J Shoulder Elbow Surg (2021) 30, 2445–2454

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

SHOULDER

Multimodal nonopioid pain protocol provides equivalent pain control versus opioids following arthroscopic shoulder labral surgery: a prospective randomized controlled trial

Toufic R. Jildeh, MD[a], Lafi S. Khalil, MD[a], Muhammad J. Abbas, BS[a], Vasilios Moutzouros, MD[a], Kelechi R. Okoroha, MD[b,*]

[a]*Department of Orthopaedic Surgery, Henry Ford Hospital, Detroit, MI, USA*
[b]*Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA*

Background: This study aimed to compare postoperative pain and patient satisfaction in patients undergoing primary arthroscopic labral surgery managed with either a nonopioid alternative pain regimen or a traditional opioid pain regimen.

Methods: Sixty consecutive patients undergoing primary arthroscopic shoulder labral surgery were assessed for participation. In accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2010 statement, a prospective randomized controlled trial was performed. The 2 arms of the study were a multimodal nonopioid analgesic protocol as the experimental group and a standard opioid regimen as the control group. The primary outcome was postoperative pain scores (on a visual analog scale [VAS]) for the first 10 days postoperatively. Secondary outcomes included patient satisfaction, patient-reported outcomes, and complications. Randomization was performed with a random number generator, and all data were collected by blinded observers. Patients were not blinded.

Results: Twelve patients did not meet the inclusion criteria or declined to participate. Thus, 48 patients were included in the final analysis: 24 in the nonopioid group and 24 in the opioid group. There was no significant difference in VAS or PROMIS (Patient-Reported Outcomes Measurement Information System) scores between patients in the 2 cohorts on any postoperative day ($P > .05$). When we controlled for confounding factors with repeated-measures mixed models, the nonopioid cohort reported significantly lower VAS and PROMIS (Patient-Reported Outcomes Measurement Information System) Pain Interference scores ($P < .01$) at all time points. No difference was found in reported adverse events (constipation, diarrhea, drowsiness, nausea, and upset stomach) between cohorts at any time point ($P > .05$).

Conclusion: This study found that a multimodal nonopioid pain regimen provided, at the minimum, equivalent pain control, an equivalent adverse reaction profile, and equivalent patient satisfaction when compared with a standard opioid-based regimen following arthroscopic shoulder labral surgery.

Level of evidence: Level I; Randomized Controlled Trial; Treatment Study

Keywords: Nonopioid; multimodal analgesia; pain; labral surgery; pain control; opioid sparing; labral repair; opioids; post-surgical pain

This project was approval by the Henry Ford Health System Institutional Review Board and was registered at ClinicalTrials.gov.

*Reprint requests: Kelechi R. Okoroha, MD, Department of Orthopedic Surgery, Mayo Clinic Sports Medicine, 600 Hennepin Avenue, Suite 310, Minneapolis MN, 55403, USA.

E-mail address: krokoroha@gmail.com (K.R. Okoroha).

The United States is in the midst of an opioid crisis. In 2019, narcotics were prescribed at a rate of 46.7 prescriptions per 100 persons (total of >153 million opioid prescriptions).[4] Studies have shown that opioid abusers often cite musculoskeletal pain

1058-2746/$ - see front matter © 2021 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2021.07.008

as the initial reason for consuming narcotics.[28] For this reason, orthopedic surgeons are uniquely positioned to curtail the prescription of narcotics in patients with musculoskeletal pain. Although orthopedic surgeons are cognizant of the detrimental effect of opioid prescriptions on patient wellness and the risks of abuse,[12,19] opioid medications remain a cornerstone of postoperative pain control for many surgeons.[20,26,30,35,37] In an effort to mitigate risk and understand which patients are at greatest risk of postoperative opioid abuse, a growing body of literature has evaluated patient risk factors prior to common orthopedic procedures.[17,18] These studies have consistently demonstrated that the use of narcotics prior to surgery is the greatest risk factor for prolonged opioid consumption postoperatively. Additionally, the opioid epidemic has made pain control a focus of governmental legislation,[27,36] as well as physician reimbursement plans, and has been the subject of an increasing number of studies searching for alternative medicines to reduce the opioid burden nationally.[1,11,13,15,16,23,25,27,28,35]

Arthroscopic shoulder surgery is one of the most commonly performed orthopedic procedures, exceeding 1 million occurrences annually.[14] Traditionally, these procedures are performed in an ambulatory setting, which portends tremendous health care savings, benefiting both providers and patients.[9] Despite this, pain control is often problematic, even after discharge. A case series by Moutzouros et al[25] compared postoperative opioid consumption following common orthopedic sport procedures and found that, after labral repair, patients consumed significantly more narcotics as compared with patients undergoing anterior cruciate ligament reconstruction, rotator cuff repair, and meniscectomy. In a retrospective review, Jildeh et al[18] determined that the chronicity of preoperative opioid use and the number of concomitant procedures, including biceps tenodesis, significantly increased postoperative opioid use by patients following arthroscopic labral surgery. Currently, there is a paucity of literature examining the impact of opioid medications on pain control, patient satisfaction, and risks of continued opioid use following arthroscopic shoulder labral surgery.[7,24,38]

The purpose of this randomized controlled trial was to assess the effectiveness of a nonopioid pain regimen in controlling postoperative pain as compared with a traditional opioid pain control regimen following primary arthroscopic shoulder labral surgery. We hypothesized that postoperative pain control would be similar between patients treated with the nonopioid alternative pain regimen and the traditional opioid regimen. Additionally, we anticipated that patients receiving the nonopioid alternative pain regimen would report fewer side effects compared with the opioid cohort.

Methods

This prospective, observer-blinded, randomized controlled trial was performed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) statement (Fig. 1).[29] The hypothesis was developed prior to study initiation. Sixty patients presenting to 2 fellowship-trained sports surgeons between February 2019 and December 2020 were screened for inclusion. The inclusion criteria included patients aged $\geq$ 15 years undergoing primary arthroscopic labral repair. The exclusion criteria included a history of peptic ulcer disease, recent or current pregnancy, substance abuse, intolerance or allergy to study medication, renal impairment or dysfunction, use of blood thinner medication, gastrointestinal bleeding, same-joint surgery within the previous year, and use of opioids within 3 months prior to surgery. Previous literature has demonstrated that prolonged preoperative opioid consumption contributed to sustained narcotic use in the postoperative period; for this reason, opioid-naive patients were chosen to limit confounding factors.[39]

Following surgical discussion, patients were approached regarding enrollment in the study. Patients who consented to be included in the study were randomized to an opioid or nonopioid postoperative pain regimen with a 1:1 allocation by use of randomization computer software (MD Anderson Cancer Center, Houston, TX, USA). All patient data were secured in a computer database throughout the study. Seven days prior to the day of surgery, surgeon ancillary staff was notified of the patient's group designation via secure e-mail by the project coordinator. Observers who were blinded to patient designation were involved in data entry. Double blinding was not required in this study as all outcomes were self-reported by the patients.

Intervention

During the preoperative period, all patients were administered a single dose of the following medications: acetaminophen, 975 mg; celecoxib, 400 mg; gabapentin, 300 mg; and tramadol, 50 mg; as well as an intravenous dose of dexamethasone, 8 mg. Arthroscopic shoulder surgery was performed under preoperative blocks. Intraoperatively, patients were administered a local infiltration using a 20-mL syringe with a 22-gauge, 2.54-cm (1-inch) needle. Local infiltrate consisted of 150 mg (30 mL) of 0.50% ropivacaine, 1 mg (1 mL) of epinephrine, and 30 mg (1 mL) of ketorolac, which was administered in 2-mL increments in the subcutaneous tissues prior to closure.

Patients in the control group were prescribed 40 pills containing 5 mg of hydrocodone plus 325 mg of acetaminophen. Patients were instructed to take 1-2 pills orally every 4-6 hours as needed. Additionally, patients were instructed not to supplement their pain control regimen with over-the-counter analgesics.

Patients in the nonopioid group were given a nonopioid multimodal pain regimen previously described in the literature.[25] The multimodal pain regimen consisted of multiple medications to target various postoperative pain generators. Medication dosing and frequency are listed in Table I. Methocarbamol was used for control of muscle spasms and cramps.[5] Gabapentin was prescribed to target neuropathic pain.[2] Nonsteroidal anti-inflammatory drugs (meloxicam and ketorolac) and acetaminophen were administered to target inflammation and pain cascades postoperatively, respectively.

At discharge, patients were instructed to contact the on-call physician regarding inadequate pain control or if they were experiencing adverse effects or complications. Additionally,

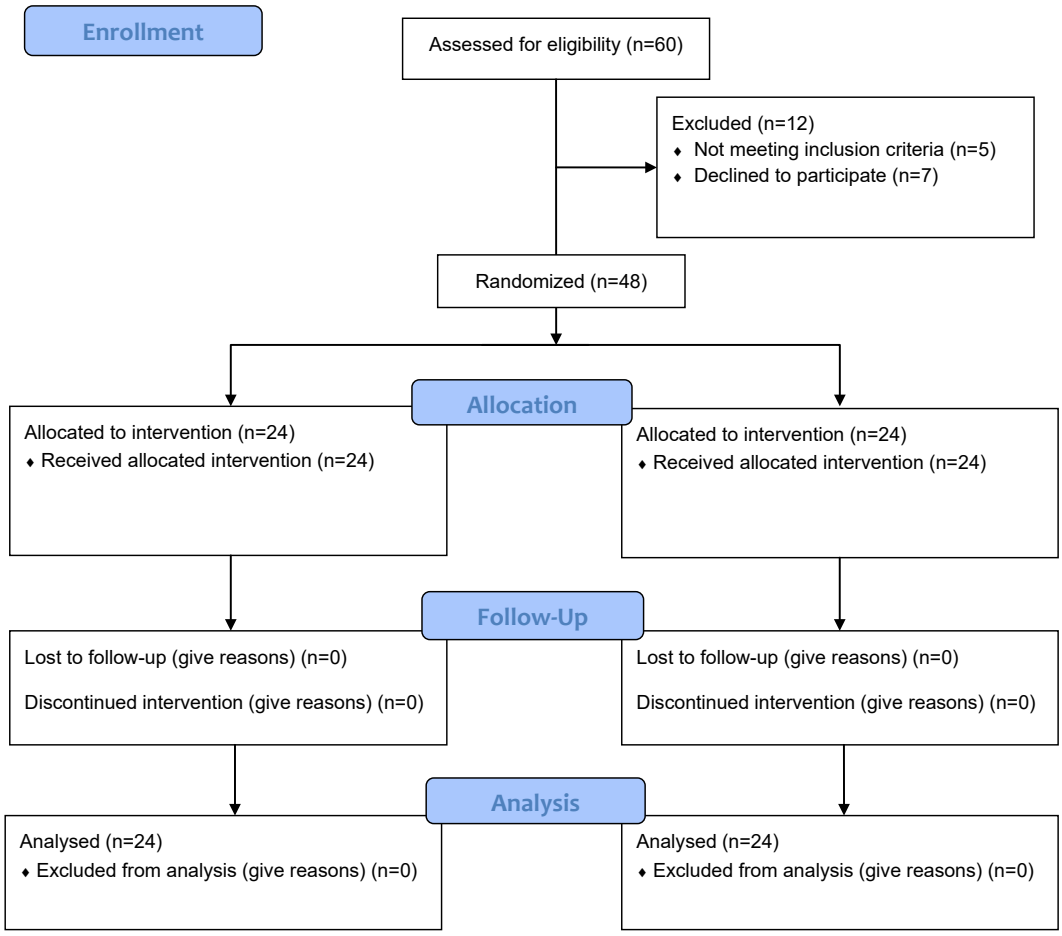

Figure 1 Consolidated Standards of Reporting Trials 2010 flow diagram.

patients were counseled on the effects of narcotics and provided an informational pamphlet.

Outcomes

Patient demographic variables including age, sex, body mass index (BMI), history of diagnosed psychiatric condition, anxiety and depression status, and workers' compensation status were abstracted from patients' medical records. Preoperatively, patients completed the Patient-Reported Outcomes Measurement Information System (PROMIS) Pain Interference (PI) Short Form questionnaire. Postoperatively, a mobile messaging service (Mosio, Seattle, WA, USA) was used to collect outcomes. This mobile messaging service allowed patients to respond to a survey via text message using numerical responses. Surveys were administered 3 times daily during the first 10 days postoperatively.

Visual analog scale (VAS) scores were collected daily in the morning (9 AM), afternoon (1 PM), and evening (7 PM). Patients were asked about adverse events and the number of narcotics consumed in the last 24-hour period (if applicable) each evening. The number of narcotics consumed in the last 24 hours was converted to morphine milligram equivalents (MMEs). PROMIS-PI Short Form scores were collected postoperatively during the first postoperative visit (day 7-10).

Statistical analysis

Previous studies have evaluated the minimal clinically significant change in acute pain levels as measured by the VAS pain score to be 2.4 mm on a 10-mm scale following arthroscopic shoulder surgery.[32] Previous literature has demonstrated a standard deviation of 2.8 mm among VAS scores on a 10-point scale for patients undergoing shoulder labral repair.[25] A power analysis was performed prior to study initiation. With a power of 80% (β level = 0.80, α level = 0.05), effect size of 2.4 mm, and standard deviation of 2.8 mm, the minimum number of patients was 23 per cohort (N = 46) to evaluate the primary outcome. A sample size of 60 (30 per cohort) was selected to allow for incomplete data collection.

Continuous variables are reported as means and standard deviations, whereas frequency counts and percentages are displayed for categorical variables. Comparisons between the 2 pain control groups (traditional and nonopioid) were performed using the χ^2 test; however, the Fisher exact test was used when expected cell counts were <5. For continuous variables, 2-group comparisons

Table I Multimodal nonopioid pain regimen

Postoperative days 1-5
Morning
Ketorolac, 10 mg
Gabapentin, 300 mg*
Methocarbamol, 750 mg
Acetaminophen, 1000 mg
Noon
Ketorolac, 10 mg
Gabapentin, 300 mg
Methocarbamol, 750 mg
Acetaminophen, 1000 mg
Afternoon
Ketorolac, 10 mg
Gabapentin, 300 mg
Methocarbamol, 750 mg
Acetaminophen, 1000 mg
Evening
Ketorolac, 10 mg
Methocarbamol, 750 mg
Postoperative days 6-14
Morning
Meloxicam, 7.5 mg
Methocarbamol, 750 mg
Acetaminophen, 1000 mg
Afternoon
Meloxicam, 7.5 mg
Methocarbamol, 750 mg
Acetaminophen, 1000 mg
Evening
Methocarbamol, 750 mg
Acetaminophen, 1000 mg

The preoperative regimen consisted of oral administration of celecoxib, 400 mg; acetaminophen, 975 mg; gabapentin, 300 mg; and tramadol, 50 mg; as well as intravenous administration of dexamethasone, 8 mg. Intraoperative local infiltration analgesia consisted of 150 mg (30 mL) of ropivacaine, 30 mg (1 mL) of ketorolac, and 1 mg (1 mL) of epinephrine.

*Gabapentin weaning began on postoperative day 6 in the following manner: 300 mg in the morning and 300 mg in the evening on days 6 and 7, 400 mg in the morning on days 8 and 9, and discontinuation on day 10.

were performed using the independent 2-sample *t* test if the variable was normally distributed and using the Wilcoxon rank sum test if the variable was non-normally distributed. Pearson correlation coefficients and their corresponding *P* values are provided to show the correlation between select variables for the traditional pain control group, the nonopioid pain control group, and all patients.

Repeated-measures analyses were performed using mixed models and included the effects of time, pain control group, and the interaction between time and pain control group as applicable. If needed, significant interaction effects were analyzed with post hoc comparisons using a Tukey-Kramer *P* value correction. Predicted means of the outcome variables resulting from the adjusted models were plotted. Statistical significance was set at $P < .05$ for group comparisons and main effect testing. Significance was set at $P < .10$ for interaction testing. All analyses were performed using SAS software (version 9.4; SAS Institute, Cary, NC, USA).

Results

Patient demographic characteristics

Sixty consecutive patients undergoing primary arthroscopic labral surgery were evaluated for study inclusion. Twelve patients declined to participate or were excluded from the study. Thus, 48 patients were included in the final analysis, with 24 randomized into the nonopioid group and 24 randomized into the opioid group. Among all 48 patients, male patients comprised 79.2%, the mean age was 25.9 ± 8.6 years, and the average BMI was 27.5 kg/m^2. A total of 13 patients (27.0%) experienced first-time dislocations. The median time from the first dislocation to the time of surgical management was 6 months. Among all patients, the average number of dislocations was 2.6 ± 2.2. Demographic information for patients by cohort is provided in Table II.

Postoperative analgesia

Mean VAS scores in the first 10 postoperative days (PODs) demonstrated no significant difference ($P > .05$) between cohorts (Fig. 2). Repeated-measures mixed models were then used to account for confounding variables. Once confounders were accounted for, patients in the nonopioid cohort were found to have significantly lower VAS scores across all PODs ($P < .01$) (Fig. 3). When evaluating preoperative PROMIS-PI scores, we observed no significant difference between the opioid and nonopioid cohorts (55.8 ± 6.7 vs. 56.9 ± 5.8, $P = .59$). However, patients in the nonopioid group demonstrated significantly lower postoperative PROMIS-PI scores (62.7 ± 6.8 vs. 54.2 ± 9.6, $P < .01$). Repeated-measures mixed models demonstrated that postoperative PROMIS-PI scores in the nonopioid group were significantly lower than those in the opioid group ($P < .01$) (Fig. 4). When repeated-measures mixed models were used to evaluate postoperative opioid consumption, they demonstrated that MMEs of opioids consumed had a significant relationship with time ($P < .01$) (Fig. 5). In the opioid cohort, the highest opioid consumption was demonstrated in the first 3 PODs (2.7 ± 1.2 pills and 13.7 ± 6.0 MMEs on POD 1, 2.6 ± 1.7 pills and 12.8 ± 8.5 MMEs on POD 2, and 2.0 ± 1.8 pills and 10.5 ± 9.1 MMEs on POD 3) and the lowest opioid consumption was observed on POD 8 (1.0 ± 1.5 pills and 5.0 ± 7.9 MMEs), POD 9 (0.9 ± 1.5 pills and 4.7 ± 7.4 MMEs), and POD 10 (1.0 ± 1.6 pills and 5.0 ± 8.0 MMEs).

Pearson correlation coefficient analysis showed no significant correlation between age, BMI, race, or sex and VAS pain scores ($P > .05$) (Table III). When evaluating concomitant injuries, we observed no relationship between bony Bankart lesions, Hill-Sachs lesions, reverse Hill-Sachs lesions, superior labrum anterior-posterior (SLAP) tears, anterior labral periosteal sleeve avulsion (ALPSA), glenoid labral articular disruption (GLAD), or humeral avulsion of

Table II Demographic characteristics of patients in opioid and nonopioid cohorts

	Opioid (n = 24)	Nonopioid (n = 24)	*P* value
Age, yr	26.4 ± 8.2	25.4 ± 9.2	.71
Sex			
Male	19 (79.2)	19 (79.2)	>.999
Female	5 (20.8)	5 (20.8)	
BMI, kg/m^2	27.5 ± 6.6	27.5 ± 7.1	.99
Race			.9
White	12 (50.0)	9 (39.1)	
African American	8 (33.3)	9 (39.1)	
Other	2 (8.3)	2 (8.3)	
Unknown	2 (8.3)	4 (16.6)	
First-time dislocation			
Yes	7 (29.2)	6 (25)	.77
No	17 (70.8)	18 (75)	
Time since first dislocation, mo	19.9 ± 30.6	2.4 ± 1.3	.37
No. of dislocations	2.4 ± 1.3	2.8 ± 2.9	.63
Workers' compensation			
No	24 (100)	24 (100)	—
Biceps tenodesis			
Yes	0 (0)	0 (0)	—
No	24 (100)	24 (100)	
ALPSA, GLAD, or HAGL			>.999
Yes	5 (20.8)	4 (16.6)	
No	19 (79.2)	20 (83.3)	
SLAP tear			.76
Yes	7 (29.2)	8 (33.3)	
No	17 (70.8)	16 (33.3)	
Bony Bankart lesion			>.999
Yes	4 (16.7)	4 (16.7)	
No	20 (83.3)	20 (83.3)	
Hill-Sachs lesion			.75
Yes	4 (16.7)	6 (25.0)	
No	20 (83.3)	18 (75.0)	
Reverse Hill-Sachs lesion			.49
Yes	0 (0)	2 (8.3)	
No	24 (100)	22 (91.7)	
No. of suture anchors	3.5 ± 1.1	3.6 ± 1.1	.79

BMI, body mass index; *ALPSA*, anterior labral periosteal sleeve avulsion; *GLAD*, glenoid labral articular disruption; *HAGL*, humeral avulsion of glenohumeral ligament; *SLAP*, superior labrum anterior-posterior.
Data are presented as mean ± standard deviation or number (percentage). $P < .05$ was deemed statistically significant.

the glenohumeral ligament (HAGL) and VAS scores ($P > .05$). When correlations related to postoperative opioid consumption were examined, Pearson correlation coefficient analysis only demonstrated a significant relationship between age and MMEs at the end of the study period (Pearson correlation coefficient = 0.56, $P < .01$).

Patient-reported adverse events

Evaluation of the duration for which patients reported adverse events showed no significant differences for constipation ($P = .431$), nausea ($P = .617$), diarrhea ($P = .464$), upset stomach ($P = .567$), drowsiness ($P = .068$), and dizziness ($P = .209$) (Table IV). There was no significant difference between cohorts in the mean number of days patients reported adverse events (3.4 ± 2.7 days for opioid group vs. 3.3 ± 3.7 days for nonopioid group, $P = .87$). The most commonly reported adverse events in both cohorts were constipation (1.8 ± 2.3 days for opioid group and 1.7 ± 2.9 days for nonopioid group), drowsiness (2.4 ± 2.8 days and 1.6 ± 3.2 days, respectively), and dizziness (0.4 ± 1.2 days and 1.1 ± 2.5 days, respectively). No patients experienced any intraoperative or postoperative complications, including infection, reoperation, and thromboembolism. No patients in the nonopioid group required emergency opioid analgesia. The nonopioid cohort reported 100% satisfaction with postoperative pain control.

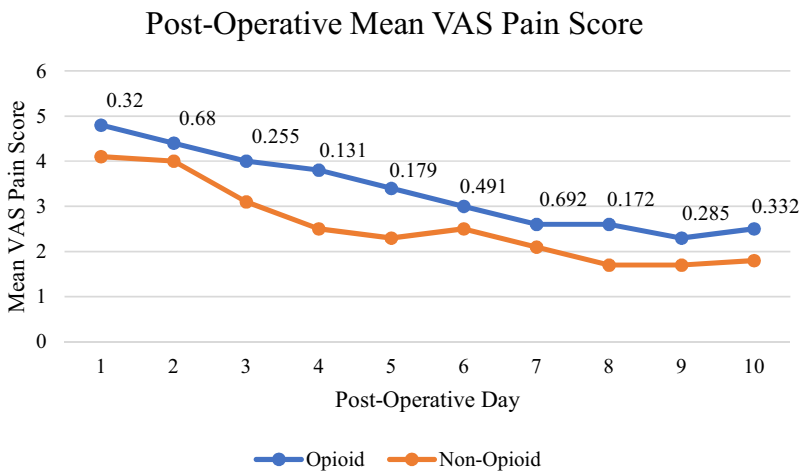

Figure 2 Mean visual analog scale (*VAS*) pain scores for opioid and nonopioid cohorts in first 10 days postoperatively. Patients in the nonopioid group reported equivalent pain control to that in the opioid cohort. $P < .05$ was deemed statistically significant.

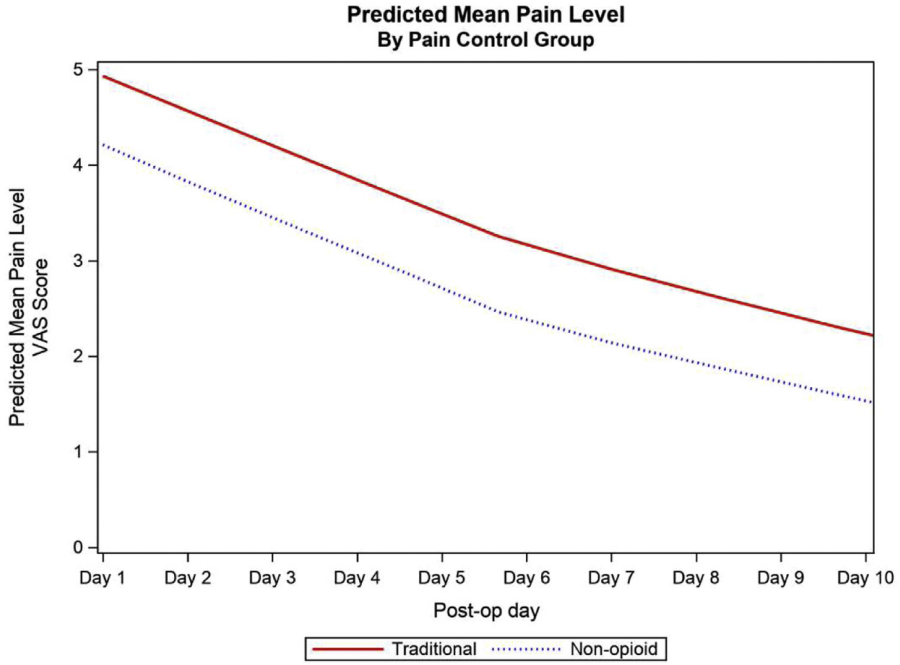

Figure 3 Predicted mean daily pain levels for opioid and nonopioid cohorts. Visual analog scale (*VAS*) scores were significantly different between cohorts when we controlled for age, sex, body mass index, and race ($P < .01$). *Post-op*, postoperative.

Discussion

This prospective, observer-blinded, randomized controlled trial evaluated postoperative pain control following primary arthroscopic labral surgery using either a nonopioid analgesic protocol or opioid-based analgesic protocol. This study found that a multimodal nonopioid pain regimen provided equivalent pain control, an equivalent adverse reaction profile, and equivalent patient satisfaction when compared with an opioid-based regimen. Given the increasing number of narcotic-related deaths in the United States and the potential for addiction associated with opioids, this study demonstrated that a nonopioid multimodal pain regimen can effectively manage postoperative pain following arthroscopic labral surgery and serve as a feasible replacement for opioid-based analgesia.

There is a paucity of literature that has investigated the effect of nonopioid pain regimens on pain scores following

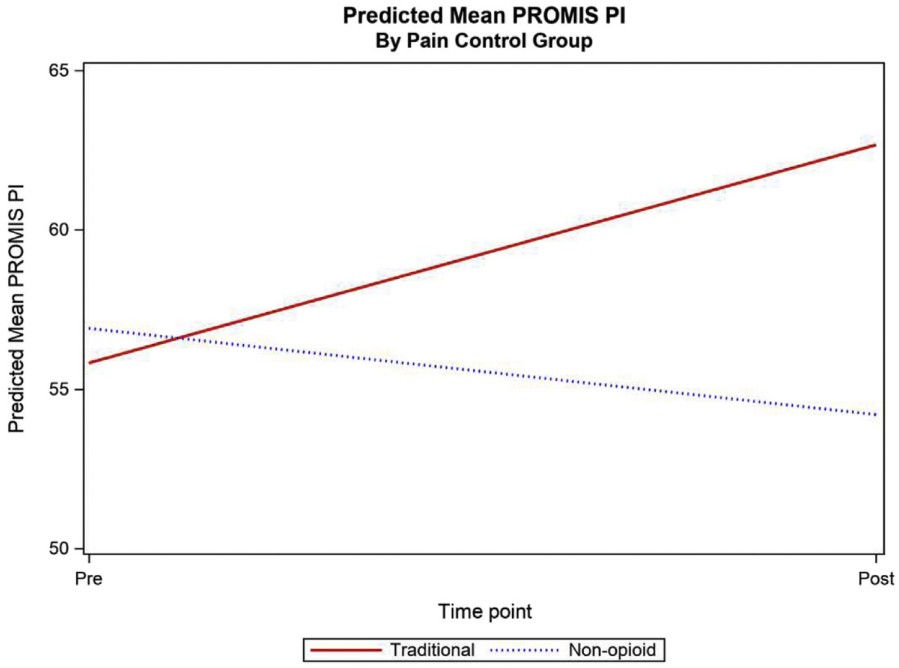

Figure 4 Predicted Patient-Reported Outcomes Measurement Information System Pain Interference (*PROMIS PI*) computerized adaptive testing scores for opioid and nonopioid cohorts. When we controlled for age, sex, body mass index, and race between cohorts, the opioid cohort reported significantly higher postoperative scores compared with the nonopioid cohort ($P < .01$). *Pre*, preoperative; *Post*, postoperative.

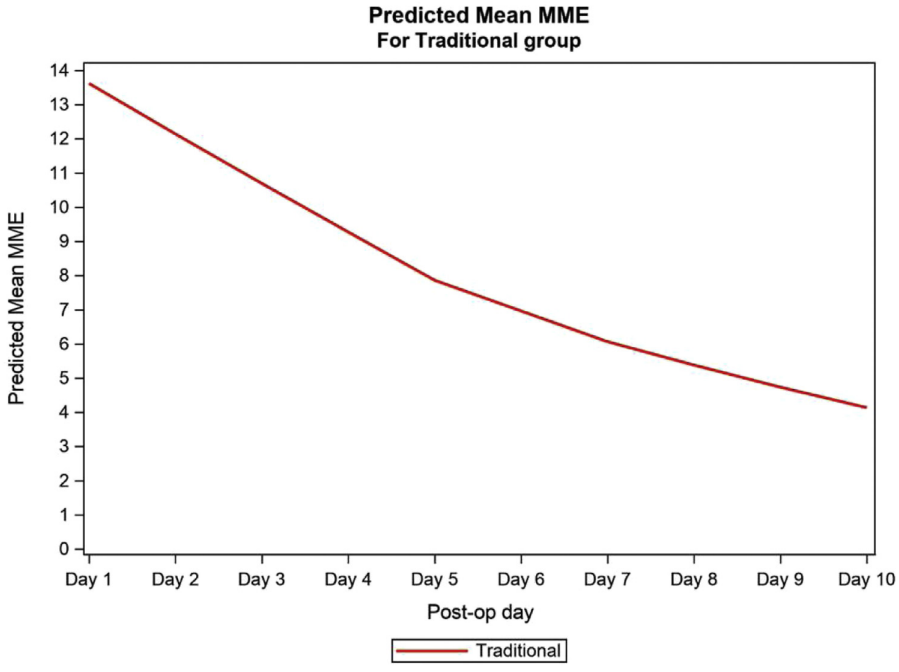

Figure 5 Predicted mean morphine milligram equivalents (*MME*) for opioid cohort. When we controlled for age, sex, body mass index, and race, no significant relationship was observed. *Post-op*, postoperative.

Table III Pearson correlation coefficients between VAS pain scores and demographic characteristics

Variable	Correlation coefficient	*P* value
Age	0.18	.22
Sex	−0.05	.74
BMI	−0.21	.84
Ethnicity	−0.01	.99

VAS, visual analog scale; *BMI*, body mass index.

arthroscopic shoulder labral surgery. In a case series of 141 patients, Moutzouros et al[25] evaluated the efficacy of a multimodal pain regimen following common orthopedic sports procedures. These procedures included anterior cruciate ligament reconstruction, rotator cuff repair, arthroscopic partial meniscectomy, and labral repair. The mean VAS score for patients undergoing labral repair was 2.9 ± 2.1, indicating adequate pain control without the use of narcotics. In a randomized controlled trial, Elkassabany et al[8] evaluated pain control after arthroscopic shoulder surgery using a multimodal perioperative pain protocol consisting of acetaminophen, gabapentin, ketorolac, and ondansetron. Their study found that, when compared with the control cohort receiving oxycodone-acetaminophen postoperatively, patients in the multimodal group had significantly lower pain scores, were in severe pain for less time overall, and had a greater percentage of overall pain relief 24 hours postoperatively (as measured by the Revised American Pain Society Patient Oriented Questionnaire) ($P < .01$). Additionally, Toivonen et al[34] performed a randomized prospective study assessing the impact of nonsteroidal anti-inflammatory drugs and adjunct pain medication following arthroscopic acromioplasty. They found that patients who received etoricoxib had significantly lower VAS scores at 30, 60, 120, and 180 minutes following surgery; furthermore, patients consumed less paracetamol-codeine in the first 7 days postoperatively ($P < .05$). In accordance with previous literature, our study found differences in VAS and PROMIS-PI scores between patients who received opioids and those who received a nonopioid multimodal pain regimen. When we controlled for confounding factors, patients in the nonopioid group experienced statistically lower VAS pain scores; however, these values did not reach clinical significance. These findings illustrate that nonopioid pain management is at least as effective as traditional opioid management and postoperative pain can be successfully managed following arthroscopic labral surgery without using narcotics.

When seeking to manage postoperative pain, it is critical to strike a balance between the therapeutic benefits of analgesics and their adverse effect profile. Studies have sought to assess the side-effect profile of nonopioid pain regimens to control postoperative pain in the context of orthopedic surgery. Moutzouros et al[25] performed a case-series study of 141 patients evaluating adverse events of a multimodal pain regimen following common orthopedic sports procedures. They reported that 53.6% of patients did not experience any adverse events. The most common adverse events reported were drowsiness (23.5%) and dizziness (15.7%). Elkassabany et al[8] performed a randomized controlled trial evaluating a multimodal pain regimen following arthroscopic shoulder surgery. Their investigation found that when compared with patients receiving narcotics, patients undergoing the multimodal pain protocol, consisting of acetaminophen, gabapentin, ketorolac, and ondansetron, showed no significant difference in nausea, drowsiness, or dizziness. In accordance with previous literature, our study found that there was no significant difference in the number of days patients in each cohort reported adverse events. Additionally, the most commonly reported adverse events in both cohorts were constipation, drowsiness, and dizziness. It is important to highlight that constipation was the most commonly reported adverse drug event even in patients receiving the nonopioid drug regimen. Although constipation is a common complaint following the use of narcotics, its presence in the nonopioid group is likely attributed to the use of gabapentin, which has been shown to induce constipation in patients.[21] Although these findings demonstrate that postoperative pain can be managed with a nonopioid regimen without incurring a significantly increased number of adverse events, further research is needed evaluating the use of a bowel regimen in conjunction with the nonopioid regimen to determine whether the adverse events reported can be further minimized.

When critically evaluating postoperative pain regimens, it is important not only to evaluate pain control and the side-effect profile but also to examine factors that are contributing to increased pain postoperatively. Durban et al[6] performed a retrospective review of 120 patients undergoing surgical management for anterior instability and concomitant SLAP lesions. They demonstrated that when compared patients with only anterior instability, patients with concomitant SLAP lesions had more severe preoperative pain as measured by VAS scores. However, in a retrospective cohort study of 340 patients, Jildeh et al[18] found that when patients who underwent arthroscopic labral surgery were stratified by shoulder instability pattern, there was no significant difference in postoperative opioid consumption between Bankart lesions, Hill-Sachs lesions, reverse Hill-Sachs lesions, anterior labroligamentous periosteal sleeve avulsion, glenolabral articular disruption, and humeral avulsion of the glenohumeral ligament ($P > .05$). Our investigation found no clinically significant relationship between shoulder injury pattern and postoperative VAS scores. It should be noted that a patient's age had a significant relationship with increased postoperative opioid consumption. This finding is in accordance with previous literature demonstrating that age is a predictor for postoperative morphine requirements.[22,31] One possible explanation for this finding is that older patients are more likely

Table IV Reported adverse events in opioid and nonopioid groups

Adverse event	Length of adverse event, d		*P* value
	Opioid (n = 24)	Nonopioid (n = 24)	
Constipation	1.8 ± 2.3	1.7 ± 2.9	.431
Nausea	0.2 ± 0.5	0.1 ± 0.2	.617
Diarrhea	0.2 ± 0.5	0.2 ± 0.9	.410
Upset stomach	0.2 ± 0.5	0.4 ± 1.2	.567
Drowsiness	2.4 ± 2.8	1.6 ± 3.2	.068
Dizziness	0.4 ± 1.2	1.1 ± 2.5	.209

* Data are presented as mean ± standard deviation. $P < .05$ was deemed statistically significant.

to have received opioids prior to surgical intervention and, for this reason, were less likely to be opioid naive prior to surgery.[3,10,33] In a retrospective analysis of factors predictive of increased opioid consumption following arthroscopic labral surgery, Jildeh et al[18] demonstrated that preoperative opioid use was the greatest risk factor for increased postoperative opioid consumption. The findings of our investigation highlight that a patient's injury pattern may not be indicative of the postoperative pain experienced, and they further corroborate the relationship between age and increased postoperative pain. Future investigations of the effect of age on pain are needed to elucidate the relationship between age and postoperative pain after shoulder arthroscopy.

Limitations

There are several limitations present in this study. Owing to the nature of the study design, it was not possible to perform this study in a double-blinded fashion, as patients had to be made aware of the medication being prescribed, as well as dosing regimens. Although patients' awareness of their treatment groups could lead to observation bias, efforts were made to ensure that all data collection was performed by blinded observers. It must be noted that this study was only powered to observe significant differences in VAS and PROMIS scores and was not sufficiently powered to discern significant differences between adverse drug events, mental status changes, postoperative outcomes, or long-term pain and disability past 10 PODs. A larger sample size would have been necessary to perform any form of subgroup analysis. Furthermore, although patients were instructed to take all medication as prescribed and not to supplement the analgesic effect with over-the-counter medication, there was no system in place to monitor and assess patient compliance. Moreover, it should be noted that bony Bankart injuries were not excluded, and patients with bony Bankart lesions may potentially confound the level of reported pain control as they may present with higher levels of postoperative pain. All patients with bony Bankart lesions were managed with suture anchor–based techniques. Finally, because it would be unethical to withhold pain medication following surgery, it was not possible to determine the total pain reduction of the multimodal analgesia protocol. For this reason, standard-of-care narcotic-based analgesia served as the control group from which comparisons were made.

Conclusion

This study found that following arthroscopic labral surgery, a multimodal nonopioid pain regimen provided, at the minimum, equivalent pain control, an equivalent adverse reaction profile, and equivalent patient satisfaction when compared with an opioid-based regimen.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Abrams GD, Frank RM, Gupta AK, Harris JD, McCormick FM, Cole BJ. Trends in meniscus repair and meniscectomy in the United States, 2005-2011. Am J Sports Med 2013;41:2333-9. https://doi.org/10.1177/0363546513495641
2. Backonja M, Glanzman RL. Gabapentin dosing for neuropathic pain: evidence from randomized, placebo-controlled clinical trials. Clin Ther 2003;25:81-104. https://doi.org/10.1016/s0149-2918(03)90011-7
3. Campbell CI, Weisner C, Leresche L, Ray GT, Saunders K, Sullivan MD, et al. Age and gender trends in long-term opioid analgesic use for noncancer pain. Am J Public Health 2010;100:2541-7. https://doi.org/10.2105/AJPH.2009.180646
4. Centers for Disease Control and Prevention. U.S. opioid dispensing rate maps. Atlanta, GA: Centers for Disease Control and Prevention; 2020. Available at: https://www.cdc.gov/drugoverdose/rxrate-maps/index.html
5. Dhaliwal JS, Rosani A, Saadabadi A. Diazepam. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2021.
6. Durban CM, Kim JK, Kim SH, Oh JH. Anterior shoulder instability with concomitant superior labrum from anterior to posterior (SLAP) lesion compared to anterior instability without SLAP lesion. Clin Orthop Surg 2016;8:168-74. https://doi.org/10.4055/cios.2016.8.2.168
7. Dwyer MK, Tumpowsky CM, Hiltz NL, Lee J, Healy WL, Bedair HS. Characterization of post-operative opioid use following total joint arthroplasty. J Arthroplasty 2018;33:668-72. https://doi.org/10.1016/j.arth.2017.10.011
8. Elkassabany NM, Wang A, Ochroch J, Mattera M, Liu J, Kuntz A. Improved quality of recovery from ambulatory shoulder surgery after implementation of a multimodal perioperative pain management protocol. Pain Med 2019;20:1012-9. https://doi.org/10.1093/pm/pny152

9. Fabricant PD, Seeley MA, Rozell JC, Fieldston E, Flynn JM, Wells LM, et al. Cost savings from utilization of an ambulatory surgery center for orthopaedic day surgery. J Am Acad Orthop Surg 2016; 24:865-71. https://doi.org/10.5435/JAAOS-D-15-00751
10. Foy R, Leaman B, McCrorie C, Petty D, House A, Bennett M, et al. Prescribed opioids in primary care: cross-sectional and longitudinal analyses of influence of patient and practice characteristics. BMJ Open 2016;6:e010276. https://doi.org/10.1136/bmjopen-2015-010276
11. Frank RM, Chalmers PN, Moric M, Leroux T, Provencher MT, Romeo AA. Incidence and changing trends of shoulder stabilization in the United States. Arthroscopy 2018;34:784-92. https://doi.org/10.1016/j.arthro.2017.08.289
12. Gomes T, Tadrous M, Mamdani MM, Paterson JM, Juurlink DN. The burden of opioid-related mortality in the United States. JAMA Netw Open 2018;1:e180217. https://doi.org/10.1001/jamanetworkopen.2018.0217
13. Herzog MM, Marshall SW, Lund JL, Pate V, Mack CD, Spang JT. Trends in incidence of ACL reconstruction and concomitant procedures among commercially insured individuals in the United States, 2002-2014. Sports Health 2018;10:523-31. https://doi.org/10.1177/1941738118803616
14. Jain NB, Higgins LD, Losina E, Collins J, Blazar PE, Katz JN. Epidemiology of musculoskeletal upper extremity ambulatory surgery in the United States. BMC Musculoskelet Disord 2014;15:4. https://doi.org/10.1186/1471-2474-15-4
15. Jensen AR, Cha PS, Devana SK, Ishmael C, Di Pauli von Treuheim T, D'Oro A, et al. Evaluation of the trends, concomitant procedures, and complications with open and arthroscopic rotator cuff repairs in the Medicare population. Orthop J Sports Med 2017;5: 2325967117731310. https://doi.org/10.1177/2325967117731310
16. Jildeh TR, Okoroha KR, Kuhlmann N, Cross A, Abbas MJ, Moutzouros V. Multimodal nonopioid pain protocol provides equivalent pain versus opioid control following meniscus surgery: a prospective randomized controlled trial. Arthroscopy 2021;37:2237-45. https://doi.org/10.1016/j.arthro.2021.02.043
17. Jildeh TR, Taylor KA, Khalil LS, Okoroha KR, Matar RN, Geisenhoff A, et al. Risk factors for postoperative opioid use in arthroscopic meniscal surgery. Arthroscopy 2019;35:575-80. https://doi.org/10.1016/j.arthro.2018.10.122
18. Jildeh TR, Taylor KA, Tramer JS, Khalil LS, Hasan L, Okoroha KR, et al. Risk factors for postoperative opioid use in arthroscopic shoulder labral surgery. Arthroscopy 2020;36:1813-20. https://doi.org/10.1016/j.arthro.2020.03.008
19. Jones CM, Lurie P, Woodcock J. Addressing prescription opioid overdose: data support a comprehensive policy approach. JAMA 2014; 312:1733-4. https://doi.org/10.1001/jama.2014.13480
20. Jones J Jr, Southerland W, Catalani B. The importance of optimizing acute pain in the orthopedic trauma patient. Orthop Clin North Am 2017;48:445-65. https://doi.org/10.1016/j.ocl.2017.06.003
21. Lee KJ, Kim JH, Cho SW. Gabapentin reduces rectal mechanosensitivity and increases rectal compliance in patients with diarrhoea-predominant irritable bowel syndrome. Aliment Pharmacol Ther 2005;22:981-8. https://doi.org/10.1111/j.1365-2036.2005.02685.x
22. Macintyre PE, Jarvis DA. Age is the best predictor of postoperative morphine requirements. Pain 1996;64:357-64.
23. Mall NA, Chalmers PN, Moric M, Tanaka MJ, Cole BJ, Bach BR Jr, et al. Incidence and trends of anterior cruciate ligament reconstruction in the United States. Am J Sports Med 2014;42:2363-70. https://doi.org/10.1177/0363546514542796
24. Morris BJ, Laughlin MS, Elkousy HA, Gartsman GM, Edwards TB. Preoperative opioid use and outcomes after reverse shoulder arthroplasty. J Shoulder Elbow Surg 2015;24:11-6. https://doi.org/10.1016/j.jse.2014.05.002
25. Moutzouros V, Jildeh TR, Khalil LS, Schwartz K, Hasan L, Matar RN, et al. A multimodal protocol to diminish pain following common orthopedic sports procedures: can we eliminate postoperative opioids? Arthroscopy 2020;36:2249-57. https://doi.org/10.1016/j.arthro.2020.04.018
26. Park SY, An HS, Lee SH, Suh SW, Kim JL, Yoon SJ. A prospective randomized comparative study of postoperative pain control using an epidural catheter in patients undergoing posterior lumbar interbody fusion. Eur Spine J 2016;25:1601-7. https://doi.org/10.1007/s00586-016-4385-8
27. Sabatino MJ, Kunkel ST, Ramkumar DB, Keeney BJ, Jevsevar DS. Excess opioid medication and variation in prescribing patterns following common orthopaedic procedures. J Bone Joint Surg Am 2018;100:180-8. https://doi.org/10.2106/JBJS.17.00672
28. Schoenfeld AJ, Jiang W, Chaudhary MA, Scully RE, Koehlmoos T, Haider AH. Sustained prescription opioid use among previously opioid-naive patients insured through TRICARE (2006-2014). JAMA Surg 2017;152:1175-6. https://doi.org/10.1001/jamasurg.2017.2628
29. Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. BMJ 2010;340:c332. https://doi.org/10.1136/bmj.c332
30. Secrist ES, Freedman KB, Ciccotti MG, Mazur DW, Hammoud S. Pain management after outpatient anterior cruciate ligament reconstruction: a systematic review of randomized controlled trials. Am J Sports Med 2016;44:2435-47. https://doi.org/10.1177/0363546515617737
31. Sun EC, Darnall BD, Baker LC, Mackey S. Incidence of and risk factors for chronic opioid use among opioid-naive patients in the postoperative period. JAMA Intern Med 2016;176:1286-93. https://doi.org/10.1001/jamainternmed.2016.3298
32. Tashjian RZ, Shin J, Broschinsky K, Yeh CC, Martin B, Chalmers PN, et al. Minimal clinically important differences in the American Shoulder and Elbow Surgeons, Simple Shoulder Test, and visual analog scale pain scores after arthroscopic rotator cuff repair. J Shoulder Elbow Surg 2020;29:1406-11. https://doi.org/10.1016/j.jse.2019.11.018
33. Thielke SM, Simoni-Wastila L, Edlund MJ, DeVries A, Martin BC, Braden JB, et al. Age and sex trends in long-term opioid use in two large American health systems between 2000 and 2005. Pain Med 2010;11:248-56. https://doi.org/10.1111/j.1526-4637.2009.00740.x
34. Toivonen J, Pitko VM, Rosenberg PH. Etoricoxib pre-medication combined with intra-operative subacromial block for pain after arthroscopic acromioplasty. Acta Anaesthesiol Scand 2007;51:316-21. https://doi.org/10.1111/j.1399-6576.2006.01204.x
35. Trasolini NA, McKnight BM, Dorr LD. The opioid crisis and the orthopedic surgeon. J Arthroplasty 2018;33:3379-82.e1. https://doi.org/10.1016/j.arth.2018.07.002
36. Volkow ND, McLellan TA, Cotto JH, Karithanom M, Weiss SR. Characteristics of opioid prescriptions in 2009. JAMA 2011;305:1299-301. https://doi.org/10.1001/jama.2011.401
37. Warrender WJ, Syed UAM, Hammoud S, Emper W, Ciccotti MG, Abboud JA, et al. Pain management after outpatient shoulder arthroscopy: a systematic review of randomized controlled trials. Am J Sports Med 2017;45:1676-86. https://doi.org/10.1177/0363546516667906
38. Westermann RW, Anthony CA, Bedard N, Glass N, Bollier M, Hettrich CM, et al. Opioid consumption after rotator cuff repair. Arthroscopy 2017;33:1467-72. https://doi.org/10.1016/j.arthro.2017.03.016
39. Zhao S, Chen F, Feng A, Han W, Zhang Y. Risk factors and prevention strategies for postoperative opioid abuse. Pain Res Manag 2019;2019: 7490801. https://doi.org/10.1155/2019/7490801