Prolonged Opioid Use following Cervical Spine Fusion Surgeries-Incidence and Predictors of Use

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ABSTRACT

Purpose: To determine the incidence and predictors of prolonged opioid use (OU) following cervical spine fusion surgery.

Methods: This is a retrospective cohort study of all patients who underwent cervical arthrodesis for degenerative cervical spine disease over 7 years, between 2010 and 2016, who had at least one year of postoperative follow up at the University of Missouri hospitals. Review of medical records was done to collect data on patient’s characteristics, associated pain measures (pre/postoperative VAS), ASA score, and pre/postoperative OU. The predictors of prolonged OU at 3, 6 and 12 months following surgery were identified using the logistic regression analyses. Significance was considered at p<0.05.

Results: Incidences of postoperative OU were 50%, 42.5% and 30.2% at 3, 6 and 12 months respectively. After adjustment for all possible confounders, preoperative OU was a significant predictor of postoperative OU at 3 months (OR=3.06, 95% CI: 1.28-7.34, p=0.012), 6 months (OR=2.86, 95% CI: 1.01-8.14, p=0.049) and 12 months (OR=7.22, 95% CI: 2.76-18.90, p<0.001). Patients with cancer diagnosis were 23 times more likely to be prolonged opioid users for 12 months after surgery (OR= 23.13, 95% CI: 1.68-317.98, p=0.019).

Conclusion: Perioperative opioid prescription for patients with cervical spine fusion is quite common. Further prospective study is necessary to minimize the effect of confounding variables such as; disease severity, and postoperative functional status on the associations between pre-and postoperative opioid use. Minimizing preoperative opioid use should be investigated as a way to mitigate long-term opioid use.

Keywords: Cervical degeneration, opioid use, postoperative, spine fusion, incidence.

I. INTRODUCTION

Prescribing oral opioid for patients with acute and chronic spinal conditions have been commonly treated with oral opioids over the last decade. These patients may present to a spine surgery clinic with surgical correctable pathology, but on high doses of opioids. Nearly two-thirds of all patients were prescribed narcotic medications in a previous study examining primary care management of acute low back pain [1]. Lack the personnel and education of how to deal with perioperative chronic pain management may lead to long-term opioid tolerance. Patients undergoing lumbar spine surgeries experienced depression and/or anxiety as adverse events for this long-term opioid use among [2]-[4]. Spine surgery patients experienced negative effects of chronic opioid use [5]-[9]. These effects have been reported in the form of higher medical costs, higher rates of revision surgery and poor outcomes [8], disability and poor quality of life [5].

Prolonged preoperative opioid use over 3 months was considered at p<0.05.

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use before surgery is a modifiable risk factor for outcomes. It also raised the question of whether surgeons should decrease or eliminate chronic OUs before surgical intervention.

Little is known regarding perioperative opioid use for spine fusion patients [5], [10], [11]. It is necessary to have more information about the percentage of patients using opioids before surgery, the typical postoperative trends in opioid requirements and risk factors for prolonged opioid use after common orthopedic procedures. This information may help to counsel patients and encourage the entire orthopedic community to minimize opioid prescribing [10]. Therefore, the aim of this study was to determine the incidence of opioid use (OU) and predictors of prolonged postoperative use following cervical spine fusion surgery.

II. METHODS

Of all patients operated with cervical spine fusion surgery during the period between 2010 and 2016 (n=1162 patients), a retrospective cohort study was conducted of all patients who underwent cervical arthrodesis for degenerative cervical spine disease and had at least one year of follow at the University of Missouri hospitals (n=260). Patients with any of the following diagnoses before surgery were excluded from the study: Those with history of infection, those with history of a major traumatic accident within 12 months prior to surgery, those operated with a cervico-thoracic fusion, and those who had a previous cervical spine fusion surgery.

III. DATA COLLECTION

Patients’ medical records were examined to collect data on the following: Patient’s characteristics [age, sex, race, monthly income, occupation, BMI, smoking behavior, comorbidities] associated pain measures [pre/postoperative VAS], ASA score, and pre/postoperative opioid use.

Operational definition: Patients were categorized as opioid users (OUs) or non-opioid users (NOUs) according to their narcotic prescription filling history. Those with an opioid prescription filled within 3 months before surgery were labeled as OUs, and those with no history of preoperative opioid prescription filling were labeled as NOUs. This study was approved by the ethical committee of Missouri Orthopedics Institute, University of Missouri.

IV. DATA ANALYSIS

Data was coded and analyzed using the (SPSS version 26.0; IBM Corporation, Armonk, NY, USA). Descriptive statistics such as mean, median, range, and standard deviation were used. Frequencies (%) with their corresponding 95% confidence intervals (CIs) were calculated, to estimate the incidence of preoperative and postoperative opioid use. Both qualitative and quantitative analyses were applied to investigate associations and differences. Student t test and Mann–Whitney U test, will be used to compare numerical data. For categorical data, chi-square test and Fisher exact test were applied. Odds ratios (ORs) with their corresponding 95% CI were calculated. Logistic regression analyses were applied to adjust for confounders of the association between preoperative and postoperative opioid use at 3, 6 and 12 months after surgery. Significance was considered at p ≤ 0.05.

V. RESULTS

Fig. 1 shows the incidence of opioid use among cervical spine surgery patients before and after surgery. Nearly one-half of patients (46.9%) were prescribed opioid before surgery. After surgery, the incidences of opioid use were 50%, 42.5% and 30.2% at 3, 6 and 12 months respectively, with an absolute risk reduction of 17% at 12 months postoperatively. However, this absolute risk reduction was 49.3% among OU. The incidence of opioid use among OU fell dramatically from 100% at the time of surgery to 68% at 3 months after surgery, with 32% reduction, while a reduction of only 8% and 10% were shown at 6 and 12 months following surgery. From the 3rd month to the 12th month after surgery, the trends of opioid prescription were parallel for both OU and NOU, and the prescription rate, with an incidence of opioid use among OU that is nearly 40% higher incidence than that among NOU, till the end of one year, where the prescription rate fell dramatically in the NOU compared with OUs (13.6% vs. 50.7%, p<0.001).

Table I shows the incidence of postoperative opioid use according to some patient and disease characteristics. OU at 3 months after surgery was significantly associated with male gender (χ2=3.90, p=0.048), smoking behavior (χ2=4.38, p=0.036), lower income (χ2=4.18, p=0.041), higher postoperative VAS score (χ2=15.81, p<0.001), and preoperative OU (χ2=18.2, p<0.001). OU at 6 months after surgery was significantly associated with non-white patients (χ2=4.06, p=0.04), patients with active cancer (FET, p=0.012), fibromyalgia (FET, p=0.041), high postoperative VAS scores (χ2=15.80, p<0.001) and preoperative OU (χ2=17.91, p<0.001). OU at 12 months after surgery was significantly associated with patients with active cancer (FET, p=0.01), higher postoperative VAS score (χ2=16.97, p<0.001) and preoperative OU (χ2=25.62, p<0.001).

Table II shows that after adjusting for confounders, using logistic regression models, preoperative OU was a significant predictor of OU at 3 months (OR=4.07, p<0.001), 6 months (OR=3.78, p=0.002) and 12 months (OR=6.72, p<0.001). Preoperative opioid users were 4 times more likely to be postoperative users at 3 and 6 months, and 7 times at 12 months. Postoperative VAS scale was significantly associated with OU at 3 months (OR=3.60, p=0.002), 6 months (OR=3.45, p=0.004) and 12 months (OR=4.35, p<0.001) after surgery. Patients with active cancer were 7 times more likely to be opioid users at 12 months post-surgery (OR=6.63, p=0.047).

Fig. 2 shows the association between preoperative and postoperative opioid use among cervical spine fusion surgery patients. OU showed significantly higher incidences of opioid use than non-opioid users (NOU) at 3, 6 and 12 months after surgery.


| Table I: Incidence of Postoperative Opioid Use According to Patients’ Disease Characteristics and Comorbidities |
|------------------------------------------------------------------------------------------------|
| At 3 months (n=254) | At 6 months (n=138) | At 12 months (n=159) |
|---------------------|---------------------|---------------------|
| **Overall incidence** | 69 (50.0) | 54 (42.5) | 48 (30.2) |
| Patients’ characteristics | | | |
| Male | 29 (61.7) | 24 (53.5) | 19 (35.2) |
| Female | 40 (44.0) | 30 (36.6) | 29 (27.6) |
| χ², p-value | 3.90, 0.048** | 3.34, 0.07 | 0.97, 0.33 |
| <50 yr | 36 (52.2) | 27 (43.5) | 26 (35.6) |
| ≥50 yr | 33 (47.8) | 27 (41.5) | 22 (25.6) |
| χ², p-value | 0.26, 0.61 | 0.052, 0.82 | 1.89, 0.17 |
| White | 58 (47.2) | 44 (39.3) | 39 (28.3) |
| Race | 11 (73.3) | 10 (66.7) | 9 (42.9) |
| Others | 3.67, 0.016 | 4.06, 0.04** | 1.84, 0.18 |
| Income | >45,000$ | 39 (59.1) | 28 (47.5) | 23 (31.9) |
| χ², p-value | 4.18, 0.04** | 1.10, 0.29 | 0.19, 0.66 |
| <50 kg/m² | 43 (55.1) | 32 (46.4) | 30 (35.7) |
| BMI | 26 (43.3) | 22 (37.9) | 18 (24.0) |
| χ², p-value | 1.89, 0.17 | 0.92, 0.34 | 2.58, 0.11 |
| Non-smoker | 36 (42.9) | 28 (37.8) | 24 (24.7) |
| Smoking behavior | 4.38, 0.04** | 1.59, 0.21 | 3.50, 0.06 |
| χ², p-value | 18 (51.4) | 14 (45.2) | 13 (33.3) |
| Employed | 64 (43.4) | 52 (38.6) | 43 (29.1) |
| Employment pre-op. | 3.80, 0.013 | 2.92, 0.027 | 0.92, 0.34 |
| Non-employed | 51 (45.9) | 40 (39.1) | 34 (29.1) |
| χ², p-value | 0.16, 0.69 | 0.99, 0.32 | 1.73, 0.19 |
| ≤5 points | yes | 47 (68.1) | 39 (60.9) | 36 (50.7) |
| Pre-op. VAS | No | 22 (31.9) | 15 (23.8) | 12 (13.6) |
| χ², p-value | 18.12, <0.001** | 17.91, <0.001** | 25.62, <0.001** |
| ≤5 points | yes | 8 (72.7) | 5 (62.5) | 4 (44.4) |
| Reimbursement | No | 61 (48.0) | 49 (41.2) | 44 (29.3) |
| χ², p-value | 2.47, 0.12 | FET, p=0.28 | 0.92, 0.34 |
| ≤5 points | yes | 4 (66.7) | 2 (40.0) | 2 (40.0) |
| Readmission | No | 65 (49.2) | 52 (42.6) | 46 (29.9) |
| χ², p-value | FET, p=0.68 | FET, p=1.00 | FET, p=0.64 |
| ≤5 points | FET, p=0.00 | 25 (50.0) | 20 (40.0) | 17 (26.2) |
| ASA class | 1-2 points | 35 (53.8) | 25 (44.6) | 21 (31.8) |
| χ², p-value | 0.09, 0.77 | 0.03, 0.85 | 0.21, 0.65 |
| ≤5 points | FET, p=0.00 | 43 (50.0) | 34 (44.2) | 31 (33.0) |
| Home | yes | 58 (48.3) | 45 (45.0) | 43 (30.5) |
| χ², p-value | 0.00, 1.00 | 0.21, 0.64 | 0.85, 0.36 |
| ≤5 points | 29 (35.8) | 21 (28.0) | 16 (14.7) |
| Postop. VAS | No | 40 (70.2) | 33 (63.5) | 32 (47.8) |
| χ², p-value | 15.81, <0.001** | 15.80, <0.001** | 16.97, <0.001** |
| ≤5 points | 1-2 points | 35 (53.8) | 25 (44.6) | 21 (31.8) |
| Discharge to | 3-4 points | 25 (51.0) | 21 (42.9) | 18 (28.1) |
| χ², p-value | 0.09, 0.77 | 0.03, 0.85 | 0.21, 0.65 |
| Others | yes | 58 (48.3) | 45 (45.0) | 40 (29.9) |
| χ², p-value | 0.55, 0.46 | 0.87, 0.35 | 0.12, 0.73 |
| ≤5 points | Yes | 5 (50.0) | 5 (62.5) | 5 (50.0) |
| Complications | No | 63 (48.5) | 49 (41.2) | 43 (28.9) |
| χ², p-value | FET=0.27 | FET=0.28 | 1.99, 0.16 |

**Note:** Data in the table are for only patients whose information about post-operative opioid use was available.

FET: Fisher-exact test; χ²: Pearson Chi square test; HBP: high blood pressure; VAS: Visual analog score; **: statistically significant.
TABLE II: SIGNIFICANT PREDICTORS OF POSTOPERATIVE OPIOID USE AMONG PATIENTS FOLLOWING CERVICAL SPINE FUSION SURGERY

| Predictors       | At 3 months |          |          |          |          |          |          |          |
|------------------|-------------|----------|----------|----------|----------|----------|----------|----------|
|                  | aOR (95% CI)| P value  | aOR (95% CI)| P value  | aOR (95% CI)| P value  |
| Sex              | 0.51 (0.22-1.17) | 0.11     | ---       | ---       | ---       | ---       |
| Income           | 0.57 (0.26-1.24) | 0.16     | ---       | ---       | ---       | ---       |
| Smoking          | 1.21 (0.54-2.71) | 0.65     | ---       | ---       | ---       | ---       |
| Race             | ---         | ---      | 2.50 (0.69-9.13) | 0.17     | ---       | ---       |
| Fibromyalgia     | ---         | ---      | 5.95 (0.63-55.86) | 0.12     | ---       | ---       |
| Cancer           | ---         | ---      | 4.55 (0.47-44.42) | 0.19     | 6.63 (1.02-42.97) | 0.047**   |
| Preoperative OU  | 4.07 (1.88-8.84)** | <-0.001** | 3.78 (1.68-8.69) | 0.002** | 6.72 (2.94-15.37) | <-0.001** |
| Postop. VAS      | 3.60 (1.63-7.98) | 0.002** | 3.45 (1.50-7.91) | 0.004** | 4.35 (1.95-9.70) | <-0.001** |

OU: opioid use, aOR: adjusted odds ratio, 95% CI: 95% confidence interval, **: statistically significant.

Fig. 1. Incidence of opioid use among cervical spine surgery patients before and after surgery. [OU: opioid use, NOU: non-opioid use].

VI. DISCUSSION

In our study, nearly one-half of patients (46.9%) were prescribed opioid before surgery. Reference [5] investigated the impact of preoperative opioid use on self-reported outcomes following spine surgery, and noted that 56% of patients reported some degree of opioid use before cervical or thoracolumbar spine surgery. Reference [10] demonstrated that over 50% of patients undergoing a cervical spinal fusion surgery were on opioids before surgery.

In the present study, after surgery, the incidences of opioid use were 50%, 30.2% at 3 and 12 months respectively, with an absolute risk reduction of 17% at 12 month postoperatively. However, this absolute risk reduction was 49.3% among OU. At the date of surgery up to 3 months after, one-third of OU stopped being prescribed opioid. This trend was similar to the trend of opioid usage up to 1 year following cervical spine surgery, by [10] who demonstrated a concerning proportion of patients, approximately 45%, still on opioids at 12 months postoperatively. Reference [11] noted a high filling rate of opioid prescription (84%), at the time of discharge of patients undergoing lumbar discectomy, decompression, and lumbar posterolateral or interbody fusions.

It has been reported that prolonged opioid use was attributed to the presence of depression or anxiety among patients undergoing lumbar spine surgeries [2]-[4]. Pugely et al. [10] demonstrated that after risk adjustment, preoperative opioid use was highly predictive of prolonged postoperative use in patients undergoing cervical spine fusion surgery; and over seven fold difference was noted in opioid filling rate. In the present study, at the 12th month after surgery, the prescription rate fell dramatically in the NOU compared with OUs [13.6% and 50.7%, respectively p<0.001]. Following risk adjustment, preoperative opioid users were 4 times more likely to be postoperative users at 3 and 6 months, and 7 times at 12 months. This dramatic increase of the effect size of preoperative opioid use on postoperative use, from 4 at 3 and 6 months to 7 at 12 months, may suggest the possibility of the addictive effect of long term opioid use, especially that the pain score after surgery was adjusted for. The finding that the incidence of opioid use among OU fell dramatically from 100% to 68% [32% reduction] at 3 month, followed by a reduction of only 8% and 10% at 6 and 12 months after surgery, also could be attributed to this addictive effect of long term opioid use.

VII. LIMITATIONS

This study has some limitations. First, the study provided valuable information on opioid prescription but not on actual opioid usage, and behavior or patterns in consumption. Second, given the lack of specific reason or indication of opioid use by patients in the database, overestimation of pre- or postoperative opioid is possible, as it may be inclusive of patients on opioid prescriptions unrelated to cervical spine disease. Lastly, many possible confounding variables such as; disease severity, and postoperative functional status, and thus these factors could not be accounted for risk adjustments while testing for associations with postoperative opioid use. Moreover, in terms of factors predictive of prolonged opioid usage, our study cannot predict causality but can only account
for associations, with the latter subjected to some degree of residual confounding.

VIII. CONCLUSION

Perioperative opioid prescription for patients with cervical spine fusion is quite common and is a predictor of prolonged post-operative opioid use. Minimizing preoperative opioid use should be investigated as a way to mitigate long-term opioid utilization post-surgery.

AVAILABILITY OF DATA AND MATERIAL

Most of the data supporting our findings is contained within the manuscript, and all others, excluding identifying/confidential patient data, will be shared upon request, by contacting the corresponding author.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

ETHICS APPROVAL

This project was approved by the ethical committee of the University of Missouri hospitals. It was conducted in accordance with the Declaration of Helsinki.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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