Radiographic evaluation of the lumbosacral disc height

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Abstract Objective. To establish criteria for the radiographic evaluation of narrowing of the L5–S1 disc height, which varies widely with transition of the L5 vertebra. Design and patients. Nondegenerated disc heights of L3–4 to L5–S1 and the thickness and length of the L5 transverse process were measured on plain radiographs of the lumbar spine in 166 outpatients, aged 18–35 years (mean 26.3 years), in whom at least the L3–4 and L5–S1 discs both showed normal signal intensity on magnetic resonance imaging. The level of the iliac crest was recorded semiquantitatively. The disc height was expressed as a percentage of the L3–4 disc height, namely “relative disc height”. The ratio of disc height to the sagittal diameter of the overlying vertebral body was termed the “disc height index”.

Results and conclusion. The relative disc height and disc height index of L5–S1 showed strong negative correlations with two anatomic variables, which were the relative thickness of the transverse process and the level of the iliac crest (P<0.0001). The results of linear regression analysis suggest that narrowing of the L5–S1 disc height can be evaluated on plain radiographs alone in relation to these anatomic variables.

Key words Lumbar spine · Disc space narrowing · Radiographs · Disc degeneration · Instability

Introduction

Narrowing of the lumbar intervertebral disc height is usually determined on plain radiographs in comparison with the adjacent disc heights, particularly one level above, because the lumbar disc height generally increases toward the lower lumbar levels except for L5–S1. Bony changes such as osteophyte formation and sclerosis of the endplates are not necessarily present with disc degeneration and are not always associated with disc height narrowing. Accordingly, without bony changes at L5–S1, narrowing of the L5–S1 disc height can not be judged on plain radiographs alone owing to its wide individual variation.

Clinically, it has been suggested that the disc height is closely related to segmental hypermobility or instability [1]. After the unstable phase, the mobile segment is considered to be spontaneously stabilized as a result of advanced disc degeneration [2]. In such cases, the degree of disc degeneration has been commonly assessed by the disc height decrease rather than by signal intensity change in the nucleus pulposus on magnetic resonance (MR) imaging. Disc degeneration has been graded roughly depending upon whether the disc height is decreased by more than 50% [3] in spite of the unknown original height. We believe, therefore, it is worthwhile evaluating the disc height more quantitatively on plain radiographs, although MR imaging provides valuable information on disc degeneration.

There have been numerous reports of measurements of the lumbar disc height [4–10], but there are no criteria for determining narrowing of the L5–S1 disc height. Even healthy young volunteers do not necessarily have normal discs. The purpose of the present study was to determine...
the normal range of the L5–S1 disc height using plain radiographs supported by MR images and to evaluate the L5–S1 disc height on plain radiographs alone in relation to anatomic characteristics such as the level of the iliac crest and the shape of the L5 transverse process.

Materials and methods

We studied 166 outpatients in whom at least the L3–4 and L5–S1 discs demonstrated normal signal intensity on midsagittal T2-weighted MR imaging [11]; they were all suffering from back pain, and their plain radiographs and MR images were available clinically. There were 86 men and 80 women, aged 18–35 years (mean 26.3 years). Their plain radiographs showed no abnormal findings except minimal spondylotic changes. In determining the vertebral level, the T12 vertebra was defined as the last vertebra with ribs including rudimentary ones. Cases of complete sacralization (unilateral or bilateral bony union between the L5 transverse process and the sacrum) and lumbarization with no bony union between the L6 transverse process and the sacrum were excluded. Cases of incomplete sacralization with unilateral or bilateral partial transitional vertebra without bony union between the L5 transverse process and the sacrum, and lumbarization with unilateral or bilateral bony union between the transverse process and the sacrum, were included.

MR imaging was performed with a 1.5-T MR imager (Gyroscan ACS-NT, Philips, The Netherlands). T2-weighted turbo spin-echo sequence images were obtained with a repetition time of 3000 ms and an echo time of 130 ms (matrix size, 256×256; section thickness, 5 mm). Even discs with a normal T2-weighted image may have discographically early degeneration [12]. However, disc height narrowing is not associated with such early degenerative changes, and segmental instability becomes marked when the disc is moderately degenerated [2]. Therefore, in the present study, using the MR criteria of Schneiderman et al. [11], the disc was defined as “nondegenerated” when the midsagittal T2-weighted image did not demonstrate any loss of signal intensity.

Plain radiographs were taken between 3 and 6 h after the patients rose in the morning; the patients were examined standing upright, the lumbar spine in neutral position. The central X-ray beam was focused on L4 in clinical use with a film-focus distance of 150 cm. Radiographs with evident projectional distortions due to lateral tilt or longitudinal rotation were excluded.

On an anteroposterior radiograph, the following measurements of the L5 vertebra were made: the interpedicular distance (A); the height of the transverse process from the medial margin of the pedicle to the tip (B); the vertical thickness of the transverse process at the junction of the middle and lateral thirds of measurement B (C) (Fig. 1) [13].

On a lateral radiograph, the following points to be marked were identified: the corners of the vertebral bodies, the midpoints of the endplates, and the midpoints of the walls of the vertebral bodies (Fig. 2); the points were determined strictly according to the criteria of Quint et al. [14] i.e. (1) when the posterior wall of the vertebral body is seen double, a point midway between the two visible posterior edges should be selected. (2) when the endplates appear as ovals rather than as straight lines seen on end, congruent edges should be selected.) Using these easily defined points, the height of a nondegenerated disc was measured from L3–4 to L5–S1. The disc height was calculated as the mean of the anterior, middle and posterior disc heights, using a combined method with reference to Dabbis’ measurement (a mean anterior and posterior disc height) [6] and the method of Nicholson et al. (a middle disc height) [7]. The sagittal diameter of the vertebral body from the anterior to posterior margin was measured at the midvertebral level (Fig. 2). The level of the iliac crest was also recorded semiquan-

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Fig. 1 Radiographic measurements of the L5 vertebra. A interpedicular distance, B length of the transverse process, C vertical thickness of the process at the junction of the middle and lateral thirds. Relative length of the transverse process= B[A×100 (%)]. Relative thickness of the transverse process= C[A×100 (%)] (Reprinted with permission from [13])

Fig. 2 Radiographic measurements of the lumbar disc height. a anterior disc height, b middle disc height, c posterior disc height, d sagittal diameter of the overlying vertebral body. Disc height=(a+b+c)/3 (mm). Disc height index= disc height/d. Relative disc height=Disc height/L3–4 disc height×100 (%)