JSES International 5 (2021) 925–929

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

An integrated educational and multimodal approach to achieving an opioid-free postoperative course after arthroscopic rotator cuff repair

Vani J. Sabesan, MD [a,*], Kiran Chatha, MD [a], Sandra Koen, ATC [a], Nikolas Echeverry, BS [b], Wilfredo J. Borroto, BS [c], Laila H. Khoury, BS [b], B. Joshua Stephens, BS [d], Gregory Gilot, MD [a]

[a] Levitetz Department of Orthopedic Surgery, Cleveland Clinic Florida, Weston, FL, USA
[b] Charles E. Schmidt College of Medicine, Florida Atlantic University, Boca Raton, FL, USA
[c] Ponce Health Sciences University, Ponce, PR, USA
[d] Nova Southeastern University Dr. Kiran C. Patel College of Osteopathic Medicine, Davie, FL, USA

ARTICLE INFO

Keywords:
Opioid use
Rotator cuff repair
Opioid dependence
Multimodal pain management
Patient education
Nonopioid alternatives

Level of evidence: Level II; Prospective Cohort Design; Treatment Study

Background: In the realm of shoulder surgery, arthroscopic rotator cuff repair (RCR) is one of the most painful procedures and is often associated with higher opioid consumption. The purpose of this study was to evaluate effectiveness of preoperative and postoperative patient education and multimodal pain management to achieve an opioid-free postoperative recovery after RCR.

Methods: Sixty patients who underwent RCR were divided in 2 groups. All patientsreceived an interscalene nerve block and multimodal pain management. The opioid intervention group (OIG) in addition received preoperative education on expectations of pain, non opioid pain protocols, and alternate therapiesto minimize pain as well as customized postoperative instructions. Patients were compared on pain levels, opioid consumption, and outcomes scores preoperatively and at 48 hours, 2 weeks, and final follow-up. Patient-reported outcomes and opioid usage were compared and analyzed using student's t-tests and logistic regression.

Results: At 48 hours, 15% of OIG patients reported use of rescue opioids after surgery compared with 100% of control group patients. Zero percent of OIG patients reported opioid use at 2 weeks compared to 90% of control group patients ($P = .0196$). Patients in both groups showed significant improvements in all outcome scores ($P \leq .05$). At 6 weeks, functional, Constant, and satisfaction outcome scores were all higher in the OIG ($P < .05$). At last follow-up, there were no significant differences for all patient-reported outcomes between groups.

Conclusions: Application of patient education tools and innovative multimodal pain management protocols successfully eliminates the need for opioids while maintaining excellent patient satisfaction and outcomes.

There is an opioid crisis in the United States with more than 130 Americans dying each day from opioid-related causes. While illicit opioid abuse has certainly contributed to this epidemic, the medical community also bears some responsibility. In the late 1990s with the introduction of pain as the 5th vital sign, physicians were pressured to not only treat their patient's pain but eliminate it entirely. Given their efficacy, opioids became the gold standard for pain management, leading to a drastic increase in opioid prescriptions in the United States. In 2016 alone, more than 236 million opioid prescriptions were written in the United States, enough for every American adult to have their own prescription. While successful, research has found 1 of every 4 patients who takes an opioid for the first time will be at risk for prolonged use and addiction.[26] Prior research has shown that nearly 50% of patients are discharged with a prescription for opioids after all types of surgery, including orthopedics.[7]

Orthopedic surgeons, among physicians, prescribe the 3rd highest quantity of opioids behind only primary care and dentists. Despite their efficacy and convenience, there is still a high potential for abuse of these opioid medications.[4,23] After just 1 month of use, opioids have been shown to alter the nervous system, beginning the path toward tolerance and dependence.[5] In addition, increased

The Cleveland Clinic Institutional Review Board approved this study (FLA 17-022).

* Corresponding author: Vani J. Sabesan, MD, Levitetz Department of Orthopedic Surgery, Cleveland Clinic Florida, 2950 Cleveland Clinic Blvd, Weston, FL 33331, USA.

E-mail address: Sabes001@gmail.com (V.J. Sabesan).

https://doi.org/10.1016/j.jseint.2020.12.018

dependence rates have been observed in patients using opioids postoperatively for prolonged periods after various types of orthopedic surgery, despite treatment of their pathology after surgery.[1–4,9] Patients treated with an arthroscopic rotator cuff repair (RCR) who used opioids before surgery were found to have lower functional outcome scores and increased opioid consumption postoperatively than opioid-naïve patients.[24] Given the prevalence of opioid misuse and dependence and the impact on outcomes, orthopedic surgeons need to examine other options for pain management. To provide adequate postoperative pain management while also decreasing opioid use, several intervention techniques have been investigated. Multimodal pain management regimens integrating multiple nonopioid medications with regional anesthesia have emerged as successful strategies to treat postoperative pain for shoulder arthroplasty and arthroscopy with minimal use of opioids.[7,10,22] Other studies have shown the efficacy of preoperative educational videos to provide patients with realistic postoperative pain expectations and more education about opioids and nonopioid alternatives as another method to decrease postoperative opioid consumption.[19–21] On their own, these methods significantly reduce the number of opioids consumed postoperatively; however, they do not eliminate the need for postoperative opioid prescriptions entirely.

With several states passing legislation limiting the number of opioids which can be prescribed for acute postoperative pain, the focus must shift to investigating an opioid-free postoperative experience. A previous study by Sabesan et al[16] was able to examine the effectiveness of a patient management model including both preoperative education and opioid-free multimodal pain management to achieve an opioid-free recovery in shoulder arthroplasty. Results were found to support complete elimination of opioid use by 2 weeks after operation without diminishing outcomes or patient satisfaction.[16] This indication is valuable as it provides an approach to opioid-free recovery for other types of shoulder surgery.[13,19] This study was performed to evaluate whether the multimodal pain protocol alone or with additional patient engagement and educational tools would be more successful in achieving an opioid-free postoperative recovery after RCR surgery.

Methods

Patient cohort and demographic data

This institutional review board approved prospective case-control study included sixty patients undergoing RCR surgery at a large single institution by 2 fellowship trained shoulder surgeons from 2018 to 2019. Patients were included in the study if they met appropriate criteria for RCR and were older than 18 years of age. Exclusion criteria included a history of opioid or alcohol/drug dependence, any cognitive or psychiatric condition inhibiting ability to provide informed consent, revision surgeries, and pregnancy. Demographic data collected included age, gender, body mass index, American Society of Anesthesiologists class, medical and psychiatric comorbidity burden, smoking status, and prior opioid use. All patient-reported preoperative opioid use and prescriptions were recorded and verified using E-FORSCE, the mandated Florida state prescription drug monitoring service. Preoperative opioid dependence was defined as 3 or more continuous opioid prescriptions in the 3-month period leading up to surgery.

Intervention

Patients were prospectively enrolled in the education and multimodal group OIG (n = 26) and in the control group (CG) (n = 34). Patients self-selected to be part of the OIG. Patients in both groups received a multimodal pain management protocol consisting of gabapentin, acetaminophen, and an ultrasound-guided interscalene block with 0.5% ropivacaine preoperatively followed by intraoperative intravenous dexamethasone and ketorolac if no contraindications were noted. Standardized surgical techniques were used for all patients enrolled in the study, and all patients underwent an RCR and subacromial decompression as indicated. At the time of incision closure, the OIG group received a local infiltration of liposomal bupivacaine (20 mg) if no contraindications were noted.

Patients in the OIG were provided with preoperative and postoperative pamphlets including educational materials on pain expectations after surgery, discharge instructions and pamphlet detailing the opioid crisis, and concerns with opioids (Table I). In addition, patients were provided with an alternative pain management plan that included information and prescriptions of nonopioid pain medications detailed below. Postoperatively, intervention patients (OIG) were given prescriptions and instructed on discharge to take oral ketorolac and scheduled acetaminophen for 48 hours and then instructed to take scheduled oral acetaminophen and ibuprofen over the counter as needed for pain if not contraindicated. All patients in the study were also given a prescription for oxycodone with acetaminophen 5-325 mg (Percocet) to be used for breakthrough pain as needed. Patients in the CG received standard multimodal pain management as described previously and did not receive preoperative education, liposomal bupivacaine infiltration, or postoperative nonopioid pain prescriptions. Patients were compared on pain levels and opioid consumption in the immediate postoperative period at 48 hours, 2 weeks, and final follow-up. All patients received an appropriate postoperative physical therapy plan as deemed by their surgeon.

Opioid use and outcomes

Patient-reported opioid consumption including dose, type of opioid and quantity of pills, visual analog scale (VAS) pain scores, and outcome scores were recorded at 48 hours, 2 weeks, and final follow-up (average of 5.2 months). Outcomes scores were further differentiated and analyzed at 6 weeks and 3 months. Patient-reported outcomes included Penn Shoulder Score (PENN), American Shoulder and Elbow Surgeons (ASES) shoulder scores, Constant scores, and subjective shoulder value (satisfaction). All patient-reported opioid consumption was converted to total oral morphine equivalents using standard conversion factors as characterized by the Consortium to Study Opioid Risks and Therapeutics.[26]

Statistical analysis

All data were compared between the intervention group and control group. VAS scores were used as a primary outcome variable. Continuous variables were summarized using descriptive statistics and categorical parameters were summarized using number and percentage of subjects. T-tests and chi-square analyses were used to analyze demographic differences between the 2 groups. T-tests were used to compare opioid consumption rates, pain levels, and outcome scores between groups. A multivariable logistic regression was performed to assess the impact of all demographic characteristics on postoperative opioid use. All statistics were performed using SPSS software (IBM SPSS Statistics for Mac, version 23.0; IBM Corp., Armonk, NY, USA).

Results

This study includedatotal of 60 patientsundergoing primary arthroscopic RCR. Of the total cohort, 26 were included in the OIG group and 34 in the CG. Overall, the average age was 62.2 years

Table I
Education materials given to opioid intervention group.

Educational material checklist:
1. Preoperative education handout including information on opioid risks, postoperative pain expectations, and alternate nonopioid treatment options
2. Preoperative discussion with physician on the risks of opioids
3. Discharge instructions after surgery with patient education and algorithms
4. Review of "The Opioid Crisis" and warnings associated with opioid usage
5. Alternative pain management protocol including prescriptions for nonopioid pain medications

Table II
Demographic characteristics of each group.

Group characteristics	Opioid intervention group	Control group	*P* value
Gender	16	17	.821
Male			
Female	10	17	
Average age (yr)	61.7 [35-83]	62.8 [46-79]	.872
ASA class	1.9	2.3	.134
BMI	27.1	28.2	.216

ASA, American Society of Anesthesiologists; *BMI*, body mass index

Table III
Preoperative and final postoperative patient-reported outcome scores.

Outcome scores	OIG	Control group	*P* value
Preoperative			
VAS	5.6	5.9	.124
ASES pain	21.8	20.6	.773
ASES function	19.3	14.2	.156
PENN function	21.9	18.8	.475
Constant	15.0	14.6	.878
Satisfaction	45.3	34.8	.100
Postoperative final follow-up			
VAS	1.5	1.2	.581
ASES pain	42.6	44.8	.400
ASES function	35.4	32.8	.992
PENN function	41.4	41.4	.908
Constant	27.3	27.9	.747
Satisfaction	72.1	77.5	.451

ASES, American Shoulder and Elbow Surgeons; *OIG*, opioid intervention group; *PENN*, Penn Shoulder Score; *VAS*, visual analog scale.

Table IV
6-week and 3-month postoperative patient-reported outcome scores.

	OIG	Control Group	*P* value
Postoperative 6-week follow-up			
ASES pain	43.8	38.4	.208
ASES function	31.7	20.1	.044*
PENN function	37.5	25.2	.034*
Constant	26.3	18.9	.025*
Satisfaction	73.9	55.9	.033*
Postoperative 3-mo follow-up			
ASES pain	41.5	46.4	.289
ASES function	26.9	29.0	.694
PENN function	35.1	37.4	.707
Constant	26.0	26.7	.784
Satisfaction	71.9	70.0	.84

ASES, American Shoulder and Elbow Surgeons; *OIG*, opioid intervention group; *PENN*, Penn Shoulder Score.
* statistical significance ($P < .05$).

(range 35-83) with no significant differences in age between the 2 groups ($P = .821$). The average American Society of Anesthesiologists class was 2 for all patients and with no significant differences between groups ($P = .134$). Body mass index was also similar between groups at an average of27.7 ($P = .216$) (Table II).

At baseline, there were no significant differences in pain, patient-reported outcome scores, or physician-assessed outcomes ($P \geq .05$) between groups. Overall average preoperative VAS pain scores were 5.8 with an average preoperative VAS pain score of 5.6 for the OIG and 5.9 for the CG ($P = .124$). The average preoperative PENN function scores were 21.9 for the OIG and 18.8 for the CG ($P = .475$). ASES pain scores were 21.8 for OIG and 20.5 for CG, ($P = .773$) (Table III).

Analysis at 6 weeks showed no significant difference in ASES pain scores between OIG, 43.8, and CG, 38.4 ($P = .208$). However, ASES function scores demonstrated significantly higher scores for the OIG (average 31.7) than for the CG (20.1, $P = .044$). The average PENN functions scores for the OIG (37.5) were also significantly higher than for the CG (25.2) ($P = .034$). The OIG Constant and subjective shoulder value scores were also significantly higher at 6 weeks postoperatively ($P = .025$ and $P = .033$, respectively) (Table IV). The OIG average subjective shoulder value was 73.9 compared with 55.9 for the CG. ASES Function, PENN Function, Constant, and satisfaction outcome scores were all higher in the OIG at 6 weeks (Table IV).

At 3 months, there were no significant differences in any of the pain or outcome scores. ASES pain scores was an average of 41.5 for the OIG and 46.4 for the CG ($P = .289$). The average ASES function scores ($P = .694$) and average PENN function scores ($P = .707$) were not significantly different (Table IV). Average Constant scores were 26.0 and 26.7 for the OIG and CG, respectively ($P = .784$), and subjective shoulder value satisfaction scores were also not significantly different between groups, with the OIG average score of 71.9 and CG average score of 70.0 ($P = .84$) (Table IV).

At the last follow-up, the VAS pain score was 1.5 for the OIG and 1.2 for the CG ($P = .581$), and patients in both the groups showed significant improvements in patient-reported outcome scores and physician-assessed outcomes from baseline (Table III). The average postoperative PENN functional scores were 41.4 and 41.4 for the OIG and CG, respectively. ($P = .908$) There were also no differences in postoperative ASES scores between the groups. Overall, there were no differences seen in any of the postoperative outcome scores. (Table III).

Postoperatively, in the intervention group, 15% of patients reported taking 1 dose of rescue opioids in the first 48 hours and 0% reported taking opioids at 2 weeks.Of those in the CG, 100% of patients reported taking opioids in the 48 hours after surgery and 90% reported continued opioid usage at 2 weeks ($P = .0196$) (Fig. 1).

Discussion

Although awareness of the opioid epidemic has grown, there has not been enough focus placed on reduced use in the setting of acute postoperative pain. As orthopedic surgeons account for a large percentage of written opioid prescriptions, it is our duty to pursue pain interventions that successfully reduce or eliminate opioid use while still providing adequate pain control and outcomes for our patients. This study aimed to develop an opioid-free postoperative pain management program that effectively manages paininpatients undergoing arthroscopic RCR through integration of multimodal nonopioid pain management protocols coupled with patient education tools on alternative pain management options.The results from this study show that between groups there was a clear advantage in patient-reported outcomes in the early postoperative period for the opioid minimizing intervention group which normalized by 3 months and final follow-up. This indicates that an opioid-free program after RCR surgery can be as effective as opioid analgesics without negatively impacting patient's recovery or diminishing outcomes.

While our study is among the first tocombine a multimodal pain management with preoperative patient education, other studies have shown that preoperative patient education alone can result in

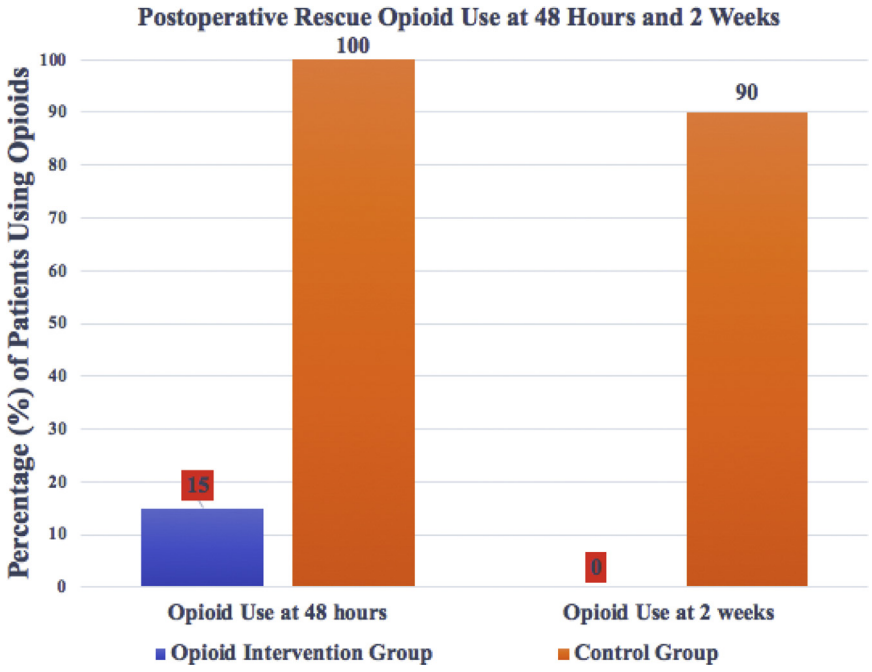

Figure 1 Postoperative opioid consumption compared between groups.

decreased postoperative opioid use after RCR, regardless of preoperative opioid dependence status.[14,18–21] One study by Syed et al[19] showed that by the 3-month follow-up, those who received preoperative education, both opioid-naïve patients and patients who use opioids preoperatively, were 2.2 times and 6.8 times more likely, respectively, to discontinue using opioids, as compared with patients who did not receive preoperative education.

After RCR, liposomal bupivacaine has been demonstrated to reduce postoperative pain, with patients reporting significantly lower average pain scores on a 10-point visual analog scale.[6] Furthermore, administration of liposomal bupivacaine led to a 64% reduction in overall opioid consumption in the postoperative period after RCR.[6] Independently, evidence suggests both preoperative patient education and liposomal bupivacaine have proven to be effective in the management of pain with decreased opioids after RCR. Our study demonstrated that a combination of the 2 modalities effectively eliminated the need for opioids by 2 weeks after surgery and improved patient-reported outcomes and patient satisfaction in the early recovery period. Despite a significant decrease in postoperative opioid consumption, this did not factor into patient's overall satisfaction rates. This suggests that given proper preoperative education on realistic postoperative pain expectations, patients will remain satisfied with an opioid-sparing postoperative experience using non-narcotic alternatives for pain instead of reliance on opioids.

Postoperatively in the past, it has been reported that each patient typically was prescribed an average of 80 pills after RCR with 32% of patients given postoperative refills.[8,15,22] In our cohort, there was an 85% reduction in the number of patients who used opioids in the 48-hour period after surgery and 100% were opioid free by 2 weeks in the intervention group.The opioid-free protocol greatly reduced the need for prolonged opioid prescriptions, at the 2-week time period none of the patients in the OIG reported opioid use, compared to 90% of patients in the CG who reported continued opioid consumption. This elimination of opioid use by 2 weeks could have a potentially enormous impact in preventing long-term postoperative opioid-dependence rates. This is especially significant given recent research which has shown that more than 85% of orthopedic surgeons prescribe short-acting opioids after RCR with greater overall quantities of opioids (average of 462.5 oral morphine equivalents) after surgery.[22] With the opioid-free pain management protocol providing such a drastic decrease in postoperative opioid utilization, its wide-spread implementation could lead to a significant decrease in not only postoperative opioid use but also the amount of opioids prescribed by orthopedic surgeons. Given the implementation of new opioid prescribing legislation throughout the country, more surgeons should consider taking time to provide preoperative education and postoperative opioid-free alternatives as a safe and effective method of controlling pain.

Prior research has shown that patients who consume opioids after shoulder surgery have an increased rate of complications and negative impact on patient recovery, therefore postoperative pain regimens that bypass the use of opioids entirely may result in decreased postoperative complications.[1,11,14,25,27] Our study supports this with clearly higher functional and satisfaction scores reported by patients in the early recovery period when they minimized opioid consumption in the intervention group. The significantly decreased amounts of opioids can be fairly correlated with impact on patients' recovery and satisfaction early on after RCR, but this did normalize over the full recovery period as demonstrated by the equivalent outcomes after 3 months. Further research is needed in this area to better understand the direct link between opioid use and patients' satisfaction and outcomes. Medicare has recently introduced bundled payments, a model of reimbursement where a single predetermined amount which must cover all services provided, including treatment of any complications and is tied to patient outcomes.[12,17] Given the increased rate of complications seen with prolonged postoperative opioid use, implementation of an opioid-free pain management protocol may lead to greater overall reimbursements for orthopedic procedures.

While our study provided several important conclusions about opioid minimizing interventions, it is not without limitations. Because patients self-selected into the OIG, our cohort was not randomized, and this may not reflect the general population.

Secondly, because patients with preexisting opioid dependence were excluded, the functional outcomes and pain scores of patients in the intervention model may not be extrapolated to opioid dependent patients. Finally, although serious attempts were made to request patient daily logs for the early postoperative period particularly in the 2-, 3-, and 7-day time periods, we had extremely poor compliance with the patient reported-logbooks, and therefore, these data were not included in our results. Better assessment methods such as phone integrated apps or daily tracking systems may improve this type of data collection and better understanding of early outcomes after RCR surgery. Futures studies applying this opioid intervention program to all patients may use more integrated data collection methods and closer follow-up to improve our understanding of the early recovery and pain levels for all patients.

Conclusion

Arthroscopic RCR is known to have an extremely painful postoperative recovery, traditionally requiring large amounts of opioids for an extended time period. By successfully combining preoperative patient education with an intraoperative/postoperative multimodal pain management protocol, we were able to significantly reduce postoperative opioid use. Despite the limitations of this study, it is important to recognize that patient education and engagement in combination with multimodal pain management is critical to help minimize postoperative opioid use among patients undergoing RCR. The results from this study show that pain control and patient-reported outcomes can be achieved in this patient population and this protocol for pain management should be considered by orthopedic surgeons performing RCR surgery to reduce postoperative opioid consumption.

Disclaimers:

Funding: No funding was disclosed by the author(s).

Conflicts of interest: 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.

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