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Research Article

Degenerative Findings on Ultrasound of the Cervical Spine in Children

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Abstract

Objective: The purpose of this study was to determine the possibilities of Ultrasound of degenerative findings of cervical spine in children.

Materials and Methods: The analysis of ultrasound images of intervertebral discs in 71 children with neck pain was carried out. The age of the children varied between 13 and 18 years. The study was carried out using ultrasonic device Philips HD-11; MRI - General Electric, Signa HDI, 1.5T.

Results: Among 71 children with neck pain, 35 had degenerative changes within the nucleus pulposus. In 29 children, disc protrusion was detected, in 7 - hernia. In 26 children with protrusion and in all children with hernia, the age varied within 16-18 years. Among the children of the comparative group, without any complaints of pain in the neck, protrusion was detected in 3 cases.

Conclusion: Ultrasonography is an affordable, low-cost method for evaluating intervertebral disc changes in children with cervical pain. In children with cervical pain, changes in the nucleus pulposus of the intervertebral discs are always detected - from minimal in the form of single dense inclusions to the formation of a hernia. Although the latter is much less common.

Keywords: *Cervical Disc Degeneration in Children; Ultrasound Diagnostics*

Introduction

According to various researchers, in recent years, the prevalence of cervical pain has increased significantly, and in the general population varies between 4 - 18% [1-3]. Pain in the neck and shoulder, numbness, hypersensitivity in the neck and upper extremities, impaired clarity of movements of the upper extremities, as well as an abnormal reflex are often found in cervical spondylosis. In recent years, the number of young people with cervical spondylosis has been progressively increasing. The main causes of cervical spondylosis include instability of the cervical vertebrae, calcification and hypertrophy of the posterior longitudinal and yellow ligaments, HA stenosis, and disc herniation [4].

Among the causes of pain in the neck, the leading place is occupied by degenerative changes in the vertebral motor segment. They lead to instability of the cervical vertebrae, the formation of protrusion and herniated discs, uncovertebral arthrosis. Changes may occur in one or more cervical segments. Some studies have shown that even in asymptomatic patients, protrusions and herniated discs can be detected Degenerative changes can develop at any level of the cervical intervertebral discs, but often occur at the C5-C6 level [5,6].

Despite the fact that MRI is not a routine study for neck pain, the popularity and trust in this method among medical professionals is quite high [7]. This is due to the fact that MRI is non-invasive and allows visualization of soft tissue structures. Many researchers note the high interobserver reliability of MRI in the diagnosis of spinal stenosis and degenerative changes in the intervertebral discs [8-13].

Ultrasound is a non-invasive method that shows the structure of soft tissue components. Although ultrasonography has limitations in visualizing bone structures, it is used to investigate the causes of back pain, in evaluation of paravertebral ligament injuries in spinal fractures.Ultrasound can help to visualize different signs of degenerative disc disease, for interventional pain relief and replace fluoroscopy for other cases. The use of ultrasonography as an instrument for diagnosing cervical disc disease in children was insufficiently developed [14-17].

The possibilities of ultrasonography in the assessment of degenerative changes in the intervertebral discs among children have not been studied enough.

Objective of the Study

The purpose of this study was to determine the possibilities of Ultrasound of degenerative findings of cervical spine in children.

Materials and Methods

The analysis of ultrasound images of intervertebral discs in 71 children aged 13 - 18 years with frequent and stable pain in the neck was carried out. Children were observed and treated by a neuropathologist (I group). The comparative group (CG) consisted of 26 children aged 13-18 years with no complaints of cervical pain and with normal neurological status.

The study was carried out using ultrasonic devices Ultima SE (Radmir) and Philips HD-7; MRI - General Electric, Signa HDI, 1.5T.

Ultrasonography of the cervical spine held on the levels from C2-C3 to C7-Th1. In the absence of degenerative changes in the intervertebral discs, the nucleus pulposus and annulus fibrosus have a homogeneous structure without hyperechoic inclusions. On ultrasound, the anterior dural space looks like a hypo-anechoic zone with smooth edges between the disc and the spinal cord. The spinal nerves inside the canals of the same name look like linear inclusions on both sides of the spinal canal and yellow ligaments line the inner contour of the spinal canal from behind (Figure 1).

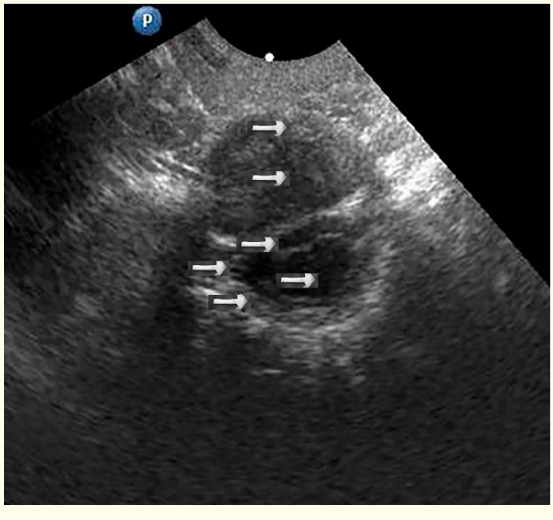

Figure 1: *Axial section of the cervical spinal motion segment. Top-down the horizontal arrows show the fibrous ring, nucleus pulposus, anterior dural space, the right spinal nerve canal, spinal cord, the yellow ligament.*

For a complete characterization of degenerative changes in the intervertebral discs, we studied the occurrence of the following ultrasound symptoms:

1) Single small (up to 2 mm) hyperechoic inclusions in the nucleus pulposus;

2) Displacement of the hyperechoic nucleus pulposus towards the annulus fibrosus;

3) Heterogeneity of the nucleus pulposus due to macrofocal fibrotic changes;

4) Narrowing of the anterior dural space due to protrusion of the intervertebral disc;

5) Discontinuity in the image of the annulus fibrosus with local protrusion of the disc more than 4 mm.

Results

The frequency of occurrence of ultrasound symptoms in children with cervical pain and the comparative group are presented in table 1.

As can be seen from table 1, among 71 children with neck pain (I group), an ultrasound symptom of degenerative disc disease in the form of single small (up to 2 mm) hyperechoic inclusions in the nucleus pulposus was registered in 87 (20.4 ± 2.0%) among 426 discs, and among 26 children of the comparative group (SG) - in 15 (9.6 ± 2.4%) discs out of 156 (P < 0,001). The ultrasound symptom of displacement of the hyperechoic nucleus pulposus towards the annulus fibrosus was registered in 53 (12,4 ± 1,6%) and in 6 (3,8 ± 1,5%) cases (P < 0,001); the heterogeneity of the nucleus pulposus due to macrofocal fibrotic changes - in 48 (11,3 ± 1,5%) and in 4 (2,6 ± 1,3%) cases (P,0,001); the narrowing of the anterior dural space due to protrusion of the intervertebral disc - in 29 (6,8 ± 1,2%) and in 3 (1,9 ± 1,1%) cases (P < 0,01), respectively. The ultrasound symptom of discontinuity in the image of the annulus fibrosus with local protrusion of the disc more than 4 mm was registered only in I group - in 7 (1,6 ± 0,6%) discs.

Ultrasound signs of degenerative disc changes	I Group (n = 71) 426 discs	CG (n = 26) 156 discs
Single small (up to 2 mm) hyperechoic inclusions in the nucleus pulposus	87 (20,4 ± 2,0%) p < 0,001	15 (9,6 ± 2,4%)
Displacement of the hyperechoic nucleus pulposus towards the annulus fibrosus	53 (12,4 ± 1,6%) p < 0,001	6 (3,8 ± 1,5%)
Heterogeneity of the nucleus pulposus due to macrofocal fibrotic changes	48 (11,3 ± 1,5%) p < 0,001	4 (2,6 ± 1,3%)
Narrowing of the anterior dural space due to protrusion of the intervertebral disc	29 (6,8 ± 1,2%) p < 0,01	3 (1,9 ± 1,1%)
Discontinuity in the image of the annulus fibrosus with local protrusion of the disc more than 4 mm	7 (1,6 ± 0,6%)	-

Table 1: *Characteristics the ultrasonic changes of discs in children with cervical pain and in a comparative group.*

Among the patients of I group, there are 24 children aged at 13 - 15 years, 47 children aged 16 - 18 years. Analysis of ultrasound images in the younger age group was carried out in 144 discs, in the older age group in 282 discs. In the comparative group, 11 children were aged

13 - 15 years, 15 children were aged 16 - 18 years. Among the first, the analysis of ultrasound images was carried out in 66 discs, among the second in 90 discs, respectively (Table 2).

As can be seen from table 2, an ultrasound symptom of degenerative disc disease in the form of single small (up to 2 mm) hyperechoic inclusions in the nucleus pulposus was registered in 41 (28.5 ± 3.2%) and in 46 (16.3 ± 2.2%) discs (P < 0,01) of I group (Figure 2). Among children of CG this symptom was registered in 7 (10.6 ± 3.8%) and in 8 (8.9 ± 3.0%) discs, respectively. The difference between Group I and CG scores was statistically significant in both age groups (P < 0.001 and P < 0.05).

Ultrasound signs	I group (n = 71)		CG (n = 26)	
	13 - 15 year (n = 24) 144 discs	16 - 18 year (n = 47) 282 discs	13 - 15 year (n = 11) 66 discs	16 - 18 year (n = 15) 90 discs
	1	2	1	2
Single small (up to 2 mm) hyperechoic inclusions in the nucleus pulposus	41 (28,5 ± 3,8%) P 1-2 < 0,01 P1-1 < 0,001	46 (16,3 ± 2,2%) P2-2 < 0,05	7 (10,6 ± 3,8%)	8 (8,9 ± 3,0%)
Displacement of the hyperechoic nucleus pulposus towards the annulus fibrosus	12 (8,3 ± 2,3%)	41 (14,5 ± 2,1%) P2-1 < 0,05 P2-2 < 0,001	2 (3,0 ± 2,1%)	4 (4,4 ± 2,2%)
Heterogeneity of the nucleus pulposus due to macrofocal fibrotic changes	9 (6,3 ± 2,0%)	39 (13,8 ± 2,1%) P2-1 < 0,05 P2-2 < 0,001	1 (1,5 ± 1,5%)	3 (3,3 ± 1,9%)
Narrowing of the anterior dural space due to protrusion of the intervertebral disc	3 (2,1 ± 1,2%)	26 (9,2 ± 1,7%) P2-1 < 0,001 P2-2 < 0,05	-	3 (3,3 ± 1,9%)
Discontinuity in the image of the annulus fibrosus with local protrusion of the disc more than 4 mm	-	7 (2,5 ± 0,9%)	-	-

Table 2: *Characteristics the ultrasonic changes of discs in children with cervical pain and in a comparative group.*

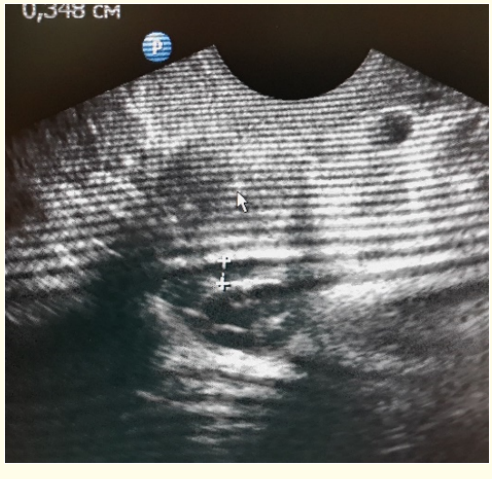

Figure 2: *Degenerative changes in the pulpous nucleus. The arrow shows a hyperechoic inclusion about 2 mm in size.*

The displacement of the hyperechoic nucleus pulposus towards the annulus fibrosus was observed in 12 (8.3 ± 2.3%), 41 (14.5 ± 2.1%), 2 (3.0 ± 2.1%) and 4 (4.4 ± 2.2%) discs, respectively (Figure 3). Among children aged 16 - 18 years, this symptom was significantly more common than in other groups (P.0.05 and P < 0.001).

Figure 3: *Displacement of the hyperechoic nucleus pulposus posteriorly towards the annulus fibrosus (arrow).*

The heterogeneity of the nucleus pulposus due to macrofocal fibrotic changes was observed in 9 (6.3 ± 2.0%), 39 (13.8 ± 2.1%), 1 (1.5 ± 1.5%) and 3 (3.3 ± 1.9%) discs, respectively (Figure 4).

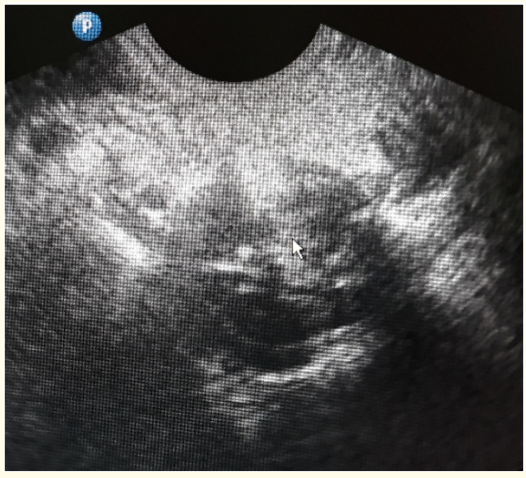

Figure 4: *Ultrasonogram of the intervertebral disc in the axial section. Arrow shows macrofocal heterogeneity of disc.*

Among children of I group the narrowing of the anterior dural space due to protrusion of the intervertebral disc was registered in 3 (2.1 ± 1.2%) and in 26 (9.2 ± 1.7%) discs (P < 0,001). In CG this symptom was registered in 3 (3.3 ± 1.9%) disc among children aged 16-18 years, significantly less (P < 0,05), then in I group (Figure 5).

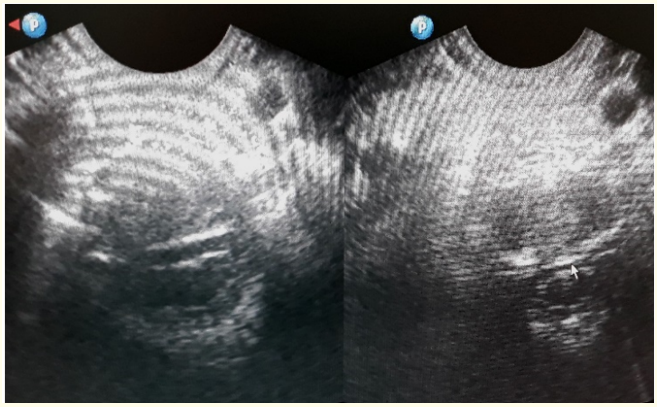

Figure 5: *Median protrusion C4-C5 leads to narrowing of the anterior dural space.*

The discontinuity in the image of the annulus fibrosus with local protrusion of the disc more than 4 mm (hernia), was registered in 7 (2.5 ± 0.9%) discs, only among children of I group aged 16 - 18 years (Figure 6).

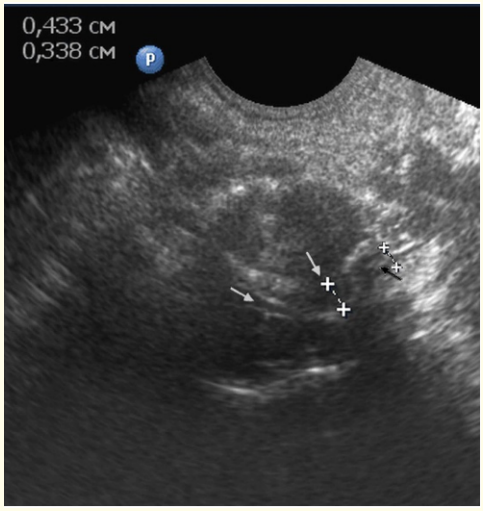

Figure 5: *Left-side paramedian hernia. The upper vertical arrow shows the hernial gates, the horizontal arrow - narrowing anterior dural space, the black arrow - narrowing left spinal nerve canal together with the compressed nerve.*

Among children of the first group at the age of 13-15 years, protrusion was recorded in 3 (12.5 ± 6.8) discs, at the age of 16-18 years - in 26 (55.3 ± 9.8) discs ($P < 0.001$). In the comparative group, protrusion was diagnosed in 3 (20.0 ± 10.3) disc of children the older age, statistically significantly ($P < 0.05$) less often than in I group (Table 3).

Ultrasound signs	I group (n = 71)		CG (n = 26)	
	13 - 15 year (n = 24)	16 - 18 year (n = 47)	13 - 15 year (n = 11)	16 - 18 year (n = 15)
	1	2	1	2
Protrusion	3 (12,5 ± 6,8%)	26 (55,3 ± 9,8%) P2-1 < 0,001 P2-2 < 0,05	-	3 (20,0 ± 10,3%)
Hernia	-	7 (2,5 ± 0,9%)	-	-

Table 3: *Characteristics the ultrasonic changes of discs in children with cervical pain and in a comparative group.*

All patients with protrusion and herniated discs underwent MRI. The results of USG and MRI coincided in all 7 cases of hernia, and the discrepancy occurred only in one case of protrusion.

Discussion

The increase in the incidence of neck pain among children requires clarification of their causes [1,2]. According to the literature, among the causes of cervicogenic pain, the leading place is occupied by the pathology of the cervical spine [4].

Radiological methods are generally accepted in the study of the spine. As you know, radiography perceives discs as intervertebral space, since it cannot visualize soft tissue structures, which include intervertebral discs. The most recognized method for diagnosing osteochondrosis is magnetic resonance imaging [8-10]. However, the method is expensive and not suitable for screening studies in pediatric practice. The use of high-frequency sensors makes it possible to obtain a high-quality image of the intervertebral discs and the spinal cord [16].

Conclusion

Our research allowed us to demonstrate the possibilities of ultrasonography in assessing the structure of the cervical intervertebral discs in children with neck pain. Changes in the disc ranged from small calcifications to large-focal heterogeneity, as well as the formation of protrusion and herniation.

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