Segmental Derotation Using Alternating Pedicular Screws in Treatment of Adolescent Idiopathic Scoliosis

Mohamed Wafa, MD, Fady Michael, MD, Ahmed ELBadrawi, MD, Yasser ELOksh, MD
Orthopedic department, EinShams University, Cairo

Abstract

Background Data: The use of pedicle screw implants for the treatment of Adolescent Idiopathic Scoliosis (AIS) has gained popularity over the past several years. Pedicle screws have been shown to be safe and effective in the treatment of AIS as well as having greater correction power in the coronal, sagittal, and axial planes over hybrid constructs.

Purpose: To assess the effectiveness and safety of segmental derotation using alternative posterior segmental fixation in managing adolescent idiopathic scoliosis.

Study Design: A prospective clinical study enrolled 26 patients with adolescent idiopathic scoliosis who were treated by segmental derotation using alternative posterior segmental fixation. The study was done from January 2005 till July 2009.

Methods: This study enrolled 26 patients with an average age of 15 yrs. All patients had a preoperative assessment by physical examination, plain radiography (anteroposterior, lateral, dynamic views). Scoliotic curves had a mean preoperative value of 67.2°. All patients underwent segmental derotation using alternating posterior segmental fixation under general anesthesia. Average follow up was 32.6 months and was done on regular basis; immediately postoperatively then at 4 weeks and regularly every 3 months by clinical and plain x-ray radiography. Measurements were done using Image Luncher 1.4.3.67 software. Statistical analysis was done by SPSS13.0 for windows software.

Results: All patients showed marked postoperative improvement of their scoliotic deformities. Mean scoliotic curves improved from 67.2° to 10.6°. Radiographic assessment revealed 100% fusion with no loss of correction. Postoperative recovery was fast with ambulation on the second postoperative day. No complications were accounted.

Conclusion: Segmental derotation using alternative pedicular fixation in managing adolescent idiopathic scoliosis provides an effective method of correcting scoliotic curves. This method provides excellent scoliotic curve correction with no loss of correction, better fusion rates, rapid postoperative recovery, and decreased complications. (2012ESJ013)

Keywords: Segmental derotation, Idiopathic scoliosis, Segmental fixation, Pedicular fixation.
Introduction

The ideal correction system for adolescent idiopathic scoliosis (AIS) should provide rigid fixation and maximal correction with minimal fusion levels. Moreover, it should correct all three dimensions of the scoliotic deformity. Using the hooks in the upper and lower stable vertebra, Harrington instrumentation applied distraction and/or compression forces for the correction and fixation of the curve. For many years, it was used throughout the world as a treatment of choice in scoliosis correction and fusion. Actually, Harrington instrumentation with compression-distraction did make some coronal correction, but there was a major complication in the sagittal plane, such as flat back deformity. Other significant complications included loss of curve correction, long fusion levels and pseudarthroses.4,15,16,17

Since the advent of Harrington instrumentation, several new instrumentation systems and corrective methods have been developed with a goal of three-dimensional correction. In the early 1980s, Cotrel-Dubousset instrumentation with rod derotation was introduced to enable a three-dimensional correction in scoliosis surgery. Early papers of Cotrel-Dubousset upholders reported that the derotation maneuver could induce a three-dimensional correction.4,5 However, recent reports question the rotational correction even though they generally find the corrections are satisfactory in both coronal and sagittal planes.1,5,6,7

The use of pedicle screw implants for the treatment of AIS has gained popularity over the past several years. Pedicle screws have been shown to be safe and effective in the treatment of AIS as well as having greater correction power in the coronal, sagittal, and axial planes over hybrid constructs.2,3,8,9,12-14 Pedicle screws have shown superior biomechanical properties over other instrumentation techniques of the spine.10 They allow for three-column fixation of the vertebral body, thereby allowing for improved correction over hook constructs. Additionally, they allow for true derotation of the spine, whereas other modern techniques provide only posterior medialization of the spinal column.11

This study was conducted to evaluate a technique of alternating pedicular screws as a new concept for segmental derotation in the treatment of AIS.

Patients & Methods

This is a prospective clinical trial conducted in the period between January 2005 and July 2009. It enrolled 26 patients with adolescent idiopathic scoliosis with age ranged 13 to 24 years old. All patients had a preoperative assessment by physical examination and plain radiography (anteroposterior both supine and erect, lateral, and dynamic right and left bending views). Estimation of scoliotic angle was done using Cobb’s method. Estimation of apical vertebral rotation was done using Nash and Moe’s method. Caudal most instrumented level was chosen using stable end vertebra method. Anterior release was done thoracoscopically in 7 cases whose curves were above 80°.

Standard posterior mid line approach was done according to the levels planned to be instrumented. The upper construct consists of 2 pedicular screws at the uppermost vertebra and the lower construct consists of 2 screws at the lowermost vertebra. In between these constructs, alternating pedicular screws were inserted such that each vertebra is instrumented with a single pedicle screw.

After insertion of all the pedicle screws, a lateral view was taken by image intensifier to confirm screws position. Decortication of the laminae and facet joints was done on the concave side to prepare this bed for grafting and fusion. Pre-shaped rod was then inserted on the concave side with rod translation by the aid of specialized devices, such as a “persuader,” to reduce the curve sequentially as vertebral segments are translated onto the rod. When the rod was secured inside the screw heads, all nuts were applied without tightening and derotation of the curve was done sequentially until the rod was well rotated to produce the proper sagittal contours then all the nuts were tightened to secure the rod properly inside the screw heads.

The convex side was then decorticated and the rod was applied to the screws. If needed distraction and compression forces were applied to gain more correction. After correction of the curve, Stagnara wake up test was done. Local bone graft was usually harvested from spinous processes. Closure was done as usual with suction drain for 48 hours.

Thoracolumbar support was used postoperatively and second day ambulation was allowed. Follow up was done on regular basis; immediately postoperatively then at 4 weeks and 3 months postoperatively for clinical and radiographic assessment by plain radiography (anteroposterior and lateral views).
Figure 1. Female patient, 18 years old, with AIS with a curve of 45° has been corrected to 1.5° (nearly straight) with alternating pedicle screws technique with Isola system. A; The erect Antero-posterior view with regional Cobb angle 45°. B; Right. C; left binding views. D; AP view after correction. (Notice the alternative screw: one in each vertebra). E; Lateral view shows the screws in the pedicles. The top loading screws are monoaxial.

Figure 2. Intraoperative photos: A; Alternating pedicle screws, B; Concave side rod insertion before derotation, C; After both sides rod insertion and derotation.
Results

Our study enrolled 18 female and 8 male patients with an average age of 15 years and a range of 13 to 24 years. The mean operative time was 225 minutes with mean blood loss of 735 ml. There was no neurologic deficits intra or postoperatively nor postoperative infection. Postoperative recovery was fast with ambulation allowed on second postoperative day. Scoliotic curves had a mean preoperative value of $67.2^\circ$ (range 45° to 96°).

All patients showed marked immediate postoperative improvement of their scoliotic deformities. Mean scoliotic curves improved from $67.2^\circ$ to $10.6^\circ$. Postoperative curves ranged 5° to 28°. Small curves had been corrected up to 97%. Rod derotation improved apical vertebral rotational deformity from a mean of 3 preoperatively to 1 postoperatively. At final follow up of a mean of 32.6 months (range 23-78 months), there was no loss of correction; no pseudoarthrosis or non union. Delayed union was observed in 4 patients (>9 months) but fusion occurred at the final follow up.

Figure 3. Female patient, 14 years old, the curve magnitude was 92°. Thoracoscopic anterior release was done followed by posterior correction by alternating screw technique. The postoperative angle was 22°. Preoperative x-rays; a; AP supine, b,c; Dynamic views. d; Postoperative AP view with good correction of the deformity by the alternating screws. e; The lateral views.
Discussion

Treatment of adolescent idiopathic scoliosis remains a subject of ongoing development and still is a matter of debate with increasing consensus regarding segmental derotation maneuvers. Current surgical tools and techniques allow for an unprecedented ability to correct even the most severe scoliotic deformities. The development of rigid segmental instrumentation devices (pedicle screws) has revolutionized the spine surgeon’s capability to manipulate the spine and reduce its deformity.

The concept of direct vertebral rotation (DVR) is simply the correction of vertebral rotation by application of a posterior force in the direction opposite to that of the deformity. Derotation maneuvers include rod derotation, rod translation and direct vertebral derotation. Rod derotation involves placing a pre-shaped rod on one or both sides of a curve and rotating it to achieve curve reduction. Both maneuvers have become popularized to obtain triplanar correction using segmental instrumentation.

Pedicle screw technique which involves insertion of pedicle screws in all the pedicles of the curve has gained marked popularity for correction of scoliotic curves with good results. In our study, we introduce alternating pedicular screws as a variant of all screws technique for correction of this coronal deformity. This alternating placement of screws provides a single pedicle and a facet joint untouched and uninjured by a screw in each vertebra involved in the curve. This allows controlled equal gaps between the screws on both the convex and concave sides alternatively without losing the advantage of controlling each vertebra in the curve that is provided by the all screws technique.

Therefore, by just decortication of the nearby lamina and spinous process together with removal of the uninjured facetal joint cartilage ensure a virgin, copious surface with preserved anatomy for impaction of bone graft and thereby more solid posterior fusion especially facetal fusion.

Also, these controlled gaps allows easier application of the rods and more space for application of the bulky instruments needed for derotation and reduction of the curves. Another advantage of this technique is being much more economic than the traditional all screws correction. Finally, if revision surgeries are needed for any reason, the surgeon still has an unmutilated pedicle in each vertebra in the curve with preserved land mark for insertion of screw or even for an osteotomy which gives better chances for recorrection of the deformity.

In this study alternative segmental pedicular fixation was proved to be safe and effective in correcting scoliotic spines if compared with traditional all screws technique. This construct allowed better correction power than sublaminar construct and prevented early loss of correction which is seen with sublaminar or hook constructs.

Conclusion

Segmental derotation using alternative pedicular fixation in managing adolescent idiopathic scoliosis provides an effective method of correcting scoliotic curves. The construct of alternating pedicular fixation allowed for a good bed for fusion on the contralateral side of the pedicular screw in each segment while allowing in the same time segmental fixation and good control of each vertebra in the curve for rod derotation maneuvers.

References

6- Ghanem IB, Hagnere F, Dubousset JF, Watier B, Skalli W, Lavaste F. Intraoperative


12- Lehman RA, Lenke LG, Keeler KA, Kim YJ, Buchowski JM, Cheh G, Kuhns CA, and Bridwell KH. Operative Treatment of Adolescent Idiopathic Scoliosis With Posterior Pedicle Screw-Only Constructs, Minimum Three-Year Follow-up of One Hundred Fourteen Cases SPINE Volume 33, Number 14, pp 1598–1604 ©2008, Lippincott Williams & Wilkins.


Address reprint request to:

Mohamed Wafa, MD
Orthopedic department, EInShams University, Cairo, Egypt.
Email: mwafaspine@hotmail.com