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Original Research Article

Role of Sonography Vs Clinical Examination in the Early Diagnosis of Developmental Dysplasia of the Hip (DDH)

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Abstract: ***Background and Objectives***: A major hip problem among infants is developmental dysplasia of the hip. It is essential to diagnose early in order to prevent long term complications. Ortolani and Barlow tests are used to diagnose developmental dysplasia, however, in mild or early cases their role is limited. Ultrasound provides a better picture in such cases. The aim of this study is to assess the diagnostic value of clinical examination compared to ultrasound in diagnosing developmental dysplasia of the hip in young infants. ***Methods***: This was a prospective cross-sectional study. It was carried out on 100 infants (<6 months of age) who attended Helena Center in Erbil between 2024 and 2025. Ortolani and Barlow tests was performed on all the infants, then a hip ultrasound was done as a standard diagnostic tool. In ultrasound the Graf method was used to categorize the babies into DDH group and Non-DDH group. The sensitivity, specificity, positive predictive value and negative predictive value of the clinical examination tests were assessed. ***Results***: The mean age of the infants in the DDH group was 4±1.1 month and the non-DDH group 3.2±0.8 months ($p<0.001$). Inadequate amniotic fluid was found in 14% of the DDH group and none of the non-DDH group ($p=0.005$). Cradling was more common (38.6%) among the non-DDH group than the DDH group (11.6%) ($p=0.003$). The Ortolani and Barlow tests were positive in 46.5% and 60.5% of the DDH group, respectively ($p<0.001$). The sensitivity for Ortolani Test was 46.5%, and for Barlow test was 60.5%. The specificity was 100% for both tests. ***Conclusion:*** Clinical examination alone can identify many cases of hip instability, but it may miss early or subtle forms of DDH. Ultrasonography provides a more accurate assessment and helps detect cases that might be overlooked clinically. Combining both methods offers the best chance for early diagnosis and timely treatment.

Keywords: Developmental dysplasia of the hip, ultrasonography, Ortolani test, Barlow test.

INTRODUCTION

Developmental dysplasia of the hip (DDH) represents a spectrum of abnormalities affecting the developing hip joint, ranging from mild acetabular dysplasia to complete dislocation.[1] It is one of the most common musculoskeletal disorders of infancy and a leading preventable cause of long-term disability when diagnosis is delayed. Untreated DDH is strongly associated with gait abnormalities, chronic hip pain, degenerative arthritis, and the eventual need for surgical reconstruction in adulthood.[1,2] The condition is detected in approximately 1–3% of newborns on ultrasound-based screening, although reported prevalence varies across populations due to differing diagnostic criteria, ethnic factors, and national screening practices.[2-4]

Early recognition is essential because timely intervention particularly within the first weeks of life—allows for non-invasive treatments with excellent outcomes. Traditionally, newborn screening relies on physical examination using the Ortolani and Barlow maneuvers to detect hip instability. However, these tests have operator-dependent sensitivity and may miss more subtle or stable forms of dysplasia. Up to 20% of infants who

have risk factors for DDH may have abnormal hips on ultrasound even if clinical examination shows normal findings.[3] Hence, the potential of false negative finding in clinical examination is high when used alone. This is especially true for infants who were of breech presentation during birth because breech presentation increases the likelihood of a normal clinical exam leading to a missed diagnosis. This makes ultrasound assessment a very important tool for this high-risk group.[3]

Ultrasound allows a detailed visualization of cartilaginous structures of the hip that are otherwise not visible on early radiographs. Therefore, it has become an invaluable tool for diagnosing DDH. Assessment of hip stability and identification of dysplasia can be done with techniques such as the Graf static method and dynamic ultrasound evaluation. Countries that have screening programs have been shown to detect DDH earlier which results in decreased incidence of late presentations that require surgical repair.[4]

Despite these benefits, there is still no worldwide agreement on the best screening method. While some healthcare systems rely on selective imaging based on risk factors or abnormal physical findings, others support universal ultrasonography. National guidelines, resource accessibility, and clinician experience all have an impact on screening variability.[5]

Physical examination is still a crucial first-line method, especially in areas with limited access to ultrasound. Even in the absence of a positive Ortolani or Barlow sign, findings like decreased hip abduction, asymmetry of thigh skin folds, or limb length difference may raise suspicions. However, it has been repeatedly demonstrated that combining clinical examination with ultrasound increases diagnostic sensitivity and lowers the number of DDH cases that are missed, supporting the case for a combined approach.[1,6]

Evaluating the relative roles of sonography and clinical examination in early DDH diagnosis is crucial given the continuous discussion about the best screening modalities. The creation of evidence-based screening protocols that maximize early detection and enhance long-term patient outcomes can be guided by an understanding of each method's advantages and disadvantages as well as how they complement one another.

MATERIAL AND METHODS

This study was a prospective cross-sectional study. It started in March 2024 until January 2025. The cases were recruited from Helena Center in Erbil, Iraq. A total of 100 infants <6 months of age were included. Ethical approval was obtained from Kurdistan Higher Council for Medical Specialties (granted on March 24, 2024 Meeting Code: 1051). After explaining the aim of the study, a written informed consent was obtained from parents of the babies before their inclusion in the study. The inclusion criteria were infants less than 6 months of age who presented with at least one risk factor for DDH or clinical suspicion of DDH. The exclusion criteria were musculoskeletal anomalies, neural tube defects, any condition preventing proper ultrasound examination. Hip examination (Ortolani and Barlow test) were performed on all included infants by an experienced clinician. Dislocated hips that were reduced upon abduction of the hip joint were considered positive Ortolani tests. Hips that dislocated upon adduction were considered positive Barlow tests. A structured questionnaire was also developed to record baseline characteristics (Infant's Age, Gender, sequence among siblings and Maternal age during pregnancy), perinatal characteristics (Amount of Amniotic fluid, Antenatal visits, pregnancy type whether single or twin), natal characteristics (Gestational age at delivery, presentation, mode of delivery, and birth weight), and risk factors for DDH (Cradling, Swaddling and Family history.

Hip ultrasonography was performed for all enrolled newborns using the Graf technique, with the hip imaged in the standard coronal plane. For each hip, α (alpha) and β (beta) angles were measured bilaterally.

DDH classification was based on Graf criteria:[7]
Type I normal hip: α angle ≥ 60°. Hips that are physiologically immature (Type IIa): α 50–59° in infants younger than three months. Dysplastic hip (Type IIb or worse): any β angle greater than 55° or α < 59° in infants older than three months. Type III–IV subluxated/dislocated hip: significantly decreased α angle and loss of femoral head coverage. For analytical purposes, DDH was diagnosed when Graf Type IIb, IIc, III, or IV hips were identified, whereas Type I and Type IIa (in infants <3 months) were considered non-pathological.

Data were analyzed using SPSS version 26. While categorical variables were expressed as frequencies and percentages, continuous variables (such as age and α angle) were summarized as mean ± standard deviation (SD). For categorical data, the chi-square test or Fisher's exact test was used for group comparisons; for continuous variables, the independent t-test was used.

Diagnostic performance of Barlow and Ortolani tests was assessed using ulttrasound as the reference standard. The following measures were calculated:

- **Sensitivity:** the proportion of true DDH cases correctly identified by the clinical test.

- **Specificity:** the proportion of infants without DDH who were correctly classified as normal.
- **Positive Predictive Value (PPV):** the likelihood that an infant with a positive clinical test truly had DDH.
- **Negative Predictive Value (NPV):** the likelihood that an infant with a negative test truly had normal hips.

A p-value <0.05 was considered statistically significant.

RESULTS

Table (1) compares maternal and neonatal demographic characteristics between the DDH and non-DDH groups. The mean age of infants was higher in the DDH group (4±1.1 months) compared with the non-DDH group (3.2±0.8 months), and this difference was statistically significant (p<0.001). Maternal age during pregnancy was similar between groups, with no significant difference (p=0.276). Most pregnancies in both groups were single pregnancies, with no significant association (p=0.508). Regular antenatal screening was reported in all non-DDH cases and in 93% of DDH cases, without a significant difference (p=0.073). Adequate amniotic fluid was present in all non-DDH infants compared with 86% of infants in the DDH group, and this difference was statistically significant (p=0.005). Birth order distribution did not differ significantly between groups (p=0.343).

Table (1): Comparison of Maternal and Neonatal Demographic Characteristics Between DDH and Non-DDH Groups

Variables		Non DDH group n=57	DDH Group n=43	p-value
Age in months, Mean±SD		3.2±0.8	4±1.1	<0.001
Maternal age during pregnancy, Mean±SD		27.5±2.8	26.8±3.2	0.276
Pregnancy type	Single	50 (87.7%)	40 (93%)	0.508*
	Twin	7 (12.3%)	3 (7%)	
Regular antenatal screening		57 (100%)	40 (93%)	0.073
Amount of amniotic fluid	Adequate	57 (100%)	37 (86%)	0.005*
	Not adequate	0 (0%)	6 (14%)	
Sequence of the baby among siblings	First	28 (49.1%)	27 (62.8%)	0.343
	Second	12 (21.1%)	8 (18.6%)	
	Third	17 (29.8%)	8 (18.6%)	

Table (2) presents perinatal and delivery-related variables for the two groups. Preterm delivery occurred in 15.8% of the non-DDH group and 18.6% of the DDH group, with no significant association (p=0.711). Cephalic presentation was the most common in both groups and showed no significant difference (p=0.311). Breech presentation occurred in 17.5% of non-DDH infants and 23.3% of DDH infants, while longitudinal presentation was seen only in the non-DDH group. Mode of delivery showed no significant association, with normal vaginal delivery reported in 45.6% of non-DDH versus 30.2% of DDH infants (p=0.118). Birth weight was nearly identical between groups (2.9±0.3 kg vs. 2.88±0.2 kg) without a significant difference (p=0.665).

Table (2): Perinatal and Delivery-Related Factors in DDH and Non-DDH Groups

Variables		Non DDH group n=57	DDH Group n=43	p-value
Gestational age at delivery	Preterm	9 915.8%)	8 (18.6%)	0.711
	Term	48 (84.2%)	35 (81.4%)	
Presentation	Cephalic	44 (77.2%)	33 (76.7%)	0.311
	Breech	10 (17.5%)	10 (23.3%)	
	Longitudinal	3 (5.3%)	0 (0%)	
Mode of delivery	NVD	26 (45.6%)	13 (30.2%)	0.118
	C/S	31 (54.4%)	30 (69.8%)	
Birth weight in kg, Mean±SD		2.9±0.3	2.88±0.2	0.665

Table (3) describes postnatal risk factors. A positive family history of DDH was identified in 10.5% of non-DDH infants and 14% of DDH infants, with no significant difference (p=0.602). Swaddling practices were similar between groups, reported in 45% of non-DDH and 48.8% of DDH infants (p=0.749). Cradling was practiced in 38.6% of non-DDH infants compared with 11.6% of DDH infants, and this difference was statistically significant (p=0.003).

Table (3): Postnatal Risk Factors Associated With DDH

Variables		Non DDH group n=57	DDH Group n=43	p-value
Family History of DDH	Positive	6 (10.5%)	6 (14%)	0.602
	Negative	51 (89.5%)	37 (86%)	
Swaddling		26 (45%)	21 (48.8%)	0.749
Cradling		22 (38.6%)	5 (11.6%)	0.003

Table (4) summarizes clinical examination findings and ultrasonographic measurements. The Ortolani test was positive in 46.5% of infants with DDH and in none of the non-DDH infants, with a significant p-value (<0.001). Similarly, the Barlow test was positive in 60.5% of DDH infants and in none of the non-DDH infants, also with a significant p-value (<0.001). Ultrasonographic measurements demonstrated significantly lower alpha angles in the DDH group for both right (59.7±4.7 vs. 63.4±2.5) and left hips (58.7±4.2 vs. 62.2±2.7), with p<0.001 for both. Beta angles were significantly higher in DDH infants for both hips (right: 55.9±6.7 vs. 51.4±3.4; left: 59.6±6.7 vs. 52.1±4.6), with all comparisons showing p<0.001.

Table (4): Clinical Examination Findings (Ortolani and Barlow Tests) and Ultrasonographic Parameters (Alpha and Beta Angles) of both hips in DDH and Non-DDH Groups

Variables		Non DDH group n=57	DDH Group n=43	p-value
Ortolani test	Positive	0 (0%)	20 (46.5%)	<0.001
	Negative	57 (100%)	23 (53.5%)	
Barlow test	Positive	0 (0%)	26 (60.5%)	<0.001
	Negative	57 (100%)	17 (39.5%)	
Right hip US/ Alpha angle		63.4± 2.5	59.7±4.7	<0.001
Right hip US/ Alpha angle		51.4±3.4	55.9±6.7	<0.001
Left hip US/ Alpha angle		62.2±2.7	58.7±4.2	<0.001
left hip US/ Beta angle		52.1±4.6	59.6±6.7	<0.001

Table (5) outlines the diagnostic performance of the Ortolani and Barlow clinical tests compared with ultrasound. The Ortolani test demonstrated a sensitivity of 46.5%, specificity of 100%, positive predictive value (PPV) of 100%, and negative predictive value (NPV) of 71.3%. The Barlow test showed higher sensitivity at 60.5%, with specificity of 100%, PPV of 100%, and NPV of 77%.

Table (5): Diagnostic Performance of Ortolani and Barlow Tests Compared With Ultrasound (Sensitivity, Specificity, PPV, NPV)

Variables		
Ortolani Test	Sensitivity	46.5%
	Specificity	100%
	PPV	100%
	NPV	71.3%
Barlow's Test	Sensitivity	60.5%
	Specificity	100%
	PPV	100%
	NPV	77%

DISCUSSION

In order to evaluate the diagnostic value of Barlow and Ortolani tests in diagnosing DDH we compared the findings with ultrasound as the reference standard. In this study we found that infants who were diagnosed with DDH were older in age compared to those who did not have DDH. This finding can be attributed to the fact that clinical signs of DDH at an early age are subtle and often undetectable. In the current study, infants with DDH had significantly higher beta angles and significantly lower alpha angles on ultrasound. This finding supports the effectiveness of ultrasound in evaluating the hip at an early age for diagnosis. Moreover, in this study Ortolani and Barlow tests demonstrated good specificity but low sensitivity. This finding is in line with previous studies. Akgün et al. reported a

sensitivity of 38.5% and specificity of 84.9% for clinical examinations when compared with ultrasound.8 In the current study both Ortolani and Barlow tests demonstrated perfect specificity (100%), their sensitivities were moderate (46.5% and 60.5%, respectively). This shows a common problem in screening for developmental dysplasia of the hip. Clinical examination methods are good at identifying normal hips. They rarely label a healthy hip as abnormal. However, they often miss early or mild cases of hip dysplasia. One possible explanation, as discussed by Akgün et al., is that early hip instability does not always cause a clear "clunk" during examination. In infants with few or no symptoms, this sign can be easy to miss. Our findings support the idea that using only clinical examination can lead to missed diagnoses, especially during the first months of life. Kyung et al. further demonstrated poor concordance between clinical and sonographic findings, even when examinations were performed by an experienced paediatric orthopaedic surgeon.9 Their study showed that most clinically "unstable" hips were normal or immature on ultrasound, and conversely, some clinically normal hips demonstrated dysplasia. Our findings align closely: several infants with negative clinical examinations were diagnosed with DDH on ultrasound, indicating similar discrepancies between physical examination and imaging. This reinforces the idea that each modality captures different aspects of hip morphology and stability. While the Ortolani and Barlow tests detect mechanical instability, ultrasound provides structural insight thus explaining why combining the two methods yields superior diagnostic accuracy. The performance of the Ortolani and Barlow tests in our study particularly their perfect specificity was also consistent with Sulaiman et al., who showed that dedicated, well-trained examiners achieve substantially better results than routine clinicians.10 In their study, clinical sensitivity reached 66.7% among trained examiners, while routine medical officers detected no cases at all. Our sensitivity values fall between these extremes, which may be attributed to examiner experience, infant relaxation, timing of assessment, and subtle differences in maneuver technique. This suggests that examiner skill remains a major determinant of clinical accuracy—supporting the growing recommendation that DDH screening programs include either experienced examiners or routine ultrasound for high-risk infants. When examining risk factors, our study identified significant associations between DDH and certain perinatal and postnatal variables particularly reduced amniotic fluid and reduced use of cradling. A similar emphasis on risk factors was described by Ürel Demir et al., who found prematurity, oligohydramnios, and a positive family history to be strongly associated with DDH.11 Our findings agree particularly with the association between reduced amniotic fluid and increased dysplasia risk. However, we did not observe strong effects for breech presentation or sex, which were prominent risk factors in their cohort. These discrepancies may reflect differences in population characteristics. For example, the majority of our sample was of similar gestational age and had relatively uniform delivery patterns, potentially diluting the effect of delivery presentation. Additionally, cultural infant care practices differ across regions; Ürel Demir et al.'s study found swaddling to be a major risk factor,11 whereas in our population swaddling was common in both groups and therefore less discriminatory. Turcan et al. explored the optimal timing of hip ultrasonography, showing that many hips categorized as physiologically immature at one week spontaneously normalized by the fifth week.12 Their findings help contextualize our results: since our infants were screened slightly later (around 3–4 months), we likely captured cases with more persistent dysplasia rather than transient immaturity. This may partly explain the clearer separation we observed in alpha and beta angles between DDH and non-DDH infants. It also supports the practice of not rushing into early diagnosis solely based on first-week ultrasound, as many mild abnormalities resolve spontaneously a consideration relevant to healthcare systems where unnecessary treatment imposes emotional and financial burdens. Dogruel et al. highlighted the low specificity of clinical exams when used alone and identified female sex, breech delivery, swaddling, and positive family history as significant predictors for DDH.13 Our findings partially agree: we similarly identified important perinatal contributors, though sex and breech presentation were not significant in our cohort. Differences in sample size, ethnic background, and local infant-care customs (such as traditional cradling or wrapping styles) might account for these variations. Cradling, which showed a significant protective relationship in our results, is known in some cultures to position the hips in a more abducted, physiologic posture possibly contributing to reduced dysplasia rates. This could explain why some risk factors appear more influential in certain populations. Finally, our ultrasound findings align with Graf's underlying principles and with broader literature supporting sonography as the cornerstone of early DDH diagnosis. Lower alpha values and higher beta values in affected infants clearly demonstrated structural immaturity and labral changes, consistent with foundational DDH definitions and with several studies validating ultrasound as the most sensitive non-invasive modality for diagnosing early dysplasia.7

CONCLUSION

The results of this study show that ultrasound and clinical examination work best when used together. Clinical tests are good at confirming normal hips.

However, they often miss early cases. This is especially true when the problem is mild and there is no clear instability. Ultrasound can detect structural changes early, before the condition becomes worse. This helps fill the gap left by clinical examination. For this reason, ultrasound is useful in high-risk infants and in cases where clinical findings are unclear. Early diagnosis using both methods is very important. It helps prevent delayed treatment and reduces the need for more invasive procedures, such as spica casting or open surgery.

Conflict of interest: The authors declare no conflict of interest

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