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ULTRASONOGRAPHY IN THE DIAGNOSIS OF LUMBAR DISC HERNIATION IN YOUNG ADULT

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The aim: *to assess the value of ultrasonography in the diagnosis of a lumbar herniation disc in young adults.*
Material and methods*: 27 patients aged 17–21 years (8 girls, 19 boys) were included in our study. During the examination by a neurologist, all patients reported pain in the lower back. The results of the ultrasound investigation were compared with MRI. Ultrasonography (USG) was conducted on a Philips HD 11XE device using a convection transducer in the frequency range 2-5 MHz; MRI - General Electric, Signa HDI, 1.5T.*
Results*: at the L3-L4 segment, hernia was diagnosed in 2 (7.4±5.0 %) cases, at the L4-L5 segment - in 14 (51.9±9.6 %) cases, and at the L5-S1 segment - in 11 (40.7±9.5 %) cases, respectively. The hernia at the segments of L5-S1 and L4-L5 was diagnosed significantly (P<0.001) more often than at the segment of L3-L4. Median hernia was diagnosed in 12 (44.4±9.6 %) cases, paramedian - in 11 (40.7±9.5 %) cases and posterolateral - in 4 (14.8±6.8 %) cases, respectively. The median and paramedian hernia was diagnosed significantly (P<0.05) more than the posterolateral. In ultrasound, only in one case, a posterolateral hernia was interpreted as paramedian*
Conclusions:
1) The lumbar hernia are localized at the segments of L5-S1 and L4-L5 significantly (P<0.001) more often than at the other segments;
2) Sciatica is significantly more common in posterolateral localization of lumbar disc herniation;
3) The ultrasonography couldbe used to find out the causes of back pain in young adult
Keywords: *hernia of the intervertebral discs of the lumbar spine, ultrasound diagnostics, young adult*

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1. Introduction

The spine is a complex biomechanical system with a dual function of maintenance and protection. The main functions of the spinal column are performing by the vertebromotor segment, which is formed by the intervertebral disc (IVD) and the ligamentous apparatus. The IVD provides flexibility by reducing stress on the vertebral bodies. It consists of the end plates, the annulus fibrosus (AF), and the nucleus pulposus (NP) [1]. Histological studies show that degenerative changes in IVD begin in childhood [2].

Degenerative disc disease (DDD) in the lumbar spine is the most common cause of pain. A study by J. P. G. Urban et al. showed the role of biomechanical factors and gene phenotypes in the development of degenerative changes in IVD at a young age [3]. The link between low back pain and degenerative changes in the discs, the role of improper loading and trauma in their development is noted in many publications [4].

A wide range of movements in the lumbar region contributes to an increase in the load on the spinal motion segment, and this, in turn, accelerates the development of degeneration in the nucleus pulposus [5]. Increasing pressure on the intervertebral discs increases the risk of cracking and rupture of the fibrous ring. In childhood, degenerative disc disease as the main cause of back pain is often not diagnosed [6].

In young people in the absence of secondary signs of degeneration in the MRI process, low signal intensity is registered in several IVD, which is an indirect sign of their dehydration [7]. Age and baseline changes in the disc, rather than genetic factors, influence the 5-year development of degeneration in patients with lumbar pain. The formation of an intervertebral hernia causes the development of spinal pain at rest [8]. Degenerative disc disease (DDD) progresses with age and involves metabolic disorders and recovery of degenerative altered MHD tissue. The degenerative and inflammatory processes that occur during disc degeneration contribute to the growth of nerve fibers and blood vessels in the disc, which potentially explains the development of pain in such patients [9, 10].

In childhood, a hernia of the lumbar intervertebral discs rarely has bright clinical symptoms. An analysis of clinical symptoms in 70 young patients with degenerative changes in the lumbar intervertebral discs showed that 54 % of pain was localized in the lower back, 46 % had sciatica. Among the examined were 35 girls and 35 boys,

the average age was 17.14±2.15 years. The most common levels of damage were L4–L5 in 54 % of patients and L5–S1 in 34 % of patients [11].

In a study by Mueller S. et al. also found no statistically significant differences in the incidence of back pain in boys and girls [12]. The results of the study by Lin I. et al. show that in 18 % of cases, pain in the lower back has the character of sciatica and is accompanied by radiculopathy [13]. According to Hammood E.Kh. et al among those operated on for herniated lumbar intervertebral discs, 1.22 % of patients were aged 13–21 years. Among all operated patients, 2/3 had a history of trauma [14].

The vertebral column consists of bone and soft tissue elements. To adequately assess the state of these structures, various imaging methods are used, which include conventional radiography, computed and magnetic resonance imaging (CT and MRI), as well as ultrasound. X-ray and CT better visualize bone structures, while MRI and ultrasonography better visualize soft tissue structures, which include intervertebral discs, ligamentum flavum, spinal nerves, and spinal cord [15, 16].

W. Brinjikji et al. analyzed the results of MRI in asymptomatic and symptomatic young patients to assess the prevalence of degenerative changes in the lumbar IVD. In patients with low back pain with radicular symptoms, bulge, degeneration, disc extrusion, the presence of a crack in the fibrous ring, central canal stenosis, and spondylolisthesis were more often recorded on MRI images [17].

In some areas, ultrasound has shown results comparable to gold standard methods such as MRI, demonstrating its potential utility in the field when MRI is not available. These features make ultrasound suitable for use in situations such as emergency trauma assessment, image-guided therapy [18–20]. Previous studies have shown the possibilities of ultrasonography in assessing the state of the cervical intervertebral discs [21]. Literature data indicate the prospects of studying the possibility of ultrasonography in the diagnosis of degenerative disease of the lumbar intervertebral discs.

The aim of the research. To assess the value of ultrasonography in the diagnosis of a lumbar herniation disc in young adults.

2. Materials and methods

The studies were carried out in Polyclinic No. 12 in Kharkov and at the Department of Ultrasound Diagnostics of the Kharkiv Medical Academy of Postgraduate Education from 2018 to 2021.

27 patients aged 17–21 years (8 girls, 19 boys) were included in our study. During the examination by a neurologist, all patients reported pain in the lower back. The main group of patients (27 people) was selected from 132 examined with low back pain, in whom a hernia of the lumbar spine was detected during clinical and MRI examinations.

The results of the ultrasound investigation were compared with MRI. Ultrasonography (USG) was conducted on a Philips HD 11XE (USA) device using a convection transducer in the frequency range 2–5 MHz; MRI – General Electric, Signa HDI, 1.5T.

The work was carried out in accordance with the Code of Ethics of the World Medical Association (Helsinki Declaration) and the protocol of the Bioethics Commission of the "Kharkiv Medical Academy of Postgraduate Education" No. 3 dated 12.10.2021 were followed. All methods are non-invasive and verbal consent was obtained from the participants.

The structure of the nucleus pulposus (NP), annulus fibrosus (AF) and the spinal nerve canals were studied. Among patients, lumbago was recorded in 22 (81.5±7.6 %) cases, sciatica in 4 (14.8±7.0 %) cases, and a combination of lumbago-sciatica in 1 (3.7±3.7 %) case. Lumbago was significantly more common than sciatica and their combination ($P<0.001$).

The results were analyzed by standard methods of variation statistics and the method of comparing quantitative factors. Student's t-test was used to assess differences in quantitative parameters between groups. Differences were considered significant at $p<0.05$.

3. Results

Visualization of the lumbar spinal motion segments was carried out in longitudinal and transverse projections along the midline of the abdomen. In the longitudinal projection, the height of the intervertebral discs, vertebral bodies, and their ratio were determined. On the axial projection, the internal structure of the discs, the central spinal canal, the canals of the spinal nerves, epidural blood flow, and the thickness of the yellow ligament were evaluated. To count the discs, we were guided by the navel, since the intervertebral disc L3-L4 was located at this level, above – L2-L3 and L1-L2, and below L4-L5 and L5-S1.

We compared the results of ultrasonography and MRI in the diagnosis of herniated lumbar intervertebral discs in terms of its presence, the level of localization in the spinal column and inside the spinal canal (Table 1). In terms of the presence and level of localization of disc herniation, the results of ultrasonography and MRI coincided in all 27 cases. In only one case, a disc herniation was interpreted by ultrasonography as posterolateral, whereas by MRI a disc herniation was interpreted as posterolateral.

Table 1

Comparison of MRI and ultrasound in the diagnosis of disc herniation

Interpretation of results	Lumbar IVD (n=27)	
	MRI	US
In fact	27	27
By level	27	27
By type	27	26 (96.3 %)

No herniation was found at the upper lumbar intervertebral disc segments. At the L3-L4 segment, hernia was diagnosed in 2 (7.4±5.0 %) cases, at the L4-L5 segment – in 14 (51.9±9.6 %) cases, and at the L5-S1 segment – in 11 (40.7±9.5 %) cases, respectively (Table 2). As could be seen from the table, hernia at the segments of L5-S1 and L4-L5 was diagnosed significantly ($P<0.001$) more often than at the segment of L3-L4.

MRI revealed a median hernia in 12 (44.4±9.6 %) cases, a paramedian hernia in 11 (40.7±9.5 %) cases and a posterolateral hernia in 4 (14.8±6.8 %) cases, respectively (Table 3). Median hernia was diagnosed in 12

(44.4±9.6 %) cases, paramedian – in 11 (40.7±9.5 %) cases and posterolateral – in 4 (14.8±6.8 %) cases, respectively. As could be seen from the Table 3 the median and paramedian localization of the hernia was diagnosed significantly (P<0.05) more than the posterolateral (Table 3). Ultrasound revealed a median hernia in 12 (44.4±9.6 %) cases, a paramedian hernia in 12 (44.4±9.6 %) cases and a posterolateral hernia in 3 (11.1±6.0 %) cases, respectively. In ultrasound, in one case, a posterolateral hernia was interpreted as paramedian (Fig. 1–4).

Table 2

The level of localization of the hernia in the lumbar spine

Segments of IVD		Hernia, n=27
1	L1-L2	–
2	L2-L3	–
3	L3-L4	2 (7.4 ±5.0 %)
4	L4-L5	14 (51.9±9.6 %) p_{4-3} <0.001
5	L5-S1	11 (40.7±9.5 %) p_{5-3}<0.001

Table 3

Comparison of the results of ultrasound and MRI in the diagnosis of localization of disc herniation inside the spinal canal in young adult

Imaging methods	The type of hernia, n=27			
	MRI		US	
1	Median	12 (44.4±9.6 %) p_{1-3}<0.05	Median	12 (44.4±9.6 %) p_{1-3}<0.01
2	Paramedian	11 (40.7±9.5 %) p_{2-3}<0.05	Paramedian	12 (44.4±9.6 %) p_{2-3}<0.01
3	Posterolateral	4 (14.8±6.8 %)	Posterolateral	3 (11.1±6.0 %)

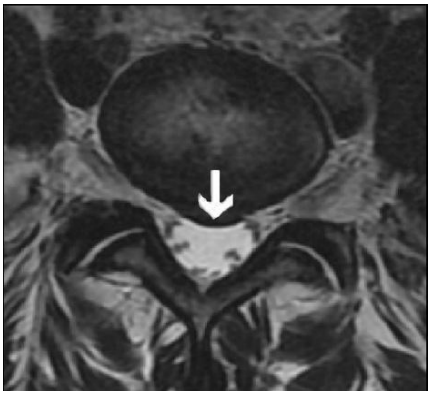

Fig. 1. MRI – axial section of the intervertebral disc L5-S1 in a patient aged 21 years. The arrow shows the local median protrusion of the disc into the lumen of the spinal canal up to 4 mm

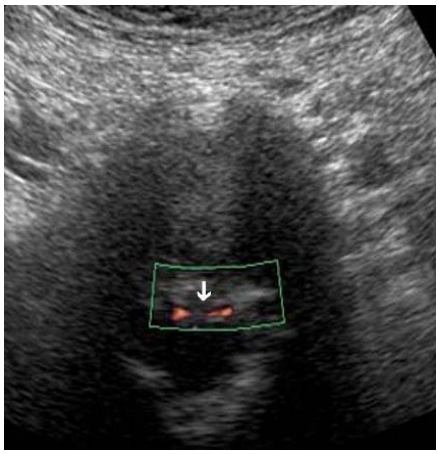

Fig. 2. Same case. Ultrasonic axial section of the intervertebral disc L5-S1. The arrow shows uneven median protrusion of the disc into the lumen of the spinal canal. The image of the fibrous ring is intermittent, the dislocation of the epidural veins is determined

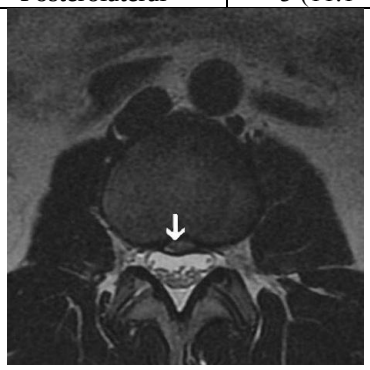

Fig. 3. MRI visualization of median hernia L4–L5 (arrow)

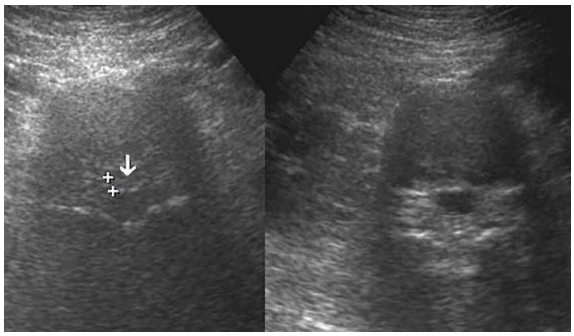

Fig. 4. Same case. Ultrasonic visualization of median hernia L4–L5 (arrow). An echogram of a normal disc L3-L4 is shown next to it

Lumbago was observed in all 12 cases of median hernia, in 9 (81.8±11.6 %) cases of paramedian hernia and in 1 (25.0±21.6 %) case of posterolateral hernia (P<0.001). Sciatica in a patient with median localization of hernia was not observed. Among patients with paramedian hernia the sciatica was observed in 1 (8.3±8.0 %) case, with posterolateral hernia – in 3 (75.0±21.6 %) case, respectively. Lumbago+Sciatica was observed in 1 (8.3±8.0 %) case of paramedian hernia (Table 4).

Table 4

Comparison of clinical symptoms and preferential localization of lumbar discs hernia in young adult

Clinical symptoms	Lumbar hernia (n=27)		
	Median (n=12)	Paramedian (n=11)	Posterolateral (n=4)
	1	2	3
Lumbago	12 (100.0±2.9 %) p_{1-3}<0.001	9 (81.8±11.6 %) p_{2-3}<0.001	1 (25.0±21.6 %)
Sciatica	–	1 (9.1±8.7 %)	3 (75.0±21.6 %) p_{3-2}<0.001
L+S	–	1 (9.1±8.7 %)	-

4. Discussion

Radiological diagnostic methods are important in assessing changes in the spinal motion segment. The most common and accessible research method is radiography performed in the anterior, lateral, and oblique projections. It helps to assess the condition of the vertebral bodies, determine spondylotic changes, and the presence of instability. Computed tomography (CT) is the most sensitive method for studying the bone structures of the spine. It could visualize calcified disc herniation, revealing all changes in bone tissue. MRI is the most sensitive method for visualizing herniated discs, as it better demonstrates the structures of soft tissues and spinal nerves in the radicular canal [22].

According to the results of MRI studies of 301 young and middle-aged patients, O. B. Panta et al. (2015) found that protrusion of the L4–L5 discs is most common in older people, and herniated disc L5–S1 in young people. In young people, radiculopathy was more often observed due to the paramedian localization of a hernia or protrusion [23].

Literature data indicate that degenerative disc disease begins in childhood, and ultrasound has shown itself to be an informative method for diagnosing pathologies of the musculoskeletal system [24]. Hernias of posterolateral localization are more often the cause of the development of a clinical symptom of sciatica, and median hernias often manifest as a lumbago. Previously published works have shown that lumbar disc herniations are more often localized in the L4-L5 and L5-S1 segments [11]. We have received similar data.

With ultrasound, patients do not receive radiation exposure. This indicates a great opportunity for echography, especially in pediatrics and use as a screening study.

Study limitations. The main limitation of the method is that it is not yet included in the standard for examining intervertebral discs. At the same time, in all leading clinics of the world, ultrasound is used to study paraspinal ligaments, muscles, to navigate the administration of drugs during anesthesia.

Prospects for further research. The results of the study show that the imaging quality of ultrasonography is not inferior to MRI. Literature data show that degenerative changes in the intervertebral discs begin much earlier than they are detected by instrumental methods. Non-invasiveness and affordability open broad prospects for using ultrasonography to diagnose degenerative changes in discs at earlier stages of development among schoolchildren.

5. Conclusions

1) The lumbar hernia is localized at the segments of L5-S1 and L4-L5 significantly (P<0.001) more often than at the other segments.

2) Sciatica is significantly more common in posterolateral localization of lumbar disc herniation.

3) Ultrasonography can be used to find out the causes of back pain in young adults.

Conflict of interests

The authors declare that they have no conflicts of interest.

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