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MRI-based Morphological Parameters to Quantify Lumbar Disc Degeneration

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Background and aims

When an intervertebral disc degenerates, structural deterioration occurs in a wide range of anatomical components within and adjacent to the disc, being clearly represented in cross-sectional imaging. To suggest reliable and valid MRI-based morphologic parameters to quantify lumbar disc degeneration, the reliabilities of 6 MRI parameters and one radiographic parameter were analyzed to choose those with high reliability. The selected parameters were further tested to determine validity by correlating with Pfirrmann and modified Pfirrmann grading, as reference standards.

Methods

85 patients over 60 years old who underwent MRI of the lumbar spine for mild low back pain were included. Two reviewers independently assessed the degree of degeneration and assigned one of the 4 ordinal scores from 0 to 3 in the following 7 parameters at 6 spinal segments: T2-signal intensity (T2-SI), disc extension beyond interspace (DEBIT), annular fissure, Modic changes, endplate integrity, osteophytes and disc height. Inter-observer and intra-observer agreements were assessed using Cohen's kappa statistic. For those parameters with high reliability, relationships with Pfirrmann and modified Pfirrmann grading were examined by calculating Spearman's correlation coefficients.
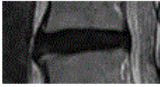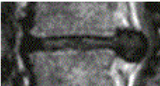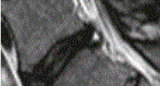
Results

While intra-observer agreements were substantial to excellent for all parameters (weighted kappa range 0.762-0.923), the inter-observer agreements were substantial to excellent for T2-SI, DEBIT, Modic changes, endplate integrity, and disc height loss (weighted kappa range 0.629-0.890), moderate for osteophytes (weighted kappa 0.573), and only fair for annular fissure (weighted kappa 0.29). T2-SI ($r=0.772$, $p<0.01$) showed high positive correlation with Pfirrmann and modified Pfirrmann grading, while DEBIT ($r=0.565$, $p<0.01$), endplate integrity ($r=0.597$, $p<0.01$), and osteophytes ($r=0.537$, $p<0.01$) showed moderate positive correlations. Only low positive correlations were observed in Modic changes ($r=0.397$, $p<0.01$) and disc height loss ($r=0.391$, $p<0.01$).

Conclusions

To quantify lumbar disc degeneration using MRI, T2-SI, DEBIT, Modic changes, endplate integrity, and osteophytes could be used as reliable parameters. Disc height loss on radiographic study also could be a reliable parameter. However, different weights might be applied to each parameter because validities to represent degeneration varied.

Table 1. Imaging parameters of disc degeneration.

	0	1	2	3
T2-SI loss	Normal	Intermediate loss	Marked loss	Absent signal
DEBIT	Intact	Bulge	Protrusion	Extrusion/ Sequestration
Annular fissure	Intact	Concentric fissures	Radial fissures	Transverse fissures
Modic changes	Normal	Type I	Type II	Type III
Endplate integrity	Intact	Isolated defects	Schmorl's node<5mm	Schmorl's node>5mm
Osteophytes	Absent	Marginal	Dis-continuous	Continuous
Disc height loss	0-10%	10-20%	20-30%	>30%

Figure 1. Grading assessment of imaging parameters.

Figure 2. Stratification of disc degeneration process.