RESULTS OF ULTRASOUND SCREENING FOR HIP DYSPLASIA IN INFANTS

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Hip dysplasia (HD) represents the congenital underdevelopment of the hip joint (HJ) being the most common orthopedic problem of newborns having the prevalence of 5–20%. Late HD detection is the main cause of coxarthrosis in young adulthood. The study was aimed to assess the results of ultrasound screening for HD in infants. The study involved 860 full-term infants aged 1–3 months (446 boys (51.9%) and 414 girls (48.1%)). All newborns underwent ultrasound imaging of the hip joint at the age of 1 month and the follow-up examination at the age of 3 months (Graf method). The χ^2 test and $p < 0.05$ were used to compare the data. In their first year of life, 685 newborns (79.7%) had joints of normal or transitory shape, 161 (18.7%) showed physiological immaturity and 14 (1.6%) showed the HJ abnormality; the HJ immaturity and abnormality were more prevalent in girls (113 cases (26.3%)) than in boys (62 cases (13.9%)). The relationship between the breech presentation and the likelihood of developing HD was revealed ($p < 0.001$). Spontaneous improvement by the age of 3 months took place in the majority of infants having the ultrasound signs of HD, the rate of normal HJ increased from 79.8 to 94.5%. Ultrasound screening is an effective method allowing one to detect HD starting from the first days of the child's life. The risk factors of HD are still female sex and breech presentation, regardless of the number of births. Spontaneous improvement following prescription of relaxing massage occurs in the majority of children.

Keywords: hip dysplasia, ultrasound screening of newborns, hip sonography, congenital hip dislocation

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Compliance with the ethical standards: the study was conducted in accordance with the Order of the Ministry of Health of the Russian Federation dated 28.04.2007 No. 307 "On the Standard of Dispensary (Preventive) Observation of a Child during His/Her First Year of Life". Parents submitted the informed consent to ultrasound. No approval by the Ethics Committee was required.

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РЕЗУЛЬТАТЫ УЛЬТРАЗВУКОВОГО СКРИНИНГА ДИСПЛАЗИИ ТАЗОБЕДРЕННЫХ СУСТАВОВ У ДЕТЕЙ ГРУДНОГО ВОЗРАСТА

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Дисплазия тазобедренного сустава (ДТБС) — врожденное недоразвитие тазобедренного сустава (ТБС), наиболее распространенное ортопедическое заболевание новорожденных, встречающееся с частотой 5–20%. Поздно выявленная ДТБС — основная причина развития коксартроза в молодом возрасте. Целью исследования было провести анализ результатов ультразвукового скрининга ДТБС у детей грудного возраста. В исследование вошли 860 доношенных детей возрастом 1–3 месяцев (446 мальчиков (51,9%) и 414 девочек (48,1%)). Всем новорожденным выполняли ультразвуковой скрининг ТБС в возрасте 1 месяц и контрольное исследование в 3 месяца (методика по Графу). Для сравнения данных использовали критерий (χ^2) и $p < 0,05$. В первый месяц жизни у 685 (79,7%) новорожденных суставы были нормальной или транзиторной формы, у 161 (18,7%) выявлена физиологическая незрелость и у 14 (1,6%) — патология ТБС, у девочек незрелость и патология ДТБС встречалась чаще — в 113 (26,3%) случаев, чем у мальчиков — 62 (13,9%). Выявлена связь между тазовым предложением плода и вероятностью развития ДТБС ($p < 0,001$). К трем месяцам у большинства детей с УЗИ-признаками ДТБС произошло спонтанное улучшение, показатели нормальных ДТБС выросли с 79,8 до 94,5%. УЗИ-скрининг — эффективный метод, который позволяет выявлять ДТБС с первых дней жизни ребенка. Факторами риска развития ДТБС остаются женский пол и ягодичное предлежание, вне зависимости от числа родов. У большинства детей улучшение происходит спонтанно или при назначении расслабляющего массажа.

Ключевые слова: дисплазия тазобедренных суставов, ультразвуковой скрининг новорожденных, сонография тазобедренных суставов, врожденный вывих бедра

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Hip dysplasia (HD) represents the congenital underdevelopment of the hip joint (HJ) associated with deformities of the articular ends of bones manifesting themselves in alterations of the shape and depth of the acetabulum, neck shaft angle, and proximal femur. HD is among the most common orthopedic problems of newborns, it constitutes 12–22% of all musculoskeletal dysplasias. The prevalence of this disorder in various populations varies between 50–200 cases per 1000 newborns (5–20 %) [1]. Developmental abnormalities of the HJ resulting from the delayed diagnosis or inadequate conservative treatment of HD are the main cause of developing dysplastic coxarthrosis in young adulthood (10–60% of cases) [2]. There is a problem of defining and clarifying epidemiological data on this disorder that is associated with the lack of official universal criteria and classification concept of HD [3]. In some children with the physiologically immature HJ, dysplasia persists after 3 months (Graf type 2b joint), without decentered femoral head or any clinical manifestations. The treatment tactics for such patients is still a matter of debate [4, 5].

The study was aimed to assess the results of the orthopedic screening of infants performed using ultrasound imaging.

METHODS

The study was based on the monitoring data of 860 children aged 1–3 months attached to the Children's City Polyclinic № 5 in the city of Vladivostok, who underwent ultrasound screening of the HJ at the age of 1 month (in accordance with the Graf method) during preventive medical examination between December 2021 and August 2023. Re-examination by pediatric orthopedic traumatologist and the follow-up ultrasound imaging (performed with the Mindray DC-70 Pro expert class ultrasound system (Mindray; China)) of the HJ were performed at the age of 3 months. In the initial group of 860 individuals, a total of 791 children were examined at the age of 3 months; other children left the territory of attachment to the clinic. Both male and female full-term infants (gestational age 38–42 weeks) were included in the study: 446 boys (51.9%) and 414 girls (48.1%). The infants, whose gestational age was under 37 weeks, and post-term infants (gestational age 42 weeks) were excluded from the study. A total of 822 children (95.6%) had cephalic presentation, 38 children (4.4%) had breech presentation (patients were not divided into groups based on the breech presentation type). It was noted, that breech presentation was more common in girls (25 (6.0%)), than in boys (13 (2.9%)). Primiparity took place in 335 cases (38.9%), the second birth took place in 393 cases (45.7%), the third or more birth took place in 132 cases (15.4%). The data were presented as absolute values and percentages. Pearson's chi-squared test (χ^2) was used to compare the data. The differences were considered significant at $p < 0.05$. The STADIA 8.0 universal statistical software package (A.P. Kulaichev; Russia) was used for data processing.

RESULTS

When performing examination, we assessed hyperechoic bone structures (bony part of the acetabular roof, external bony prominence, external part of the ilium, femur) and hypoechoic structures (femoral head, limbus, triradiate cartilage). Relative positions of the joint components were determined based on the bony roof angle (α angle) and the angle formed by the cartilaginous roof (β angle). According to the Graf classification, four types of HJ are distinguished based on the angles and the femoral head position [3, 6]:

1 a — mature hip (α angle > 60°, β angle < 55°);

1 b — transitory hip (α angle > 60°, β angle > 55°);

2 a — physiological immaturity under the age of 3 months (α angle = 59–50°, β angle > 55°);

2 b — HD (shallow acetabulum, α angle = 59–50°, β angle > 55°) in children over the age of 3 months;

2 c — severe HD, preluxation (α angle = 43–49°, β angle 56–77°);

type D — severe HD, slight decentralization;

3 a,b — decentered HJ (subluxation) (α angle < 43°, β angle < 43°);

4 — severe HJ dislocation.

In our study, 685 newborns (79.7%) had type 1a,b type HJ (mature or transitory HJ) in their first month of life; physiological immaturity, type 2a HJ (flattening of the bone edge, expansion and shortening of the limbus, shallow, flattened acetabular floor) was reported in 161 children (18.7%). Abnormalities were detected in 14 newborns (1.6%). Type 2c HJ was reported in 10 cases (femoral head decentered only during functional tests, preluxation; stable and unstable joints were not distinguished), subluxation of the hip, type 3a,b HJ (decentered joint), was reported in three cases (later confirmed by clinical and radiography data). Congenital hip dislocation (type 4 HJ) was detected in one infant. This patient was referred to inpatient treatment and withdrawn from the study.

It should be noted that the HJ immaturity and HD were more common in girls (113 cases (27.3%)), than in boys (62 cases (13.9%)). Among children with breech presentation, immaturity of the HJ was detected in 18 cases (47.3%), while among children with cephalic presentation it was detected in 157 cases (13.9%). We revealed a significant correlation between the infant's female sex, breech presentation, and the likelihood of developing HD ($p < 0.001$). At the same time, there was no relationship between the detection frequency of HD in the first-born and later-born individuals ($p = 0.495$) (Table 1).

The recommended infant management algorithm was selected based on the HJ ultrasound imaging data [6]. Children with type 2a,b and 3a,b HJ (175 patients (20.3%)) underwent the course of massage; the fixing orthoses were used in individuals with the adductor contracture and decentered femoral head. The follow-up ultrasound imaging of the HJ was performed at the age of 3 months. Abnormalities (joint type 2b, 3a,b), i.e. flattening of the bone edge, expansion and shortening of the limbus, shallow, flattened acetabular floor, decentered femoral head, α angle < 59°, β angle > 55°, persisted in 48 children (6.1%) (Table 2).

DISCUSSION

Our findings are in line with the literature data: the non-physiological position of the fetus inside the uterus due to the child's legs pressed up (breech presentation), especially under conditions of oligoamnios, represents a prognostic sign and increases the likelihood of developing HD [1, 6, 7]. The fact that HP is more common in girls has been confirmed. This can be explained by the exposure to extra estrogens produced by female fetus, which contributes to the ligament laxity. At the same time, we have revealed no relationship between HD and the number of births.

The majority of children having ultrasound signs of HD show spontaneous improvement or improvement following prescription of relaxing massage [8, 9]. Thus, according to the data of our study, joints of 1a type (normal) were revealed in 743 children by the age of 3 months. The group of children with normal HJ expanded within two months: from 79.7% at the first

Table 1. Ultrasound imaging results obtained at the age of 1 month

Trait	HJ type (Graph classification)			χ^2 test and significance level (2 degrees of freedom)
	1 a, b	2 a, b	2 c; 3 a, b; 4	
Sex (abs./%)				
Boys (n = 446)	384 (86,1)	59 (13,2)	3 (0,7)	χ^2 = 24.957, p < 0.001, significant correlation
Girls (n = 414)	301 (72,7)	102 (24,6)	11 (2,7)	
Presentation (abs./%)				
Cephalic (n = 822)	665 (80.4)	147 (17.9)	10 (1.7)	χ^2 = 29.955, p < 0.001, significant correlation
Breech (n = 38)	20 (52.7)	14 (36.8)	4 (10.5)	
Birth (abs./%)				
First (n = 335)	260 (77.6)	69 (20.6)	6 (1.8)	χ^2 = 1.408, p = 0.495, non-significant correlation
Repeated (n = 525)	425 (81.0)	92 (17.5)	8 (1.5)	
Total	685 (79.7)	161 (18.7)	14 (1.6)	860 (100)

Table 2. Comparison of ultrasound imaging results obtained at the age of 1 month and 3 months

Months of life	HJ type (Graph classification)		
	1 a, b	2 a, b	2 c, 3 a, b; 4
1 month (n = 860)	685 (79.7)	161 (18.7)	14 (1.6)
3 months (n = 791)	743 (93.9)	45 (5.7)	3 (0.4)

Note: χ^2 = 72.036 (2 degrees of freedom), p < 0.001, significant correlation.

examination to 93.9% at the follow-up examination conducted at the age of 3 months. Prescription of prolonged immobilization to such children can cause necrosis of the femoral head, while prescription of the courses of intense massage can increase joint instability.

HD is divided into hip preluxation, subluxation, dislocation based on the severity of symptoms and prognosis. Congenital hip displacement is observed in 0.1–0.4% of newborns, while preluxation and subluxation are 10 times more prevalent [10, 11]. In our study, congenital hip displacement was diagnosed in one newborn (0.1%). There is a possibility that children with congenital hip displacement are transferred to the specialized orthopedic unit from maternity unit. That is why these children were not included in our statistics.

The HD diagnosis is based on a combination of clinical symptoms: Barlow provocative maneuver, the “click” sign (Ortolani sign), asymmetry of femoral and gluteal folds, limited hip abduction, lower limb shortening, excessive rotational movements. The diagnostic value of the symptoms detected in young children, except for clinical tests for instability and limb shortening, is 50–80%, since these symptoms are rather common in children showing no HJ underdevelopment. It is not always possible to notice the differences in the limb length in newborns, and provocative tests require good skills. The diagnostic radiography is highly informative, however, X-ray diagnosis of HP abnormalities in children in their first months of life is hampered by the fact that the HJ skeletal system of a newborn consists partially of the cartilage tissue. Ultrasound imaging of the HJ in newborns has none of these problems, that is why it is being used since 1980s [1, 4, 9, 12]. The method makes it possible to diagnose the most prevalent acetabular HD that is found in 62% of cases. Stable proximal femoral dysplasias (abnormalities not resulting in the femoral head decentering — coxa valga and coxa vara, femoral neck shortening, rotational dysplasia) rarely respond to conservative therapy and require surgical treatment. In young children with acetabular dysplasia, the HJ deformity is successfully corrected through adequate conservative treatment (massage, orthopedic positioning devices, closed reduction of dislocation). If the disorder is detected in children under the age of 3 months, it possible to achieve good outcome in 97% of cases [11].

However, there are certain difficulties related to interpretation of sonography results. Orthopedic traumatologists follow a common treatment tactics for congenital hip subluxation and displacement (correspond to the Graf HJ types 3a,b–4) involving early orthopedic treatment, while the management algorithm for infants with the HJ type 2b, specifically treatment duration, is still a matter of debate [1, 6, 12]. Persistent minor alteration of the head and acetabular arc without apparent joint instability can later result in orthopedic disorder of the lower limbs. In our opinion, in this situation, when selecting treatment tactics, priority should be given to the data obtained during radiographic diagnosis and follow-up examinations of the child.

CONCLUSIONS

Sonography in infancy is a highly informative method to diagnose HD due to high prevalence of the disorder among newborns, low informational content of radiographic methods, and ambiguity of the examination data interpretation. Analysis of the results of ultrasound orthopedic screening of infants has shown that female sex and breech presentation remain the risk factors of HD development in children, regardless of the number of births. The majority of children with ultrasound signs of HD show spontaneous improvement or improvement following prescription of relaxing massage. In case of persistent minor alterations of the HJ without apparent joint instability, the data of radiographic diagnosis and follow-up examinations of the child become a priority for selection of treatment tactics.

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