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Opioid consumption following orthopedic shoulder surgery: a retrospective analysis

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Background: Prescription opioid misuse has become an epidemic in the United States and is a leading cause of death in Americans. Postoperative opioid prescriptions are a significant contributor to the opioid epidemic, with orthopedic surgeons being the third highest prescribers of opioid prescriptions among physicians across all specialties. Our aim was to retrospectively evaluate overall opioid consumption patterns following surgical treatment for shoulder pathology and recommend evidence-based guidelines for standardized postoperative opioid prescriptions.

Methods: We conducted a retrospective chart review of patients who underwent shoulder arthroscopy or arthroplasty from a single shoulder/elbow fellowship-trained surgeon (principal investigator). Patient and surgery characteristics were summarized for the entire sample and further stratified by surgery type. Total opioid consumption at the time of the first postoperative visit and refill patterns were compared between each surgery group. Opioid consumption was analyzed in morphine milligram equivalents (MMEs) and is reported in the equivalent number of 5-mg oxycodone tablets.

Results: A total of 119 patients were included in our analysis. The average age was 58 ± 13 years, and 59% of patients were male. Rotator cuff repair was the most frequent surgery (n = 52), followed by arthroplasty (n = 35) and arthroscopy (n = 28). On average, the patients in the study used 82.5 ± 233 MME units, equivalent to 11 ± 31.067 tablets of 5-mg oxycodone. Sixteen percent of patients did not use any opioids. There was no significant difference in opioid consumption or refills across surgery type. In the bivariate analysis for the entire sample, age was the only predictor that was statistically significantly associated with the amount of opioid consumption. In the multivariable model for patient demographics, significant predictors of opioid consumption were age, gender, and pain scores. In the multivariate analysis by surgery type, significant predictors of higher opioid consumption were age, gender, pain score, and surgery performed on the dominant side.

Conclusion: On the basis of the consumption patterns observed in our patient cohort, we recommend prescribing 112.5 MME (15 tablets of 5-mg oxycodone) for arthroscopic shoulder procedures, and 75 MME (10 tablets of 5-mg oxycodone) for shoulder arthroplasties.

Level of evidence: Level II; Retrospective Study

Keywords: Postoperative pain management; opioid; shoulder arthroplasty; shoulder arthroscopy

Prescription opioid misuse has become an epidemic in the United States and is one of the leading causes of death in Americans aged <50 years.[15] The overall number of narcotic-associated deaths have quadrupled since 2000.[14] Similarly, opioid prescribing has almost tripled since 1999.[16] In 2017 alone, there were more than 47,000 overdose deaths in the United States involving opioids,[4] and the

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societal cost of prescription opioid misuse is estimated to be almost $80 billion per year.[5]

Postoperative opioid prescription is a significant contributor to the opioid epidemic. Three to eight percent of opioid-naive patients continue taking narcotics 1 year after surgery.[6] As of 2015, orthopedic surgeons were the third highest prescribers of opioid prescriptions among physicians across all specialties[12]; they are responsible for 8% of all prescription opioids while comprising less than 3% of all physicians.[17] As the opioid epidemic continues to worsen, it is crucial for orthopedic surgeons to adopt safer prescribing patterns or adopt other methods of pain control.

Recent studies indicate that a considerable amount of prescribed postoperative opioids go unused across a variety of specialties.[7,9,19] A systematic review of studies describing opioid oversupply across 7 procedure types found that postoperative prescription opioids are often not completely used, stored unlocked, and go undisposed.[2] They also show that a higher availability of medication may lead to opioid misuse. There is limited information regarding postoperative pain medication consumption following orthopedic shoulder surgery. Shoulder surgery can be particularly painful, often requiring preoperative nerve blocks, and can result in prolonged use of narcotic pain medications following surgery. Our aim was to retrospectively evaluate overall opioid consumption patterns following surgical treatment for shoulder pathology and recommend evidence-based guidelines for standardized postoperative opioid prescriptions. Opioid consumption data were dependent on the reliability of patient self-reporting. This may introduce recall bias in this study because of the subjective nature of pill consumption reporting by patients.

Methods

We conducted a retrospective chart review of patients who underwent shoulder arthroscopy or arthroplasty from a single shoulder/elbow fellowship-trained surgeon (principal investigator) at an academic health care institution between February 19, 2019, and June 20, 2019. Self-reported opioid use (consumption and number of refills) was recorded in the electronic medical record at the time of the first postoperative visit, typically 7-14 days from the date of surgery. Initial postoperative prescription (type of opioid medication and number of pills) and intraoperative analgesia were not standardized within the patient sample. Opioid consumption was converted to and analyzed in morphine milligram equivalents (MMEs) and reported in the equivalent number of 5-mg oxycodone tablets.

Statistical analysis

Patient and surgery characteristics were summarized for the entire sample and further stratified by surgery type (arthroplasty, arthroscopic rotator cuff repair, arthroscopic procedures without rotator cuff repair, or other; eg, proximal humerus open reduction internal fixation). Total opioid consumption and refill patterns were compared between each surgery group. To assess differences between continuous variables, analysis of variance or Kruskal-Wallis tests were used. Categorical variables were compared with Pearson χ^2 or Fisher exact tests.

Linear regression models were used to assess the relationship between opioid use postsurgery and patient demographics (age, sex, body mass index), surgery laterality (dominant side) and postoperative characteristics. Multivariable models for patient demographics (age, gender, body mass index), type of surgery (represented by 3 indicator variables with arthroplasty as the reference group), surgical side, dominant side, type of surgery, and NPRS (numeric pain rating scale), American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score, and Subjective Shoulder Value scores were used to determine predictors of increased opioid use. All models included Huber-White robust variance estimates. These models were fit for the entire sample as well as, separately, by the type of surgery. Exploratory plots helped determine whether linear relationship holds for continuous predictors. All other linear model assumptions were checked using diagnostic plots.

All tests were 2-sided and were run at .05 level of statistical significance. The analyses were performed using Stata, version 15.1, statistical software program.

Results

A total of 119 patients were included in our analysis. All patients were encouraged to use multimodal postoperative pain management consisting of Aleve, Tylenol, and cryotherapy; however, data on nonsteroidal anti-inflammatory drug usage and alternate pain relief methods were not collected or included in analysis. Oral opioid medication refills following initial prescription were also provided to all patients as needed.

The average age was 58 $\pm$ 13 years and 59% of patients were men. Rotator cuff repair was the most frequent surgery (n = 52), followed by arthroplasty (n = 35), arthroscopy (n = 28), and other (n = 4). Patients undergoing arthroplasty were older (68 $\pm$ 10 years) than those who underwent arthroscopy (48 $\pm$ 14 years) ($P < .001$). Additionally, 40% of the total number of Caucasian patients in this study received arthroplasty, whereas 61% of all African Americans underwent rotator cuff repair ($P = .013$). No other patient characteristics or functional scores were different across each surgery group (Table I).

The patients in the study used an average of 82.5 $\pm$ 233 MME, equivalent to 11 $\pm$ 31.067 tablets of 5-mg oxycodone. Within the surgical categories, patients undergoing arthroplasty used an average of 67.5 MME (9 tablets of 5-mg oxycodone), arthroscopic rotator cuff repair used an average of 90 MME (12 tablets of 5-mg oxycodone), arthroscopic procedure not including rotator cuff repair used an average of 86.25 MME (11.5 tablets of 5-mg oxycodone), and other procedures used an average of 90 MME (12 tablets of 5-mg oxycodone). Sixteen percent of patients (n=19) did not use any opioids. There was no significant difference in opioid consumption or refills across surgery type.

Table I Demographics and characteristics by surgical category

	Total (N = 119)	Arthroplasty (n = 35)	Rotator cuff repair (n = 52)	Arthroscopy (n = 28)	Other (n = 4)	*P* value*
Age, mean (SD)	57.52 (13.08)	68.19 (10.04)	55.78 (8.90)	47.52 (14.18)	56.80 (10.69)	<.001
Gender						.18
Female	49 (41.2)	13 (37.1)	17 (32.7)	15 (53.6)	4 (100.0)	
Male	70 (58.8)	22 (62.9)	35 (67.3)	13 (46.4)	0 (0.0)	
Race						.013
Caucasian	76 (63.9)	30 (85.7)	26 (50.0)	17 (60.7)	3 (75.0)	
African American	33 (27.7)	4 (11.4)	20 (38.5)	9 (32.1)	0 (0.0)	
Other	10 (8.4)	1 (2.9)	6 (11.5)	2 (7.1)	1 (25.0)	
BMI, mean (SD)	30.20 (6.09)	30.03 (6.32)	30.27 (5.79)	30.97 (6.24)	25.58 (7.27)	.82
Surgical side						.80
Left	54 (45.4)	16 (45.7)	22 (42.3)	14 (50.0)	2 (50.0)	
Right	65 (54.6)	19 (54.3)	30 (57.7)	14 (50.0)	2 (50.0)	
Dominant side						.41
No	55 (46.2)	14 (40.0)	27 (51.9)	12 (42.9)	2 (50.0)	
Yes	58 (48.7)	20 (57.1)	22 (42.3)	15 (53.6)	1 (25.0)	
Missing	6 (5.0)	1 (2.9)	3 (5.8)	1 (3.6)	1 (25.0)	
Scores at first postoperative follow-up						
NPRS, mean (range)	3.00 (1.00-6.00)	3.00 (1.00-6.00)	3.50 (2.00-6.00)	3.50 (2.00-6.00)	3.00 (2.00-5.00)	.40
ASES, mean (SD)	39.81 (14.44)	43.33 (14.37)	38.37 (14.08)	38.12 (15.73)	38.89 (6.74)	.29
SSV, mean (range)	20.00 (10.00-40.00)	20.00 (10.00-30.00)	30.00 (10.00-50.00)	15.00 (0.00-30.00)	20.00 (0.00-50.00)	.11
Refill						.22
No	99 (83.2)	30 (85.7)	45 (86.5)	20 (71.4)	4 (100.0)	
Yes	20 (16.8)	5 (14.3)	7 (13.5)	8 (28.6)	0 (0.0)	

SD, standard deviation; *BMI*, body mass index; *NPRS*, numeric pain rating scale; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *SSV*, Subjective Shoulder Value; *CI*, confidence interval.
Unless otherwise noted, values are n (%).
* $P < .05$.

In the bivariate analysis for the entire sample, age was the only predictor that was significantly associated with the amount of opioid consumption; the results indicated that for every year of age, consumption on average decreases by 2.35 MME ($P = .012$), equivalent to 0.313 tablets of 5-mg oxycodone (Table II).

In the multivariable model for patient demographics, significant predictors of opioid consumption were age, gender, and NPRS scores. For every year of age, opioid consumption on average decreases by 3.08 MME ($P = .005$), equivalent to 0.411 tablets of 5-mg oxycodone. Controlling for other variables, opioid consumption for men was 51 MME (6.8 tablets 5-mg oxycodone) less than the opioid consumption for women ($P = .033$). Additionally, for every 1-unit increase in the NPRS score, opioid consumption increased by 24.4 MME ($P < .001$), equivalent to 3.25 tablets of 5-mg oxycodone.

In the multivariate analysis by surgery type, none of the candidate predictors were associated with opioid consumption in the arthroplasty group. In the rotator cuff repair group, younger age ($P = .029$), higher NPRS ($P = .006$), and surgery performed on dominant side (0.013) were associated with higher opioid consumption. For the arthroscopy group, higher NPRS ($P = .001$) and dominant side ($P = .015$) were positively associated with opioid use (Table III).

Discussion

In this retrospective study of postoperative opioid use in shoulder surgery, we found no significant difference in opioid consumption by surgery type. Most of our patients did not take the total amount of opioid analgesics initially prescribed, with 16% (n = 19) taking none. The total amount of unused narcotic medication from these 119 patients was equivalent to 2382 tablets of 5-mg oxycodone. Several other studies have shown limited postoperative opioid use in patients undergoing surgical procedures. Within orthopedic joint and spine surgery, Bicket et al[3] found that almost 75% of patients reported unused medication at 1 month postoperation, and that less than 10% of patients received dual nonopioid therapy. Regarding unilateral hip and knee arthroplasty, a retrospective cohort study found that increased opioid prescription was

Table II Bivariate analysis of opioid consumption by patient characteristics

	Unadjusted models		Adjusted model	
	Estimated slope (95% CI) (n = 119)	*P* value	Estimated slope (95% CI) (n = 94)	*P* value
Age	−2.354* (−4.175, −0.532)	.012	−3.076** (−5.183, −0.968)	.005
Gender				
Male vs. female	−66.64 (−163.5, 30.18)	.175	−50.69* (−97.30, −4.084)	.033
BMI	5.813 (−3.171, 14.80)	.203	−1.711 (−6.314, 2.892)	.462
Surgery type				
Type 2 vs. type 1	48.69 (−2.659, 100.0)	.063	−17.92 (−66.80, 30.96)	.468
Type 3 vs. type 1	119.8 (−39.91, 279.5)	.14	−55.86 (−116.7, 4.941)	.071
Type 4 vs. type 1	26.95 (−98.91, 152.8)	.672	−120.8 (−284.3, 42.68)	.145
Surgical side				
Right vs. left	−41.43 (−132.9, 50.01)	.371	30.51 (−61.81, 122.8)	.513
Dominant side				
Yes vs. no	−53.02 (−143.5, 37.49)	.248	−50.67 (−138.3, 36.94)	.253
Scores at first postoperative follow-up				
NPRS	22.99*** (13.94, 32.04)	<.001	24.38*** (14.44, 34.32)	<.001
ASES	−3.212*** (−4.786, −1.638)	<.001	−0.646 (−1.599, 0.307)	
SSV	−0.174 (−1.144, 0.797)	.723	336.6** (105.2, 568.0)	.181
R^2	0.017		0.335	
AIC	1636.5		1157.5	

BMI, body mass index; *NPRS*, numeric pain rating scale; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *SSV*, Subjective Shoulder Value; *AIC*, Akaike information criterion; *CI*, confidence interval.
Surgery type 1: arthroplasty; surgery type 2: arthroscopic rotator cuff repair; surgery type 3: arthroscopic surgery without rotator cuff repair; surgery type 4: other.
*$P < .05$, **$P < .01$, ***$P < .001$.

associated with increased consumption and recommended a maximum of 50 tablets of 5-mg oxycodone after TKA and 30 tablets after THA.[13] Additionally, a prospective study of patients undergoing upper-extremity procedures found that soft-tissue procedures required fewer opioid medication than fracture-related procedures or joint procedures.[10] These findings can be used to more accurately tailor postoperative prescriptions in orthopedic surgery.

Based on consumptions patterns observed in our patient cohort, we recommend prescribing 112.5 MME (15 tablets of 5-mg oxycodone) for arthroscopic shoulder procedures, and 75 MME (10 tablets of 5-mg oxycodone) for shoulder arthroplasties. Because of the small sample sizes, we are unable to make recommendations for other major types of shoulder surgery (eg, trauma). Other factors, including, age, pain scores, surgery laterality, and gender may be used to further adjust prescriptions appropriately.

In 2001, the Joint Commission required pain level assessment to be recorded as a fifth vital sign.[1] This increased emphasis on pain management has led to the appropriate development of chronic pain practices but has also inadvertently encouraged drug-seeking behavior. This requirement may change pain from an expected, short-term side effect of surgery to an overtreated condition, leading to increased analgesic prescriptions. As new evidence and regulations for opioid prescriptions continue to be introduced, physicians should reassess prescribing habits. Recommendations by the American Orthopedic Association include multimodal pharmacologic therapy, such as supplementing nonsteroidal anti-inflammatory drugs with opioid prescriptions, and patient education.[17] Although our study did not assess the effects of nonopioid medication on MME consumption, nonopioid medication reduces reliance on opioids and are associated with fewer side effects without compromising bone formation.[11] Recent studies have also shown the efficacy of multimodal pain management following orthopedic surgery. After implementation of restrictive opioid-prescribing guidelines for total hip arthroplasty and total knee arthroplasty, combined with nonopioid analgesic medication and preoperative patient education, a study found that patients received significantly lower initial prescriptions, received significantly fewer refills, and received significantly lower total quantity of opioids per patient. There were also significantly fewer calls to the office, and no significant difference in clinical outcomes.[8] Additionally, a randomized clinical trial of patients receiving opioid-related preoperative patient education prior to rotator cuff surgery found that the education intervention significantly decreased opioid consumption at 3 months after surgery.[18] Emphasizing nonopioid and multimodal analgesia in postoperative pain management protocols and utilizing preoperative patient education tools can decrease the quantity of opioid medication prescribed and decrease opioid oversupply.

Our study has several limitations. First, our study relied on patient self-reporting and recall. Patients may have inaccurately reported usage of pills during their postoperative visit, as a result of underestimation of consumption, stigma of opioid

Table III Multivariate analysis by surgical category

	Type 1		Type 2		Type 3	
	Estimated slope (95% CI) (n = 29)	*P* value	Estimated slope (95% CI) (n = 40)	*P* value	Estimated slope (95% CI) (n = 23)	*P* value
Age	−3.448 (−7.642, 0.746)	.102	−5.746* (−10.87, −0.625)	.029	−3.009 (−8.030, 2.011)	.221
Gender						
Male vs. female	−47.74 (−123.0, 27.51)	.201	−66.72 (−157.9, 24.46)	.146	−4.875 (−119.2, 109.5)	.929
BMI	−2.742 (−8.041, 2.557)	.294	−0.703 (−8.973, 7.567)	.864	−1.968 (−11.95, 8.009)	.68
Surgical side						
Right vs. left	82.7 (−26.33, 191.7)	.13	51.51 (−36.49, 139.5)	.242	−176.4*** (−265.2, −87.49)	.001
Dominant side						
Yes vs. no	−73.51 (−212.5, 65.46)	.284	−109.7* (−194.4, −24.99)	.013	176.6* (39.99, 313.2)	.015
Scores at first postoperative follow-up						
NPRS	11.42 (−6.344, 29.18)	.196	28.64** (8.956, 48.33)	.006	29.49** (14.01, 44.97)	.001
SSV	−0.687 (−2.824, 1.451)	.512	−0.192 (−1.660, 1.277)	.792	−0.84 (−4.147, 2.468)	.596
Intercept	414.1 (−20.34, 848.6)		435.6 (−15.47, 886.7)		225.4 (−225.4, 676.3)	
R^2	0.371		0.39		0.512	
AIC	341.7		507.4		284.9	

BMI, body mass index; *NPRS*, numeric pain rating scale; *SSV*, Subjective Shoulder Value; *AIC*, Akaike information criterion; *CI*, confidence interval.

Surgery type 1: arthroplasty; surgery type 2: arthroscopic rotator cuff repair; surgery type 3: arthroscopic surgery without rotator cuff repair; surgery type 4: other.

*$P < .05$, **$P < .01$, ***$P < .001$.

use, or incorrect memory. Our study also did not control for surgical complications, risk factors for increased narcotic use, type of surgical anesthesia, or use of supplemental pain control methods, which could influence postoperative opioid consumption. Additionally, generalizability to other patient populations may be limited by our study's setting at a single academic institution, which results in a more homogenous patient population for analysis.

Conclusion

Our data suggest that opioids continue to be overprescribed after major orthopedic shoulder surgery. Postoperative opioid prescriptions should be adjusted based on variables such as surgery type, age, gender, and preoperative pain score. Surgeons can play an integral role in decreasing the amount of narcotic medication introduced into the public by using evidence-based postoperative pain management guidelines.

Disclaimer

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