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Our three-year experience with an ultrasonographic hip screening program conducted in infants at 3 to 4 weeks of age

Üç-dört haftalık bebeklerde yürütülen ultrasonografik kalça taraması programında üç yıllık deneyimimiz

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Amaç: Bu çalışmada, yaşamın üçüncü-dördüncü haftalarında yapılan yenidoğan kalça tarama programının sonuçları incelendi ve bu programın Türkiye şartlarında kullanılabilirliği değerlendirildi.

Çalışma planı: Üç yıllık bir süreçte doğan 1440 bebeğin aileleriyle doğum sonrası ilk 48 saat içinde gelişimsel kalça displazisi (GKD) hakkında aydınlatıcı bir görüşme yapıldı ve GKD için risk faktörleri belirlendi. Bu bebekler 3-4 hafta sonra kalçaların fizik bakısı ve ultrasonografik incelemesi için yeniden çağrıldı.

Sonuçlar: Belirlenen tarama randevusuna 975 bebek (%67.7; 488 kız, 487 erkek; ort. yaş 26 gün; dağılım 17-34 gün) getirildi. Graf sınıflamasına göre, 1664 kalça (%85.3) tip I olarak değerlendirildi. Tip IIc, D ve IIIa saptanan 22 kalçada (%1.2) sağaltıma hemen başlandı. Bu kalçaların biri dışında tümünde sağaltım ile en geç sekiz hafta sonra tip I kalça elde edildi. İzlemi yapılabilen tip IIa kalçaların %12'sine sağaltım gereksimi doğdu. Toplamda, 35 bebeğin (bebeklerin %3.6'sı) 45 kalçası (kalçaların %2.3'ü) tercihen Pavlik bandajı ile sağaltıma alındı. Bu bebeklerin 10'unda (%28.6) GKD için risk faktörü vardı. Pozitif aile öyküsü en fazla karşılaşılan risk faktörüydü (7 bebek; %20). Sağaltıma alınan 45 kalçanın 12'sinde (%26.7), en sık uyluk/kasık pili asimetrisi olmak üzere klinik bulgu vardı.

Çıkarımlar: Üç-dört haftalıkken yapılan ultrasonografik kalça tarama programı GKD'de erken tanı ve etkin sağaltım açısından etkilidir. Ancak, doğumdan hemen sonra ailelerin GKD hakkında yeterince bilgilendirilmelerine karşın, bebeklerin yaklaşık üçte biri randevuya getirilmemiştir.

Anahtar sözcükler: Kalça çıkığı, doğuştan/tedavi/ultrasonografi; bebek, yenidoğan; yenidoğan taraması; risk faktörü.

Objectives: The aim of this study was to evaluate the results of a newborn ultrasonographic hip screening program conducted at 3-4 weeks of life, and to assess its utility and feasibility in Turkey.

Methods: During a three-year period, parents of 1440 newborns were interviewed within 48 hours following birth to be informed in detail about developmental dysplasia of the hip (DDH) and its risk factors. They were asked to bring their infants for clinical and ultrasonographic examinations of the hips 3 to 4 weeks after birth.

Results: A total of 975 infants (67.7%; 488 girls, 487 boys; mean age 26 days; range 17 to 34 days) were available on the day of screening. According to the Graf's classification, 1664 hips (85.3%) were considered type I. Immediate treatment was initiated for 22 hips (1.2%) which were considered type IIc, D, or IIIa. All but one hip were found to be type I after eight weeks of treatment. Among type IIa hips with a complete follow-up, 12% required treatment. In total, 45 hips (2.3%) of 35 infants (3.6%) were treated preferably with a Pavlik harness. Of these, 10 infants (28.6%) had at least one risk factor for DDH, the most common being a positive family history (n=7, 20%). Of 45 treated hips, 12 hips (26.7%) exhibited positive clinical findings, the most common being asymmetry of the thigh/inguinal folds.

Conclusion: Ultrasonographic hip screening program conducted at the age of 3 to 4 weeks is effective for early diagnosis and successful treatment of DDH. However, nearly one-thirds of the infants were not available at the appointed date, despite transmission of detailed inf rmation to the parents just after birth.

Key words: Hip dislocation, congenital/therapy/ultrasonography; infant, newborn; neonatal screening; risk factors.

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The incidence of developmental dysplasia of the hip (DDH) currently varies from nearly zero to 50 per 1000 live births.[1] The exact incidence of DDH in Turkey is still unknown, but it has been considered to be somewhere between 5 and 15 per 1000 live births.[2] The ideal period for diagnosis and treatment of DDH is the newborn period. Recognition of the known risk factors, clinical examination and radiological examination including ultrasonography and plain radiography are the major components of diagnostic approach to DDH.[1] Although the clinical examination has been considered the gold standard in diagnosing DDH, hip ultrasonography has become a worldwide-accepted tool for accurate diagnosis. However, debate still continues on whether or not DDH should be diagnosed only by ultrasonography.[1,3-5] In this prospective study, the results of a newborn ultrasonographic hip screening program which was developed by the authors and made at the age of 3-4 weeks was investigated and its usefulness in Turkey's conditions was discussed.

Patients and methods

The presented newborn hip screening and management algorithm (Figure 1) was initially planned and supervised by the second author (HÖ) at the Eskişehir Osmangazi University Hospital and retained by the Orthopaedics and Traumatology, Radiology, Pediatrics and Gynecology and Obstetrics Departments. 1440 newborns who were born between 1 July 2002 and 30 June 2005 at the authors' hospital and did not have any neuromuscular disorders, neural tube defects or any type of genetic syndromes were included the study. Within the first 48 hours following birth, an interview with the newborns' parents about DDH was made by a resident from the Orthopaedics and Traumatology Department. Parents were informed about the possible causes, diagnosis, course and treatment of DDH and an informative brochure about DDH was given to them. Besides this, risk factors were recorded, if present. Babies were invited for clinical and ultrasonographic examinations at the age of 3-4 weeks.

Among the invited babies, 975 (67.7%; 488 girls and 487 boys; mean age 26 days range from 17 to 34 days) of them were brought to the mentioned meeting. First, a detailed clinical examination was performed by a resident from the Orthopaedics and Traumatology Department, and positive clinical findings were recorded. Then, the ultrasonographic examination of both hips was made by the residents from Radiology and Orthopaedics and Traumatology Departments under the supervision of the fourth author (NA) using the Graf's technique [6] in the standard frontal plane while the baby was lying in the lateral decubitis position. The ultrasono-

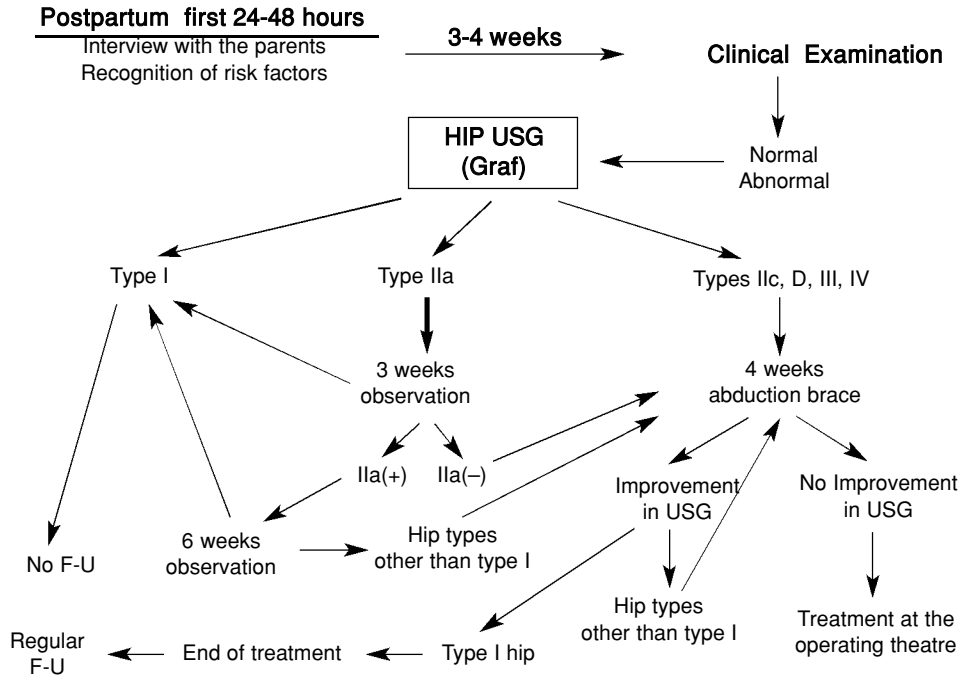

Figure 1. Newborn hip screening and management algorithm of the present study.

Table 1. Ultrasonographic hip typing according to the Graf's classification system.[6]

Type	Description	α angle (°)	β angle (°)
I	Mature (normal) hip	≥60	Ia: <55
			Ib: ≥55
IIa	Physiological delay in maturation (£3 months of age)	50-59	55-77
IIb	Pathological delay in maturation (>3 months of age)	50-59	55-77
IIc	At-risk or critical hip	43-49	≤77
D	Hip on the point of dislocation (decentric)	43-49	>77
III	Dislocated hip	<43	>77
	III a: No disturbance in the structure of the cartilaginous acetabular roof		
	III b: Disturbance in the structure of the cartilaginous acetabular roof		
IV	Highly dislocated hip	<43	>77

graphic examinations were performed using a 7.5-MHz linear transducer. Two printed sonograms in the standard plane from each hip were obtained and assessed according to the Graf's classification system (Table 1). The final decisions about the hip typing and the necessity of treatment, if present, were primarily made by the second author (HÖ). An additional study to assess the measurement variations was not made as Graf's method was previously found to have satisfactory agreement levels.[7] Babies with type I considered hips at 3-4 weeks were not followed. Babies with type II a considered hips were invited for an ultrasonographic re-examination 3 weeks later. Babies with type II c, D, III and IV considered hips were immediately treated. Initially type IIa considered hips were treated if they were considered type IIa- three weeks later (Figure 1). Pavlik harness[8] was the first choice of treatment tool. If, even the smallest size of the Pavlik harness could not be applied properly or any hesitation on the reliable monitorisation of the Pavlik harness due to insufficient correlation with the parents occurred, then the use of a rigid abduction brace (Ilfeld-Craig type) was preferred. Application of the Pavlik harness was always performed by a resident or specialist from the Orthopaedics and Traumatology Department and the parents were informed in detail about the Pavlik harness application. The treated babies were followed-up regularly 4 weeks apart by ultrasonographic examination until a type I hip was obtained (Figure 1).

Results

Following the ultrasonographic examination, nearly 85 percent of the hips were considered normal (Table 2).

Twenty-two hips (1.2%; 4 bilateral, 5 right, 9 left) of 18 babies (1.8%; 14 girls, 4 boys) were considered ultrasonographically critical or unstable hips (Types II c, D and III a) and the treatment was started immediately. Risk factors for DDH were determined in 7 (39%) babies (6 positive family history, 1 breech presentation). Besides this, positive clinical finding was present in 9 of 22 hips (41%). In four of these hips (3 type D, 1 type IIIa), there was more than one clinical finding (8 asymmetry of the thigh or inguinal folds, 4 limitation of abduction, 1 Ortolani, 1 Allis sign).

Type I hip was obtained in all but one such hips within 8 weeks. In an initially type D considered right hip of a girl, the treatment with the Pavlik harness could barely be started at the age of 8 weeks due to parents' hesitation with the use of the harness and the conservative treatment was considered to be failed at the end of 3 months. A soft tissue surgical procedure by the medial approach was performed at the age of 6 months, in this patient.Type IIa hip was nearly three times more common in girls than boys. Existence of a risk factor for DDH and positive clinical finding were seldom in babies with type IIa hips (Table 3). Among initially 264 type IIa considered hips, nearly one fourth of them were lost to follow

Table 2: Ultrasonographic types of the screened hips (n=1950).

	No	%
Type I	1664	85.3
Type IIa	264	13.5
Type IIc	7	0.4
Type D	14	0.7
Type IIIa	1	0.1

Table 3. The data of 198 babies (142 girls and 56 boys) with type IIa hips (no of hips 264).

No of risk factors	Positive clinical finding	The result of 3 weeks F-U
30 babies (15%)	14 hips (5%)	155 type I hip (59%)
15 positive family history	9 asymmetry of the folds	18 type IIa+ (7%)
7 breech presentation	5 limitation of abduction	22 type IIa- (8%)
4 multiple pregnancy		69 lost to F-U (26%)
3 foot deformity		
1 oligohydroamniosis		

up. Among the followed ones, most of them were considered type 1 at the end of six weeks (Table 3). Type IIa+ ($56^o \leq \propto \leq 59^o$) considered hips were followed for an additional six weeks and all but one of them were considered type I at the end of this observation period. Right hip of a girl was considered type IIb at the end of 12 weeks and a rigid abduction brace therapy was performed for 4 weeks and completed with success. Treatment with an abduction brace was immediately started in all type IIa- ($50^o \leq \propto \leq 55^o$) considered hips. Type I hip was obtained in all but two type IIa- hips due to incompliance of the parents and closed reduction and casting under general anesthesia was performed at the age of 5 months. In total, among the completely followed type IIa hips, 23 (12%) of them were treated (Table 4). In total, among 1950 hips of 975 babies, 45 hips (2.3% of the hips) of 35 babies (3.6% of the babies) were treated by an abduction brace, preferably the Pavlik harness, due to ultrasonographically detected unilateral or bilateral DDH. Among the screened 488 girls and 487 boys, 30 of them (6.2%) and 5 of them (1%) were treated, respectively. Avascular necrosis of the femoral head was not observed in any of these hips during the short-term follow-up period. Among 35 treated babies, a known risk factor for DDH was determined in 10 (29%). Positive family history was the most common risk factor (7 babies; 20%). Among 45 treated hips, at least one positive clinical finding was present in 12 (27%). Asymmetry of the thigh and/or inguinal folds was the most common clinical finding.

Discussion

The main aim of hip ultrasonography is to detect borderline cases, which have critical ossification deficits and cannot be detected clinically, rather than to detect the severe cases with high degrees of instability or established dislocation.[9] Tonnis et al [10] stated that none of the type IV hips, 40 percent of the type III hips, almost 50 percent of the type IIc and D hips and 60 percent of the type IIa and II b hips could be missed by clinical examination. Omeroglu and Koparal [11] reported that it was possible to detect all the types D, III and IV hips by clinical examination in highly experienced hands under ideal conditions but type II a-, II b and II c hips usually had the risk of missed diagnosis by the clinical examination even in the experienced hands. In both studies, limitation of abduction ($<70^o$ of abduction) was found to be the most common clinical finding in ultrasonographically detected dysplastic hips. [10,11] Demirhan et al [12] stated that positive clinical finding was present barely 40% of the babies who had ultrasonographic pathology. In the present study, among the treated hips, nearly 25% had at least one positive clinical finding being asymmetry of the thigh/inguinal folds the most common. Besides this, there was a correlation between the existence of clinical findings and hip types. The rate of positive clinical finding was nearly three times higher in types IIc, D and IIIa hips than type IIa hips. However, as the clinical examinations were performed by different physicians in the present study, the comments on the clinical examination might not

Table 4. The data of 17 babies (15 girls and 2 boys) who had initially type IIa hips and then were treated due to delay in maturation (no of hips 23; 6 bilateral, 4 right, 7 left)

No of risk factors	Positive clinical finding	Pre-treatment status
3 babies (17.7%)	3 hips (13%)	22 type IIa-
1 positive family history	3 asymmetry of the folds	1 type IIb (from type IIa+)
2 breech presentation		

be so reliable due to lack of standardization. Positive family history, breech presentation and foot deformities have been reported to be the most common seen risk factors during ultrasonographic hip screening.[10-14] In the present study, a positive risk factor being positive family history the most common could be determined in nearly one fourth of the infants with treated hips. Nevertheless, existence of a risk factor was nearly two times more common in babies with types IIc, D and IIIa hips than the babies with type II a hips. Based on our results, the risk of detecting an ultrasonographically abnormal hip seems to be higher in babies without any risk factors and with normal clinical findings.

Ultrasonographic hip screening can be general or selective. In a meta-analysis, Woolcat et al [5] reported that evidence was not sufficient to support or reject universal ultrasonographic hip screening of newborns. Holen et al [15] found the rate of late detected DDH (diagnosed after 1 month of age) as 0.13 per 1000 births in the general screening group and 0.65 per 1000 births in the selective screening group. Rosendhal et al [16] reported that the rates of late subluxation or dislocation was 0.3, 0.7 and 1.3 per 1000 in general, selective and no ultrasonographic screening groups, respectively. At present, the introduction of a general ultrasonographic hip screening program in Turkey is impracticable as there is nearly 1.4 million live births per year, and the number of physicians who properly perform and assess the infantile hip ultrasonography, is limited. Selective ultrasonographic hip screening for infants with risk factors and/or with positive clinical findings currently seems to be the best way of hip screening in Turkey. Such babies can be referred to the certain regional hip screening centers including one or more physicians who properly perform and assess infantile hip ultrasonography. General hip screening program may be performed in big health centers having adequate equipment and staff.

The ideal timing of the ultrasonographic hip screening is still controversial. It is usually accepted that hip ultrasonography that is made at the age of 4-6 weeks provides a more accurate indication of hip abnormality.[4] Bialik et al[17] stated that among the hips those featured any type of ultrasonographic pathology at 1 to 3 days of life only 10% of them remained abnormal within the first 6 weeks of life. Graf et al [9] found the rate of primary surgery as zero in dysplastic hips those were diagnosed and treated before the age of 1 month. Based on these observations, we believe that the best time for ultrasonographic hip screening when the real hip abnormalities requiring treatment can be assessed and delaying in the treatment can be avoided is at 3-4 weeks of age. We have been using this period for screening for more than 3 years.

Ultrasonographic hip screening is considered to lead to over diagnosis and over treatment.[4,5] In a big series from Turkey, the rate of treatment was found to be 0.5% following clinical and ultrasonographic screening.[18] The rate of treatment in our series is 36 per 1000 babies or 23 per 1000 hips. In our series, the rate of treatment or in another words the occurrence rate of DDH is six times higher in girls than boys. Besides this, girl/boy ratio was found to be 3-4/1 in type IIc and more severe hips, nearly 3/1 in type IIa hips and 7-8/1 in treated type IIa hips. There is no doubt that type IIc or worse hips should immediately be treated when diagnosed at 3-4 weeks of age. In the present study, the ratio of such hips has been found 0.18%. However, some may think that all of the type II a- considered hips do not need an immediate treatment at the age of 6 weeks. It was recently reported that 85 percent of the type II a- hips of the infants at the age of 1 month became normal at the age of 3 months without any treatment. [19] On the other hand, it was noted that when type II a- hips were undertaken therapy at 6 weeks of age, all of them reached type I after a mean bracing period of 2.5 months.[20] Graf and Wilson[6] has considered type II a- hips having the risk of failure in normal maturation process and advised immediate treatment without losing the valuable time. Half of the treated hips in the present series are type II a- hips. The rate of treatment in type IIa hips has been reported between 2% and 17%.[19] In the present study, the rate of treatment in completely followed type IIa hips is 12%. We believe that, undertaking the type II a- hips to an abduction brace therapy at the age of 6 weeks is not an over treatment. Besides these, based on our results we think that, girl babies with type IIa hips should be followed with more care, as such hips are more common and more prone to delay in maturation. In our experience, the rate of further surgical intervention can reach to zero if an effective conservative treatment preferably by the Pavlik harness can be started before the age of 1 month for type IIc

and more severe hips and at the age of nearly 1.5 months for IIa- hips. The main problem, existing in the presented screening program, is the some parents' insensitivity in the health of their babies' hips. It was surprising that 32 percent of the parents did not bring their babies to the clinical and ultrasonographic examinations at the age of 3-4 weeks although they were properly informed about DDH within the first 48 hours following the birth. Besides this, 26 percent of the type II a hips could not be re-examined at the age of 6 weeks. When retrospectively reviewed, it was seen that most of the infants who were not brought to their appointments were living in another city and when a telephone contact could be obtained with their parents, it was commonly stated that it was not possible to come to the appointments due to high travel costs or busy daily working. However, it was not so clear that ultrasonographic examinations of these infants were performed in the city where they lived. The reasons for declining the ultrasonographic examination are; the parents may not accept the hip screening or may be still aware of the importance of early diagnosis and treatment of DDH or physicians properly performing and assessing the infantile hip ultrasonography may not be present where they live.

In conclusion, we think that, although the clinical examination of the hips and recognition of the risk factors are important in the early diagnosis of DDH, hip ultrasonography should be used as the definite diagnostic tool for DDH in the newborn period. Ultrasonographic hip screening at the age of 3-4 weeks is very effective for both accurately diagnosing DDH and avoiding further surgical intervention However, in a screening program conducted at the age of 3-4 weeks in Turkey's conditions, the infants (one third, in the present study) have the risk of missing their clinical and ultrasonographic examination appointments at the age of 3-4 weeks, although their parents have been properly informed about DDH just after the birth. Some preventive measures should be developed to increase the number of screened infants in such hip screening programs performed at the age of 3-4 weeks.

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