# PARTIAL CORRECTION OF COBB ANGLE PRIOR TO POSTERIOR SPINAL INSTRUMENTATION

Yaser M. Behairy, MD, FRCSC; Diana L. Hauser, PhD; Douglas Hill, MBA; James Mahood, MD, FRCSC; Marc Moreau, MD, FRCSC

**Background:** A substantial contribution to the overall surgical correction of Cobb angle has been observed to occur prior to securing the instrumentation. Knowledge specific to the amount of correction prior to instrumentation is scarce in the medical literature. If significant correction is due to the positioning and muscle stripping during exposure of the spine, questions arise about the usefulness and need for extensive rod-rotation maneuvers to further straighten the spine. This study quantifies the extent of correction achieved from standing to prone, with the spine exposed before and after instrumentation.

**Materials and Methods:** Eleven patients with the diagnosis of adolescent idiopathic scoliosis (AIS) and a right thoracic major curve were included in the study. Intraoperative changes in Cobb angle were measured before and after instrumentation, as well as postoperatively. The patients underwent posterior spinal instrumentation by the same surgical team using the rod-rotation techniques. Radiographs were taken prior to surgery, intraoperatively before and after instrumentation and postoperatively within one week from surgery. Cobb angle measurements were performed by the same examiner.

**Results:** The median preoperative Cobb angle of 60°±14° (48-90°) corrected to a median of 26°±22° (10-80°) on the right bend film, to a median of 55°±12° (30-70°) intraoperatively after exposure, and to a median 30°±10° (20-46°) after rod-rotation/instrumentation and fixation. The follow-up standing radiograph median Cobb angle was 40°±14° (9-56°). A median intraoperative correction of 28° was obtained, 10° of which was prior to the rod rotation and instrumentation. High variability was observed in the percentage contribution of pre-instrumentation release with a median of 42%±25% (0-67%).

**Conclusion:** Approximately one-third of the total correction occurred prior to instrumentation being applied, and even though it was variable and substantial, the actual surgical rod rotation and instrumentation maneuver provided the majority of correction.

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**Key Words**: Spine, adolescent idiopathic scoliosis, Cobb angle, surgery.

Scoliosis is a complex three-dimensional deformity of the spine and ribcage, where individual vertebrae are translated laterally and rotated.[1] The standard method of assessing scoliosis curves is the Cobb angle measurement from a standing posterior-anterior (PA) radiograph of the spine.[2] Although it is clear that curve size is a function of more than the Cobb angle,[3] and this angle does not measure the three-dimensional correction, it is the current gold standard for assessing scoliosis.

Surgical treatment of scoliosis has evolved over the last few decades into the current available systems that use bilateral rods with wires, hooks, and/or screws to further enhance the surgeon's ability to correct the spinal deformity and fix the spine in a stable fashion.[4,5] There are several commonly used systems for posterior spinal instrumentation, including the Cotrel-Dubousset System,[6] Texas Scottish Rite System,[7] Isola, and Moss-Miami Instrumentation Systems. The major advantage of these new systems is that they allow for quicker mobilization of the patient without the need for external bracing. They also achieve better control over the sagittal plane, and allow for the rod rotation maneuver.[8] Several studies have documented the use and outcome of these newer instrumentation techniques, as well as the problems that may be encountered, such as postoperative decompensation,[9,10] and change in the shape of scoliotic curves.[11]

A fundamental element of the preoperative planning for adolescent idiopathic scoliosis (AIS) surgery is selecting the fusion levels and determining the amount of curve correction required to achieve the goals of surgery.[3,4,8,12] Several studies have looked at the preoperative supine films, with maximum bending versus traction bending and their effect on the curve and their usefulness in selecting fusion levels.[11,13-16] These studies showed that the selection

From the Departments of Orthopedic Surgery (Drs. Behairy and Hauser), Harvard Medical School, USA, and University of Alberta (Drs. Mahood and Moreau), and the Glenrose Rehabilitation Center (Mr. Hill), Edmonton, Alberta, Canada.

Address reprint requests and correspondence to Dr. Behairy: P.O. Box 53118, Riyadh 11583, Saudi Arabia. E-mail: ybehairy@yahoo.com.

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of fusion level is best determined by a combination of preoperative standing PA and lateral radiographs and supine maximum bend films. Other studies have looked at the usefulness of preoperative correction of curves, using techniques such as halo-pelvic traction and Cotrel dynamic traction, and found no usefulness to them.[17]

It has been observed that substantial contributions to the overall surgical correction of scoliosis can occur prior to securing the instrumentation. To the best of the authors' knowledge, studies about the amount of correction prior to instrumentation compared to the overall amount of correction of AIS curves have not been well documented. A thorough review of Medline failed to reveal any documentary studies regarding this specific area. Pre-instrumentation correction could be due to the effect of anesthesia and muscle relaxants, the prone position of the patient on the operating table, or to dissection of the paraspinal muscles as part of the posterior approach to the spine. If significant correction obtained is due to one or all of these factors, the question arises as to the usefulness of extensive surgical maneuvers to further straighten the spine, especially when it is known that the danger of injuring the spinal cord occurs during such maneuvers.[21] Another question is whether the information obtained by measuring this pre-instrumentation correction could possibly alter the selection of fusion levels.

## Materials and Methods

Eleven patients with the diagnosis of AIS and right thoracic curve were included in this study. Each patient had a progressive curve requiring surgical treatment. The instrumentation and fusion levels were individually selected by the treating surgical team, according to the criteria set by King et al.[12] Each patient underwent posterior spinal instrumentation and fusion by the same surgical team, using the rod-rotation technique and one of two instrumentation systems, which were either the Cotrel-Dubousset or the Moss-Miami System. Each patient had a complete set of radiographs that are part of the standard care for AIS patients at the University of Alberta Hospital. These included a preoperative standing PA and lateral views of the spine, a preoperative right and left maximum bend supine films, and two intraoperative prone PA radiographs.

One of these intraoperative radiographs was taken after careful subperiosteal exposure of the spine, and a towel clip applied at one of the spinous processes to identify the vertebral level. The second intraoperative film was taken after completion of the rod-rotation maneuver and secure fixation of the instrumentation. Standing PA radiographs were obtained within the first week postoperatively. No lateral views of the spine were done intraoperatively. Cobb angle measurements on these radiographs were done by the same examiner with the same accurate protractor. Medical records provided information on the patient's age at time of surgery, skeletal maturity, and diagnosis. The median, standard deviation, and range of the Cobb angles and their respective changes were calculated. Linear regression analysis was used to describe the relationship between independent and dependent variables (Microsoft Excel™, Seattle, Washington, USA).

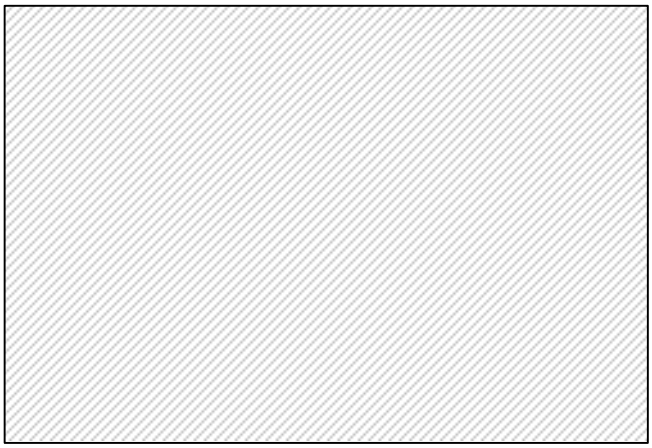

FIGURE 1. Patient vs. Cobb angle correction prior to and after instrumentation.

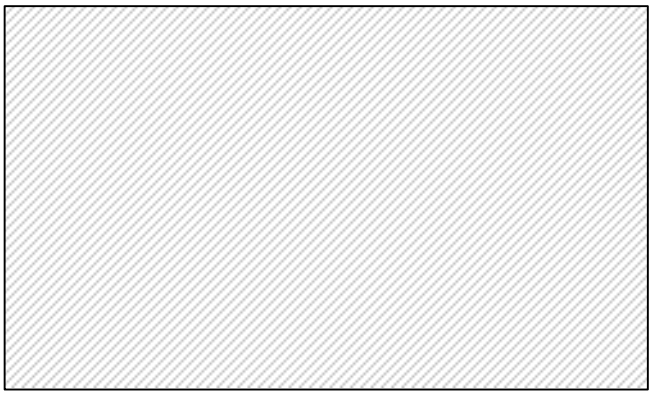

FIGURE 2. Cobb angle correction on right bend film vs. postoperative Cobb angle correction.

## Results

There were 10 females and one male, with a mean age at the time of surgery of 14 years (range, 12-16). The median preoperative Cobb angle was 60°±14° (range, 48-90°), which was corrected to a median of 26°±22° (10-80°) on preoperative supine right bend film (Figure 1). This angle was then corrected to a median of 55°±12° (30-70°) intraoperatively, prior to instrumentation. The median final intraoperative Cobb angle was 30°±10° (20-46°). The postoperative angle was 40°±14° (9-56°). Pre-instrumentation release contributed a median 42%±25% to the overall correction, with a wide range of 0%-67% contribution. The degree of pre-instrumentation correction was found not to be significantly correlated with the degree of measured preoperative Cobb angle, based upon linear regression analysis ($r^2$=0.019). A poor correlation ($r^2$=0.001) between curve flexibility (as demonstrated by

correction measured on the preoperative right bending film) and the amount of correction obtained intraoperatively prior to instrumentation was demonstrated. The degree of correction obtained postoperatively could be predicted from the preoperative right bend film ($r^2$=0.62, $P$=0.006, n=11), as shown in Figure 2.

## Discussion

Approximately one-third of the total correction obtained in AIS surgery occurred prior to instrumentation of the spine. Although this is a substantial amount, the actual surgical maneuver provides the majority of curve correction, contributing to the justification of the associated risks. This study is one of the first to quantify the magnitude and variability of the correction achieved, proving that they can be highly variable. This is most likely due to the degree of normal and/or pathologic anatomic variation. In addition, the patient population studied was homogeneous for AIS diagnosis, representative in age and gender (i.e., 90% female), and possessed the predominant right thoracic curvature. Careful control was exhibited with parallel technique by the same examiner and surgical team. One of the limitations of this study, however, is the known intra- and inter-observer variation for manual Cobb angle measurement, with reported variations from 2.8 to 10°, depending upon optimality of conditions.[13,19,20] Shea et al.[21] reported intra-observer variability of 3.3° (range, 2.5-4.5°) for the 95% confidence interval when measured under similar conditions used for this study. This variation of less than 5° would not have changed the findings of this study, but would have altered the magnitude proportionately. In addition, the fact that the preoperative radiographs were taken while standing, in contrast to the prone position used intraoperatively, may introduce another anticipated small measurement error, not significantly changing the interpretation of the data. In a study on 287 girls with AIS, Torell et al.[22] reported an average of a 9° increase in curve severity from the supine to the standing position. This difference was independent of curve severity.

In our study group, we demonstrated that there was a positive correlation between the percentage of final correction obtained after instrumentation, and the flexibility of the curve, as demonstrated on preoperative bending films. Takahashi[15] noted a similar relationship for thoracic curves between the postoperative Cobb angle and the preoperative Cobb angle in traction. However, a poor correlation was found between the amount of pre-instrumentation correction, and both the severity of the curve and the maximum correction on bending film, which can possibly be explained by the variability in the degeneration of the soft-tissue structures, and the underlying inherent anatomical variation.

This study, therefore, supports the notion that it is not possible to predict in any patient the amount of interoperative pre-instrumentation correction based on the preoperative supine and bending films. This means that it is not possible to predict from the severity of the curve alone or from the preoperative bending film whether the majority of intraoperative correction in a particular curve will be obtained prior to the derotation maneuver or after it. Of note, the pre-instrumentation correction was not greater than 50% for our cases, thus the derotation maneuver was performed. There is not sufficient data from this analysis to factor into the selection of fusion level. In conclusion, we have quantified the pre-instrumentation correction, demonstrated it to be contributory, and illuminated the magnitude of the need for the posterior spinal instrumentation.

## References


1. Weinstein SL. Adolescent idiopathic scoliosis: prevalence and natural history. Instructional course lectures. The American Academy of Orthopedic Surgeons, 1989;38:115-28.
2. Cobb JR. Outline for the study of scoliosis. Instructional course lectures. The American Academy of Orthopedic Surgeons 1948;5: 261-75.
3. Bridwell KH. Surgical treatment of adolescent idiopathic scoliosis: the basics and the controversies. Spine 1994;19:1095-100.
4. Bridwell KH. Spinal instrumentation in the management of adolescent scoliosis. Clin Orthop 1997;335:64-72.
5. Mielke CH, Lonstein JE, Denis F, Vandenbrink K, Winter RB. Surgical treatment of adolescent idiopathic scoliosis: a comprehensive review. J Bone Joint Surg (Am) 1989;71B:1170-7.
6. Gray JH, Smith BW, Ashley RK, Lagrone MO, Mall J. Derotational analysis of Cotrel-Dubousset instrumentation in idiopathic scoliosis. Spine 1991;16(8 Suppl):S391-3.
7. Richards BS, Herring JA, Johnston CE, Birch JG, Roach JW. Treatment of adolescent idiopathic scoliosis using Texas Scottish Rite Hospital instrumentation. Spine 1994;19:1598-606.
8. Hamill CL, Lenke LG, Bridwell KH, Chapman MP, Blanke K, Baldus C. The use of pedicle screw fixation to improve correction in the lumbar spine of patients with idiopathic scoliosis. Is it warranted? Spine 1996;21:1241-9.
9. Bridwell KH, Betz R, Capelli AM, Huss G, Harvey C. Sagittal plane analysis in idiopathic scoliosis patients treated with Cotrel-Dubousset instrumentation. Spine 1990;15:644-9.
10. Richards BS, Birch JG, Herring JA, Johnston CE, Roach JW. Frontal plane and sagittal plane balance following Cotrel-Dubousset instrumentation for idiopathic scoliosis. Spine 1989;14:733-7.
11. Stokes IA, Ronchetti PJ, Aronsson DD. Changes in shape of the adolescent idiopathic scoliosis curve after surgical correction. Spine 1994;19:1032-5.
12. King HA, Moe JH, Bradford DS, Winter RB. The selection of fusion levels in thoracic idiopathic scoliosis. J Bone Joint Surg (Am) 1983; 65:1302-13.
13. Morose RT, Goldsmith GS, Hall EC, Keel D, Cow H. Measurement of the Cobb angle on radiographs of patients who have scoliosis. J Bone Joint Surg (Am) 1990;72:320-7.
14. Polly DW, Sturm PF. Traction versus supine side bending. Which technique best determines curve flexibility? Spine 1998;23:804-8.
15. Takahashi S, Passuti N, Delecrin J. Interpretation and utility of traction radiography in scoliosis surgery: analysis of patients treated with Cotrel-Dubousset instrumentation. Spine 1997;22:2542-6.
16. Vaughan JJ, Winter RB, Longstein JE. Comparison of the use of supine bending and traction radiographs in the selection of the fusion area in adolescent idiopathic scoliosis. Spine 1996;21:2469-73.
17. Edger MA, Chapman RH, Glascgow MM. Preoperative correction in adolescent idiopathic scoliosis. J Bone Joint surg (Br) 1982;64:530-5.
18. Vauzelle C, Stagnara P, Jouvinroux P. Functional monitoring of spinal cord activity during spinal surgery. Clin Orthop 1973;93:173-8.
19. Carman DL, Browne RH, Birch JG. Measurement of scoliosis and kyphosis radiographs: intraobserver and interobserver variation. J Bone Joint Surg (Am) 1990;72:328-33.

20. Lenke LG, Betz RR, Bridwell KH, Clements DH, Harms J, Lowe TG, et al. Intraobserver and interobserver reliability of the classification of thoracic adolescent idiopathic scoliosis. J Bone Joint Surg (Am) 1998;80:1097-106.
21. Shea KG, Stevens PM, Nelson M, Smith JT, Masters KS, Yandow S. A comparison of manual versus computer-assisted radiographic measurement: intraobserver measurement variability for Cobb angles. Spine 1998;23:551-5.
22. Torell G, Nachemson A, Haderspeck-Grib K, Schultz A. Standing and supine Cobb measures in girls with idiopathic scoliosis. Spine 1985;10:425-7.