Spine Deformity
www.spine-deformity.org

Spine Deformity 4 (2016) 400–406

MRIs Are Less Accurate Tools for the Most Critically Worrisome Pedicles Compared to CT Scans

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Received 29 February 2016; revised 25 July 2016; accepted 6 August 2016

Abstract

Study Design: Retrospective review of magnetic resonance imaging (MRI) and computed tomographic (CT) scan imaging modalities.
Objective: To determine MRI's capability of identifying pedicle morphology.
Summary of Background Data: Understanding pedicle morphology is important for accurate placement of pedicle screws. The gold standard modality to assess pedicle morphology is CT scan. However, CT scans carry the risk of radiation exposure. We have studied MRI as a potential alternative to CT scan.
Methods: Nine hundred seventy pedicles in 33 spinal deformity patients were reviewed. Pedicle morphology was classified as follows: Type A (normal pedicle): >4-mm cancellous channel; Type B: 2–4-mm channel; Type C: any size cortical channel; and Type D: <2-mm cortical or cancellous channel. Pedicles in the same patients were classified on both low-dose CT scan and MRI. Concordance and discordance rates of MRI relative to CT scan in classification of pedicles into types A, B, C, and D were calculated for the entire length of the thoracolumbar spine and subgrouped into spinal sections. All images were evaluated by a single fellowship-trained musculoskeletal radiologist.
Results: CT scan had 809 Type A, 126 Type B, 29 Type C, and 6 Type D pedicles. Group II (MRI) had 735 Type A, 203 Type B, 30 Type C, and 2 Type D pedicles. Analysis of the entire spinal column showed a concordance rate of 86.7% in classification of the pedicles into the 4 types. In the upper thoracic region, the concordance rate was 77.1%, main thoracic 85.5%, thoracolumbar 96%, and lumbar 98.1%. MRI has a poor overall accuracy for detecting Type C pedicles, only a 44.8% concordance with CT scan. MRI overcalls Type B pedicles, often calling Type A pedicles Type B.
Conclusions: MRI is an inferior alternative to CT scan as it has poor accuracy to properly detect pedicle abnormalities. The more severe the pedicle abnormality, the less diagnostic value the MRI has.
Level of Evidence: Level III, diagnostic.

Keywords: Spinal deformity; Pedicle screws; Screw placement; MRI; CT; Radiation exposure

Introduction

Since its introduction, pedicle screw instrumentation has become an increasingly popular method for spinal fixation, fusion, and deformity correction. A thorough understanding of pedicle morphology is necessary for proper pedicle screw placement, as screw misplacement may impair pull-out strength or lead to severe complications involving the surrounding visceral, vascular, and neurologic structures [1-4]. Computed tomography (CT)–based pedicle classification has been described to aid spinal surgeons in placing

Author disclosures: VS (other from Medtronic, other from Precision Spine, outside the submitted work); TA (none); SW (none); RG (none); ES (none); YL (none); DW (none); BT (none).

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2212-134X/$ - see front matter
http://dx.doi.org/10.1016/j.jspd.2016.08.002

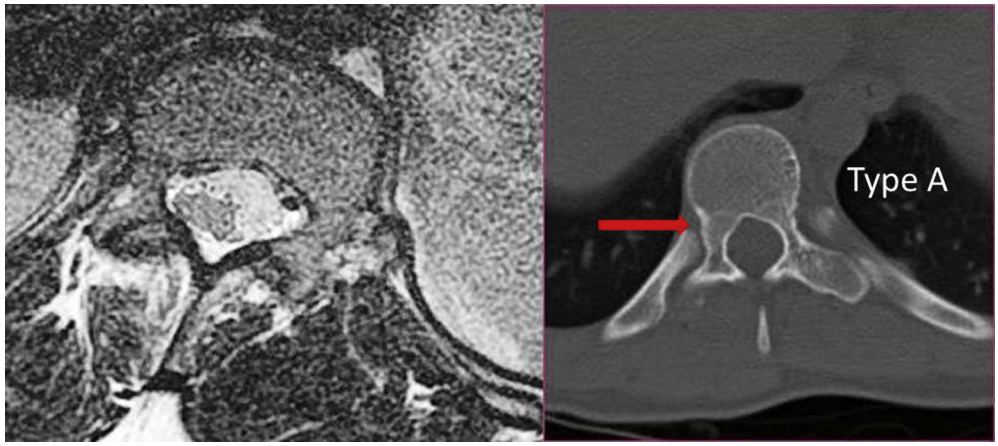

Fig. 1. Pedicles with a cancellous channel greater than 4 mm were considered to be Type A pedicles. The MRI (L) and the CT-Scan (R) images display examples of Type A pedicles.

pedicle screws in patients with spinal deformity [5]. This study reviewed more than 6,000 pedicles and found increased incidence of dysmorphic pedicles adolescent idiopathic scoliosis (AIS). In addition, the study found a significantly increased rate of malpositioned pedicle screws in dysmorphic pedicles. Preoperative knowledge of dysmorphic pedicles may help surgeons avoid these pedicles or approach them in a way that can decrease the rate of pedicle screw misplacement.

Although CT scan is currently the gold standard imaging modality for assessing three-dimensional bony morphology, it also carries the risk of significant radiation exposure. Magnetic resonance imaging (MRI) presents a potential nonionizing alternative that could significantly reduce the need for CT scan in certain instances. The goal of this study was to assess the accuracy and reliability of using MRI to measure pedicle morphology for preoperative planning of pedicle screw placement in AIS patients.

Materials and Methods

CT and MRI scans of 970 pedicles from 33 patients with scoliosis were examined with the permission of the institutional review board. Criteria for patient selection were as follows: all pediatric patients with spinal deformity undergoing posterior spine fusion from January 2004 to June 2010 were reviewed. Patients were included if they 1) carried a diagnosis of scoliosis with ICD-9-CM codes of 737.30 (AIS), 754.2 (Congenital Scoliosis), and 737.43 (Neuromuscular Scoliosis); 2) had preoperative radiographs; 3) had preoperative CT scans on file; and 4) had MRI images on file. CT scans had been obtained during this time period for preoperative planning at our institution. MRI scans had been obtained to rule out any intraspinal abnormality. Multidetector computed tomography (MDCT) was performed on 16-slice (Mx8000; Philips Medical Imaging, Netherlands) or 64-slice (Lightspeed; General Electric Medical Systems, Milwaukee, WI) scanners. Scans were obtained in the axial plane followed by sagittal and coronal reformatting. Axial MRI scans were obtained on 1.5 T (Signa Excite; General Electric) or 3.0 T (Intera; Royal Philips Electronics, Netherlands) using T2-weighted 3D fast recovery, fast spin echo (FRFSE) sequences (average TR 2200/TE106, slice thickness 4-mm, no gap). The images were ‘‘stacked,’’ that is, obtained contiguously without change in the angulation of the slices. Most

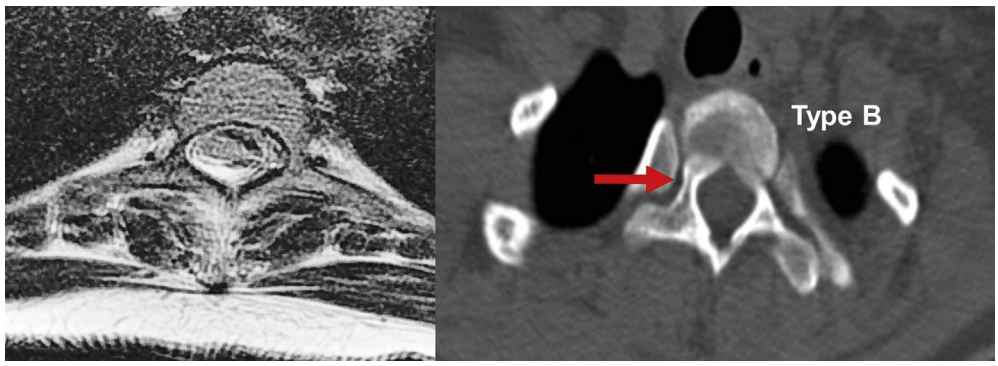

Fig. 2. Pedicles with a cancellous channel between 2-4 mm were considered to be Type B and examples can be seen in the MRI (L) and CT-Scan (R).