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B-MODE ULTRASONOGRAPHY OF HERNIATED CERVICAL DISCS IN YOUNG PEOPLE

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The aim: to evaluate the possibilities of ultrasonography in the diagnosis of herniated cervical intervertebral discs in young people.

Material and methods: an analysis of the results of USG in 29 patients with cervical IVD hernia revealed by MRI from 123 patients aged 18–44 years, with complaints of neck pain of varying intensity, duration, and irradiation. 23 (79.3 %) patients had clinical signs of cervical radiculopathy. The results of the ultrasonography (USG) were compared with MRI. USG was conducted on a Philips HD 11XE scanner using a 4–9 MHz frequency transducer; MRI – General Electric, Signa HDI, 1.5T.

Results: in 13 (44.8±9.2 %) cases the hernia was registered in the C5-C6 disk, in 12 (41.4±9.0 %) – in the C4-C5 disk, in 2 (6.9±4.7 %) – in the disk C3-C4 and in 2 (6.9±4.7 %) – in the disk C6-C7. In discs C5-C6 and C4-C5 hernia was formed significantly ($p<0.01$ and $p<0.001$) more often than in discs C2-C3 and C6-C7. Paramedian hernia was diagnosed in 13 (44.8±9.2 %) cases, posterior – in 12 (41.4±9.1 %), median – in 4 (13.8±6.4 %). Paramedian and posterolateral hernias were registered significantly more often than median ($p<0.01$ and $p<0.05$).

Conclusions: A direct sign of a herniated cervical intervertebral disc is its uneven protrusion with a discontinuous image of the fibrous ring into the lumen of the spinal canal and spinal nerve canal more than 4 mm. An indirect sign of a herniated cervical intervertebral disc is a local deformation of the anterior epidural space with the absence of its visualization. Ultrasonography is a reliable method for diagnosing herniated cervical intervertebral discs, both in segments and inside the spinal canal. The method can be used to find out the causes of neck pain in young people

Keywords: hernia of the intervertebral discs of the cervical spine, ultrasonography, magnetic resonance imaging, young people

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1. Introduction

Degenerative changes in the cervical intervertebral discs are a common cause of neck pain radiating to the shoulder and arm. Factors in the development of these changes could be a genetic component, a history of trauma, inflammatory processes in the discs and epidural space. As the discs age, they begin to lose hydration, which leads to a decrease in cushioning capacity with an increased tendency to form a crack and rupture of the annulus. Rupture of the fibrous ring is accompanied by a protrusion of the degenerative disc into the lumen of the spinal canal [1].

A herniated cervical intervertebral disc could cause severe neck pain with appropriate irradiation depending on the damage to the spinal motion segment. However, in most cases, the clinical symptoms of acute herniated discs gradually improve and may resolve on their own. According to some researchers, the symptoms of cervical radiculopathy in acute hernia could disappear within 4–6 weeks, and in some cases, clinical symptoms could last for months. Pain in cervical radiculopathy due to a herniated disc may be more intense than in uncover-

tebral arthrosis due to irritation of the spinal nerve roots by osteophytes. This is because disc herniation is often accompanied by inflammatory processes in the nucleus pulposus, which increase the sensitivity of the spinal nerve roots [2].

Some studies show that at a young age, clinical symptoms are more pronounced than in the elderly. This is due to the fact that in older people, fibrotic changes with calcification of the nucleus pulposus, annulus fibrosus, and ligamentous apparatus reduce the sensitivity of nerve endings. According to some authors, in about half of people, the initial signs of disc degeneration on MRI appear before the age of 20 years [3].

Degenerative changes could develop in any segment of the cervical spine, but most often occur at the level of C4-C5, C5-C6 segments. Some patients with herniated discs may have no clinical symptoms [4]. Ikeda H. et al. (2012) described a case of formation of a herniated cervical intervertebral disc with stenosis of the spinal canal and the development of a symptom of myelopathy, which was eliminated by surgical placement [5].

Imaging techniques 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 general condition of the spine, to find spondylotic changes, the presence of instability. Computed tomography (CT) is the most sensitive method for studying the bone structures of the spine. It could show a calcified IVD hernia, reveal all changes in the bone tissue. MRI is a more sensitive imaging modality for IVD herniation, as it better demonstrates soft tissue structures and the nerve as it emerges from the foramen [6, 7].

However, given the lower cost, availability, high resolution, and real-time imaging, ultrasound may be a suitable alternative for screening. Ultrasound is usually most effective on tissues with a high collagen content, such as tendons, ligaments, and joint capsules. Some researchers have used ultrasound to assess paraspinal ligament injuries after spinal fractures [8].

The Accreditation Council for Ultrasound Practice of the American Institute of Ultrasound in Medicine (AIUM) has developed standards for the accreditation of ultrasound practitioners. These standards serve as a benchmark for ultrasound professionals seeking to comply with national protocols [9]. In previous studies, the results of ultrasound examination in assessing the state of the cervical and lumbar intervertebral discs in normal conditions and with unexpressed degenerative changes in adolescents were presented [10–12].

The aim of the research was to evaluate the possibilities of ultrasonography in the diagnosis of herniated cervical intervertebral discs in young people.

2. Materials and methods

The studies were carried out from 2018 to 2021 at the City Clinical Hospital No. 17, which is the clinical base of the Department of Radiography and Radiology of the Kharkiv Medical Academy of Postgraduate Education. An analysis of the results of USG in 29 patients with cervical IVD hernia revealed by MRI from 123 patients aged 18–44 years (average age 24±5 years), with complaints of neck pain of varying intensity, duration, and irradiation. 23 (79.3 %) patients had clinical signs of cervical radiculopathy. The patients included 17 men and 12 women.

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.

Patients with suspected cervicogenic radiculopathy and vertebral artery syndrome were referred by a neurologist to imaging studies to clarify the diagnosis. Radiography of the cervical spine was performed in anterior and lateral projections, as well as with the help of functional tests with flexion and extension of the head on devices – MPEA643A4003, 2020, Siemens, Head – 01068; Aster DR, Head AS 0047, 2021. USG was conducted on a Philips HD 11XE scanner using a 4–9 MHz

frequency transducer; MRI – General Electric, Signa HDI, 1.5T.

The structure of the nucleus pulposus (NP), annulus fibrosus (AF), anterior dural space (ADS) and the spinal nerve canals were studied.

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

In young people without degenerative changes of cervical discs, the anterior dural space on the echogram looks like an anechogenic zone with even edges between fibrous ring and spinal cord (Fig. 1).

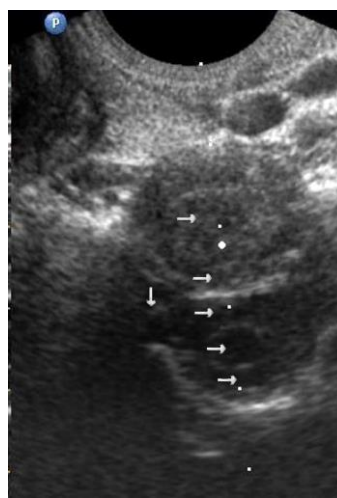


Fig. 1. Axial section of the cervical intervertebral disc and vertebral canal. Top-down the horizontal arrows show the nucleus pulposus, fibrous ring, anterior dural space, spinal cord, posterior dural space; the vertical arrow shows the right spinal nerve canal

For a detailed characterization of degenerative changes in the IVD and spinal canal, we studied the frequency of occurrence of the following echographic symptoms:

- 1) increased echogenicity of the NP;
- 2) calcification of the AF;
- 3) displacement of hyperechoic NP towards AF;
- 4) lack of differentiation of NP and AF;
- 5) local deformation of the anterior dural space with the absence of its visualization;

6) uneven local protrusion of the disc into the lumen of the spinal canal and spinal nerve canal more than 4 mm.

Increased echogenicity of the NP was registered in 20 (69.0±8.6 %), calcification of the NP – in 18 (62.1±9.0 %), displacement of the hyperechoic NP toward the AF – in 19 (65.5±8.8 %), lack of differentiation of the NP and AF in 26 (89.6±5.7), local deformation of the anterior dural space with no visualization – in 24 (82.8±7.0 %), uneven local protrusion of the disc into the lumen of the spinal canal more than 4 mm in 27 (93.1±4.7 %), uneven local protrusion of the disc into the lumen of spinal nerve canal with its narrowing - in 16 (55.2±9.2 %) cases (Table 1).

Table 1

The incidence of echographic signs of degenerative changes in patients with herniated cervical discs

Echographic signs of degenerative changes in NP	No.	USG (n=29)
Increasing the echogenicity of NP	1	20 (69.0±8.6 %)
Calcification of NP	2	18 (62.1±9.0 %)
Displacement hyperechoic NP in the direction of AF	3	19 (65.5±8.8 %)
Lack of differentiation of NP and AF	4	26 (89.6±5.7 %) p ₄₋₁ <0,05 p ₄₋₂ <0,05 p ₄₋₇ <0,01
Local deformation of the anterior dural space with the lack of its visualization	5	24 (82.8±7.0 %) p ₅₋₇ <0,05
Uneven local protrusion of the disk into the lumen of the SC over 4 mm	6	27 (93.1 ±4.7 %) p ₆₋₁ <0,05 p ₆₋₂ <0,01 p ₆₋₃ <0,05 p ₆₋₇ <0,001
Uneven local protrusion of the disc into the lumen of the spinal nerve canal with its narrowing	7	16 (55.2 ±9.2 %)

The symptom of uneven local protrusion of the disc into the lumen of the VC more than 4 mm occupies the first place and was recorded significantly more often than the symptom of increased echogenicity of the NP (p<0.05), calcification of the NP (p<0.01), displacement of the hyperechoic NP towards the AF (p<0.05) and uneven local protrusion of the disc into the lumen of the spinal nerve canal with its narrowing (p<0.001). The echographic symptom – the absence of differentiation of the NP and AF (89.6 %) ranked second in prevalence and was significantly more common than the symptom of increased echogenicity of the NP (p<0.05), calcification of the NP (p<0.05) and uneven local protrusion of the disc in lumen of the spinal nerve canal with its narrowing (p<0.01). The third place was taken by the symptom – local deformation of the anterior dural space with the absence of its visualization and significantly (p<0.05) differed only from the symptom of uneven local protrusion of the disc into the lumen of the spinal canal with its narrowing.

In 13 (44.8±9.2 %) cases the hernia was recorded in the C5-C6 disc, in 12 (41.4±9.0 %) cases it was in the C4-C5 disc, in 2 (6.9±4.7 %) – in disk C3-C4 and in 2 (6.9 %±4.7 %) – in disk C6-C7 (Table 2)

Table 2

The incidence of cervical disc segments with hernia

Cervical disc segments		Discs hernia, n=29
C2-C3	1	–
C3-C4	2	2 (6.9±4.7)
C4-C5	3	12 (41.4±9.0) p ₃₋₂ <0.01 p ₃₋₅ <0.01
C5-C6	4	13 (44.8±9.2) p ₄₋₅ <0.001 p ₄₋₂ <0.001
C6-C7	5	2 (6.9±4.7)
C7-Th1	6	–

In C5-C6 and C4-C5 discs, hernia was formed significantly (p<0.001 and p<0.01) more often than in C2-C3 and C6-C7 discs. Considering that, hypothetically, clinical symptoms may be related to the localization of the hernia inside the spinal canal, we have identified 3 types: median, paramedian, and posterolateral. In Table 3 is showed the frequency of herniated cervical intervertebral discs, taking into account their type.

As could be seen from Table 3, paramedian hernia was diagnosed in 13 (44.8±9.2 %) cases, posterolateral – in 12 (41.4±9.1 %), median – in 4 (13.8±6.4 %). Paramedian and posterolateral hernias were registered significantly more often than (p<0.01 and p<0.05) the median one (Fig. 2–4).

Table 3

Types of cervical discs hernia

The types of hernia	Discs hernia, n=29
Paramedian	13 (44.8±9.2 %) p<0.01
Posterolateral	12 (41.4±9.1 %) p<0.05
Median	4 (13.8±6.4 %)

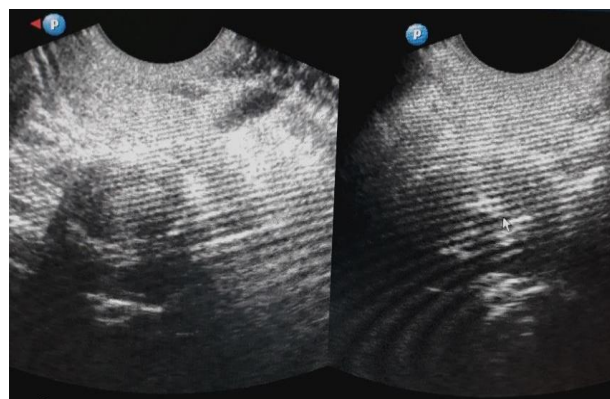


Fig. 2. Axial section of intervertebral disc and vertebral canal. On the echogram, a paramedian hernia and a hernial orifice are visible on the left, and large calcifications in the nucleus pulposus are visible on the right

Thus, in the cervical spine, paramedian and posterolateral hernias are most common, and they are more often localized at the level of C5-C6 and C4-C5; signs of a hernia of the intervertebral disc is its protrusion of more than 4 mm with the absence of the limit of the nucleus pulposus and fibrous ring; disappearance of the image of the anterior dural space and deformation of the spinal cord; narrowing of the radicular on the side of the uneven protrusion of the disc.

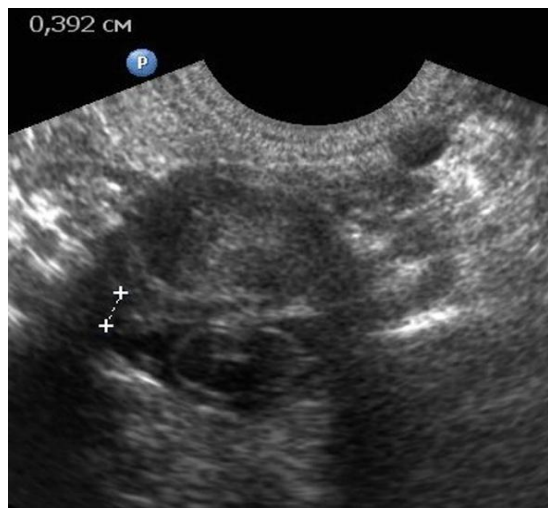


Fig. 3. Right-sided large posterolateral hernia

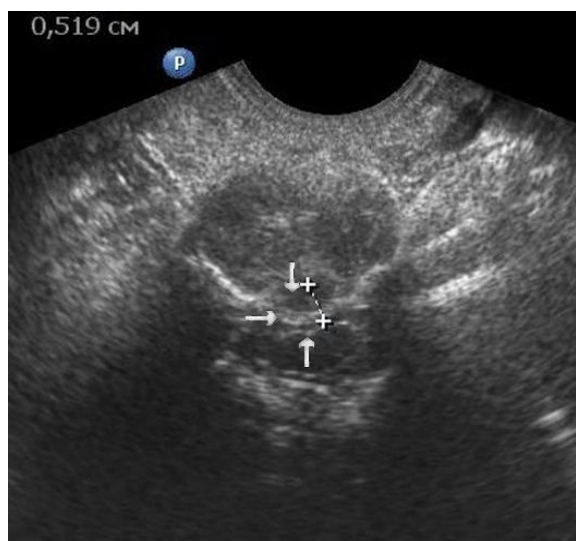


Fig. 4. Axial section of the IVD and SC. Median hernia. The upper arrow shows the hernial gates, lower arrow – deformation of the anterior spinal cord contour, the horizontal arrow shows the discs hernia

4. Discussion

Radiography is the most common and accessible diagnostic method of vertebral bodies pathology. But it is his ability to visualize the soft tissue elements of the spinal motion segment [13]. Computed tomography can visualize calcified disc herniation, revealing all changes in bone tissue [7]. 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 [14].

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, it becomes necessary to study the characteristics of disc herniation in young adults [15].

An analysis of publications devoted to the use of ultrasound in the diagnosis of pathology of the vertebral motor segment shows that the method is still rarely used. In most cases, ultrasound is used as navigation for the introduction of drugs into the paraspinal zones [16].

We used ultrasound to visualize intervertebral discs in young people, to develop qualitative parameters of degenerative changes cervical discs. During the study, it was found that the following ultrasound symptoms can have important significance that the uneven local protrusion of the disc into the lumen of the central vertebral canal more than 4 mm, calcification of the nucleus NP, displacement of the hyperechoic NP towards the AF and uneven local protrusion of the disc into the lumen of the spinal nerve canal with its narrowing, the absence of differentiation of the NP and AF.

Study limitations. The main limitation in obtaining a high-quality image of the intervertebral discs is a short neck with developed muscle mass and obesity.

Prospects for further research. The possibility of simultaneous examination of the vertebral arteries, elements of the spinal motion segments and neck muscles using triplex ultrasonography expands the range of use of the method in all patients with pain in the neck, the presence of neurological symptoms. This makes it possible to determine the involvement of degenerative changes to the development of clinical symptoms.

6. Conclusions

1) A direct sign of a herniated cervical intervertebral disc is its uneven protrusion with a discontinuous image of the fibrous ring into the lumen of the spinal canal and spinal nerve canal more than 4 mm;

2) An indirect sign of a herniated cervical intervertebral disc is a local deformation of the anterior dural space with the absence of its visualization;

3) Ultrasonography is a reliable method for diagnosing herniated cervical intervertebral discs, both in segments and inside the spinal canal. The method can be used to find out the causes of neck pain in young people.

Conflict of interest

The authors declare that they have no conflicts of interest.

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