

Clinical Study

The clinical importance of sacral slanting in patients with adolescent idiopathic scoliosis undergoing surgery

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Abstract

BACKGROUND CONTEXT: The phenomenon of sacral slanting has not been assessed in patients with adolescent idiopathic scoliosis (AIS). It could be important in determining distal fusion level.

PURPOSE: The purpose of this study is to clarify sacral slanting and to reveal frequency, character, and clinical importance of sacral slanting in AIS patients who underwent surgery.

STUDY DESIGN/SETTING: Retrospective review of radiographs.

PATIENT SAMPLE: The study included 389 patients who underwent surgery for AIS at a single center.

OUTCOME MEASURES: Slanted angles of sacrum, distal curve types, and postoperative decompensation were assessed in whole spine anteroposterior radiographs.

METHODS: This was a retrospective case series, which included 389 AIS patients who underwent corrective surgeries. The degree of sacral slanting was defined as the angle between the horizontal line and the upper end plate of the sacrum. Distal curves were classified according to the direction of L4 tilt (L4-left type and L4-right type). The frequency, direction, and relationship with curve types were analyzed descriptively. Postoperative changes of sacral slanting were compared by paired *t* test. Decompensation by distal fusion level and distal curve types was analyzed descriptively. The *p* value of less than .05 was considered as statistically significant.

RESULTS: The frequency of sacral slanting was 19.5% (76 of 389), 29.6% (115 of 389), and 40.6% (158 of 389) by using criteria of 5°, 4°, and 3°, respectively. The 86.7% showed sacral slanting on the left side. The combination of L4-left type with left-sided sacral slanting was the most frequent (124 of 158, 78.7%). Slanted angles were decreased in some cases after surgery. Decompensation in the coronal plane was observed in 2 of 22 patients (9.1%) with a distal fusion level of L4 but in none of the 70 patients with a distal fusion level of L3.

CONCLUSIONS: Sacral slanting in patients with AIS is a unique and frequently observed finding that has never been researched to date. Most importantly, sacral slanting is a critical consideration in selecting distal fusion level when planning corrective surgery in patients with AIS. © 2015 Elsevier Inc. All rights reserved.

Keywords: Adolescent idiopathic scoliosis; Sacrum; Slanting; Decompensation; Distal fusion level; Frequency

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Introduction

Adolescent idiopathic scoliosis (AIS) is a three-dimensional deformity characterized by scoliotic curvature in the coronal plane, various changes in the sagittal plane, and rotational deformity [1]. In general, surgery is planned when Cobb's angle is more than 40° to 45°, the probability of progression is high, and rapid progression occurs despite brace therapy. The main goal of surgery is correction of the deformity, with posterior fusion accomplished by rod derotation or direct vertebral rotation [2]. However, the selection of fusion level is unclear, with many hypotheses proposed regarding adequate fusion level [3–5].

Among the factors considered important in selecting a proximal fusion level are the rigidity of the proximal thoracic curve and the appearance, including the difference in shoulder height and trapezial fullness [6,7]. Studies assessing the selection of distal fusion level, however, have mainly considered the types of curves and the relationship between the position of the lower instrumented vertebra and the end, neutral, and stable vertebrae [8,9]. We have found, however, that many AIS patients who undergo surgery show sacral slanting, which may be compared with shoulder height difference in proximal aspects (Fig. 1). These findings suggested that a slanted sacrum must be considered in determining distal fusion level. To our knowledge, the phenomenon of sacral slanting has not been assessed in patients with AIS.

This study was designed to clarify the definition of sacral slanting and to assess its frequency and characteristics, as well as to determine the clinical importance of sacral slanting in determining distal fusion level in patients undergoing surgery for AIS.

Materials and methods

This retrospective study involved the 389 AIS patients who underwent corrective surgery between November 2007 and December 2011. The surgeries were operated by single surgeon in one institution. All patients were followed up for at least 2 years. Patients with a specific cause of scoliosis, such as neuromuscular disease or congenital heart disease, and those undergoing revision surgery were excluded. Demographic and radiological data were collected by reviewing the electronic medical records and the picture archiving communication system of our institution. Demographic data included patient age, sex, height, weight, and body mass index. Pre- and postoperative whole spine anteroposterior (AP) and lateral radiographs were obtained with the patient in an upright standing posture in both views and with arms folded forward in lateral views. Curve flexibility was assessed by examining active and passive lateral bending whole spine AP radiographs. Curve types were classified by the King and Lenke methods [10,11]. All patients underwent surgery using the rod derotation method with pedicle screws [2]. Patients were regularly followed up for schedules 1, 6, and 12 months after surgery, and yearly thereafter. The study was approved by the institutional review board of our institution, which

EVIDENCE & METHODS

Context

The authors postulate that the phenomenon of sacral slanting may be prevalent in patients with adolescent idiopathic scoliosis (AIS) and that such morphology is important in determining the distal extent of spinal fusion. The authors sought to evaluate the presence of sacral slanting in a retrospective series of patients treated surgically for AIS.

Contribution

Among this series of 389 patients, the authors concluded that sacral slanting was present in close to 20% of the population if the most stringent criteria were used. If more liberal criteria were employed, nearly 41% of patients would be considered to have sacral slanting. Among the 22 patients with sacral slanting and a distal fusion level of L4, coronal decompensation occurred in two individuals. This complication was not encountered in the 70 patients with sacral slanting and fusion extended only to L3.

Implications

As a retrospective review, this study is limited to the experience of patients with AIS who (a) were referred for surgical intervention and (b) opted to undergo the procedure. The sample size is relatively small and even more so when determinations regarding coronal decompensation are taken into account. While raising some important technical considerations that surgeons should be aware of when planning spinal fusion for the treatment of AIS, the findings presented here necessitate validation in larger, prospectively gathered, patient samples.

—The Editors

waived the requirement for informed consent because of the retrospective nature of the study.

Radiological assessment

The degrees of coronal and sagittal deformity were assessed by Cobb's angle method. A decompensated state in the coronal plane was defined as a distance >20 mm between the C7 plumb line and the central sacral vertical line in AP views. The L4 tilt was assessed by measuring the angle between the upper end plate of L4 and the line connecting the top of both iliac crests. Distal curves were classified according to the direction of L4 tilt as L4-left (L4-L), L4-right (L4-R), and L4-neutral types.

The degree of sacral slanting was defined as the angle between the horizontal line and the upper end plate of the sacrum, with each patient assessed by two independent observers. To adjust measurement errors, the angles of sacral slanting were

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