13% vs 3%)
				rTSA ISNB catheter (72)			N/a	Yes	
				aTSA Local LB (22)	N/a	130	N/a	No	
				rTSA Local LB (36)			N/a	No	

Table 2. Shoulder Arthroscopy Opioid Consumption

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Author (Ref #)	**Journal**	**Publication Year**	**LoE**	**Procedure & Group (n)**	**Pill Consumption**	**MME**	**Multimodal Meds?**	**Nerve Block?**	**Comments**
Vattigunta (67)	J Shoulder Elbow Surg	2021	III	ARCR (52)	12 pills	90	N/a	N/a	Single surgeon; No nerve block data provided; Consumption reported 7-14 days post-op; Overall 16.8% refill rate; Mean 20 tablets unused per patient; Recommend 112.5 MME (15 tablets 5-mg oxycodone) for shoulder arthroscopy, 75 MME (10 tablets) for TSA
				TSA (35)	9 pills	67.5			
				Shoulder Arthroscopy w/o RCR (28)	11.5 pills	86.25			
				Other (4)	12 pills	90			
Mandava (68)	J Shoulder Elbow Surg	2021	II	ARCR w/ ISNB (standard Bupivicaine) (50)	14.9 pills	111.3	Yes	Yes	Pill consumption recorded for 14 days post-op; Significantly less consumption in LB ISNB group vs. standard Bupivicaine; Overall refill rate 3.5%; Recommend prescribing 15 or fewer oxycodone 5mg
				ARCR w/ ISNB (LB) (50)	8.8 pills	65.8			
Verdecchia (70)	J Shoulder Elbow Surg	2021	II	ARCR w/ ISNB w/o Local (LB) (26)	N/a	116.8	Yes	Yes	Single-surgeon; Consumption recorded through POD 3; Minimal improvement in pain control when LB injected into subacromial space & port sites
				ARCR w/ ISNB w/ Local (LB) (25)	N/a	109.3	Yes	Yes	
Sethi (73)	J Shoulder Elbow Surg	2019	II	ARCR w/ ISNB (SB) (25)	27.3 pills	204.9	Yes	Yes	Full thickness tears only; Consumption recorded through POD 5; Author conflict of interest
				ARCR w/ ISNB (SB) + Local LB (25)	9.84 pills	73.8	Yes	Yes	
Singh (25)	J Shoulder Elbow Surg	2021	II	ARCR Multimodal Post-op only (21)	12.97	97.3	Yes	Yes	Acetaminophen primary multimodal medication; Consumption recorded through POD 7
				ARCR Opioid only (18)	18.88	141.6	No	Yes	
				ARCR Multimodal Pre&Postop (18)	8.94	67.1	Yes	Yes	
Moutzouros (26)	Arthroscopy	2020	II	ARCR (27)	3.9	29.3	Yes	No	Consumption recorded through POD 7-10

Table 2: Shoulder Arthroscopy Opioid Consumption									
				Labral Repair (16)	13.1	98.3	Yes	Yes	
Tangtiphaiboontana (28)	J Shoulder Elbow Surg	2021	II	ARCR (Placebo) (50)	21.1 pills	210.9	No	Yes	Ibuprofen dose: 400mg q8hr x 14 days; Opioid consumption recorded through POD 7; No difference in retear rates on MSK US 1 year after surgery
				ARCR (Ibuprofen) (49)	16.8 pills	168.3	Yes	Yes	
Thompson (29)	Arthrosc Sports Med Rehabil	2020	II	Arthroscopic Bankart Repair Ibuprofen (40)	7.9 pills	59.3	Yes	Yes	Ibuprofen group prescribed 600mg q6-8 prn; Consumption recorded through POD 7
				Arthroscopic Bankart Repair Opioid (40)	11.7 pills	87.8	No	Yes	
Mardani-Kivi (58)	Orthop Traumatol Surg Res	2016	II	Arthroscopic Bankart Repair Gabapentin (37)	N/a	N/a	Yes	No	Consumption recorded through 24 hrs post-op; Narcotic used: Pethedine (units not provided)
				Arthroscopic Bankart Repair Placebo (34)	N/a	2.1x more consumed	No	No	
Ahn (60)	Can J Anaesth	2016	II	Arthroscopic Bankart Repair Pregabalin (7)	N/a	51.0	Yes	No	Single dose of pregabalin 150mg given one hour before surgery; Ketorolac offered to all patients for breakthrough pain; Consumption recorded 48 hrs post-op
				ARCR Pregabalin (23)	N/a		Yes	No	
				Arthroscopic Bankart Repair Placebo (8)	N/a	74.7	Yes	No	
				ARCR Placebo (22)	N/a		Yes	No	

Table 3. Opioid Consumption in Studies with Open or Combined Surgeries

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Author (Ref #)	**Journal**	**Publication Year**	**LoE**	**Procedure & Group (n)**	**Pill Consumption**	**MME**	**Multimodal Meds?**	**Nerve Block?**	**Comments**
Capelle (63)	Arch Bone Jt Surg	2021	II	TSA (17)	40.2 pills	N/a	Yes	Yes	Various narcotics prescribed; Nerve block in 70% of patients - details not provided
				Shoulder ORIF (9)	29.4 pills				
				Distal Biceps Repair (12)	27.9 pills				
				Shoulder Arthroscopy/ Other (41)	13.7 pills				
Cunningham (64)	J Shoulder Elbow Surg	2022	III	ORIF Distal Humerus / Proximal Forearm w/ Nerve Block (326)	N/a	138.6	Yes	Yes	Consumption reported at 90 days post-op; 74% of nerve blocks were single-shot; 26% continuous catheter infusion
				ORIF Distal Humerus / Proximal Forearm w/o Nerve Block (92)	N/a	181	Yes	No	
Ilyas (19)	Orthopedics	2021	II	Soft Tissue and/or Arthroscopy S/E Procedure (84)	15.0 pills	109	Yes	N/a	45% of Shoulder / Elbow patients received pre-op opioid education; 10.6% refill rate; consumption totals reported combined
				Bony S/E Procedure (20)			Yes	N/a	
Kim (7)	J Bone Joint Surg Am	2016	II	RCR / Acromioplasty (7)	21.4 pills	N/a	N/a	N/a	Surgeries performed by 9 Hand surgeons; Various narcotics prescribed
				Distal Clavicle Excision (2)	31.0 pills				
				ORIF Humerus (4)	53.5 pills				
				Lateral Epicondyle Debridement (23)	13.5 pills				
				Distal Biceps Repair (13)	11.1 pills				
Rodgers (5)	J Hand Surg Am	2012	II	Hand/Wrist ORIF / Arthroplasty (46)	14 pills (bone procedures)	N/a	Yes	No	Surgeries performed by 9 Hand surgeons; Various narcotics prescribed; Consumption reported combined with all procedures; Assessment conducted mean 11 days post-op; 7% got a refill or intended to ask for one
				Elbow ORIF / Lateral Epicondyle / DBTR (9)					
				RCR (3)					
				Hand/Wrist Soft Tissue (156)	9 pills (soft tissue)				
				Elbow Soft Tissue (29)					
				Shoulder Arthroscopy w/o RCR (6)					

GLUCOCORTICOIDS

Intravenous glucocorticoid use has been recently studied to prolong the duration of postoperative pain relief limited by short-acting perioperative regional anesthesia. Studies have shown that intravenous administration of additives such as dexmedetomidine or dexamethasone can provide the same benefit of extended anesthesia as is seen with perineural glucocorticoid additives in interscalene blocks.[71–73] However, a higher dose of these additives is typically required when administered intravenously to achieve the desired effect as in perineural dosing, and the duration of action is still limited to approximately 20 hours for dexamethasone and 10 hours for dexmedetomidine. While intravenous dexamethasone lasts longer, it also prolongs postoperative motor blockade, whereas dexmedetomidine selectively accentuates the sensory blockade. Additionally, transient hyperglycemia may be an anticipated side effect of intravenous dexamethasone. However, other concerns associated with glucocorticoids, such as increased infection rates or delayed wound healing, do not appear to be associated with single-shot perioperative doses.[74] A recent RCT utilizing a co-administration of intravenous dexamethasone and dexmedetomidine for arthroscopic shoulder surgery demonstrated a cumulative effect in reducing postoperative opioid consumption, improving sleep quality, and improving patient satisfaction.[75] Additional research is still needed to determine optimal dosing combinations and potential side effects of co-administration. Based on these findings, we recommend using a single dose of perioperative intravenous glucocorticoids to assist with pain control while monitoring for the potential undesirable side effects of prolonged motor blockade and transient hyperglycemia.

LOCAL ANESTHESIA

In shoulder surgery, local anesthetic infiltration into soft tissue surrounding the surgical site has also been investigated. Various agents, volumes, and concentrations of local anesthetic have been evaluated. Namdari and colleagues designed a non-blinded RCT in which patients were randomized to receive either an ISNB (30 mL of 0.5% ropivacaine) or intraoperative soft-tissue infiltration (20mL 1.3% Exparel (bupivacaine liposome injectable suspension) diluted in 20mL normal saline) after primary TSA.[76] Patients in this group consumed a similar number of morphine milligram equivalents (MME) (14.4) over the first 24 hours after surgery when compared to the standard ISNB (14.8). However, they did require additional narcotics intraoperatively (Table 1). The same group performed a similar RCT comparing standard ropivacaine ISNB alone to ISNB with the addition of the same local anesthetic (Exparel) in TSA patients. Interestingly, the ISNB group consumed a mean of 18.9 MME over the next 24 hours compared to 35.3 MME in the group receiving both forms of analgesia ($p = 0.009$).[77] Bjørnholdt et al. randomized 61 undergoing primary TSA patients to receive either ISNB with continuous catheter infusion (0.75% ropivacaine) or local infiltration with 0.2% ropivacaine (150mL) with epinephrine.[78] Pain scores and opioid consumption were significantly higher in the local infiltration group during the first 24 postoperative hours. Weller and colleagues noted a similar discrepancy in MME consumption in the early postoperative period (24 hours) after primary TSA in patients receiving local infiltration alone (20 mL of liposomal 0.5% bupivacaine, 10 cc 0.5% bupivacaine with epinephrine, 2 mg of morphine, and 30 mg of ketorolac) compared to indwelling catheter infusion (Table 1).[79] Given these findings, we cannot recommend local infiltration alone for perioperative analgesia in TSA.

In shoulder arthroscopy, there has been research interest in intra-articular local anesthetic infiltration, particularly in patients not candidates for ISNB. A recent systematic review by Yung et al. described higher pain scores and lower satisfaction with intra-articular infiltration than standard ISNB.[80] However, opioid consumption in the early postoperative period was comparable. The theoretical risk of chondrotoxicity with this technique remains a valid concern.[81–83] Continuous infusion of local anesthetic in the subacromial space after shoulder arthroscopy has also been investigated. In most of these studies, continuous subacromial infiltration is not an effective mode of analgesia.[84–87]

NERVE BLOCKS FOR PERIOPERATIVE ANALGESIA

The optimal pain regimen following shoulder arthroplasty and shoulder arthroscopy has not been well-established. However, using perioperative regional anesthetic has demonstrated utility in improving patient satisfaction and reducing postoperative opioid requirements. The incidence of severe intraoperative or postoperative pain, particularly in the setting of arthroscopic shoulder surgery, reaches as high as 45%, increasing the demand for multimodal pain control with peripheral nerve blocks for this procedure.[88] Interscalene block of the brachial plexus, in particular, has been a well-studied, safe, and effective analgesic technique that can help reduce perioperative complications and lead to shorter hospital stays.[89–91] Additionally, patients with interscalene blocks have been shown to spend less time in the postoperative recovery unit and require less opioid medication in the hospital postoperatively.[92,93]

While the clinical benefits of interscalene blocks have been well studied, the application of this anesthetic technique for shoulder surgery is not universal. A recent national survey of 82,561 patients undergoing arthroscopic shoulder surgeries found 54,578 (66.1%) of whom received a peripheral nerve block, with a linear trend of increased usage over this period.[94] A recent national database study of 94,787 inpatient and 3,293 outpatient shoulder arthroplasty cases between 2006 and 2016 demonstrated a peripheral nerve block utility rate of 19.1% and 20.8%, respectively. Trends did show increased usage rates in inpatient high-volume centers and outpatient medium-sized nonteaching hospitals.[95]

Despite the clinical benefits, widespread implementation of interscalene block may be limited due to the risk of block failure, associated complications, and rebound pain following the resolution of the analgesic effect. Failure rates of interscalene block are estimated as high as

10-20%.[92,96] An accepted block complication is the risk of hemi-diaphragmatic paralysis resulting from anesthetic reaching over the anterior scalene muscle and affecting the phrenic nerve. Urney et al. were among the first to study this effect, concluding that diaphragmatic paresis was an "inevitable consequence of interscalene brachial plexus block when providing anesthesia sufficient for shoulder surgery."[97] Further research has demonstrated that local anesthetic volumes greater than 20ml invariably evoke a phrenic nerve palsy, with an incidence of 100% in continuous interscalene blocks.[98,99] However, the normal ventilatory function is typically preserved due to other inspiratory muscles, i.e., intercostals, that help compensate. Although a rare development, persistent phrenic nerve palsy can be potentially life-threatening, especially in patients with previous lung function impairment.[100] For this reason, interscalene blocks are typically not recommended for patients with decreased respiratory reserves or reduced ability to maintain ventilation via compensatory mechanisms, including patients with contralateral nerve palsy, COPD, restrictive lung disease, or high body mass index. Lastly, patients who received an interscalene block perioperatively face the likelihood of rebound pain after the limited analgesic wears off. Abdullah et al. performed a meta-analysis of 23 randomized controlled trials in patients undergoing interscalene nerve block, finding effective analgesic benefit for 8 hours postoperative but none after that and increased rebound pain 24 hours postoperatively.[38]

The type of block administered varies from continuous interscalene blocks to a single injection technique with a local anesthetic, such as bupivacaine. Continuous blocks offer the advantage of pain management beyond the 12-16 hour window of a single injection, but these blocks are labor intensive and may fail due to catheter dislodgement.[101] Kwater et al. compared the use of a perineural catheter versus single-dose liposomal bupivacaine on patients with shoulder trauma undergoing surgery and found no significant difference in postoperative pain or opioid consumption between the two methods. However, there was an increased complication rate associated with catheter use.[102] Single interscalene injections with either liposomal bupivacaine or standard bupivacaine combined with additives such as perineural dexamethasone have been recently seen as effective strategies in prolonging pain control timelines up to 72 hours and minimizing diaphragmatic dysfunction.[103–105] However, the actual clinical value of liposomal bupivacaine over standard bupivacaine for interscalene blocks remains undetermined. For example, Vandepitte et al. found lower "worst pain" scores with a modest effect in patients with liposomal bupivacaine compared to standard bupivacaine in their interscalene blocks for shoulder surgery.[106] Alternatively, Hattrup et al. found no clinically relevant benefit for using liposomal versus standard bupivacaine in interscalene block for shoulder arthroplasty.[107] In their cohort, while patients with liposomal bupivacaine had statistically lower second-day pain scores, this disparity was less than the minimally clinically important difference, and no difference was found in postoperative opioid use or patient satisfaction.

In shoulder arthroscopy, the suprascapular nerve block has also been evaluated as a safe alternative to interscalene block to avoid phrenic nerve palsy. Suprascapular nerve block has demonstrated efficacious pain control and diminished opiate use after shoulder arthroscopy but appears to reach an inferior analgesic effect relative to interscalene nerve block.[108,109] However, the degree of pain relief from a suprascapular nerve block becomes more potent when used with an axillary nerve block. A recent meta-analysis of randomized trials showed, in comparison to patients treated with interscalene blocks, patients with suprascapular plus axillary nerve blocks in the setting of arthroscopic shoulder surgery had higher pain scores 6 hours after surgery but decreased rates of dyspnea, numbness/tingling, weakness, and Horner's syndrome. There was no difference in patient satisfaction or pain scores at 24 hours.[110]

Relevant studies summarizing opioid consumption are broken down into Tables 1, 2, and 3 based on surgery type (arthroplasty vs. arthroscopy) and/or grouping performed by authors of the individual studies. Mean MME was calculated whenever possible. Lastly, Table 4 represents our general recommendations for perioperative analgesia in our orthopaedic practice's most commonly performed shoulder surgeries.

RECOMMENDATIONS

1. We recommend that all decisions regarding the use of perioperative nerve blocks be reached in collaboration with the anesthesiology team
2. We recommend the use of interscalene nerve block to reduce perioperative opioid consumption for patients who are at low risk for respiratory compromise in the event of phrenic nerve palsy, with counseling for potential rebound pain
3. In high-risk shoulder arthroscopy patients who are ineligible for an interscalene block for shoulder arthroscopy, we recommend the use of either suprascapular plus axillary nerve block or local liposomal bupivacaine injection
4. Postoperative local infiltration with liposomal bupivacaine is a viable alternative instead of, NOT in addition to, interscalene block for multimodal pain control

The available shoulder and elbow literature provides quality baseline data helpful in developing evidence-based opioid prescribing guidelines. We strictly adhere to dispensing smaller amounts of opioids postoperatively to avoid inadvertent over-prescribing and diversion. Facilitating prescription refill requests is strongly preferred to potential initial over-prescribing.

Opioid stewardship by shoulder and elbow surgeons can majorly combat the ongoing opioid epidemic in the United States. Appropriate opioid dosing and postoperative multimodal analgesic strategies are more important than ever, with opioid overdoses increasing steadily since the COVID-19 pandemic. Our guidelines offer straightforward,

Table 4. Perioperative Analgesia Recommendations in Common Shoulder

Table 4: Perioperative Analgesia Recommendations in Common Shoulder Surgeries				
Surgery Category	**Representative Procedures**	**Preoperative Management**	**Intraoperative Management**	**Postoperative Management**
Arthroplasty	Anatomic Total Shoulder	**1)**Opioid Education & Contract **2)**Acetaminophen 1000mg q6 hrs x 3 doses 1 day prior to surgery **3)**Acetemainophen 1000mg 2hrs prior to surgery **4)**Celecoxib 200mg 2hrs prior to surgery	**1)**US-guided single-shot interscalene nerve block* **2)**IV Dexamethasone 0.11mg/kg (single dose)*	**1)**Acetaminophen 1000mg q8 hrs around the clock POD 0-5, then as needed, dispense #60 (500mg tablets) **2)**Ketorolac 10mg q8 hrs x 2 doses POD 0 **3)**Celecoxib 200mg q12 hrs daily POD 1-5, then as needed, dispense #20 **4)**Oxycodone 5mg q4 hrs as needed, dispense #15
	Reverse Total Shoulder			
	Shoulder Hemiarthroplasty			
Open Bony Surgery	Latarjet Procedure			
Arthroscopy	Rotator Cuff Repair	**1)**Opioid Education & Contract **2)**Acetaminophen 1000mg q6 hrs x3 doses day prior to surgery **3)**Acetemainophen 1000mg 2hrs prior to surgery **4)**Ibuprofen 400mg 2hrs prior to surgery	**1)**US-guided single-shot interscalene nerve block* **2)**IV Dexamethasone 0.11mg/kg (single dose)*	**1)**Acetaminophen 1000mg q8 hrs around the clock POD 0-5, then as needed, dispense #60 (500mg tablets) **2)**Ketorolac 15mg q8 hrs x 2 doses POD 0 **3)**Ibuprofen 400mg q8 hrs around the clock POD 1-5, then as needed, dispense #40 **4)**Oxycodone 5mg q4 hrs as needed, dispense #15
	Labral / Capsular Repair			
	Arthroscopic Biceps Tenodesis			
Open Soft Tissue Surgery	Open Biceps Tenodesis			
	Pectoralis Tendon Repair			

*administration at the discretion of the anesthesia team

comprehensive, and evidence-based perioperative analgesic regimens for the most common shoulder surgeries.

DECLARATION OF CONFLICT OF INTEREST

The authors do not have any potential conflicts of interest in the information and production of this manuscript.

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