

Clinical Study

# Interpedicular height as a predictor of radicular pain in adult degenerative scoliosis

Ammar H. Hawasli, MD, PhD<sup>a,\*</sup>, Jodie Chang, BA<sup>a</sup>, Chester K. Yarbrough, MD<sup>a</sup>,  
Karen Steger-May, MA<sup>b</sup>, Lawrence G. Lenke, MD<sup>c</sup>, Ian G. Dorward, MD<sup>a,c</sup>

<sup>a</sup>Department of Neurosurgery, Washington University School of Medicine, 660 S. Euclid Ave., CB 8057 St. Louis, MO 63110, USA

<sup>b</sup>Division of Biostatistics, Washington University School of Medicine, Campus Box 8067, 660 South Euclid Ave. St. Louis, MO 63110-1093, USA

<sup>c</sup>The Spine Hospital New York-Presbyterian, Allen 5141 Broadway 3 Field West New York, NY 10034, USA

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## Abstract

**BACKGROUND CONTEXT:** Spine surgeons must correlate clinical presentation with radiographic findings in a patient-tailored approach. Despite the prevalence of adult degenerative scoliosis (ADS), there are few radiographic markers to predict the presence of radiculopathy. Emerging data suggest that spondylolisthesis, obliquity, foraminal stenosis, and curve concavity may be associated with radiculopathy in ADS.

**PURPOSE:** The purpose of this study was to determine if radicular pain in ADS is associated with reduced interpedicular heights (IPHS) as measured on routine radiographs.

**STUDY DESIGN/SETTING:** This is a retrospective case-controlled study.

**PATIENT SAMPLE:** The authors carried out a retrospective chart review at a tertiary care referral center that included ADS patients referred to scoliosis surgeons between 2012 and 2014. Inclusion criteria included patients with ADS and no prior thoracolumbar surgery. Data were collected from initial spine surgeon clinic notes and radiographs.

**OUTCOME MEASURES:** Clinical outcome data included presence, side(s), and level(s) of radicular pain; presence of motor deficits; and presence of sensory deficits.

FDA device/drug status: Not applicable.

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\* Corresponding author. Department of Neurosurgery, Washington University School of Medicine, 660 S. Euclid Ave., CB 8057 St. Louis, MO 63110, USA. Tel.: 1-314-362-3577.

E-mail address: [hawaslia@wudosis.wustl.edu](mailto:hawaslia@wudosis.wustl.edu) (A.H. Hawasli)

**METHODS:** Variables included age, gender, Scoliosis Research Society-30 (SRS-30) and Oswestry Disability Index (ODI) questionnaire data, and radiographic measurements. Radiographic measurements included Cobb angles and L1 to S1 IPHs on upright and supine radiographs. Associations between variables and outcome measures were assessed with univariate and multivariate statistical analyses. Authors have no conflicts of interests relevant to this study.

**RESULTS:** A total of 200 patients with an average age of 51 years met the inclusion criteria. Sixty of the 200 patients presented with radicular pain. Older age was associated with radicular pain, weakness, and sensory deficits. Patients who were 55 years or older were approximately eight times more likely to have radicular pain (odds ratio [OR]=7.96, 95% confidence interval [CI]: 3.73, 17.0;  $p<.001$ ), five times more likely to have motor deficit (OR=5, 95% CI: 2.55, 9.79;  $p<.001$ ), and five times more likely to have sensory deficit (OR=5.2, 95% CI: 2.65, 10.2;  $p<.001$ ) than those younger than 55. More caudally located nerve roots are more likely to develop radicular pain ( $p<.001$ ). Motor deficits were associated with worse SRS-30 functional ( $p=.02$ ) and ODI scores ( $p=.005$ ), but radicular pain and sensory deficits were not associated with lower SRS-30 or ODI scores. Ipsilateral and same-level radicular pain were associated with reduced IPH on supine radiographs ( $p=.002$  and  $p=.0002$ , respectively). Finally, reduced IPH on upright radiographs was associated with side- and level-specific radicular pain ( $p=.04$ ).

**CONCLUSIONS:** Radicular pain in ADS patients is associated with reduced IPHs and older age. Measuring IPHs on routine radiographs may be helpful in associating clinical radiculopathy with radiographic measures to guide patient management and surgical planning. © 2016 Elsevier Inc. All rights reserved.

*Keywords:* Adult degenerative scoliosis; Interpedicular height; Radiculopathy; Spinal deformity; Radicular pain; Foraminal stenosis

## Introduction

The prevalence of adult scoliosis ranges from 1% to 10% but has been observed in 30% of elderly patients without a history of spinal disease [1–5]. Adult degenerative scoliosis (ADS) is one etiology of adult scoliosis and is typically diagnosed in late middle-aged patients without a history of adolescent idiopathic scoliosis [6]. Patients with ADS typically present with worsening back pain, progressive skeletal deformity, or neurologic symptoms (ie, radicular pain, radiculopathy, or neurogenic claudication) [2–4,6]. Adult degenerative scoliosis results from age-related degenerative disc disease, joint arthropathy, and collapse and wedging of the disc spaces [3,4,6,7]. It is typically observed in the thoracolumbar and lumbar spine, and often includes both a coronal-plane deformity and loss of lumbar lordosis.

Many patients are referred to scoliosis surgeons because of worsening back pain associated with a progressing scoliotic curve. Axial back pain has been associated with pelvic retroversion, disc-space obliquity, vertebral body listhesis, and sagittal imbalance [3,8–10]. Patients with ADS alternatively present with neurologic symptoms, including radiculopathy or neurogenic claudication. There is a well-described association between lumbar stenosis and neurogenic claudication [2,11–13]. Clinical association between radiographic lumbar stenosis and neurogenic claudication allows for efficacious surgical treatment by decompression [11,14]. It is believed that severe foraminal stenosis may be present in a large fraction of patients with ADS [1] and may contribute to radiculitis and radiculopathy and poor clinical outcome [15]. Evaluation of computed tomography (CT) has also suggested an association between foraminal size and curve concavity with radiculopathy [16]. Although foraminal

size cannot be directly assessed on plain radiographs of the spine, we propose that the height between the pedicles that constitute the rostral and caudal boundaries of a foramen (or the interpedicular height [IPH]) could serve as a proxy measurement of foraminal size. Other clinical and radiographic modifiers likely play a role in the presentation and outcome of ADS. For example, we hypothesized that older age may be associated with increased lumbar spondylosis and lateral recess stenosis and hence radicular pain. Clinical performance indices, such as those attained on the Scoliosis Research Society-30 (SRS-30) questionnaire or by Oswestry Disability Index (ODI), may also predict radicular pain. In addition to IPH, thoracolumbar (TL) and fractional lumbosacral (FLS) Cobb angles on radiographs may predict radicular pain. We hypothesize that reduced IPH would be associated with the presence of radicular pain. To test this hypothesis, we performed an exploratory retrospective review of ADS patients referred for scoliosis surgery to ascertain if there was an association between IPH and clinical radiculopathy symptoms, including radicular pain, motor symptoms, and sensory deficits.

## Materials and methods

### Database

After approval by the Washington University Institutional Review Board, patients with ADS were identified for retrospective review. We utilized a prospectively collected database of spinal deformity patients to identify 200 consecutive patients treated for ADS at the Washington University School of Medicine between 2012 and 2014. Given the exploratory nature of this study and the lack of preexisting data on the

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