Volume: 28, Issue: 4, October 2017 pp: 233-236 ORIGINAL ARTICLE

turkishspine

ANALYZING THE PREOPERATIVE AND POSTOPERATIVE SPINOPELVIC PARAMETERS IN LENKE TYPE 1 ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS

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ABSTRACT

Objective: To analyze the pre and postoperative changes of sagittal spinopelvic parameters in Lenke type 1AIS patients.

Methods: Thirty Lenke 1 AIS patients evaluated retrospectively. Thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt angles were measured on preoperative and last follow-up standing full-length lateral radiographs. Kolmogorov-Smirnov test was utilized to assess distribution of study parameters. Preoperative and postoperative results were compared with Wilcoxen Sum Rank test. p<0.05 considered as statistically significant.

Results: There were 28 females and 2 males. Mean age was 13.4 years, mean follow-up was 38 months. Mean preoperative thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt were 35.3°±11.9°, 50.8°±7.4°, 48.3°±8.5°, 33.4°±5.6°, and 15.5°±4.5°, respectively. Mean postoperative thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt were 28.6°±4.6°, 46.3°±7.1°, °7.7±°34.3 ,°7.5±°49.5, and 7°.7±°15.2, respectively. Comparison of the preoperative and last follow-up thoracic kyphosis and lumbar lordosis showed that there is a significant difference statistically. However, there is no statistical difference between preoperative and last follow-up pelvic incidence, sacral slope and pelvic tilt.

Conclusion: Lenke type 1 AIS thoracic structural curve and fusing the thoracic and lumbar region may change the spinopelvic parameters thus compensatory mechanisms should not be corrupted during the surgery.

Key words: Adolescent idiopathic scoliosis; Lenke type 1, sagittal balance, spinopelvic parameters

Level of evidence: Retrospective clinical study, Level III

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Received: 12th May, 2017.
Accepted: 14th July, 2017.

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a three planar deformity of the spine but etiology is not understood well. Treatment depends on several factors like age, curve type, curve size. Several classification systems have been identified to better understand different curve types in AIS. In 2001, Lenke [8] introduced a new classification for AIS with the aim to account for all types of curves and this classification system guides selection of fusion levels. The recommended treatment is fuse the structural curves when non-structural curvature leave unfused.

Many studies have shown the importance of the spinopelvic alignment for the treatment of spinal pathologies [14]. Duval-Beaupere[3] described the relationship between the pelvis and lumbar lordosis. They introduced the pelvic incidence (PI) angle that does not affected by the change of orientation of pelvis. Many authors [1,5,7,12,13] showed that there are correlations between the adjacent spinopelvic sagittal parameters: PI and sacral slope (SS), PI and pelvic tilt (PT), PI and lumbar lordosis (LL), SS and LL and finally LL and thoracic kyphosis (TK). PI is the only parameter that is anatomically fixed. PI determines SS and PT. SS, which is also the distal part of the lordosis, determines LL. In turn, LL balances with TK. This upward successive influence provides the spino-pelvic balance of the upright position.

Lenke type 1 curves are major thoracic curves with a major main thoracic and a nonstructural thoracolumbar or lumbar curve. The importance of these curve is the if fuse the too distal level unnecessarily [9], this may cause decompensation of spinopelvic alignment due to restriction of mobile segments close to spinopelvic region.

Thus, we aimed to analyze the pre and postoperative changes of sagittal spinopelvic parameters in Lenke type 1 AIS patients.

MATERIALS - METHODS

A retrospective study of Lenke type 1 AIS patients treated at a single institution the period of 2008-2013 by a single surgeon was conducted. Inclusion criteria included: 1) a diagnosis of Lenke type 1 AIS, 2) patients treated with posterior pedicle screw only instrumentation, 3) no previous spine surgery 4) full sets of preoperative and last follow-up standing full-length AP and lateral radiographs. Patients who had previous spinal surgery, suffered from congenital deformities, hybrid constructs, anterior surgery and osteotomy were excluded. Those whose radiographs did not meet standards were also excluded in order to discard measurement error.

The same attending senior spinal surgeon performed all surgical procedure. Segmental pedicle screws with 6.0-mm titanium rod were used in all patients. All patients received standard posterior surgery. After facetectomies within the fusion levels, pedicle screws were placed. The lowest instrumented vertebrae (LIV) was chosen according to the stable vertebra theory, which is the first-touched vertebra by the central sacral vertical line and lateral side-bending radiographs prior to surgery. Several surgical maneuvers were used in combination, including rod-rotation, apical vertebral derotation, convex compression, and concave distraction.

The Surgimap software (New York, New York, USA) was used to measure the sagittal spinal and pelvic parameters. Standing full-length lateral radiographs before surgery and at the last follow-up measured by the author who did not attend the surgeries. In the lateral standing radiographs, five sagittal parameters were measured: thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), sacral slope (SS), and pelvic tilt (PT). The LL was measured as the Cobb angle between the upper endplate of the L1 and S1. The TK was measured as the Cobb angle between the upper endplate of the T5 and T12. The PI, PT, and SS were measured as the angle between the vertical line of the sacral plate and the line connecting the midpoint of the sacral plate to the mid-point of the bilateral femoral head center, the angle between the plumb line and the line connecting the midpoint of the sacral plate with the midpoint of the bilateral femoral head center, and the angle between the sacral plate and the horizontal line, respectively.

Measurement values were analyzed with SPSS software (version 15.0, SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov test was utilized to assess distribution of study parameters. Preoperative and postoperative results were compared with Wilcoxen Sum Rank test. $p<0.05$ considered as statistically significant.

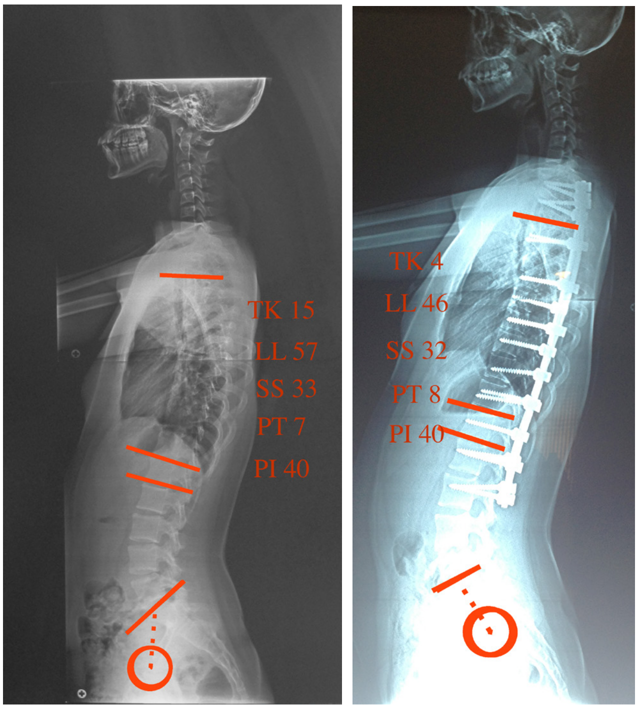

Figure-1. Preoperative and postoperative photos of a 15 year-old Lenke type 1 patient

RESULTS

Two-hundred-eighteen AIS patients in the database were assessed and finally 30 patients (28 females, 2 males) with mean ages 13.4 ± 2.21 were included in the study who met all the criteria. The mean follow-up was 38 ± 8.4 months. Lower instrumented vertebra (LIV) was L2 in 18 patients, L3 in 11 patients and L4 in one patient. Mean preoperative thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt were 35.3° ± 11.9°, 50.8° ± 7.4°, 48.3° ± 8.5°, 33.4° ± 5.6°, and 15.5° ± 4.5, respectively. Mean postoperative thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt were 28.6° ± 4.6°, 46.3° ± 7.1°, 49.5° ± 7.5°, 34.3° ± 7.7°, and 15.2° ± 7.7°, respectively.

Preoperative and last follow-up thoracic kyphosis and lumbar lordosis comparison showed that there is a significant difference ($p<0.05$), however there is no difference in comparison preoperative and last follow-up pelvic incidence, sacral slope and pelvic tilt. ($p=0.81$, $p=0.28$ and $p=0.92$).

DISCUSSION

After the explanation the relation between pelvic morphology spinal alignment by Duval-Beaupe`re et al [3], many studies investigated the sagittal spinopelvic parameters in adults but little research has been devoted to examining this relationship on patients with AIS. Very little studies focused on the spinal balance in adolescent idiopathic scoliosis (AIS) [2, 10], but its relation to pelvic configuration is not defined detailed in the literature.

In the literature, the findings of relation between spinopelvic parameters and pelvic orientation shows variability. Although some authors stated no difference between the two populations [6,13-14,17], some authors [10-11] found the PI to be higher in patients with AIS compared to the normal population.

Spinopelvic parameters investigated by Farshad et al [6] in different types of AIS curves, and found that the spinopelvic balance was not statistically distinguishable in different Lenke curve types. They found a slight difference of spinopelvic balance only in Lenke type 5 and 6 (major curve at the thoracolumbar/lumbar region) with a pelvis incidence of 44°, sacral slope of 34° and pelvic tilt of 10°, when compared with normal population values. In our study investigating the Lenke tpye 1, those also have the non-structural lumbar curves, when compared with other studies, we found a slight higher values in pelvic incidence, similar values in sacral slope and a slight higher values in pelvic tilt. However, when compared with normal population [11], pelvic incidence and sacral slope were similar but pelvic tilt was slightly higher.

In the literature regarding variances relevant to some spinopelvic parameters in patients with AIS following surgical management. La Maida et al. reported a statistically significant increase in pelvic tilt (PT) [6], similarly Tanguay et al. acquired significant relationship between lumbar lordosis (LL) and pelvic parameters below and within the fusion from the analysis of 60 patients with AIS following posterior spinal instrumentation and fusion surgery [15]. Different to the literature, in our data, PT following surgery showed no statistically significant difference, however, LL showed a statistically significant decrease.

Our study showed that pelvic parameters did not change significantly after the surgery. This indicates that the decrease in the thoracic kyphosis was compensated by the decrease in lumbar kyphosis and the spinopelvic compensatory mechanisms worked only in the spine and did not extend to the pelvic region. Additionally, in our study ,unlike the other studies about AIS, [8,16] mean thoracic kyphosis value for our patients was 35.3° and it changed to 28.6° postoperatively. While these pre-surgical values do not represent hypokyphosis, surgery seems to be further decreasing amount of kyphosis. This we believe may be a result of compensation to correction of lumbar lordosis or simple over correction by the surgeon.

Nevertheless, there are some limitations to our study as well. First, this is a retrospective study and it lacks randomization. The measurements were done by a computer-based software and there could be some measurement errors.

CONCLUSION

Sagittal spinopelvic parameters are important in treating adolescent idiopathic scoliosis and must be taken into account before and after surgery. Lenke type 1 AIS are major thoracic structural curve and fusing the thoracal and lumbar region may change the spinopelvic parameters thus compensatory mechanisms should not be corrupted during the surgery.

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