Incidence and follow-up outcomes of developmental hip dysplasia of newborns in the Western Mediterranean Region

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SUMMARY: Çekiç B, Erdem-Toslak İ, Sertkaya Ö, Filiz S, Kılar Y, Köroğlu M, Köse Ö. Incidence and follow-up outcomes of developmental hip dysplasia of neworns in the Western Mediterranean Region. Turk J Pediatr 2015; 57: 353-358.

The aim of our study was to determine the incidence of developmental hip dysplasia (DHD) in the Western Mediterranean Region of Turkey and evaluate follow-up results of physiologically immature hips classified as type 2 according to Graf classification. Ultrasononographic examinations of the hips were performed using Graf's technique on 1162 infants (2324 hips) referred to our clinic for hip ultrasounds between March 2013 and March 2014. DHD was detected in 1.36% of 1162 infants. Among infants who were brought into repetitive follow-ups, 191 out of type 2a hip displasias of 201 infants were improved to type 1 and 10 type 2a hip dysplasias worsened. Sonographically worsened tip 2a group consisted of 4 type 2b, 6 type 2c DHDs. Hip ultrasound performed during neonatal period and infancy in the detection of developmental hip dysplasias and follow-up of hip dysplasias diagnosed as type 2a convey importance because of sonographically detected potential deterioration.

Key words: developmental hip dysplasia, newborn, incidence, follow-up, outcomes.

Developmental hip dysplasia (DHD) has been evaluated within a wide spectrum of clinical manifestations from acetabular dysplasia up to irreducible dysplasia of the hip. Acetabular dysplasia and ligamentous laxity are fundamental componenets of this clinical picture¹.

In studies based on clinical and radiological data, the incidence of DHD ranges between 0-50 for every 1000 live births². However, in investigations performed in our country, incidence rates varying between 0.5 and 1.5% have been reported³. Differences in incidence rates for DHD have been explained with genetic and ethnic characteristics, living conditions changing with geographic regions, local traditions and childrearing habits^{4,5}.

Since early diagnosis and functional treatment enable complete improvement without sequela, approach to the disease during neonatal period carries utmost importance^{6,7}.

For these reasons, screening programs which will minimize the requirement for surgical intervention, were necessitated and in the whole world including our country these types of programs were adapted and implemented as health policies⁸. Nowadays, ultrasonographic screening employed in most of the countries can pick up clinically silent hip dysplasias without increasing treatment rates of spontaneously resolved minor anomalies⁹.

Since newborn hip has mainly cartilaginous structure, it is difficult to evaluate it using direct radiography. Currently used hip ultrasonography technique has been globally introduced by Dr. Graf in 1978^{8,10}. In the diagnosis of DHD in newborns, especially during the first 6 months of life, it is accepted as a gold standard³. The aim in the diagnosis of DHD is to determine the position of the femoral head and reveal the developmental stage of the acetabulum using alpha angle method.

Development of the hip joint is a dynamic process continuing during the neonatal period. Ultrasound (US) is used within the first 3 months in the follow-up of Graf type 2a newborns with findings of physiological immaturity, inadequate cartilage, but adequate bone formation. This condition which has been

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attributed to physiologic immaturity is expected to be provisional. Though frequency of type 2a hip dysplasia changes with the timing of the first ultrasonographic evaluation, it varies between 10 and 45 percent. Most (95-97%) of the hips evaluated in favour of type 2a resolve spontaneously within 3 months and 3-5% of them progress to DHD^{11,12}.

The aim of this study was to evaluate hips of 1162 newborns who were referred to our radiology clinic between March 2013 and March 2014 using Graf classification and investigate follow-up outcomes of the hips classified as type 2.

Material and Methods

Study design: Approval for the use of the data in the study was obtained from the Ethics Committee of Antalya Training and Research Hospital. A total of 1162 infants aged > 6 weeks referred to Radiodiagnostic Clinics of Antalya Training and Research Hospital within the frame of Turkish Ministry of Health DHD Screening Program between March 15, 2013 and March 15, 2014 were prospectively evaluated. The infants underwent ultrasonographic hip examinations using Graf technique performed by a radiologist who received certification training on hip US.

We did not include babies aged < 6 weeks in our study. Our aim was to decrease the number of cases with physiologic immaturity and those with amenable to spontaneous resolution which is seen within the first 6 weeks of life.

Hitachi brand (HI vision Preirius Tokyo Japan) US device with 7.5 mHz linear probe and Graf method were used for hip US while the baby was laid in lateral decubitus position with his/her hip and knees semiflexed in 15-20° internal rotation. An appropriate gel was applied on the skin overlying trochanter major and with the probe held perpendicular to the body, coronal sections parallel to the longitudinal axis of the body were obtained. When cuts were obtained from all reference





Alpha (α) : The *angle* created between the lines drawn along the straight part of the iliac *bone* and the acetabular roof (1. line iliac bone, 2. line: bony roof).

Beta (β): The *angle* created between the lines drawn along the straight part of the iliac *bone* and the cartilaginous roof (1. line: iliac bone, 3. line: cartilaginous roof).

Iable I. Graf Classification.						
Graf classification	Alpha angle (bone roof)	Beta angle –Age (cartilaginous roof)	Explanation			
Type 1a	$\alpha > 60^{\circ}$	$\beta < 55^{\circ}$	Normal hip			
Type 2a (+)	$\alpha = 55^{\circ}-60^{\circ}$	$\beta > 55^{\circ}$ < 3 month	Physiological immature hip			
Туре 2а (-)	$\alpha = 50^{\circ}-55^{\circ}$	β >55° < 3 month	Pathological immature hip			
Type 2b	$\alpha = 50^{\circ}-60^{\circ}$	$\beta > 55^{\circ}$ > 3 month	Centered hip - stable			
Type 2c	$\alpha = 43^{\circ} - 49^{\circ}$	$\beta < 77^{\circ}$	Centered hip - unstable			
Type D	$\alpha = 43^{\circ} - 49^{\circ}$	$\beta > 77^{\circ}$	Decentered hip			
Туре 3	$\alpha < 43^{\circ}$	$\beta > 77^{\circ}$	Eccentered hip			
Type 4	$\alpha < 43^{\circ}$	$\beta > 77^{\circ}$	Dislocated hip			

points of the hip (the deepest point of the acetabulum, flat and vertical appearance of the iliac wing plane, labrum) as observed on the monitor, the frames were frozen. On the images obtained baseline, pubic bone and cartilage lines were drawn. After determining alpha and beta angles, hip dysplasias were ultrasonographically classified based on the Graf method. Standard sections were obtained on the coronal plane and measurements of alpha and beta angles were used in the Graf method¹⁰ (Fig. 1).

Type 1 hips determined according to Graf classification were evaluated as normal finding and these patients were not called for a return visit. Type 2a hips were assessed as "immature" hips on their development cycle and the patients were called for control visits at 4 week-intervals. Type 2b hips were evaluated as those which did not manifest any sign of development. Type 2c and type D hips were evaluated as "dysplasic" and type 3 and 4 hips as "dislocations" (Table I).

Type 2a hips divide into 2a (+) and 2a (-) categories based on their alpha angles. On hip USs obtained from the 6th week of life, alpha angles between 55°-59° were classified as type 2a(+) and evaluated in favour of immaturity¹³ (Figs. 2 and 3).

If alpha angle on USs obtained after 6th week of life was between 50° and 54° then these hips were termed as type 2a(-) and maturation of these hip joints were evaluated as a risky process⁶.

Based on Graf classification, infants with type 2a (+) hips who were followed up in our hospital up to 12 weeks and whose alpha angles did not reach 60° but worsened to type 2b as well as infants diagnosed as having type 2a (-) hips underwent Pavlik's therapy by ortopedic clinic of our hospital.

Statistical	analysis:
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Tablo II. Gender Distribution of the Infants.

	Frequency	Percent (%)
Male	523	45.0
Female	639	55.0
Total	1162	100.0



Fig. 2. Type 2a hip.



Fig. 3. Type 1a hip.



Fig. 4. Type 2a cases who attended follow-up visits.

Right			Left			
Hip type	Frequency	Percent (%)	Hip type	Frequency	Percent (%)	
1a	1026	88.3%	1a	900	77.5%	
2a	116	10.0%	2a	210	18.1%	
2b	16	1.4%	2b	40	3.4%	
2c	3	0.3%	2c	10	0.9%	
3a	1	0.1%	3a	1	0.1%	
3b	0	0%	3b	1	0.1%	
Total	1162	100.0%	Total	1162	100.0%	

Table IV. Type 2a Thps	Which Bld Not	i inipiove to iy	pe ia, woit	sened to Typ	10^{-1}	and $2c$ ($n=0$).
n=10	Type 2a (+)	Туре 2а (-)	Male	Female	Left Hip	Right Hip
Type 2a (worsening)	3 (30%)	7 (70%)	3 (30%)	7 (70%)	8 (80%)	2 (20%)

Table IV. Type 2a Hips Which Did Not Improve to Type 1a, Worsened to Type 2b (n=4) and 2c (n=6).

Table V. Incidence of Developmental Hip Dysplasia Conducted in Our Country.

Authors	Publication year	n	City	Type of study	DHD incidence
Kutlu et al. ⁴	1992	4173	Konya	Clinical	1.34%
Köse et al. ⁵	2006	975	Eskisehir	Clinical + radiological	1.2%
Levent et al. ¹⁶	2001	18000	Izmir	Clinical	0.5%
Akman et al. ¹⁹	2007	403	Ankara	Clinical + radiological	3.4%
Çakır et al. ¹⁵	2009	300	Ankara	Clinical + radiological	1.2%
Tosun et al. ¹⁸	2010	310	Elazig	Clinical + radiological	5-7.9%
Karapınar et al. 1	2002	327	Izmir	Clinical + radiological	5.2%
Doğruel et al. ¹⁷	2008	3560	Ankara	Clinical + radiological	5.3%
Current Study	2014	1162	Antalya	Clinical & radiological	1.36%

n= number; DHD= Developmental hip dysplasia

A descriptive analysis of the continuous and categorical data was performed using proportions, frequency distributions, means, and standard deviations. No statistical analysis was performed in this cross sectional study.

Results

In our study, ultrasonographic data of 2324 hips of 1162 infants referred to our hospital for the DHD screening conducted between 03.15.2013 and 02.15.2014 were evaluated.

Mean age of the infants at their first admission was 72.5 ± 22.5 (range, 36-168) days . A total of 1162 infants referred to our hospital consisting of 523 (45%) male and 639 (55%) female infants (Table II). Ultrasonographic evaluation of the right hip joints of 1162 infants revealed type 1a (n=1026; 88.3%), type 2a (n=116; 10%), type 2b (n=16;1.4%) , type 2c (n=3; 0.3%) and type 3a (n=1: 0.1%) DHDs. Ultrasonographic evaluation of the left hip joints of 1162 infants revealed type 1a (n=900; 77.5%), type 2a (n=210; 18.1%), type 2b (n=10;3.4%) , type 2c (n=4; 0.9%) and type 3a (n=1; 0.1%) DHDs (Table III).

When distribution of type 2a hips of 1162 infants were evaluated based on Graf classification patients with 49 right hip type 2a and left hip type 1a, 145 left hip type 2a and right type 1a and 63 bilateral hip type 2a were detected.

Follow-ups were performed at 4-week intervals. Among the 257 infants with type 2a DHDs, only those with type 2a hips, 201 (78%) of patients, were brought into the repetitive follow-up visits and 191 of the type 2a hips improved to type 1a.

Sixteen out of 20 infants with type 2b, 2c, type D, 3a or 3b hips were brought into follow-up visits and all of the attenders were managed with pelvic bandages applied in the orthopedic clinic of our hospital. All types of DHDs of these 16 cases were improved to type 1a within 2-4 months.

As an outcome of follow-ups of 201 type 2a hips, we observed improvement in 19 (95%) hips to type 1a, while 10 (4.97%) type 2a hips remained the same. The latter 10 type 2a hips which did not improve to type 1a, worsened to type 2b (n=4; 1.99%) and 2c (n=6; 2.98%). In our orthopedic clinic we applied Pavlik bandages for the management of the worsened or unchanged cases (Fig. 4).

When 10 infants whose type 2a hips remained stable or worsened to type 2c were evaluated, alpha angles of 7 type 2a hips were found to be below 55° [type 2a (-)], while the remaining 3 hip joints had alpha angles above 55° [type 2a (+)]. This group consisted of 7 female and 3 male infants (Table IV).

Discussion

Our survey is the first screening study aiming at determination of DHD incidence in Western Mediterranean Region of Turkey using ultrasonographic examinations of the hips of the infants in addition to investigation of followup outcomes of physiologically immature hips (type 2a) using Graf classification . In our study, we detected the incidence rate of DHD as 1.36% in 1162 infants (2324 hip joints) including type 2c (1.11%) and type 3a (0.17%) hips. All infants diagnosed as DHD were managed with Pavlik bandage method performed in the orthopedic clinic of our hospital and all types of DHD were improved to type 1a.

In studies investigating the incidence of DHD based on clinical and radiological data, incidence rates ranging between 0.5 and 1.5% have been reported³. Differences in incidence rates have been reportedly attributed to genetic and ethnic characteristics, various living conditions in diverse geographic regions, local conventions, childrearing habits and use of diagnostic methods⁷. Because of unfavourable practices prevalent in our country and especially our nationwide cultural practice of swaddling, swinging newborns upside down, trying to position hips and knees of the newborns in extension so as to straighten their legs and extremely tight clothing of the babies , incidence rates of DHD higher than those reported have been assumed³. Since annual number of live births in Turkey are nearly 1.4 million, every year our population increases with an addition of approximately 15-20 thousand individuals with DHDs^{3,15}.

Incidence rates similar to findings have been detected in combined clinical and radiological studies performed by Kutlu et al⁴. in our country which detected the incidence of DHD as 1.34 percent⁴. In a study conducted by Köse et al⁵. on 975 newborns, incidence of DHD was reported as 1.2 percent⁵. In a study by Çakır et al¹⁵. on 300 newborns, the incidence of DHD was detected as 1.2 percent¹⁵. However Levent et al¹⁶. from Izmir screened 15.000 infants born between the years 1993 and 1996 only with ortopedic examination without using US and the incidence of DHD was found to be 0.5 percent. Lower DHD rates in their studies when compared with those of the other studies from our country are related to their screening infants with only orthopedic examination without ultrasonographic evaluation of the hips¹⁶. Dogruel et al¹⁷. from Turkey performed combined clinical and radiological examinations on 3560 newborns and found the incidence of DHD as 5.3%, while Tosun et al¹⁸. detected incidence of DHD as 5.7% in their study on 310 infants^{17,18}. Akman et al.¹⁹ also performed another clinical and radiological examinations on 403 newborns and found the incidence of DHD as 3.4% in their study¹⁹. Since the above mentioned studies have been performed more frequently by orthopedic clinics of tertiary healthcare institutions and ultrasonographic

hip examinations were applied only in certain medical centers during the time period of some investigations in addition to increased number of cases referred with the initial diagnosis of DHD, their incidence rates for DHD were suggestively higher than ours.

Among the surveys performed abroad, in Mongolia, Munkhuu et al⁶. performed a study on 8356 newborns in 2013 with an average age of 7 days and detected DHD incidence as 0.7 percent⁶. In a study performed by Tong SH et al²⁰. in 2011 in The Children's Hospital of Hong Kong University, the authors reviewed medical records of the children and found incidence rate of DHD as 0.87 percent²⁰ (Table V).

When our study on 2224 hip joints were evaluated within the context of 2b, 2c, type D and type 3 DHDs, our incidence of DHD was %1.36 percent. Although the outcomes we obtained are comparable to those of the other studies performed in Turkey, higher incidence rates relative to survey studies conducted abroad were related to abovementioned genetic characteristics, local traditions and childrearing habits peculiar to our country. Since our hospital is a referenced tertiary health care institution in the Western Mediterranean Region having a newborn DHD service which we provided in collaboration with the orthopedic clinic of our hospital, infants included in the screening program together with referrals from other hospitals and neighbouring cities with the initial diagnosis of DHD increased our incidence of abnormal hip joints.

In sonographic follow-up studies on immature hips termed as type 2a, spontaneous resolutions have been indicated in 84-97% of the cases^{21,22}. In our country, Ömeroğlu et al¹³. detected improvements in 79% of 285 hips, while Kosar et al. revealed worsening in 6.8% of type 2a hips^{13,11}. Roovers et al²¹. reviewed 5170 patients and reported that 95.3% of the cases evaluated as type 2a (+) and 84.4% of type 2a (-) hips which were followed up without treatment were improved to type 1 a within 2 months²². Ganger et al²³. scanned 1991 patients and similarly reported that type 2a hips of all the patients improved to type I within 2.5 months of follow-up without treatment²³. In our investigation, 191 out of 201 type 2a hips of newborns improved to type 1 a, but 10 (4.97%) type 2a hips did not improve to type 1a. Four (1.99%) of them remained the same, then changed to type 2b. While 6 (2.98%) of them progressed to type 2c. In our study, sonographic worsening of 4.97% of type 2a hips revealed that follow-up and management

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of 2a hips are very important issues.

One of the limitations of our study is that although we detected type 2a DHDs in 257 out of 1162 infants with accessible data, only 201 (78%) type 2a infants were brought into repetitive follow-up visits. Although parents were informed by physicians about the DHD screening program, since this screening program had been implemented by Turkish Ministry of Health for only 3 years, plus inadequate awareness of our public about this issue and a wide geographical area of the Antalya region which make it difficult for the parents to attend recurrent control visits can be enumerated among reasons of noncompliance.

In conclusion, in our study, the incidence of DHD was detected as 1.38% in the Western Mediterranean Region and hip US is important in the early diagnosis, treatment and follow-up of DHDs. In our study 4.97% of the type 2a hips of the infants who complied with follow-up visits worsened sonographically. Type 2a hips and especially those with alpha angles less than 55° ie. type 2a (-) subgroup hips carry a higher risk of sonographic deterioration which underlines the critical importance of follow-up and management of type 2a hips. Therefore, parents should be informed about the importance of their compliance to follow-up protocols.

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