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Radiographic grading of facet degeneration, is it reliable?—a comparison of MR or CT grading with histologic grading in lumbar fusion candidates

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Abstract

BACKGROUND CONTEXT: The current interest in motion-sparing surgery highlights the need for a more accurate radiologic evaluation of the degree of facet degeneration. In the presence of severe facet degeneration, a surgeon cannot ensure a positive outcome, even after successful surgery. To the best of our knowledge, no prospective study has compared the accuracy of grading facet degeneration by computed tomography (CT) or magnetic resonance (MR) scans with that attained from a real histologic evaluation.

PURPOSE: The purpose of this study was to determine the accuracy and reliability of CT or MR assessments of lumbar facet degeneration by comparing it with the histologic grading of the resected facets during surgery.

STUDY DESIGN/SETTING: A prospective study of consecutive patients undergoing posterior lumbar fusion surgery.

METHODS: Forty-four excised facets from 18 patients who received lumbar fusion were evaluated using radiographic and histologic techniques. All patients prospectively underwent CT scanning, routine axial T2-weighted MR scanning, and axial MR using a double echo steady state (DESS) sequence for cartilage imaging. The facets were graded radiologically using four-point scales. The inferior articular processes including the cartilage and subchondral bone of the corresponding facets were resected during surgery and evaluated histologically using a four-point grading system.

RESULTS: Radiologic grading revealed a tendency for underestimating facet degeneration than histologic grading. The number of facets undergraded by radiologic evaluations was 24 (55%) facets by CT, 16 (36%) by routine MR, and 22 (49%) by DESS. The weighted kappa coefficients between the histologic and radiologic grading also showed a poor correlation (0.120 for CT, 0.128 for routine MR, and 0.280 for MR using DESS sequence, respectively). The false-negative rates for detecting histologic degeneration by radiologic studies were 41% to 54%. The receiver operating characteristic curve revealed MR using DESS to have a better performance.

CONCLUSIONS: The degree of facet degeneration can be underestimated by current radiologic modalities, and their ability to detect facet degeneration is quite limited. Surgeons should be aware of these limitations during a preoperative evaluation of patients considered for motion-sparing techniques in lumbar spinal surgery.

Keywords: Facet degeneration; Radiographic grading; Histologic grading; Motion-sparing surgery; Lumbar spine

Introduction

Facet joints are true synovial joints in the spine consisting of hyaline cartilage, synovium, and joint capsule [1,2]. Degenerative changes affect the posterior and anterior structures of the spine with age [3]. Degenerative changes in the facet might be asymptomatic, but patients often develop back pain and disability [1,4–6].

FDA device/drug status: Not applicable.

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Total disc replacement and various motion-sparing devices have been proposed as substitutes for spinal fusion in the treatment of degenerative lumbar disease. However, back pain may persist when the patients have significant facet degeneration, even after successful replacement of the disc [7–9]. Generally, a grade of three or four in the ''four-point grading'' of facet joint degeneration is considered a contraindication of disc arthroplasty [10]. Current interests in total disc arthroplasty and motion-sparing devices highlight the need for a more accurate radiologic evaluation of the degree of facet degeneration.

Previous studies for grading facet degeneration were confined to radiologic examinations using computed tomography (CT) and magnetic resonance (MR) scans [3,11,12]. To the best of our knowledge, no study has compared the accuracy of grading facet degeneration by CT or MR with that achieved by a real histologic evaluation of a resected articular process during surgery. This study examined the accuracy and reliability of a CT or an MR assessment of lumbar facet degeneration by comparing it with the histologic grading and whether there is an underestimation or overestimation of the facet degeneration in imaging studies compared with histologic findings. The diagnostic performance of the imaging studies for histologic facet degeneration was also evaluated.

Materials and methods

Subjects

Eighteen consecutive patients (14 females and 4 males; average age, 61.9±12.1 years) were recruited from lumbar fusion candidates. The etiologies requiring spinal fusion were spondylolisthesis in nine patients (seven degenerative and two lytic) and spinal stenosis in nine of them. Patients who had previously undergone spinal surgery, had arthritis, a neoplasm, collagen disease involving the lumbosacral area, a history of drug or alcohol abuse, and the use of a pacemaker or other implanted prosthetic devices were excluded. All patients provided informed consent, and the institutional review boards at our hospital approved this study.

The patients were examined by CT, MR, and MR using a double echo steady state (DESS) sequence for cartilage imaging before surgery. Forty-four inferior articular processes were resected during surgery and prepared for a histologic examination: 4 facets at L2–L3, 12 facets at L3–L4, 17 facets at L4–L5, and 11 facets at L5–S1.

Image acquisition

Computed tomographic and MR images were obtained prospectively before surgery using the routine image-acquiring protocol of CT and MR to increase the clinical relevance to normal spinal patients, and additional MR axial imaging using a special sequence was also performed for detailed facet joint imaging.

Computed tomography was performed using a high-speed helical CT (Somatome Sensation; Siemens, Erlangen, Germany) under the following conditions: 120 kv, 160 mA, exposure time of 750 milliseconds, and a slice thickness of 5 mm. A lateral scout scan was obtained to align the sections through to each disc level.

The MR studies were performed on a 1.5-tesla whole body imaging system (Sonata; Siemens, Erlangen, Germany) using a dedicated spinal coil. A sagittal localizing sequence was then performed to identify the lumbar disc space intervals. The midpoint of each interspace was used as a reference point to establish the orientation of the slices for transaxial imaging. There were three slices per level, 4-mm thick with a 0.8-mm space between each slice. The T2-weighted images were then obtained using the following imaging sequence: repetition time/echo time (TR/TE)=3,200/93 milliseconds, thickness of 5 mm, increment of 0.5 mm, field of view of 200 mm, matrix 320×252, number of excitations three times, and echo train length of 1.

Additional axial MR studies using a DESS sequence for facet joint cartilage imaging were obtained on the same MR machine using a different protocol: TR/TE=25.51/7.15 milliseconds, thickness of 2 mm without interslice gap, field of view of 160 mm, matrix 256×256, number of excitations two times, echo train length of 11, TR of 25 milliseconds, TE of 7.15 milliseconds, and echo train length of 1.

Image evaluation

The images were saved in DICOM (Picture Archiving and Communication System) file format for picture archiving and communication system. Two experienced musculoskeletal radiologists reviewed the CT and MR images independently (J.-K.C. and H.-J.K. with 8 and 4 years of experience, respectively) and graded the facet degeneration on the axial images. Before commencing this study, two radiologists met in person and reviewed a sample set of images to refine the standardized definitions and features of grading.

The degeneration of the facet joint on the CT images was graded according to the criteria reported by Weishaupt et al. [12]: Grade 1, normal facet joint space (2–4 mm); Grade 2, narrowing of the joint space (<2 mm), small osteophytes, and/or mild articular process hypertrophy; Grade 3, narrowing of the joint space, moderate osteophytes, articular process hypertrophy, and/or mild subarticular bone erosions; and Grade 4, narrowing of the joint space, severe osteophytes, articular process hypertrophy, severe subarticular bone erosions, and/or subchondral cysts. The original grading from Grade 0 to 3 of Weishaupt was converted to Grade 1 to 4 to compare with the MR and histologic gradings.

Four grades of facet degeneration on the MR images were defined using the criteria reported by Grogan et al. [11]. Articular cartilage degeneration of the facets was classified as follows: Grade 1, uniformly thick cartilage covers