The Egyptian Journal of Hospital Medicine (July 2022) Vol. 88, Page 3319-3324

Prevalence of Developmental Dysplastic Hip in Zagazig University Hospitals; Ultra-Sound Study

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ABSTRACT
Background: Developmental Dysplastic Hip (DDH) is common impaired development in newborns. Ultrasound (US) is the gold standard for assessing hip development in infants younger than six months.
Objective: This study aimed to detect diagnostic accuracy of ultrasound examination for hip joint in neonates and to detect possible risk factors related with prevalence of DDH.
Patients and methods: A total of 525 infants were referred to the Radiology Section at Zagazig University Hospitals after showing indicators of hip instability during their neonatal examinations. They were included in this cross-sectional trial. All patients were subjected to thorough history and clinical evaluation as well as US modality.
Results: Of the 5,360 hip joints analyzed, 89.57% were categorized as type Ia or Ib by Graf, 10.19% as type IIa, and 0.24% as types IIc to IV. There was significant differences between clinical and sonographic assessments. A greater birth weight was found to have a negative impact on the α-angles in univariate regression analysis, as was a later delivery (by weeks) beyond the due date. Birth weight, female gender, and a family history of DDH were found to significantly affect α-angles-angles by multiple regression analysis ($p<0.0001$, $p<0.0001$, $p=0.005$ successively).
Conclusion: There were significant differences between clinical and sonographic assessments. We also detected some possible risk factors related with prevalence of DDH. In comparison to 2D ultrasound, DDH detection with 3D ultrasound took less time and had higher inter-rater reliability.
Keywords: Ultra-Sound, Developmental dysplastic hip.

INTRODUCTION

Impairment in hip development, known as developmental dysplasia of the hip (DDH). It is a frequent problem in neonates [(1)]. DDH is a collection of anatomical anomalies brought on by a misalignment of the femoral head in relation to the hip socket. Variables including the prevalence of women [(2)]. Predisposition to DDH has been linked to factors such as being born to a white mother, having a low birth weight, being born breech, having a mother with high oestrogen levels, and being born into a socially and emotionally unstable environment. Complications arise when a diagnosis is delayed. It is undeniable that early diagnosis is crucial for the long-term therapeutic success of newborns with hip dislocation [(3)]. The recognized approach for identifying DDH is routine clinical screening of neonates with the Ortolani/Barlow maneuvers. Nevertheless, the sensitivity and specificity of the clinical tests may be inadequate. Furthermore, throughout early childhood, cartilage forms the majority of the hip joint, which cannot be seen on simple radiographs [(4)].

When examining the hip in infants younger than 6 months of age, ultrasound (US) is the technique of choice. It combines the advantages of dynamic examination of the hip with stress movement and direct imaging of cartilaginous regions of the hip that cannot be seen on standard radiographs [(5)]. Hip issues that are missed by clinical and radiographic exams can be found with ultrasonography, and the joint's stability can also be assessed [(3)]. When combined with a clinical examination, sonography may usually help doctors diagnose DDH in the first few weeks of a baby's life so they can begin therapy right away. DDH is thought to fall on a continuum of congenital hip diseases, and many of its problems can be detected with early clinical screening [(6)].

Increased surgical intervention and the onset of crippling end-stage adolescent degenerative hip joint disease are both risks associated with a delayed diagnosis of DDH in children [(7)].

In order to better understand the development of the hip joint in babies, **Dahlstrom *et al.*** [(8)], used a variety of ultrasonic techniques. **Graf** [(9)] set the gold standard for ultrasonography of the hip in infants [(10)].

Another widely used measuring technique is femoral head coverage method, which calculate the percentage of acetabular coverage around the femoral head [(11)].

The aim of this study was detecting diagnostic accuracy of ultrasound examination for hip joint in neonates and detecting possible risk factors related with prevalence of DDH.

PATIENTS AND METHODS

This cross-sectional current study included 525 infants referred to Radiology Department (Diagnostic Radiology), Zagazig University Hospitals.

Inclusion Criteria: All infants less than 6 months.
Exclusion Criteria: Children more than 6 months.

Ethical consent:

Research Ethics Council at Zagazig University approved the study (ZU-IRB#6652) as long as parents of all participants provided informed

Received: 01/03/2022
Accepted: 28/04/2022

consent forms. Ethics guidelines for human experimentation were adhered to by the World Medical Association's Helsinki Declaration.

All studied groups underwent the following:

- Complete history taking including delivery (normal or C section).
- Full clinical examinations.

Early clinical manifestations of DDH.

The classic examination finding is revealed with the

Ortolani maneuver [12]. When the hip is moved in and out of the acetabulum and across the neolimbus, a discernible "clunk" is heard and felt. There is probably not much of a connection between a high-pitched "click" (as opposed to a clunk) and acetabular pathology. This creaking sound was first noted by Ortolani, who associated it with hip subluxation or reduction (in or out of the acetabulum). Typically, the Ortolani sign is described as a clunk felt as the hip lowers into the acetabulum while the hip is in abduction. It is important to use caution when doing the Ortolani manoeuvre, the surgeon's fingertips should not turn white.

Clinical evaluation for DDH in the late infantile (age 3–6 months) period varies significantly from that of early DDH.

- If the hip is dislocated at this point, it is usually displaced in a permanent posture.
- Unilateral hip dislocation is typically diagnosed with the help of the Galeazzi sign.

Hip ultrasound examinations for detecting DDH:

The 7MHZ linear array transducer is used to capture a single coronal image of the hip, and its placement is analysed in detail. The child's hips are flexed to 90 degrees while they are put in a lateral position. A coronal section is taken through the middle of the acetabular roof using an ultrasonic probe positioned in a coronal plane parallel to the spine. The presence of the three points below designates this plane as the "standard.": (1) A boney extension of the hip socket located below the acetabulum. (2) The anatomical region of the acetabular roof located roughly at the middle. (3) Specifically, the labrum of the acetabulum.

The alpha and beta angles are commonly used in ultrasound examination. The alpha angle describes the slant of the acetabulum's superior aspect; a value greater than 60 degrees is considered to be within normal range. The cartilaginous component of the acetabulum is represented by the beta angle, which is considered normal if less than 55 degrees.

Statistical analysis

In order to analyze the data acquired, Statistical Package of Social Services version 20 was used to execute it on a computer (SPSS). In order to convey the findings, tables and graphs were employed.

The quantitative data were presented in the form of the mean, median, standard deviation, and confidence intervals. The information was presented using qualitative statistics such as frequency and percentage. The student's t test (T) is used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square and Chi-Square for Linear Trend (X^2) were used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined.

RESULTS

525 child were screened with mean age of 16.49 weeks and female predominance 66.3% and male in 33.7% (Table 1).

Table (1): Demographics (n = 525)

	No.	%
Sex		
Male	177	33.7
Female	348	66.3
Age (weeks)		
Min. – Max.	8.0 – 21.0	
Mean ± SD.	16.49 ± 3.97	
Median (IQR)	18.0 (12.0 – 21.0)	

Risk factors among affected children included mode of delivery mostly NVD in 65.3% and CS in 34.7%, oligohydramnios in 2.7%, breech presentation in 1.1%, family history founded in 2.1%, associated anomalies in 1% (Table 2).

Table (2): Risk factor distribution (n=525)

Risk factor	No.	%
Mode of delivery		
CS	182	34.7
NVD (Natural vaginal delivery)	343	65.3
Oligohydramnios	14	2.7
Breech presentation	6	1.1
Family history	11	2.1
Associated malformations	5	1.0

As regards hip joint, it was Congruous in 98.3% in Rt hip and 98.5% in Lt and immature in 1.7% in Rt and 1.5% in Lt. Modified Graf was, Graf Type I in 96% in Rt hip, 97.3% in Lt hip, Graf Type IIa in 1.7% in Rt hip and 1.1% in Lt hip, Graf Type IIb in 1.9% in Rt hip and 1.3% in Lt hip and Graf Type IIc in 0.4% in Rt and 0.2% in Lt. Mean alpha angle was 66.61 in Rt hip and 66.84 in Lt hip. As regards mean b angle, it was 42.14 in Rt hip and 42.06 in Lt hip (Table 3).

Table (3): Hip type distribution (n=525)

Hip type	Rt		Lt	
	No.	%	No.	%
Hip joint				
Congruous	516	98.3	517	98.5
Immature	9	1.7	8	1.5
Modified graf				
Graf Type I	504	96.0	511	97.3
Graf Type IIa	9	1.7	6	1.1
Graf Type IIb	10	1.9	7	1.3
Graf Type IIc	2	0.4	1	0.2
Alpha angle				
Min. – Max.	43.0 – 70.0		43.0 – 70.0	
Mean ± SD.	66.61 ± 2.74		66.84 ± 2.32	
Median (IQR)	67.0(66.0 – 68.0)		67.0(66.0 – 68.0)	
Angle				
Min. – Max.	34.0 – 72.0		34.0 – 72.0	
Mean ± SD.	42.14 ± 6.12		42.06 ± 5.49	
Median (IQR)	43.0(35.0 – 46.0)		43.0(35.0 – 46.0)	

IQR: Inter quartile range SD: Standard deviation

Hips were deemed normal and not sent to the clinic for further evaluation in 95.6% of cases, unstable and referred to the "one-stop" clinic for further evaluation in 4.2% of cases, and irreducible hip dislocations were found in 0.2% of cases that were not referred during the neonatal period (Table 4).

Table (4): Distribution of the studied cases according to clinical assessments result (n = 525)

Clinical assessments result	No.	%
- Normal hips that were not referred	502	95.6
- Referred as unstable hips and were diagnosed as unstable in the 'one-stop' clinic	22	4.2
- Irreducible hip joint dislocation not referred in the neonatal period; "late dislocations	1	0.2

Clinical assessments were positive in 4.4% of children in comparison to ultrasound assessments were positive in 5.7% of children and 94.3% were normal (Table 5).

Table (5): Clinical positive and sonographic assessment (n = 525)

	No.	%
Clinical positive		
Normal	502	95.6
Positive	23	4.4
Sonographic assessment		
Normal	495	94.3
Positive	30	5.7

Concerning mode of delivery, CS was in 35.8% of normal sonographic result and in 16.7% in positive sonographic results on the other hand NVD was in 64.2% in normal sonographic results and in 83.3% in positive sonographic results.

As regards oligohydramnios, it was 0.2% of cases in normal sonographic results and in 43.3% in positive sonographic results. Breech presentation was founded among 0.2% of normal sonographic results and in 16.7% in positive sonographic result.

Family history was found among 0.2% of normal sonographic finding and in 33.3% in positive finding. Associated anomalies were found in 0.2% in normal sonographic finding and in 13.3% of positive sonographic finding.

As regards relations between sonographic results, there was significant relation between NVD mode of delivery, oligohydramnios, breech presentation, family history and associated anomalies (Table 6).

Table (6): Relation between sonographic assessment and risk factor

Risk factor	Sonographic assessment				χ^2	P
	Normal (n = 495)		Positive (n = 30)			
	No.	%	No.	%		
Mode of delivery						
CS	177	35.8	5	16.7	4.552*	0.033*
NVD	318	64.2	25	83.3		
Oligohydramnios	1	0.2	13	43.3	202.732*	FEp<0.001*
Breech presentation	1	0.2	5	16.7	67.869*	FEp<0.001*
Family history	1	0.2	10	33.3	151.359	FEp<0.001*
Associated malformations	1	0.2	4	13.3	51.705*	FEp<0.001*

Regarding sensitivity, specificity, PPV, NPV and accuracy of sonographic assessments in comparison with clinical results, they were 73.33, 99.8, 95.65, 98.41 and 98.29% respectively (Table 7).

Table (7): Relation between sonographic assessment and clinical positive

Clinical positive	Sonographic assessment				Sensitivity	Specificity	PPV	NPV	Accuracy
	Normal (n = 495)		Positive (n = 30)						
	No.	%	No.	%					
Normal	494	99.8	8	26.7	73.33	99.80	95.65	98.41	98.29
Positive	1	0.2	22	73.3					
χ^2(FEp)	361.128*(<0.001*)								

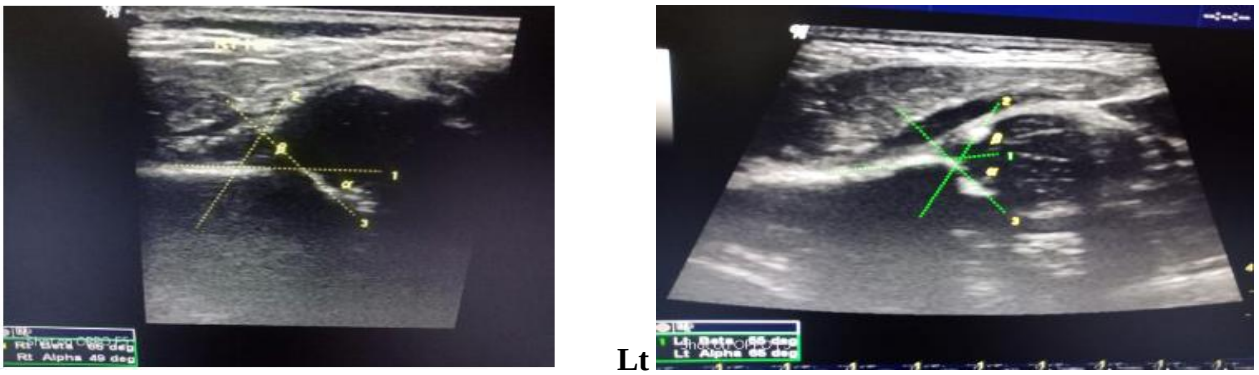

Fig. (3): Female child patient, aged 3 months. History of return with gestational age 34 weeks. Parent complained of less mobility of Rt hip, Ultrasonographic findings: Rt hip B 65° Type IICα 49° Lt hip B 55° type I normal mature hip α 65°.

DISCUSSION

DDH occurs in infants at a rate between 1% and 7% in some communities. Differences exist, and they may stem from both innate personality traits and learned social norms. Since the introduction of clinical and sonographic screening, there has been a dramatic rise in the number of cases recorded, which may indicate that there has been an increase in overdiagnosis [13].

There are a number of diagnostic and preventative screening options for people with DDH. The clinical examination of a newborn involves the Ortolani and Barlow techniques, and the medical history of the mother and child is also determined. Because cartilage is visible in ultrasound screening, aberrant alignment of the femoral head within the acetabulum, instability, and dysplasia can be detected at a very young age. This imaging method was developed in particular by **Graf [14], Harcke and Grissom [15] and Terjesen *et al.* [16].**

Some people think that ultrasonography-detected DDH needs to be treated immediately or monitored closely. Supporters of ultrasound screening assume that untreated cases will have a negative outcome, while opponents of the practice point to the high risk of overtreatment and argue that the cost-benefit ratio does not justify the procedure [17]**.** Therefore, in several European nations like Germany and Switzerland, it is common practice to test all newborns for DDH using ultrasound imaging shortly after birth. However, this approach has not been widely adopted in the United Kingdom, the United States, or Scandinavia [18]**.**

In the present study, 525 child were screened with mean age of 16.49 weeks and female predominance (66.3%) and male in 33.7%. More women than men are impacted. These findings corroborated those of **Weinstein [19],** who found that eighty percent of DDH cases were female newborns. **Paton [20]** reported that females had seven times the risk of developing DDH than males. According to the study's authors **De Hundt *et al.* [21], Ortiz-Neira *et al.* [22], Abdullah and Zytoon [23]** and **Woodacre *et al.* [24],** the prevalence of DDH in women is two to seven times higher than in men. Ligamentous laxity and the increased risk of DDH are both likely caused by estrogen that circulates from both the mother and the fetus. DDH patients had more estrogen receptors than controls, suggesting that hormones play a role in the disease's etiology.

It was determined how the femoral head related to the acetabulum using ultrasonographic results, as defined by Graf''s criteria, and the various stages of DDH were classified accordingly. The USG-based standardized quantitative approach is commonly utilized for DDH detection [23]**.**

As regards hip joint was Congruous in 98.3% in Rt hip and 98.5% in Lt and immature in 1.7% in Rt and 1.5% in Lt modified. Concerning Graf, there was Graf type I in 96% in Rt hip, 97.3% in Lt hip, Graf type IIa in 1.7% in Rt hip and 1.1% in Lt hip, Graf type IIb in 1.9% in Rt hip and 1.3% in Lt hip and Graf Type IIc in 0.4% in Rt and 0.2% in Rt. Mean alpha angle was 66.61 in Rt hip and 66.84 in Lt hip. Mean b angle was 42.14 in Rt hip and 42.06 in Lt hip.

Type II was 44% in the Rt hip and 46% in Lt hip with increased affection in females than males. Type II

in the Rt side was 22%, type IIa, 18% type IIb and 4% type IIc. Graf type II in Lt side was distributed as 18% type IIa, 22% type IIb, 4% type IIc and 2% type IID. This is parallel with **Dante *et al.*** [26] who demonstrated that type IIa was from 23.6 to 57.6% and type IIc-IId range between 0.8 to 7.0%. **Roovers** [27] demonstrated that the frequency of type II was 32% IIa, 1.9% IIb), 0.7%. Type IIc. **Omeroglu *et al.*** [2] reported that among the hips they examined there were 86.3% type I, 12.7 % type IIa, 0.4% IIc and 0.5% type IID. This is consistent with the findings of **Guille *et al.*** [28]**,** who found that 60% of children had involvement only in the left hip, 20% in the right hip, and 20% in both hips, the left hip was more commonly impacted than the right hip. **Abdullah and Zytoon** [23] reported that hip dysplasia, when unilateral (as in 80% of instances), is up to four times more likely to afflict the Lt than the Rt hip. This is explained by the study's authors, who found that 16% of the right hips of the study group had Graf type-II and 23.7% of the left hips had. The most typical fetal position (Lt occiputanterior) causes adduction of the Lt hip because of its proximity to the maternal sacrum.

As regards relations between sonographic results there was significant relation between NVD mode of delivery, oligohydramnios, breech presentation, family history and associated anomalies. **Mace & Paton** [29] demonstrated a non-significant (Spearman's coefficient 0.127; one-tailed p = 0.326) but steady increase in referrals over the course of 15 years. Forty of the 48 clinically unstable hips at birth (or 83%), and 74 of 99 (74%) Graf type IV hips, occurred in females.

Increases in birth weight (per 100 g) were found to have a negative effect on α -angles (β=0.071, p0.0001, 95 percent CI: 0.096 to 0.046) in a univariate regression analysis.

The risk of developing DDH is increased in people who have a positive family history compared to those who do not [30], especially among first-degree relatives. Increased risk of DDH in infants has been consistently linked to a positive family history of the condition. Additionally, **Sutton** [31] observed that children born via caesarean section are more likely to have associated instability and dislocations. **Abdullah and Zytoon** [23] discovered that caesarean section delivery was the most common risk factor in our cohort (52.2 percent). However, **Dante *et al.*** [26] found that family history was the most common risk factor, while oligohydramnios was the second most common..

While the American Institute of Ultrasound in Medicine has recommended that ultrasound screening not be performed in infants with clinical signs or risk factors for DDH until they are 3-4 weeks of age due to the normal physiologic laxity that resolves spontaneously by 6 weeks of age, our study found a higher prevalence of cases with DDH as we target the high risk infants [32]**.**

As regard sensitivity, specificity, PPV, NPV and accuracy of sonographic assessments in comparison to clinical results was 73.33, 99.8, 95.65, 98.41 and 98.29% respectively.

In detecting abnormal hip results, USG was shown to be more accurate than physical examination with or without the presence of risk factors. Dislocated or dislocatable hips are far less common, being discovered in just around 1.15% (1 in 1000) of live infants. However most newborn screening studies estimate that this level of instability can be observed in anywhere from 1% (in 100 babies) to 5% (in 250 babies). Applying Graf's criteria of ultrasonography to examine hip dislocation or instability revealed few anatomic anomalies found early, most of which will not impair the later development of the hip, which will go on to become normal [33].

CONCLUSION

There were significant differences between clinical and sonographic assessments. We also detected some possible risk factors related with prevalence of DDH. When compared to 2D ultrasound, DDH detection with 3D ultrasound took less time and had higher inter-rater reliability. The technical ependence of the operator can be decreased and the user-friendliness of 3D ultrasound can rise, both of which contribute to the technology's rising popularity. After the first month, the USG can be used to reduce the number of infants who have a delay in treatment for DDH and its consequences. Early USG use increases the likelihood of identifying, treating, and preventing problems in newborns at high risk.

Conflict of interest: The authors declared no conflict of interest.
Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Author contribution: Authors contributed equally in the study.

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