ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

Ultrasonographic Evaluation of Lumbar Intervertebral Discs Protrusion in High School Aged Children

Rizvan Ya Abdullaiev*, Igor A Voronzhev, Roman R Abdullaiev and Nataly S Lisenko

Kharkov National Medical University, Ukraine

***Corresponding Author:** Rizvan Ya Abdullaiev, Kharkov National Medical University, Ukraine.

Received: December 16, 2025; **Published:** December 30, 2025

Abstract

Materials and Methods: A retrospective analysis of the ultrasonography results of 180 lumbar intervertebral discs in 36 children aged 13 - 18 years was carried out. In 43 discs, degenerative changes in the nucleus pulposus and annulus fibrosus were detected, while the integrity of the annulus fibrosus was preserved. The examination was performed in sagittal and axial views. In the sagittal projection, the height of the vertebral bodies and intervertebral discs was measured, and in the axial projection, the anteroposterior dimensions of the central and lateral spinal canals were measured.

Results: In 4 (9.3 ± 4.4%) cases, the protrusion was located at the L2-L3 level, in 7 (16.3 ± 5.6%) cases - at the L3-L4 level, in 15 (34.9 ± 7.3%) cases - at the L4-L5 level, and in 17 (39.5 ± 7.5%) cases - at the L5-S1 level, respectively. There were no significant differences in the frequency of occurrence between L2-L3 and L3-L4, as well as L4-L5 and L5-S1. The lower located lumbar discs (74,4%) were significantly more affected than the upper (25,6%) ones ($P < 0.001$).

Median protrusion localization was recorded in 19 (44.2 ± 7.6%) cases, paramedian - in 18 (41.9 ± 7.5%) cases, and posterolateral - in 6 (13.9 ± 5.3%) cases, respectively. The median and paramedian protrusions was significantly more frequently recorded than the posterolateral ($P < 0,01$) types.

Conclusion:

1. Among high school-aged children, lumbar intervertebral disc protrusion of lower (L5-S1 and L4-L5) locations is significantly ($P < 0.001$) more common than of the upper (L2-L3 and L3-L4) locations.
2. Median and paramedian protrusion locations are significantly ($P < 0.01$) more common than posterolateral protrusion.

Keywords: *Lumbar Disc Degeneration in High School Aged Children; Ultrasonography; Protrusion of Lumbar Discs; Fibrous Ring; Nucleus Pulposus*

Introduction

Degenerative disc disease is a condition that occurs due to the erosion of one or more intervertebral discs, causing the vertebrae to rub against each other, leading to dysfunction of the spinal motion segment. The disease most often develops at the level of the lower lumbar discs and is accompanied by the development of pain and a deterioration in the patient's quality of life [1].

Degeneration of the intervertebral discs can also lead to severe pain and chronic discomfort in the knees, back, hips, shoulders, and neck [2]. A crack or tear in the disc structure causes the discs to bulge into the spinal canal (nucleus pulposus herniation), which causes excessive pressure on the spinal nerves [3].

Repetitive mechanical stress is the most common cause of clinical symptoms in patients with degenerative changes in the intervertebral discs. Among the factors, mechanical stress is one of the causative factors that can contribute to the development of this condition due to common occupational exposures such as heavy lifting or vibration, obesity, or trauma [4,5]. Some researchers note that genetic predisposition may play a role in the development of disc degeneration [6].

Further progression of degenerative changes in the nucleus pulposus with increasing dehydration leads to the formation of calcifications and thinning of the cartilaginous endplates, which reduces the diffusion of nutrients into the disc. All these processes result in the formation of microcracks in the subchondral bone and a significant reduction in the blood supply to the endplates [7-9].

An intact intervertebral disc's nucleus pulposus has a gelatinous, soft, viscous, and well-hydrated structure. Meanwhile, the annulus fibrosus consists of concentric lamellae of collagen fibers. Gradually, the nucleus pulposus dehydrates and loses its ability to act as a shock absorber, and with constant damage, it becomes rigid and dehydrated. All these changes in the discs lead to a decrease in their height and an increase in surface area, thereby disrupting normal load transfer and further damaging the annulus fibrosus. Disc displacement, protrusion or herniation, instability, and back pain are all the result of damage to the annulus fibrosus [4,10-13].

Herniated discs are among the most common causes of disability across age groups. Their development is caused by a combination of factors including genetic predisposition, degeneration, and prolonged mechanical stress. Advances in diagnostic imaging techniques and image analysis using artificial intelligence have facilitated early diagnosis and treatment planning [14].

With minimal disc degeneration in the early stages of osteochondrosis, clinical symptoms are minimal or absent. The intensity, location, and prevalence of pain vary depending on the degree and location of the greatest disc erosion [8]. It should be noted that movements that reduce stress on the lower back, such as sitting or lying down, can help alleviate back pain [15,16].

Diagnosing the causes of low back pain and intervertebral disc degeneration is complex due to the presence of multiple factors. Imaging is essential to identify the underlying and associated pathologies that are fundamentally related to the development of pain [17,18].

Although X-ray imaging is the most common method for examining the spinal column, it does not directly visualize the intervertebral discs and defines the discs as intervertebral spaces. A marked decrease in disc height or "intervertebral space" occurs with severe degenerative disc changes. Currently, magnetic resonance imaging is the primary method for diagnosing osteochondrosis [19].

In recent years, ultrasound has been effectively used not only in diagnosing soft tissue pathologies of the extremities but also in visualizing intervertebral discs in the cervical and lumbar spine [20,21].

Objective of the Study

The aim of the study was to determine the capabilities of ultrasonography in identifying and localizing protrusion of lumbar intervertebral discs in older school-age children.

Materials and Methods

A retrospective analysis of the ultrasonography results of 180 lumbar intervertebral discs in 36 children aged 13-18 years was carried out. In 43 discs, degenerative changes in the nucleus pulposus and annulus fibrosus were detected, while the integrity of the annulus fibrosus was preserved. The examination was performed in sagittal and axial views. In the sagittal projection, the height of the vertebral bodies and intervertebral discs was measured, and in the axial projection, the anteroposterior dimensions of the central and lateral spinal canals were measured.

Results

In the sagittal plane, the lumbar intervertebral discs at L3-L4 were visualized along the abdominal midline at the level of the umbilicus. Upward movement of the ultrasound transducer visualized the L2-L3 and L1-L2 discs, while downward movement allowed visualization of the L4-L5 and L5-S1 discs. Sagittal views allowed assessment of the position of the lumbar vertebral bodies, the presence of ante- or retrolisthesis, and measurement of disc height. Axial sonograms clearly visualized the disc structure-the nucleus pulposus and annulus fibrosus, the central spinal canal, and the spinal nerve canals.

On axial imaging, a normal lumbar intervertebral disc has a homogeneous structure, and the posterior contour appears as a hyperechoic horizontal linear structure (Figure 1).

Figure 1: *Visualization of the lumbar intervertebral disc at L3-L4. The upper arrow shows the nucleus pulposus, and the short arrows show the central spinal canal. The posterior margin of the disc has a hyperechoic horizontal structure (upper short arrow).*

On axial ultrasound images, a direct sign of protrusion of lumbar intervertebral discs was the localized protrusion of the posterior disc margin toward the spinal canal by more than 2 mm from the horizontal line. The integrity of the outer margin of the fibrous ring was always preserved, and hyperechoic inclusions were visualized in the nucleus pulposus, most often located near the fibrous ring. Depending on the location of the protrusion of the posterior margin of the disc, median, paramedian, and posterolateral protrusions were distinguished (Figure 2-4).

Figure 2: *Right-sided paramedian protrusion of L4-L5. The upper arrow shows hyperechoic inclusions - degenerative changes at the border of the nucleus pulposus and the fibrous ring, and the lower arrow - the protrusion.*

Figure 3: *Median protrusion of L5-S1. The upper arrow shows hyperechoic inclusions - degenerative changes at the border of the nucleus pulposus and the fibrous ring, and the lower arrow - the protrusion.*

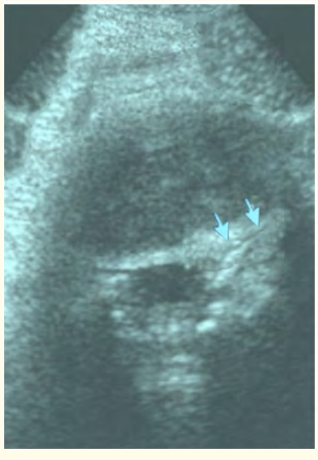

Figure 4: *Left sided posterolateral protrusion of L5-S1 (arrows). The spinal nerve canal is narrowed.*

Median protrusion localization was recorded in 19 (44.2 ± 7.6%) cases, paramedian - in 18 (41.9 ± 7.5%) cases, and posterolateral - in 6 (13.9 ± 5.3%) cases, respectively. The median and paramedian protrusions was significantly more frequently recorded than the posterolateral (P < 0,01) types (Table 1).

The type of protrusion		Protrusion
1	Median	19 (44.2 ± 7.6%) P 5-3 < 0,01
2	Paramedian	18 (41.9 ± 7.5%) P 4-3 < 0,01
3	Posterolateral	6 (13.9 ± 5.3%)

Table 1: *The level of localization of the protrusion inside of lumbar spine canal.*

In 4 (9.3 ± 4.4%) cases, the protrusion was located at the L2-L3 level, in 7 (16.3 ± 5.6%) cases - at the L3-L4 level, in 15 (34.9 ± 7.3%) cases - at the L4-L5 level, and in 17 (39.5 ± 7.5%) cases - at the L5-S1 level, respectively (Table 2). There were no significant differences in the frequency of occurrence between L2-L3 and L3-L4, as well as L4-L5 and L5-S1. Protrusion of L4-L5 and L5-S1 was recorded significantly more often than L2-L3 (P < 0.05 and P < 0.01) and L3-L4 (P < 0.05 and P < 0.01), respectively.

The level of IVD		Protrusion
1	L1-L2	-
2	L2-L3	4 (9.3 ± 4.4%)
3	L3-L4	7 (16.3 ± 5.6%)
4	L4-L5	15 (34.9 ± 7.3%) P 4-3 < 0,05 P 4-2 < 0,01
5	L5-S1	17 (39.5 ± 7.5%) P 5-3 < 0,05 P 5-2 < 0,001

Table 2: *The lumbar intervertebral disc levels with protrusion.*

The lower located lumbar discs (74,4%) were significantly (P < 0.001) more affected than the upper (25,6%) ones (Table 3).

The level of IVD		Protrusion
High level	L2-L3 and L3-L4	11 (25,6 ± 6,7%)
Lower level	L4-L5 and L5-S1	32 (74,4 ± 6,7%) P < 0,001

Table 3: *The lumbar intervertebral disc levels with protrusion.*

Discussion

Early diagnosis is crucial for effective treatment and preventive measures to delay the progression of degenerative changes in the spinal motor segment. Diagnosis of degenerative disc disease includes history, analysis of clinical symptoms, results of functional tests and imaging methods such as radiography, magnetic resonance imaging (MRI), ultrasound [22,23].

Typically, the first imaging method for investigating degenerative disc disease is routine anteroposterior and lateral radiography. Radiography is not known to directly visualize the discs themselves, viewing them as intervertebral spaces. Since there is no noticeable reduction in disc height in the early stages of osteochondrosis, radiography only reveals osteophytes, narrowing of the facet joint spaces, and flattening of the lordosis [24].

MRI is considered the best non-invasive method for examining intervertebral discs, as it allows for better differentiation of the soft tissue structure of the spinal motion segment [25]. According to MRI, the most common manifestation of disc degeneration is its dehydration and most often it is recorded only at the L4/L5 level [26].

In recent years, ultrasonography has been actively introduced into the diagnosis of musculoskeletal pathologies, in particular to determine the causes of low back pain [27,28].

Ultrasound imaging is a cheap method, which is not inferior to MRI in terms of visualization. Our investigations demonstrated that discs L4-L5, L5-S1 most often undergo degenerative changes. This indicates a great opportunity for echography, especially in pediatrics and use it as a screening study.

Conclusion:

1. Among high school-aged children, lumbar intervertebral disc protrusion of lower (L5-S1 and L4-L5) locations is significantly ($P < 0.001$) more common than of the upper (L2-L3 and L3-L4) locations.
2. Median and paramedian protrusion locations are significantly ($P < 0.01$) more common than posterolateral protrusion.

Conflict of Interest

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Bibliography

1. Beall DP., *et al*. "New biomaterials for degenerative disc disease". The Disc and Degenerative Disc Disease: Remove or Regenerate? (2020): 273-309.
2. Wangler S., *et al*. "Uncovering the secretome of mesenchymal stromal cells exposed to healthy, traumatic, and degenerative intervertebral discs: a proteomic analysis". *Stem Cell Research and Therapy* 12.1 (2021): 12-17.
3. Kirnaz S., *et al*. "Pathomechanism and biomechanics of degenerative disc disease: features of healthy and degenerated discs". *International Journal of Spine Surgery* 15.s1 (2021): 10-25.
4. Zielinska N., *et al*. "Risk factors of intervertebral disc pathology? A point of view formerly and today? A review". *Journal of Clinical Medicine* 10.3 (2021): 409.
5. Kirnaz S., *et al*. "Fundamentals of intervertebral disc degeneration". *World Neurosurgery* 157 (2022): 264-273.
6. Xia Y., *et al*. "Application of mesenchymal stem cell-derived exosomes from different sources in intervertebral disc degeneration". *Frontiers in Bioengineering and Biotechnology* 10 (2022): 1019437.
7. Kim J-W., *et al*. "Regeneration in spinal disease: therapeutic role of hypoxia-inducible factor-1 alpha in regeneration of degenerative intervertebral disc". *International Journal of Molecular Sciences* 22.10 (2021): 5281.

8. Scarcia L., *et al*. "Degenerative disc disease of the spine: from anatomy to pathophysiology and radiological appearance, with morphological and functional considerations". *Journal of Personalized Medicine* 12.11 (2022): 1810.

9. Zehra U., *et al*. "Mechanisms and clinical implications of intervertebral disc calcification". *Nature Reviews Rheumatology* 18.6 (2022): 352-362.

10. Bogduk N. "On understanding the validity of diagnostic tests". *Interventional Pain Medicine* 1.2 (2022): 100127.

11. Li B., *et al*. "Stem cell therapy and exercise for treatment of intervertebral disc degeneration". *Stem Cells International* (2021): 7982333.

12. Rajesh N., *et al*. "Smoking and degenerative spinal disease: A systematic review". *Brain and Spine* 2 (2022): 100916.

13. Thailand, R. C. of. "Can stem cells help reverse degenerative disc disease?" Stem Cell Regeneration Center. Stemcellthailand.Org (2024).

14. Shivali Parwani., *et al*. "Study of causes, symptoms, and diagnosis of lumbar disc herniation". *CME Journal Geriatric Medicine* 17.3 (2025): 1-10.

15. Lyu F-J., *et al*. "Painful intervertebral disc degeneration and inflammation: from laboratory evidence to clinical interventions". *Bone Research* 9.1 (2021): 7.

16. Xin J., *et al*. "Treatment of intervertebral disc degeneration". *Orthopaedic Surgery* 14.7 (2022): 1271-1280.

17. Chou R., *et al*. "The Global Spine Care Initiative: applying evidence-based guidelines on the non-invasive management of back and neck pain to low-and middle-income communities". *European Spine Journal* 27.6 (2018): 851-860.

18. Foster NE., *et al*. "Prevention and treatment of low back pain: evidence, challenges, and promising directions". *The Lancet* 391.10137 (2018): 2368-2383.

19. Almushayti ZA., *et al*. "Incidental findings during degenerative intervertebral disc disease evaluation at magnetic resonance imaging of the lumbar spine". *Medical Science* 25.107 (2021): 76-81.

20. Barry MS., *et al*. "Facts and fallacies of diagnostic ultrasound of the adult spine". *Dynamic Chiropractic* 14.9 (2019).

21. Rizvan Ya Abdullaiev., *et al*. "Degenerative findings on ultrasound of the cervical spine in children". *EC Orthopaedics* 13.4 (2022): 106-113.

22. Sääksjärvi S., *et al*. "Disc degeneration of young low back pain patients: a prospective 30-year follow-up MTI study". *Spine (Phila Pa 1976)* 45.19 (2020): 1341-1347.

23. Spinal Ultrasonography. United Health care Community Plan Medical Policy. Effective 11/01/2020 Proprietary Information of UnitedHealthcare. Copyright 2020 United HealthCare Services (2021).

24. Wu PH., *et al*. "Intervertebral disc diseases part 2: a review of the current diagnostic and treatment strategies for intervertebral disc disease". *International Journal of Molecular Sciences* 21.6 (2020): 2135.

25. Chen SQ., *et al*. "Different spinal subtypes with varying characteristics of lumbar disc degeneration at specific level with age: A study based on an asymptomatic population". *Journal of Orthopaedic Surgery and Research* 15.1 (2020): 3.

26. Almushayti Z., *et al*. "Prevalence of MRI findings in lumbosacral spine in patients with chronic low back pain: A cross-sectional study". *Medical Science* 26 (2022): ms33e2053.

27. Rahmani N., *et al*. "Comparing the reliability of abdominal muscles thickness using ultrasonography in adolescents with low back pain and healthy adolescents". *Journal of Babol University of Medical Sciences* 19.8 (2017): 12-19.

28. Maeda M., *et al*. "Diagnosis of lumbar transverse process fractures in orthopedic clinics using sonography". *Journal of Ultrasound in Medicine* 41.7 (2022): 1825-1835.

Volume 17 Issue 1 January 2026