National Trends in Use of Regional Anesthesia and Postoperative Patterns of Opioid Prescription Filling in Shoulder Arthroscopy

A Procedure-Specific Analysis in Patients With or Without Recent Opioid Exposure

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Background: There are few large database studies on national trends in regional anesthesia for various arthroscopic shoulder procedures and the effect of nerve blocks on the postoperative rate of opioid prescription filling.

Hypothesis: The use of regional nerve block will decrease the rate of opioid prescription filling after various shoulder arthroscopic procedures. Also, the postoperative pattern of opioid prescription filling will be affected by the preoperative opioid prescription-filling history.

Study Design: Cohort study; Level of evidence, 3.

Methods: Patient data from Humana, a large national private insurer, were queried via PearlDiver software, and a retrospective review was conducted from 2007 through 2015. Patients undergoing arthroscopic shoulder procedures were identified through Current Procedural Terminology codes. Nerve blocks were identified by relevant codes for single-shot and indwelling catheter blocks. The blocked and unblocked cases were age and sex matched to compare the pain medication prescription-filling pattern. Postoperative opioid trends (up to 6 months) were compared by regression analysis.

Results: We identified 82,561 cases, of which 54,578 (66.1%) included a peripheral nerve block. Of the patients who received a block, 508 underwent diagnostic shoulder arthroscopy; 2449 had labral repair; 4746 had subacromial decompression procedure; and 12,616 underwent rotator cuff repair. The percentage of patients undergoing a nerve block increased linearly over the 9-year study period ($R^2 = 0.77$; $P = .002$). After matching across the 2 cohorts, there was an identical trend in opioid prescription filling between blocked and unblocked cases ($P = .95$). When subdivided by procedure, there was no difference in the trends between blocked and unblocked cases ($P = .52$ for diagnostic arthroscopies; $P = .24$ for labral procedures; $P = .71$ for subacromial decompressions; $P = .34$ for rotator cuff repairs). However, when preoperative opioid users were isolated, postoperative opioid prescription filling was found to be less common in the first 2 weeks after surgery when a nerve block was given versus not given ($P < .001$).

Conclusion: An increasing percentage of shoulder arthroscopies are being performed with regional nerve blocks. However, there was no difference in patterns of filled postoperative opioid prescriptions between blocked and unblocked cases, except for the subgroup of patients who had filled an opioid prescription within 1 to 3 months prior to shoulder arthroscopy. Future research should focus on recording the amount of prescribed opioids consumed in national databases to reinforce our strategy against the opioid epidemic.

Keywords: opioid; filling prescription; nerve block; shoulder arthroscopy; Humana

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The negative socioeconomic impact of the opioid epidemic in the United States is well known.[30] According to a 2016 report from the US Centers for Disease Control and

Prevention, the number of opioid-related deaths tripled between 1999 and 2014, and >60% of overdose deaths in the 2010-2015 period were opioid related.[31] A 2019 study of 4.2 billion prescriptions in the National Prescription Audit found surgeons to account for 36.5% of opioid prescriptions, second only to pain management physicians (48.6%).[26] Moreover, orthopaedic surgeons write 7.7% of all opioid prescriptions, making them the third-most common prescription provider among all physicians.[37] Apart from addiction, commonly observed adverse effects attributed to opioid administration after surgery include nausea, vomiting, ileus, psychiatric disorders, and respiratory depression.[18] Long-term opioid use has been associated with immunosuppression, endocrinopathy, and hyperalgesia.[18]

Opioid analgesics are commonly prescribed to orthopaedic patients to manage severe pain attributed to chronic conditions or for acute posttraumatic or postoperative pain.[28] During the past decade, a significant increase has been noted in opioid prescriptions written after elective and nonelective orthopaedic procedures.[4,19,28,30,32,41] It is a general belief that the frequent opioid prescription writing by orthopaedic surgeons is likely contributing to the national opioid epidemic, as prescription opioid use has been associated with illicit or recreational use.[16] The risk of inherent bias has been documented in studies that analyzed the effectiveness of regional anesthesia in patients undergoing shoulder surgery and the impact of nerve lock utilization on opioid use. The reason is that the detection of differences in pain is based on subjective scales (eg, visual analog scale), and the amount of opioids used long term, after surgery, is subject to recall bias or depends on how honest a patient is.[10,27] In addition, many patients might fill an opioid prescription but not take the medication. In the last case, the number of opioid prescriptions filled is not representative of the amount of opioid consumed by the patient.[10,23,39]

Additional factors must be considered when investigating the pattern of opiate usage in surgical patients, as they constitute potential confounders. For example, any patient with a medical history of drug dependency or addiction is at higher risk for postoperative opiate misuse.[16] On the surgeon's side, the postoperative "routine" of prescribing opioids might be difficult to overcome. As a result, surgeons might prescribe opioids in certain amounts, regardless of the administration of a nerve block to their patients. Because the effectiveness of a nerve block is not always guaranteed, surgeons might prescribe opioids to patients to potentially protect them from having uncontrolled pain.

Although shoulder arthroscopy is a minimally invasive procedure, it causes significant postoperative pain attributed to significant bone resection, extensive removal of bursal tissue, insertion of suture anchors, and soft tissue distension from the irrigation fluid. Because of this, the combination of systemic and regional analgesia is often necessary for adequate pain management. Regional nerve blocks in combination with intravenous or oral analgesics have been proven to be useful for the management of perioperative pain in patients undergoing shoulder arthroscopy.[6,8,11,13-15] Another reported advantage of performing a nerve block in these patients is the reduction in the amount of opioid analgesics consumed following the procedure, which reduces the risk of potential opioid recreational use or abuse.[1,2,22,24,25,33,36]

Previous studies have reported the trends of postoperative opioid prescription filling after shoulder arthroscopy and other orthopaedic procedures, using data from national registries.[§] Factors that have been identified to increase the risk of prolonged opioid use (>180 days) following shoulder arthroscopy include preoperative opioid use, rotator cuff surgery, alcohol abuse, psychiatric disorders, female sex, higher Charlson Comorbidity index, obesity, and tobacco use.[22,25] There is a paucity of large studies examining trends in regional anesthesia for shoulder arthroscopy. In addition, none of the large database studies cited has examined the procedure-specific opioid trends in patients undergoing shoulder arthroscopy who received a regional nerve block versus those who did not.

This study aimed to report the trends of regional nerve block utilization and compare the patterns of opioid prescription filling in patients who undergo shoulder arthroscopy, using a national registry. We hypothesized that the use of regional nerve block would decrease the rate of opioid prescription filling, regardless of the type of arthroscopic shoulder procedure performed, and that preoperative opioid prescription-filling history would affect the pattern of postoperative opioid prescription filling.

METHODS

Deidentified patient data from the database of a large national private insurer (Humana) were queried through PearlDiver software (PearlDiver Inc). A retrospective review was conducted on the entire database from 2007 through

[§]References 5, 12, 17, 21, 22, 25, 29, 34, 40, 41.

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Ethical approval was not sought for the present study.

2015. With the PearlDiver research tool, deidentified information of >25 million patients can be accessed across the country. Patients included in this database are insured privately or through Medicare, and patient information can be retrieved by using Current Procedural Terminology (CPT) codes, International Classification of Diseases, Ninth and Tenth Revision (ICD-9 and ICD-10) codes, and National Drug Codes. This information includes age, sex, race region, field number (primary, secondary, tertiary, etc), comorbidities, complications, prescription medications, and discharge status. The Humana database also allows for evaluation of monthly opioid prescriptions filled by patients before and after surgery, and the data are updated on a quarterly basis. Patients who are included in the database receive treatment in various settings and can be tracked longitudinally.

For this study, patients undergoing arthroscopic shoulder procedures were identified through the relevant CPT codes. Four specific procedures were then identified for subgroup analysis: diagnostic shoulder arthroscopy, arthroscopic shoulder labral repair, arthroscopic subacromial decompression, and arthroscopic rotator cuff repair. For each group, patients were excluded if they had any other procedure concurrently, unless the concomitant procedure was a diagnostic arthroscopy. For example, a patient who underwent diagnostic arthroscopy and rotator cuff repair on the same day was categorized as undergoing a rotator cuff repair. However, the specific diagnostic arthroscopy group underwent diagnostic arthroscopy only (CPT 29805) with no other concurrent code. Additionally, patients were not excluded from the rotator cuff repair group if they underwent subacromial decompression at the same time; however, the subacromial decompression group only underwent decompression without any other procedure except diagnostic arthroscopy.

Next, these operative groups were divided into patients who received a peripheral nerve block on the day of surgery and those who did not. Nerve blocks were identified with relevant CPT codes for single-shot and indwelling catheter blocks. The blocked and unblocked cases within each operative subgroup were then age and sex matched to reduce confounders before comparison of the opioid medication prescription-filling patterns. Preoperative opioid exposure was defined as filling at least 1 opioid prescription 1 to 3 months before surgery. Postoperative patterns of opioid prescription filling were examined during the first 6 months after surgery.

Statistical analysis of arthroscopy and nerve block trends was performed with linear regressions in Microsoft Excel (Microsoft Corp). The incidence of arthroscopy in the plateau region was reported as mean ± SD. Chi-square tests were used to compare the percentage of patients filling opioid prescriptions at the time of surgery between blocked and unblocked cohorts. For statistical analysis of opioid prescription-filling pattern versus time, the trend was linearized by log transformation of the percentage use, which was then analyzed by linear regression.[9] The slopes of the lines were then compared by a 2-tailed t test.[3] Descriptive statistics were analyzed with Microsoft Excel, and advanced statistics including regression analyses were performed with SPSS (Version 23; IBM Analytics).

RESULTS

Study Population

We identified 82,561 shoulder arthroscopies in the study period (Figure 1). The total number of cases performed each year was normalized to the total Humana patient enrollment for that given year to account for yearly variations in the total number of patients in this population. Figure 2 presents the age distributions of shoulder arthroscopies and the number of cases that were blocked and unblocked in each age group.

National Trends in Arthroscopic Shoulder Surgery and Use of Regional Anesthesia

The yearly incidence of shoulder arthroscopies in the study population increased linearly ($R^2 > 0.99$; $P < .001$) from 2007 to 2010 and then reached a plateau at 1.38 ± 0.037 shoulder arthroscopies per 1000 patients per year (Figure 3). The trends in use of regional nerve block in patients undergoing shoulder arthroscopy are depicted in Figure 4. Within the 82,561 cases, 54,578 (66.1%) had a concurrent regional anesthesia CPT code, indicating that the patient received a peripheral nerve block. The percentage of patients undergoing a nerve block increased linearly over the 9-year study period, from 52% in 2007 to 67% in 2015 ($R^2 = 0.77$; $P = .002$).

Procedure-Specific Trends in Use of Regional Nerve Block in Patients Undergoing Shoulder Arthroscopy Over Time

Figure 5 depicts the trends in use of regional nerve block over time stratified by procedure (labral repair, diagnostic arthroscopy, subacromial decompression, rotator cuff repair). There were linear yearly increases in the percentage of cases performed with a block for arthroscopic shoulder labral procedures ($R^2 = 0.46$; $P = .03$), rotator cuff repairs ($R^2 = 0.66$; $P = .004$), and isolated subacromial decompressions ($R^2 = 0.70$; $P = .003$). There was no significant trend for isolated diagnostic shoulder arthroscopies ($P = .38$).

Overall and Procedure-Specific Patterns of Opioid Prescription Filling in Shoulder Arthroscopy Cases With and Without a Regional Nerve Block

On the day of surgery, 56.9% of patients with a nerve block and 54.1% of patients without a nerve block filled an opioid prescription. This was a statistically significant difference ($P < .0001$) but a small effect size (2.8%). When the 2 cohorts were matched for age and sex, there was an identical trend over time in filling prescriptions between the blocked and unblocked cases ($P = .95$). In other words, opioid prescription-filling patterns were similar between patients with and without a nerve block (Figure 6). When subdivided by procedure, there was also no difference in the trends between blocked and unblocked cases ($P = .52$

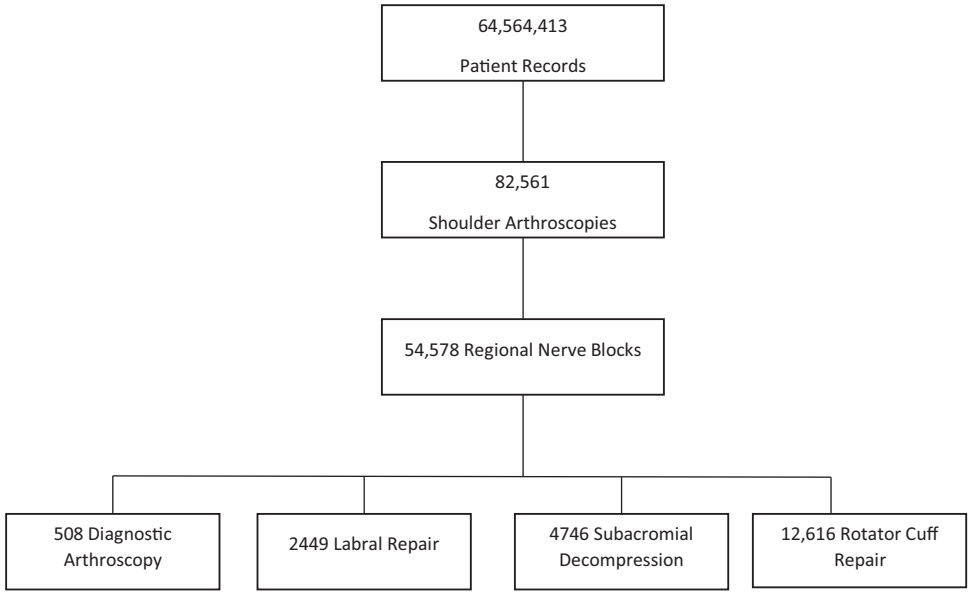

Figure 1. Shoulders meeting criteria for subgroup analysis.

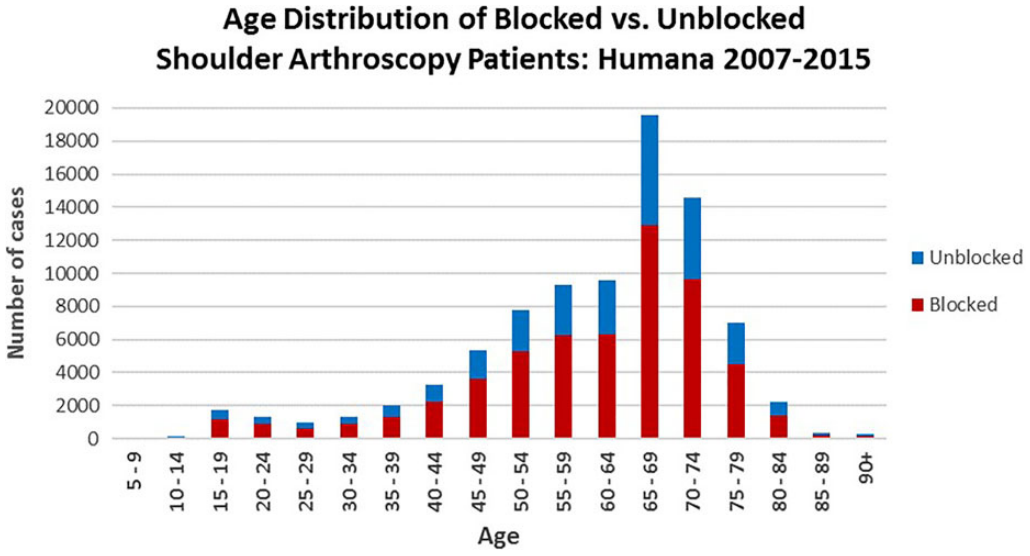

Figure 2. Age distribution of patients undergoing shoulder arthroscopies. There was a similar age distribution of patients with and without a peripheral nerve block over the study period. The highest number of shoulder arthroscopies were performed between the ages of 65 and 69 years. In almost every age segment, approximately two-thirds of patients underwent a nerve block.

for diagnostic arthroscopies; $P = .24$ for labral procedures, $P = .71$ for subacromial decompressions, and $P = .34$ for rotator cuff repairs).

Postoperative Shoulder Arthroscopy Patterns of Opioid Prescription Filling Between Patients With and Without Preoperative Opioid Prescriptions

The effect of preoperative opioid prescription filling after age and sex matching was analyzed (Figure 7). The trends for postoperative opioid use in preoperative users were significantly different from those who did not use opioids ($P < .001$ for all arthroscopies and for all procedure subgroups). Preoperative users were more likely to use opioids from 0 to 3 months postoperatively when compared with patients who did not use opioids preoperatively ($P < .001$). In particular, preoperative users were 1.8 times as likely to fill prescriptions at the time of surgery and 2 weeks postoperatively (100% vs 56.7% and 74.2% vs 40.3%, respectively). However, the magnitude of the difference was only 1% after 1 month.

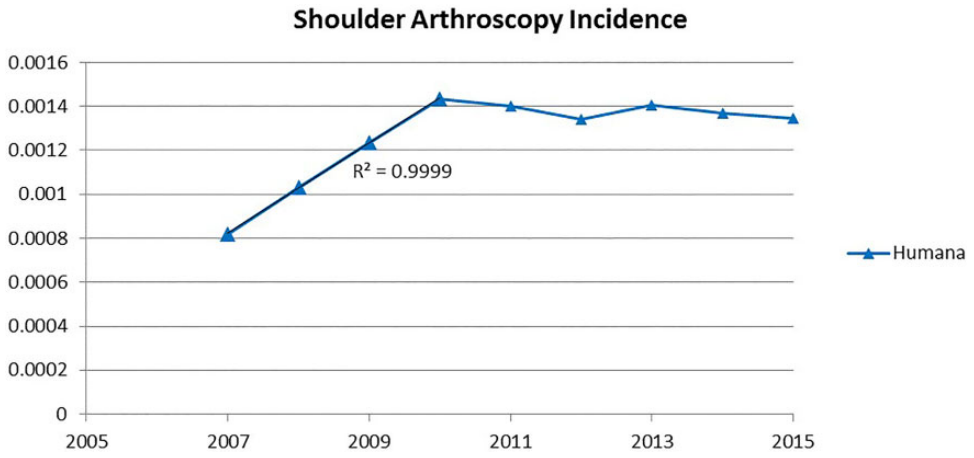

Figure 3. Incidence of shoulder arthroscopy over the study period. Of note, there was a linear increase in the incidence of these procedures from 2007 to 2010, at which point a plateau was reached ($P < .001$). The apparent slight downtrend over the plateau period was statistically nonsignificant ($P = .13$).

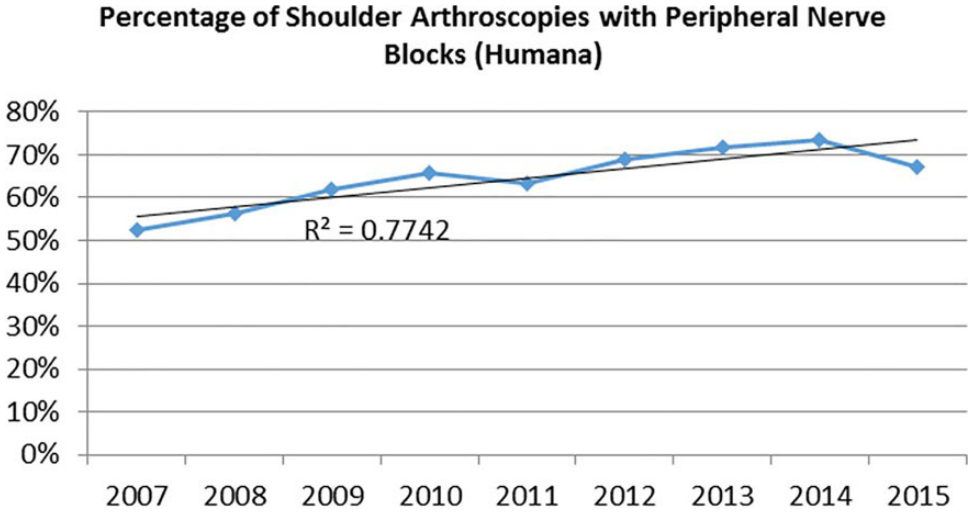

Figure 4. Percentage of shoulder arthroscopies receiving regional nerve blocks from 2007 to 2015. There was an increasing trend over the study period ($R^2 = 0.77$; $P = .002$).

Overall and Procedure-Specific Postoperative Shoulder Arthroscopy Patterns of Opioid Prescription Filling in Patients With Preoperative Opioid Exposure: Blocked vs Unblocked Cases

When nerve block use was examined in patients who had filled an opioid prescription 1 to 3 months preoperatively (preoperative opioid exposure), there were statistically significant differences in postoperative prescription filling patterns ($P < .001$). These trends were consistent when all subgroups were subdivided by procedure ($P < .001$), except diagnostic arthroscopy ($P = .08$). When patients with preoperative opioid exposure received a nerve block, they were less likely to fill new opioid prescriptions than opioid-exposed patients who did not receive a nerve block at earlier time points (Figure 8). At the time of surgery, patients without a nerve block were 1.8 times as likely to fill opioid prescriptions. At postoperative 2 weeks, they were 1.3 times as likely to fill prescriptions. This effect was not observed at later time points.

DISCUSSION

Within the study period (2007-2015), an increasing incidence of arthroscopic shoulder procedures performed was observed between 2007 and 2010, but this number reached a plateau afterward. In contrast, there were linear yearly increases in the percentage of shoulder arthroscopy cases performed with a regional nerve block during the 9-year period. Postoperative patterns (0-6 months) of opioid prescription filling were similar between blocked and unblocked cases of various arthroscopic shoulder procedures. Patients who filled an opioid prescription within the 3 months before shoulder

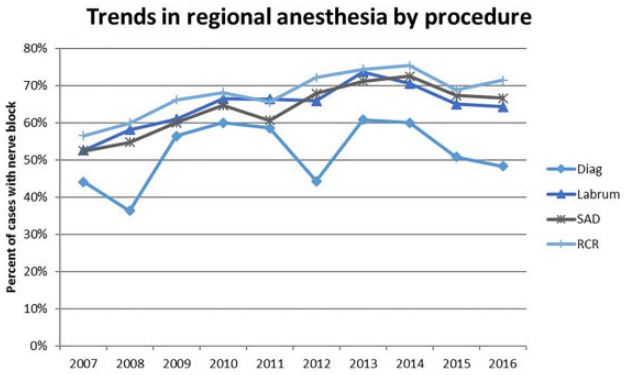

Figure 5. Trends in regional anesthesia by procedure. There was a linear increase in the percentage of cases performed with a block for labral procedures ($R^2 = 0.46$; $P = .03$), rotator cuff repairs ($R^2 = 0.66$; $P = .004$), and subacromial decompressions ($R^2 = 0.70$; $P = .003$). There was no significant trend for diagnostic arthroscopies ($P = .38$). Diag, diagnostic arthroscopy only; Labrum, labral procedures; RCR, rotator cuff repair; SAD, subacromial decompression only.

arthroscopy were more likely to fill an opioid prescription within the first postoperative month as compared with patients without preoperative opioid exposure. For patients with preoperative opioid exposure, having received a regional nerve block on the day of shoulder arthroscopy decreased the likelihood of their filling an opioid prescription within the first 2 postoperative weeks as compared with not having received a nerve block. The last statement applied to cases of labral repair, rotator cuff repair, and subacromial decompression but not to diagnostic arthroscopies.

The explanation of the trend in the administration of nerve block in shoulder arthroscopy cases is likely multifactorial. Performing a regional nerve block requires specialized training. There is evidence that the use of regional nerve blocks for the management of postoperative pain has increased dramatically over the past decade,[20] and this trend is confirmed by our data in shoulder arthroscopy cases. Therefore, we believe that the number of physicians trained to perform nerve blocks is following a similar trend.[42] In addition, the fact that most insurance plans will cover a regional nerve block in shoulder arthroscopy cases might have helped in the expansion of this pain management technique.[35] Finally, regional nerve blocks are generally safe, and patients undergoing shoulder arthroscopy seem to be satisfied with their use in clinical practice.[7]

Similar to our methodology, previous studies have extracted data from the Humana database to identify the trends in perioperative opioid prescription in patients undergoing shoulder procedures and to explore the risk factors for increased postoperative opioid demand.[22,25,40] These factors include a history of alcohol abuse, psychiatric disorders, female sex, and higher index of comorbidity, among others. While Leroux et al[25] and Khazi et al[22] studied patients who underwent open and arthroscopic shoulder surgery, Westermann et al[40] focused on patients who underwent arthroscopic rotator cuff repair, and we compared the trends of opioid prescription filling among 4 common arthroscopic shoulder procedures (labral repair, subacromial decompression, rotator cuff repair, and diagnostic arthroscopy). We found that patients who had filled $\geq$1 opioid prescriptions within the 3 months before surgery were more likely to fill an opioid prescription at the time of surgery and 2 weeks postoperatively as compared with patients without preoperative opioid prescription filling. This finding was consistent in all 4 surgery subgroups and agreed with the existing literature for rotator cuff repair.[40] The identification of any patient-specific risk factors that may increase the likelihood of opioid prescription filling after shoulder arthroscopy was out of the scope of this study.

Based on our results, the magnitude of the difference in postoperative rate of opioid prescription filling between patients with and without preoperative opioid exposure

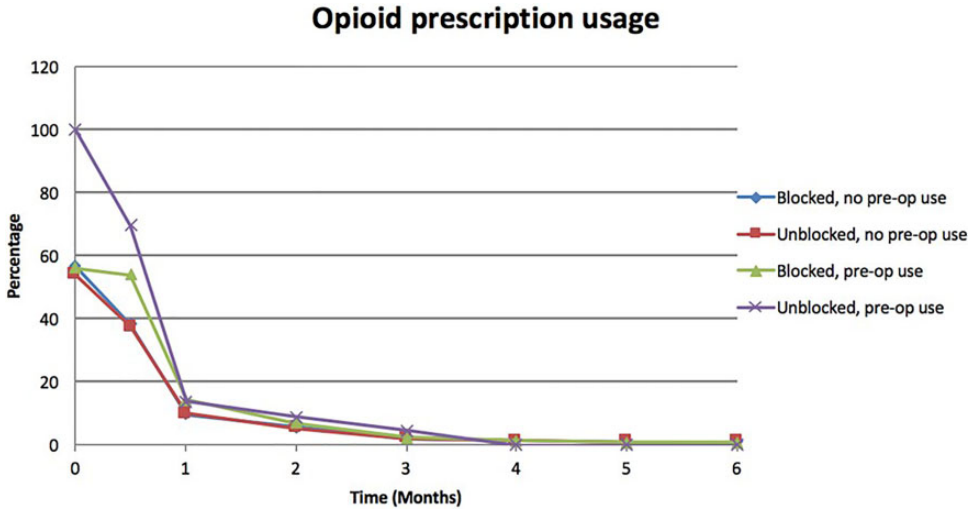

Figure 6. Opioid prescription usage. There was no clinically or statistically significant difference in the patterns of postoperatively filled opioid prescriptions between patients who received a nerve block and those who did not.

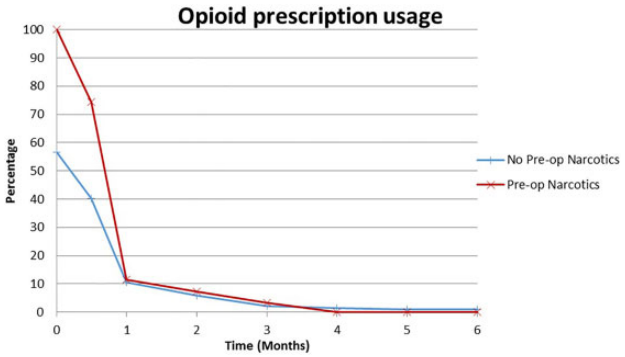

Figure 7. Postoperatively filled opioid prescriptions in preoperative opioid users as compared with those who did not fill prescriptions preoperatively. The trends in opioid demand were significantly different. The percentage of opioid users was statistically different at all time points but with an effect size of $\leq$1% after 1 postoperative month.

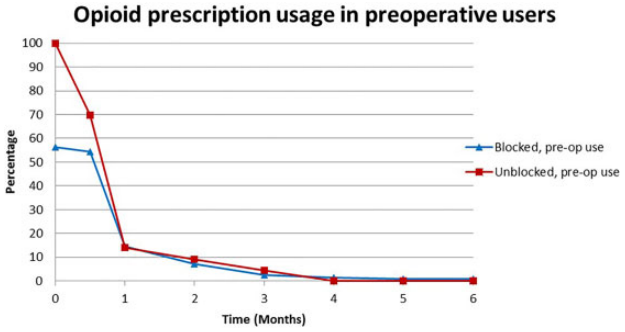

Figure 8. Filled opioid prescriptions after surgery for patients with and without a nerve block who had filled an opioid prescription preoperatively. Opioid demand in the first month was less common in patients who had a nerve block at the time of surgery, but there was a smaller effect after 1 month.

was only 1% after the first month. Westermann et al[40] reported that patients who filled an opioid prescription 1 to 3 months before undergoing arthroscopic rotator cuff repair were 7.45 times more likely to fill opioid prescriptions at 3 months postoperatively and 12.47 times more likely to do so at 9 months postoperatively, compared with patients who did not fill opioid prescriptions before surgery. Our follow-up time for postoperative opioid prescription filling was only 6 months, which constitutes a major limitation. In addition, the fact that some surgeons "do not believe in nerve blocks" could be part of the reason why the trend of decreased opioid prescription filling after surgery was not sustained after the first month. As we mentioned, even if a surgeon supports the administration of a nerve block in shoulder arthroscopy, the routine of prescribing opioid medications is more difficult to change. Longitudinal studies are necessary to explore these hypotheses.

Unlike previous studies, we also examined the effect of regional nerve block on the postoperative pattern of opioid prescription filling in patients who had filled opioid prescriptions preoperatively. For patients with preoperative opioid use, those who received a nerve block were less likely to fill a postoperative prescription compared with those with no nerve block (Figure 8). This is an important finding, suggesting that in preoperative opioid users who undergo shoulder arthroscopy, surgeons should offer a nerve block to reduce the amount of opioid usage within the first postoperative month. In theory, given that postoperative pain progressively improves with time, reducing the amount of opioid consumed during the first month after surgery could help reduce the potential risk of long-term opioid misuse. However, our data suggest that the use of the nerve block did not relieve the burden of opioid prescription filling after the postoperative month (and up to 6 months) in shoulder arthroscopy patients. Because our follow-up time was limited to 6 months postoperatively, we cannot answer the question of whether in this cohort, the short-term reduction of postoperative opioid prescription filling attributed to nerve block administration can be translated to a long-term outcome.

Although several randomized clinical trials have shown that performing a regional nerve block in shoulder arthroscopy significantly reduces the amount of postoperative opioids consumed,[38] we did not identify any differences in postoperative patterns of opioid prescription filling between blocked and unblocked cases of shoulder arthroscopy, and this finding held true in all the procedure subgroups. However, the database we used only recorded whether or not patients filled an opioid prescription postoperatively, not the amount of opioid medication consumed. Thus, we were unable to compare our findings with existing randomized clinical trials. To develop effective strategies against the national opioid epidemic, steps should be taken to design methods for capturing the consumption rates of the prescribed opioids at national and international levels.

Limitations

This study has several limitations, primarily related to the database used. One major disadvantage of our analysis is that the amount of opioids consumed could not be recorded. As stated previously, we were unsure if the number of opioid prescriptions filled reflected the amount of opioid used by the patients. Because of this, the impact of performing a regional nerve block in shoulder arthroscopy cases on the amount of postoperative opiate consumption cannot be estimated with confidence based on our results, which limits the clinical relevance. In addition, the accuracy of the information in the database is dependent on the accuracy of ICD-9 and CPT codes. Incorrect coding could lead to false information within the database. Next, there are no patient satisfaction data, pain scores, or functional outcome data available within this database. Further studies using these measures are necessary to determine whether the patterns of opioid prescription filling are translating to differences in subjective and objective clinical outcomes. Finally, no study has examined the effect of preoperative opioid exposure within the 6 to 12 months before shoulder arthroscopy, which would provide a better understanding of the impact

of chronic opioid use on perioperative opioid demand. The large size of our study population constitutes a strength of this analysis, while use of the Humana database allowed for comparison of our results with previous studies.

CONCLUSION

An increasing percentage of shoulder arthroscopies are being performed with regional nerve blocks. However, there was no difference in the patterns of filled postoperative opioid prescriptions between blocked and unblocked cases, except when we compared these patterns in a subgroup of patients who had filled an opioid prescription within 1 to 3 months before shoulder arthroscopy. Future research should focus on recording the amount of prescribed opioids consumed in national databases to reinforce our strategy against the opioid epidemic.

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