Clinical and Radiographic Characteristics of Upper Lumbar Disc Herniation: Ten-Year Microsurgical Experience

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Abstract

Upper and lower lumbar disc herniation apparently have different background, symptoms, and operative results. This retrospective study reviewed the clinical records of 403 patients (409 discs) who underwent lumbar microdiscectomy performed by different surgeons at our institute between 1999 and 2009. The 290 male (72.0%) and 113 female (28.0%) patients were aged from 19 to 77 years (mean 44 years). Demographics, symptoms, and static and dynamic radiographic and magnetic resonance images obtained at the L1-2, L2-3, L3-4, L4-5, and L5-S1 intervertebral levels were analyzed. Of the 409 herniations, 3 were at L1-2, 9 at L2-3, 21 at L3-4, 166 at L4-5, and 210 at L5-S1. The mean age at herniation at L1-2 and L2-3 levels was 55.7 years. Patients with herniation of discs at L3-4 or above were significantly older than patients who suffered herniation at L4-5 or below ($p < 0.0001$), and the incidence of urinary disturbance was significantly higher in patients with herniation at L1-2 and L2-3 levels ($p = 0.0013$). The incidence of degenerative scoliosis was significantly higher in patients with herniation at L1-2 and L2-3 than in those with herniated discs at L3-4 or below ($p < 0.0001$). Patients with upper lumbar disc herniation were older and manifested a higher incidence of urinary disturbance. A high incidence of degenerative scoliosis was noted in the course of prolonged degenerative processes.

Key words: upper lumbar disc herniation, urinary dysfunction, degenerative scoliosis, dorsal migration, microsurgery

Introduction

Lumbar discectomy was reported to be appropriate treatment in 80% of patients with lumbago and radicular pain in 1947.³⁾ More recent studies have revealed differences in the symptoms, background, past medical history, and postoperative clinical course of patients with herniation at different lumbar disc levels. Patients with disc herniation at the L1-2 and L2-3 intervertebral levels had significantly higher incidence of prior lumbar surgery and additional arthrodesis compared to patients with herniation at L3-4.¹⁴⁾ On the other hand, patients with upper-level disc herniation did not show significantly different age, history of previous lumbar surgery, and postoperative outcomes based on the Oswestry Disability Index (ODI).¹³⁾ A randomized study of

lumbar disc herniation in the United States (Spine Patient Outcomes Research Trial)^{10,11)} found that patients with upper-level disc herniation had better surgical prognosis.

The present retrospective study elucidated the clinical and radiographic characteristics of upper lumbar disc herniation to investigate the effect of the herniation level on treatment outcomes.

Methods

We created a database of 403 patients (409 discs) who had undergone lumbar discectomy at Azabu Neurosurgical Hospital between 1999 and 2009. All operations were performed with the operating microscope by various surgeons of our spinal team. The patients' medical records were retrospectively reviewed to record age, sex, past history of lumbar surgery, preoperative symptoms (back and radicular pain, motor and sensory disturbances, urinary dys-

function, intermittent claudication, and Lasegue sign), and additional post-discectomy surgical interventions (reenucleation for disc recurrence, dural plasty for cerebrospinal fluid [CSF] leakage, abscess irrigation, and arthrodesis). Preoperative radiographic and magnetic resonance (MR) images were reviewed by one author (MI). The presence of degenerative scoliosis, spondylolisthesis, instability, and posterior epidural migration of disc fragments were included in the database. Degenerative scoliosis was recorded when the largest angle between the lines at the superior aspect of the upper lumbar vertebra and the inferior aspect of the lower vertebra on anteroposterior radiographic views (Cobb angle) exceeded 10° , instability when the posterior intervertebral opening angle on lateral radiographic view exceeded 10° and hypermobility was present with the dynamic range of an intervertebral angle between flexion and extension greater than 10° , and posterior epidural migration of a disc fragment when there was a posterior projection over the posterior dural sac line drawn horizontally on T₂-weighted axial MR images.

All patients underwent microdiscectomy using the Love method or laminectomy if there was evidence of central canal stenosis or apparent medial-type discs. Statistical analysis of data obtained at different disc levels was performed with two-way repeated measures analysis of variance ($\alpha = 0.05$) and pairwise multiple post hoc comparisons using the Bonferroni t-test ($\alpha = 0.0083$). The numbers of herniations at L1-2 and L2-3 were too small for statistical analysis, so were combined and evaluated as a group (L1-L3).

The medical records of most patients did not contain conventional pre- and postoperative evaluation data, as the different surgeons had graded back and radicular pain, and motor and sensory disturbance as improved, unchanged, or exacerbated. Therefore, our retrospective study replaced the recorded grade with continuous parameters and applied the paired t-test and intergroup comparison.

Results

Of the 409 discectomies, 3 (0.7%) were at L1-2, 9 (2%) at L2-3, 21 (5%) at L3-4, 166 (41%) at L4-5, and 210 (51%) at L5-S1. The mean age of patients with herniations at the L1-L3 (mean $\pm$ standard deviation, 55.7 ± 14.4 years) or L3-4 levels (59.9 ± 14.2 years) was higher than in patients operated at L4-5 (41.8 ± 14.8 years) or L5-S1 level (42.5 ± 10.9 years) ($p < 0.0001$). The male:female ratio ($p = 0.1048$) and the incidence of prior lumbar surgery ($p = 0.9940$) were not statistically different irrespective of the level of herniation. Table 1 lists the incidence of preoperative symptoms, showing no significant difference in back and radicular pain, motor and sensory disturbances, intermittent claudication, and Lasegue sign between the different groups. On the other hand, significantly more patients with herniation at the L1-L3 levels manifested urinary dysfunction ($p = 0.0013$).

Comparison of the severity of pre- and postoperative symptoms, e.g. back and radicular pain, and motor and sensory disturbance, showed significant improvement irrespective of the operated level ($p < 0.05$). Comparison of the symptom severity recorded before and 3 months after surgery found that more patients operated at L1-L3 tended to report persistent back pain ($p = 0.0609$).

Of the 403 patients, 2 with discectomy at L3-4, 15 operated at L4-5, and 17 treated at L5-S1 required additional surgical intervention due to recurrent disc extrusion, CSF leakage, or wound infection; but were not statistically significant. None of the patients manifested symptomatic post-discectomy instability, so no arthrodesis procedures were performed in this series.

Posterior epidural migration of disc fragments occurred only in patients operated at L1-2 ($n = 1$) and L2-3 ($n = 2$); the overall rate in this series was 0.7%. The incidence of degenerative scoliosis was significantly higher in patients operated at L1-L3 ($n = 6$) than in the other groups (L3-4, $n = 3$; L4-5, $n = 24$; L5-S1, $n = 11$) ($p < 0.0001$). Half of patients with L1-L3 herniations had degenerative scoliosis. There

Table 1 Baseline symptoms categorized by herniation level

Level	No. of discs	Back pain	Radicular pain	Motor disturbance	Sensory disturbance	Intermittent claudication	Urinary dysfunction	Lasegue sign
L1-L3	12	9 (75.0%)	11 (91.7%)	5 (41.7%)	7 (58.3%)	4 (33.3%)	4 (33.3%)	7 (58.3%)
L3-4	21	18 (85.7%)	21 (100%)	7 (33.3%)	17 (81.0%)	6 (28.6%)	0 (0%)	14 (66.7%)
L4-5	166	149 (89.8%)	153 (92.2%)	47 (28.3%)	118 (71.1%)	13 (7.8%)	7 (4.2%)	122 (73.5%)
L5-S1	210	169 (80.5%)	202 (96.2%)	54 (25.7%)	155 (73.8%)	29 (13.8%)	14 (6.7%)	173 (82.4%)
Total	409	345 (84.4%)	387 (94.6%)	113 (27.6%)	297 (72.6%)	52 (12.7%)	25 (6.1%)	316 (77.3%)

was no statistically significant intergroup difference with respect to preexisting instability ($p = 0.2580$) and spondylolisthesis ($p = 0.8726$).

Discussion

The concept of the “upper” lumbar discs has no clear definition of “upper,” so many authors have classified lumbar levels from their own analysis data.^{2,10,13} This study did not try to define the “upper” lumbar level, as all data were analyzed using intergroup comparison at the different disc levels. Consequently, this study did not detect any distinct “upper” level according to the difference of results from any examination. This study analyzed the clinical findings at each lumbar disc level based on a comparatively major series of Japanese patients.

Increasing age brings about changes in the mobility of various facets in the lower lumbar canal and mechanical stress shifts to the upper lumbar level. In fact, we also found that patients who underwent discectomy at L2-3 and L3-4 were significantly older than patients operated at L4-5 and L5-S1.¹⁰ Significantly more patients operated at L1-L3 than L3-4 had undergone prior lumbar surgery and post-discectomy arthrodesis.¹⁴ Previous and the present findings suggest that age-related degeneration of the lumbar canal contributes to the occurrence of upper disc herniation. In our series, significantly more patients with herniation at L1-L3 presented with preoperative urinary disturbance, suggesting that morphological factors, such as smaller cross-sectional area of the upper compared to the lower lumbar canal, facilitate compression of the conus medullaris or multiple cauda equina.⁶

The postoperative outcomes recorded for our patient population suggest that discectomy at any of the studied levels yielded satisfactory results. Although pre- and postoperative data were not recorded based on conventionally-used parameters, most patients experienced symptom improvements. No difference was reported in the surgical outcome of patients operated at L3-4 or above and L4-5 or below,² and there was no statistically significant difference in the decrease in the ODI score in patients operated at L3-4 or above and L4-5 or below, although postoperative ODI scores were significantly higher in patients with upper lumbar disc herniation ($p = 0.001$).¹³ Among our patients, those who had undergone surgery at L1-L3 tended to suffer persistent back pain, although an earlier randomized study¹⁰ found that at 2-year follow-up patients with upper lumbar herniations (L2-3 or L3-4) manifested significantly greater treatment effects than did patients with L5-S1 herniations for all

outcome measures (Medical Outcomes Study Short Form-36 Health Survey [SF-36] bodily pain, physical functioning, and ODI). Differences in treatment effects between the upper lumbar levels and L4-5 were significant with respect to SF-36 bodily pain only; the greatest treatment benefits were obtained in patients with herniation at L2-3 and L3-4. On the other hand, in another randomized trial,¹ patients treated surgically for L4-5 herniation fared better than patients treated by discectomy at L5-S1. Studies using conventional evaluation parameters are underway at our institute to determine whether, and at what lumbar level, discectomy yields satisfactory treatment results.

Posterior epidural migration of disc fragment was only recognized at L1-2 and L2-3. Posterior migration is usually obstructed by the so-called “peridural membrane,” which is the band medially attached to the lateral edge of posterior longitudinal ligament and extending to the lateral wall of spinal canal.^{15,16} This peridural membrane limits the movement of the extruded disc fragment.^{7,15} Other involved structures include the midline and lateral dural ligaments of Hoffmann, which connect the anterior dural surface to the posterior longitudinal ligament and posterior vertebral periosteum,^{17,18} and normally lead to the lateral or posterolateral path of migration.¹² Traction, heavy labor, and hypermobility may predispose the disc to move posterior migration.^{8,9} Review of this phenomenon found almost the same number of cases at all levels except for no cases at the L5-S1 level (L1-2 = 1, L2-3 = 4, L3-4 = 4, and L4-5 = 5). Explanation of the basic distribution of cases at each disc level may involve frequent posterior epidural migration in the upper herniation group, which may be related to the vertebral rotation angle in the axial plane which tends to be wider at the upper lumbar vertebral level.

We found that upper lumbar disc herniation was associated with a high incidence of degenerative scoliosis. Although some studies documented disc degeneration at the concave aspect of scoliosis,^{4,5} we think that degenerative changes involving the disc and endplate can originate from preexisting scoliosis. Asymmetric degenerative disc changes and the subsequent development of frontal deviation and concomitant rotation with unilateral facet joints as a pivot produce what has been called the discogenic curve.¹ The development of the primary degenerative curve is primarily attributable to limited disc degeneration. Based on the chain of events in the course of the degenerative process, it is not surprising that the upper discs are primarily involved by degenerative scoliosis, and that mostly older individuals are affected.

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