# The Possibilities of Ultrasound in the Diagnosis of Congenital Dysplasia of the Hip Joint

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## Abstract

Hip dysplasia is still the most common pathology in the structure of orthopedic pathology in children, and its diagnosis is difficult, and even with timely diagnosis, treatment does not always bring success, we were faced with the task of optimizing radiation diagnosis of this pathology based on assumptions about the multiple etiological nature of dysplasia.

To solve this problem, we selected 75 children from our ultrasound clinic. There were 52 girls and 23 boys with an average age of 14 weeks.. Based on the ultrasound study, a technique has been developed to assess the degree of maturity of the skeleton. Ultrasonic standards for the structure of the hip joints for children living in the iodine-deficient region have been developed. Ultrasound signs of somatic, orthopedic and neurogenic forms of hip dysplasia were revealed.

***Keywords:*** *Young children, multiple etiological dysplasia, hip joints.*

## Introduction

Congenital hip dislocation remains a topical issue in pediatric orthopedics. Hip joint dysplasia and congenital dislocation of the hip are the most common pathology among all the malformations of the musculoskeletal system that are expected and ranges from 5 to 16 cases per 1000 newborns[1]. The frequency of this pathology according to various authors varies from 3 to 20% (in endemic areas) [2]. In ecologically unfavorable areas, there is an increase in the frequency of this disease compared with the average European level [2].

The late diagnosis of dysplasia and dislocation is associated with poverty and nonspecific clinical symptoms in newborns and children of the first months of life, and untimely treatment, in turn, leads to a significant number of unsatisfactory results [3]. The traditional diagnostic method remains X-ray, recording changes only in bone structures, the number of which in children in the first months of life is relatively small[4]. According to various domestic and foreign authors, an X-ray examination of the hip joints becomes informative at the age of no earlier than 3-5 months of life[5].

Among the many alleged causes of dysplasia are the elderly parents, orthopedic diseases, heredity, bacterial, protozoal and viral diseases of the mother during pregnancy, endocrinopathy, toxicosis of pregnant women, vitamin D deficiency, hormonal changes in the mother, and pelvic delivery of the fetus and some others[6]. In addition, there are few reports in the literature about the effect of perinatal damage to the central nervous system on the formation of the pathology of the hip joint. Neurogenic dysplasia obtained in the experiments of Ratner AY et al. [7] and his staff described, however, the study of radiation signs of neurogenic dysplasia of the hip joint in children was not conducted.

For a long time, the diagnosis of dysplasia and

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dislocation of the hip joints was made on the basis of an examination by an orthopedist and the results of an X-ray examination[8]. However, the use of radiography up to 3 months of age is associated with an unjustified risk of exposure to the child, and the interpretation of radiographs is difficult due to the predominance of cartilage in the elements of the child's hip joint[9]. Therefore, indications for x-ray examination are limited. In recent years, due to the widespread introduction of ultrasound in pediatrics, the situation has changed. This method allows you to visualize soft tissue and cartilage components, there is no radiation exposure and the need for special preparation of the patient. The possibility of using the method as a screening and for dynamic control during therapy is also important[10].

The fundamental work of R. Graf in 1978, which served as the basis for the development of orthopedic ultrasound diagnostics in pediatrics, contains a number of diagnostic method and schemes that can reliably diagnose various degrees of dysplasia and dislocation[11]. However, this work and research by a number of late authors are devoted exclusively to the orthopedic problem and do not contain data on the possibility of a multi-etiological lesion of the joint and their radiation diagnosis[12].

The above arguments determined the purpose of our study, which was to develop ultrasound criteria for diagnosing the results of etiology-related disorders in the formation of hip joints - dysplasia - in children of the first year of life[13].

The aim of the study was to determine the significance of early ultrasonographic diagnosis of congenital hip dysplasia in children.

## Materials and Method

We selected 75 children from our ultrasound clinic. There were 52 girls and 23 boys with an average age of 14 weeks (2 to 40). Everyone had a standard assessment with a history and physical examination. Ultrasonography of both hips using a 5 MHz linear sensor of the Siemens Sonoline 1 apparatus (Siemens, Erlangen, Germany) was performed by a pediatric orthopedic surgeon, who then classified the hips according to the Graf method and made recommendations for treatment. After obtaining parental consent, the babies then underwent a second ultrasound from another examiner who did not have a history and physical examination and did not see the first record. Thus, a total of 150 hips were examined, each of which had two ultrasound scans (300 strips in hard copy).

For ultrasound examination of the hip and hip joints, we used the method of R. Graf. In total, including control, 1640 ultrasound examinations were performed. The child was laid on its side, the leg was bent at an angle of 20-30° in the hip joint, which made it possible to obtain a better oblique section.

Since there is no lumbar lordosis in newborns, the optimal scan was when the scan plane (linear sensor) was parallel to the lumbar spine in the projection of the greater trochanter of the femur. Moving the sensor posteriorly allowed us to obtain an image of a mid-section of the femoral head, which has the form of a spherical formation of reduced echogenicity and fine-grained texture.

Normally, the femoral head was centered on a Y-shaped cartilage. The bony part of the roof was visualized at a slight angle to the horizontal line, the cartilaginous part (limbus) was determined as a hyperechoic strip covering the femoral head. The main center line was drawn along the horizontally located edge of the ilium, parallel to it, which corresponded to the center of the acetabulum. The bone bottom line was drawn through the bone protrusion and the Y-shaped cartilage, thus obtaining the angle alpha - the angle of inclination of the bone roof of the acetabulum. The cartilaginous roof line was drawn through the bony protrusion along the base of the limbus and received a beta angle - the angle of inclination of the cartilaginous roof of the acetabulum. The magnitude of these angles and the degree of ossification of the femoral head judged the maturity and anatomical usefulness of the joint.

## Results

Indications for ultrasound examination are: symptoms of "click" and "slip" in the first week of life; hip abduction restriction; asymmetry of the gluteal folds; shortening of the leg; violation of hip rotation; birth in the buttock; increased muscle tone in the lower extremities; the presence of pathology of the hip joints in close relatives.

Normally, the joint head is centered in the acetabular cavity. The bony part of the roof is visualized almost horizontally, the cartilaginous part (limbus) is defined as a hyperechoic strip covering the head of the joint. The main line is drawn along the edge of the ilium, parallel to

it, through the center of the acetabulum. The bony roof line runs through the bony protrusion and the U-shaped cartilage and forms an angle alpha. The cartilaginous roof line is drawn through the bony protrusion at the base of the limbus and forms the angle of the betta.

## Discussions

According to the results of ultrasound, 72.41% of children were diagnosed with types 1a and 1b of the hip joints (according to G. Reingard). Clinically and sonographically, types 1a and 1b correspond to the age of the child - these are healthy joints. The bony part of the acetabulum is well defined, the bone bay window is slightly flattened or rectangular, the cartilaginous part of the roof covers the head of the femur, the bone-cartilage ratio is greater than or equal to 2/3. The angle α is greater than or equal to 60°. Angle β less than 55° - type 1a; angle β is greater than 55° - type 1b.

Type 2a of the hip joints was diagnosed in 11.6% of children. This is a variant of the physiological delay in the development of hip joints in children under 12 weeks of age, at which the angle α is less than 59°, but more than 50°, respectively, the angle β is more than 60°.

Type 2b of hip joints was detected in 6.33% of children - hip dysplasia in children older than 3 months. The bone acetabulum is underdeveloped, the bone bay window is rounded, the bone-cartilage ratio is less than 2/3, the cartilaginous part of the roof covers the head of the femur. Angle α is less than 59°, but greater than 50°, angle β is greater than 60°.

Type 2c of the hip joints was found in 0.51% of children. This is a variant of severe dysplasia at any age. All components of the joint are underdeveloped. The bony part of the acetabulum is flattened, the bone bay window is rounded or flat, the cartilaginous part of the acetabulum is expanded, but still covers the femoral head. Angle α is less than 49°, but greater than 43°, angle β is greater than 65°, but less than 72°. This type of joint, without appropriate treatment, entails a progressive decentration of the femoral head.

In 0.25% of the child, type 3a of the hip joint was revealed - congenital dislocation of the hip. The bony part of the acetabulum and the bay window are flat, the cartilaginous part of the acetabulum is displaced cranially, since the femoral head cannot be fixed in the acetabulum, its decentration occurs. The structure of the cartilaginous part of the roof is not changed. The angle α is less than 43°.

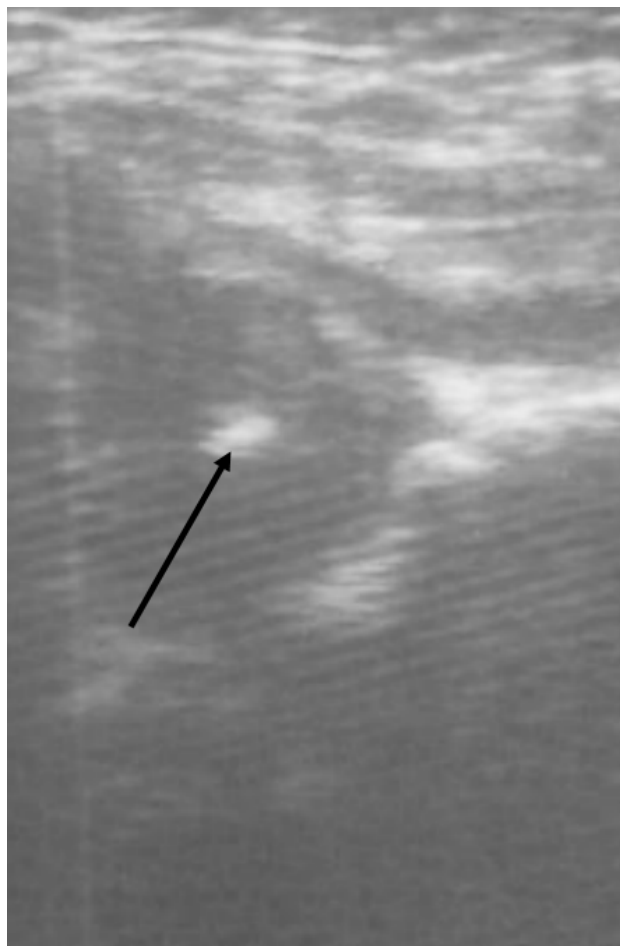

**Fig. 1. Ultrasound image of the unchanged hip joint of a child of three months of life.**

**Note:** The angle of inclination of the bone roof of the acetabulum α=68°; the angle of inclination of the cartilaginous roof to the trochanter of the female cavity is β=54°. The arrow shows the core of the ossification of the femoral head.

All children with identified pathology were referred for consultation with an orthopedic surgeon.

As a result, 70% of children with timely diagnosed pathology after the treatment have healthy joints of the first type, 30% of children with preserved pathology were sent for a second course of therapy.

Clinical screening for congenital hip dysplasia during the first year of life is considered a reliable strategy for reducing the incidence of dysplasia with a late diagnosis or hip dislocation, but only clinical screening sometimes leads to late diagnosis. Thus, ultrasound screening was used to further reduce the frequency of late diagnosis. Most ultrasound screening method for congenital hip dysplasia are based on a combination of static morphological assessment and dynamic stability assessment. The combination of universal clinical

screening and selective ultrasound screening is widely used throughout the world. Although it is logical to assume that selective ultrasound screening of high-risk patients should reduce the late diagnosis of congenital hip dysplasia, available studies have not confirmed this assumption. Further studies are needed to elucidate the role of ultrasound in screening for congenital dysplasia of the hip joint.

We have developed and patented an ultrasonic technique for determining the degree of maturity of the bone skeleton by means of the ossification of nuclei of ossification of the capitate and hooked bones of the wrist, which should be visible in a child aged 2 months. If a child over two months of age displays the indicated ossification nuclei and nuclei of the femoral heads, then this condition, with all other normal parameters, is estimated as the age norm (Fig. 1)

If the nuclei of ossification of the bones of the wrists were visualized, and the nuclei of the heads of the femurs were not detected, this condition was defined as a local violation of ossification in the area of the hip joints and a sign of somatic dysplasia of the hip-joint. If the nuclei of ossification were absent either in the carpal bones or in the heads of the femur, then a conclusion was drawn about a systemic slowdown in the ossification of the skeleton. It is these children, that is, those who suffered from local and systemic disorders of ossification and who had clinical signs of hip joint pathology, made up the II (1) group with somatic dysplasia.

Children suffering from somatic dysplasia of the hip joints, in 80.88% of cases had minor changes in the angles α and β, but without going into a state of subluxation and dislocation. This, in our opinion, is of great importance for the following treatment, since in such children, vitamin-D prophylaxis and treatment of rickets or rickets-like disease are primarily needed. The close attention of the pediatrician and the correction of somatic pathology leads to a complete restoration of the joint structure within 2 months after the start of treatment. Subsequently, during follow-up observation, these children were assigned to a group that did not have an uropathic pathology. Consequently, infants suffering from somatic dysplasia do not need to use fixing orthopedic devices, which in this case bring unconditional harm!

## Conclusions

The study confirms the need for ultrasound of the hip joints for children under 6 months of age on an outpatient basis, avoiding unjustified radiation exposure. Using the information obtained makes it possible to conduct corrective therapy in a timely manner for all types of hip joints in the early period, followed by their correct formation.

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