THREE DIMENSIONAL CORRECTION OF ADOLESCENT IDIOPATHIC SCOLIOSIS

By

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ABSTRACT

Background: The fixation technique in treating idiopathic scoliosis ranged from either posterior fixation, anterior approach, or combined anterior and posterior approach.


Patients and Methods: Twenty consecutive patients were prospectively included with minimum of 6-months follow-up. The average age of surgery ranged between 11 and 18 years, with a mean age of 15.25 ± 2.24 years. Radiographic and clinical measurements were assessed at preoperative (preop), postoperative (PO), and final follow-up (FFU) period for curve correction rate, correction loss rate, and complications.

Results: The average main thoracic curve was corrected from 69.80 ± 21.0° preop to 17.73 ± 7.38° postop. This revealed a rate of 74.56 ± 7.32% correction. The average thoracolumbar curve was corrected from 52.14 ± 20° preop to 15.36 ± 10.53° postop, with a rate of 66.87 ± 24.81 % correction.

Conclusion: All-screw method was an efficient and safe method.

Key words: Scoliosis, three dimensional correction.

INTRODUCTION

Scoliosis is defined as a three-dimensional deformity of the spine, accompanied with vertebral rotation (Boissiere et al., 2014). Surgical treatment of adolescent idiopathic scoliosis entails instrumentation to provide correction and stability combined with sound principles of meticulous spinal arthrodesis with bone grafting (Barrey et al., 2014).

The main goals of surgical treatment of adolescent idiopathic scoliosis (AIS) is to achieve curve correction, obtain a balanced spine, and to improve cosmesis (Zheng et al., 2014). This approach is either anteriorly, posteriorly, or combined (Wang and Lenke, 2011).

Pedicular screws still remain the main surgical technique for correction of adolescent idiopathic scoliosis (AIS), where the scoliotic deformity can be corrected in three dimensional plane, superior to the two previous methods, like the all-hook method and hook/screw hybrid method (Zhu et al., 2011). The use of the pedicle-screw method achieves additionally, more motion segments which could be saved by reduction of the fusion length in thoracic scoliosis (Lehman et
al., 2008). However, the insertion of pedicle screws in the thoracic spine is always a safety concern, especially in the upper thoracic area because of small pedicle calibers, close anatomical relations to adjacent neural structures, and deformed anatomical structures (Davis and Dunn, 2013).

Skip pedicle screws, is the fixation technique in treating idiopathic scoliosis with the aim to decrease screw density and for financial causes, with comparable correction rate and minimal complications to all pedicle screws (Hicks et al., 2010).

The present work aimed to assess the short-term outcome of pedicle screw fixation method in treating of adolescent idiopathic scoliosis.

PATIENTS AND METHODS

The study was approved by the local ethics committee, and after fulfilling written consents from the patients and their relatives, on the procedure, anticipated results, and potential complications. Twenty AIS patients (12 females, 8 males) were prospectively evaluated. The patients were chosen with age from 10 years to below 18 years old. Congenital and all other acquired scoliosis will be excluded from the study. The initial evaluation of the patient included a thorough history, complete physical and neurological examination. All patients were operated on by the pedicle-screw method. The minimum follow-up was 6 months.

Procedures:

Pedicle screws were inserted on the concave side one by one from the lumbar up to the thoracic segments. Then the screws were inserted to the convex side, ranging in every other segment from lower to the uppermost segment. We preferred inserting 2 screws each in the lower and uppermost adjacent 2 segments. The contoured rods were linked to the rods by vertical tapping on the rods into the heads of the screws on each side. Facetectomies were also performed in each segment. Derotation started on the concave side first after completion of connecting rod to the screws. This procedure finished after rotating the rod to the vertical position as seen from the top. Only mild distraction of the screws was necessary.

In the lower lumbar scoliotic ends, due to its convexity, compression between screws can be performed. Then, the same procedure was performed on the convex side. With proper decortication of the laminae, the bone chips were placed on them. Thoracoplasty was considered and carried out only when the rib protrusion was obvious and the angle of trunk rotation (ATR) was greater than 15°.

Statistical analysis: After fulfilling each patient sheet, the data is collected, and statistical analysed using a computer based software program (SPSS v 20, sing Wilcoxon signed ranks test, Kruskal Wallis test, and McNemar test).

RESULTS

The mean patient age at the time of the operation was 15.25 ± 2.24 years (range:11.0 – 18.0years). The period between deformity detection and surgery ranged between 0.5 - 3 years, with a mean of 12.6 months.

In our study, only five patients (25 %) have the shoulders leveled. All of them had a right thoracic curve. Seven patients (35%) had the right shoulder elevated. They also all had a right thoracic curve. The remaining eight patients (40 %) had
the left shoulder elevated: Five patients of them had a left thoracic curve, and the other three patients had a right thoracic curve.

Using the Lenke classification, the patient numbers were type 1 (n = 12), type 2 (n = 2), and type 3 (n = 6).

The main thoracic curves ranged from 40.0-110.0° with a median of 68.5°, and the bending angle ranged from 28.0 - 95.0°. The thoracolumbar curves ranged from 29.0 – 88.0° with a median of 50.0°, and the bending angle ranged from 19.0 - 75.0° (Table 1).

Table (1): Curve cobb angle according to curve location.

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Cobb angle</th>
<th>Bending angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt (n=20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. – Max</td>
<td>40.0 – 110.0</td>
<td>28.0 – 95.0</td>
</tr>
<tr>
<td>Mean ± SD.</td>
<td>69.80 ± 21.0</td>
<td>53.0 ± 21.32</td>
</tr>
<tr>
<td>Median</td>
<td>68.50</td>
<td>53.50</td>
</tr>
<tr>
<td>TL(n=11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. – Max</td>
<td>29.0 – 88.0</td>
<td>19.0 – 75.0</td>
</tr>
<tr>
<td>Mean ± SD.</td>
<td>52.14 ± 20.26</td>
<td>39.14 ± 16.37</td>
</tr>
<tr>
<td>Median</td>
<td>50.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Coronal plane correction: In the coronal plane, the preoperative Cobb angle of the major curve was 69.80 ± 21.0° (range, 40.0 - 110.0°), which was corrected by 74.56 ± 7.32% to 17.73 ± 7.38° (range, 7.0 – 33.0°). The preoperative Cobb angle of the thoracolumbar curve was 52.14 ± 20.26° (range, 29.0 – 88.0°), which was corrected by 66.87 ± 24.81% to 15.36 ± 10.53° (range, 5.0 – 45.0°). The percentage of correction loss for major curve of all 20 patients at FFU was 3.25 % (Table 2).

Table (2): Distribution of the studied cases according to cobb angle.

<table>
<thead>
<tr>
<th>Cobb angle</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Change</th>
<th>% of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt (n=20)</td>
<td></td>
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</tr>
<tr>
<td>Min. – Max</td>
<td>40.0 – 110.0</td>
<td>7.0 – 33.0</td>
<td>28.50 – 90.0</td>
<td>59.15 – 88.33</td>
</tr>
<tr>
<td>Mean ± SD.</td>
<td>69.80 ± 21.0</td>
<td>17.73 ± 7.38</td>
<td>52.08 ± 16.66</td>
<td>74.56 ± 7.32</td>
</tr>
<tr>
<td>Median</td>
<td>68.50</td>
<td>15.25</td>
<td>54.0</td>
<td>73.07</td>
</tr>
<tr>
<td>Z(p)</td>
<td>3.920 (&lt;0.001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL(n=11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. – Max</td>
<td>29.0 – 88.0</td>
<td>5.0 – 45.0</td>
<td>1.0 – 73.0</td>
<td>2.17 – 87.50</td>
</tr>
<tr>
<td>Mean ± SD.</td>
<td>52.14 ± 20.26</td>
<td>15.36 ± 10.53</td>
<td>36.77 ± 22.88</td>
<td>66.87 ± 24.81</td>
</tr>
<tr>
<td>Median</td>
<td>50.0</td>
<td>14.0</td>
<td>38.0</td>
<td>72.73</td>
</tr>
<tr>
<td>Z(p)</td>
<td>2.934 (0.003)</td>
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</table>
Sagittal curve correction: The mean preoperative thoracic kyphosis (T4-T12) of $34.58 \pm 10.45\degree$ (range: $16.0 \text{–} 55.90\degree$) changed to $36.13 \pm 4.94\degree$ (range: $20.0 \text{–} 40.50\degree$) after surgery. The mean preoperative lumbar lordosis (L1-L5) decreased from $51.85 \pm 9.85\degree$ (range: $63.00 \text{–} 12.00\degree$) to $45.40 \pm 6.17\degree$ (range: $34.0 \text{–} 55.50\degree$) after surgery.

Axial plan alignment: The preoperative Nash and Moe grading of axial vertebral rotation of the main structural curves was graded: 3 curves (15\%) was grade 2, 11 curves (55\%) was grade 3, 5 curves (25\%) was grade 4, and 1 curves (5\%) was grade 5. Post operatively the curves were graded: 10 curves (50\%) was grade 1, and 10 curves (50\%) was grade 2 (Table 3).

Table 3: Comparison between preoperative and postoperative Nash moe grading.

<table>
<thead>
<tr>
<th>Nash moe grading</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>(\chi^2)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. %</td>
<td>No. %</td>
<td></td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>I 0.0</td>
<td>10 50.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II 15.0</td>
<td>10 50.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III 55.0</td>
<td>0 0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV 25.0</td>
<td>0 0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V 5.0</td>
<td>0 0.0</td>
<td></td>
<td></td>
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</table>

Complications: Intraoperatively, one patient suffered from one screw pull out during correction. One of them was at the apex, and the other one at the upper anchor. This problem was managed by applying sublaminar wires around the screws under stress. One case had pleural opening during rib resection, managed by sutures and inserting chest tube intraoperatively, then removed 3 days post operatively.

Early postoperatively, there was one case that suffered of transient ileus, which was totally recovered at the third postoperative day with fluid and conservative treatment. Other two cases suffered from superficial wound infection that healed totally with daily dressing and antibiotic according to culture results within 10 days, one of them had bad scare as experienced by the patient. Late post operatively, only one patient suffered from progression of the proximal curve and post operative coronal imbalance, managed in a second session surgery by fixation and including the proximal curve in instrumentation system.

DISCUSSION

Pedicle screw fixation for deformity surgery in thoracic spine became popular. It has been shown to be safe and accurate method and even in large curves can be used without pedicle screw related visceral or neurologic complications in experienced hands (Ersen et al., 2014).
Although some controversy does exist, the all-screw construct has gained worldwide popularity in treating idiopathic scoliosis in the last decade. Ledonio et al. (2011) concluded that pedicle screw constructs had a significantly larger percentage of Cobb angle correction compared with hooks and hybrid constructs.

There are limited studies investigating whether bilateral pedicle screw placement improves correction of deformity compared to alternate segmental fixation in AIS (Obeid et al., 2014). Quan and Gibson (2010) retrospectively reviewed Lenke Type 1, AIS who underwent one stage posterior only spinal fusion and found bilateral segmental fixation did not improve curve correction compared to unilateral or alternate segmental fixation. Yang et al. (2011) evaluated the relationship between implant density, Cobb angle correction, and cosmesis and found that increasing density did not improve Cobb angle, and did not change cosmesis parameters.

In the present study, we used alternate pedicle fixation, with a correction rate of 73.07%. This correction rate equals those of other studies on segmental pedicle screw fixation of idiopathic scoliosis. Correction loss of the major curve with various types of instrumentation has been given great attention in the literature. Yu et al. (2012) stated that the mean correction loss for major curve of all patients at final follow up was 2.4° (3.92%). In the present study, with minimum 6 month follow-up, the correction loss averaged 3.25%.

In the present study, the thoracic kyphosis and lumbar lordosis were well-maintained PO, and at the latest follow-up. In addition, the thoracic hypokyphosis and hyperkyphosis improved. Ersen (2014) found that bilateral segmental fixation group’s results were similar to alternate fixation group.

Therefore, we considered that placement of thoracic pedicle screws using free hand technique was a safe and reliable technique. However, the technique required experienced personal with better tactile feedback skills, and a thorough understanding of the deformed spine anatomy. The technique additionally benefited from the more user-friendly instrumentation tools developed in recent years (Bianco et al., 2014).

Limitations of this study included relatively small samplesizes and no comparative groups. We also did not use CT scan to assess the accuracy of screw placement. However, this study demonstrated the early experience and clinical results of using all-screw method.

CONCLUSIONS

The all-screw method was efficient and safe. The outcomes in three-dimensional correction were satisfactory and comparable. The curve maintenance was good with minimal loss of correction.

REFERENCES


التصحيح ثلاثي الأبعاد للجنف الذاتي للمراهقين

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خلفية البحث: تتراوح طرق التدخل الجراحي للجنف الذاتي في المراهقين بين التثبيت الخلفي لل الفقرات، أو التثبيت الأمامي، أو التثبيت المشترك (الخلفي و الأمامي).

الهدف من البحث: تقييم التثبيت الخلفي لل الفقرات باستخدام البراغي السويقية (مسمر عمق الفقرة)، في معالجة الجفن الذاتي للمراهقين.

المرضى وطريق البحث: تضمن البحث عشرين مريضاً متالياً من مرضى الجفن الذاتي في المراهق، بالذن الأدنى من المتابعة و هو 6 شهور. العمر المتوسط للجراحة تراوح بين 11-18 سنة، مع عمر متوسط 15.25 ± 2.24 سنوات. و تم تقييم المقابل الإشعاعية والسريرية في ما قبل الجراحة، و ما بعد الجراحة، و متابعة نهائية لنتيجة التصحيح المنحني، و نسبة خسارة تصحيح، و مضاعفات الجراحة.

النتائج: تم تصحيح متوسط المنحني الصدرى الرئيسي من 69.80 ± 21.0 درجة قبل الجراحة إلى 73.88 ± 7.38 درجة بعد الجراحة. و هذا يظهر نسبة تصحيح 74.65 ± 32.32 %، و أما متوسط المنحني الصدرى القطنى فقد صرح من 52.14 ± 20.00 درجة قبل الجراحة إلى 15.36 ± 10.53 درجة بعد الجراحة. و هذا يظهر نسبة تصحيح 66.87 ± 24.81 %.

الإستنتاج: طريقة التثبيت الخلفي لل الفقرات باستخدام البراغي السويقية (مسمر عمق الفقرة) في التصحيح ثلاثي الأبعاد للجنف الذاتي للمراهقين هي طريقة ذات كفاءة وأمانة.