

Neonatal screening for developmental dysplasia of the hip on the maternity wards in Crete, Greece. Correlation to risk factors

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Summary

Objective: To evaluate the effects of ultrasound examination of newborns in early detection and management of developmental dysplasia of the hip (DDH), and its correlation to known risk factors. The incidence of DDH in newborns throughout the general population of Crete has also been investigated.

Methods: From 1996 to 2000, 6,140 full-term newborns were examined in the Maternity Department of the University Hospital. All received standard assessments, with their medical history recorded, and a physical examination performed on the first and the fifth postpartum days. Ultrasonography of both hips using the Graf technique was performed on the 15th day after birth on both high-risk newborns and those with any clinical suspicion of DDH. Treatment was initiated according to the Graf classification.

Results: Ultrasound examination was performed on 220 newborns (3.58%). Ultrasound findings were positive in 65 neonates (10.83 per 1,000). Twenty-one neonates whose clinical examination was normal, but who underwent ultrasound because of the presence of risk factors had pathological findings on the hip sonography (32.30%).

Conclusion: The incidence of DDH in Crete is estimated to be 10.83 per 1,000; higher than in the rest of Greece. Medical and family histories and clinical examination play an important role in the diagnosis of hip instability. Selective ultrasonography for all infants with risk factors, and those with clinical abnormality of the hip, is an adjunctive tool which aids early diagnosis and offers higher control in the results of treatment.

Key words: Ultrasonography; Developmental dysplasia of the hip; Risk factors.

Introduction

Developmental dysplasia of the hip describes a developmental condition of progressive deformation of the hip, in which the proximal femur, the acetabulum, and the capsule are defective. Developmental dysplasia of the hip (DDH) falls into two major categories: a) typical, which occurs in otherwise normal infants, and b) teratologic, which is associated with other severe malformations such as chromosomal abnormalities, and myelomeningocele. Typical DDH can occur in utero, at birth, or after birth. It is subdivided into three types: subluxation, dislocatable, dislocation.

The etiology is multifactorial; intrauterine malposture, acetabular antetorsion, excessive femoral antetorsion, and ligamentous hyperlaxity. The risk factors for the presence of DDH are: 1) a positive family history, 2) the patient is first-born and female, 3) a breech presentation in utero or at birth, 4) associated malformation (congenital talipes equinovarus, metatarsus primus varus), and 5) a twin or multiple pregnancy [1].

The aim of screening newborn infants for developmental dysplasia of the hip is the early detection of DDH before the hip has stabilised in a dislocated position. Clinical examinations fails to diagnose at birth all patients with significant abnormality of the hip, therefore a method of diagnosis which includes something more than clinical acumen is still required.

The aim of this prospective study was to evaluate the effects of ultrasound examination of the newborns in early detection and appropriate therapeutic intervention of DDH, especially in cases with normal clinical examinations and known risk factors. The incidence of DDH in newborns throughout the general population of Crete was also investigated.

Materials and Methods

Between January 1996 and January 2000, 6,140 full-term newborns were examined in the Maternity Clinic at the University Hospital; 3,347 were females and 2,793 were males. We followed a program of ultrasonographic assessment of the hip in addition to clinical examination for all newborns with a clinical abnormality of the hip and those with risk factors. The routine neonatal examination was performed by two experienced pediatricians. Newborns with teratologic hips, severe congenital malformations, and neurological diseases were excluded from the study. A standard assessment was carried out, including a medical history and physical examination on the first and fifth postpartum days. The protocol for this study recorded the family history of the neonate, any problems during pregnancy, and other relevant risk factors. Physical examination included Ortolani and Barlow tests, asymmetry of inguinal folds, and limited hip abduction.

Hips of newborns with signs of dislocation were classified into three types: 1) the subluxatable hip, in which the femoral head can be partially displaced from the acetabulum, 2) the dislocatable hip, in which the femoral head is still located in the acetabulum but can be easily displaced outside (Barlow test

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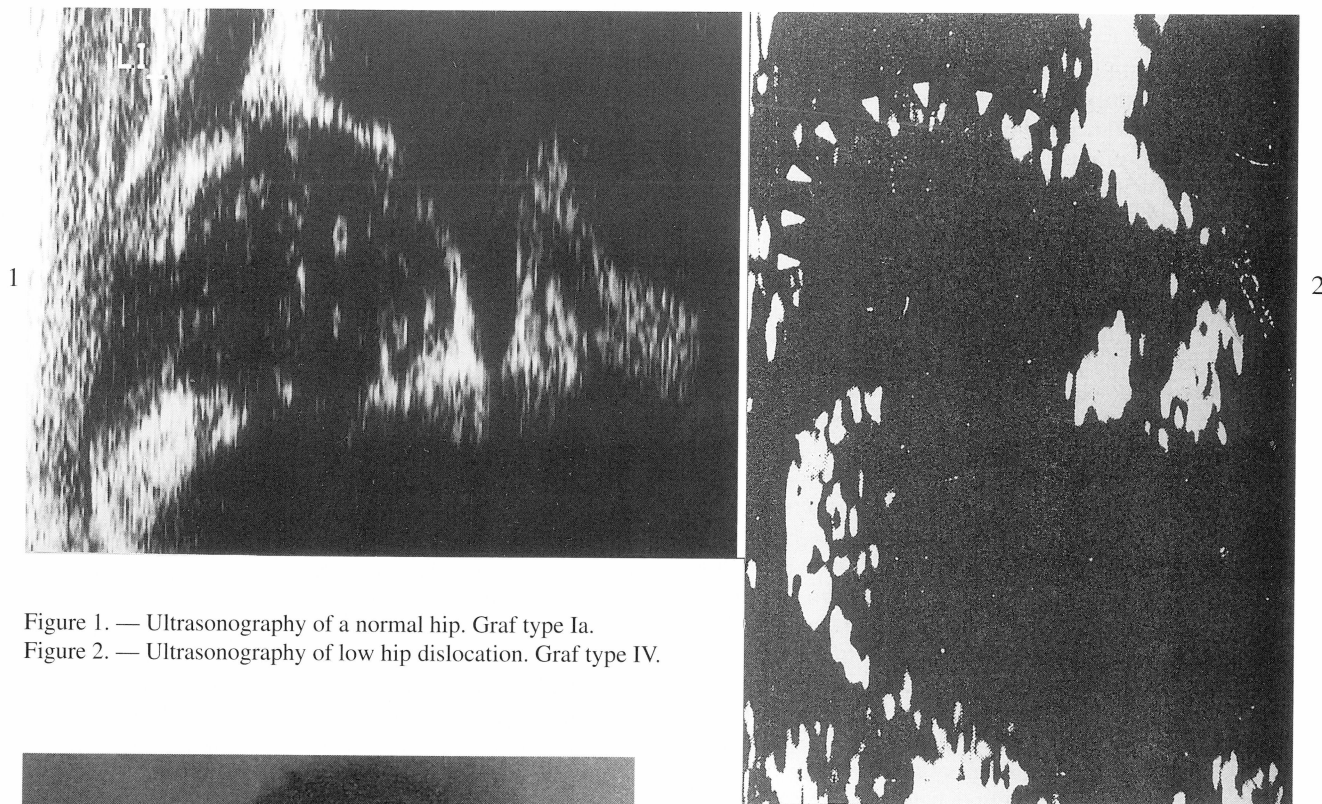


Figure 1. — Ultrasonography of a normal hip. Graf type Ia.

Figure 2. — Ultrasonography of low hip dislocation. Graf type IV.

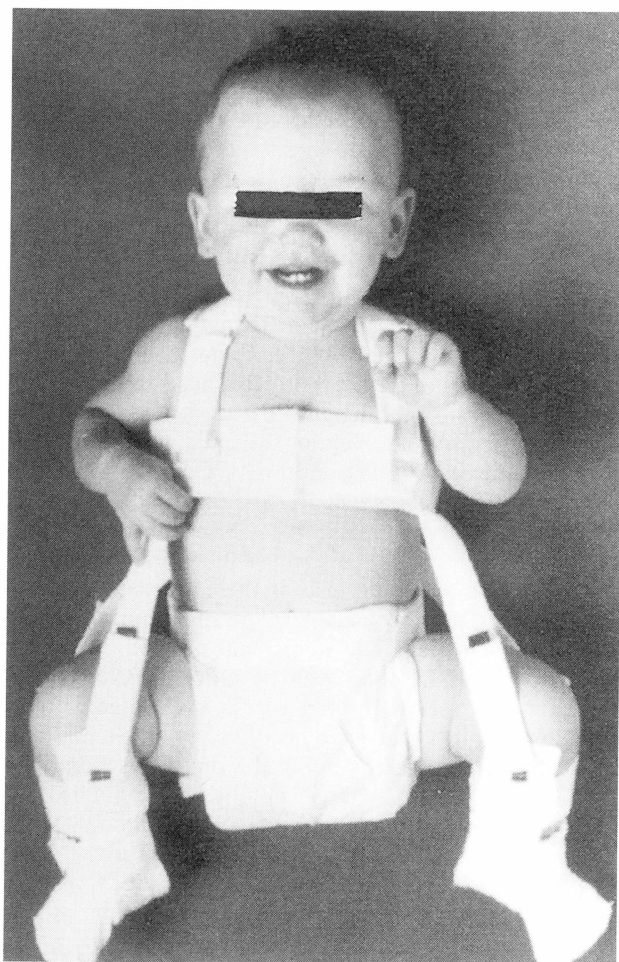


Figure 3. — Newborn treated with a Pavlik harness.

positive), and 3) the dislocated hip, in which the femoral head is found to be completely outside the acetabulum (Ortolani test positive).

Newborns with risk factors or clinical signs of DDH were re-examined by an orthopaedic surgeon specialized in children's orthopaedics and immediate treatment was initiated.

Selective ultrasonography of both hips was performed in all neonates with a positive clinical examination or with specific risk factors, on the 15th postpartum day. Graf's static technique was performed with the infant in the lateral decubitus position, and the hip at 35° of flexion and 100° of internal rotation. A Siemens linear scanner with a 7.5 MHz transducer was placed over the great trochanter of the hip. A coronal image of the hip was obtained and three lines were constructed from the image. The two angles which form the alpha angle of the bony acetabular roof, and the beta angle of the cartilaginous acetabular roof were measured, and hip stability could be estimated [2].

Treatment was based on the Graf classification. Grade Ia and Ib hips were considered normal and they were not re-examined (Figure 1). Grade 2a were still immature and were re-examined four weeks later, both clinically and ultrasonically. No further treatment and no follow-up was required in these cases. Hips grade 2a(-) (delayed ossification age < 3 months), 2b (delayed ossification age > 3 months), and 2c (concentric position with very deficient acetabulum) were treated using an abduction pillow for a three-month period [3]. Hips grade 2d (hip subluxation), 3a, 3b (low hip dislocation), (Figure 2), were treated using a Pavlik harness for a six-month period (Figure 3) [4]. Hips grade 4 (high hip dislocation) was treated with close reduction. Follow-up examinations to monitor the progress of treatment were carried out: at one week, six weeks, three months and six months. An anteroposterior X-ray check, with the hips in a neutral position, was performed at 12 and 24 months. The mean follow-up period was 25 months (range 12 to 38).

Results

Of the birth study group (6140 neonates), 220 (3.58%) underwent ultrasound examination because they had pathological clinical findings, or at least one risk factor. Of these, 110 infants (1.79%) showed clinical signs of dislocation; 155 (2.52%) had indications of one risk factor, and 45 had both (0.73%).

Sixty-five of the 6,140 newborns (10.58 per thousand) showed abnormal results on ultrasound examination. Of the 65 infants with abnormal ultrasound results, 54 were females and 11 males; a ratio of 4.9:1. There was therefore a female preponderance. DDH was present in the left hip in 40 neonates (61.53%); 15 were affected in the right hip (23.07%), and ten were affected in both hips (15.38%).

Clinical examinations for DDH were positive in 44 of the 65 newborns with pathological findings at ultrasound screening (67.69%). Risk factors were present in 43 of the 65 neonates (66.15%). Twenty-one neonates whose clinical examination was normal, but who underwent ultrasound because of risk factors, had pathological findings on hip sonography (32.30%) (Table 1). In those newborns whose ultrasound examination revealed abnormal findings, a positive family history of DDH was considered the most common risk factor (35.38%) (Table 2).

Of the group with normal scans, ten neonates had immature hips (grade 2a) and were re-examined clinically

and by ultrasound after four weeks, and no treatment was needed. None of the neonates with initially normal scans went on to develop DDH. Of the babies in the group with abnormal-scans, 43 treated with abduction pillows appeared normal after three months of treatment. Twenty out of the 22 neonates treated with the Pavlik harness appeared normal after 7.5 months (range 6 to 9). Two newborns (3.07%) with hip dislocation (grade 4 Graf classification) were treated with closed reduction (Table 3).

No complications were recorded and no patient showed any further problems by the time they were walking.

Discussion

The acronym congenital dysplasia of the hip (CDH) has been used to describe the term congenital dislocation of the hip. It is known that a dislocated hip is a physical sign, not a diagnosis, and the term 'congenital' means present at birth. The correct term that should be used is developmental dysplasia of the hip (DDH), because the word 'developmental', acknowledges that the dysplasia may occur at any time before or after birth. Dysplasia, as a term, means an abnormality in development and encompasses a wide spectrum of hip problems.

The incidence of DDH in Europe is 1-3 per 1,000 births, and in Greece it is seven per 1,000 births [5]. Our study was conducted over a small geographical area, the island of Crete, which is ethnically homogeneous with 700,000 inhabitants and where the incidence of DDH is higher than that in the rest of Greece.

The etiology of DDH is unknown, but it may be genetically determined or it may co-exist with a congenital ligamentous laxity. Risk factors should be always be recorded in the medical history.

There is general agreement that a more successful outcome could be achieved by early detections of congenital dislocations of the hip. Early diagnosis is very important in decreasing the length of treatment and possibly avoiding operative intervention. Late diagnosis also leads to structural deformities, such as acetabular dysplasia, augmented femoral anteversion and soft tissue contractures, which make treatment difficult and of longer duration [6, 7].

The aim of screening tests is the early detection and treatment of DDH. A diagnostic screening model has not yet been identified. The traditional method of routine screening for DDH has been by clinical examination. Ortolani and Barlow introduced clinical screening tests for hip instability that have been widely adopted. These clinical indicators are useful in the first three months of a newborn's life. After three months of age, limited hip abduction and asymmetrical inguinal folds are important clinical signs in the diagnosis of DDH [8]. These clinical tests are specific (100%), but their sensitivity (probably less than 60%) depends on the experience of the examiner [9]. The detection of those neonates with DDH which is not apparent on clinical examination, is therefore of great importance.

Table 1. — *The distribution of positive risk factors and positive clinical examinations of sonographic pathological hips.*

	Abnormal ultrasound examination (n = 65)	%
Positive clinical examination	22	33.84
Positive risk factors	21	32.30
Both positive	22	33.84

Table 2. — *Distribution of DDH risk factors of sonographic pathological hips.*

Risk Factors	Newborn number (n = 65)	%
Family history	23	35.38
Breech delivery	12	18.46
Congenital deformities	4	6.15
First born female	10	15.38
Twin delivery	1	1.53

Table 3. — *Patient distribution according to the Graf classification and the type of treatment.*

Graf classification	Number of patients	Type of treatment
1a, 1b	145	None
2a +	10	Re-examination after 4 weeks.
2a -	15	Abduction pillow
2b	10	Abduction pillow
2c	18	Abduction pillow
2d	15	Pavlik harness
3a, 3b	5	Pavlik harness
4	2	Closed reduction

In 1980 Graf developed the idea of using ultrasound to study the neonatal hip [10]. Since then ultrasound has been used in DDH diagnosis, follow-up examinations, and to monitor the results of treatment. The two methods currently in use are: a) the Graf static technique [10], and b) the Harcke dynamic stress technique [11]. The ideal time for ultrasound screening is on the 15th day of life because many previously unstable hips have stabilised by then [12]. The advantages of ultrasound examination are its accuracy, safety, and ability to detect abnormalities not apparent on physical examination. However, although it is highly sensitive it also has some deficiencies. The disadvantages of ultrasound screening include: a) it is operator-dependent; b) because of its high sensitivity it can give a false-positive examination, and overtreatment may occur; c) after six months of age the acetabular roof can not be detected because of the presence of the secondary ossification center of the proximal femur [13].

With regards to X-rays, the anteroposterior pelvis X-ray is difficult to interpret during the neonatal period because the femoral head and much of the neonatal pelvis are cartilaginous, making the neonatal pelvis difficult to define. Other disadvantages of X-rays are that, in positioning the newborn for the radiograph, the dislocated hip may be reduced spontaneously, producing a normal radiograph result. Also, if the neonate is not positioned correctly, asymmetry is introduced which makes interpretation difficult [14].

Therefore ultrasonography is a sensitive test for detection of DDH and has gained wider acceptance. Opinion is divided however, among those supporting universal ultrasound screening and those who support selective use. In Austria and Germany all children are now screened ultrasonically at birth. Other reports have suggested that ultrasound should not be performed as a general screening procedure in clinically healthy newborns [15, 16]. The disadvantages of universal ultrasound screening are the cost and neonate suffering [17]. The occurrence of avascular necrosis of the femoral head after abduction splinting, in an otherwise normal child, constitutes a major hazard of ultrasound screening. Also, a routine ultrasound screening program may result in overdiagnosis and overtreatment.

In the current study ultrasound examination was performed on neonates with at least one risk factor or a pathological result on clinical examination (220 hips of 6,140 newborns, 3.58%). Of these infants, 65 had abnormal hip ultrasounds requiring treatment. Twenty-one neonates with pathological findings at ultrasound were undetected during clinical examination and were identified from the 'at-risk' screening program (32.30%). The results show clearly that if ultrasound screening is applied only to clinically pathological cases, then a significant number of affected neonates will remain unidentified. The presence of risk factors leads to further sonographic examination of the neonates with negative clinical examinations, detection of the pathological conditions and early treatment. According to the study design, routine ultrasound screening of at-risk groups in the neonatal period results in a higher rate of detection of DDH.

We also studied some previously mentioned risk factors and found that the most frequent was a positive family history (35.38%). This finding may explain the high incidence of DDH on our island, estimated to be 10.58 per 1,000; higher than the rest of Greece.

Effectiveness of treatment should be monitored by clinical and ultrasound examination. Follow-up must be done frequently, at four weeks, three months, six months, 12 months, and until hip stability has been established. Newborns with severely dysplastic hips (Graf types 2d, 3a, and 3b), who are treated using a Pavlik harness, should be re-examined after one week because of possible femoral or brachial nerve palsy, anterior or inferior hip dislocation, and medial knee instability [18]. The hips of newborns who undergo sustained closed reduction (Graf 4), should be re-examined radiologically [19]. In the current study, no complications were recorded and successful treatment was achieved.

Physicians must realise that a normal clinical examination does not exclude DDH, and when there is high suspicion of hip dysplasia, or at least one risk factor present, newborns should be screened ultrasonically on the 15th day of life; and where abnormality is found, treatment must be initiated immediately. In our study 32.30% of the abnormal hips which were shown on ultrasound, were not detected on clinical examination.

In conclusion, we recommend that all newborns should continue to be screened, with a careful clinical examination performed by experienced clinicians. Selective ultrasonographic assessment of the hip, in addition to clinical examination for all infants with known risk factors, and those with a clinical abnormality of the hip would lead to improved diagnosis and treatment of DDH.

References

- [1] Tachdjian M. O. "Developmental dysplasia of the hip". In: Tachdjian M. O. *Clinical Pediatric Orthopedics. The Art of Diagnosis and Principles of Management*. USA, Appleton & Lange Co, 1996, 168.
- [2] Graf R. "Hip sonography-how reliable? Sector scanning versus linear scanning? Dynamic versus static examination?" *Clin. Orthop.*, 1992, 281, 18.
- [3] Pavlik A. "The functional method of treatment using a harness with stirrups as the primary method of conservative therapy for infants with congenital dislocation of the hip. 1957". *Clin. Orthop.*, 1992, 281, 4.
- [4] Harris I. E., Dickens R., Menelaus M. B. "Use of the Pavlik harness for hip displacements. When to abandon treatment". *Clin. Orthop.*, 1992, 281, 29.
- [5] Simeonidis P. P. "Congenital hip dislocation or developmental hip dysplasia". In: Simeonidis PP *Orthopaedics*, second edition. Thessaloniki, University Studio Press, 1996, 383.
- [6] Aronsson D. D., Goldberg M. J., Kling T. F. Jr., Roy D. R. "Developmental dysplasia of the hip". *Pediatrics*, 1994, 94, 2, 201.
- [7] Clarke N. M., Clegg J., Al-Chalabi A. N. "Ultrasound screening of hips at risk for CDH. Failure to reduce the incidence of late cases". *J. Bone Joint Surg. Br.*, 1989, 71, 1, 9.
- [8] Herring J. A. "Conservative treatment of congenital dislocation of the hip in the newborn and infant". *Clin. Orthop.*, 1992, 281, 41.
- [9] Jones D. "Neonatal detection of developmental dysplasia of the hip (DDH)". *J. Bone Joint Surg. Br.*, 1998, 80, 6, 943.
- [10] Graf R. "The diagnosis of congenital hip-joint dislocation by the ultrasonic compound treatment". *Arch. Orthop. Trauma Surg.*, 1980, 97, 2, 117.

- [11] Harcke H. T. "Imaging in congenital dislocation and dysplasia of the hip". *Clin. Orthop.*, 1992, 281, 22.
- [12] Tonnis D., Storch K., Ulbrich H. "Results of newborn screening for CDH with and without sonography and correlation of risk factors". *J. Pediatr. Orthop.*, 1990, 10, 2, 145.
- [13] Bar-On E., Meyer S., Harari G., Porat S. "Ultrasonography of the hip in developmental hip dysplasia". *J. Bone Joint Surg. Br.*, 1998, 80, 2, 321.
- [14] Weinstein S. L. "Congenital hip dislocation. Long range problems, residual signs, and symptoms after successful treatment". *Clin. Orthop.*, 1992, 281, 69.
- [15] Castelein R. M., Sauter A. J., de Vlieger M., van Linge B. "Natural history of ultrasound hip abnormalities in clinically normal newborns". *J. Pediatr. Orthop.*, 1992, 12, 4, 423.
- [16] Rosendahl K., Markestad T., Lie R. T. "Ultrasound screening for developmental dysplasia of the hip in the neonate: the effect on treatment rate and prevalence of late cases". *Pediatrics*, 1994, 94, 1, 47.
- [17] Tredwell S. J. "Neonatal screening for hip joint instability. Its clinical and economic relevance". *Clin. Orthop.*, 1992, 281, 63.
- [18] Song K. M., Lapinsky A. "Determination of hip position in the Pavlik harness". *J. Pediatr. Orthop.*, 2000, 20, 3, 317.
- [19] Malvitz T. A., Weinstein S. L. "Closed reduction for congenital dysplasia of the hip. Functional and radiographic results after an average of thirty years". *J. Bone J. Surg. Am.*, 1994, 76, 12, 1777.

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