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The Spine Journal 15 (2015) 1210–1216

THE SPINE JOURNAL

Clinical Study

Associations between lumbosacral transitional anatomy types and degeneration at the transitional and adjacent segments

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Received 5 February 2013; revised 18 July 2013; accepted 23 October 2013

Abstract

BACKGROUND CONTEXT: The relation between specific types of lumbosacral transitional vertebra and the degree of degeneration at and adjacent to the transitional level is unclear. It is also unknown whether the adjacent cephalad segment to a transitional vertebra is prone to greater degeneration than a normal L5–S1 level.

PURPOSE: The purpose of this study was to evaluate the relation between specific lumbosacral transitional vertebra subtypes according to the Castellvi classification, and to determine the severity of degeneration at the transitional level and the adjacent cephalad segment.

STUDY DESIGN: This study was a retrospective review.

PATIENT SAMPLES: Ninety-two subjects with lumbosacral transitional vertebra grade 2 or higher and 94 control subjects without were retrieved from a picture archiving and communication system (PACS) search.

OUTCOME MEASURES: Disc degeneration parameters at the transitional and at the adjacent cephalad level were measured.

METHODS: After institutional review board approval, 92 subjects (42 men; mean age, 57±16 years) with lumbosacral transitional vertebra grade 2 or higher and 94 control subjects (41 men; mean age, 51±16 years) without were retrieved from a PACS search. Degeneration of the last two segments of the lumbar spine was quantified using the Pfirrmann and Modic classifications, along with documentation of annular tears, disc herniations, and disc height, and were compared between the two groups. Furthermore, L5–S1 levels in the control subjects were compared with the adjacent cephalad segments of the transitional vertebrae for the same parameters.

RESULTS: Although the control subjects, at L5–S1, had moderate to severe degeneration by Pfirrmann grades (31%) and Modic changes ([MC] 20%), in comparison, the discs at the transitional level of the lumbosacral transitional vertebra group demonstrated significant less degeneration (3% and 1%, respectively; each $p<.05$). The adjacent cephalad segments of the lumbosacral transitional vertebra group showed significantly greater degeneration (Pfirrmann grade 5, 39%; MC, 30%) compared with the L4–L5 level in control subjects (16% and 11%, respectively; each $p<.05$). The severity of disc degeneration using all parameters correlated with the type of lumbosacral transitional vertebra. The degree of degeneration of L5–S1 in control subjects was similar to the adjacent cephalad segment in lumbosacral transitional vertebrae.

CONCLUSION: Increasing the mechanical connection of a lumbosacral transitional vertebra protects the disc at the transitional level and predisposes the adjacent cephalad segment to greater

FDA device/drug status: Not applicable.

Author disclosures: ***NAF-A:*** Swiss National Foundation (PBZHP3_143674) (D). ***RJH:*** Nothing to disclose. ***APH:*** Consulting: SpineView, Inc. (C), NuVasive, Inc. (F, Paid directly to institution); Grants: NuVasive, Inc. (F, Paid directly to institution). ***AA:*** Nothing to disclose. ***MF:*** Nothing to disclose.

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

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http://dx.doi.org/10.1016/j.spinee.2013.10.029

degeneration. The adjacent cephalad segment had a comparable degree of degeneration as the L5–S1 level in control subjects.

Keywords: Disc degeneration; Transitional vertebra; Lumbosacral anomalies; LSTV; Lumbosacral transitional vertebra; Spine transitional anomalies

Introduction

Lumbosacral transitional vertebrae are common in the general population with a prevalence of 7% to 36% [1–8]. The lumbosacral transitional vertebra is defined as the last lumbar vertebra with a unilateral or bilateral transverse process that may articulate with the sacrum. This finding can be classified by the Castellvi classification into four different types according to its relation to the sacrum [6] (Table 1).

Prior studies have demonstrated that a lumbosacral transitional vertebra is protective for disc degeneration at the transitional segment, but the adjacent cephalad segment is prone to greater disc degeneration [9,10]. Other investigators have reported that the presence of a lumbosacral transitional vertebra leads to earlier occurrence and more severe disc degeneration, and is particularly observed in younger individuals [9,11].

It seems plausible that the degree of congenital L5–S1 fusion, as represented in the Castellvi classification [6], might affect adjacent segment disease. However, to the authors' knowledge, there are no prior studies that document the relation between the specific types of lumbosacral transitional vertebrae and the corresponding segment degeneration. Furthermore, it is unknown whether the adjacent cephalad segment of a lumbosacral transitional vertebra is prone to greater degeneration than the normal L5–S1 level in patients without a lumbosacral transitional vertebra.

These issues were the purpose of the current study, because their resolution can help elucidate the natural history of lumbar spine degeneration in the presence of a lumbosacral transitional vertebra, and may possibly impact surgical decision making, particularly in regard to selection of fusion levels or disc replacement.

Materials and methods

Subjects

The institutional review board approved this retrospective study. The first 92 consecutive patients with report of a lumbosacral transitional vertebra and no prior surgery that could be identified with a picture archiving and communication system (PACS) search starting at September 2010 were included retrospectively in the study (42 men, 50 women; mean age, 57±16 years) and are referred to as the case group. This group was divided into three subgroups base on the Castellvi classification [6]—type 2, articulated connection (N=46); type 3, osseous connection (N=32); and type 4, both osseous and articulated connection (N=14)—by one radiologist using MRI images. A previously published study demonstrated a very good interreader agreement in classification of LSTV using MRI [12]. Ninety-four subjects without a lumbosacral transitional vertebra, in whom a lumbar spine magnetic resonance imaging (MRI) had been performed between June 2012 and November 2012 (41 men, 53 women; mean age, 51±16 years) were added randomly and are referred to as the control group. Exclusion criteria for both groups were prior lumbar spine surgery or fractures of the last three fully developed disc segments.

Magnetic resonance imaging

Both groups underwent the same imaging protocols. Magnetic resonance imaging was performed with a 1.5-T or 3-T system (General Electric Health Care, Waukesha, WI, USA). Sequences included a sagittal T1-weighted and T2-weighted fast spin-echo (FSE) sequence, a sagittal short-tau inversion recovery sequence, and a coronal T2-weighted FSE and axial T2-weighted FSE sequences.

Quantification of degeneration

All images were reviewed at a PACS workstation (Sectra IDS7, version 12.5.0.234; Linköping, Sweden). The last two fully developed disc segments of the lumbar spine were assessed for degeneration using the Pfirrmann (eg, grades 1–5) [13] and Modic classification (eg, types 1–3) [14], along with documentation of annular tears, presence and size of disc herniation (1, small herniation; 2, moderate herniation; 3, large herniation) and disc height (in millimeters) (Fig. 1). The disc height was measured on MRI on the midsagittal slice at the center of the disc.

Statistical analysis

Statistic analysis was performed using the software Prism (version 6, Graphpad Software, La Jolla, CA, USA). A chi-square test was used for statistical comparison between the two groups and subgroups for annular tears.

An unpaired, two-tailed Mann-Whitney *U* test was used to compare Pfirrmann grades, Modic changes, and grades of disc herniation between the two groups and among each subgroup. An unpaired, two-tailed Student *t* test was used to compare disc height because these data were normally distributed. A p value of less than .05 was defined as statistically significant.