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The Effects of Spinal Fusion on Lumbar Disc Degeneration in Patients with Adolescent Idiopathic Scoliosis: A Minimum 10-Year Follow-Up

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Abstract

Study design: Retrospective study.
Objectives: This study focused on patients with adolescent idiopathic scoliosis (AIS) who were followed up for more than 10 years, and assessed the influence of spinal balance on lumbar degenerative changes at distal unfused segments (DUS).
Summary of Background Data: Previous studies suggested that longer fusion segments may result in higher rates of occurrence of disc degeneration (DD) at unfused segments adjacent to the distal fused area. However, there are no existing studies that correlate the degree of DD to the location of lower instrumented vertebra (LIV) and the amount of the residual lumbar curve during the follow-up period.
Methods: Radiologic measurements were recorded at the time of surgery, immediately after surgery, and 10 years after surgery. The Pfirrmann grading scale was used to rate the MR images of these patients. The presence of vertebral DD was also used to classify patients into DD+ and DD− groups.
Results: 93 patients with AIS participated in this study. The average age at the time of surgery was 15.2 years; the average follow-up time was 154 months. DD was found in 45 patients (48%) and L5/S1 was the most common (40%) location in those patients. The L1 group experienced DD at a frequency of 34%, whereas the frequency increased with lower LIV placement. There was a significant difference between DD+ and DD− in age at the time of operation, the L4 tilt (pre Op. and post. 10 years), and the number of mobile segments.
Conclusions: Disc degeneration occurred in 48% of the patients at the time of postop. 10 years. Disc degeneration had a tendency to occur in patients with greater preoperative and postoperative 10 years L4 tilt angle and fewer mobile segments in the lower lumbar spine.
Level of Evidence: Level III.

Keywords: Adolescent idiopathic scoliosis; Lumbar disc degeneration; L4 tilt; Mobile segments; Long term follow-up

Introduction

Corrective surgeries for scoliosis commonly target patients during their growth period. Although the trend in contemporary scoliosis surgery suggests selective fusion of spinal segments, there are reports of disc degeneration occurring in unfused segments adjacent to fused area. Therefore, evaluations of surgeries should be done with more data than those available immediately after surgery. In other words, evaluations on the success and efficacy of previously done surgeries require long-term, post-growth follow-up.

In the past, patients who underwent corrective surgery with Harrington instrumentation frequently experienced disc degeneration at unfused segments adjacent to the fused area [1,2,4,5]. Evaluation of the relationship between the location of lower instrumented vertebra (LIV) with the stability of the lumbar spine, and the existence of slippage or low back pain in those patients were done through data obtained from X-ray images [1-5]. In addition, such surgeries ignored the physiological sagittal contour of the spine and have caused "flat back." Although there were

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studies linking disc degeneration at unfused segments adjacent to the fused area and the location of LIV; no studies attempted to correlate this finding with the spinal alignment.

The advent of MR imaging has opened new avenues to evaluations. Degenerative lumbar discs from patients treated with the Cotrel-Dubousset instrumentation, a treatment popular in the mid-1980s−1990s, were evaluated by magnetic resonance imaging (MRI) [9]. These studies suggest that there is little correlation between low back pain in unfused spinal segments below the fused area in comparison to control groups, whereas others suggest that frequency of low back pain increases when LIV is placed below L4 [1-4]. Correction techniques that preserve the physiological curve of the spine in the sagittal and coronal planes were developed when hybrid instrumentations from several spinal instrumentation systems became available [9].

Suk et al. reported the use of segmental pedicle screws in 1995, and corrective surgeries using pedicle screws became a standard treatment. It is now possible to perform three-dimentional corrections using direct vertebral rotation [13]. Suk et al. reported positive results in patients who underwent such treatments after a 10-year follow-up [14]. Three-dimensional corrections may affect clinical outcomes with respect to the surgical method. In other words, different correction methods may have a different impact on the spontaneous correction of unfused lumbar curve. The mechanical stress applied to the lumbar vertebra may differ with a long-term follow-up, which may yield a different outcome than those seen in earlier studies.

This study focuses on degenerative discs occurring in unfused lumbar segments in patients who underwent corrective surgery using hybrid instrumentation (screw, hooks, wires) with a postoperative follow-up period of at least 10 years. Degenerative discs were evaluated on MR images. Plain X-ray evaluations were used to examine unfused segments that may cause disc degeneration. In addition, the coronal balance and sagittal curve were taken into account to investigate factors that may affect the onset of disc degeneration.

Materials and Methods

A single surgeon (NK) at an institution conducted surgery over a 10-year period (1990−2002). Four hundred seventy patients underwent scoliosis surgery, and those who met the following criteria were selected for the study: 1) idiopathic scoliosis, 2) younger than 21 years at the time of surgery, 3) correction of thoracic curves with or without lumbar curves, 4) LIV location between T11 and L4, and 5) use of posterior pedicle screws with/without hooks. One hundred twenty-one patients met those criteria, and out of those, 93 patients (3 males, 90 females) could follow up for 10 years or more (follow-up rate = 76.7%). The average age at the time of surgery was 15.2 years (range = 11−20) and the average follow-up time was 154 months (range = 120−215 months). All patients were examined periodically at our clinic and magnetic resonance image (MRI) and X-ray were taken during the postoperative 10 years.

When planning the surgical strategy, the LIV for the Lenke type 1A curve was basically determined on the stable vertebra. In the case with greater flexibility of the thoracic curve showing that the center sacral line bisected the one vertebra above the stable vertebra, it was chosen as an LIV. Selective fusion was performed for Lenke 1B, 1C, or 3C curves when the lumbar curves were smaller than 45 degrees.

Radiologic Evaluation

Measurements of X-ray images and evaluation of MRI images were performed by two doctors who were not related to treatment of the patients. The evaluation was conducted using whole-spine anteroposterior and lateral radiographs, as well as standing flexion and extension lumbar radiographs. The Cobb angle (thoracic curve, lumbar curve) was measured preoperatively, postoperatively, and 10 years postoperatively. In addition, the wedging angle of each vertebra of fused segments, tilt angle, maximum tilt of unfused segments, LIV−sacrum, and the coronal balance (measurement of horizontal distance between C7 plumb line and the central sacral vertical line) were measured in all patients.

Lateral radiograph and sagittal balance (measurement of horizontal distance between C7 plumb line and the posterior sacral vertical line) was measured for thoracic kyphosis (T2−T12), lumbar lordosis (T12−S), sacral slope, and LIV−sacrum. Lateral bending radiographic images were taken in 85 patients. Radiographs for eight of 93 patients were missing, and evaluation was not possible for these patients. Sagittal instability was defined as segmental kyphosis greater than 5° at flexion on any motion segments and was evaluated among 85 patients.

Evaluation of Magnetic Resonance Image

The Pfirrmann grading scale was used to classify each patient into five grades based on their T2-weighted image and sagittal images [11]. Patients classified as higher than grade 3 were defined to have disc degeneration.

Low back pain

Patients were evaluated as whether they had low back pain or not at 10 years postoperation, and the relationship between low back pain and disc degeneration was investigated.

Results

Preoperative curve types according to Lenke classification was type 1 in 58 patients, type 2 in 23, type 3 in four,