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The Value of Radiological Methods in Diagnosis of Dysmenorrhea of Puberty.

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ABSTRACT

The scientific article "The Value of Radiological Methods in Diagnosis of Dysmenorrhea of Puberty" presents the results of studies using non-invasive diagnostic technologies: magnetic resonance imaging and three-dimensional ultrasonography with color Doppler blood flow imaging (CDI). The evaluation of the features of radiological indices in the patients with dysmenorrhea of functional and organic genesis of severe degree based on the study of the results of 3D ultrasound examination, MRI of small pelvic organs, as well as the state of uterine and endomyometrial blood flow to improve the algorithm of diagnostics has been carried out. A high percentage (51,11%) of the rate of detection of organic pathology in the patients with severe dysmenorrhea (anomalies of the uterus development in the form of bicornuate, saddle, septal, horned, leiomyoma of the uterus body, various forms of endometriosis, combination of leiomyoma and endometriosis of womb) has been stated. Revealed hemodynamic abnormality in the basins of the uterine arteries, the low degree of arterial vascularization of subendomyometrial layer and endometrium, high vascular resistance and rate reduction in blood flow were detected, which is more evident in the patients with functional dysmenorrhea. On the basis of comparative evaluation of informativeness of the research methods, expedience of their use has been substantiated.

Keywords: dysmenorrhea, puberty, radiation methods.

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INTRODUCTION

In recent years, due to unfavorable demographic shifts the interest in the reproductive health of children and adolescents has been raised, because hope for improving the physical and reproductive health is associated with them in the future [3,6,8].

Dysmenorrhea is a pathological cyclic process, characterized by severe uterine pains in the days of menstruation, accompanied by general weakness, nausea, vomiting, diarrhea, headache, dizziness, irritability, fainting and other symptoms [9, 10, 11].

According to the classification of the disease, primary and secondary dysmenorrhoea are differentiated. The primary dysmenorrhea implies the absence of organic pathology of the pelvic minor organs and is caused by a dysfunction of the hypothalamic-hypophysial-ovarian system, cortical-subcortical interrelations, accompanied by disturbance of the synthesis of estrogen, progesterone, neurotransmitters, and other biologically active compounds which enhance afferent activity of impulses, irritating pain centers in the CNS [1, 10, 11]. The secondary one is the result of many factors: malformations of the uterus, its post-traumatic damaging (synechia, scar deformity), tumors (leiomyoma), endometriosis, inflammatory diseases, IUD, commissural process in small pelvis, varicose pelvic veins, Allen-Masters syndrome [6,8,11,12].

Dysmenorrhea can be compensated and decompensated. According to the degree of severity, one differentiates mild, moderate, and severe forms [11,12].

The emergence of new advances in adolescent gynecology is largely due to the use of modern highly informative non-invasive diagnostic techniques in the assessment of the organs of small pelvis: magnetic resonance tomography and three-dimensional sonography with color Doppler imaging of blood flow (CDI) [2,4,5].

Multi-dimensional reconstruction, the possibility of layer-by-layer analysis of an organ, retrospective processing of the stored ultrasound data are the main advantages of three-dimensional echography, which can improve the information content of a standard ultrasound and make it possible to visualize the structures of the uterus and its appendages at the level out-of-reach earlier.

Possibilities of ultrasound scanning have greatly been enhanced with the introduction of the practice of ultrasound technology, allowing to receive images of the human body's blood vessels (color Doppler and power mapping and Doppler-metry) [7,14]. Color Doppler imaging (CDI) is a method for the preparation of color cartograms based on the Doppler effect with the registration of sanguimotion velocities encoded with different colors based on the direction of movement [13]. Qualitative and quantitative analysis of indicators intraorganic blood flow in the CDI provides a detailed assessment of the uterine bloodstream [13, 14]. Due to the high resolution of the currently applied equipment, visualization and identification of the minute vessels is possible, up to the microvasculature system. All levels of uterine blood supply are available, including uterine, arcuate, radial, basal and spiral arteries. To quantify parameters of blood flow at different levels, one uses pulsed Doppler-metry, the basis of which is the analysis of the Doppler curve, the velocity indicators, the calculation of quantitative indicators: resistance index, pulse index, systolic-diastolic ratio [13].

It is believed that the combination of three-dimensional study and the Doppler method gives a more accurate characterization of blood flow on the whole [14].

MRI is based on the phenomenon of nuclear magnetic resonance and registration of energy emitted by the nuclei after prior exposure to a broad spectrum radio-frequency pulse. The ability to obtain images in any plane, the high resolution of soft tissue contrast study and lack of radiation exposure arouse wide interest in this diagnostic method. However, the duration of the procedure and high cost are a deterrent for its wide application. Despite many works with MRI application in gynecology, there is no evidence of using this technique in patients with dysmenorrhea in Russian literature and it is rare in foreign publications.

The Objective of the Research evaluation of diagnostic features of application of 3D ultrasound, the MRI of the pelvic organs, the study of the features of the uterine and endomyometrial blood flow in the patients with puberty dysmenorrhea.

MATERIALS AND METHODS

The paper is based on the analysis of the survey of 480 teenagers aged 13-18, the examination of 278 of them with dysmenorrhea with the separation of the patients with severe disease. The main group of study consisted of 90 patients with a previous diagnosis of dysmenorrhea of functional genesis. The survey conducted allowed to differentiate functional dysmenorrhea in 44 of them (group I) and organic - in 46 (group II); the control group consisted of 15 healthy adolescents.

Ultrasound diagnosis was performed using Doppler-metry and methods of color Doppler imaging (CDI) on scanners: 2D ultrasound - apparatus Acuson 128 XP / 10 (Siemens), Acuson 512 Sequoia (Siemens), 3D - Voluson 730 Expert (GEMS) with a multifrequency convex abdominal transducer of frequency of 3,5 MHz and multifrequency transrectal and transvaginal transducer (7,5 MHz), with Doppler attachment, providing the possibility of color mapping.

To evaluate the curves of velocities of blood flow, the following parameters were used: resistance index (RI), pulsation index (PI), the local blood flow velocity (LBV).

The MRI studies were conducted on «Magnetom Symphony» MR-imaging installation of the «Siemens» company with the magnetic field of 1, 5 Tesla, with T1 and T2-weighted imaging in three projections.

The radiological methods were carried out in the late of luteal phase, in addition the MRI - in dynamics in the 1st and 3rd days of the menstrual cycle.

The statistical analysis of the results was carried out using ASUS personal computer with Pentium M Centrion processor with an application of the statistical package of BIOSTAT 2001 programs (S. Glants, 1999). The calculations of indicators of descriptive statistics were performed: the number of observations (n), arithmetic mean (M), the mean error of the arithmetic mean (m_m) and non-parametric correlation coefficients (Kruskal-Wallis test, Newman Keuls test). Closeness of the relations was determined by the coefficient of correlation and the degree of reliability. The weak link was observed with the correlation coefficient of 0,2-0,49; mean 0,5-0,74; strong 0,75-0,95. The degree of reliability: less than 0,05 - with the accuracy up to 95%; less than 0,01 - with the accuracy up to 99%; less than 0,001 - with the accuracy up to 99,9%. Significant correlation was confirmed by regression analysis.

THE RESEARCH RESULTS

The analysis of the results of 2D, 3D ultrasound of the pelvic organs, uterine and endomyometrial blood flow, MRI of uterine in detecting genesis of dysmenorrhea. At the stage of two-dimensional ultrasound using traditional longitudinal and transverse sections, the genital pathology in 90 patients of the main group was not detected. 3D ultrasound and MRI of the pelvic organs allowed to differentiate the function (n = 44) and organic (n = 46) dysmenorrhea in all 90 patients of the main group with their distribution in groups I and II, respectively.

3D ultrasound detected the following in the patients of group I with functional dysmenorrhea.

Uterus location in all patients was in the central line, it was in hyperanteflexio 16 (36,36%), in hyperretroflexio - in 7 (15,91%) patients. The average sizes were: at the age of 13-14 years: $38,3 \pm 0,78 \times 23,3 \pm 1,32 \times 32 \pm 1,67$ mm, the length of cervix uteri - $27,1 \pm 1,01$ mm; at the age of 15-16 years: $40,83 \pm 0,61 \times 27,89 \pm 0,67 \times 37,61 \pm 0,73$ and $26,33 \pm 0,7$ mm, respectively; aged 17-18 years: $43,44 \pm 0,81 \times 30,69 \pm 0,80 \times 40,56 \pm 0,97$ and $26,94 \pm 0,46$ mm, respectively. The average value of the ratio of the length of the body and the cervix uteri was $1,56 \pm 0,03352$.

The ovaries in most patients had typical location, but their high placement at the side walls of the pelvis was detected in 5 (11,36%) patients, which in combination with uterine hypoplasia and a long neck is an indication of sexual infantilism. The average sizes of the ovaries according to the age were identical with the sizes of healthy adolescents, respectively.

To confirm the absence of anatomical changes of genitalia, the MRI of pelvic organs was performed in the patients in group I on their first day of the menstrual cycle, when the pain syndrome was severe, and in seven of them (15.91%) on the third day when the pain was alleviating. In T2-weighted images (WI) of low signal intensity, myometrium was significantly thicker on the first cycle day (up to 22 mm on the anterior wall and 20 – posterior wall) with strong pains, had irregular thickening with marked distortion of the contour of endometrium, which may be associated with increased intrauterine pressure and disoriented spastic contractions of the uterine muscles. By the third day of the cycle, the thickness of myometrium had significantly decreased, and endometrial distortion contour had disappeared. Changing of the contour of endometrium and thickening of myometrium can be considered as the sign of adenomyosis. However, the complete disappearance by the third day of the cycle indicates the functional character of the disturbances.

In the patients of the second main group of the investigation according to the data of 3D ultrasound, frontal scanning allowed to detect: uterine malformations (n = 22), adenomyosis (n = 12), leiomyoma (n = 3), the combination of adenomyosis and leiomyoma (n = 2), endometrioid ovarian cysts (n = 4) and retrocervical endometriosis (n = 3).

The uterus was in hyperanteflexio in 11 (23,91%) patients, in hyperretroflexio – in 5 (10,87%) patients. Position of ovaries was typical in all patients.

Uterus bicornis was diagnosed in five patients, four of them were with the notch in the fundus of uterus of 1/3 of the body; abnormally hypoplastic horn was detected in the fifth from the right. Arcuate uterus with normal outer contour with splitting in the fundus in the form of a “saddle” was detected in 6 patients. In 10 cases, there was detected an incomplete uterine cavity septum, partially separating its proximal portion. The essential difference between the septal and bicornuate uterus was smooth outer contour of the uterine fundus in cases of septum and its splitting with bicornuate uterus. With fundus impression in the septal womb, it was of a depth of less than 1 cm in contrast to the bicornuate. One patient had one-horned uterus, based on the deviation of its axis laterally, reducing the width and increasing the length of the uterus.

Thus, the 3D ultrasound helped clarify the character of the anatomical changes in the patients with an abnormality of the uterus, not diagnosed using the 2D ultrasound.

In 10 patients the signs of diffuse adenomyosis were detected due to the presence of fine inclusions in myometrium (up to 1-3 mm), the nodes of adenomyosis of the diameter of 4 mm and 5 mm were found in two patients. The uterus size and shape were not changed.

In 3 cases the uterine leiomyoma of small sizes was detected, including the uncharacteristic position of the nodes. The use of the frontal plane of scanning with simultaneous image of the whole uterus, including the area of tubal angles and cervical canal made it possible to detect 1 - cervical node of the diameter of 3 mm and 1 - submucous node of 5 mm, from the left side wall of the uterus. The third patients was diagnosed with one node of 9 mm with interstitial position in the uterus.

The combination of uterine endometriosis and leiomyomas was diagnosed in 2 patients. Imaging of the frontal plane of the uterine cavity facilitated to detect nodular adenomyosis, including the nodules relatively small in size (3 mm) and differentiate them from myoma nodes. In scanning image leiomyoma had mostly the decreased echogenicity, adenomyosis node – the increased one. A clearly visualized capsule of the node is characteristic for myoma, and its nonvisualization indicates adenomyosis.

Three-dimensional reconstruction of the uterine appendages, clear visualization of rectouterine space allowed to find the so-called “minor” forms of external endometriosis. In 4 patients small endometrioid ovarian cysts in the form of parietal hyperechoic inclusions of homogeneous structure (in two cases - bilateral) of a diameter from 2 to 4 mm were diagnosed. Three patients had retrocervical endometriosis with formations on posterior surface of the cervix uteri of 1-3 mm, at that the contours of the posterior Douglas’ cul-de-sac were deformed, with the presence of retraction forming asymmetrical cavity. Characteristic of patients with retrocervical endometriosis was painfulness when running with sensors and gynecological examination.

Determining the average size of the uterus of the patients of group II, and comparing them with group I and control group revealed a decrease in linear body size in all patients and an increase in the length of the

neck of uterus in patients aged 13-16 of group 1. The detected high placement of the ovaries in 5 of the patients can be connected with the manifestation of the visceral form of dysplasia of connective tissue. Of 46 patients of group II, the greatest linear sizes of the uterus were found in 29 patients aged 17-18, but they were within the upper limit of normal feature.

Ultrasound evaluation of ovarian size of the patients from the main and control groups did not reveal significant differences. It should be noted that the sizes of the uterus and the ovaries by 3D ultrasound data coincide with those based on MRI.

All patients of group II had the control MRI of the pelvic organs done, the coincidence of diagnoses is complete. According to many authors, MRI allows to determine in 100% cases the type of uterus malformation (bicornis, arcuatus, septal with measurement of the thickness and the length of the intrauterine septum), the character, size and location of leiomyomas and endometriosis. MRI makes it possible to delineate the borders between endomyometrial zones. In T2 - WI diffuse adenomyosis is evident with the thickening of hypointensive connective zone that characterizes a basal layer of the endometrium, but it takes no more than 1/3 of the wall of the uterus, which according to the classification by B. I. Zheleznov and A. N. Strizhakov (1985) corresponds to proliferation stage I. In an intact uterus the connective zone is located between the hyperintensive endometrium in T2 and isointensive myometrium. The proliferation of stromal cells in myometrium with diffuse adenomyosis declares itself with the extension of connective zone by reducing isointensive myometrium in T2. The nodal form of the disease in T2 is detected as low intensive area, clearly separated from the adjacent myometrium; retrocervical endometriosis - the presence in retrocervical space of small formations of irregular shape with increased signal in T2 - WI.

The MR tomographic picture of leiomyoma is similar to nodular form of adenomyosis, hypointensive in T2-WI, but at the same time, leiomyoma, despite its small sizes, has a regular round shape and is clearly demarcated from the surrounding myometrium, and closer to the "capsule" the MR signal becomes more intensive, since due to vascularization of the "capsule" itself has a hyperintensive signal.

With the aim of studying the genesis of dysmenorrhea the analysis of the indicators of uterine and endomyometrial blood flow by color Doppler imaging of blood vessels (CDI) and Doppler imaging on the day before menstruation. According to CDM, blood flow in uterine (UA), arcuate (AA) and radial (RA) arteries was recorded in all groups. In healthy girls of the control group basal (BA) arteries were visualized in 86, 67%, in 26,67% - spiral arteries (SA) in the form of small dots of vascularization, chaotically placed in the projection of uterine echo. Such a high frequency of detection of small arteries in the control group may be connected with the use of three-dimensional reconstruction of the uterine vessels in 3D in order to improve their visualization. In group I BA and SA were visualized in 27, 27% and 4, 55%, in group II - in 41,30% and 6,52%, respectively. Thus, the frequency of detection of basal arteries in group I was less than 3,18 times, in group II - 2,1; spiral - 5,86 and 4,09 times, respectively, compared with the control group.

The Doppler values of the indices of vascular resistance (PI and RI) exhibit highly resistant blood flow up to the terminal branches of the uterine arteries with the lack of vascularization of subendometrial layer in 13, 33% and endometry - in 73, 33% of the girls in the control group, among the patients of group I in 72,73% and 95,45%, and in 58,70% and 93,48% - in group II, respectively. The spectrum of the curve of uterine artery blood flow velocity in group I in 4 (9,09%) patients had reversing blood flow, which is maintained in the arcuate arteries in 3 (6,82%) and in the radial - in 2 (4,55%) patients.

Evident highly resistant blood flow with the presence of reversible component in the right (PI - 6, 92, RI - 1, 17) and left-UA (PI - 6,02, RI - 1.16) of patient K., 13 years old is shown in Figures 1 and 2.

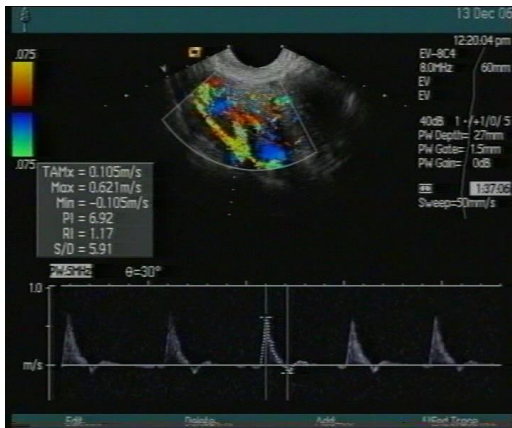


Fig. 1. CDI and Doppler of the right uterine artery of patient K., 13 years old with primary dysmenorrhea.

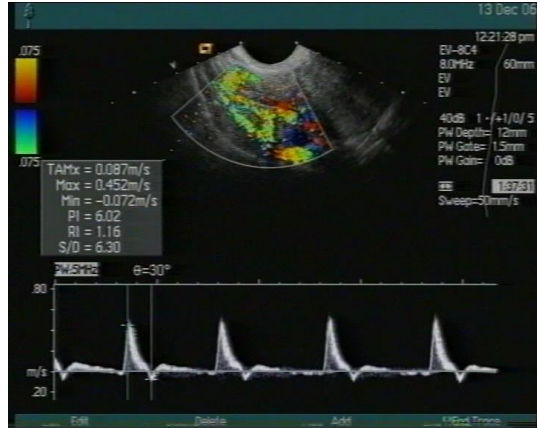


Fig. 2. CDI and Doppler of the left uterine artery of patient K., 13 years old with primary dysmenorrhea.

This patient has also high indices of vascular resistance in BA (PI – 1,08, RI – 0,62) (Fig. 3).

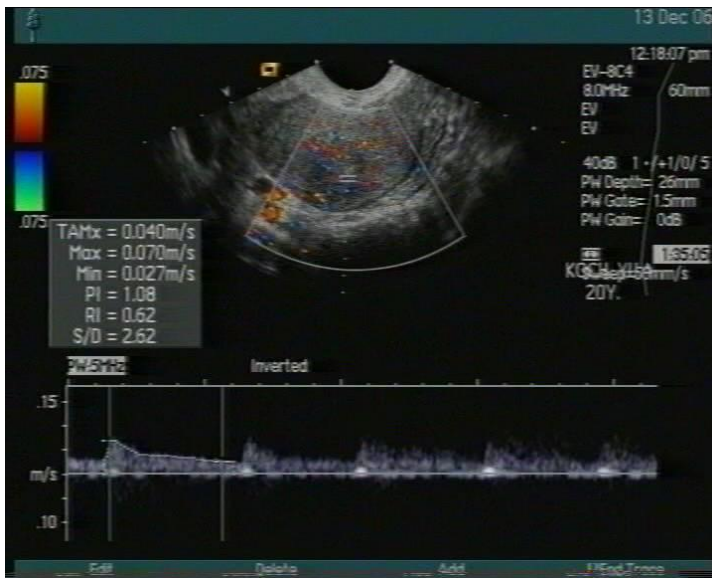


Fig. 3. CDI and Doppler of basal artery of patient K., 13 years old with primary dysmenorrhea.

Performance indices of vascular resistance and blood flow in uterine artery basin are given in Table 1.

Table 1: Performance Indices of Vascular Resistance and Blood Flow Velocity in the Patients from the Main and Control Groups

Indices	Groups		
	one(n=44)	two (n=46)	control (n=15)
PI UA right	4,9±0,098***	4,36±0,08**	2,26±0,12
PI UA left	4,902±0,902***	4,42±0,07***	2,273±0,13
PI AA	3,616±0,052***	3,417±0,06***	1,56±0,09
PI RA	2,78±0,04***	2,49±0,06**	1,11±0,08
PI BA	2,25±0,09*	1,8±0,12*	0,89±0,05
PI SA	are not subject to statistical treatment		
RI MA right	0,91±0,01*	0,89±0,01*	0,82±0,01
RI MA left	0,91±0,005*	0,88±0,009*	0,817±0,01
RI AA	0,83±0,007*	0,78±0,006*	0,73±0,01
RI RA	0,75±0,008*	0,67±0,009*	0,61±0,02
RI BA	0,62±0,01*	0,53±0,02	0,48±0,02
RI SA	are not subject to statistical treatment		

LBV UA right	53,82±1,41*	58,87±1,71	61,67±3,41
LBV UA left	55,16±1,66*	57,43±1,82*	66,4±2,26
LBV AA	36,89±1,06	39,28±0,98	37,07±2,51
LBV RA	20,59±0,98	24,15±1,14	24,67±2,39
LBV BA	11,42±1,35	13,56±1,25	15,4±1,88
* - D<0,05, ** - D<0,01, *** - D<0,001 veracity of differences as compared to the control group			

There were significant differences in performance of PI and RI in all basins of the studied arteries in patients from groups I and II (d <0, 05). The reduced velocity of blood flow is more evident in group I.

The data obtained allowed to reveal a decrease in the detection rate of small arteries (basal, spiral) as they move away from the major uterine vessels and proximity to the endometrium, accompanied by a gradual decrease in the values of vascular resistance and blood flow velocity. The degree of arterial vascularization of subendometrial layers and endometrium in the patients of groups I and II was lower compared with the control group, it is the least evident in group I, the blood flow in the basin of UA represents disturbance of the microcirculatory section in the patients with dysmenorrhea, which is more evident in the patients with primary dysmenorrhea.

CDI allowed to provide additional information on organic pathology: on leiomyoma - the region of neoangiogenesis is detected in the form of a ring on periphery of myoma node and intratumoral vessels. The detected myoma of the diameter of 3 mm is avascular, which is consistent with the opinion of a number of authors about the absence of blood vessels in the small myoma nodes. Colored spots in uterine septa suggest the presence of vascularized myometrium fibers in the septum (Fig. 4).



Fig. 4. CDI of the vessels of myometrium in the uterine septum of patient P., 15 years.

SUMMARY

3D ultrasound can reliably differentiate the functional and organic dysmenorrhea, which is confirmed with the results of MRI of the pelvic organs. The study of the character of blood flow in the basin of uterine arteries allowed to detect more severe hemodynamic disturbances in the patients with functional dysmenorrhea. The low degree of arterial vascularization of subendometrial layers and endometrium, high vascular resistance and decreased blood flow in the basins of the UA reflects the presence of vasospasm, delayed uterine blood flow and local ischemia myometrium with dysmenorrhea.

CONCLUSION

In adolescents with severe dysmenorrhea, with a negative NSAID test and resistance to the standard therapy, it is advisable to use a 3D ultrasound OMT. Inclusion of dysmenorrhea of the studies of uterine blood

flow and endomyometrial vessels in the diagnostic algorithm is effective and allows to detect organic pathology.

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