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Opioid use after adult spinal deformity surgery: A propensity-matched comparison of Japanese vs. American cohorts

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Abstract

BACKGROUND: Amidst a current US opioid epidemic, it is important to understand factors that contribute to long-term opioid use after elective surgery. In Asian countries, opioids are rarely prescribed for post-operative pain.

MATERIALS AND METHODS: We propensity-matched 127 JPN to 619 US adult spinal deformity (ASD) patients based on age, sex, 3-column osteotomy, pelvic fixation, number of levels fused, and pre-operative sagittal vertical axis (SVA). Pre-operative and 2-year post-operative opioid use was determined using responses to SRS-22r Q11 and grouped into three categories (none, weekly, or daily).

RESULTS: From each cohort, 34 cases were successfully matched, with no difference in baseline parameters, including baseline opioid use (P = 0.095), between the cohorts. At 2 years following surgery, 22 US (65%) vs. 31 JPN (91%) reported no opioid use; 11 US (32%) vs. 3 JPN (9%) reported daily use (P = 0.009). There was no difference in 2-year SRS-22r Self-image and Mental Health between the two groups, whereas US patients had better satisfaction (4.29 vs. 3.84, P = 0.032) but lower function scores (3.52 vs. 3.90, P = 0.029).

CONCLUSION: In propensity-matched ASD cohorts, 35% of US patients were still using opioids 2 years after surgery compared with 9% of JPN patients, with the most taking opioids daily. Further studies are needed to identify sources of this variability.

Keywords:

Adult spinal deformity, chronic opioid use, opioid crisis, opioid dependence

Introduction

The USA is facing an unprecedented opioid crisis, with Americans consuming 80% of the global opioid supply even though they comprise only 4.6% of the world's population.[1] More than 2 million Americans are addicted to prescription opioids.[2] The rate of deaths related to opioid overdose has increased over 200% since 2000.[3] Several studies have shown that elective surgery has contributed to developing opioid dependence.[4-6] In opioid-naive patients, 3% continued to use opioids for more than 90 days after major elective surgery.[4] An alarming report states that 38% of patients undergoing major spine surgery are still on opioids 1 year after surgery in the USA.[7]

In contrast, in Asian countries, opioids are far less commonly prescribed. A recent

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survey of primary care physicians found that opioids are used significantly less in Japan than in the US.[8] A similar survey showed less number of pills with shorter duration had been provided by orthopedic surgeons in Japan compared with those in the USA.[9] To better understand factors contributing to long-term opioid use after elective spine surgery, we compared opioid use between American (US) and Japanese (JPN) cohorts at baseline and at 2 years after adult spinal deformity (ASD) surgery. ASD may be an optimal condition for this purpose as ASD surgery is considered one of the major spine procedures and may be expected to have greater amount of opioid use for post-operative pain control.

Materials and Methods

This is a propensity-matched comparison of US and JPN ASD patients. From a prospective, multicenter US ASD database, 1282 patients were enrolled. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the University of Louisville Institutional Review Board (HSPPO#17.1027) and Norton Healthcare Office of Research Administration (RO#17.N0288), and informed consent was taken from all the patients. Of these 666 had complete 2-year data, whereas 619 patients had opioid consumption data. From a prospective, multicenter JPN ASD database, 459 patients were enrolled. Of these 321 (70%) had complete 2-year data, whereas 127 patients had opioid consumption data. ASD was defined as a coronal Cobb angle ≥ 20°, sagittal vertical axis (SVA) ≥ 5 cm, pelvic tilt (PT) ≥ 25°, thoracic kyphosis ≥ 60°, a Cobb angle ≥ 20°, C7 sagittal vertical axis (C7SVA) ≥ 5 cm, or PT ≥ 25°. Patients were excluded if they did not have appropriate radiographs or HRQOL data. Patients with deformity secondary to neuromuscular disorders, connective tissue or autoimmune diseases, infection, malignancy, or trauma were also excluded. In total, 746 consecutive ASD patients (619 patients in the US and 127 patients in JPN) who had undergone corrective spine surgery were included prior to propensity matching. Patients were then propensity-matched based on age, sex, 3-column osteotomy, pelvic fixation, number of levels fused, and pre-operative SVA. Opioid use was measured using the SRS-22r Q11.

Statistical analysis

Differences between the US and JPN groups were compared using unpaired *t*-tests and χ^2 tests depending on variable types. A *P*-value < 0.05 with a confidence interval of 95% was considered statistically significant. All analyses were performed using the Statistical Package for the Social Sciences (SPSS version 26.0, IBM Corp., Armonk, NY, USA).

Results

Prior to matching, patients in the USA were using significantly more narcotics [Table 1]. Of 619 patients in the US and 127 patients in the JPN cohorts, 34 cases in each group with complete data were successfully propensity-matched. Consistent with propensity matching, there were no differences in age, sex, 3-column osteotomy, pelvic fixation, or pre-operative SVA. Body mass index (BMI) and number of vertebral levels fused were greater in the USA. Baseline SRS-22r domain scores were significantly different except for the self-image domain. However, pre-operative narcotics use was not different between the two cohorts following matching [Table 2].

Post-operative comparisons are summarized in Table 3. Narcotics were significantly more commonly used in the USA (*P*=0.038). More than 90% of the patients used no narcotics in the JPN cohort, whereas 31% were still on narcotics in the US cohort at 2 years following surgery.

Discussion

This study compared opioid use after ASD surgery between the USA and Japan. The US had a significantly higher rate of opioid use with 28% being on daily opioids at 2 years following surgery. This is the first study to compare post-operative opioid use following spine surgery between the US and JPN. Tannoury *et al*.[9] performed a survey to compare orthopedic surgeon-reported opioid prescribing patterns after various orthopedic procedures in the USA and Japan. They found that orthopedic surgeons in Japan prescribed significantly less opioids post-operatively in terms of number of pills provided and duration of prescriptions compared with orthopedic surgeons in the USA. They used physician-reported data from limited institutions, which may not represent the reality or may introduce sample bias. In our study, we used actual patient data from a multicenter ASD database and propensity-matched to avoid selection bias, suggesting that our finding may be more accurate and spine-surgery-specific.

The observed differences in post-operative opioid use between the cohorts may be due to difference in the healthcare systems. In Japan, all nationals can receive healthcare service through a national insurance system, whereas the USA lacks a universal insurance system.

Table 1: Pre-operative opioid use prior to matching

Parameters	USA	Japan	*P*-value
Narcotic use (%)			**< 0.001**
No narcotics	46.6	43.2	
Weekly	9.0	28.8	
Daily	44.4	28.0	

Table 2: Comparison of pre-operative background characteristics in each cohort

Parameter	USA (*n*=34)	Japan (*n*=34)	*P*-value
Age (years)	59.4±12.7	52.9±18.2	0.097
Gender (female %)	85.3	88.2	1.000
BMI	28.8±7.1	21.0±2.6	**< 0.001**
SRS-22			
Function	2.9±0.9	3.5±0.9	**0.007**
Pain	2.3±0.8	3.3±0.9	**< 0.001**
Self-image	2.5±0.6	2.3±0.6	0.105
Mental health	3.6±0.8	3.0±1.0	**0.009**
Narcotic use			0.095
No narcotics (%)	50	76.5	
Weekly (%)	8.8	5.9	
Daily (%)	41.2	17.6	
Pre-op SVA (mm)	29.6±53.2	42.1±48.1	0.316
Revision (%)	35.3	2.9	**0.002**
Pelvic fixation (%)	64.7	52.9	0.324
3CO (%)	6.3	6.3	1.000
Number of levels fused	11.9±4.9	9.3±2.2	**0.006**

Mean ± standard deviation
SVA: sagittal vertical axis, 3CO: 3-column osteotomy
Bold letters represent $P < 0.05$

Table 3: Comparison of SRS-22 and narcotics use at 2-year post-operatively

Parameter	USA(*n*=34)	Japan(*n*=34)	*P*-value
SRS-22			
Function	3.5±1.0	4.0±0.6	**0.029**
Pain	3.5±1.1	3.8±0.8	0.143
Self-image	3.7±0.9	3.6±0.6	0.562
Mental health	3.8±1.0	3.7±0.8	0.704
Satisfaction	4.3±1.0	3.8±0.8	**0.032**
Change in SRS-22			
Function	0.6±0.8	0.5±0.7	0.377
Pain	1.2±1.2	0.5±1.1	**0.022**
Self-image	1.1±0.9	1.3±0.9	0.562
Mental health	0.2±0.7	0.7±1.2	**0.043**
Narcotic use			**0.038**
No narcotics (%)	68.8	90.3	
Weekly (%)	3.1	0	
Daily (%)	28.1	9.7	

Mean ± standard deviation
Bold letters represent $P < 0.05$

Therefore, Japanese patients tend to be hospitalized for several weeks after spine procedures. Kobayashi *et al*.[10] reported that the mean length of stay was 20.8 days after lumbar fusion surgery, which is much longer compared with the USA.[11] While hospitalized, the Japanese patients receive rehabilitation and pain management under close medical and nursing care. Therefore, their initial exposure to opioids is under strict supervision. In contrast, patients in the USA typically move more rapidly toward outpatient settings of care.[12] They have less strict supervision in terms of opioid use, which may be associated with more initial exposure to opioids. A greater amount of initial opioid use is associated with greater risk of long-term use, misuse, and overdose.[13,14]

The decreased use of opioids in treating acute post-surgical pain in Japan may reflect the lower initial exposure to opioids, and, consequently, the lower rates of long-term opioid use and misuse among the Japanese patients. Also, Japanese national insurance is strict, and indications for opioid use are limited. For instance, the insurance indicates use of oxycodone only for cancer pain; therefore, it cannot be prescribed for other post-operative pain. The difference in the medical and hospital systems can be a primary reason for the difference in opioid use at 2 years post-operatively.

Another possible explanation for the differences in opioid use between the cohorts relates to cultural difference.

Attitudes toward opioid medications are largely different across cultures. In the USA, the introduction of pain as the fifth vital sign has resulted in dramatic increases in opioid prescriptions.[15] In contrast, in Japan, chronic opioid use tends to be viewed as a criminal act.[16] Japan has a particularly strict storage regulation for opioids under the Narcotics and Psychotropic Control Law. Driving after taking opioids is strictly prohibited under Japan's Road Traffic Act. These regulations may suggest useful strategies to implement or further reinforce in the USA.

Another possible explanation for the differences observed in the present study stems from differences in the interpretation of pain across populations. The way of perceiving, expressing, and controlling pain is culture-specific.[17] Pain is the most frequent complaint brought to physician offices in North America, whereas Japanese patients may be less likely to complain of pain.[8,17] The USA has a significantly worse post-operative score in the SRS-22 function and equivalent scores in pain, self-image, and mental health. However, satisfaction is significantly better. US patients tend to have higher satisfaction than JPN patients despite similar surgical outcomes,[18] suggesting that perception may depend on culture. Cultural difference may also play an important role in the perception of pain.

There are limitations in this study. First, we only included patients with ASD. Our findings may be specific to ASD surgery and not extend to other spinal procedures. In addition, ASD typically includes heterogeneous pathologies such as idiopathic scoliosis, *de novo* scoliosis, and kyphosis. Opioid use might be different depending on the specific pathology. Secondly, characteristics, such as BMI, number of levels fused, and rate of revision, are not completely equal, although we propensity-matched the cohorts with similar weighting of these factors. The US cohort included more patients with greater BMI, revision procedure, and greater levels fused. Patients with a greater BMI may need more opioid use, which might be associated with chronic opioid use in the USA. In addition, revision procedures and a greater number of levels fused result in more invasive procedures. Although both of these factors might affect the difference in opioid prescription between the two cohorts, the difference between 9 and 11 levels fused is unlikely clinically significant. Lastly, our sample size is relatively small as matching was limited by baseline differences between the cohorts. One reason for this is the big discrepancy in the pre-operative narcotics use and BMI between the two cohorts. As shown in Table 1, the JPN cohort had significantly less narcotics use prior to propensity matching. BMI was significantly different as expected. These factors contributed to a small sample size after matching.

Conclusions

In propensity-matched ASD cohorts, 31% of the US patients were still using opioids 2 years after surgery compared with 10% of JPN patients, with most taking opioids daily. The Japanese spine surgeons demonstrate a different perspective on post-operative pain control that may provide insight for US spine surgeons in their attempts to mitigate the effects of over-prescription of opioid medications. Further studies are needed to identify sources of this variability.

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Conflicts of interest
There are no conflicts of interest.

Authors' contribution
This manuscript has been read and approved by all the authors.

(I) Conception and design: JLG and LYC

(II) Administrative support: JLG, LYC, MM, KW, VFL, and CPA

(III) Provision of study materials or patients: all authors

(IV) Collection and assembly of data: YO, JLG, LYC, MY, and VFL

(V) Data analysis and interpretation: all authors

(VI) Manuscript writing: all authors

(VII) Final approval of manuscript: all authors

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