Role of Ultrasound in assessment of Developmental Dysplasia of the Hip Joints

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Abstract

Background: Developmental dysplasia of the hip (DDH) include spectrum of anatomical abnormalities of the hip joint (dislocated, subluxed ,and dysplasia) arising from a deviation in normal hip development during embryonic, fetal and infantile growth periods. the use of ultrasonography is recommended as well as the clinical evaluation. It is the best to clarify the physical finding, detect a high-risk infant and monitoring DDH to be observed or treated

Objectives: Ultrasound has provided increased accuracy in comparison to the clinical and radiographic examinations which has been the accepted techniques for evaluating the hip in the first year of life

Patients and methods: The current study was a retrospective study conducted at qena university hospital from 2019 to 2020.ultrasound machine used to obtain alpha angle , assessment of structural anatomy and hip joint stability.

Results: right leg affection is represented in 25% for clinically suspected analyzed cases. Left leg represent 30% , both legs represent 40% .

Conclusion: Ultrasonographic techniques include static assessment of morphologic features of the hip, as popularized in Europe by Graf and a dynamic evaluation, as developed by Harcke that assesses the hip for stability of the femoral head in the socket, as well as static anatomy. The use of ultrasonography is recommended as an adjunct to the clinical evaluation. It is the technique of choice for extract a physical finding ,detect a high-risk infant and monitoring DDH to be observed or treated.

Keywords: Developmental Dysplasia of the Hip; Ultrasonography; Infants, legs

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Introduction

Developmental dysplasia of the hip (DDH) include multiple pathologic conditions, varying from subtle acetabular dysplasia to irreducible hip dislocation with proximal femoral displacement **(Vivek et al., 2013).**

The reported incidence of DDH varies from 1.5 to 2.5 per 1000 live births. Unlike "congenital dysplasia of the hip", DDH is not limited to congenital malformation, but also includes developmental disturbance. Good evidence exists to suggest that untreated dysplasia will culminate in degenerative joint disease *(***Vivek et al., 2013***).*
The detection of DDH not only by orthopedic specialists but also radiologists and pediatricians and is mostly based on ultrasonographic (US) evaluation *(***Ivan et al., 2011).**

The earlier treatment for hip dysplasia results in higher probability of success. It should be diagnosed within the first six weeks of life. Recently, the increasing use of ultrasound is a good window for early detection this disorder. Today, it represents the best choice technique for screening newborns for dysplasia of the hip during the first months of life **(Dessì et al., 2009).**

Ultrasound imaging techniques allows the visualization of the femoral head and acetabular cartilage at a very young age and can detect abnormal positioning, instability and dysplasia *(***Anand et al., 2011).**

The use of ultrasound in the detection of DDH was first suggested by Graf in the 1980s. Since then many different techniques modified which included into two main groups: static tests to assess morphology and dynamic tests to assess stability *(***Mathew et al., 2011).**

The static evaluation method assigns hips to one of four groups on the basis of the bony acetabular roof modelling (α-angle), cartilaginous roof (β-angle) and bony rim. Dynamic tests simplified by Harcke et al. ,by stressing the hip in a technique similar to the Barlow maneuver to judge stability using real-time ultrasonography. The examined Hips are tabulated as normal, subluxated or dislocated. Dynamic technique operator should have skill in performing the examination and good images comment **(Mathew et al., 2011).**

Ultrasound of the hips for developmental dysplasia of the hip (DDH) was introduced at least 25 years ago and has had a tremendous impact on the early detection of DDH. Although there are continuing controversies regarding what type of scan to perform, when to perform the scan, and which infants should have a scan *(***Leslie et al., 2008).**

We aimed to highlight the role of ultrasound in assessment of newborns with suspicious clinical diagnosis of developmental dysplasia of hip joints..

Patients and methods

The current study was retrospective study conducted at qena university hospital, the period from 2019 to 2020

Patients: The patients clinically suspected to have hip dysplasia , they referred from orthopedic surgery department the study included 20 patients with the following criteria

*Inclusion criteria**:** Clinically suspected to have hip dysplasia ,who clinically examined by referral clinician by barlow and ortalani tests and age less than 6 months

*Exclusion criteria**:** age more than 6 months and patient who receive operative treatment

Ultrasound machine and technique

Superficial and musculoskletal probes used at ultrasound unit of Radio-diagnosis Department at Qena University Hospital

****Graph technique*** :US examination of the infant hip while the baby lying in the lateral decubitus position, **(Falliner et al., 2009)**. coronal scan of the hip joint representing the deepest point of the acetabulum is the reference plane for taking alpha angle measurement measurements, With knees slightly flexed. but the hip can also be placed in neutral or slight internal rotation **(Graf, 2004) ,** then two lines drown ,the first one is the iliac line (baseline), it pass tangential to the wing of ilium, the second one named acetabular roof line, that joins the promontory with the deepest edge of the acetabulum**;** The crisscrossing of those two lines forms the α angle (acetabular inclination angle)

sonographic hip type of examined hips according to graf classification include:

Type Ia (alpha angle >60^0) (considered normal hip)…Type IIa (alpha angle measures 50-59^0 ,** age less than one month baby)(considered stable

hip)...**Type IIb (alpha angle measures 50-59^{o}) (inherentlstable hip)…**Type IIc (alpha anglemeasures 43-49^{o})(cosidered unstable hip)...**Type IIIa (alpha angle <43^{o}without structural changes)(considered dislocated hip)…**Type IIIb (alpha angle measures<43^{o} with structural changes) (considered dislocated hip)…** Type IV(non measurable alpha angle)(definite dislocation hip)

****Herckle technique:**The infant is examined supine using a four- step scanning technique based on coronal and transverse planes obtained in neutral and flexion positions, at rest and during stress.to assess stability of hip joint **(Harcke et al., 2004).**

Statistical analysis

Analysis of data was performed by statical package for social sciences (SPSS) as follows:

1-describtion of quantitative data as mean and standard deviation

2- description of quantitative data as a number and percentage (%) and frequency

3-Chi-square test is used to compare qualitative parameters

Ethical consideration: written consents was obtained from many participants and verbal consents were obtained from most participants. Confidentiality was be secured and access to the data on the participants were be allowed only to the researcher.

Results

Table 1. Patient characteristics

Variables		Frequency /mean	Percent
Age (weeks)		7.8±5.1	
Sex	Male	7	65%
	Female	13	35%
Oligohydrmmnios	Yes	4	20%
	No	16	80%
Cesarean section	Yes	14	70%
	No	6	30%
Breach presentation	Yes	12	60%
	No	8	40%
Preterm	Yes	4	20%
	No	16	80%
Associated structure change	Yes	1	5%
	No	19	95%
Examined leg	Right	5	25%
	Left	6	30%
	Bilateral	9	40%

Table 2. Right leg graphic classification and susceptible risk factors

Variables		Right leg graphic classification						P value
		Ia 1	IIa 4	IIb 1	IIc 1	IIIa 2	IIIb	
Age(weeks)		11±7	2.5±.7	12	3±1.4	7±1.4	7±5.5	.419
Sex	**Male**	3(75%)	0(0%)	1(100%)	0	0	1(50%)	.172
	Female	1(25%)	2(100%)	0	2(100%)	2	1	
Oligohydrmmnios	**Yes**	1(25%)	0	0	0	0	1(50%)	.693
	No	3(75%)	2(100%)	1(100%)	2(100%)	2(100%)	1(50%)	
Cesarean section	**Yes**	1(25%)	1(50%)	1(100%)	2(100%)	2(100%)	2(100%)	.211
	No	3(75%)	1(50%)	0	0	0	0	
breach presentation	**Yes**	1(25%)	1(50%)	0	2(100%)	1(50%)	2(100%)	.310

	No	3(75)	1(50%)	1(100%)	0	1(50%)	0	
Preterm	**Yes**	1(25%)	0	0	1(50%)	0	1(50%)	.678
	No	3(75%)	2(100%)	1(100%)	1(50%)	2(100%)	1(50%)	
Associated structure change	**Yes**	0	0	0	0	0	1(50%)	.310
	No	4(100%)	2(100%)	1(100%)	2(100%)	2(100%)	1(50%)	

Table 3. Left leg graphic classification and susceptible risk factors

Variables		**left leg graphic classification**						**P value**
		Ia	IIa	IIb	IIc	IIIa	IIIb	
Age		1.5±.7	2.5±.7	10±2	4±2	9±4	12	.058
Sex	Male	2(100%)	0	1(50%)	0	0	1(100%)	.05
	Female	0	2(100%)	1(50%)	4(100%)	4(100%)	0	
Oligohydrmmnios	Yes	1(50%)	0	2(100%)	1(25%)	0	0	.05
	No	1(50%)	2(100%)	0	3(75%)	4(100%)	1(100%)	
Cesarean section	Yes	1(50%)	1(50%)	2(100%)	4(100%)	3(75%)	1(100%)	.4
	No	1(50%)	1(50%)	0	0	1(25%)	0	
breach presentation	Yes	1(50%)	1(50%)	2(100%)	4(100%)	3(75%)	1(100%)	.04
	No	1(50%)	1(50%)	0	0	1(75)	0	
Preterm	Yes	1(50%)	0	1(50%)	2(50%)	0	0	.2
	No	1(50%)	2(100%)	1(50%)	2(50%)	4(100%)	1(100%)	
Associated structure change	Yes	0	0	0	0	0	1(100%)	.003
	No	2)100%)	2(100%)	2(100%)	4(100%)	4(100%)	0	

Table 4. Relation between right leg graph classification and alpha angle measure of the right hip.

right leg graphic classification	**Alpha angle measure**	**P value**
Ia	70.2±4.2	.002
IIa	56.5±2.1	
IIb	50	
IIc	45±.01	
IIIa	36.4±9	
IIIb	41.5±9	

Table 5. Relation between left leg graph classification and alpha angle measure of the left hip

Left leg graphic classification	**Alpha angle measure**	**P value**
Ia	69±1.4	000
IIa	54±1.4	
IIb	50	
IIc	47.5±2.5	
IIIa	37.3±3.3	
IIIb	30	

Case presentation

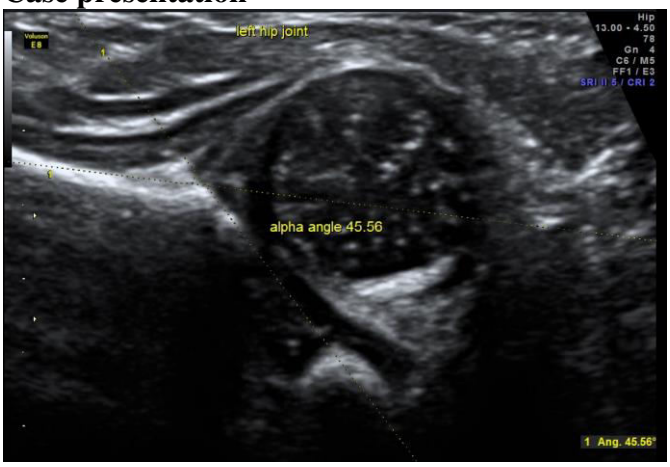

Fig.1. On point of dislocation (unstable)left hip

Female patient two months clinically suspected to have hip dysplasia of left hip with history of caesarean section and breach presentation
Ultrasound examination revealed: (**Fig.1**)
* Alpha angle measures 45.5 degree
*rounded Superior bone rim
*compressed cranially cartilaginous rim
* No structural changes
*Graf type IId

Fig.2. On point of dislocation (unstable) right hip

Female patient two months clinically suspected to have hip dysplasia of right hip with history of cesarean section and breach presentation
Ultrasound examination revealed: (Fig.2)
* Alpha angle measures 46degree
*rounded Superior bone rim
*compressed cranially cartilaginous rim
* No structural changes
*graf type IIc

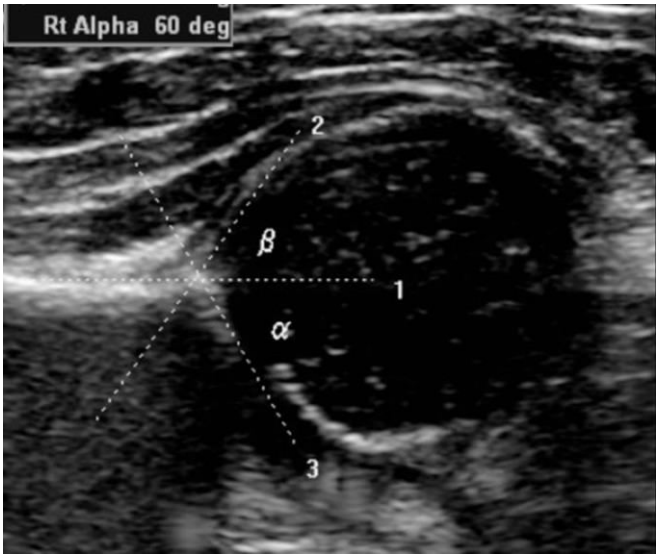

Fig.3. Normal right hip

Male patient three months clinically suspected to have hip dysplasia of left hip with history of cesarean section and breach presentation
Alpha angle measures 60 degree
Ultrasound examination revealed: normal right hip **(Fig.3).**

Discussion

In our study , 20 babies examined, According to the Graf classification, we consider normal values of alpha angle above 60°.Ultrasound examination was performed using General Electric Logiq B8 (General Electric Company (GE) multifunctional equipment, in the field, using a linear probe type , musculoskeletal probe (6-15MHz) , The data for this study were collected using unitary ultrasound examination reports. he parameters monitorized and analyzed were represented by demographic data (age, gender, medical history), ultrasound data (values of alpha angle, ultrasound examination of alpha angle type according the Graf classification,

Data collected from the ultrasound and clinical files were computerized, stored, and processed. The statistical analysis was performed using SPSS (IBM) statistical software. The article reports frequency tables and percentages. Descriptive statistics are based on central trend indicators (average, median) and the dispersion indicators were expressed by the minimum and maximum standard deviation (SD). In analytical or inferential statistics, we used Chi-squar

In our study , graf type Ia detected in four babies, three male and one female of right leg while left leg detected in two male,, graf type IIa detected in two female babies in right leg as left

leg ,, graf type IIb detected in two babies,, one male and one female presented in left leg only ,,graf type IIc detected in two female babies in right leg and four female babies in left leg ,,graf type IIIb detected in two babies ,,one male and one female while of left leg represented in one male baby.

In our study , type II is the most common , then type III then type Ia is rarest in this study. This finding show some disagreement with another study published in January 2019 by Simona Mureşan , revealed that the examination of both hips show the most frequent stage was type Ia, and the rarest stage was III. The Ia stage of right hip joints (87.3%) was higher than in the left hip joints (87.2%). As for type III, it was more common in the left hip joints (0.2%) compared with the right hip joints (0.1%). The statistical analysis of the database indicated the presence of only two cases (0.2%) of type IIa identified in the left hip joints. Frequency of type Ib in the right hip joints (12.6%) was higher than in the left hip joints (12.4%).(**Ali et al.,2017**).our study disagree with Omeroglu, that revealed 86.3% type I, 12.7 % type IIa, 0.4% IIc and 0.5%type IID (**Omeroglu ,2014)**

In our study ,Risk factors include Female sex (35% of examined children) involved in 100% dislocation of right and left legs and ,breach presentation (60% of examined children)involved in 100% of dislocated right and left legs , oligohydramnios (80% of examined children) show dislocation of 50% of examined right leg and 100% of examined left leg ,preterm (20%of examined children) involved in 50% of dislocated of right leg and 100% of left leg, cesarean section delivery(70%of examined children) involved in 100% of dislocated right and left legs, neer similar finding by aprospective study done at 2008 by song shows Risk factors include female sex (80% of the affected children) probably due to increased ligamentous laxity as a result of the circulating maternal hormone relaxin. The left hip affected in 60% of the children, the right hip in 20% ,bilateral involvement seen in 20%. commonly The left side is more involved, owing to the left occiput anterior positioning of most non-breech newborns where the left hip is adducted against the mother's spine which limit abduction**.** The breech position is probably the most important single risk factor, whether delivered vaginally or by caesarean section. Other risk factors include first born baby, postural deformities, oligohydramnios and a positive family history, the Latest reviews impress that prematurity is not a risk factor for hip dysplasia **(Song et al .,2008)**

In our study the left hip affected more than the right hip this is agree with Guille et al., reported that the left side is involved in 60% of the children, the right side in 20% and 20% have bilateral involvement(**Guille et al.,2000)**

In our study most common risk factor was breach presentation(60%) this was disagree with Abdullah and Zy-toon ,reported that the most prevalent risk factor was Caesarean section delivery(52.2%) as Caesarean section are more likely to have associated instability and dislocation (**Abdullah et al,.2015)**

In our study , according the reliability of α angle measurement, there is minor change in angle measurement between inter- and intra observer angle measurement (+/- one degree, that not affect the hip graf classification), a number of studies have been published in which the authors have attempted to assess inter- and intra observer agreement in angle measurement. However comparisons among such studies are limited by variations in methodology, including skill levels/ training of participants (and the detail in which these are described), case-mix and statistical methods used to analyse level of agreement. Rosendahl et al. described a comparison of two US examiners, with 5 and 2 years' experience respectively, in the acquisition and interpretation of US images. Notably, the study showed moderate interobserver agreement (κ 0.5) based on subjective classification of hips, with no improvement on agreement when measurement of the α angle was added. This may have been largely due to the fact that there was only fair interobserver agreement (κ 0.3) for α angle measurement between the two US examiners, with a low mean difference in α angle of 0.9° but relatively high standard deviation (SD) of 6.5°. In the same study, three separate observers measured α angles on the same images acquired by the more experienced US examiner. This resulted in a higher interobserver agreement for α angle measurement (mean difference 2°, SD 3.8°), (**Rosendahl et al. 1995).**

Small number of clinical studies have been published comparing hip assessment using the Graf method with that of FHC(femoral head coverage) measurement, with varying classifications/normal limits used for FHC. Falliner et al. in a study of 232 neonates , in their first 4 days of life, result in 1.3% of hips were pathological, according to the Graf method (IIc, D or IIIa), compared with 4.1%,

according to FHC measurement (with the lower limit of normal FHC defined as 44% in females and 47% in males). The authors comment that the results according to the Graf method better reflected the reported frequency (1–2%) of hip dysplasia in Europe.(**Falliner et al .2006)** , in our study, we use graf as it is most sensitive method

In our study there is no false negative or false positive with correlation of our finding with orthopedic examination ,this agree with a study done by Boal and Schwenkter, findings of 212 sonograms of infant hips that were correlated with radiographies, orthopedic examination, or both. There were no false-negative or false-positive results in congenital hip dysplasia infants diagnosed by US.**(Boal etal.,1985)**

Conclusion

Ultrasonographic techniques used for static evaluation of the morphologic features of the hip, as popularized in Europe by Graf ,and a dynamic evaluation, as developed by Harcke that assesses the hip for stability of the femoral head in the socket, as well as static anatomy. the use of ultrasonography is recommended as an adjunct to the clinical evaluation. It is the technique of choice for clarifying a physical finding, assessing a high-risk infant and monitoring DDH as it is observed or treated.

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