

ANALYSIS OF THE DIAGNOSTIC EFFICIENCY OF ULTRASOUND IMAGING OF THE HIP JOINT IN CHILDREN**B. Shirov, G. Mardieva**

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Key words: congenital dysplasia of the hip, ultrasound sonography, infants, risk factors, diagnosis, treatment.**Таянч сўзлар:** сон-чакоқ бўғими дисплазияси, ультратовуш сонография, чақалоқлар, хавф омиллари, диагностика, даволаш.**Ключевые слова:** дисплазия тазобедренного сустава, ультразвуковая сонография, младенцы, факторы риска, диагностика, лечение.

The aim of this study is to evaluate the effectiveness of ultrasound sonography in diagnosing various forms of congenital dysplasia of the hip (CHD) in infants under six months of age and to investigate the relationship between this pathology and potential risk factors. The study included 120 infants aged from the neonatal period to 6 months and a control group of 30 healthy children. All participants underwent ultrasound examinations using the Reinhard Graf method with a Toshiba XARIO-200 device. Angles α and β were measured to assess the degree of development of the bony and cartilaginous structures of the acetabulum. Based on the results, orthopedic surgeons recommended appropriate treatment and monitored its effectiveness. The results showed that 77.5% of the children had immature hip joints (type II according to Graf's classification), among which subtypes IIa and IIb differed in the age of the children and the need for orthopedic intervention. 16.67% of the children had decentered femoral heads (type III), requiring longer treatment. 5.83% of the children were diagnosed with complete hip dislocation, which required careful management and intervention. An analysis was also conducted to identify the most significant risk factors, taking into account regional characteristics. Factors such as family history of the disease, fetal position in the womb, the presence of birth injuries, and other medical indicators were considered in the analysis. Data analysis revealed that children with a burdened family history were more likely to have the disease, highlighting the genetic predisposition to CHD. Additionally, children born in breech presentation had an increased risk of developing hip dysplasia. The identified correlations between risk factors and the development of CHD can contribute to early diagnosis and prevention of the disease, as well as to the improvement of treatment methods. The study emphasizes the importance of regular ultrasound screening in infants for timely detection and correction of hip dysplasia.

БОЛАЛАРДА СОН-ЧАНОҚ БЎҒИМИНИНГ УЛЬТРАТОВУШ ТЕКШИРУВИНИНГ ДИАГНОСТИК САМАРАДОРЛИГИНИ ТАҲЛИЛ ҚИЛИШ**Б. Широ́в, Г. Мардиева**

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Ушбу тадқиқотнинг мақсади - олти ойдан кичик болаларда турли шаклдаги сон бўғими дисплазиясини диагностика қилишда ультратовуш сонографиянинг самарадорлигини баҳолаш ва ушбу патология билан боғлиқ эҳтимолий хавф омилларини ўрганиш. Тадқиқотга янги туғилганлик давридан 6 ойгача бўлган 120 нафар чақалоқ ва 30 нафар соғлом болалардан иборат назорат гуруҳи киритилди. Барча иштирокчиларга Toshiba XARIO-200 апаратидан фойдаланиб, Райнхард Граф усулида ультратовуш текширув ўтказилди. Сон суяги бошчаси бирикадиган жой (asetabulum) тоғай ва суяги ривожланиш даражасини баҳолаш учун α ва β бурчаклари ўлчанган. Натижалар асосида ортопед жарроҳлар тегишли даволашни тавсия қилган ва унинг самарадорлигини назорат қилган. Натижалар шундан иборат бўлдики, 77,5% болаларда тўлиқ стилмаган сон чаноқ бўғимлари аниқланган (Граф таснифига кўра II тур), улар орасида IIa ва IIb подтиплари болаларнинг ёшига ва ортопедик аралашувга бўлган эҳтиёжга қараб фарқланган. 16,67% болаларда сон суяги бошининг деформацияси (III тур) аниқланган, бу узокроқ даволашни талаб қилади. 5,83% болаларда тўлиқ сон бўғими чиқиши диагнози қўйилган бўлиб, бу эса жиддий бошқариш ва аралашувни талаб қилади. Шунингдек, минтақавий хусусиятларни ҳисобга олган ҳолда энг аҳамиятли хавф омилларини аниқлаш бўйича таҳлил ўтказилди. Таҳлил давомида касалликнинг оилавий тарихи, ҳомила жойлашуви, туғилиш жароҳатлари ва бошқа тиббий кўрсаткичлар ҳисобга олинди. Маълумотлар таҳлили шуни кўрсатдики, оилавий тарихи оғир бўлган болаларда касаллик кўпроқ учрайди, бу эса сон бўғими дисплазиясига генетик мойилликни таъкидлайди. Шунингдек, чаноқ томони билан туғилган болаларда сон бўғими дисплазияси ривожланиш хавфи юқори бўлган. Хавф омиллари ва сон бўғими дисплазияси ривожланиши ўртасидаги аниқланган боғлиқлик касалликнинг эрта диагностикаси ва профилактикасига, шунингдек даволаш усулларини яхшилашга ёрдам бериши мумкин. Тадқиқот чақалоқларда сон бўғими дисплазиясини ўз вақтида аниқлаш ва тузатиш учун мунтазам ультратовуш скринингнинг аҳамиятини таъкидлайди.

АНАЛИЗ ДИАГНОСТИЧЕСКОЙ ЭФФЕКТИВНОСТИ УЛЬТРАЗВУКОВОЙ ВИЗУАЛИЗАЦИИ ТАЗОБЕДРЕННОГО СУСТАВА У ДЕТЕЙ**Б. Широ́в, Г. Мардиева**

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Цель данного исследования — оценить эффективность ультразвуковой сонографии в диагностике различных форм дисплазии тазобедренного сустава (ДТС) у младенцев до шести месяцев и изучить связь

между этой патологией и потенциальными факторами риска. В исследование вошли 120 младенцев в возрасте от новорожденности до 6 месяцев и контрольная группа из 30 здоровых детей. Всем участникам проводились ультразвуковые исследования методом Райнхарда Графа с использованием аппарата Toshiba XARIO-200. Были измерены углы α и β , которые помогают оценить степень развития костного и хрящевого сводов вертлужной впадины. На основе полученных данных ортопедические хирурги рекомендовали соответствующее лечение и контролировали его эффективность. Результаты показали, что у 77,5% детей были обнаружены незрелые тазобедренные суставы (тип II по классификации Графа), среди которых подтипы IIa и IIb различались по возрасту детей и необходимости в ортопедическом вмешательстве. У 16,67% детей была выявлена децентрация головки бедренной кости (тип III), требующая более длительного лечения. У 5,83% детей был диагностирован полный вывих тазобедренного сустава, что требовало тщательного управления и вмешательства. Также был проведен анализ для выявления наиболее значимых факторов риска, учитывая региональные особенности. В ходе анализа учитывались такие факторы, как семейная история заболевания, положение плода в утробе матери, наличие родовых травм и прочие медицинские показатели. Анализ данных позволил выявить, что у детей с отягощенной семейной историей заболевание встречалось чаще, что подчеркивает генетическую предрасположенность к ДТС. Кроме того, дети, рожденные в тазовом предлежании, имели повышенный риск развития дисплазии тазобедренного сустава. Обнаруженные связи между факторами риска и развитием ДТС могут способствовать ранней диагностике и профилактике заболевания, а также улучшению методов лечения. Исследование подчеркивает важность регулярного ультразвукового скрининга у младенцев для своевременного выявления и коррекции дисплазии тазобедренного сустава.

Introduction. Congenital Hip Dysplasia (CHD) is a prevalent condition characterized by a range of severities, from mild underdevelopment of the acetabulum (dysplasia) to complete dislocation of the joint [1,2,5]. Population studies reveal that approximately 75-85% of newborns have normal hip morphology, 13-25% exhibit joint immaturity, and 2-4% have dysplastic hips. The incidence of CHD varies widely due to geographic, genetic, and cultural factors, with prevalence rates ranging from 0.006% in African populations to 7.6% among Native Americans. Typically, dysplasia is the most common presentation, with only about 10% of cases involving complete dislocation, translating to approximately 1 in 1,000 individuals [3,6,9,12].

Hip dysplasia encompasses a variety of developmental abnormalities of the hip joint, differing in their severity. Diagnosis is primarily based on clinical signs detected during a physical examination [4,7,11,13]. In newborns, signs of hip dislocation include palpable instability, asymmetrical leg lengths, and uneven skin folds on the thighs. Older children may present with abnormal gait patterns and restricted hip abduction. Although there is some debate regarding the role of ultrasound, it is widely used to confirm the diagnosis of CHD and to monitor treatment progress [8,10,14,16].

The most effective treatment for infants under six months is bracing. When conservative treatment is ineffective, or when treating this pathology in older children, surgery becomes the preferred approach. Figure 1 illustrates the differences between a healthy hip joint and a dysplastic hip joint. Alongside physical examination, ultrasound remains the preferred imaging technique for screening hip dysplasia in infants under six months, due to its non-invasive nature and high sensitivity [15,17,19].

Additionally, other factors such as family history, breech presentation, and certain cultural practices can influence the likelihood of developing CHD. Understanding these factors is crucial for early detection and intervention, which can significantly improve treatment outcomes [18,20]. Regular ultrasound screenings are advocated for timely identification and management of hip dysplasia, ensuring better long-term health for affected infants.

The objective of this study was to assess the effectiveness of ultrasound sonography in diagnosing various forms of hip dysplasia in infants under six months of age and to investigate the relationship between this condition and potential risk factors. By comprehensively evaluating the diagnostic capabilities of ultrasound technology, this research aimed to provide insights into the early identification and management of hip dysplasia, ultimately contributing to improved clinical outcomes for affected infants.

Materials and research methods. 120 infants from the neonatal period up to 6 months were examined, as well as a control group of 30 healthy children. All subjects underwent ultrasound examinations using the R. Graf method with a Toshiba XARIO-200 machine equipped with a linear probe with a frequency of 2-5 MHz. Additionally, for comparison, some patients underwent radiography.

Results of the Study. The method of Reinhard Graf used in ultrasound examinations includes the measurement of angles α and β . The alpha angle, defined between the baseline and the

Hartofilakidis Classification

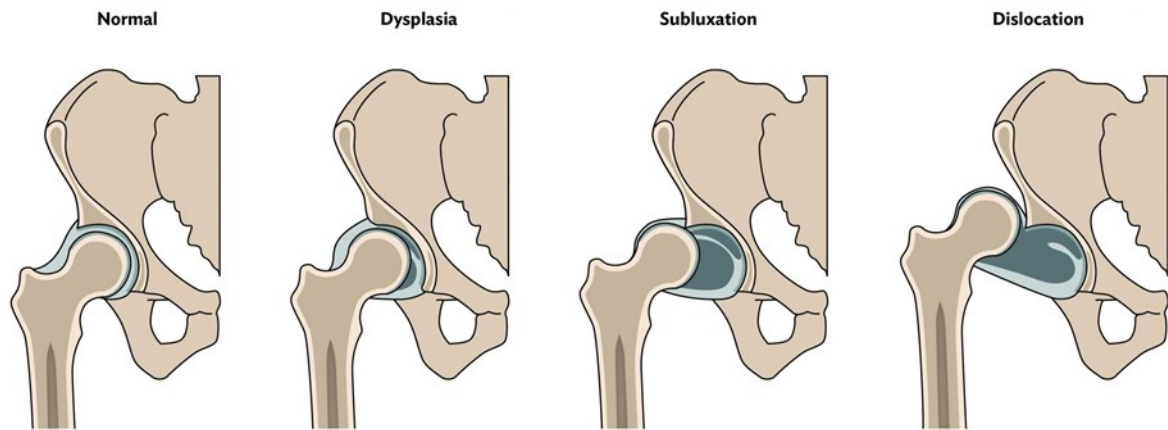


Fig. 1. Hip joint condition: normal, dysplastic, subluxation, severe dysplasia (<https://hipdysplasia.org/adults/diagnosis/>)

bony roof, evaluates the development of the bony acetabular roof. The beta angle, defined between the cartilaginous roof and the baseline, assesses the development of the cartilaginous acetabular zone. A smaller α angle and a larger β angle indicate a higher degree of joint underdevelopment. Ultrasound markers necessary for detecting hip dysplasia on ultrasound sonography are shown in Figure 2.

The conducted study allowed us to classify patients by types and subtypes of dysplasia according to the severity. Special attention was paid to three main groups of patients: children with immature hip joints, those with a decentered femoral head, and those with a complete joint dislocation.

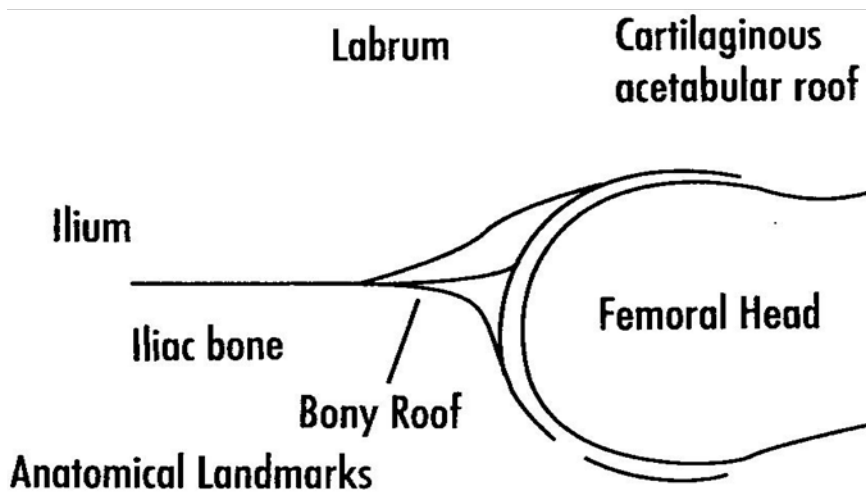
Based on the results of our work, patients were divided into the following groups:

Group 1 - Children with immature hip joints. This category included 93 children, constituting 77.5% of the total number of patients. Ultrasound examinations classified these children as Type II according to Graf's classification. Within this group, two subtypes were identified:

Subtype IIa is characterized by an alpha angle ranging from 59° to 50° , a beta angle ranging from 56° to 77° , and the child's age being up to 3 months. This condition is referred to as "immature joint" and usually does not require active orthopedic intervention. Recommended measures include massage, physiotherapy, and dynamic ultrasound monitoring to promote maturation.

Subtype IIb is characterized by an alpha angle ranging from 59° to 50° , with the child being older than 3 months. Despite similar angle values, the child's age exceeds the permissible period for natural maturation. In such cases, the diagnosis may indicate "mild dysplasia" or "immature joint," requiring orthopedic consultation and the use of special orthopedic devices to stimulate the growth of the acetabular bony roof.

Group 2 - Children with a decentered femoral head. This group included 20 children, constituting 16.67% of the total number of patients. Ultrasound examinations classified these cases as Type III (subluxation) according to Graf's classification, with subtypes A and B. Subtype B required longer



Anatomical Landmarks

Fig. 2. Ultrasonic markers for determining α and β angles. (<http://www.bonepit.com/reference/neonatal%20hip%20ultrasound.htm>)

treatment and fixation due to the need for additional time for the remodeling of cartilaginous tissue before the onset of ossification processes. The alpha angle ranged from 50° to 43°, and the beta angle from 59° to 77°.

Group 3 - Children with a complete hip joint dislocation. Seven children, making up 5.83% of the total number of patients, were classified into this group. Clinically diagnosed with "complete joint dysplasia," precise measurement of alpha and beta angles was difficult due to significant displacement of the femoral head either upwards or downwards relative to the acetabulum. This condition required careful management and intervention.

Based on the results of ultrasound examinations, orthopedic surgeons can recommend appropriate treatment and monitor its effectiveness without exposing the child to radiation. Treatment recommendations for each group range from massage and physiotherapy to specialized orthopedic devices and surgical intervention in cases of complete dislocation.

In the course of the conducted study, various risk factors associated with hip dysplasia in infants were identified. The results showed that 12% of infants had a combination of various risk factors, indicating a multifactorial influence on the development of hip dysplasia. Additionally, 20% of hip dysplasia cases were associated with swaddling, highlighting the importance of infant care practices in joint development.

The study also revealed that 42% of infants with hip dysplasia were female, demonstrating a greater susceptibility of girls to this condition compared to boys. The highest percentage of cases, namely 46%, was observed in infants born in the breech position, emphasizing the significant influence of birth position on hip joint development.

These results are presented in the diagram, illustrating the distribution of risk factors for hip dysplasia in infants.

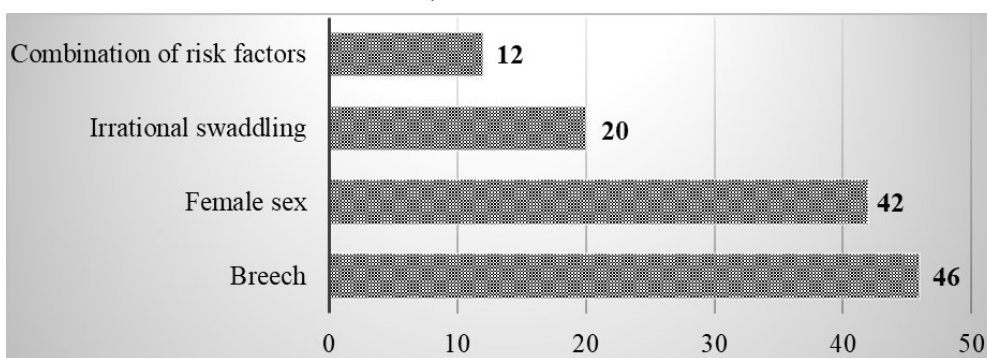
The study emphasizes the advantages of ultrasound diagnostics over traditional radiography: the absence of radiation exposure, the ability for repeat examinations, and high efficiency in early detection of pathology. These factors are particularly important for children aged one to six months, where minimizing exposure and ensuring diagnostic accuracy are key criteria. These results are presented in the diagram, illustrating the distribution of risk factors for hip dysplasia in infants.

Discussion. Summarizing the findings, the relevance of studying the impact of various risk factors on the occurrence of hip dysplasia in infants and the search for reliable, yet accessible, methods for its detection and optimization of therapeutic approaches necessitates further research. The primary structural change identified via ultrasound diagnostics is the variation in the angles α and β , which are crucial in assessing the development of the acetabular roof.

In our study, the frequency of immature hip joints was notable, with 77.5% of the infants falling into this category. This percentage is consistent with other studies, which indicate a high prevalence of hip dysplasia in infants, particularly among females and those born in the breech position. The use of the R. Graf method allowed for precise classification and assessment of the hip joint condition, highlighting the importance of early and accurate diagnosis.

Interestingly, the study also revealed that the prevalence of hip dysplasia was higher in female infants (42%) and those born in the breech position (46%), which aligns with previous research indicating these as significant risk factors. These findings underscore the necessity of targeted screening and intervention strategies for these high-risk groups.

The capabilities of modern ultrasound machines, such as the Toshiba XARIO-200 used in this study, provide detailed anatomical information about the hip joint structure, enabling early detection and monitoring of dysplasia without exposing infants to radiation. The results emphasize the advantages of ultra-



Diag. 1. Distribution of risk factors for hip dysplasia in infants.

sound over traditional radiography, including the absence of radiation exposure, the ability for repeated examinations and higher efficiency in early pathology detection.

The conducted research allowed for the classification of patients by types and subtypes of dysplasia according to the severity. Special attention was given to three main groups: children with immature hip joints, those with a decentered femoral head, and those with a complete joint dislocation. Based on the ultrasound findings, orthopedic surgeons can recommend appropriate treatments and monitor their effectiveness, ranging from massage and physiotherapy to specialized orthopedic devices and surgical interventions in severe cases.

To accurately predict the impact of identified risk factors on hip dysplasia, several questions need to be addressed:

Establishing the relationship between the angles α and β and the overall hip joint development,

Determining the completeness of the acetabular roof, identifying unilateral or bilateral nature of the dysplasia, Exploring the individual anatomical variations in each case.

The integration of these data points can provide a comprehensive prognosis regarding potential causal factors leading to hip dysplasia, facilitating early intervention and improving long-term outcomes for affected infants.

These results are presented in the accompanying diagram, illustrating the distribution of risk factors for hip dysplasia in infants. The study emphasizes the importance of ultrasound diagnostics as an effective, non-invasive method for timely detection and monitoring of hip dysplasia, ultimately aiding in the prevention of long-term complications.

Conclusions. Ultrasound examination of the hip joint is an effective non-invasive method for the timely detection of various degrees of hip dysplasia in young children. The main advantages of this approach include the absence of radiation exposure, speed, non-invasiveness, the ability for repeated examinations, and greater efficiency compared to traditional radiography in children aged infants to 6 months old. Above mentioned increases the likelihood of early detection and the initiation of effective non-surgical treatment.

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