Multifidus Degeneration, A New Risk Factor for Lumbar Spinal Stenosis: A Case–Control Study

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OBJECTIVES: **To analyze whether multifidus degeneration has a relationship with degenerative lumbar spinal stenosis (LSS).**

MATERIALS AND METHODS: **Clinical data of 40 patients with LSS were analyzed retrospectively. Moreover, 40 healthy people were selected as controls. Subjects of both groups underwent a 1.5-T lumbar spinal magnetic resonance imaging scan in our hospital, and then the multifidus muscularity, fatty infiltration ratio, and bilateral asymmetry at L4/5 level on magnetic resonance imaging were measured with ImageJ software to analyze and compare the multifidus parameters between the 2 groups.**

RESULTS: **Compared with the control group, the multifidus muscularity was lower, fatty infiltration ratio was greater, and muscle asymmetry was more significant at the L4/5 level in patients with LSS, and the difference between the 2 groups was statistically significant.**

CONCLUSIONS: **Multifidus degeneration, including reduced volume, increased fatty infiltration, and bilateral muscle asymmetry, has an association with LSS.**

INTRODUCTION

Degenerative lumbar spinal stenosis (LSS) is a common spinal disease that occurs mostly in elderly patients.[1] This disease can induce lumbocrural pain, intermittent claudication, and other symptoms; limit physical activities of patients; accelerate the decline of cardiopulmonary function; and thus severely decrease the quality of a patients' life.[2] Many patients may, however, lose the opportunity to undergo surgery because of advanced age and poor constitution, despite having clear surgical indications.[3] Therefore, early prevention and intervention for LSS particularly are important.

In surgical treatment for patients with LSS, the paraspinal muscles were found to have significant fatty infiltration and adhered weakly to the bones. Paraspinal muscles are the main source to maintain the spinal stability, of which the multifidus is particularly important for maintaining the stability of lumbar spine because of its anatomical structure and morphologic characteristics.[4] Lumbosacral multifidus can be divided into superficial and deep layers. The superficial multifidus originates from the long sacroiliac ligament and inner side of the posterior superior iliac spine, whereas the deep multifidus originates from the short sacroiliac ligament and sacral lamina.[5] In terms of morphology, the multifidus is short, whereas its belly has a large cross-sectional area (CSA), with abundant muscle fibers.[6] All these morphologic characteristics indicate that the multifidus can generate a powerful force to maintain the stability of the spine.

As to the location, the deep multifidus is distributed in single segments and is adjacent to the rotation center of the joint of lumbar vertebra.[7] Thus, a small torque is able to generate a large compressive force, thereby controlling the movement between vertebral segments and improving spinal stability. The major function of multifidus contraction is to resist rotation and sliding of the spine as well as maintain the presence of lumbar lordosis instead of enabling the movement of lumbar vertebrae, which is an important factor for the dynamic stability of the spine.[8]

Key words
- Bilateral asymmetry
- Degenerative lumbar spinal stenosis
- Fatty infiltration ratio
- Multifidus degeneration
- Muscularity

Abbreviations and Acronyms
BMI: Body mass index
CSA: Cross-sectional area
FIR: Fatty infiltration ratio
LM: lumbar muscularity
MA: Muscle asymmetry
MRI: Magnetic resonance imaging
LSS: Lumbar spinal stenosis
VB: Vertebral body

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Figure 1. Shown is a 60-year-old male patient who complained of lumbago accompanied by numbness and weakness of the right lower extremity for half a year. Lumbar magnetic resonance imaging revealed canal stenosis at L4/5 segment on the sagittal plane.

Thus, the question is whether the pathogenesis of LSS is associated with multifidus degeneration. Studies have revealed that multifidus degeneration can lead to low back pain, degenerative lumbar spondylolisthesis, lumbar kyphosis, and other diseases.[9-11] The relationship between multifidus degeneration and degenerative LSS, however, has not been reported yet. This study aimed to assess the multifidus degeneration in patients with degenerative LSS by lumbar magnetic resonance imaging (MRI) and analyze their relationship.

MATERIALS AND METHODS

Population

Data of 40 patients who underwent posterior lumbar decompression, interbody fusion, and fixation due to LSS in our hospital between January 2015 and June 2016 were selected. The inclusion criteria were as follows: patients aged 55–65 years, having lumbocrural pain, numbness of lower extremities, intermittent claudication, and other symptoms. MRI revealed reduced sagittal diameter of the lumbar spinal canal, central spinal and lateral stenosis, hypertrophy of ligamentum flavum, involvement of L4/5 segment, and compression of the nerve root and dural sac at the corresponding segment. Patients did not have histories of spinal deformity, lumbar spondylolisthesis, or prolapse of lumbar intervertebral disc.

At the same time, 40 healthy people undergoing lumbar spinal MRI during the same time period were selected as controls. The inclusion criteria were as follows: population with the age of 55–65 years without lumbago, nerve compression, and other symptoms. MRI also was performed to exclude the presence of lumbar spondylosis.

The study was approved by the ethical committees of our hospital. Every patient gave informed consent.

Imaging Procedures

All subjects underwent high-resolution 1.5-T MRI examination at our hospital,[12] of which spin-echo sequences were adopted for T1-weighted images, whereas fast spin-echo sequences were selected for T2-weighted images. Also, a surface coil was deployed for scanning, with the thickness of 4 mm and acquisition matrix of 512 × 256. The sequence parameters were doubling time of 420 milliseconds and echo time of 10 milliseconds for T1-weighted images and doubling time of 3000 milliseconds and echo time of 100 milliseconds for T2-weighted images.

Image Analysis

The following values were measured with MRI: CSA (cm^2), sum of multifidus area on both sides of L4/5 level; vertebral body (VB; cm^2) size, CSA of L5 vertebra; lumbar muscularity (LM), CSA/VB; fatty infiltration ratio (FIR); and muscle asymmetry (MA), the ratio of difference of multifidus area on both sides of L4/5 level over CSA. The CSA was measured with image-processing software (ImageJ, version 1.50, National Institutes of Health, Bethesda, Maryland, USA), and the FIR was obtained by the threshold technique in ImageJ.[13] All the imaging data consecutively were measured thrice by 3 independent surgeons, and the average value was adopted. Imaging measurement data in a typical case are shown in Figures 1–5.

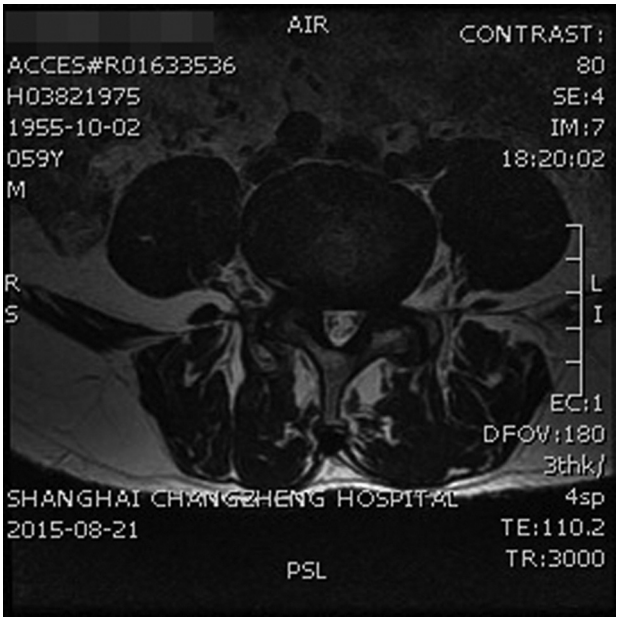

Figure 2. The magnetic resonance imaging of L4/5 transverse plane revealed canal stenosis.