



Additive Benefit Analysis of Spinal Discectomy Tissue Specimens

Burhan Oral Gudu

Istanbul Medipol University, Faculty of Medicine, Department of Neurosurgery, İstanbul, Türkiye

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Abstract

Aim: The necessity of performing routine histopathological examinations on intervertebral disc specimens obtained during microdiscectomy remains a matter of debate with limited data available in the current literature. This study aimed to evaluate whether such routine examinations provide additional diagnostic or therapeutic value.

Material and Method: A total of 224 intervertebral disc specimens (78 cervical, 146 lumbar) obtained from 190 consecutive patients who underwent surgery for symptomatic disc herniation between 2017 and 2021 were retrospectively analyzed. Clinical, radiological, intraoperative, and histopathological findings were systematically analyzed and compared.

Results: The most frequently affected levels were C5–C6 and C6–C7 in the cervical spine, and L4–L5 and L5–S1 in the lumbar spine. A statistically significant difference was observed in the type of herniation between the cervical and lumbar regions ($p=0.0005$). Histopathological examination revealed degenerative changes in all specimens. In one case, polymorphonuclear cell infiltration was noted; however, there were no supporting clinical or radiological signs suggestive of discitis. In another case, the intraoperative discovery of black disc material led to a diagnosis of alkaptonuria, which was later confirmed by genetic analysis.

Conclusion: Routine histopathological examination of intervertebral disc specimens obtained during microdiscectomy did not contribute to diagnosis or treatment planning in our study. Given the low diagnostic yield and additional cost, such evaluations should be reserved for selected cases with specific clinical, radiological, or intraoperative suspicion.

Keywords: Microdiscectomy, histopathological examination, intervertebral disc, degenerative disc disease, cost-effectiveness

INTRODUCTION

Intervertebral discs (IVDs) are fibrocartilaginous structures located between the vertebral bodies, contributing to both the load-bearing capacity and flexibility of the spine. Unlike other connective tissues, IVDs begin to show degenerative changes early in life. The development of disc herniation is primarily influenced by factors such as aging, mechanical stress, repetitive microtrauma, genetic predisposition, and alterations in the biochemical composition of the disc. Histopathologically, this process is characterized by disorganization of collagen fibers, loss of glycosaminoglycans, fibroblastic proliferation, inflammatory cell infiltration, and endochondral ossification (1-4).

Degenerative changes compromise the mechanical integrity of the disc, increasing its susceptibility to herniation. The severity of clinical symptoms is generally

associated with the direction of disc herniation, its impact on neural structures, and the degree of the inflammatory response (1,2,5). Although intervertebral disc herniations (IVDHs) manifest with distinct clinical presentations depending on their anatomical location, they share similar pathophysiological mechanisms (2,3). Cervical, thoracic, and lumbar disc herniations produce varying clinical pictures depending on regional anatomy and the involvement of adjacent neural elements (6-10). Herniations at the cervical and thoracic levels may cause spinal cord compression due to the narrower canal diameter, often leading to cervical or thoracic myelopathy. Additionally, foraminal narrowing may result in radiculopathy symptoms (4-6,11). In contrast, since the spinal cord terminates in the lumbar region, lumbar disc herniations typically compress nerve roots, presenting with symptoms such as sciatica, low back pain, and functional impairment in the lower extremities (11-15).

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Corresponding Author: Burhan Oral Gudu, İstanbul Medipol University, Faculty of Medicine, Department of Neurosurgery, İstanbul, Türkiye

E-mail: burhan.gudu@medipol.edu.tr

Histological studies have shown that structural degeneration of the IVD can begin as early as childhood, even around the age of 11 (3,16). This degenerative progression compromises the biomechanical integrity of the disc over time and clinically manifests as neck and back pain (2,14,16). Low back pain affects approximately 80% of the population at some point in their lives, while neck pain affects around 20% (6,17-19). Although most patients improve with conservative management, about 2–10% eventually require surgical intervention (7,11,14,15). The treatment of IVDH includes conservative modalities such as physical therapy, epidural injections, and surgical interventions, including microdiscectomy, decompression, disc replacement, or spinal fusion. Microdiscectomy is a commonly preferred surgical technique in the presence of radiculopathy or neurological deficit, with reported success rates ranging between 80% and 90% (11,14).

Histopathological examination of disc material obtained during surgery is typically performed to rule out rare malignancies and infections, as well as to fulfill medicolegal documentation and institutional protocols. However, several studies have questioned the clinical utility of routine pathological evaluation in cases of benign disc herniation, suggesting its limited contribution to patient management (4,16,20).

This study aims to systematically assess whether histopathological analysis of disc specimens obtained from cervical and lumbar microdiscectomy cases performed for degenerative disc disease, trauma, spondylolisthesis, spondylolysis, spinal stenosis or spondylosis offers any diagnostic or therapeutic value in the clinical decision-making process. By doing so, we seek to objectively evaluate the role and necessity of routine pathological assessment in contemporary spine surgery practice.

MATERIAL AND METHOD

Between January 2017 and October 2021, all histopathological reports of intervertebral disc specimens obtained by a single surgeon at a single tertiary care center were retrospectively reviewed. Patients with a preoperative clinical suspicion of infection or malignancy were excluded from the study. Particular attention was paid to any histopathological findings that altered the course of clinical management. For each patient, preoperative diagnoses, intraoperative findings, and postoperative discharge diagnoses were reviewed and compared.

The study protocol was approved by the Ethics Committee of Kanuni Sultan Süleyman Research and Training Hospital (Approval Date: November 26, 2021; Approval Number: 2021.11.286). All procedures were performed in accordance with the principles outlined in the Declaration of Helsinki.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to present means and

standard deviations for continuous variables and frequencies with percentages for categorical variables. Comparisons between cervical and lumbar disc herniation groups were made using the independent samples t-test for age and the Chi-square test for categorical variables. Fisher's exact test was applied when expected cell counts were below 5. A p -value < 0.05 was considered statistically significant.

RESULTS

A total of 190 patients who underwent surgery for symptomatic intervertebral disc herniation were included in the study, comprising 78 cervical and 146 lumbar cases. The mean age of the cervical group was 48.2 ± 9.6 years, while the lumbar group had a significantly higher mean age of 52.5 ± 11.4 years ($p = 0.0032$). The proportion of male patients was 53.8% in the cervical group and 60.3% in the lumbar group, with no statistically significant difference between groups ($p = 0.4315$).

Based on Magnetic Resonance Imaging (MRI) findings, the most common type of herniation in the cervical region was protrusion (62.8%), followed by extrusion (26.9%) and sequestration (10.3%). In contrast, extrusion was the predominant type in the lumbar group (48.6%), followed by protrusion (35.6%) and sequestration (15.8%). The distribution of herniation types differed significantly between the two regions ($p = 0.0005$). Anatomically, the most frequently affected levels were C6–C7 (42.3%) and C5–C6 (33.3%) in the cervical spine, and L5–S1 (48.3%) and L4–L5 (35.9%) in the lumbar spine. Less frequently involved levels included C4–C5 (17.9%), C3–C4 (6.4%), and C7–T1 (0.0%) in the cervical region, and L3–L4 (10.3%), L2–L3 (6.1%), and L1–L2 (0.0%) in the lumbar region. Multilevel disc herniation was observed in 14.1% of cervical and 19.9% of lumbar cases, without a statistically significant difference ($p = 0.3738$). Similarly, the rates of severe spinal canal stenosis were comparable between the groups (cervical: 21.8%, lumbar: 23.3%; $p = 0.931$) (Table 1).

Intraoperative findings documented in surgical records included sequestered or protruding disc fragments, free disc material compressing nerve roots, osteophytic formations, ligamentum flavum hypertrophy, and varying degrees of spinal stenosis. No findings suggestive of infectious or malignant pathology were noted in any case.

A total of 224 disc specimens (78 cervical, 146 lumbar) were subjected to histopathological evaluation. All samples exhibited histological features consistent with benign degenerative changes, including fibrocartilaginous degeneration, fragmentation of the chondroid matrix, and fibrosis. None of the histopathological findings led to a change in clinical treatment protocol. In one case with a histopathological diagnosis suggestive of discitis, no supporting clinical, radiological, or intraoperative evidence of infection was found, and the patient was monitored without antibiotic therapy. In another case, black-colored disc material was noted intraoperatively; although histology revealed only typical degenerative features, the patient was subsequently diagnosed with alkaptonuria via genetic testing (Figure 1).

In all cervical discectomy cases, an interbody cage or disc prosthesis was implanted. In contrast, only a minority of patients in the lumbar discectomy group underwent fusion

or stabilization procedures, which were performed based on the presence of preoperative or intraoperative signs of instability or spinal deformity.

Table 1. Demographic characteristics, MRI findings, and distribution of herniation types and levels in cervical and lumbar disc herniation cases				
Parameters	Intervertebral cervical disc tissue samples (n=78)		Intervertebral lumbar disc tissue samples (n=146)	
Mean age (years)	48.2±9.6		52.5±11.4	
Gender (Male %)	42 (53.8%)		88 (60.3%)	
Most common herniation type	Protrusion	(n=49, 62.8%)	Extrusion	(n=71, 48.6%)
	Extrusion	(n=21, 26.9%)	Protrusion	(n=52, 35.6%)
	Sequestration	(n=8, 10.3%)	Sequestration	(n=23, 15.8%)
Most common disc level(s)	C3–C4	5 (6.4%)	L1–L2	0 (0.0%)
	C4–C5	14 (17.9%)	L2–L3	9 (6.1%)
	C5–C6	26 (33.3%)	L3–L4	15 (10.3%)
	C6–C7	33 (42.3%)	L4–L5	52 (35.9%)
	C7–T1	0 (0.0%)	L5–S1	70 (48.3%)
Multilevel Involvement	n=11 (14.1%)		n=29 (19.9%)	
Severe canal stenosis	n=17 (21.8%)		n=34 (23.3%)	
Degenerative disc disease (DDD)	65		106	
Spondylosis	9		16	
Spondylolisthesis	1		9	
Spondylolysis	0		6	



Figure 1. Macroscopically, the nucleus pulposus removed from the L4-5 disc was black in colour

DISCUSSION

The histopathological evaluation of all specimens in this study revealed only degenerative changes, and no clinically significant pathological findings were identified that would necessitate a change in the treatment protocol. In one case of lumbar microdiscectomy at the L4–L5 level, polymorphonuclear leukocyte infiltration was observed histologically; however, the absence of any clinical or laboratory indicators suggestive of discitis eliminated the need for antibiotic therapy. In another case, black-colored disc material was noted intraoperatively. Although histopathological evaluation identified this tissue as degenerative chondroid material, further genetic testing ultimately led to a diagnosis of alkaptonuria.

These findings suggest that histopathological evaluation has limited diagnostic value and clinical significance, except in rare and exceptional cases. Therefore, the cost-effectiveness of routine histopathological analysis should be critically assessed. Routine pathological examination may provide meaningful diagnostic insights in selected cases particularly those with supporting clinical, radiological, or intraoperative suspicion but the automatic submission of all discectomy specimens for histopathological evaluation is not aligned with current clinical practice and raises concerns regarding the balance between cost and benefit. As demonstrated in this study, microscopic analysis did not alter the treatment protocol in any case, reaffirming its limited role outside of specific clinical indications. Although histopathological examination of discectomy specimens rarely yields diagnostic information, it may

be valuable in patients with preoperative suspicion of infection or malignancy and can significantly contribute to treatment planning in such cases. In a study by Hasselblatt et al. involving 2,177 intervertebral disc specimens, only three unexpected pathologies were reported: one case of cavernous malformation and two malignancies (0.1%) metastatic prostate carcinoma and diffuse large B-cell lymphoma (21). Despite these rare findings, the study concluded that routine histopathological evaluation of disc specimens during spinal surgery is both clinically justified and cost-effective. However, the methodological context of these exceptional cases warrants closer examination. The patient diagnosed with diffuse large B-cell lymphoma had MRI findings inconsistent with a typical disc herniation, while the patient with metastatic prostate carcinoma had a known oncological history and underwent surgery based solely on Computed Tomography (CT) imaging, without prior MRI. These cases underscore the importance of thorough preoperative evaluation and selective pathological analysis, rather than routine application in all disc surgeries. The exceedingly low diagnostic yield of routine histopathological evaluation of discectomy specimens has also been supported by previous large-scale studies. Daftari et al. analyzed 506 disc levels in 394 patients and estimated that, after 506 consecutive negative results, the likelihood of encountering a positive pathological finding was approximately 0.6% (22). Similarly, the incidence of unexpected and clinically significant histopathological findings in disc specimens obtained during discectomy for benign indications has been reported to be as low as 1 in 10,000 (16). In a retrospective review of 1,109 cases, it was concluded that histopathological evaluation of intervertebral disc specimens contributed meaningfully to clinical decision-making only when there was significant preoperative clinical suspicion of an underlying diagnosis (23). In another study analyzing 1,775 routine and 70 non-routine discectomy specimens, the authors explicitly stated that routine histopathological examination is unnecessary in cases without specific clinical indications (20). Similarly, Keller et al., in their retrospective study involving 1,387 patients who underwent cervical or lumbar discectomy, concluded that pathological examination of herniated nucleus pulposus removed during decompressive surgery was not required (24). Supporting these findings, Boutin et al., in a series of 508 laminectomy patients, demonstrated that routine pathological evaluation of disc material had no significant impact on clinical management (13). The consistent findings across multiple studies support the premise that routine histopathological analysis of disc specimens obtained during standard microdiscectomy for degenerative pathology offers extremely limited clinical benefit and may not be justifiable in terms of cost-effectiveness. Therefore, a more selective, indication-focused approach is recommended to optimize resource utilization in spinal surgery. The intraoperative observation of black disc material allowed for further metabolic evaluation, ultimately leading to a diagnosis of alkaptonuria. Based on current evidence, routine histopathological examination of intervertebral disc specimens appears unnecessary (16,24).

The decision to submit disc material for pathological analysis should be based on a combination of clinical presentation, laboratory and radiological findings, and intraoperative observations. Spine surgeons experienced in microsurgical techniques can often recognize disc tissue macroscopically with ease, and routine submission of specimens for pathological evaluation may not be necessary in every case (4,16,20). In an era of increasing demand for healthcare services, efficient and responsible use of available resources is of critical importance. Indeed, many hospital protocols already provide clear guidelines regarding which types of surgical specimens should be submitted for histopathological examination. Pathological examination performed by a pathologist cannot directly confirm whether the submitted specimen was truly obtained from a herniated disc, whether the disc was indeed herniated, or whether it was responsible for the patient's clinical symptoms. At best, histopathological analysis can serve as indirect evidence that disc tissue was removed during surgery (16,20). In modern healthcare systems, providing cost-effective and high-quality care has become a central priority. Cost-effectiveness is now recognized as a critical component of patient management. Although the primary aim of this retrospective study was not to assess the cost-effectiveness of routine pathological analysis of disc specimens, the associated economic burden warrants consideration. The routine submission of surgical specimens for histopathological analysis may be driven by institutional, insurance, or medicolegal policies aiming to document the physical removal of tissue during surgery. While identification of removed material in operative reports or intraoperative radiographic imaging may provide some degree of verification, these methods cannot always be accepted as definitive physical evidence. Alternatively, more cost-effective medicolegal documentation methods—such as photographing the disc specimen, labeling it with patient identifiers, and preserving it for potential presentation to the patient or family—may be adopted. Nevertheless, institutional surgical practices and laboratory protocols should be periodically re-evaluated on a case-by-case basis. Cervical discectomies, typically performed via an anterior approach, allow for direct and comprehensive visualization of the disc, whereas lumbar discectomies are generally carried out posteriorly and offer more limited disc exposure (7,11). However, in general, neural structures are more readily visualized in lumbar surgeries compared to anterior cervical approaches. In the absence of clear clinical indications, it is not always possible for surgeons to anticipate or identify occult pathological processes in surgical specimens. Additionally, when bone or endplate material is submitted along with the disc specimen, additional laboratory charges may be incurred.

Limitations of this study include a relatively small sample size, its retrospective single-center design, the exclusion of thoracic disc herniations (which account for less than 1% of surgical cases), and the use of standard histopathological

protocols mandated by the national health system. Furthermore, the study did not assess neuroinflammatory markers or other biochemical indicators, and all surgeries were performed by a single surgeon. A formal cost-benefit analysis was also not conducted.

CONCLUSION

The routine submission of disc specimens for histopathological examination serves as a medicolegal safeguard for the surgeon, providing the only tangible intraoperative evidence beyond radiological findings. Nonetheless, the decision to request pathological analysis ultimately remains at the discretion of the operating surgeon.

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