

The Association of Sacral Table Angle Measurements With Spondylolytic and Spondylolisthetic Defects at the Lumbosacral Articulation: A Radiographic Analysis

Richard A. Tallarico, MD^a, Bruce E. Fredrickson, MD^a, Thomas E. Whitesides, Jr, MD^b,
William F. Lavelle, MD^{a,*}

^aDepartment of Orthopedic Surgery, SUNY Upstate Medical University, 6620 Fly Road, Suite 200, East Syracuse, NY 13057, USA

^bDepartment of Orthopaedics, Emory University School of Medicine, 59 Executive Park South, Atlanta, GA 30320, USA

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Abstract

Study Design: Retrospective radiographic study of 6 patients with L5 spondylolysis observed prospectively before the onset of lysis through adulthood. A radiographic analysis of 50 pediatric control subjects was compared with the study group.

Objective: To determine whether sacral table angle (STA) measurements bear etiologic association with the development of spondylolysis and/or subsequent spondylolisthesis.

Summary of Background Data: Although radiographic parameters in association with spondylolysis and isthmic spondylolisthesis have been studied, no parameter has been shown to definitively have a role in development of this disease process. The STA is a recently described radiographic parameter useful in measuring anatomic changes across the lumbosacral articulation. This measurement's role as a predictor of pars lysis and subsequent slippage remains unknown.

Methods: The researchers examined the longitudinal plain radiographs of 6 patients observed from childhood, before the development of spondylolysis, through adulthood. Measurements of STA and percent slippage were performed. Fifty pediatric control subjects' radiographs were also examined with STA measurements. Statistical analysis was conducted on results.

Results: Mean STA of the study group before the development of spondylolysis was $95^\circ \pm 5.5^\circ$. Mean STA from the control group was $97.5^\circ \pm 4.3^\circ$. No statistical difference was found between groups ($p > .05$). No index patient had an abnormal STA before spondylolysis (less than 89° , defined as being outside 2 standard deviations from the control mean). Four of 6 index patients with spondylolysis developed spondylolisthesis. A negative correlation ($r = .54$) was seen for STA as a function of increasing percent slip when assessed longitudinally.

Conclusions: Abnormal STA measurement was not seen before the development of spondylolysis in this study population. Decreasing STAs were seen secondarily in patients with L5 spondylolisthetic progression. This finding points to anatomic change and secondary remodeling of the upper sacrum as a result of slippage.

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Keywords: Sacral table angle measurements; Spondylolysis; Spondylolisthesis; Lumbosacral articulation; Etiologic association

Introduction

The natural history of spondylolysis and spondylolisthesis has been extensively studied and described over the past several decades [1-6]. However, the etiology of spondylolysis and subsequent slippage has been debated at great

length and remains unclear [7-10]. A multitude of radiographic parameters have been described to assess and/or prognosticate the sagittal deformity seen in association with spondylolisthesis [1,11-17]. These measurements tend to be descriptive and none have proven an etiologic association with spondylolysis or listhesis through serial X-rays that show patients developing the deformity.

In addition to environmental factors, genetic predisposition may have an important role in the development of a pars defect [9,18-21]. The incidence of spondylolysis and spondylolisthesis in racially distinct groups has been reported to vary from as low as 3% in people of African

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*Corresponding author. Department of Orthopedic Surgery, SUNY Upstate Medical University, 6620 Fly Road, Suite 200, East Syracuse, NY 13057, USA. Tel.: (315) 464-8602; fax: (315) 464-5223.

E-mail address: lavellew@upstate.edu (W.F. Lavelle).

descent to as high as 50% of the Inuits [18,22,23]. To date, there are no morphologic or radiographic parameters identified that predispose certain individuals to this disease process.

Whitesides, et al. [24] recently described a radiographic parameter, the sacral table angle (STA), proposed to be etiologically related to spondylolysis and subsequent listhesis. The STA is the angle created by a line drawn along the sacral end plate and a line drawn along the posterior aspect of the S1 vertebral body (Fig. 1). It has been postulated that an abnormally decreased, initial, and genetically based STA would place increased stress and shear forces across the more vertically oriented lumbosacral articulation, leading to a greater likelihood of fatigue failure at the pars interarticularis [24].

This measurement was originally described by Österman and Österman [25], in their study of rabbits, as the sacral end plate angle. Inoue et al. [13] later applied this measurement in a study of the Japanese population as the STA. Those authors were able to show a statistically significant decrease in STA in patients with slippage compared with

those without a documented slip. In an archeological study, Whitesides et al. [24] found a lower STA in normal specimens from a genetically homogeneous group known to have increased occurrence rates of spondylolysis.

The purpose of this investigation was to assess the STA measurement as a predictor for the occurrence of L5 spondylolysis in Caucasian patients from the northeastern United States. The secondary objective was to determine whether the association between a decreased STA and isthmic spondylolisthesis is causative or an anatomic change seen as a result of secondary remodeling.

Materials and Methods

Initiated in 1955, a prospective study to determine the incidence and natural history of spondylolisthesis was conducted on 500 first-grade children from Sayre, Pennsylvania [1]. Those subjects were followed longitudinally with serial radiographs through adulthood. The only criterion for inclusion in the study was that the child attend any one of several local public elementary schools in the years 1954 to 1957, when the study was conducted. Parental permission was obtained for each child in the study, which was conducted in a relatively small community on the border between New York and Pennsylvania. Most children in each class participated. The small size of each class made it necessary to include classes in 3 consecutive years to obtain an adequate population for the study.

Supine anteroposterior, lateral, and oblique roentgenograms of the lumbar spine were made for each child. The children were also checked clinically for any spinal deformities. The roentgenograms and all ancillary studies were reviewed by 1 of the now senior orthopedic staff (BEF) and a radiologist. Any questionable defect was studied with supplemental oblique roentgenograms. Tomography was used when further clarification was needed because this data collection was completed in the 1950s. When the existence of a defect was questionable, the roentgenograms were repeated 1 year later. All subjects available for follow-up had repeat roentgenograms at ages 10 to 12, 15 to 16, and 18 years or older. Children who were not readily available for follow-up were traced through school and hospital records whenever possible.

A total of 27 subjects were identified throughout the course of the study to have a pars defect at L5, 8 of whom developed this lesion subsequent to initial radiographic evaluation. Serial radiographic studies were retrieved from 6 of these 8 subjects and comprised the index group for this study. The radiographs for the other 2 subjects were lost, damaged, or rendered useless owing to a flood in the archive where they were held from the authors' original longitudinal study [1].

The STA measurements were performed, according to the method of Österman and Österman [25], on each of the radiographs by 2 independent researchers. Each researcher was blinded to the other's findings. The corner of the

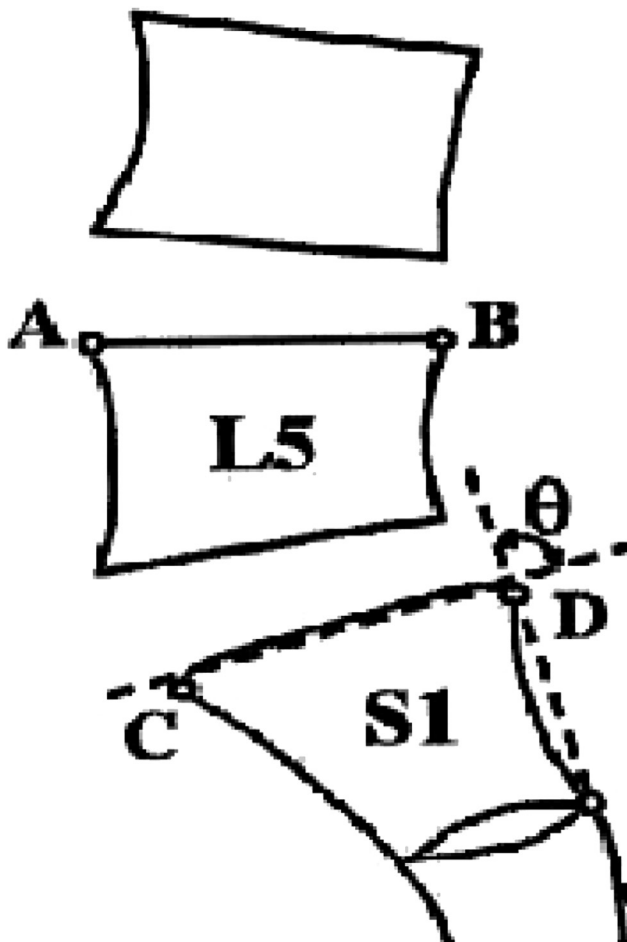


Fig. 1. Method of measuring the sacral table angle, which is the angle (theta) formed between a line drawn along the sacral end plate (C) and a line drawn along the posterior S1 vertebral body (D). (Adapted with permission from Inoue et al. [13].)

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