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Scoliosis Curve: Before and After Surgical Correction

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Abstract: The main purpose of this study was to report the surgical experiences and to evaluate the effectiveness of Two-stage operation (including 1-anterior release and fusion with hylofemoral traction and 2-posterior correction and fusion) in scoliosis. The prospective study was performed on 45 scoliotic patients presenting to Tabriz Shohada Orthopedics Teaching Referral Hospital between January 2002 and July 2007. Two-stage operation (anterior release and fusion with hylofemoral traction followed by posterior correction and fusion) was performed for cases in which the scoliosis angle was >70° and the correction level on bending films was less than 50%. Forty five patients, 32 (71.1%) female and 13 (28.9%) male, with mean age of 15.13±0.34 years (range of 10 to 18 years), were studied. According to the consecutive sampling, the relation of scoliosis with patients sex was significant ($p<0.005$). The mean scoliosis angle was 73.31±4.21 before operation and 36.11±2.56 after operation ($p<0.005$). The mean preoperative kyphosis angle was 29.95±3.9 and the mean postoperative kyphosis angle was 24.6±2.2 ($p<0.005$). Scoliosis was significantly more severe in males than females.

Key words: Scoliosis, surgical techniques, outcome, kyphosis

INTRODUCTION

Children diagnosed with scoliosis after 3 years and before 10 years constitute 8-21% of those with scoliosis and present a distinct clinical entity. Vertebral absence, partial formation or lack of segmentation may cause asymmetrical growth and resultant deformity (Samdani and Storm, 2007; Batra and Ahuja, 2008). The severity of the curve is related to the type of defect and whether or not the primary problem is accompanied by any compensatory developmental changes. The progression and ultimate prognosis are dependent upon the specific vertebral anomaly and anatomic location (Giampietro *et al*., 2003; Hedequist and Emans, 2007).

Approximately 70% of curves in patients with juvenile idiopathic scoliosis progress and require surgery (Sarlak *et al*., 2009). Adolescent Idiopathic Scoliosis (AIS) is the most common type of scoliosis occupying approximately 50% of all scoliosis (Mineiro and Weinstein, 2002; Sarlak *et al*., 2009). The incidence of AIS has been reported from 3.7 to 0.08% of general population according to screening test and radiographic studies (Goldberg *et al*., 2007; Han *et al*., 2008). The hallmark of surgical treatment is early intervention before the development of large curvatures. The primary goal of treatment of scoliosis is to prevent the development of a severe deformity. The best result that can be achieved is spinal growth that is balanced on the convexity. In these circumstances, the optimum result is a short relatively straight spine rather than the severely crooked spine that would have developed without treatment (Giampietro *et al*., 2003; Hedequist and Emans, 2007).

A variety of surgical approaches for AIS have been introduced anteriorly or posteriorly. Recently, anterior correction with instrumentation is known to have specific advantages, such as an easy correction and short segment fusion levels, in some types of AIS (Han *et al*., 2008). The main purpose of this study was to report the surgical experiences and to evaluate the effectiveness of Two-stage operation (including 1-anterior release and fusion with hylofemoral traction and 2-posterior correction and fusion) in scoliosis.

MATERIALS AND METHODS

The prospective study was performed on 45 scoliotic patients presenting to Tabriz Shohada Orthopedics Teaching Referral Hospital between January 2002 and July 2007. The patients were enrolled using convenience sampling and random allocation. Inclusion criteria were having scoliosis diagnosed by an orthopedist, absence of co-morbidities such as chronic disease and signing informed consent. Exclusion criteria were congenital anomalies, presence of neurological symptom, underlying

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disease and intracanal or cord anomaly. A detailed history was achieved and a full physical examination performed for detection of common associated anomalies of other organs. Maternal, perinatal and family history and developmental milestones were fully explored. A detailed neurological examination was performed.

Preoperative standing long-cassette anteroposterior (AP) and lateral radiographs, as well as right and left bending coronal radiographs were reviewed. Standing long-cassette AP and lateral radiographs from three different time periods (preoperative, immediate postoperative) were evaluated to determine deformity correction and changes in radiographic characteristics. The roentgenograms were thoroughly examined for any evidence of widening of pedicles or midline bony defects that may indicate an underlying cord anomaly. MRI and CT scan studies were reserved and left for neurological abnormalities such as diastematomyelia according to neurosurgens' indications.

The scoliotic curves magnitude must be measured from the standing AP view. We applied the most commonly used method (the Cobb method of measurement recommended by Terminology Committee of the Scoliosis Research Society). To use the Cobb method, one must first decide which vertebrae are the end-vertebrae of the curve. These end-vertebrae are the vertebrae at the upper and lower limits of the curve which tilt most severely toward the concavity of the curve. Once these vertebrae have been selected, one then draws a line along the upper endplate of the upper body and along the lower endplate of the lower body as shown below. The angle of interest is simply the angle between these two lines (Gupta *et al*., 2007) (Fig. 1).

Indication of surgical correction was scoliosis angle of >50° in standing AP films measured by Cobb method; except for two cases which were operated for cosmetic reasons. Two-stage operation (including 1-anterior release and fusion with hylofemoral traction and 2-posterior correction and fusion) was performed for cases in which the scoliosis angle was >70° and the correction level on bending films was less than 50%. The lower end of fusion was determined by definition of Stable Vertebra. When the stable vertebra was L5, if there was the mobility of L4-L5 disc space, the selected vertebra in bending films was L4 and if there was the mobility of L3-L4 disc space, the selected vertebra in bending films was L3.

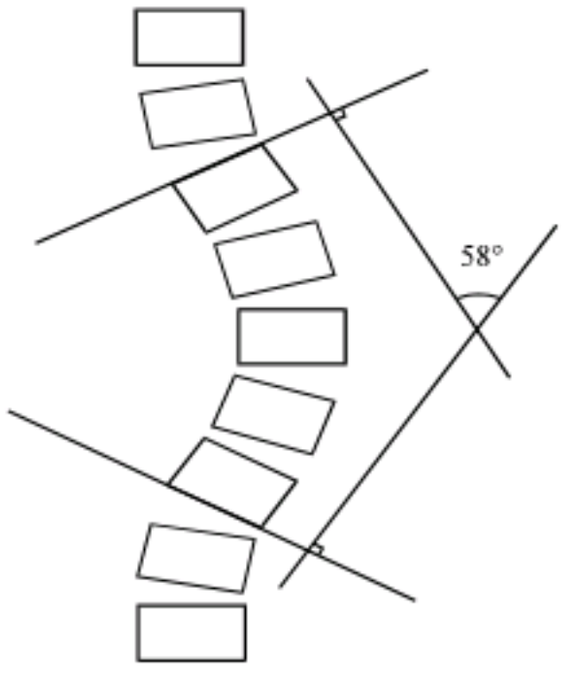

Fig. 1: Cobb method for measurement of scoliosis (Gupta *et al*., 2007)

All patients underwent photography with posterior and hump (forward bending view). Our purpose during operation was almost the making balance and approximating the curve apex to midline.

The collected data were analyzed by SPSS 13 statistical software using the following methods: descriptive methods for individual and anthropometric characteristics, t-test for comparison of quantitative variables, paired t-test for comparison of quantitative variables, Chi-square test for comparison of qualitative variables and ANOVA test for comparison of averages in various groups of quantitative variables. The p-value less than 0.05 were considered significant.

RESULTS

Two patients with severe deviation (150°), affected by respiratory failure following the first stage and became respirator-dependent for two months. So, the second stage of operation was cancelled and the cases excluded from the study. Remaining 45 patients, 32 (71.1%) female and 13 (28.9%) male, with mean age of 15.13±0.34 years (range of 10 to 18 years), were studied. According the consecutive sampling, the relation of scoliosis with patients sex was significant ($p<0.005$). All patients had scoliosis, of which 32 (71.1%) in right thoracic region, 7 (15.6%) in left thoracolumbar region, 3 (6.7%) in left thoracic region and 3 (6.7%) in left lumbar region. The mean diagnosis-to-operation time was 40.84±4.05 months. The most common chief compliant was abnormal bulging detected by others.

Figure 2 and 3 show the pre- and post-operation photographs in two patients. The comparison of pre- and post-operation photographs indicated that our corrections were greatly successful. In fact, the achieved clinical correction (comparison of photographs) was by far more significant than radiographic correction.

The mean scoliosis angle was 73.31±4.21 before operation and 36.11±2.56 after operation ($p<0.005$). The mean preoperative kyphosis angle was 29.95±3.9 and the mean postoperative kyphosis angle was 24.6±2.2

Fig. 2: One of patients with idiopathic scoliosis, (a, b) before (c, d) and after surgical correction

Fig. 3: One of patients with idiopathic scoliosis, (a, b) before and (c, d) after surgical correction

(p<0.005). As showed in Table 1, the scoliosis was significantly more severe in males than females.

Table 1: The comparison of scoliosis angle before and after operation in boys and girls

Scoliosis angle	Pre-operative	Post-operative	p-value
Boys	96.76°	52.15°	<0.05
Girls	61.84°	28.43°	<0.05
p-value	<0.05	<0.05	

In two cases there was similar idiopathic scoliosis in two siblings (a sister and a brother), which both had indication for surgical correction and operated. Of all patients, 27 (60%) underwent one-stage operation, 16 (35.5%) underwent two-stage and 2 (4.4%) underwent three-stage operation. The mean duration of surgery (scalpel-to-skin suture) was 4.77±0.57 h in one-stage operation and 6.16±1.09 h in two-stage operation.

In two cases, severe bleeding caused that we perform instrumentation and decortications delay to third stage. Correction was mainly based on passive correction during operation and adjusting the curves by previously bended rods. Severe distraction was avoided. In the case of severe curves, which severe distraction was inevitable, the well-being of nerve functions was controlled by wake up test during operation. In implantation technique, the insertion of hook within spinal canal was avoided. The preoperative coronal balance of 2.84±0.26 was corrected to 0.72±0.11 at the most recent follow-up (p<0.005). The mean sagittal balance was -0.27±0.19. There was not any case of clinical sagittal imbalance, probably because of trying to maintain of mobile segments in lumbar region.

The mean volume of blood transfused during and after operation was 4.8±0.23 unit. Complications were 1 (2.2%) early and 3 (6.7%) late. The only early postoperative complication was unilateral shoulder humility following operation, requiring reoperation for extension of instrumentation to upper thoracic levels and correction of upper thoracic curve. The late complications were local infection in three cases, appeared three years after operative correction, caused by gram negative bacillus, staphylococcus epidermidimis and staphylococcus aureus. In these cases, the operation site was exposed, instruments were extracted for ensure of throughout fusion. This measure caused to recovery in all three patients. Unlike neuromuscular scoliosis, the idiopathic scoliosis was not complicated with implant failure.

DISCUSSION

Scoliosis is defined as lateral deviation of the spinal column. One of the most popular categories, idiopathic scoliosis (no associated abnormalities and diseases) is subdivided by age at onset: infantile, juvenile, adolescent (Han *et al*., 2008). The therapeutic efficacy of scoliosis is

influenced by many factors, such as the severity of deformity, spine flexibility, patient's age, type of deformity and associated deformities (Yamin *et al*., 2008). The aim of spinal surgery for scoliosis is to make a spine that is balanced in both sagittal and coronal planes and that has an appearance acceptable to the patients and their families (Han *et al*., 2008).

Scoliosis surgery is not to make a beautiful X-ray image, but to make a functional improvement such as the prevention of cardiopulmonary dysfunction and deformity progression (Han *et al*., 2008; Halm *et al*., 2009). The primary goal of treatment of scoliosis in this study was to prevent the development of a severe deformity. So, we did not wait until a severe deformity has developed and then attempt to perform a major and dangerous corrective procedure. In the present study, the clinical correction was more significant than radiographic correction.

Aesthetic appearance has been reported as an important consideration in the treatment of scoliosis (Negrini *et al*., 2006; Zaina *et al*., 2009). Trunk deformity significantly influences scoliosis patients perception of function and self-image (Asher *et al*., 2004). Therefore, both rehabilitation experts and surgeons emphasize this aspect in the decision-making process in scoliosis (Negrini *et al*., 2006; Donaldson *et al*., 2007; Zaina *et al*., 2009). In our experience, usually the patients did not have clear awareness about their seeming status and their awareness became complete when radiographic images were performed. Also, pre- and post operation photography and every year after surgical correction photography and comparison of photos by patient and parents made them more acquiescent. This experience has not been reported in previous studies (Negrini *et al*., 2006; Donaldson *et al*., 2007; Zaina *et al*., 2009).

Two-stage operation (including anterior release and fusion with hylofemoral traction followed by posterior correction and fusion) was performed for cases in which the scoliosis angle was >70° and the correction level on bending films was less than 50%. In scoliosis surgery, the approach can be divided into anterior or posterior. Classically, posterior instrumentation and fusion represents the gold standard in the treatment of idiopathic scoliosis (Boachie-Adjei *et al*., 2007; Han *et al*., 2008; Qiu *et al*., 2008). However, selective anterior fusion technique can be used in scoliosis with Lenke type 1 (main thoracic curves) and 5 curve (thoracolumbar/lumbar curves) (Han *et al*., 2008). Anterior spinal correction and fusion of Scoliosis with Lenke 1 and 5 curve showed excellent deformity correction without any complications (Han *et al*., 2008). Wang *et al*. (2008) compared the radiologic and clinical outcomes, efficiency and cost between Anterior Spinal Fusion (ASF) and Posterior Spine Fusion (PSF) in surgical treatment of moderate lumbar/thoracolumbar Adolescent Idiopathic Scoliosis (AIS). Anterior spinal fusion versus PSF comparison did not show significant differences in regards to safety or efficacy but demonstrated shorter fusion levels, reduced surgical trauma and costs in ASF (Wang *et al*., 2008).

The indication for surgery is to get a better posture which lead to less risk of pressure sores and that an upright position lead to better possibility to easily breath with fewer episodes of pneumonia and a better general health as result (Larsson *et al*., 2009). In our series, stabilized spine resulted in sufficient strength to keep the body upright with the possibility of looking around at the surroundings more easily.

In this study, indication of surgical correction was scoliosis angle of >50° in standing AP films measured by Cobb method. In Geiger and Rauschmann study, apart from age and Cobb angle, the rib-vertebral angle difference and rotation of the vertebrae were decisive for the prognosis. Surgery is indicated if, despite consistent brace treatment, a progression of >10 degrees or a Cobb angle of more than 45 degrees is found (Geiger and Rauschmann, 2009).

Two-stage operation resulted in significant correction of deformation and restoration of physiological or close to physiological sagittal profile of spine. All patients and their parents were satisfied with the deformity correction. In Han *et al*. (2008) study, the mean Cobb angle of major curve was reduced from 43.3° to 14.8° (65.8% correction) postoperatively and the rib hump corrected less than 5° (Han *et al*., 2008).

Female sex is a risk factor for progress of idiopathic scoliosis and female to male ratio of the disease in angles >40° is 10:1 (Barney and Freeman, 2008). However, in this study, the most severe cases were seen in boys and the prevalence of the disease in male sex was more than expected.

To date, studies explaining the spectrum of complication for spine surgeries, particularly scoliosis revealed impediments such as an inadvertent pneumothorax during posterior procedures, as may dural tears. A postoperative ileus and pulmonary atelectasis after anterior or posterior procedures are both quite common. Cardio-respiratory problems are seen in those with a neuromuscular etiology and excessive bleeding can be troublesome in dystrophic patients (Lonstein and Bradford, 1995; Mohanty and Kumar, 2000). According to the blood loss for each patient documented from anesthesiologist's records, blood transfusion were made averaged 4.8 unites for maintaining the optimum circulation. However, complications such as massive bleeding did not encountered during different steps of

surgeries, but there were two cases of abnormal bleeding which caused decortication and fusion to be performed in another steps. One of these cases was a girl which underwent surgery during menstrual period indicating the need for assessment of relation between abnormal bleeding, coagulation abnormalities and menstrual period. The overall deep infection rate following scoliosis surgery is up to 5%. (Mohanty and Kumar, 2000; Newton and Wenger, 2001; Barney and Freeman, 2008). Our complication profile comprised three case of late local infections (6.6%). This fact shows that late local infections were dominant in this study.

CONCLUSION

This study results highlight: attention to progressive idiopathic scoliosis and on-time surgery for preventing two-stage operations, attention to male scoliosis and not underestimating them in low angles, photography before and after operation and radiographic and photographic follow up and safeness of intra-operative passive correction and adjustment with pre-bend rods in comparison with multi-stage distraction method.

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