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Correlation of Developmental Dysplasia of Hip in Newborns with Mode of Presentation on Graf Method Ultrasound

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ABSTRACT

Developmental dysplasia of hip (DDH) affects 1.5-20/1000 live births. Early detection and treatment have spared many patients from crippling. The dislocation of the hip is always postnatal. Defects in hip occur because of the flexibility of the joint capsule at birth, underdeveloped hip acetabulum and immature femur head. **Objective:** To correlate incidence of developmental dysplasia of hip in newborns with modes of presentation at birth (vertex, breech and transverse) using Graf method ultrasound. **Methods:** The six-month analytical cross-sectional study was conducted after ethical approval and informed parental consent. A total of 115 healthy newborns below 28 days age were inducted in the study. The study excluded neuromuscular disease, neural tube defects and genetic anomaly cases. The bilateral hip angles were measured on ultrasound, categorized and recorded. Modes of presentation (vertex, breech and transverse) and physical exam findings were included. **Results:** Hip angles were measured in 115 newborns. The vertex presentation was the most common; 96 (83.48%). Infants with vertex presentation had the significantly smaller frequency of dysplasia ($p<0.001$). Breech presentation had significantly high incidence of hip dysplasia ($p<0.001$). Bilateral pathological immature hip (2a-) and centered unstable (2c) hip dysplasia types were most common in all groups. Severe dysplasia types D and 4 were seen in the vertex and breech groups. **Conclusions:** Developmental dysplasia of hip occurs with vertex, transverse and breech presentation postnatally. The most frequent variants are the immature pathological and centered unstable hips. The severe forms of dysplasia occur in vertex and breech presentations.

INTRODUCTION

Developmental Dysplasia of Hip (DDH) is a hip disease in which the proximal femur and acetabulum do not mature normally, resulting in deformity and instability of the hip [1]. An association of DDH with genetic, mechanical and hormonal factors has been established by previous studies. A hormonal imbalance between estrogen and progesterone is linked with DDH. High levels of progesterone in such cases promote the dislocation in contrast to high levels of estrogen, which has an inhibitory effect. Mechanical factors include the effects of restricted space in utero during development such as uterine structural anomalies and breech position at birth. Infants in the breech position at birth have 25% risk of DDH. In reported cases of DDH, 30% to 50% had breech presentation at the time of delivery [2]. Furthermore, among the cases of DDH the left hip was affected in 69% cases as compared to the right hip, although bilateral involvement has also been reported in previous studies. The increased flexion of the already flexed knee and hip joints in the breech position has been linked to the dislocation of the hip. Previous studies have reported that it affects female six times more often than male [2]. Early identification with treatment has shown good prognosis. National screening programs involving both clinical and radiological methods have been explored previously. Ultrasound of hip joints is the most widely accepted method for diagnosis of DDH in the first six months after birth. The Graf classification of hip growth has gained popularity in early detection of abnormalities. The method involves measurement of alpha (α) and beta (β) angles of the hip to identify its type. The alpha (α) angle determines the degree of bony acetabular roof inclination. The larger

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the angle, the more developed the acetabular roof. The β angle determines the degree of development of the cartilaginous acetabular roof. Normally developed hips have a small β angle [3]. The cases in which DDH is misdiagnosed or missed, its symptoms present in the adolescent group. Delay in its treatment is known to cause degeneration of the joint [4]. DDH detected before the age of six months can be managed with non-surgical methods such as the Pavlik harness. However, studies report a high number of cases of DDH in the low- and middle-income countries that present in adolescence or adulthood. Surgical intervention is expensive and the only option for such patients [5]. Symptoms of complications caused by DDH include tiptoe walking on the affected side or waddling gait, due to less efficient hip abductors. Over time, the patient develops lumbar lordosis resulting in pain in the hip, lower back, and ultimately the knee [6, 7].

This study aimed to correlate the incidence of DDH in newborns with the vertex, breech and transverse presentations at birth. The findings from this study can be used for early diagnosis of DDH in newborns using the Graf method ultrasound and monitoring of pediatric patients with immature hips to prevent need for surgical intervention in future. This study will raise awareness about this condition among clinicians, students and parents for prevention of DDH, thereby reducing disease and financial burden on the healthcare system.

METHODS

This analytical cross-sectional study was conducted over a six-month period between January to June 2022. The data were collected from PNS Shifa Hospital, National Institute of Child Health (NICH), Fazaia Ruth Pfau Medical College (FRPMC), Zubaida Medical Center, and Bantava Anis Hospitals in Karachi after ethical approval (ERC 88/2021). Written informed consent was taken from the parents after which the newborn was inducted into the study. The study included healthy newborns below 28 days age. Infants diagnosed with neuromuscular disease, neural tube defects or genetic abnormality were excluded from the study. The sample size of 115 was calculated using OpenEpi software with 95% confidence interval with hypothesized frequency of outcome factor in the population (p): 2.7%+/-3. Data were collected using non-probability convenience sampling. The hip ultrasound findings were categorized based on Graf classification documented [8, 9] (Table 1). All findings were cross-checked and verified by attending classified radiologist. Statistical analysis was done using SPSS version 24.0. A p-value less than 0.05 was considered statistically significant. The Fischer's-Exact test was applied to determine the significance of association between the variables.

Table 1: Graf Classification of Hip

Hip Type	Characteristics
1	Normal hip (mature hip); α angle >60º. Subtypes are Type 1a (β angle >55º) and Type 1b (β angle <55º)
2a (+)	Physiological immature hip with α angle 55º-60º and β angle >55º in infants less than three months old.
2a (-)	Pathological immature hip (acetabular dysplasia) with α angle 50º-55º and β angle β angle >55º in infants less than three months old.
2b	Centered hip but stable with α angle 55º-60º and β angle >55º in infants above three months.
2c	Centered, unstable hip with α angle 43º-49º and β angle<77º
D	Decentered hip with α angle 43º-49º and β angle>77º
3	Eccentered hip (cartilaginous roof is pushed cranially) with α angle <43º and β angle>77º
4	Dislocated hip (cartilaginous roof is pushed caudally) with α angle< 43º and β angle>77º

The principal investigator recorded the mode of delivery, physical exam findings for DDH, measured angles (alpha and beta) and dysplasia classification if present in the proforma. The ultrasound was performed with the infant in the decubitus position using the Toshiba Aplio 300, High Frequency Linear Probe 7.5 MHz, Japan. The images were analyzed in the coronal plane. The transducer of the probe was placed parallel and lateral to the hip. The following landmarks were identified on the image: head of the femur, ilium, bony acetabular roof, labrum, iliac bone, and triradiate cartilage. Subsequently the alpha and beta angles were determined [9]. The alpha angle was measured between the cortex of the ilium and a line passing through the acetabular roof. The beta angle was measured between the outer cortex of the ilium and the center of the acetabular labrum [10, 11] (Figure 1).

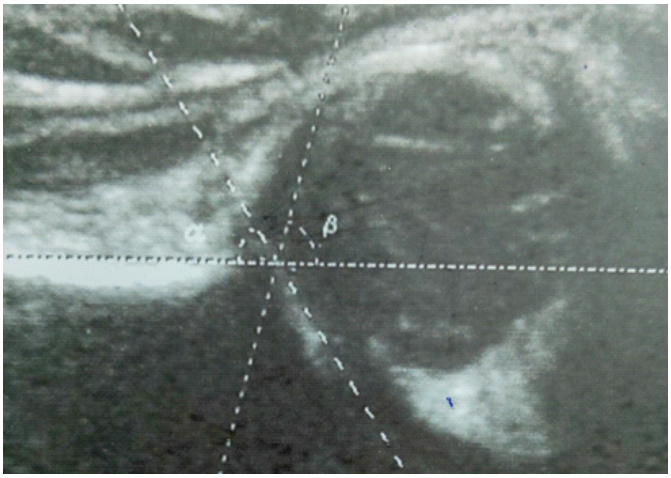

Figure 1: Measurement of alpha and beta Angles of Hip Joint

RESULTS

The study consisted of 115 healthy male and female infants (230 hips) below 28 days of age. The newborns of the present study were grouped according to their mode of presentation (vertex, breech and transverse) at the time of birth. Using Graf method ultrasound, the right and left hip angles were measured, categorized and compared. In the study the most common mode of presentation at birth was

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vertex (96; 83.48%) followed by breech (16; 14%) and transverse(4; 3.48%)(Table 2).

Table 2: Distribution of Study Participants Based on Mode of Presentation at Birth

Presentation at Birth	n=115 Frequency (%)
Vertex	
Yes	96 (83.48%)
No	19 (16.52%)
Breech	
Yes	15 (13.04%)
No	15 (13.04%)
Transverse	
Yes	4 (3.48%)
No	111 (96.52%)

Among the vertex presentation group, normal and physiologically mature hips were most prevalent 1a (77; 40.5%) and 2a+ (64; 33.7%). Pathological immature hip (2a-) was the most prevalent type of hip dysplasia (36; 18.9%). Centered unstable hip (9; 4.7%) and decentered hip (1; 0.5%) types were also observed. The difference between the groups was highly statistically significant (p=0.001) (Table 3).

Table 3: Distribution of Hip Types Among Vertex Presentation in Newborns According to Graf Method Ultrasound

Type of Hip on Graf Method Ultrasound	Vertex		Total Frequency (%)	p-value
	Yes Frequency (%)	No Frequency (%)		
1a	77 (40.5%)	12 (30.0%)	89 (38.7%)	0.001**
2a+	64 (33.7%)	7 (17.5%)	71 (30.9%)	
2a-	36 (18.9%)	10 (25.0%)	46 (20.0%)	
2c	9 (4.7%)	9 (22.5%)	18 (7.8%)	
D	1 (0.5%)	1 (2.5%)	2 (0.9%)	
3	0 (0.0%)	1 (2.5%)	1 (0.4%)	
4	3 (1.6%)	0 (0.0%)	3 (1.3%)	
Total	190 (100.0%)	40 (100.0%)	230 (100.0%)	

p-value ≤0.05: statistically significant; p-value≤0.001 highly statistically significant; Test applied: Fischer's-Exact In the infants with breech presentation at the time of delivery, pathological immature (2a-) hip was observed in 8 (25.0%) newborns. The centered unstable (2c) was seen in 8 (25.0%) while 1 (3.1%) had decentered dysplastic hip type D. The mature (1a) hip was seen in 8 (25.0%) while the physiologically immature hips (2a+) were observed in 6 (18.8%) newborns. The difference in the groups was highly statistically significant (p=0.001)(Table 4).

Table 4 : Distribution of Hip Types Among Breech Presentation in Newborns According to Graph Method Ultrasound

Type of Graf Method Ultrasound	Breech		Total Frequency (%)	p-value
	No Frequency (%)	Yes Frequency (%)		
1a	81 (40.9%)	8 (25.0%)	89 (38.7%)	0.001
2a+	65 (32.8%)	6 (18.8%)	71 (30.9%)	
2a-	38 (19.2%)	8 (25.0%)	46 (20.0%)	
2c	10 (5.1%)	8 (25.0%)	18 (7.8%)	
D	1 (0.5%)	1 (3.1%)	2 (0.9%)	
3	0 (0.0%)	1 (3.1%)	1 (0.4%)	
4	3 (1.5%)	0 (0.0%)	3 (1.3%)	
Total	198 (100.0%)	32 (100.0%)	230 (100.0%)	

p-value ≤0.05: statistically significant; p-value≤0.001 highly statistically significant; Test applied: Fischer's Exact

Infants with transverse lie at birth showed the pathological immature (2a-) and centered unstable hip types (2c); 2 (25.0%), 1 (12.5%) respectively. The majority had normal mature hips (1a); 4 (50.0%). The difference between the groups was statistically insignificant (p=0.647)(Table 5).

Table 5: Distribution of Hip Types Among Transverse Presentation in Newborns According to Graph Method Ultrasound

Type of Graf Method Ultrasound	Transverse		Total Frequency (%)	p-value
	Yes Frequency (%)	No Frequency (%)		
1a	4 (50.0%)	85 (38.3%)	89 (38.7%)	0.647
2a+	1 (12.5%)	70 (31.5%)	71 (30.9%)	
2a-	2 (25.0%)	44 (19.8%)	46 (20.0%)	
2c	1 (12.5%)	17 (7.7%)	18 (7.8%)	
D	0 (0.0%)	2 (0.9%)	2 (0.9%)	
3	0 (0.0%)	1 (0.5%)	1 (0.4%)	
4	0 (0.0%)	3 (1.4%)	3 (1.3%)	
Total	8 (100.0%)	222 (100.0%)	230 (100.0%)	

p-value ≤0.05: statistically significant; p-value≤0.001 highly statistically significant; Test Applied: Fischer's Exact

DISCUSSION

The advent of hip ultrasonography has completely transformed the pathology and detection of DDH. It has made it possible for an early detection, enabling more appropriate and potent management of DDH [12, 13]. In the current study 115 newborns (230 hips) were examined by Graf method ultrasonography. In the current study, the modes of presentation at birth were analyzed as risk factors for DDH. Similar approach was taken by Treiber *et al* [11], Zeb et al [12] and Khabiah et al [13]. In the current study the vertex or cephalic presentation was predominant. The breech presentation frequency was greater than that of transverse. In our study, newborns with vertex presentation at birth had significantly smaller number of dysplastic hips as compared to non-vertex presentation (p≤0.001). Similarly, Patil *et al.*, reported high incidence of vertex presentation, followed by breech and transverse lie

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at birth in their study cohort [14]. Like our study, Ionescu *et al.*,in a retrospective single center multifactorial study, reported that the incidence of DDH with cephalic presentation at birth was less than other presentation types (7.5%; 220 patients) [15]. The study determined a highly statistically significant difference (p=0.0001) between incidence of DDH in cephalic and non-cephalic presentations at birth. Rosete *et al.*, had similar results were in their case control study. This indicates that mode of presentation at the time of delivery has a strong impact on the stress at the hip joints of the infant. In such cases, awareness about the condition would be helpful in management [16]. We observed pathologically immature hips, centered unstable and severe dysplasia (types D and 4) in the vertex presentation group. Types D and 4 would require follow up and intervention. The difference in the groups with vertex and non-vertex presentation was highly significant in our study (p=0.001). Ionescu *et al.*, also documented high number of cases with type D hip dysplasia with statistically significant difference (p=0.0001). Furthermore, their study also detected type III hip dysplasia in the vertex presentation group [15]. In contrast to our study, Kolovos *et al.*, did not observe any cases of type D and 4 in their study. This could be attributed to the difference in study population and sample size [2]. In this study, most infants with transverse lie at birth had the normal physiological hips. The only dysplastic hip types that we observed were the pathological immature (2a-) and centered unstable (2c) variations. In our study group the other dysplastic hip types were not seen with transverse lie. Statistical analysis revealed no significant association between DDH and transverse lie at birth in our study. Like our study, Ionescu *et al.*, also reported normal physiological hips in this group. However, they did not find the centered unstable variety but the more severe, eccentered type of DDH in their study [15]. In contrast to our study, they determined highly significant difference between the transverse and other groups of presentations at birth (p=0.0001). The difference in findings could be attributed to a larger sample size in their study.

We detected centered unstable hip as well as severe dysplasia of types D and 4 in the breech presentation group. Our findings showed that breech presentation had highly significant association with DDH (p ≤0.001). It has been deduced that breech presentation places a significant amount of stress on the lower extremities and prolonged strain on lower limbs during a breech delivery [17]. Similar results between breech presentation and occurrence of DDH were reported in studies conducted in Bangladesh [4], Egypt [9], Slovenia [11], Saudi Arabia [13, 18] and China [19]. A case control study also reported an increasing risk of developing DDH with gestational age and duration of breech presentation [19]. In contradiction, a study in England has reported no significant risk of DDH with breech delivery [20]. This indicates that breech presentation carries high risk of DDH across all populations.

CONCLUSIONS

Developmental dysplasia of hip occurs with vertex, transverse and breech presentation at the time of delivery. The most frequent variants are the immature pathological and centered unstable hips. The severe forms of dysplasia occur most commonly in vertex and breech presentations.

Authors Contribution

Conceptualization: NM, OA
Methodology: SKK, AQ
Formal analysis: AQ, SKK
Writing, review and editing: YM, SF

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest

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REFERENCES

[1] Chavoshi M, Mirshahvalad SA, Mahdizadeh M, Zamani F. Diagnostic Accuracy of Ultrasonography Method of Graf in The Detection of Developmental Dysplasia of The Hip: A Meta-Analysis and Systematic Review. Archives of Bone and Joint Surgery.2021 May; 9(3): 297-305. doi: 10.22038/abjs.2021.55292.27 55.

[2] Kolovos S, Sioutis S, Polyzou M, Papakonstantinou ME, Karampikas V, Altsitzioglou P *et al*. The Risk of DDH Between Breech and Cephalic-Delivered Neonates Using Graf Ultrasonography. European Journal of Orthopaedic Surgery & Traumatology. 2024 Feb; 34(2): 1103-9. doi: 10.1007/s00590-023-03770-0.

[3] Bakarman K, Alsiddiky AM, Zamzam M, Alzain KO, Alhuzaimi FS, Rafiq Z. Developmental Dysplasia of The Hip (DDH): Etiology, Diagnosis, and Management. Cureus. 2023 Aug; 15(8): 2-12. doi: 10.7759/cureus.43207.

[4] Saif Ullah M, Noor-ul Ferdous KM, Mahmud SM, Hasan MN, Alam MM. Evaluation and Management of Developmental Dysplasia of Hip (DDH) in Children - Our Experience. East African Scholars Journal of Medical Sciences. 2023 Jan; 6(1): 5-11. doi:10.36349/easms.2023.v06i01.002.

[5] Sioutis S, Kolovos S, Papakonstantinou ME, Reppas L, Koulalis D, Mavrogenis AF. Developmental Dysplasia of the Hip: A Review. Journal of Long-Term Effects of Medical Implants. 2022; 32(3): 39-56.doi:10.1615/JlongTermEffMedImplants.2022040393.

DOI: https://doi.org/10.54393/pjhs.v5i10.1951

[6] Pigeolet M, Gaafar H, Naamani D, Khan MA, Alkire BC, Chinoy MA *et al*. Cost-Effectiveness of Screening for Developmental Dysplasia of The Hip in Karachi, Pakistan Using A Universally Applicable Cost-Effectiveness Model. British Medical Journal Public Health. 2024 Jul; 2(1): 1-10. doi: 10.1136/ bmjph-2023-000340.

[7] Pandey RA and Johari AN. Screening of Newborns and Infants for Developmental Dysplasia of The Hip: A Systematic Review. Indian Journal of Orthopaedics. 2021 Dec; 55(6): 1388–1401. doi: 10.1007/s43465-021-00409-2.

[8] Çekiç B, Erdem-Toslak İ, Sertkaya Ö, Filiz S, Kılar Y, Köroğlu M *et al*. Incidence and Follow-Up Outcomes of Developmental Hip Dysplasia of Newborns in The Western Mediterranean Region. The Turkish Journal of Pediatrics. 2015 Aug; 57(4): 353-8.

[9] El sheikh, H., shalan, A., Kadhim, R. Ultrasound in Detecting Developmental Hip Dysplasia in Neonates at Risk. Benha Medical Journal, 2023; 40(Special issue(Radiology)): 192-205. doi: 10.21608/bmfj.2023.172157.1701.

[10] Ömeroğlu H, Akceylan A, Köse NU. Associations Between Risk Factors and Developmental Dysplasia of The Hip and Ultrasonographic Hip Type: A Retrospective Case Control Study. Journal of Children's Orthopaedics.2019 Apr; 13(2): 161-6. doi: 10.1302/1863-2548.13.180174.

[11] Treiber M, Korpar B, Sirše M, Merc M. Early Neonatal Universal Ultrasound Screening for Developmental Dysplasia of The Hip: A Single Institution Observational Study. International Orthopaedics. 2021 Apr; 45(4): 991-5.doi: 10.1007/s00264-020-04915-0.

[12] Zeb J, Hayat S, Afzal I, Haq SN, Shoaib M, Zeb M *et al*. Frequency of Risk factors for Developmental Dyslasia of Hip (DDH) in patients presenting to a Tertiary Care Hospital.Journal of Pakistan Orthopaedic Association. 2022; 34(04): 163-5.

[13] Khabiah MM, Al Hunaif AM, Al Mudawi EA, Alkhalifah KM, Asiri NA, Alqahtani RF *et al*. Prevalence of Breech Presentation and Other Gestational/Delivery Characteristics Among Patients Born with Developmental Dysplasia of the Hip.Cureus. 2023Jul; 15(7): 2-10. doi: 10.7759/cureus.42750.

[14] Patil N, Tapadia J, Sharma A. A Cross-Sectional Study of Early Detection of Developmental Dysplasia of Hip Joint by Ultrasonography in Infants below 90 days of Age. Scholars Journal of Applied Medical Sciences. 2023 Mar; 11(3): 840-3. doi: 10.36347/sjams.2023.v11i05.005.

[15] Ionescu A, Dragomirescu MC, Herdea A, Ulici A. Developmental Dysplasia of the Hip: How many Risk Factors are Needed? Children.2023 May; 10(6):29.doi: 10.3390/children10060968.

[16] Ramírez-Rosete JA, Hurtado-Vazquez A, Miranda-Duarte A, Peralta-Cruz S, Cuevas-Olivo R, Martínez-Junco JA *et al*. Environmental and Genetic Risk Factors in Developmental Dysplasia of the Hip for Early Detection of the Affected Population. Diagnostics. 2024 Apr; 14(9): 2-13.doi: 10.3390/diagnostics14090898.

[17] Harsanyi S, Zamborsky R, Krajciova L, Kokavec M, Danisovic L. Developmental Dysplasia of The Hip: A Review of Etiopathogenesis, Risk Factors, and Genetic Aspects. Medicina. 2020 Mar; 56(4): 2-12. doi: 10.3390/medicina56040153.

[18] Alshehri F and Almalki Y. Developmental Dysplasia of The Hip in Infants Younger than Six Months: Ultrasonographic Assessment in Relation with Risk Factors. International Journal of Health Sciences. 2023 Mar; 17(2): 37-45.

[19] Xiao H, Tang Y, Su Y. Risk Factors of Developmental Dysplasia of The Hip in a Single Clinical Center. Scientific Reports. 2022 Nov; 12(1): 1-7.doi:10.1038/s41598-022-24025-8.

[20] Konijnendijk A, Vrugteveen E, Voorthuis B, Boere-Boonekamp M. Association Between Timing and Duration of Breech Presentation During Pregnancy and Developmental Dysplasia of The Hip: A Case-Control Study. Journal of Child Health Care. 2023 Mar; 27(1): 35-45.doi: 10.1177/13674935211042198.