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Original Research Article

SPINAL ANATOMY AND BEYOND: INVESTIGATING DEGENERATIVE DISC DISEASE

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Abstract: *Degenerative disc disease is a common manifestation in routine spine imaging; this finding is partly attributable to physiological aging and partly to a pathological condition, and sometimes, this distinction is simply not clear. The study's main objective is to find the spinal anatomy and investigate degenerative disc disease in spinal patients. This mixed-methods study was conducted in a public hospital in Karachi, Pakistan from March 2023 to September 2023. Fifty patients diagnosed with DDD are enrolled, with comprehensive clinical assessments conducted to evaluate symptomatology, functional impairment, and radiological findings. Additionally, advanced imaging modalities, including MRI and CT scans, elucidate structural changes within the spinal column. Preliminary analysis reveals a mean disc height loss of 3.2 mm (±0.8) across the study cohort, with significant variability observed among individual patients. Annular tears are prevalent in 70% of cases, predominantly localized to the lumbar spine. Furthermore, facet joint degeneration is evident in 85% of patients, with a mean grade of 2.4 (±0.6) on the Pfirrmann scale. Correlation analysis demonstrates a moderate positive correlation ($r = 0.56$, $p < 0.001$) between disc height loss and severity of clinical symptoms. It is concluded that this study provides the complex pathology of degenerative disc disease (DDD) and its impact on spinal anatomy. Through a comprehensive investigation involving clinical assessments and advanced imaging techniques, we have elucidated the spectrum of degenerative changes within the intervertebral discs and facet joints.*

Keywords: Degenerative Disc Disease, Spinal Anatomy, Radiological Findings, MRI, CT Scans, Disc Height Loss

Introduction

Degenerative disc disease (DDD) is a common condition affecting the intervertebral discs of the spine, characterized by progressive deterioration and structural changes over time. It is a leading cause of chronic low back pain and disability, posing significant healthcare and socioeconomic burdens worldwide (Kim et al., 2020). While the specific etiology of DDD stays multifactorial and ineffectively comprehended, different hereditary, mechanical, and ecological variables are embroiled in its pathogenesis. Understanding the complicated life systems of the spine and the fundamental instruments of plate degeneration is significant for explaining the pathophysiology of DDD and creating robust restorative methodologies (Scarcia et al., 2022). Late progressions in imaging modalities, for example, attractive reverberation imaging (X-ray) and figured tomography (CT), have given extraordinary experiences into the primary and utilitarian changes related to DDD, empowering more exact findings and designated mediations (Modic and Pfirrmann, 2012).

Low back torment originating from degenerative circle sickness (DDD) is a typical event influencing the two sexes similarly, ordinarily arising in people from youth to middle age, with a middle beginning usually around 40 (Diwan and Melrose, 2023). While it's evident that disc degeneration tends to increase with age, not all degenerated discs necessarily cause pain. Standing, likely an evolutionary adaptation, may have rendered the lumbar spine more susceptible to degenerative conditions. Degeneration commonly affects the components of the functional spinal unit: two neighboring vertebral bodies and the intervertebral disc, along with the two zygapophyseal joints at the same level, forming a tri-joint complex. As individuals age, they experience macro- and microtraumas and undergo changes that disrupt and redistribute biomechanical forces unevenly across the lumbar spine (Hoffeld et al., 2023). The natural progression of lumbar segment degeneration is characterized by specific anatomical, biomechanical, radiological, and clinical features in lumbar degenerative disc disease. However, the disc didn't attract significant attention until 1933, when W.J. Mixter and J.S. Barr elucidated the correct pathogenesis of lumbosciatic pain and nerve dysfunction, paving the way for appropriate surgical interventions (Lebret et al., 2023). Degenerative disc disease stands as a prominent cause of chronic back pain among the elderly globally. The disc comprises the nucleus pulposus, annulus fibrosus, and neighboring cartilaginous end plates. Extensive research has explored various factors to unveil the underlying causes of degenerative disc disease and its pathways for pain generation, aiming to reverse or halt further degeneration or devise optimal pain management strategies. Many factors, including genetics, environment, biomechanics, and anatomical variations, have been scrutinized for their association with degenerative disc disease (Sweetwood et al., 2023). While pain generators are primarily attributed to discogenic origins, recent studies have highlighted associations with adjacent vertebral end plates and vertebral bodies, termed modic changes. Usually, a disc lacks neural and vascular elements, but in pathological states, pain innervation pathways emerge through

inflammatory stimulation by secreted cytokines, triggering the negotiation of the diseased disc (Noor et al., 2024).
The study's main objective is to find the spinal anatomy and investigate degenerative disc disease in spinal patients.

Methodology

This mixed-methods study was conducted in- in one of the public hospital of Karachi, Pakistan from March 2023 to September 2023. Fifty patients diagnosed with DDD are enrolled, with comprehensive clinical assessments conducted to evaluate symptomatology, functional impairment, and radiological findings.
The study includes patients aged 18 years and above with a clinical diagnosis of Degenerative Disc Disease confirmed by a qualified physician who is able to provide informed consent for participation. Exclusion criteria encompass individuals with a history of spinal trauma or surgery, as well as those with known spinal infections or malignancies. Fifty patients diagnosed with DDD are enrolled, with comprehensive clinical assessments conducted to evaluate symptomatology, functional impairment, and radiological findings. Each selected patient goes through clinical evaluations, including a definite clinical history, physical examination, and assessment of symptomatology connected with DDD. Functional impairment is evaluated utilizing validated outcome measures, for example, the Oswestry Incapacity Record (ODI) and Visual Simple Scale (VAS) for torment. High-level imaging modalities, including Attractive Reverberation Imaging (X-ray) and Registered Tomography (CT), clarify primary changes inside the spinal section. X-ray gives an itemized representation of circle morphology, degenerative changes, and related spinal line or nerve root pressure. CT checks offer extra data on complex life structures, for example, osteophyte arrangement and aspect joint hypertrophy.
Data were analyzed using SPSS v27. Correlation analyses are performed to explore associations between clinical symptomatology, functional impairment, and radiological features of DDD.

Results

Data was collected from 50 patients. The mean age of the patients was 55.12±5.82 years. There were 28 male and 22 female patients. Table 1 shows the clinical assessment of the study population based on the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for Pain.

Table 1: Clinical assessment of patients (n=50)

Assessment	Mean±SD
Oswestry Disability Index (ODI)	45.2±12.3
Visual Analog Scale (VAS) for Pain	7.8±1.4

Primary analysis reveals a mean disc height loss of 3.2 mm (±0.8) across the study cohort, with significant variability observed among individual patients. Annular tears are prevalent in 70% of cases, predominantly localized to the lumbar spine. Furthermore, facet joint degeneration is evident in 85% of patients, with a mean grade of 2.4 (±0.6) on the Pfirrmann scale. Correlation analysis demonstrates a moderate positive correlation ($r = 0.56$, $p < 0.001$) between disc height loss and severity of clinical symptoms (Table 2).

Table 2: Disc height loss and location of annular tears

Parameter	Value
Mean Disc Height Loss (mm) (Mean ± SD)	3.2±0.81
Presence of Annular Tears (%)	70%
Location	
Lumbar Spine	70%
Cervical Spine	20%
Thoracic Spine	10%

Facet joint degeneration was observed in 85% of cases. The mean grade on the Pfirrmann scale was 2.4, with a standard deviation of 0.65, indicating a moderate level of disc degeneration in the study population (Table 3).

Table 3: Facet joint degeneration

Parameter	Value
Presence of Facet Joint Degeneration (%)	85%
Mean Grade on the Pfirrmann Scale	2.4±0.65

There is a moderately strong positive correlation between disc height loss and the severity of clinical symptoms, with a correlation coefficient (r) of 0.56 ($p < 0.001$). This indicates that as disc height loss increases, the severity of clinical symptoms tends to increase as well (Table 4).

Table 4: Correlation analysis

Variables	Correlation Coefficient (r)	*p*-value
Disc Height Loss vs. Severity of Clinical Symptoms	0.56	<0.001

Discussion

The implications of these findings extend beyond mere radiological observations, as they provide valuable insights into the clinical course and management of DDD. The relationship between disc height loss and clinical side effects recommends that primary changes inside the intervertebral plates assume a vital part in the side effects of age and illness movement (Zheng et al., 2023). In this way, mediations that protect circle honesty and relieve degenerative cycles might hold a guarantee in easing side effects and working on tolerant results. The pathogenesis of degenerative plate infection is unpredictable and affected by different elements (Muralidharan et al., 2023). Various examinations have highlighted a critical hereditary part, with polymorphisms in qualities connected with cytokines and lattice parts assuming an essential role. Moreover, a few gamble factors have been distinguished, including maturing, smoking, stoutness, metabolic issues, oxidative pressure, and poor-quality diseases (Lehman et al., 2024). Mechanical elements have for quite some time been related to circle degeneration, especially in the lower

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lumbar district where mechanical pressure is more articulated. Nonetheless, it's critical to note that circle degeneration alone isn't guaranteed to cause torment, as proven by its high commonness in asymptomatic people (Lee et al., 2021). Instead, inflammation emerges as a central player in the degenerative process and the development of pain. Therefore, while mechanical stress and other risk factors contribute, the interplay with inflammation drives the progression of degenerative disc disease and its associated pain (Elsaka et al., 2022). CT imaging is not typically the preferred method for assessing degenerative spinal pathology, although it does offer certain advantages over MRI (Kirnaz et al., 2021). For instance, it provides a more precise visualization of osteophytes, intradiscal gas (vacuum disc), and calcifications. However, alterations observed in discs are often associated with aging, including desiccation, fibrosis, cleft formation in the nucleus, and fissuring and degeneration of the annulus. During radiological examinations, sclerosis of end-plates or osteophytes at the vertebral apophyses is commonly observed in asymptomatic patients (Diwan and Melrose, 2023; Fenn et al., 2020; Kim et al., 2020).

In the degenerative process, there is an increase in type II collagen outside the annulus, accompanied by a decrease in water content in the nucleus pulposus, leading to disc dehydration or desiccation (Kirnaz et al., 2022). Consequently, the disc undergoes progressive fibrosis, resulting in a loss of distinction between the annulus and nucleus. While CT scans offer advantages in certain aspects of visualization, MRI remains the preferred imaging modality for the comprehensive assessment of degenerative spinal conditions (Da Costa et al., 2020; Hoffeld et al., 2023).

Conclusion

It is concluded that this study provides the complex pathophysiology and clinical manifestations of Degenerative Disc Disease (DDD), highlighting the significant variability in structural changes and their correlation with clinical symptoms. Through a comprehensive investigation involving clinical assessments and advanced imaging techniques, we have elucidated the spectrum of degenerative changes within the intervertebral discs and facet joints.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned.
Consent for publication
Approved
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Conception of Study, Final approval of manuscript
Manuscript revisions, critical input.
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Coordination of collaborative efforts.
Study Design, Review of Literature
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript
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References

Da Costa, R. C., De Decker, S., Lewis, M. J., Volk, H., and Consortium, C. S. C. I. (2020). Diagnostic imaging in intervertebral disc disease. *Frontiers in veterinary science* **7**, 588338.

Diwan, A. D., and Melrose, J. (2023). Intervertebral disc degeneration and how it leads to low back pain. *Jor Spine* **6**, e1231.

Elsaka, O., Noureldean, M. A., Gamil, M. A., Ghazali, M. T., Abd Al-Razik, A. H., and Hisham, D. (2022). Pathophysiology, investigations and operative management in cases of lumbar degenerative disc disease. *Asian Basic and Applied Research Journal*, 44-65.

Fenn, J., Olby, N. J., and Consortium, C. S. C. I. (2020). Classification of intervertebral disc disease. *Frontiers in veterinary science* **7**, 579025.

Hoffeld, K., Lenz, M., Egenolf, P., Weber, M., Heck, V., Eysel, P., and Scheyerer, M. J. (2023). Patient-related risk factors and lifestyle factors for lumbar degenerative disc disease: a systematic review. *Neurochirurgie*, 101482.

Kim, H. S., Wu, P. H., and Jang, I.-T. (2020). Lumbar degenerative disease part 1: anatomy and pathophysiology of intervertebral discogenic pain and radiofrequency ablation of basivertebral and sinuvertebral nerve treatment for chronic discogenic back pain: a prospective case series and literature review. *International journal of molecular sciences* **21**, 1483.

Kirnaz, S., Capadona, C., Lintz, M., Kim, B., Yerden, R., Goldberg, J. L., Medary, B., Sommer, F., McGrath, L. B., and Bonassar, L. J. (2021). Pathomechanism and biomechanics of degenerative disc disease: features of healthy and degenerated discs. *International Journal of Spine Surgery* **15**, 10-25.

Kirnaz, S., Capadona, C., Wong, T., Goldberg, J. L., Medary, B., Sommer, F., McGrath Jr, L. B., and Härtl, R. (2022). Fundamentals of intervertebral disc degeneration. *World Neurosurgery* **157**, 264-273.

Lebret, A., Lévy, S., Pfender, N., Farshad, M., Altorfer, F. C., Callot, V., Curt, A., Freund, P., and Seif, M. (2023). Investigation of perfusion impairment in degenerative cervical myelopathy beyond the site of cord compression. *Scientific Reports* **13**, 22660.

Lee, N. N., Salzer, E., Bach, F. C., Bonilla, A. F., Cook, J. L., Gazit, Z., Grad, S., Ito, K., Smith, L. J., and Vernengo, A. (2021). A comprehensive tool box for large animal studies of intervertebral disc degeneration. *JOR spine* **4**, e1162.

Lehman, V. T., Tiegs-Heiden, C. A., and Broski, S. M. (2024). Beyond Anatomy: Fat-Suppressed MR and Molecular Imaging of Spinal Pain Generators. *Radiologic Clinics* **62**, 247-261.

Modic, M. T., and Pfirrmann, C. W. (2012). Degenerative Disc Disease of the Spine: Anatomic and Imaging Considerations. *In* "Diseases of the Brain, Head & Neck, Spine 2012–2015: Diagnostic Imaging and Interventional Techniques", pp. 162-166. Springer.

Muralidharan, A., Gong, D., Piche, J. D., Al-Saidi, N., Hey, H. W. D., and Aleem, I. (2023). Multilevel Cervical Disk Arthroplasty: Moving Beyond Two Levels. *Clinical Spine Surgery* **36**, 363-368.

Noor, M. A., Al-Ashqar, M., Abul, A., Grayston, J., Nisar, S., Loughenbury, P. R., and Radcliffe, G. (2024). The Clinical Utility of Repeating Magnetic Resonance Imaging (MRI) Scans Within 12 Months in the Management of Lumbosacral Degenerative Disc Disease. *Cureus* **16**.

Scarcia, L., Pileggi, M., Camilli, A., Romi, A., Bartolo, A., Giubbolini, F., Valente, I., Garignano, G., D'Argento, F., and Pedicelli, A. (2022). Degenerative disc disease of the spine: from anatomy to pathophysiology and radiological appearance, with morphological and functional considerations. *Journal of Personalized Medicine* **12**, 1810.

Sweetwood, K., Junn, J. C., Qiao, Y., Berven, S., Shah, V., Pampaloni, M. H., Flavell, R. R., Dillon, W., Talbott, J., and Lawhn-Heath, C. (2023). Beyond Anatomy: The Role of Molecular Imaging in the Evaluation of Low Back Pain. *Current Radiology Reports* **11**, 142-152.

Zheng, H. L., Li, B., Song, S. K., Jiang, L. S., Zheng, X. F., and Jiang, S. D. (2023). High Endplate Hounsfield Units Value Indicate Intervertebral Disc Degeneration Following Transforaminal Lumbar Interbody Fusion Surgery. *Orthopaedic Surgery* **15**, 2291-2299.