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Clinical Study

Disproportion of end plates and the lumbar intervertebral disc herniation

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Abstract

BACKGROUND CONTEXT: It is suggested that the shape of the vertebral end plates may play a role in the development of abnormalities in the intervertebral disc. On midsagittal magnetic resonance images of the spine in patients with lumbar intervertebral disc herniation, a notable disproportion frequently exists between the end plates of two vertebrae to which the disc is attached. There is apparently no study in the literature examining possible association of this disproportion with development of disc herniation.

PURPOSE: To determine whether a disproportion between two neighboring vertebral end plates is associated with the presence of disc herniation at the same level.

STUDY DESIGN: Case-control study.

PATIENT SAMPLE: Two hundred fifty patients with primary lumbar disc herniation in the case group and 250 age- and sex-matched normal individuals in the control group.

OUTCOME MEASURES: On midsagittal sections, the difference of anteroposterior diameter of upper and lower end plates neighboring a herniated (in the case group) or normal (in the control group) intervertebral disc was calculated and expressed as ''difference of end plates'' or ''DEP.''

METHODS: Subjects with previous spinal surgery, spondylolisthesis, or a significant vertebral deformity were excluded. For the main outcome variable, DEP was calculated at the level with herniated intervertebral disc in the case group, and the mean value was compared with mean DEP at the same level in the controls.

RESULTS: Mean DEP was significantly higher in the case group at both L4–L5 (2.45 ± 0.28 vs. 2.08 ± 0.27 mm, $p=.02$) and L5–S1 (3.32 ± 0.18 vs. 2.51 ± 0.13 mm, $p<.001$) levels. Similar differences were only marginally insignificant at L2–L3 (1.96 ± 0.14 mm in the cases vs. 1.33 ± 0.15 mm in the controls, $p=.07$) and L3–L4 (2.17 ± 0.11 mm in the cases vs. 1.55 ± 0.09 mm in the controls, $p=.06$) levels, with no significant difference at L1–L2 level (1.81 ± 0.10 mm in the cases vs. 1.28 ± 0.09 mm in the controls, $p=.12$). Each 1 mm increase of DEP at L4–L5 and L5–S1 levels was associated with 53% and 56% elevation in disc herniation risk at the corresponding levels, respectively.

CONCLUSIONS: Difference of end plate is a significant and probably independent risk factor for lumbar disc herniation.

Keywords: Lumbar disc herniation; End plate; Disproportion

Introduction

Various etiologic factors, such as aging and exposure to rotational and axial loading forces, have been implicated in the development of lumbar intervertebral disc herniation [1,2]. However, in a considerable number of cases, no apparent culprit could be identified.

A complex physiopathology and existence of a myriad of still unrecognized causal and contributing factors may be the reason of this ambiguity, and careful incremental research could slowly unravel them [3].

The end plates that are located at the cranial and caudal ends of each disc separate the vertebral bone from the disc and prevent the nucleus from bulging into the adjacent vertebrae. They also absorb the hydrostatic pressure that results from mechanical loading of the spine and transfer

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the axial load on the vertebral body to the next vertebra [4–6].

The shapes of end plates and their association with the mechanical loading on the corresponding vertebra have been investigated in some studies. Harrington et al. [7] postulated that because the end plate is the point of transfer of force between the vertebrae and the disc, the shape of the end plate could affect the frequency of annular failure and disc herniation. They concluded that the size of the end plate was correlated with disc herniation in larger men.

Muller and Alkalay [8] correlated the changes within end plate three-dimensional morphology with the changes in the degenerative state of the cartilaginous end plate and corresponding diffusion patterns within the disc.

Pappou et al. [9] investigated the shape of end plates on sagittal magnetic resonance image (MRI) cuts and correlated the findings with disc degeneration on MRI and disc height measurements.

Based on the authors' experiences, a remarkable disproportion between the end plates of two adjacent lumbar vertebrae with relevant disc herniation could be spotted on midsagittal MRI sections. The objective of the present study was to examine possible association of this disproportion with the presence of intervertebral disc herniation at the same level in a case-control setting.

EVIDENCE & METHODS

Context
Very few specific risk factors are known for lumbar HNP. This paper explores one possibility.

Contribution
Using a case-control design the authors found that patients with HNP more often have differing AP diameters between the superior and inferior endplates (as measured on mid-sagittal MRI cuts) when compared to controls with no HNP.

Implication
This is a novel finding of a possible non-modifiable risk factor for symptomatic disc herniation. This effect will need to be evaluated/confirmed by similar independent studies in patients. To determine the strength of this effect on risk, the prevalence of this finding should also be assessed in asymptomatic control subjects.

—The Editors

Materials and methods

Study design and population

This case-control study was carried out on 250 patients with primary lumbar disc herniation presenting to three MRI centers affiliated to a local medical university between July 2010 and July 2011, and 250 healthy controls randomly selected from a population pool of 3,451 individuals who were evaluated by spinal MRI in a national project aiming to determine normal dimensions of the spinal canal. Participants in both groups were from the same ethnicity and community. The exclusion criteria were previous spinal surgery, a history of spondylolisthesis, and a significant vertebral deformity resulting from any etiology. This study was approved by the ethics committee of the local medical university. Written informed consents were obtained from all participants.

MRI and measuring methods

Lumbar disc herniation was confirmed on sagittal and axial T1- and T2-weighted images in the case group by two skilled radiologists. They also confirmed normality of the lumbar vertebrae and intervertebral discs in the control group.

On MRI, an intervertebral disc herniation was reported when an extension of the disc margin was beyond the confines of the adjacent vertebral end plate through an annular tear. A herniated disc was further subclassified as protruded, extruded, or sequestered [10].

An MRI scanning was performed using a 1.5 Tesla scanner (MAGNETOM Avanto 1.5 Tesla MRI system; Siemens, Erlangen, Germany). The images were digitized and stored on a picture archive and communication system. In addition to storage, this system also incorporates image enhancement and manipulation tools, such as magnification, and a sensitive measuring tool.

To measure the distance between two points, a cursor is positioned using the mouse over an initial reference point. The cursor is then moved to the second reference point by dragging the mouse. When the mouse button is released, the distance between the two points is automatically displayed in a box. The eFilm Workstation v.2.1.2 (Merge Healthcare, Milwaukee, WI, USA) was used for this purpose.

In the case group, anteroposterior (AP) diameters of the upper and lower end plates neighboring the herniated intervertebral disc and at other levels with intact intervertebral discs were measured on midsagittal sections, and the difference of end plates (DEP) was calculated by using Excel software (Office 2003; Microsoft Corporation, Redmond, WA, USA) (see Figure).

The measurements included the end plates of lower L1 and upper L2 (L1 intervertebral disc), lower L2 and upper L3 (L2 intervertebral disc), lower L3 and upper L4 (L3 intervertebral disc), lower L4 and upper L5 (L4 intervertebral disc), and lower L5 and upper S1 (L5 intervertebral disc). Similar measurements were made at all levels of the lumbar spine in the control group.

The DEP was compared at similar levels of the lumber spine between three groups: cases with herniated