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Original Research

Analysis of Migration Patterns of Disk Fragments and Contributing Factors in Extruded Lumbar Disk Herniation

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Abstract

Background: The exact location of migrated extruded lumbar disk fragments is an important consideration in selecting a treatment plan. However, few descriptive reports of the migration pattern of extruded lumbar disk fragments are available.
Objective: To examine the distribution of disk fragments and possible contributing factors that affect their migration.
Design: Retrospective descriptive study.
Setting: Tertiary university outpatient and inpatient clinic.
Patients: A total of 164 patients diagnosed with a symptomatic extruded lumbar disk from January 2011 to December 2012.
Methods: Lumbar spine magnetic resonance imaging scans of patients were retrospectively reviewed. The term "migration" was defined as the horizontal and vertical displacement of extruded material away from the opening in the annulus through which the material has extruded. Migration of the disk material was recorded in both the horizontal and vertical plane. In the horizontal plane, migration was recorded as central, paracentral, subarticular, or foraminal. In the vertical plane, migration was recorded as rostral or caudal.
Main Outcome Measurements: The pattern of migration and the associated factors (age and the level of herniation) were analyzed.
Results: Rostral and caudal migration was observed in 27% (95% confidence interval [CI], 21%-35%) and 73% (95% CI, 66%-79%) of the patients. Central, paracentral, subarticular, and foraminal migration was observed in 6% (95% CI, 3%-11%), 67% (95% CI, 60%-74%), 18% (95% CI, 13%-25%), and 9% (95% CI, 5%-14%) of the patients, respectively. A significant increase was observed in the incidence of rostral migration with increasing age ($P = .048$). A significant association was also noted between migration in the horizontal plane and increasing age ($P = .01$). A significant increase occurred in the incidence of foraminal extrusion with increasing age ($P = .01$). A significant association was found between migration in the vertical plane and horizontal plane; in patients with foraminal herniations, migration was always rostral ($P < .001$).
Conclusion: The migration of extruded lumbar disk materials follows some general patterns. The results of this study may help spine interventionists and surgeons choose appropriate treatments for patients who have radiculopathy associated with lumbar disk extrusions.

Introduction

Disk herniation generally refers to a localized displacement of disk materials (nucleus pulposus, cartilage, fragmented apophyseal bone, or annular tissue) through a disruption in the annulus beyond the limits of the intervertebral disk space [1]. Disk herniation usually occurs as a result of age-related degeneration of disk, failure of nutrient supply, mechanical loading of the spine, and genetic factors [2]. Lumbar disk herniation is a common disorder that causes back pain and/or radicular pain in the lower extremities. After Dandy [3] recognized the clinical syndrome of radicular pain 80 years ago and Mixter and Barr [4] documented a surgical approach to the extruded disk material, comprehensive studies of the cause, pathophysiology, and treatment of disk herniation have been reported. It has been recognized that displaced fragments of a herniated disk can migrate within the spinal canal in many directions (rostral or caudal in the vertical plane and some lateral directions in the horizontal plane) [1,5].

Magnetic resonance imaging (MRI) is recognized as the best method for visualizing intraspinal canal

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structures, especially disk material and nerve roots [6,7]. Knowing the exact location of the migrated lumbar disk fragments is important to help the physician select a treatment plan. This knowledge may also affect the approach for epidural steroid injection and help avoid unnecessary 2-level explorations or inadequate removal of migrated disk fragments if surgery is to be performed. Despite the importance of identifying migrated disk fragments in patients with lumbar disk herniation, few studies have reported the location and patterns of such migration. The aims of the present study were to examine the distribution of disk fragments and possible contributing factors that affect their migration.

Methods

The results of lumbar spine MRI of patients diagnosed with symptomatic extruded disk were retrospectively reviewed from January 2011 to December 2012. Symptoms were defined as radicular pain or sensory or motor deficits in the lower extremities. The exclusion criteria were back pain only, history of back surgery, inflammatory spine diseases, infection, trauma, fracture, and coexistent atherosclerotic vascular disease in the lower extremities. High-quality axial and sagittal T1- and T2-weighted MRI scans of the lumbar spine were obtained using a 1.5-T scanner (Avanto, Siemens Corp., Erlangen, Germany). The images were reviewed independently by 2 faculty clinicians with more than 10 years of experience in the field of the spine. According to the classification of lumbar disk disease proposed by Fardon et al [1], an extrusion was considered to have occurred when any single distance between the edges of the disk material beyond the disk space was greater than the distance between the edges of the base measured in the same plane or when no continuity existed between the disk material beyond and within the disk space. The term "migrated" refers to the horizontal or vertical displacement of the extruded material away from the opening in the annulus through which the material was extruded [1]. Migration of disk material was reported in both horizontal and vertical planes. From central to lateral in the horizontal plane, migration was defined as "central," "paracentral," "subarticular," and "foraminal" [1,5] (Figure 1). We defined migration as "paracentral" when the preferential side in the central canal zone was definite [5]. We did not evaluate the "extraforaminal" direction because of the difficulty of assessing migration in the vertical plane. From the disk level upward or downward in the vertical plane, migration was defined as "rostral" or "caudal," respectively (Figure 2). If the reports by the 2 physicians differed, the final report was based on an agreement reached after a discussion between them. This study was performed with the approval of the Institutional Review Board (IRB No. 2015-05-003).

Statistical Analysis

SPSS software version 20.0 (IBM Corp, Armonk, NY) was used for statistical analyses. The Pearson χ^2 test was used to analyze the association between the direction of migration and contributing factors. A significance level of $P < .05$ was used.

Results

This study population included 164 patients (81 men and 83 women) with a mean age of 59.9 $\pm$ 15.4 years (range, 20-92 years). Patient characteristics are summarized in Table 1. Migration was observed at the following levels: L1-L2 (9 cases, 5%, 95% confidence interval [CI] 3%-10%); L2-L3 (21 cases, 13%, 95% CI 8%-19%); L3-L4 (29 cases, 18%, 95% CI 13%-24%); L4-L5 (72 cases, 44%, 95% CI 37%-52%); and L5-S1 (33 cases, 20%, 95% CI 14%-27%). In the vertical plane, migration was rostral in 45 cases (27%, 95% CI 21%-35%) and caudal in 119 cases (73%, 95% CI 66%-79%). In the horizontal plane, migration was central in 10 cases (6%, 95% CI 3%-11%), paracentral in 110 cases (67%, 95% CI 60%-74%), subarticular in 30 cases (18%, 95% CI 13%-25%), and foraminal in 14 cases (9%, 95% CI 5%-14%).

Association Between Migration in the Vertical Plane and Age or Spine Level

Rostral and caudal migration was present in 1 (12.5%, 95% CI 2.2%-47.1%) and 7 (87.5%, 95% CI 52.9%-97.8%) patients, respectively, in the 20- to 29-year age group; 0 (0%, 95% CI 0%-28%) and 10 (100%, 95% CI 72%-100%) patients in the 30- to 39-year age group; 3 (20%, 95% CI 7%-45%) and 12 (80%, 95% CI 54%-93%) patients in the 40- to 49-year age group; 10 (21.7%, 95% CI 12.3%-35.6%) and 36 (78.3%, 95% CI 64.4%-87.7%) patients in the 50- to 59-year age group; 10 (28.6%, 95% CI 16.3%-45.1%) and 25 (71.4%, 95% CI 54.9%-83.7%) patients in the 60- to 69-year age group; and 21 (42%, 95% CI 29%-56%) and 29 (58%, 95% CI 44%-71%) patients in the $\geq$70-year age group. A significant increase was observed in the percentage of rostral migration cases with increasing age ($P = .048$; Figure 3). No significant association was found between the level of the lumbar spine and the location of migrated disk materials in the vertical plane ($P = .289$).

Association Between Migration in the Horizontal Plane and Age or Spine Level

No significant differences were found between the spine level and migration in the horizontal plane ($P = .452$). A significant association was found between migration in the horizontal plane and increasing age ($P = .01$; Figure 4). A significant increase in the incidence of foraminal extrusion occurred with increasing age ($P = .01$).