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Characterization of Developmental Hip Dysplasia in Saudi infants using Ultrasonography

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Abstract: *Developmental dysplasia of the hip (DDH) represents a spectrum of anatomic abnormalities that can result in permanent disability. Ultrasonography(US) technique allows evaluation of different anatomical structures and their pathological changes, in the bony profile of the joint surfaces, ischial tuberosity, and greater trochanter .The objective of this study is to characterize the DDH in Saudi infants using US .The study was conducted during the period extended from 2011 up to 2017. The hips of 536 newborn infants were examined by US using routines screening program for DDH at age 0days up to 4 months. The sample including 145(27.1%) females and 391(72.9%) males. All infants were examined clinically and underwent US of the hip.US was performed with a 7.5-3.5 ,5 MHZ, but most examination were performed with 3MHZ linear transducer (Toshiba, Philips 2010, volusum4000, Son layer SSA-270A, Japan)using Graf method.*

The most common affected age were ages<30 days, 280 were of type1, 9 were 2a < 3m, 75 were 2b >3m and 29 were 2c. 44 were type 3 and 30 were type 4 with significant relation with age at p=0.018, 0.000, 0.005 for type 1, 2, and 4 respectively .There is significant relation between type 2 and 3 dislocation and the risk factor.
When characterizing hip joint and its development in different types of DDH, results showed that the acetabulum is well developed in type 1 and least developed in type 3 and 4 significantly
the femoral head is outside the acetabuler cavity in both type 3 and 4 while it was found inside the groove in type 1 .The ischium is found to be well developed in type1 while in type 3and4 most of the cases were not developed .Normal Illiac line capsule, acetabular cartilage, Femoral head ligament were detected in type 1 where significant changes were detected in type 3 and 4 .
Regarding the results; US has documented its ability to detect abnormal position, instability, and dysplasia not evident on clinical examination as well screening of all infants at risk . Consequently, the use of US 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, it can guide treatment and may prevent overtreatment

Key word: *Graf Method, Hip dislocation, DDH*

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I. Introduction

Estimates of the incidence of developmental hip dysplasia (DDH) in infants vary between 1.5 and 20 per 1000 births.[1] The incidence of DDH in infants is influenced by a number of factors, including diagnostic criteria, gender, genetic and racial factors, and age of the population in question.[2] The reported incidence has increased significantly since the advent of clinical and sonographic screening, suggesting possible overdiagnosis.[3] In addition to a higher prevalence of DDH in females, reported risk factors for the development of DDH include a family history of DDH, breech intrauterine positioning, and additional in utero postural deformities.[4-6]However, the majority of cases of DDH have no identifiable risk factors[7]

The infantile hip ultrasonography method of Graf is the most widely used method. If the previously well-defined examination, interpretation and measurement techniques are meticulously followed, it is easy to manage the newborn hip problem by using this method .[8]In older children, a large femoral head ossification centre can obscure the visualization of the lower limb, which is essential for obtaining a standard plane, so this method is ultimately limited by the age of the patient [8].However, the Graf method may be used in older children if the visualization problem of the lower limb can be overcome [9]

According to the Graf ultrasonographic hip classification system, the a and b angles are the quantitative indicators of the bony and cartilage acetabular roofs, respectively. The a angle mainly determines the hip type and the other parameters, such as the age of the patient, b angle value, b angle value under stress, course of the perichondrium of the cartilage acetabular roof and structural changes in the cartilage roof, give particular differentiations [8] . A hip joint becomes ultrasonographically mature at 34 weeks of gestation [10] If an initially mature (type I) hip deteriorates over time, it is due to a neuromuscular hip instability, a hip joint

effusion or a secondary hip dysplasia following a successful treatment. Otherwise, the initial diagnosis is wrong [8,11]. Graf advocates the immediate treatment of type IIa- and worse hips [8] However, there still exists controversy in the natural history and management of immature hips. Graf type IIa hips has a lower spontaneous normalization rate and a higher treatment rate in girls than in boys [12]. Graf recommends to treat the type IIa- hips for completely avoiding the development of residual hip dysplasia and to closely follow the type IIa hips for determining whether or not a mature hip can be attained by the end of 3 months [8,11] Besides,nearly one in every four type IIb hips carries the risk of development of residual hip dysplasia in the long-term follow-up, even if they have initially been treated with success [13]

This research documents the results of a prospective study designed to determine the validity of a standardized ultrasound and clinical screening protocol for early detection of developmental dysplasia of the hip in Saudi infants during their first 6 months;as well to characterize the hip joint anatomical structure in different types of DDH.

II. Materials And Methods

Between December 2011- December 2014 the hips of 536 newborn infants were examined by ultrasound in our hospitals by routines screening program for DDH at age 0days up to 4 months.

Sample including 145(27.1%) females and 391(72.9%) males .Participant's age were <30 days were 506(94.4%),31-60 days were 9(1.7%),61-90 days were 11(2.1%) ,and ages between 91-120 days were (10(1.9%).All infants were examined clinically and underwent Ultrasonographic of the hip. Infants who had teratology DDH or who had been diagnosed with DDH at another center and referred to our hospital for treatment were not included in the study. Risk factors such as primperity, positive family history, swaddling use, gender, breech delivery, cesarean delivery, oligohydramnios, low birth weights and prematurity were also investigated at risk factors. Ultrasonographic was performed with a 7.5-3.5 ,5 MHZ, but most examination were performed with 3MHZscan head by available patients documents CD by numbers hip normal ,abnormal, linear transducer (Toshiba, Philips 2010, volusum4000, Son layer SSA-270A, Japan).several views of the infant hip were obtained by placing the transducer in the different position. Combination of two views was selected as being most reliable in the identification of the anatomical structures. In both views, the images are obtained by placing the transducer laterally in the region of the greater trochanter. In the view (transverse neutral, the infant is supine and the hip in the neutral position to identify the anatomical landmarks. The coronal flexion view, the ultrasound sector effectively scans a coronal section of the hip joint, the femur is in the flexed position and the transducer is rotated through 90 degree to identify anatomical landmarks. The sonograms were classified according to Graf's method in terms of the α and β angles. Infants who had mature hip joints (Graf type Ia or Ib) were exempted from follow-up. Infants with physiologically immature hips (Graf type IIa) were followed up with ultrasound until they were three months old, and if maturity was not complete at this time, the hip was classified as Graf type IIb. Infants with Graf type IIb hips as well as infants who on the initial ultrasound had Graf type IIc, type D, type III or type IV hips were assigned a diagnosis of DDH. All clinical examinations were performed by the authors, and included the Barlo and Ortolani tests. To classify the ultrasound participants according to hip instability, the following system was used: grade 1, slight capsular instability with no snapping sign and/or limitation of hip abduction to within 70° of the midline; grade 2, subluxated hip (Ortolani snapping); grade 3, dislocatable and reducible hip (dislocation sign); grade 4, fully dislocated, irreducible hip. This is the system described by Toni's with an additional criterion of limited hip abduction included in grade 1.

III. Figures and Tables

Table No (1) Distribution of study sample according to DDH Type

Type1 Frequency%	Type 2 Frequency %	Type3 Frequency%	Type4 Frequency %
288(53.7%)	2a < 3m (27(20.3%)	45(8.4%)	33(6.2%)
-	2b >3m(76(57.1%)	-	-
-	2c(30(22.6%)	-	-

Table No (2) Type of dislocation cross tabulated with Age/days

P-value	Type		Age/days				Total
			<30 days	31-60 days	61-90 days	91-120 days	
0.018	***Type1***	Count	280	2	4	2	288
		%	52.2%	0.4%	0.7%	0.4%	53.7%
0.000	***Type2***	Count	9	4	5	9	27
	2a < 3m	%	6.8%	3.0%	3.8%	6.8%	20.3%
	2b >3m	Count	75	0	1	0	76
		%	56.4%	0.0%	0.8%	0.0%	57.1%
	2c	Count	29	1	0	0	30
		%	21.8%	0.8%	0.0%	0.0%	22.6%
0.613	***Type3***	Count	44	0	1	0	45

		%	8.2%	0.0%	0.2%	0.0%	8.4%
0.005	***Type4***	Count	30	3	0	0	33
		%	5.6%	0.6%	0.0%	0.0%	6.2%

Table (3) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the clinical results

P-value	Type		Clinical Data					Total
			routine exam	CDH	hip click	check up	DDH	
0.333	***Type1***	Count	130	66	87	2	1	286
		%	24.3%	12.4%	16.3%	0.4%	0.2%	53.6%
0.077	***Type2***	Count	22	3	2	0	-	27
	2a < 3m	%	16.5%	2.3%	1.5%	0.0%	-	20.3%
	" 2b >3m"	Count	36	19	20	1	-	76
		%	27.1%	14.3%	15.0%	0.8%	-	57.1%
	2c	Count	17	4	9	0	-	30
		%	12.8%	3.0%	6.8%	0.0%	-	22.6%
0.000	***Type3***	Count	5	22	18	0	0	45
		%	0.9%	4.1%	3.4%	0.0%	0.0%	8.4%
0.798	***Type4***	Count	15	10	8	0	0	33
		%	2.8%	1.9%	1.5%	0.0%	0.0%	6.2%

Table (4) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the DDH Risk Factor (Family History, Breach History Pregnancy)

P-value	Type		DDH Risk Factor		Total
			With	Without	
0.062	***Type1***	Count	164	90	254
		%	33.8%	18.6%	52.4%
0.000	2a < 3m	Count	25	2	27
		%	19.5%	1.6%	21.1%
	2b >3m	Count	36	38	74
		%	28.1%	29.7%	57.8%
	2c	Count	14	13	27
		%	10.9%	10.2%	21.1%
0.000	***Type3***	Count	9	36	45
		%	1.9%	7.4%	9.3%
0.223	***Type4***	Count	22	9	31
		%	4.5%	1.9%	6.4%

Table (5) characterization of hip joint development in different types of DDH

	Type1	**Type2**	**Type3**	**Type4**
Acetabulum Development	**Yes 179(49.6%)** **No 24(6.6%)** *P-value=0.002*	**Yes 73(82.0%)** **No 16(18.0%)** P-value=0.725	**Yes 2(0.6%)** **No 13(3.6%)** P-value=0.000	**Yes 2(0.6%)** **No 21(5.8%)** P-value=0.000
Femoral Head Within Acetabuler cavity	**In 194(53.6%)** **Out 8(2.2%)** *P-value=0.000*	**In 71(81.6%)** **Out 16(18.4%)** *P-value=0.679*	**In 2(0.6%)** **Out 18(5.0%)** *P-value=0.000*	**In 2(0.6%)** **Out 23(6.4%)** *P-value=0.000*
Ischium Development	**Yes 191(35.8%)** **No 97(18.2%)** *P-value=0.000*	**Yes 65(49.2%)** **No 67(50.8%)** *P-value=0.239*	**Yes 3(0.6%)** **No 42(7.9%)** *P-value=0.000*	**Yes 7(1.3%)** **No 25(4.7%)** *P-value=0.000*
Illiac line capsule, acetabular cartage Femoral Head Ligament Teres	**Yes 189(54.8%)** **No 7(2.0%)** *P-value=0.000*	**Yes 62(80.5%)** **No 15(19.5%)** *P-value=0.977*	**Yes 2(0.6%)** **No 17(4.9%)** *P-value=0.000*	**Yes 3(0.9%)** **No 21(6.1%)** *P-value=0.000*

IV. Discussion

Table (1) showed the distribution of study sample according to DDH Type. The most common affected age were ages<30 days, 280 were of type1, 9 were 2a < 3m, 75 were 2b >3m and 29 were 2c. 44 were type 3 and 30 were type 4 with significant relation with age at p=0.018, 0.000, 0.005 for type 1, 2, and 4 respectively as presented in table (2).

Table (3) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the clinical results the clinical examinations showed no consistency between the clinical findings as CHD,DDH, Hip click or other findings with ultrasound results as type1, 2 and 4

The clicking hip, DDH, CHD are found in babies of the high-risk factors there is general agreement on the importance of breech position, postural deformities and family history. Table (4) showed the risk factor cross tabulated with the DDH type. The risk of an abnormality on ultrasound for each of these was shown to be

increased significantly in type 2,3, this supports the opinion that a clicking hip should never be ignored (Cunningham et al 1984)[14]. Of the 70 babies which were abnormal on ultrasound, 9 were Graf types III showing definite evidence of subluxation or dislocation. These were usually clinically detectable; it could be argued that the vast majority would have not been detected without ultrasound.

The remainder 133 babies were Graf type II; these are usually clinically normal and, in our series, were found most commonly in the 'clicking' 20(15.0%) and CHD 19(14.3%).

There is significant relation between type 2 and 3 with the risk factor table (4), however in type 1and 4 there is no significant relation with the presence of risk factor, it was mentioned that more than 60% of infants with DDH have no identifiable risk factors. [15] Infants with the following features have been considered to be at high risk for DDH, although these risk factors have not been validated: first-degree relative with DDH, breech delivery or clinical evidence of joint instability.[15,16,17,18,19].Less widely accepted risk factors include persistent "click" on clinical examination, congenital postural or foot deformities, and fetal growth retardation. [15, 17, 19]Certain ethnic and geographic populations have also been identified as being at high risk for DDH including Canadians [20].

When characterizing hip joint and its development in different types of DDH, results showed that the acetabulum is well developed in type 1 and least developed in type 3 and 4 significantly

the femoral head is outside the acetabuler cavity in both type 3 and 4 while it was found inside the groove in type 1 the ischium is found to be well developed in type1 while in type 3and4 most of the cases were not developed .Normal Illiac line capsule, acetabular cartilage, Femoral Head Ligament were detected in type 1 where significant changes were detected in type 3 and 4 this was presented in table (5)

When comparing the clinical examination results /methods with ultrasound methods , Studies showed that the Ortolani and Barlow clinical tests were done during the first several months of life and testing for DDH in older infants and children have always been applied[1]. The Ortolani test relocates the dislocated hip into the normal acetabular position and is accompanied with a palpable "clunk." The Barlow test is a challenging test of dislocation of the hip joint. [21-23] For the diagnosis of hip dislocation, the Barlow test has been associated with a low positive predictive value. [24] When the Ortolani and Barlow tests are combined; they show high specificity in the diagnosis of hip dislocation or subluxation. [24,25] as well the tests become less sensitive in older infants, in part because of the larger size and muscle bulk and the development of hip contractures. [26] Serial clinical examinations appear to be an effective screening strategy. However in the clinical screening period, the detection rate of hip joint instability at birth has ranged from 5 to 20 cases per 1000 infants, depending mainly on age at testing and examiner experience. [24,27] With serial clinical examination, the operative rate for DDH has decreased by more than 50%, [24,27] This favorable decline needs to be balanced with the increase in false-positive results and false negative results . These facts were consistent with our results; therefore ultrasongraphy should be applied together with the clinical approach .Infants who underwent ultrasound screening had both morphologic and dynamic hip testing One ultrasonographic study showed that Infants were treated with abduction splints. Hips with dysplastic morphology were also treated, whether or not there were clinical findings of instability. Mildly dysplastic hips were treated only if they were found to be unstable clinically or ultrasonographically. Hips with only ultrasound evidence of instability were not treated. [28] Of significance, ultrasound screening identified many cases whom were clinically normal infants. Comparing results of ultrasound screening with those of clinical screening; selective ultrasound screening alone did not decrease the value of diagnosis of DDH compared with clinical screening but it considered as harmonizing for proper and accurate diagnosis.

V. Conclusion

Regarding the results ultrasonography has documented its ability to detect abnormal position, instability, and dysplasia not evident on clinical examination, screening of all infants at. Consequently, 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. Used in this selective capacity, it can guide treatment and may prevent overtreatment

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