

**THE EFFECT OF TWO SURGEONS ON BLOOD LOSS AND OPERATIVE TIME IN PATIENTS WITH
ADOLESCENT IDIOPATHIC SCOLIOSIS UNDERGOING POSTERIOR SPINAL FUSION**

A thesis submitted to the University of Arizona College of Medicine - Phoenix
in partial fulfillment of the requirements for the Degree of Doctor of Medicine

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Class of 2017

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Abstract

Background and Significance: Surgical correction of Adolescent Idiopathic Scoliosis (AIS) carries a substantial risk of complication. The literature supports improved perioperative outcomes through the two surgeon strategy in other complex orthopedic procedures.

Research Question: Does the presence of 2 versus 1 attending surgeons affect the perioperative morbidity of posterior spinal fusion (PSF) in patients with AIS curves greater than 70°.

Methods: We reviewed the database from a large regional children's hospital of all patients with AIS curves greater than 70° who underwent PSF from 2009-2014 and divided the cohort into single versus 2-surgeon groups (28 vs. 19 cases, respectively). We analyzed cases for length of surgery, estimated blood loss, and length of stay.

Results: The groups were identical when comparing age, gender, spinal levels fused, and average ASA score. However, the average Cobb angle in the single surgeon group was significantly less than in the 2 surgeon group at 78.4 vs 84.0 degrees, respectively ($p=0.049$). Mean operative time for single versus 2 surgeons was 238 (SD 48) vs 212 (SD 46) minutes ($p=0.078$). Mean percent estimated blood loss was 26% (SD 14.1) for single surgeon vs 31% (SD 14.9) for 2 surgeons ($p=0.236$), and mean estimated blood loss for single surgeon vs 2 surgeons was 830ml (SD 361) vs 1045ml (SD 346) ($p=0.052$). Mean length of stay was significantly decreased in the 2 surgeon group at 5.16 days (SD 1.7) versus the single surgeon group at 6.82 days (SD 6.82) ($p=0.002$).

Conclusions: The use of 2 surgeons in AIS deformity correction at an experienced regional children's hospital did not improve clinical outcomes. The average length of stay was reduced in the two-surgeon group, but there was no significant impact on blood loss or operative time. However, this study does not rule out the potential for positive impact with a two-surgeon strategy, and given previous supportive data in the literature, this approach should further evaluated to determine its effect on improving perioperative outcomes.

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Introduction:

Adolescent Idiopathic Scoliosis (AIS) is the most common cause of spinal deformity and occurs in the general population at a prevalence of 0.47-5.2%^{1,2}. AIS is defined as a three dimensional deformity of the spine with a lateral curve in the coronal plane of greater than 10° in children above the age of 10 with an unknown etiology³.

Scoliosis that occurs in the adolescent period (after age 10) does not constitute a statistically higher risk of mortality⁴. However, it does threaten pulmonary function over time^{5,6}. Curves greater than 60° risk respiratory failure by the fourth decade of life and curves greater than 90° may necessitate tracheostomy intubation. Severe scoliotic curves that are not surgically corrected can progress after skeletal maturity and eventually impact respiratory muscle efficiency by placing these muscles in positions inconducive to their functioning⁷. In addition, cosmetic appearance is a concern for patients' quality of life. Disfiguring curves can impact a patient's social life and general functioning.

It is important to treat scoliosis early and aggressively. The rate of progression is steepest during the adolescent growth period⁸. Curves greater than 30° at the onset of puberty carry a surgical risk of 100%. Beyond skeletal maturity, thoracic curves progress at an average of 1° per year. Thoracolumbar curves progress at 0.5° and lumbar curves progress at 0.24°⁹.

Surgery is indicated to treat curves with a Cobb angle greater than 45-50° or a scoliotic deformity that is likely to progress. Bracing is not a useful corrective measure in curves above 40°¹⁰. The goals of surgery are to arrest curve progression by achieving solid fusion, correct the deformity, improve cosmetic appearance and halt the progression of secondary comorbidities³. Currently, the best method of surgical correction for severe scoliosis is pedicle screw instrumentation with posterior-only arthrodesis. All-pedicle screw fixation results in less intraoperative blood loss and less time in the intensive care unit without a statistically significant decrease in surgical time^{11,12}. It allows for adequate curve reduction and is associated with lower risk of pseudarthrosis, infection, neurologic deficit, and reoperation compared with Harrington rod and Cotrel-Dubousset instrumentation^{13,14,15}.

Regardless of the method, surgical correction of scoliosis is associated with significant

perioperative morbidity¹⁶. For this reason, it is important to mitigate risk factors to the greatest extent possible. There is a correlation between increased surgical time and greater intraoperative blood loss¹⁷. Increased blood loss during surgery also correlated with prolonged hospital and ICU stay¹⁴. Excessive bleeding and prolonged hypotension during surgery are a risk factor for neurological complications¹⁶. Prolonged anesthesia time and excessive blood loss are cited as factors contributing to non-neurologic complications while ICU stay length is a predictor of both surgical site infection rate and long-term survival rate^{16,18,19}.

Previous studies have shown that intraoperative risk factors can be reduced by having two surgeons operate simultaneously. Gurtner, Robertson and Chung showed that oesophagectomies performed synchronously by two surgical teams were performed significantly faster and reduced mean hospital stay from 24 to 16 days²⁰. Similarly, simultaneous bilateral anterior cruciate ligament repair performed by two surgical teams was determined to be a safe alternative to either single-setting reconstruction or staged surgeries performed by a single surgical team²¹. Most recently, Ames compared perioperative outcomes of pedicle subtraction osteotomy of single versus 2-surgeon groups²². Perioperative outcomes were significantly improved for the two-surgeon group in regards to mean percent estimated blood loss and average surgical time.

Despite the evidence of improved perioperative outcomes with two surgeons, there have been no studies conducted about the impact of using two surgeons for corrective spinal surgery in adolescent idiopathic scoliosis patients with large magnitude curves. Using a two-surgeon method in this patient population may lead to decreased intraoperative risk factors and improved outcomes. The goal of this study was to determine whether using two surgeons for posterior spinal fusion in adolescent idiopathic scoliosis patients with curves greater than 70° improves perioperative outcomes by decreasing operating time, blood loss and hospital length of stay.

Methods:

Available data on all eligible patients referred to PCH between January 1, 2009 and December 31, 2014 was used to perform a retrospective chart review of patients with adolescent idiopathic scoliosis with curves greater than 70° who underwent posterior spinal fusion. The subjects were identified by a search of the hospital's ICD9 and discharge diagnoses. Patients were not contacted. IRB approval was obtained through PCH. 47 patients were identified, 28 of whom had two attending surgeons while 19 underwent posterior spinal fusion performed by a single attending surgeon assisted by a resident or PA.

Data collection of patient and injury demographics included patient age, gender, weight, ASA classification, severity of curve, anesthesia time, total operative time, estimated blood loss (EBL), percent estimated blood loss (%EBL), blood transfusions, spinal levels fused, and hospital length of stay. %EBL was calculated as EBL divided by total estimated blood volume, which was estimated as weight in kilograms multiplied by either 75ml/kg for males or 65ml/kg for females. The severity of the curve was assessed by measuring the Cobb angle from preoperative radiographs.

Patients with large magnitude curves due to neuromuscular diseases or any defined pathology other than idiopathic scoliosis were excluded, as well as patients with kyphotic curves. Patients requiring staged procedures due to interrupted motor evoked potentials during operation were excluded as their total operative time and hospital length measurements are no longer comparable to patients with a single stage procedure.

The Student's T-test was used to compare the three major variables of blood loss, anesthesia time, and hospital length of stay between the single-surgeon and two-surgeon groups. Levene's Test for equality of variances was used to compare the two groups in terms of age, severity of curve, spinal levels fused, and patient ASA classification. Equal variances were assumed unless they were statistically different, in which case equal variances were not assumed. A Chi-Square test was used to compare categorical variables between the groups. Statistical significance was designated at $p < 0.05$.

Results:

Patients in the single-surgeon group and the 2-surgeon group were demographically similar with no significant difference in age or gender (Table 1). Patients in the two groups underwent comparable surgical procedures in terms of spinal levels fused, and ASA classification (Table 1). However, the preoperative Cobb angle did reach significance with the two surgeon group having a higher average Cobb angle (84.02 vs. 78.42) (**Table 1**).

Table 1:

	Single Surgeon	Two Surgeon	P value
Patients (n)	28	19	
Mean age (years)	13.57	13.05	0.334
Gender	5 Male, 23 Female	4 Male, 15 Female	
Mean Cobb angle (degrees)	78.42	84.02	0.049
Mean levels fused	12.75	13.11	0.170
Mean ASA score	1.61	1.58	0.880

There was no statistical difference between the total operative time, anesthesia time, EBL, %EBL, or blood transfusion units (Table 2). Total operative time was lower on average for the two-surgeon group (212.11 vs. 238.07 minutes, SD 46 vs. 48, $p=0.078$). Total anesthesia time was also lower on average for the two-surgeon group (302.21 vs. 325.71 minutes, SD 45 vs. 54, $p=0.135$). EBL was higher on average for the two-surgeon group with p approaching significance (1045 vs 830mL, SD 346 vs. 361, $p=0.052$). %EBL was also higher for the two-surgeon group although p did not approach significance (31.39 vs. 26.13, SD 14.9 vs. 14.1, $p=0.236$). Blood transfusion units for the two-surgeon group on average was 0.26 units, for the single-surgeon group it was 0.39 units ($p=0.50$). Significance was observed in the difference of average hospital length of stay between the two groups (two-surgeon 5.16 days with SD 1.7, single-surgeon 6.82 days with SD 3.2, $p=0.002$) (**Table 2**).

Table 2

	Single Surgeon	Two Surgeon	P value
Operative time (minutes)	238.07	212.11	0.078
Anesthesia time (minutes)	325.71	302.21	0.135
Estimated Blood Loss (mL)	830.36	1045.37	0.052
Percent Estimated Blood Loss	26.13	31.39	0.236
Transfusions (units packed RBC's)	0.39	0.26	0.498
Length of Stay (days)	6.82	5.16	0.002

Discussion:

Posterior spinal fusion with pedicle screw instrumentation currently remains a safe and effective method of operative treatment for adolescent idiopathic scoliosis. Previously, large magnitude idiopathic scoliotic curves greater than 80° were performed using an anterior release through an open thoracotomy followed by posterior instrumentation²³. The current posterior-only approach eliminates the need for an anterior procedure, resulting in reduced operating times, fewer complications, and shorter hospital stays. It allows for greater deformity correction in the coronal plane and results in less loss of correction at follow up²⁴. Still, it is a surgical procedure that is demanding in time and skill and does carry significant risk for complications.

The aim of this project was to identify an area of improvement upon which the surgical correction of large magnitude scoliotic curves in AIS patients can be made safer. There is reasonable precedent for the simultaneous use of two surgeons with the goal of reducing operating time, blood loss, and hospital length of stay. Most similar to this study is Ames' 2012 findings that pedicle subtraction osteotomy performed with two surgeons resulted in significantly less operative time and estimated blood loss²². Unfortunately, the data analyzed in this study did not yield results that showed significant improvement in outcome with two surgeons.

There was a trend ($p=0.078$) for reduced operative time in the two-surgeon group, 212 minutes, compared to 238 minutes for the single-surgeon group.

Most disappointing was the finding that estimated blood loss actually increased for the two-surgeon group. This difference did approach significance ($p=0.052$). However, the more important measurement of blood loss is arguably the percent estimated blood loss. This takes into account the size of the patient and recognizes that larger patients will likely have greater blood loss. This figure was not statistically significant ($p=0.236$), suggesting that at best we cannot make inferences about the impact of two surgeons on blood loss from this study. Interestingly, despite the lack of significance in the previous two parameters, length of stay was significantly decreased for patients in the two-surgeon group ($p=0.002$). It is difficult to say

what led to a significant decrease in stay length without concurrent significant decreases in blood loss and operative time.

There are many factors that may have led to the outcomes in this study. Most importantly, and probably the main reason for a lack of significance in many areas of investigation is that the sample size was exceedingly limited. Adolescent idiopathic scoliotic curves of large magnitude, specifically greater than 70°, are rare. Despite the study site being located at one of the 10 largest children's hospitals in the nation, only 47 patients in 6 years met the inclusion criteria. The vast majority of cases of adolescent idiopathic scoliosis are identified years before surgical correction is indicated, and most receive treatment as soon as the curve reaches surgical size (45-50°). Curves that reach 70° or greater usually occur due to loss to follow up until the patient presents again at a much progressed stage of disease.

Demographically, the single-surgeon and two-surgeon groups were comparable. They were not significantly different in regards to age, gender, and spinal levels fused. However, the preoperative Cobb angle was of significant difference (single-surgeon 78.4° vs. two-surgeon 84.0°, $p=0.049$). This calls into question the process by which patients were assigned to the single-surgeon and two-surgeon groups. The surgeons involved in the study described the assignments as random and mainly based on scheduling practicality. With the greater Cobb angle in the two-surgeon group, though, it is possible that more difficult cases were given higher priority for receiving two operating surgeons. Nugent found that larger preoperative Cobb angle was significantly correlated with greater EBL and higher risk of RBC transfusion as well as increased operative time²⁵. The more difficult nature of these cases could be an

Future Directions:

This study does not rule out the positive impact that two surgeons may have on procedural outcome. As a retrospective chart review, it is a low-power study. This study could yield much different results if performed in a prospective, randomized controlled manner with much larger subject enrollment. The surgeons would also need to be distributed evenly between the two groups. This study is inconclusive as to the impact of a two-surgeon vs single-surgeon operation for large magnitude adolescent idiopathic scoliosis curves and further investigation is warranted.

Conclusion:

The technique of having two experienced orthopaedic spine surgeons work simultaneously performing pedicle screw only posterior spinal fusion on large magnitude AIS curves greater than 70° significantly decreased the average length of stay but did not significantly impact blood loss or operative time. Increased EBL and operative time is correlated with prolonged hospital stay and is a risk factor for both neurological and non-neurological complications. The simultaneous use of two surgeons for other orthopaedic procedures has previously been shown to decrease operative time and blood loss. More investigation is needed to determine if the use of two surgeons would benefit patients with large magnitude AIS curves.

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