DOES ADJUNCTIVE PAIN CONTROL WITH DEXMEDETOMIDINE IMPROVE OUTCOMES IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS?

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Kole Spaulding
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Mentor: M. Wade Shrader, MD

ABSTRACT

Adolescent Idiopathic Scoliosis (AIS) is typically treated surgically by Posterior Spinal Fusion (PSF) surgery. Intravenous analgesics and oral opioids are commonly used for pain management. Several adjunct therapies are used in addition to the standard treatments. One of these therapies is the use of dexmedetomidine (dex). Though dex has been found to be an effective sedative for post-operative patients, there are also several adverse effects that are associated with its use. The purpose of this study was to investigate the effectiveness and overall benefit of using dex for pain control for patients undergoing PSF for AIS.

IRB approval was obtained. A group of 43 patients with AIS undergoing PSF and using Dex for adjunctive pain control were matched with 43 patients who did not use Dex. The groups were matched based on gender, age, height, weight, and level of spinal fusion. During the patients' post-operative hospital stay, the total opioid use and clinical pain scores were compared between the two groups using t-tests, with significance set at $p<0.05$.

Total opiate use was 239.6 morphine equivalent doses in the non-Dex (control) group and 246.2 in the group that received Dex ($p=0.72$). The average pain score in the control group was 2.3, and the group that received Dex was 2.6 ($p =0.43$). There were no differences in the complication rate between the two groups, specifically the oversedation rates and pulmonary complications. Lastly, the average length of stay for the control group was 4.8 days compared to the dex group, which was 5.0 days ($p=0.35$).

Although adjunctive pain modalities may be very useful in the treatment of postoperative pain after PSF in patients with AIS, the use of Dex in this cohort did not improve pain scores, lower opioid use, or lower the LOS. Based on these results, we do not recommend the routine use of dexmedetomidine as an adjunctive pain control modality.

Adjunctive modalities are important in pain control in patients with AIS undergoing PSF, but the use of dexmedotomidine was not effective in improving pain control.

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INTRODUCTION, SIGNIFICANCE, RATIONALE

Background of AIS, PSF and Dexmedetomidine

There is substantial postoperative pain following posterior spinal fusion (PSF) surgery done to correct adolescent idiopathic scoliosis (AIS) [1, 2]. Poor pain management can lead to a number of complications for the patient such as higher levels of discomfort as well as inability to participate in physical therapy programs. Inadequate pain control also leads to anxiety for the patient's family and longer hospital stays[3-5].

For most hospitals, pain management following PSF surgery is done through intravenous patient controlled analgesia and oral opioids[6]. In addition to opioid use for pain management, practitioners use other, less studied, therapies to improve patient care due to the inadequacy of traditional approaches[7-8]. Patient or parent controlled analgesia (PCA), intravenous ketorolac, dexmedetomidine infusions, and local anesthetic infusion via indwelling catheters are some of the therapies used[9-12]. Practitioners observe improvement of pain management when using these therapies[13]. Better pain control leads to better participation in physical therapy regimens, and shorter hospital stays[14].

Dexmedetomidine (dex) is a selective alpha-2 adrenergic agonist used primarily for IV sedation[15]. Critical care units often use dex to sedate initially intubated and mechanically ventilated patients[16]. Dex is FDA approved for sedation during surgery and frequently is used as an adjunct therapy for patients recovering from PSF surgery. Dex has been associated with less post-operative delirium, decreased duration of mechanical ventilation, and shorter ICU stays[17-19]. However, overall effectiveness and potential adverse effects of dex have not been well established at this point.

As an alpha 2-adrenergic agonist, dex has the potential to cause a number of unfavorable results. Some of the common adverse effects include: hypotension, hypertension, nausea and vomiting, fever, and hypoxia[16,20, 21]. The use of dex is well established for adults as well as specific populations such as geriatric and pregnant patients, however, the safety and efficacy is not well established in children younger than 18 years of age[16]. Also, there are few

studies that have looked specifically at dex's effectiveness on the postoperative pain management of AIS patients recovering from PSF surgery.

Rationale

Though dex has shown some benefits for postoperative pain management and recovery, it has not been well established for the pediatric population or for PSF postoperative pain management. Dex has also been shown to have a number of potential adverse effects associated with it. For these reasons, it is necessary to determine the effectiveness of dex in PSF postoperative pain management. This study is aimed to determine if there is enough of a benefit from using dex that outweighs its potential adverse effects. We hypothesized that Dex would effective in reducing the overall pain scores of postoperative PSF patients; we also hypothesized that dex would effective in reducing the amount of narcotics used for these patients and that it would not have a significantly higher rate of complications associated with its use.

METHODOLOGICAL APPROACH

Study Design and Population

This was a retrospective case match study of all patients between the ages of 10 and 18 with AIS who underwent PSF surgery at Phoenix Children's Hospital. Charts were reviewed, only, so no patients were contacted directly. Surgery outcomes during the summer months (May-August) of 2011, 2012, and 2013 were analyzed. Patients who underwent PSF surgery for any other reason than AIS were excluded from this study. Patients were placed into two groups: 1) those that received dexmedetomidine infusions and 2) those that did not receive dexmedetomidine infusions. 86 total subjects (43 from each group) were matched based on age, gender, weight, level of spinal fusion, and length of hospital stay. After the data was collected and subjects properly matched, the total narcotic use and average clinical pain scores were compared between the two groups.

An opioid conversion calculator was used to measure total narcotic use. Oral opioids including oxycodone, morphine, hydrocodone, and codeine as well as IV opioids including hydromorphone, morphine, and fentanyl were all converted to a daily IV morphine equivalent dose (MED). The daily MED was calculated for the first 24 hours post-operatively as well as the total narcotic use during the post-operative period up to 5 days. This calculator was used to address the potentially different potencies of each opioid used.

The numerical pain scale was used with patients to assess their pain levels. With this scale the patient reports the pain score on a scale from 1-10, and the nurse records it. It is used as a standard pain assessment tool in adult and pediatric hospitals throughout the country.[22] In addition to the numerical pain scale, the Face, Legs, Activity, Cry, and Consolability (FLACC) scale was used in those immediate post-operative patients who were unable to report their pain scores. This scale has been validated in measuring post-operative pain in the pediatric population.[23]

Information placed in the database was limited to data concerning the patient's post-operation pain and function that is related to their pain management after surgery. Data collection and patient demographics included patient age, gender, height, weight,

race/ethnicity, social history, insurance, specifics of PSF (implants, level), complications, reoperations, date of admission, date of discharge, length of stay (LOS), Dex use, IV narcotics used, On-Q use, benzodiazepines used, ketorolac use, daily opioid use (MED) days 1-5 postop, total opioid use (MED), number of days to ambulation, number of days to tolerating solid foods, nausea and vomiting, fever, O_2 sat., urinary retention, hypertension, hypotension, sedation, reintubation, readmission to ICU, naloxone use, pre-operation pain score, post-operation pain score recorded at 24 hours as well as the average pain score during the hospital stay.

Statistical Analysis

In order to determine the effectiveness of dexmedetomidine, patients who did receive dex treatment were matched with patients who did not receive dex infusions. Subjects were matched on age, gender, weight, and levels of spinal fusion. The main dependent variables were the amount of narcotic use and clinical pain scores. This information was compared between those patients that did receive dex and those who did not receive dex infusions. This information on the two groups was then be studied using a T-test analysis. Significance was set at the .05 level.

Other dependent variables such as length of hospital stay, adverse effects, days until ambulation, and any complications of surgery, were statistically analyzed to determine any significance associated with dex treatment.

RESULTS

When the 43 patients from each group were matched, the variables were analyzed using T-test analysis. The results of the matching process were as follows are illustrated in **table 1**. Patient gender was not reported in this table as all males were only paired with males and females with females.

The length of hospital stay was analyzed first. It was found that the non-dex group averaged a length of stay of 4.8 days compared to the dex group which was 5.0 days (p=.35). Next, the opioid use between the two groups was analyzed. These values are recorded in morphine equivalent dose (MED) units. Again, an opioid calculator was used in order to convert all forms of opioids into MED for easier comparison between groups. The mean opioid use for the first 24 hour post-operative period was 24 MED in the Dex group and 24.6 in the non-Dex group. **Figure 1** illustrates this comparison.

The total mean opioid use for the two groups was calculated up to 5 days out from each patient's surgery. The Dex group had a mean total opioid use of 246.2 MED compared to the non-Dex group which had a mean of 239.6 MED. The comparison of these two groups is further illustrated in **Figure 2.**

The next variable analyzed was the average pain scores experienced in the initial 24-hour post-operative period compared between the Dex and non-Dex groups. Pain scores are recorded on the traditional severity level (1-10) with 10 being the highest amount of pain possible. The Dex group had a mean score of 2.1 while the Non-Dex group had a score of 1.8. For the mean total pain scores reported during the post-operative period, the average for the Dex group was 2.6 and the non-Dex group 2.3. The comparison for both the 24 hour and total mean pain scores is shown in **Figure 3.**

There were a number of post-operative complications recorded in the charts of both non-dex and dex patients. In the dex group, there were 37 total patients who experienced complications compared to the non-dex group, which had 40 total patients with complications (p=0.29). A complete list of the types of complications can be seen in **table 2.** Some patients experienced more than 1 complication at a given time.

Variable	Non-Dex	Dex
Average Height	158.6 cm	158.9 cm
Average Weight	53.1 kg	52.9 kg
Age	14.1	14.6
Number of spinal levels fused	11.7	11.7

Table 1. Results of the dex and non-dex group matching.

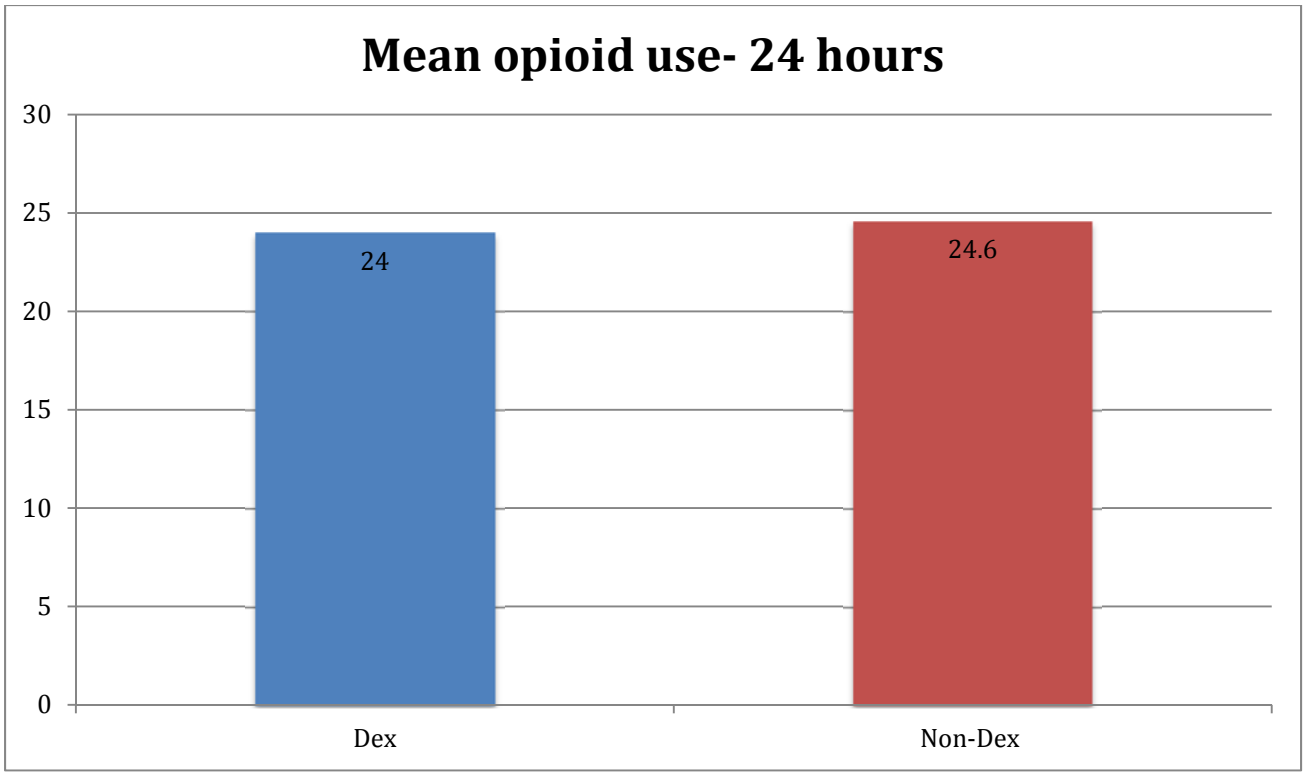

Figure 1. Average opioid use, recorded in Morphine Equivalent Dose (MED), compared between Dex and Non-Dex groups in the initial 24 hour post-operative period.

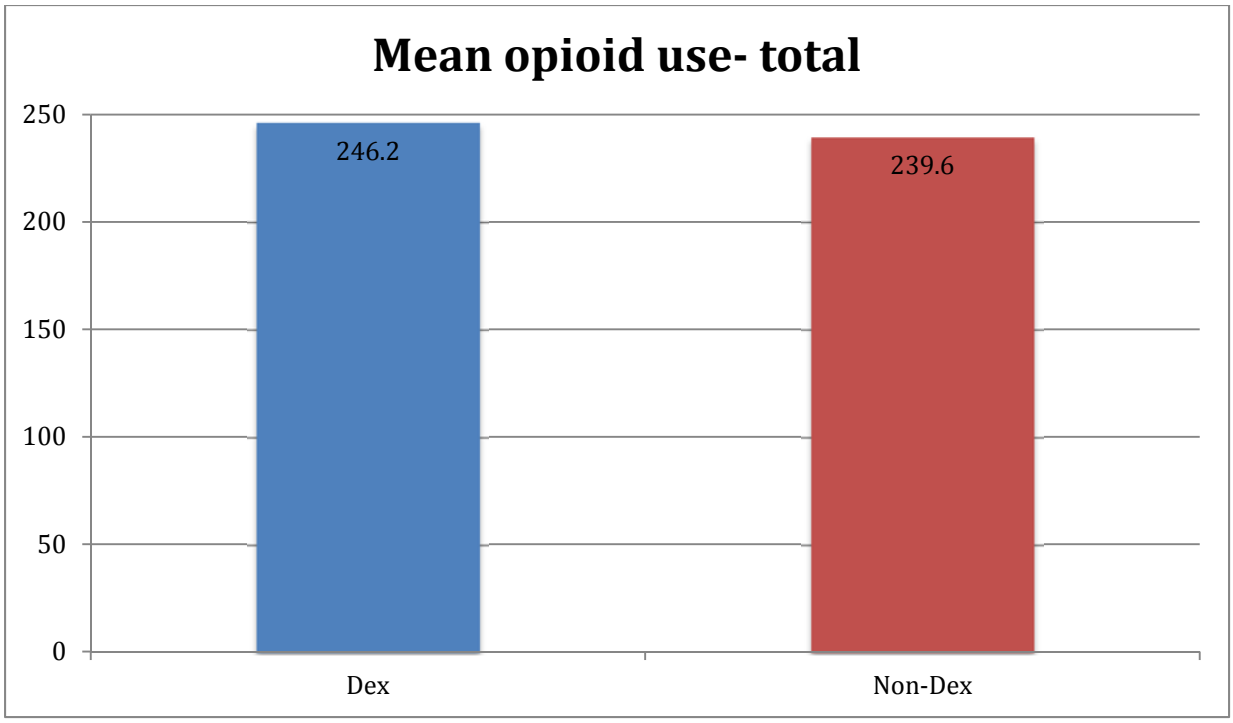

Figure 2. A comparison of the mean total opioid use recorded in Morphine Equivalent Dose (MED) of the Dex and non-Dex groups during the post-operative period.

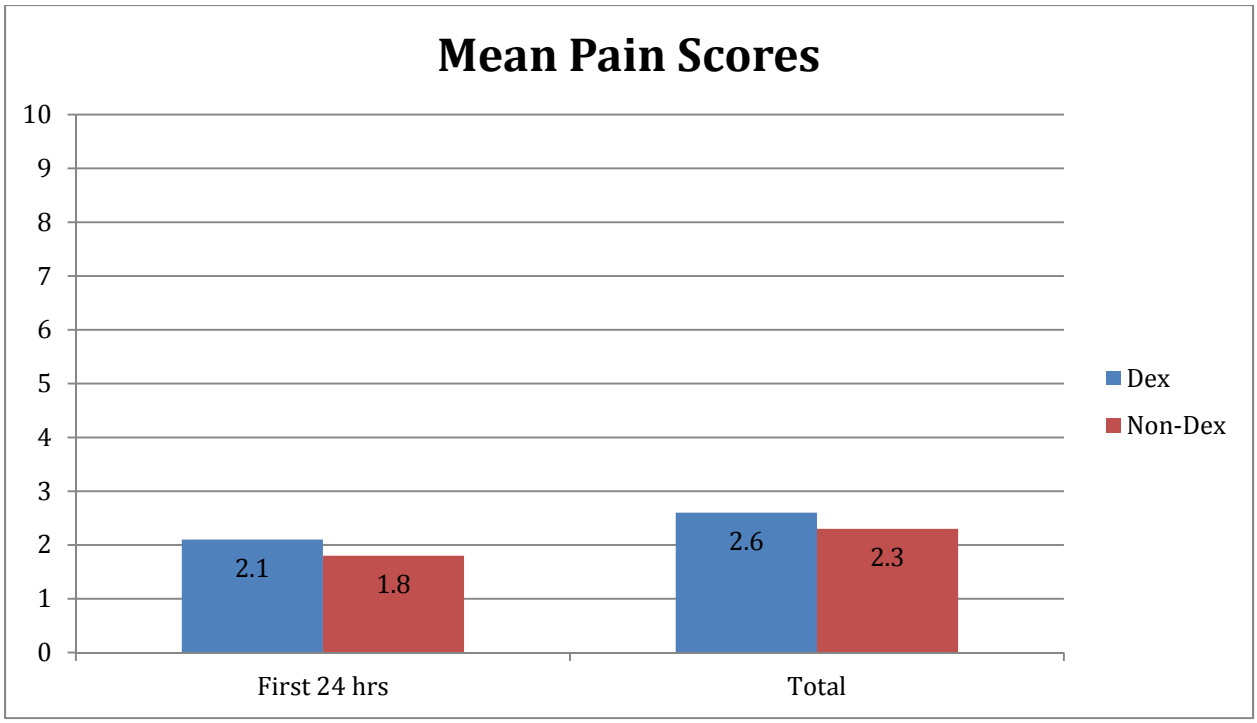

Figure 3. The average pain scores, reported on a 1-10 severity scale, compared between the Dex and non-Dex groups for the initial 24 hours as well as the total post-operative course.

Complication	Non-Dex	Dex
Post-hemorrhagic anemia	32	27
Pulmonary insufficiency	7	9
Nausea and/or vomiting	3	3
Hypotension	7	6
Coagulation defect	1	0
Acidosis	1	3
Drop in HCT	2	4
Constipation	3	8
Hypoxia/Hypoxemia	2	1
Dysrhythmia	1	1
Pulmonary Embolism	1	2
Pruritus	1	1
Anxiety	1	2
Tachycardia	2	2
Hypocalcemia	2	0
UTI	1	0
Respiratory distress	1	2
Urine retention	1	0
Fever	1	0
Migraine	1	0
Respiratory failure	1	0
Shock	1	0
Thrombocytopenia	1	0
Pneumothorax	2	0
Paralytic ileus	0	2
Pulmonary collapse	0	2
Adverse effect from anesthesia	0	3
Emboli UE	0	1
Hypo-osmolality	0	1
Total complications	78	81

Table 2. List of post-operative complications in both Dex and Non-Dex patients.

DISCUSSION

There are no statistically significant differences in the initial 24-hour narcotic use, total narcotic use, and average pain scores between the two groups. These were unexpected results, as it was hypothesized that the dex groups would have decreased average pain scores and significantly less total narcotic use. The complication rate between the two groups also was very similar. This suggests that the use of dex, with all of its potential side effects, does not increase the risk of post-operative complications, as was anticipated.

The results show that there is a slight increase in the length of stay for those patients receiving dex infusions. This is likely due to the additional sedating factors that dex has on patients. With an increase in sedation in the initial post-operative period, patients most likely need an additional few hours to recover. However, the statistical difference in the length of stay was small between the two groups. This difference may be due to the small sample size of this study. Nonetheless, as the data suggests that dex might increase sedation and might increase hospital stay, then the use of this adjunctive medication should be questioned.

There are few studies that have analyzed dexmedetomidine's effectiveness in the post-operative pain management for PSF done to correct AIS. This is an important question to in order to further establish whether or not the use of dex should be standard of care in post-operative pain management. The results from this investigation indicate that further investigation of dex as an adjunct therapy for post-operative pain in PSF patients is merited. If more information, perhaps in a larger study, could be gathered it is possible that the necessity of dex in this patient population could be confirmed or rejected.

FUTURE DIRECTIONS

As this study was limited by sample size, it would be ideal to have a similar study done on a larger scale. Currently, several abstracts have been submitted for presentation for both the Scoliosis Research Society (SRS) as well as the Pediatric Orthopaedic Society for North America (POSNA). The goal is that a presentation or possible publication of this study will lead to avenues to further research the use of dex in this patient population.

CONCLUSIONS

The major findings of this study were as follows: there was no statistical significance in the total narcotic use between the dex and non-dex groups, the mean pain score was similar between the two groups, and the post-operative complication rates between the two groups were similar. According to the findings of this study, there appears to be little improvement in patient outcomes after receiving dex, compared to not receiving dex during the post-operative period. The implication of these results is that the use of dex during the recovery phase of PSF patients should be questioned and further investigated. If a larger study were able to confirm these findings, it is likely that the use of dex would be decreased if not entirely eliminated from the arsenal of adjunctive pain medications.

RESOURCES/FACILITIES

The work done on this project was guided and supervised by Dr. Wade Shrader M.D., Dr. Greg White M.D., and Carla Plantikow who is the research coordinator for the Center for Pediatric Orthopaedic Surgery will also be used as a resource for the duration of this study. All of the surgeries took place at the Phoenix Children's Hospital (PCH) Center for Pediatric Orthopaedic Surgery. The data will be analyzed in the Center for Pediatric Orthopaedic Surgery located on the second floor of PCH.

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