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The Frequency of Developmental Dysplasia of the Hip in Iraq and the Relationship between Clinical Versus Ultrasound Examination in Early Detection of Developmental Dysplasia of the Hip

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Original Research Article

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Abstract: Developmental Dysplasia of the Hip is a significant cause of disability in children and young adult it can result in gait abnormalities, chronic pain, degenerative arthritis and long term suffers. Early detection and early simple treatment prevent such disabilities and offer a less expensive mod of therapy. The rationale for this study was to highlight the frequency of Developmental Dysplasia of the Hip in a sample of Iraqi neonates based on clinical and ultrasound examination in addition to evaluate the disparity and the concordance between the clinical versus ultrasound examination for detection of early Developmental Dysplasia of the Hip in the neonatal period. A prospective screening study was done in Baghdad at the neonatal care unit of The Central Child teaching Hospital in a period of 22 months (from 3oth of January 2016 to 30th of November 2017). Clinical as well as ultrasonic examination was done at the same time to the hips of 500 neonates for early detection of Developmental Dysplasia of the Hip. Infants enrolled in this screening program were those healthy neonates aged less than 4 weeks before they discharged from the hospital, excluding infants with neuromuscular anomalies, congenital anomalies and those who were missed from the reevaluation visit. Infants with clubfoot and torticollis were included as these deformities considered to be risk factors of Developmental Dysplasia of the Hip. A total of 500 newborns participated in this study (232 were females and 268 were males). Only 2 neonates (3 hips) (0.4%) were diagnosed as DDH that needed the referral to orthopedic surgeon for treatment. Both were clinically (grade 3) and by sonography (Graf's type IIc, III) during the 1st and 2nd visites. In other 2 neonates (0.4%) had unilateral subluxatable hips (grade 2 hips) clinically with normal sonography (Graf's type I). Sixteen newborns (3.2%) had normal clinical examination but with unilateral different types of sonogram abnormalities (12 were Graf's type IIc & 4 were type III). Those babies turned to be normal on follow up examination at the age of 5 to 8 weeks that need no treatment. The remaining 480 (96%) babies were normal both clinically and by sonography [253 (50.6%) Graf's type I and 227 (45.4%) type IIa]. According to the present study, in the screening of early Developmental Dysplasia of the Hip, the frequency is 4 in 1000 in this sample of Iraqi neonates. There was high false positive result of developmental dysplasia of the hip diagnosed by U\S (84.2%) in comparison to clinical false positive results (60%) with high concordance between the 2 examinations in the second visit in comparison with the first one.

Keywords: Developmental Dysplasia of The Hip (Ddh), U\S(Ultrasound), Dci(Dynamic Coverage Index).

INTRODUCTION

Developmental Dysplasia of the Hip (DDH) is the preferred term to illustrate a condition in which the femoral head has an abnormal relationship to the acetabulum. It includes frank dislocation (luxation), partial dislocation (subluxation), instability where in the femoral head comes in and out of the socket, and an array of radiographic sign that reflect inadequate formation of the acetabulum [1].

The term developmental more accurately reflects the biological features than does the previous term congenital which is of no more in use, considering that the abnormalities of the hip may develop with growth and many of these finding may not present at

birth [2, 3]. The earlier a dislocated hip is detected the simpler and more effective is the treatment [4, 5].

The incidence of DDH varies world wid. It rang from 0.06 in 1000 live birth in Africans in Africa to 76.1 in Native Americans with significant variability between different ethnic groups. This variability may be associated with different methods for screening and to the local definition of DDH [6, 7].

Clinical surveillance for hip dysplasia was instituted in many countries after the publication of two landmark studies in 1962 [8, 9]. The Ortolani and Barlow maneuvers have been the standard techniques for detecting hip instability in a newborn [10]. These maneuvers cannot be performed in a fussy, crying infant whose muscle activity may inhibit the movement of an unstable hip, and they are also different according to the child's age and the type of the dislocation; the Barlow and Ortolani tests are useful in neonates but become difficult by 2-3 months of age. On the other hand, stable hips may be dysplastic with negative Barlow and Ortolani then the limitation of hip abduction (less than 60°) when the hip is flexed to 90° is the most important sign of a dislocated or dysplastic hip [11]. Since the introduction of U\S in 1980 for the diagnosis of DDH, it has been widely used for hip screening within the first days or weeks after birth in many countries. Early reports showed promising results [12].

Finally, diagnostic tools have different values in different ages, for example ultrasonography is useful from birth to 4 months of age but pelvic X-ray is more useful in older infants and children once the femoral head ossification center has developed [32]. All these highlight the need for finding out the most effective screening method for hip dysplasia and to have an idea about its frequency in Iraq.

OBJECTIVES OF THE STUDY

The rationale for this study is

- To estimate the frequency of DDH in a sample of Iraqi neonates based on clinical and ultrasound examination.
- To evaluate the disparity and the concordance between the clinical versus ultrasound examination for detection of early DDH in the neonatal period.

PATIENTS AND METHODS

A prospective screening study was done in Baghdad at The Central Child teaching Hospital in a period of 22 months (from 30th of January 2016 to 30th of November 2017).

Clinical as well as ultrasonic examinations were done at the same time to the hips of 500 neonates in the neonatal care unit for early detection of DDH.

Approval from The Central Child teaching Hospital was obtained, as well as informed consent from the parents of the studied neonates.

The study took place at the nursery care unit where neonates were admitted for various diseases affecting neonates less than 28 days old.

Infants enrolled in this screening program are

- All neonates (who recovered from their current illness) aged less than 28 days before they discharged from the hospital.
- Infants with clubfoot and torticollis are included as these deformities considered to be risk factors of DDH.

Excluding infants with

- Neuromuscular anomalies.
- Congenital anomalies.
- Those who were missed from the reevaluation visit.
- Family disagreement in participation in this study.

Direct interviewing the mother or a relative of the neonate, asking about age, sex of the neonate, gestation age, mode of delivery, presenting part and positive family history of DDH. Then the babies were examined by a single pediatrician who did the examination on a flat couch with relaxed baby, uncovered (below waist) and examining a single hip each time. Looking for asymmetry of the skin folds and assessing for leg length discrepancy by Galliezi test, limitation of hip abduction in addition to hip stability.

Hip stability was assessed with the Barlow and Ortolani tests using Tonnis system [13]. It classifies the hips instability as following:

- grade 1, slight capsular instability with no snapping sign and/or limitation of hip abduction to within 70° of the midline (normal hip);
- grade 2, subluxatable hip (Ortolani's snapping);
- grade 3, dislocatable and reducible hip (dislocation sign);
- grade 4, fully dislocated, irreducible hip (as shown in figure 1)

Grade 1 is absolutely normal, Grade 2, 3, 4 considered abnormal in this study.

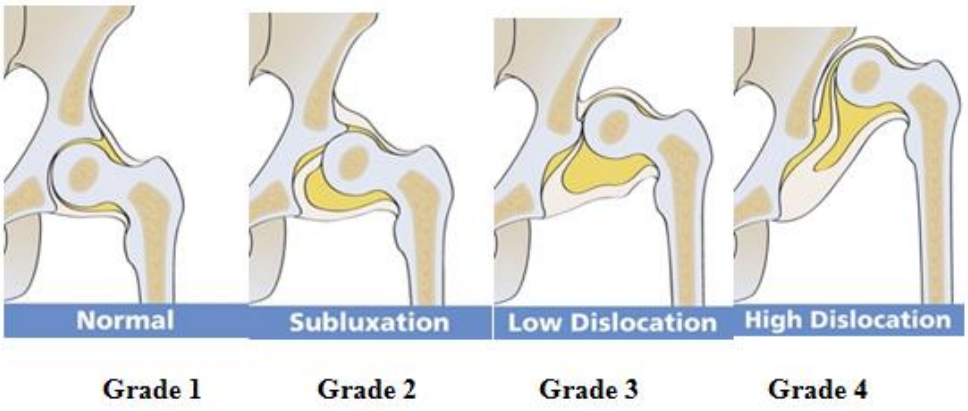

Fig-1: Shows Tonnis grading of hip instability

Feeling a clunk by Barlow indicates that the hip can be dislocated while feeling a clunk with Ortolani test significantly indicates that the dislocated hip is reducible hip [31].

A click with an unstable hip requires follow up [14]. Audible high-pitched "clicks" without a sensation of instability have no pathological significance [15]. All hip abnormalities were recoded.

On the same day an ultrasonic examination was done for the same babies by a single radiologist using GE Voluson E6 machine with linear superficial probe of 7.5 MHZ frequency.

It was done by keeping the neonate on lateral decubitus position for assessment of alpha, beta angels and femoral head coverage percentage, in the none stress position (static image) then evaluation of the hips in the dynamic stress position. The scanning was performed on the coronal and transvers plans (figure 2).

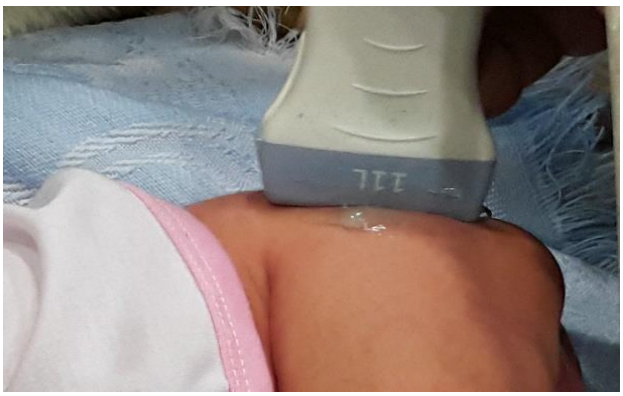

Fig-2: shows the coronal position during U/S examination

The alpha angle refers to the angle between the acetabular roof and vertical cortex of the ilium. The beta angle is the angle formed between the vertical cortex of the ilium and the triangular labral fibrocartilage (echogenic triangle) (figure 3).

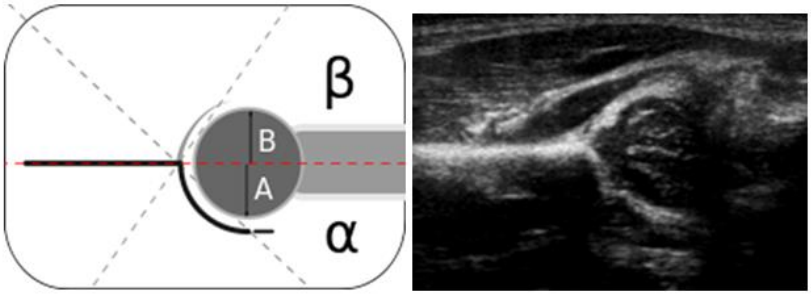

Fig-3: shows the alpha and beta angles assessment

Ultrasound also asses the dynamic coverage index (DCI) that refers to ultrasound measured femoral head coverage with the hip in coronal flexion and adduction.

The results were analyzed according to Graf's classification (table 1)[16].

- Type I hips are deemed mature (normal hips).
- Type IIa+ hips is immature but appropriate for age (normal hips).
- Type IIa- hips is immature and inappropriate for age.
- Type IIb hips has delay development.
- Type IIc, III, IV hips are abnormal.

Accordingly, abnormal hips were those with Graf's type IIc, III, IV considered abnormal by U\S and Grade 2, 3, 4 considered abnormal by clinical examination. Follow- up examination was done for all infants with abnormal findings (whether clinically or by U\S) by the same investigators after 4 weeks from the first examination (5-8 week of life). Neonates who had persistence of hip abnormalities were referred to an orthopedic surgeon for further management.

The data were analyzed using Graph Pad in Stat (version 3.00 for Windows 95, Graph Pad Software, San Diego California USA, www.graphpad.com).

Table 1: modified Graf's classification [16]

Type	Mturity	Bony roof	Alpha Angle	Bony rim	Cartilage Roof	Beta angle	Age
Type I	mature	good	>60	sharp	Good coverage femoral head	Type Ia<55 Type Ib>55	All ages
Type IIa+	Immature but appropriate for age	adequate	50-59	blunt	Coverage femoral head		<3 months
Type IIa-	Immature but inappropriate for age	deficient	50-59	rounded	Coverage femoral head		<3 months
Type IIb	Delay in development	deficient	50-59	rounded	Coverage femoral head		>3 months
Type IIc	Stable or instable	Severely deficient	43-49	Rounded \flat	Still Coverage femoral head	<77	All
Type D	decentring	Severely deficient	43-49	Rounded \flat	displased	>77	All
Type III	eccentring	poor	<43	flat	Librum pressed upword		All
Type IV	eccentring	poor	<43	flat	Librum pressed downword		All

RESULTS

A total of 500 neonates (1000 hips), 234 were females and 266 were males. 186 were preterm with gestational age between 34 and 36 weeks, 314 newborns were full term.

Table-2: distribution of the studied sample according to their sex and gestational age

Sex	No.	%
Males	266	53.2%
Females	234	46.8%
Maturity		
Preterm	186	37.2%
Full term	314	62.8%

The age of first examination was ranging between 2 – 28 days with a mean age of 13.52 ±7.88 days. Out of the 500 newborns, 2 patients (one unilateral and the other bilateral) had pathologic both clinically and by U/S. Both were clinically (grade 3) and by sonography (Graf's type IIc, III) during the 1st and 2nd visits as shown in (table 3).

Table 3: shows clinical and ultra-sonic hip finding in term of numbers of neonates

	Clinical examination		U\S examination	
	1st visit	2nd visit	1st visit	2nd visit
Normal examination	496(99.2)	498(99.6)	482(96.4)	498(99.6)
Abnormal examination	4(0.8)	2(0.4)	18(3.6)	2(0.4)

Two neonates (0.4%) had unilateral Ortolani snapping with subluxatable hips (grade II clinical), their U/S show Graf's type I. On the follow up visit they were clinically normal with Graf's type I.

Four neonates (0.8%) had normal clinical examination but their U/S revealed unilateral type III Graf's. Four weeks later they were clinically normal and their U/S show stable hip. Other 12 neonates (2.4%) had normal bilateral clinical examination. Their U/S revealed unilateral type IIc Graf's, their follow up showed stable hip.

In this study, out of 500 neonates, 253 (50.6%) had bilateral normal clinical (grade 1) and U/S examination (graf's type I). the remaining 227 neonates (45.4%) had a normal clinical examination and Graf's type IIa (physiological immaturity with stable hip). Both of these groups (480 neonates 96%) were considered normal as shown in table 4.

Table-4: Clinical versus U/S examination in term of number of hips defined as normal or pathologic in the first visit (1- 4weeks of life)

	First visit		Second visit	
	No	%	No	%
Abnormal both clinically and by u\s(grade IIc-III)	2(one unilateral &the other bilateral)	0.4**%**	2	0.4%
Normal clinically but abnormal by u\s(grade IIc)	12	2.4%	0	0%
Normal clinically but abnormal by u\s(grade III)	4	0.8%	0	0%
Clinically abnormal (subluxation grade II) but normal by u\s	2	0.4%	0	0%
Clinically and by u\s normal	480	96**%**	498	99.6%
Total	500	100%	500	100%

Out of 19 hips with abnormal sonogram examination, only 3 had persistent sonogram abnormalities (false positive result is 84.2%). While 0f the 5 hips with abnormal clinical examination, 3 had persistence of clinical abnormalities (false positive result is 60%). So that U\S examination had false positive finding more than that of the clinical examination, as shown in table 5 and 6.

Table-5: Clinical versus U\S examination in term of the number of hips defined as normal or pathological in the first visit (1-4 weeks of life)

	Normal US		Abnormal US (Pathological)		
	Graf's I	Graf's IIa	Graf's IIc	Graf's III	Total no. of hips
Clinically normal	589	390	12	4	995
Clinically Pathological	2	0	1	2	5
Total	591	390	13	6	1000

Table-6: Clinical versus U/S examination in term of number of hips defined as normal or pathologic in the second visit (5-8weeks of life)

	Normal US		Abnormal US (Pathological)		
	Graf's I	Graf's IIa	Graf's IIc	Graf's III	Total no. of hips
Clinically normal	654	343	0	0	997
Clinically pathological	0	0	1	2	3
Total no. of hips	654	343	1	2	1000

The estimated frequency of DDH in our Iraqi sample was 4 in 1000. The two patients who had positive first clinical examination with abnormal hip sonogram and on the follow up visit the abnormality were the same, were as following:

The first patient was female, ten days old, 35 weeks gestational age, her birth weight was 2100 g. Cephalic presentation, vaginal delivery, negative family history for DDH. Her Barlow and Ortolani test was positive by feeling a clunk (reducible dislocation) for both hips. U\S done on the same day and it disclosed Graf's III of both hips. Four weeks later examination results were the same so we refer her to an orthopedic surgeon whom treated her with Pavilak harness for 2 months with good outcome.

The second patient was male, 11 days old, 37 weeks gestational age, his birth weight was2600 g. Cephalic presentation, vaginal delivery and negative family history for DDH. He had clunk with Barlow and Ortolani test of the left hip (reducible dislocation). U/S examination revealed Graf's IIc. Follow up at the age of 6 weeks still showing reducible dislocation of the left hip while the U/S detected Graf's IIc with femoral head coverage less than 30%. The patient referred to the orthopedic surgeon and was treated with Pavilak harness.

Over all the number of hips examined were 1000 hips, of them 979 showed normal clinical examination with Graf's type I-IIa. 16 were clinically normal but pathologic hips sonography [Grafs'IIc-III] that turned to be normal on follow up visit. 2 hips were pathologic on clinical examination with Graf's type I which return normal at the follow up visit, and the remaining 3 hips were pathological both clinically and by U/S (Graf's IIc, III both in 1st and 2nd visit (as shown in table 4 &5)

DISCUSSION

DDH is certainly an important condition to screen for. However, there is some debate about the method used for screening and the appropriate time. In our study, we found that the frequency of DDH in this sample of Iraqi neonates was 4 in 1000. The incidence per 1000 live births worldwide ranges from 0.06 in Africans in Africa to 76.1 in Native Americans with significant variability between and within racial groups and geographic location, the incidence of clinical neonatal hip instability at birth ranges from 0.4 in Africans to 61.7 in Polish Caucasians[6]. The incidence of clinical neonatal hip instability is 4.9 in Dammam, Saudi Arabia [17], and 36.5 in Abha, Saudi Arabia [18]. In Dubai, UAE, the incidence is 3.17 [11]. In Ankara, Turkey, it is 1.7 [19].

This wide variability in the incidence in DDH is due to different definitions of hip dysplasia, different methods of diagnosis (e.g., physical exam, plain radiographs, ultrasound), different ages of the population studied (e.g., new born, 1 month old, 3 months old, etc), clinical experience of the examiner [20], in addition to different ethnicities/races in the examined population, and different geographic locations within similar ethnic population [21, 22.

In the present study, it has been found that U\S examination had more false positive results than clinical examination (84.2% verse 60%), with high concordance between the 2 examinations in the second visit in comparison with the first one. This was similar to other studies like what was found by Rosendahl K, Toma P [23], who noted that 97% of sonographically immature hips tend to normalize spontaneously within 3 months.

Some authors do not advocate the routine use of ultrasonography to screen all neonates for DDH. Castelein *et al*. reported that in 101 hips in their series, ultra-sonographic findings were abnormal, and clinical examination findings were normal [24]. None were treated, and after six months DDH developed in four hips. The authors concluded that ultrasonography may be too sensitive because it also identifies clinically unimportant instability. Clarke *et al*. recommend the use of ultrasonography in infants who are at risk and have positive clinical examination findings [25]. The sensitivity, specificity, positive predictive value and negative predictive values of having abnormal clinical hip examination findings were 100.0%, 88.9%, 1.6% and 100.0%, respectively [26].

Reasons of this mismatch in the results between clinical and U\S examination may be as follows: The structure of the hip in the early birth time is influenced by the maternal hormones [27]. So the immature hip can naturally be existed in the first few days to weeks and this immature laxity of hip although not so considerable to make usual clinical tests positive, can be detectable on the U\S examination.

They conclude that physical examination is the cornerstone of DDH screening and that serial hip examinations performed during health examination visits provide an opportunity to identify DDH cases. On the contrary of these studies, other studies suggest the priority of U\S examination over the clinical one. Marks *et al*. reported that ultrasound screening for DDH can detect cases of instability not diagnosed at birth by routine clinical examination and in infants who have no risk factors for DDH [28].

Tonnis *et al.* [13] and Rosenberg *et al*. [27] reported respectively that 52.2% and 50% of the ultrasonographically pathological hips in their studies had no clinical sign of instability. Omeroglu and Koparal found that ultrasonography can detect acetabular dysplasia in patients whose clinical examination findings are normal [29].

This diversity in the results of different studies can be attributed to the fact that physical and U\S examination accuracy is operator dependent as experienced individuals are essential for accurate analysis and diagnosis of DDH [30]. In addition a single examination of the neonate will not exclude the appearance of DDH as it may develop later on with growth as DDH is an evolving disease [2, 3].

Limitation of the study

There are few limitations to our study. The number of the neonates participated in this study (500) were small in comparison with other studies in spite of the long duration that it took place in (2years). In addition, the follow up period was only 4to6 weeks, an

age when the hip joint is still developing where there is a possibility of acquiring DDH later on.

The reason behind these limitations was the difficulty in convincing the parents to do U\S examination to their normal infants at the first examination and also for those who require follow up.

CONCLUSION

According to the present study, in the screening of early DDH, the frequency of DDH was 4 in 1000 in this sample of Iraqi neonates. There was a high false positive result (84.2%) in the diagnosis of DDH by hip U\S examination in comparison to clinical examination (60% false positive), with high concordance between the 2 examination in the second visit in comparison with first one.

RECOMMENDATION

All neonates should undergo regular physical examination for early detection of DDH as a part of screening programs for detection of DDH in the primary care center and in the private clinic in every infantile follow up visit.

Encourage educational programs for the Iraqi families about the importance of early detection of DDH and the consequence of missing diagnoses. Emphasize the training of the medical students for the appropriate way of the physical examination for DDH.

Further studies in a larger population are required for more epidemiological information about the incidence and the prevalence of DDH in Iraq and to evaluate the role of selective versus nonselective ultrasound screening programs in our society in relation to the cost effectiveness and the effect of early detection in prevention of late DDH (early adulthood).

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