Evaluation of risk factors in developmental dysplasia of the hip: results of infantile hip ultrasonography

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In this study, risk factors of developmental dysplasia of the hip (DDH) were evaluated. History, clinical examination and risk factors for DDH of the babies were recorded. The hips were evaluated with ultrasonography. Infantile hip ultrasonography is one of the best methods for screening of DDH. Ultrasonography is easy, repeatable and provides visualization of the cartilage part of the hip joint. Graf's method of infantile hip ultrasonography was used to evaluate the hip in this study. Both hips of 371 babies and 32 unilateral hips of 32 babies were included in the study. In 403 babies, 14 (3.4%) had DDH. There were 5 type IIB, 7 type IIC, 1 type D, and 1 type IV hips. Physiological immaturity was present in 81 hips (19% of babies). According to risk factor analysis, the only risk factor in unilateral analysis was presence of oligohydramnios (odd ratio-OR: 11.8, confidence interval-CI: 2.7-52.7). In correlation analysis, there was a correlation between female gender and swaddling. There was overall increase in DDH in female babies who were swaddled compared to those who were not. The results of this study showed that the most important risk factor was oligohydramnios for DDH. Swaddling and female gender increased the risk of the disease, but further studies in larger series are necessary for the confirmation of these results.

Key words: hip dysplasia, infantile hip ultrasonography.

Developmental dysplasia of the hip (DDH) is a wide spectrum disease with multifactorial etiology. The inability of the acetabulum to keep the femur head in its appropriate position due to joint capsule laxity ultimately causes DDH, whatever the etiology. The disease presents itself in the newborn period either as total or subluxation of the hip[1]. Since its first description by Gullaume Duputyren in 1832, it is a disease which today affects the newborn population with incidences ranging between 0.1 to 3.4% according to racial, geographic and socioeconomic differences[2].

Hip ultrasonography was reported to be useful in the diagnosis of DDH by Graf et al.[3]. This is a very effective method for screening of DDH. DDH is still frequently encountered in our country, where traditional methods like swaddling are not rare in the newborn period. Hence, the aim of this study was to evaluate results of 500 consecutive patients' hip ultrasonography and the relation to etiological factors so that a strategy for diagnosis and follow-up in the Turkish population can be documented.

Material and Methods

Patients

The first 497 consecutive patients who underwent hip ultrasonography were included in the study, and their hips were evaluated with Graf's method[4]. Patients born in our hospital were evaluated and recorded by a pediatrician in the newborn unit and hip examination of these patients was repeated before ultrasonography by the orthopedic surgeon. All other patients were evaluated and recorded (if not previously) before ultrasonography by an orthopedic

surgeon. Age (weeks), sex, gestational history (primiparity, presence of oligohydramnios), birth presentation (head, breech or transverse), birth weight, history of swaddling, presence of foot deformity, torticollis, brachial plexus palsy, family history of DDH, and physical examination results (Ortolani test, Barlow test, Galeazzi sign, restriction in abduction, asymmetry of thigh folds and gluteal creases) were all recorded. Any suspicious data were confirmed by telephone.

Patients who had one or more risk factors and had a normal ultrasonography were invited for a second physical examination and ultrasonography six months after the first sonographic examination.

Ultrasonographic Evaluation

All ultrasonographic evaluations were performed according to the method described by Graf elsewhere[4]. Toshiba® EUD-415 was used with 7.5 MHz probe for newborns and 5 MHz probe for infants. According to Graf, hips are divided into four groups according to their appearance and measured angles in ultrasonography. α (alpha angle) is analogous to acetabular index and β (beta angle) represents the cartilaginous roof of the acetabulum. Ultrasonographic evaluation of the hips was performed by the residents and supervised by a pediatric orthopedic surgeon.

Type I hip: The mature hip. Bone socket sufficiently developed. Bone edge is open. Cartilage acetabular roof surrounds the femoral head and holds it in the socket.

Type II hip: Development of acetabular bone roof is not sufficient. Bone edge is round.

Cartilage part includes a greater part of acetabular roof but femoral head is still in the socket.

Type II hips are divided into three subgroups according to ultrasonography.

Type IIa hip: Physiologically immature hip.

Type IIb hip: These hips do not gain physiologic maturity after three months. It describes a dysplastic hip.

Type D: Decentered hips.

Type III hip: The hip is dislocated. Bone socket development is insufficient. Bone edge is flattened. The cartilage acetabulum roof is pushed cranially. It has two subgroups.

Type IIIa hip: Femoral head displaces the acetabular roof cranially but there is no change in hyaline cartilage, because of which it is hypoechoic.

Type IIIb hip: There is histological change in cartilage roof as evidenced by echoes on ultrasonography.

Type IV hip: The joint is dislocated. Cartilage roof is pushed cranially because of the dislocated femoral head. The echo of perichondrium is narrower and placed horizontally. Cartilage roof is squeezed between femoral head and bone roof towards the original acetabulum[4-7] (Fig. 1, Table I).

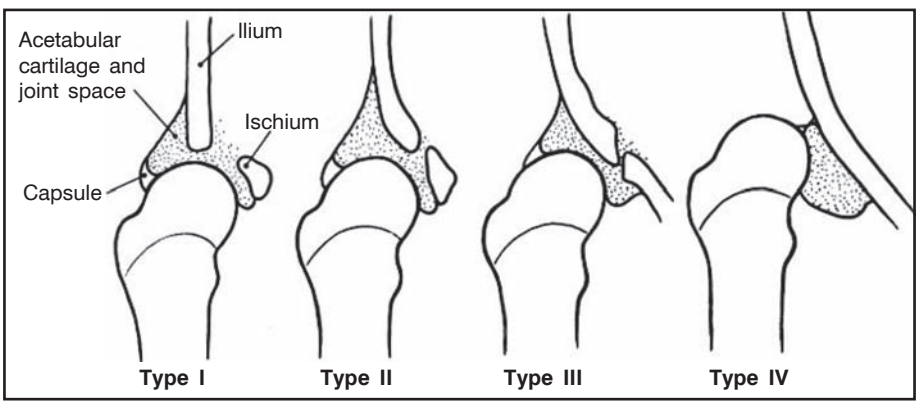

Fig. 1. Morphologic appearance of hip types according to Graf.

Table I. Hip Types According to Graf and Gross Description

Type	α Angle	β Angle	Description
I	>60°	<55°	Mature
IIa	50°-60°	55°-77°	Physiologic immaturity (<3 mos)
IIb	50°-60°	55°-77°	Delayed maturity (>3 mos)
IIc	43°-49°	<77°	Severe dysplasia
D	43°-49°	>77°	Unstable, decentered
III	<43° or not measurable	>77° or not measurable	Dislocated
IV	Not measurable	Not measurable	Dislocated

From ultrasonographs, a printout of the best position for each hip is obtained. All the printouts were scanned at 300 dpi gray scale resolutions and transferred to digital format for analysis. Each ultrasonographic appearance was re-evaluated according to suitability to Graf's ultrasonographic criteria[4]. Presence of smooth vertical iliac spine ending with superior bone edge of acetabulum, cartilage acetabular edge ending with labrum, and inferior iliac edge were the three criteria considered necessary for evaluation. Any ultrasonograph not providing these criteria was excluded.

By using vectoral analysis program according to Graf method (Scion Image for Windows v4.02 Beta, Scion Image Inc, Frederick, Maryland, USA), α and β angles were calculated.

Odds ratio (OR), chi-square, Fisher's exact test and binary logistic regression were used in statistical analysis. Female sex, family history, breech presentation, primiparity, swaddling, torticollis, oligohydramnios, foot deformity, multigravida, and brachial plexus palsy were considered in the risk group analysis. SPSS for Windows 10.0 (SPSS, Chicago, IL, USA) was used for statistical analysis.

Results

Ultrasonographic results of 94 babies not appropriate according to Graf's criteria were excluded.

Results of 403 babies were evaluated. There were 194 female and 209 male patients. In 371 bilateral, in 22 right, and in 10 left hip ultrasonography was performed. Average month of ultrasonography was 6.4 (4 weeks-10 months) months.

In 403 babies, 14 (3.4%) had DDH (9 female, 5 male). Nine DHD were in right and five in left hip. There was physiological immaturity in 81 babies (19%). Distribution according to hip type was as follows: 5 Type IIb, 7 Type IIc, 1 Type D and 1 Type IV hips. Of the four babies who had abduction restriction, one had DDH. The only baby who had Galeazzi sign had Type IV hip. The confirmation rate of physical examination was 80% in normal babies and 20% in babies with DDH. Cesarean section rate was high, but as elective cesarean is frequently applied, this was not taken into consideration. Four babies with DDH had birth weigh less than 2500 g.

According to risk factor analysis, female gender, family history, swaddling, and primiparity were not statistically significant. The only significant risk factor in unilateral analysis was presence of oligohydramnios (OR: 11.8, confidence interval-CI: 2.7-52.7, Table II).

Breech presentation was present in four and foot deformity in three babies. Seven babies were born from multiple pregnancies. Two babies had torticollis and two had brachial

Table II. Results of Unilateral Analysis of Risk Factors

Risk factor	Incidence	Odds Ratio (OR)	Confidence Interval (CI)
Female gender	4.6%	2.4	0.8-8.1
Family history	6.5%	1.12	0.5-10.7
Oligohydramnios	25%	11.8	2.7-52.7
Swaddling	10%	3.1	0.1-2.7
Primiparity	2.1%	0.62	0.1-2.9

plexus palsy but none of these situations was associated with DDH. In correlation analysis, there was a correlation between female gender and swaddling. There was an overall increase in DDH in female babies who were swaddled compared to those who were not (OR: 6.1, CI: 11-35.2; $p<0.05$).

Discussion

In this study, in which we performed hip ultrasonographic evaluation, we found that 14 (3.4%) patients had DDH. There was physiological immaturity in 81 babies (19%). Oligohydramnios and swaddling in the presence of female gender were found as predictors of DDH.

Hip ultrasonography is a noninvasive, repeatable study, which can evaluate the newborn without ionizing radiation[4]. It facilitates demonstration of abnormalities that may not be detected on physical examination[5]. This is the only method that can be used in the diagnosis, follow-up and confirmation of reduction in the Pavlik harness[2,6-9]. Although high incidences are reported in studies in which ultrasonography is used, a meta-analysis of 44 studies showed the incidences of any pathology related to hip and of physiologic immaturity to be 4% (0.04-13.4%) and 28% (0.5-88.9%), respectively, so our incidences were comparable with the current literature[2,10].

Physical examination, especially Ortolani and Barlow tests, are significant in diagnosis, but both of them lose their positivity due to the loss of reducibility of hip joint after the first month of life. Repeated physical examination may lead to avascular necrosis of the femoral head, but its incidence is reported to be 1 in 23,108 babies, so this risk is quite low[10]. As the repeatability of physical examination in DDH was 20% in our study, our results support the literature, which has demonstrated the limitation of the physical examination, related to physician and method factors[11]. In spite of these results, application of ultrasonography without physical examination has some disadvantages. Although it enables early detection of acetabular hypoplasia, which would otherwise be overlooked, it probably overdiagnoses DDH and leads to unnecessary treatment[12]. In a metaanalysis of 49 studies, 90% of the children with Type IIa hip dysplasia were found to be normal in the follow-up[10]. The need for experienced staff and expensive equipment is another disadvantage[12].

Female gender, breech presentation, foot deformities (e.g. pes equinovarus, pes calcaneovarus metatarsus adductus), multigravida, family history of DDH, torticollis and swaddling are the well-known risk factors for DDH[1]. We found oligohydramnios and swaddling in the presence of female gender as significant predictive factors of DDH. The last four weeks of gestation have the highest risk for DDH due to increased mechanical forces in the presence of malposition, oligohydramnios, multigravida and breech presentation[1]. In oligohydramnios, the decreased intrauterine space places too much load on the unborn baby's hip[13,14]. Swaddling is shown to increase DDH in many studies[15,16]. Although female gender increases the risk 1.8-fold, it was insignificant, but the risk was significantly high in female babies who were swaddled compared with the ones who were not. The overall ratio of swaddling was 5% in the whole study population, which shows that population-based education from the aspect of swaddling is effective. Nevertheless, to decrease incidence further, such efforts should continue because a great proportion of the Turkish population is still unaware of the possible harmful effects of swaddling.

Ultrasonography is without question useful, but its routine use as a screening tool is still debatable. Two different approaches, as either screening all newborns or those with risk factors, can be used according to the incidence of DDH in different countries[10,11,17,18]. Though DDH is still encountered in our country, considering the nature of the disease, screening newborns with risk factors could be a reasonable approach in Turkey. Larger studies are definitely needed to clarify the risk factors for our country. Despite its being a well-known risk factor for DDH, there is still a high incidence of swaddling in the Turkish population, and every effort should be made to increase public awareness about its danger.

REFERENCES

1. Herring JA. Developmental dysplasia of the hip. In: Herring JA (ed). Tachdjian's Pediatric Orthopaedics (3rd ed). Vol. 1. Philadelphia: W.B. Saunders Company; 2002: 513-654.
2. Rosendahl K, Makestat T, Lie RT. Developmental dysplasia of the hip. A population-based comparison of ultrasound and clinical findings. Acta Pediatr 1996; 85: 64-69.
3. Graf R. The diagnosis of congenital hip-joint dislocation by the ultrasonic Combound treatment. Arch Orthop Traum Surg 1980; 97: 117-133.

4. Graf R, Wilson B. Sonography of the Infant Hip and its Therapeutic Implications. Weinheim: Chapman & Hall; 1995: 27-102.
5. 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: 145-152.
6. de Raadt RJ, Diepstraten AF, Meradjim M, Robben SF. Ultrasonography as initial imaging study can replace roentgen studies under certain circumstances in suspected congenital hip dysplasia. Ned Tijdschr Geneeeskd 1992; 136: 982-985.
7. Sanders FB, Gardeniers JW, Ruijs JH, Bozon LA, Varbeek AL, Rosenbusch G. The value of echography in the early diagnosis of congenital hip dysplasia. Ned Tijdschr Geneeskd 1988; 132: 547-552.
8. Harding MG, Harcke HT, Bowen JR, Guille JT, Glutting J. Management of dislocated hips with Pavlik harness treatment and ultrasound monitoring. J Pediatr Orthop 1997; 17: 189-198.
9. Suzuki S. Ultrasound and the Pavlik harness in CDH. J Bone Joint Surg Br 1993; 75: 483-487.
10. Puhan MA, Woolacott N, Kleijnen J, Steurer J. Observational studies of ultrasound screening for developmental dysplasia of the hip in newborns - a systematic review. Ultraschall in Med 2003; 24: 377-382.
11. Roposch A. Twenty years of hip ultrasonography: are we doing better today? [Editorial]. J Pediatr Orthop 2003; 23: 691-692.
12. Clegg J, Bache CE, Raut VV. Financial justification for routine ultrasound screening of neonatal hip. J Bone Joint Surg Br 1999; 81: 852-857.
13. Dunn P. The anatomy and pathology of the congenital dislocation of the hip. Clin Orthop 1976; 119: 23-27.
14. Dunn P. Perinatal observation on the etiology of congenital dislocation of the hip. Clin Orthop 1976; 119: 11-22.
15. Coleman S. Congenital dysplasia of the hip in the Navajo infant. Clin Orthop 1968; 56: 179-193.
16. Race C, Herring JA. Congenital dislocation of the hip: an evaluation of closed reduction. J Pediatr Orthop 1983; 3: 166-172.
17. Holen KJ, Tegnander A, Bredland T, et al. Universal or selective screening of the neonatal hip using ultrasound? J Bone Joint Surg Br 2002; 84: 886-890.
18. Boeree NR, Clarke NM. Ultrasound imaging and secondary screening for congenital dislocation of the hip. J Bone Joint Surg Br 1994; 76: 525-533.