Diagnosis can predict opioid usage and dependence in reverse shoulder arthroplasty

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Introduction: Reverse shoulder arthroplasty (RSA) has seen exponential growth over the past 2 decades. In addition, the recent focus on opioid usage and dependence has led to an increased understanding of the risk factors that lead to dependence. The purpose of this study was to examine associations between diagnosis and opioid consumption and dependence in RSA.

Methods: A retrospective review was performed of 441 patients who had undergone a primary RSA from 2012 to 2016. Demographics were collected and patients were categorized based on top 4 diagnoses: glenohumeral osteoarthritis (n = 129), irreparable rotator cuff tear (n = 85), rotator cuff arthropathy (RCA) (n = 184), and proximal humerus fracture (n = 69). Opioid consumption within 90 days surrounding surgery was recorded from Prescription Drug Monitoring Programs. Logistic regression was performed.

Results: Baseline characteristics for sex (P = .0001), ethnicity (P = .04), age (P = .01), and preoperative opioid use (P = .029) were significantly different. Patients with osteoarthritis had the lowest preoperative total morphine equivalents (TMEs) at 22.82 compared with fractures (53.36, P = .02) and RCA (46.54, P = .02). There was no significant difference in preoperative opioid dependence based on diagnosis (P = .16); however, postoperatively, the RCA group had the highest dependence at 40.3% (P = .03). In addition, there were no significant differences postoperatively in TMEs prescribed (P = .197). The preoperatively dependent patients were 8 times more likely to remain dependent regardless of diagnosis.

Conclusion: Patients with fractures consume the highest amounts of opioids surrounding surgery. Surgeons should tailor their preoperative education and pain management protocols accordingly based on diagnoses for RSA. In addition, increased awareness and protocols need to be implemented for preoperative opioid-dependent patients regardless of diagnosis.

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excess opioid medication postoperatively.\textsuperscript{3,12,26} Given the expanded indications for an RSA procedure and the prevailing concern regarding the culture of overprescribing, there needs to be a better understanding of how to tailor opioid-prescribing practices to reduce abuse among orthopedic patients, while adequately managing postoperative pain.\textsuperscript{3,15} Within orthopedics in particular, prescribing parameters do not exist. The aim of this study was to identify associations in preoperative diagnosis and opioid use patterns and risk of dependence for patients undergoing an RSA.

Methods

This study was a retrospective review of preoperative opioid use in 500 patients who underwent a primary RSA performed within a single hospital system with 10 geographic sites in 2 states between 2012 and 2016 by one of 8 fellowship-trained shoulder surgeons. Patients undergoing an RSA were identified by the use of Current Procedural Terminology code 23472. Demographic data including age, sex, race, ethnicity, body mass index, American Society of Anesthesiologists, and smoking status were collected and recorded for all patients. Preoperative diagnoses were collected based on a detailed review of preoperative surgeon notes and verified based on International Classification of Diseases—Nine Edition diagnoses. For each patient, the orthopedic surgeon’s primary assessment was recorded. Our institution’s standard of care for imaging is computed tomographic scan or magnetic resonance imaging based on a patient’s preoperative examination, and the results of these imaging studies were used to verify the recorded diagnosis. Patients were categorized based on preoperative diagnosis, and the top 4 most common diagnoses in patients who underwent a primary RSA were selected to include a total of 441 patients in this cohort. The top 4 diagnoses in patients who underwent a primary RSA were based on preoperative diagnosis, and the top 4 most common diagnoses in patients who underwent a primary RSA were selected to include a total of 441 patients in this cohort.

Statistical analyses

Continuous parameters were summarized using descriptive statistics and categorical characters summarized using numerical and percentage of cases. All doses of opioids were converted to TMEs to allow for analysis. Analysis of variance was performed to compare the means of TMEs between preoperative diagnosis groups. Independent t tests were used for continuous variables, and analyses of variance were used for comparisons of more than 2 groups. Chi-square test was performed for all categorical variables. Risk of postoperative opioid dependence was calculated using a logistic regression. Significance was considered $P \leq .05$. All statistical analyses were performed using SPSS software (IBM SPSS Statistics for Macintosh, version 24.0; IBM, Armonk, NY, USA).

Results

A total of 441 patients who underwent primary RSA were included in this study. Results for baseline characteristics were significantly different between the diagnostic groups, for sex ($P = .0001$), ethnicity ($P = .04$), and age ($P = .01$) (Table I). There were no significant differences found between the groups for race ($P = .067$), body mass index ($P = .06$), and American Society of Anesthesiologists class ($P = .27$) (Table I). Of the whole cohort, 189 patients had a preoperative opioid prescription filled with average preoperative TMEs of 40.9 morphine milligram equivalents (MMEs) (range 5-780 MMEs). The average number of preoperative opioid prescriptions per patient was 2.41 for the cohort. Preoperative use (TME) between the diagnosis groups was significantly different ($P = .029$) (Table II). Preoperative prescriptions for arthritis were on average 22.8 TMEs. For RCT, it was 46.12 TME; for RCA, 46.54 TME; and for fractures, 53.36 TMEs. Post hoc analysis showed that patients with osteoarthritis had the lowest average TMEs (22.82) compared with RCA (average TMEs = 46.54, $P = .02$) and fractures (TMEs = 53.36, $P = .02$), which was the highest (Table II). Although differences in opioid use existed, there were no significant differences in preoperative opioid dependence rates according to diagnosis ($P = .16$). RCT showed a trend toward higher opioid dependence at 40.8% compared with RCT (24.8%) and fractures (11.2%), but it was not statistically significant.

Postoperatively, the average TME for the RSA cohort overall was 148.41 MMEs (range 0-2475). For OA patients, the postoperative average TME was 116.39, 196.86 for RCT, 158.43 for RCA, and 214.22 for fractures. There were no significant differences in postoperative TMEs between the groups ($P = .197$) (Table III). Of the whole cohort, 227 patients (50%) received more than 1 opioid prescription postoperatively. 148 patients (33%) received 3 postoperative prescriptions, and 105 patients (23.8%) received 4 or more prescriptions. Postoperatively, the OA group received an average of 85 pills in their primary prescription, compared with 83 in the RCT group, 78 in the RCA group, and 81 in the fracture group. There were no significant differences between groups ($P = .75$). Logistic regression demonstrated that patients with preoperative opioid

| Table I |
| Demographics of each diagnosis group |

| Sex | Glenohumeral osteoarthritis | Rotator cuff repairs | Rotator cuff arthropathy | Fractures | $P$ Value |
|-----|-----------------------------|----------------------|--------------------------|-----------|-----------|
| Male | 65                          | 30                   | 83                       | 10        | .0001     |
| Female | 64                         | 55                   | 101                      | 33        |           |
| Average age, yr | 71.14                   | 69.21                | 72.42                    | 75.49     | .01       |
| Average BMI | 30.8                    | 30.6                 | 29.8                     | 30.5      | .6        |
| ASA class, % | |                       | |                        | | .27       |
| 1   | 0                           | 1.2                  | 0                        | 0         |           |
| 2   | 35.9                        | 19.3                 | 26.8                     | 26.8      |           |
| 3   | 59.4                        | 72.3                 | 64.8                     | 68.3      |           |
| 4   | 4.7                         | 7.2                  | 7.8                      | 4.9       |           |

BMI, body mass index; ASA, American Society of Anesthesiologists.
use standardized postoperative opioid-prescribing patterns for surgeons in awareness and risk stratification for surgical procedure. This information is critical for orthopedic surgeons. Rodgers et al. found that most patients did not take opioid medications as prescribed, and furthermore, most did not finish their prescriptions as they were either no longer in pain or because they experienced adverse side effects. Overprescribing has meant that much of the unused medication has been stockpiled by patients who are often not educated on safe disposal, leaving unused pills open to diversion and alternate use.

The difference in preoperative usage and dependence rates for different pathologies highlights the need for surgeons to be aware of patient pathology and diagnosis when planning for postoperative pain management for any specific procedure such as RSA. Clearly, a one-size-fits-all approach in postoperative pain management may not be optimal given the increased risks of preoperative exposure to and dependence on opioids depending on various diagnoses. Based on our results, patients undergoing RSA for RCA may be at the highest risk for postoperative opioid dependence. Perhaps we should limit postoperative prescriptions for RCA may be at the highest risk for postoperative opioid dependence. This was in concurrence with the hip and knee arthroplasty literature as well as those patients undergoing arthroscopic repairs. It was also found that postoperative opioid use in these preoperative opioid-dependent patients continued even at 1-year follow-up (mean final follow-up of 47.1 months), indicating that patients who are opioid-dependent before shoulder arthroplasty remain chronically opioid-dependent even following surgery. Perhaps implementing a weaning program for these preoperative dependent patients may more successfully get them off opioids postoperatively and decrease long-term dependence. In addition, our study has demonstrated that preoperatively dependent patients had an 8 times higher risk of postoperative dependence after RSA. Integrating a preoperative risk assessment that includes diagnosis may be important to plan for effective pain management following RSA in the future while helping to curb postoperative dependence. Recently, there has been focus on integrating multimodal pain protocols with acetaminophen, gabapentin, and liposomal bupivacaine to curb postoperative opioid dependence, and these have been found to have some success, but the literature has not reached a consensus on optimizing these types of medications. Future studies are needed to assess the efficacy of these types of protocols in reducing or eliminating the need for opioids based on different diagnoses.

Although we can draw some important conclusions from this study, it is not without limitations. This was a database study based on prescriptions recorded from state databases and not actual patient consumption patterns. In addition, we did not take into account other diagnoses that may have led to preoperative opioid dependence, and these comorbidities and pain generators were not available. Because this was a retrospective review, there was no outcome data recorded to correlate each diagnosis with effects of opioid use and dependence on outcomes. Future studies should focus on stratifying opioid use and dependence with impact on patient-reported and functional outcomes following shoulder arthroplasty.

**Table II**

| Preoperative average opioid consumption (TME) | Glenohumeral osteoarthritis (OA) | Rotator cuff tear (RCT) | Rotator cuff arthropathy (RCA) | Fractures (Fx) | P value |
|---------------------------------------------|----------------------------------|------------------------|-------------------------------|---------------|---------|
| TME in the preoperative period              | 22.82                            | 46.12                  | 46.54                         | 53.36         | .04     |
| Preoperative TME post hoc analysis          | OA vs. RCA P = .02               | OA vs. Fx P = .02      | OA vs. RCT P = .55            |               |         |

TME, total morphine equivalent.

**Discussion**

With more than 38,329 overdose deaths in 2010 and 75% of these involving prescription pain medications, it is clear we have an opioid epidemic in the United States. Several studies have described how opioids are being inadvertently overprescribed to patients postoperatively across all specialties, but it is especially pronounced within the orthopedic specialty. The main purpose of our study was to assess whether there were variations in opioid use based on pathology or diagnoses for 1 specific orthopedic surgical procedure. This information is critical for orthopedic surgeons in awareness and risk stratification as there is a tendency to use standardized postoperative opioid-prescribing patterns for specific procedures. Recent studies by Shrank et al. and Rodgers et al. found that most patients did not take opioid medications as prescribed, and furthermore, most did not finish their prescriptions as they were either no longer in pain or because they experienced adverse side effects. Overprescribing has meant that much of the unused medication has been stockpiled by patients who are often not educated on safe disposal, leaving unused pills open to diversion and alternate use.

The difference in preoperative usage and dependence rates for different pathologies highlights the need for surgeons to be aware of patient pathology and diagnosis when planning for postoperative pain management for any specific procedure such as RSA. Clearly, a one-size-fits-all approach in postoperative pain management may not be optimal given the increased risks of preoperative exposure to and dependence on opioids depending on various diagnoses. Based on our results, patients undergoing RSA for RCA may be at the highest risk for postoperative opioid dependence. Perhaps we should limit postoperative prescriptions for RCA for these patients given recent studies among orthopedic trauma patients that found the opioid quantity dispensed at discharge after surgery is predictive of opioid use postoperatively. The difference in opioid dependence rates is also important to note in that despite getting the same surgery, patients with preoperative OA require significantly less opioids than those with RCA. Despite both these conditions being chronic pathologies, there seems to be increased pain with muscle injury. This is contrary to current findings which suggest that soft tissue surgery patients consumed less opioid medications.

It has also been reported that preoperative opioid use is highly correlated with postoperative use among patients undergoing joint arthroplasty. Among a population of patients who underwent shoulder arthroplasty, we found that preoperative opioid use increased the risk of postoperative opioid use and dependence. This was in concurrence with the hip and knee arthroplasty literature as well as those patients undergoing arthroscopic repairs. It was also found that postoperative opioid use in these preoperative opioid-dependent patients continued even at 1-year follow-up (mean final follow-up of 47.1 months), indicating that patients who are opioid-dependent before shoulder arthroplasty remain chronically opioid-dependent even following surgery. Perhaps implementing a weaning program for these preoperative dependent patients may more successfully get them off opioids postoperatively and decrease long-term dependence. In addition, our study has demonstrated that preoperatively dependent patients had an 8 times higher risk of postoperative dependence after RSA. Integrating a preoperative risk assessment that includes diagnosis may be important to plan for effective pain management following RSA in the future while helping to curb postoperative dependence. Recently, there has been focus on integrating multimodal pain protocols with acetaminophen, gabapentin, and liposomal bupivacaine to curb postoperative opioid dependence, and these have been found to have some success, but the literature has not reached a consensus on optimizing these types of medications. Future studies are needed to assess the efficacy of these types of protocols in reducing or eliminating the need for opioids based on different diagnoses.

Although we can draw some important conclusions from this study, it is not without limitations. This was a database study based on prescriptions recorded from state databases and not actual patient consumption patterns. In addition, we did not take into account other diagnoses that may have led to preoperative opioid dependence, and these comorbidities and pain generators were not available. Because this was a retrospective review, there was no outcome data recorded to correlate each diagnosis with effects of opioid use and dependence on outcomes. Future studies should focus on stratifying opioid use and dependence with impact on patient-reported and functional outcomes following shoulder arthroplasty.

**Table III**

Postoperative average opioid consumption (TME)

| Postoperative average opioid consumption (TME) | Glenohumeral osteoarthritis (OA) | Rotator cuff tear (RCT) | Rotator cuff arthropathy (RCA) | Fractures (Fx) | P value |
|---------------------------------------------|----------------------------------|------------------------|-------------------------------|---------------|---------|
| TME in the postoperative period              | 116.4                            | 196.9                  | 158.4                         | 214.2         | .197    |

TME, total morphine equivalent.
addition, future studies should use risk screening and focused interventions to see if orthopedic surgeons can customize postoperative pain protocols to influence postoperative opioid use and dependence rates.

Conclusions

Our study demonstrated that patients diagnosed with a fracture before undergoing RSA consume the highest amounts of opioids both pre- and postoperatively compared with other preoperative diagnoses; however, RCA patients had the highest dependence rates. Surgeons should tailor their preoperative education and postoperative pain management protocols accordingly, based on specific diagnoses for RSA. In addition, steps should be taken to increase awareness and improved pain protocols ought to be implemented for preoperative opioid-dependent patients, as they are 8 times more likely to remain opioid-dependent postoperatively.

Disclaimer

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