



Dual Sequential Short Anterior Correction in Double Major Adolescent Idiopathic Scoliosis

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Abstract

Study Design: retrospective comparative study.

Introduction: The standard surgical technique for double major adolescent idiopathic scoliosis (AIS) has been the fusion of both thoracic and thoracolumbar/lumbar curves from the posterior approach. Although short anterior correction is established in AIS with single thoracic or thoracolumbar/lumbar curves, anterior correction in double major curves has not yet been described. The purpose of this study is to compare this novel technique with standard posterior pedicle screw instrumentation in double major AIS.

Methods: 19 consecutive patients with a double major AIS were treated surgically either with pedicle screw instrumentation and posterior fusion ($n = 11$) or dual anterior short instrumentation and fusion ($n = 8$) of both curves. The mean follow-up was 5.6 ± 3 years (2–10 years). Clinical and radiologic results, results of pulmonary function, and Scoliosis Research Society (SRS) questionnaire are analyzed and compared.

Results: The length of fusion was 7.6 ± 0.7 vertebrae with the anterior technique and 12 ± 1 vertebrae with the posterior technique ($p < .001$). Cobb angle correction was 78% and 53% in thoracic curves, and 80% and 59% in lumbar curves with posterior and anterior technique respectively ($p < .05$). The preoperative pulmonary function remained unchanged to the last follow-up in both groups. The scores of SRS-24 questionnaire were similar preoperatively and at the last follow-up in both groups.

Conclusion: This novel technique of dual sequential short anterior correction is an alternative to the standard posterior long fusions in the double major AIS. A significantly less amount of mobile segments needs to be fused leaving the thoracolumbar junction mobile and saving at least one lumbar mobile segment distally.

Level of Evidence: Level III.

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Keywords: Adolescent idiopathic scoliosis; Double major; Anterior correction

Introduction

Anterior correction of single curves in adolescent idiopathic scoliosis (AIS) is an established alternative to posterior instrumentation and correction in single thoracic as well as in thoracolumbar/lumbar curves [1–12]. With the anterior technique, the length of fusion is much shorter than with the posterior method in single curves [1,8,11,13–15]. Although previous reports showed changes in pulmonary function after anterior instrumentation [16,17], more recent reports showed that the pulmonary function is not affected

by the thoracotomy and anterior instrumentation [8,18]. For the double major AIS, the standard technique has been posterior instrumentation [19,20]. However, with the current techniques, long fusions with posterior instrumentation of the thoracic and lumbar curves are necessary. Those are associated with limitation of movement and predict adjacent segment degeneration [21]. Although combined anteroposterior surgical techniques have been described in the treatment of large double major curves [22,23], an all-anterior approach has never been reported to our knowledge. We have developed a surgical method, which combines the short anterior correction of thoracic curve and lumbar curve resulting in dual sequential correction of both curves in double major scoliosis aiming to reduce the length of fusion and keeping the spine as mobile as possible. The aim of this study was to analyze the results of

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this novel surgical technique and to compare these results with those of posterior long fusions of the same surgeon in the same Institution.

Methods

The data of 19 consecutive patients with double major AIS who underwent surgical correction during February 1996 until July 2010 were collected prospectively and analyzed retrospectively. Fusion of both curves from posterior with pedicle screw alone instrumentation was done in 11 patients (posterior group, 2 male and 9 female), and sequential short anterior instrumentation of both curves was performed in 8 patients (anterior group, all female). All patients were followed at least 2 years clinically, radiographically, and with pulmonary function tests. The duration of follow-up was in mean 5.6 ± 3 years (2–10 years). Only 4 of the patients (3 posterior, 1 anterior) had a follow-up less than 5 years. Standard radiographs of the spine were done preoperatively, 6 weeks postoperatively, at 2 years, and at the last follow-up. Pulmonary function tests were done preoperatively, at 2 years, and at latest follow-up. Assessment of patient's satisfaction with the SRS-24 [24] questionnaire was done preoperatively, at 2 years and at the last follow-up.

The mean age (anterior 14.2 ± 1.7 years, posterior 15.2 ± 2.6 , $p = .355$) and Risser stage (anterior: 1.9 ± 0.8 , posterior: 2.2 ± 1.7 , $p = .605$) were statistically similar. The thoracic curves were right-sided in all patients, with the apex at T7 ($n = 4$), T8 ($n = 11$), or T9 ($n = 4$). The thoracolumbar/lumbar curves were left sided, with the apex at L1 ($n = 6$), L2 ($n = 12$), or L3 ($n = 1$) with no differences between the groups. The patients and their families were thoroughly advised about both surgical techniques and the advantages and disadvantages of both techniques. Crucial in this series for the decision making was the preference of the patients and their families to choose independently between the two techniques. Those in the anterior group chose the technique because they wanted to avoid stiffness of the spine after long posterior fusion and the ones in the posterior group because they wanted to avoid two surgeries. The same surgeon (KM) performed all surgeries. Two independent readers analyzed the data; these readers were not involved in direct care of the patients.

Surgical techniques

Posterior surgery

Pedicle-screw-alone instrumentation of both curves was done in all patients. The implant density was $57\% \pm 8\%$. The upper end of the instrumentation was the upper end vertebra of the thoracic curve in all cases. The lower end of the instrumentation was the vertebra of the lumbar curve which, was touched by the midsacral line in the standing anteroposterior radiograph.

Anterior surgery

The choice of fusion levels and the operative technique was made according to previous reports for single-curve corrections. Corresponding to this, we used side-bending radiographs to evaluate the first caudal disc in the curve that is opening in the concavity. The last instrumented vertebra is then defined as the one directly proximal to this disc. The amount of vertebrae from the apex vertebra to the last instrumented vertebra is then counted and added in cranial direction starting from the apex vertebra to define the first or upper-end instrumented vertebra. After left-sided and, respectively, right-sided minithoracotomy, a 360° discectomy was conducted. Bicortical insertion of screws was then carried out about 10 mm in front of the spinal canal along the posterior cortices of the vertebral bodies under direct visualization [8,25]. The correction of the lower curve was carried out first because a single lung intubation was not necessary for the surgery of the lower curve, and in our opinion it is better to do the upper curve correction with a single lung intubation at the second stage. After the first surgery, standing radiographs of the whole spine were done routinely at the 5th postoperative day to assess the instrumented lower curve. The correction of thoracic curve was done one week later. Correction of both curves on the same day was not intended, as we wanted to limit the surgical strain on the patient by doing staged correction of the scoliosis. Ambulation of the patient began on the first day after each operation. Intraoperative neuro-monitoring with SSEP and MEP was done routinely.

Statistical analyses

The statistical software PRISM (version 5 for Mac Os X, GraphPad) was used for statistical analyses. Descriptive statistics were used to report means and standard deviations (SD) of the patients' demographics, curves, amount of correction, and data of pulmonary function test as well as the SRS scores. Two-sided unpaired Student *t* test was employed for comparison between the groups and two-sided paired Student *t* test for intragroup time-dependent comparisons. A *p* value of $<.05$ was defined as statistically significant.

Results

Fusion levels

There was a significant difference with a mean of 7.6 ± 0.7 (range 7-9) fused vertebrae in the anterior versus 12 ± 1 (range 10-14) in the posterior group ($p < .001$). With the anterior technique, 4 or 5 vertebrae were instrumented for correction in the upper curve. Three vertebrae were instrumented in the lower curve in all but one patient. The uppermost instrumented vertebrae were T5 ($n = 1$), T6 ($n = 4$), and T7 ($n = 3$) in the anterior group and T4 ($n = 4$) and T5 ($n = 7$) in the posterior group. The lowest instrumented vertebra was either L2 ($n = 4$) or L3 ($n = 4$)

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