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Comparative Evaluation of Clinical and Ultrasound Examination in Neonatal Hip Screening for the Detection of Developmental Dysplasia of the Hip – A Hospital-Based Cross-Sectional Study

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Abstract

Background: During infancy, among developmental abnormalities of the hip joint, a broad-spectrum anomaly is developmental dysplasia of the hip (DDH). To examine this abnormality, no standardized screening protocol is available. Clinical examination is most frequently followed, and in doubtful cases, ultrasound (US) examination is used to confirm the diagnosis.

Aims: The present study aims to compare the sensitivity and specificity of clinical to US examination in neonatal hip screening to detect DDH.

Materials and Methods: This is a 1-year hospital-based cross-sectional study. Newborns who were referred to the Department of Orthopaedics with suspected DDH and examined by both clinical examination and US examination were included in the study. The Chi-square test and Fisher's t-test were used for statistical analysis.

Results: Out of the 75 babies, referred two-thirds were girls. The mean age of the babies was 6.25 ± 3.50 days. The breech presentation was the common risk factor (85.33%) for DDH, and LSCS was the standard mode of delivery. Clinical diagnosis of DDH was positive among babies, more on the left side than the right side. Eight babies (10.67%) were diagnosed to have DDH based on Graf's test using USG. Among them, 4 (50%) babies had a clinical diagnosis of DDH. The sensitivity of the clinical trial with USG as reference standard was 50%.

Conclusion: Due to the lower sensitivity of clinical examination, USG screening should be done to detect DDH.

Keywords: Hip dislocation, infant, newborn, ultrasonography, mass screening.

Introduction

Developmental dysplasia of the hip (DDH) is a set of abnormalities ranging from the abnormal acetabulum (dysplasia) and mild subluxation of the femoral head to fixed displacement (congenital dislocation) [1]. DDH affects 1–3% of newborns and is responsible for 29% of primary hip replacements in people up to 60 years [2].

In India, the incidence has been reported to be 1.0–9.2/1000 in various studies, with the incidence being more in the northern region [3, 4, 5, 6]. Various factors are involved in the pathogenesis of DDH, such as positive family history, gender, age, oligohydramnios, race, and intrauterine fetal position. Most commonly, the hip is dislocated on the left side when compared to the right. This abnormality is more widely observed in newborns who have swaddled a maneuver that forces the hips into extension and adduction [7, 8]. The optimum time for diagnosis is immediately after birth, but currently, there is no national guideline for screening DDH based on age [9]. Diagnosis is now based on a clinical examination where a positive Barlow and Ortolani test is indicative of DDH. Ultrasound (US) is a confirmatory tool of choice in high-risk cases only. Delays in

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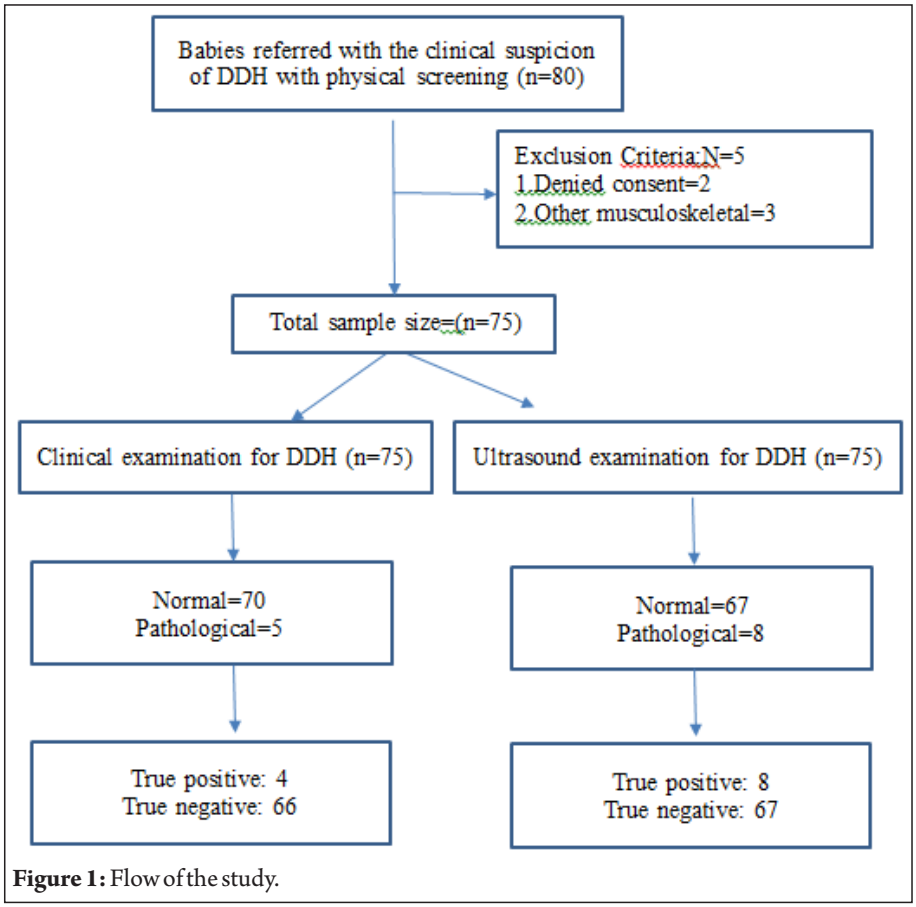

Figure 1: Flow of the study.

diagnosis of DDH can be disastrous on the normal development of the child, leading to a progressive worsening of the disease. Early diagnosis results in an improved success rate (95%) of clinical treatment with lesser complications [10].

Ultrasonographic examination is a standardized screening tool to confirm DDH in clinically suspected cases. Due to high cost and availability in a low-resource setting, US is not used frequently. It is used only for high-risk patients, making clinical examination, the only tool of choice in such settings until a few weeks after birth (2–3 months) [11].

Keeping this information in mind regarding the lack of national screening protocol and the importance of diagnosis of DDH, the present study was undertaken to compare sensitivity and specificity of clinical to US examination in neonatal hip screening for detection of DDH.

Materials and Methods

The present study was a 1-year hospital-based cross-sectional study. This study was conducted at a tertiary care hospital from January 2017 to December 2017. Before the commencement, approval for the study was obtained from the Institutional Ethical Committee.

Study population

All the babies delivered at the tertiary care center and Charitable Hospital, after clinical examination with clinical suspicion of DDH, were studied.

Sample size

The sample size was calculated from a study done by Arti et al. [12] came out to be 37, where, d = standard error, which was considered 6%, and p = disease prevalence, which was considered 3%. However, during the study period, 75 babies were referred for the diagnosis of DDH to the department of orthopedics, and all the babies fulfilled the selection criteria (Fig. 1).

Inclusion criteria

1. All the babies referred after clinical examination with clinical suspicion of DDH were enrolled in the study.

Exclusion criteria

1. Babies with fracture of the femur and neonates musculoskeletal disorders such as arthrogryposis, teratological hip dysplasia, neural tube defects, and neonates admitted in intensive care unit ward were excluded from the study
2. Participants whose parents refused consent were excluded from the study.

Examiners

Clinical examination was done independently by an experienced orthopedic surgeon who evaluated all the selected hips of babies on USG on the same day or latest, by the next day. There was no follow-up in the present study. US (Philips HD11) was performed by an experienced radiologist who has completed at least 100 ultrasonography procedures as suggested by Kumar and Harck [11].

Diagnostic criteria for US (DDH) [13, 14]

The babies underwent US examination based on Graf's method. USG findings of Type 2A (alpha angle between 50 and 59) and higher levels were considered that pathological infants with pathological findings were followed and, ifneeded, treated.

Both alpha and beta angles have been used in classifying infant DDH according to the Graf method for an US classification system (Table 1) [13, 14].

Diagnostic criteria for clinical examination (DDH) [15]

When evaluating clinically, the following physical findings were regarded as

1. Asymmetry of skin creases.
2. Inequality of leg lengths.
3. Positive values of the Ortolani-Barlow test [15].

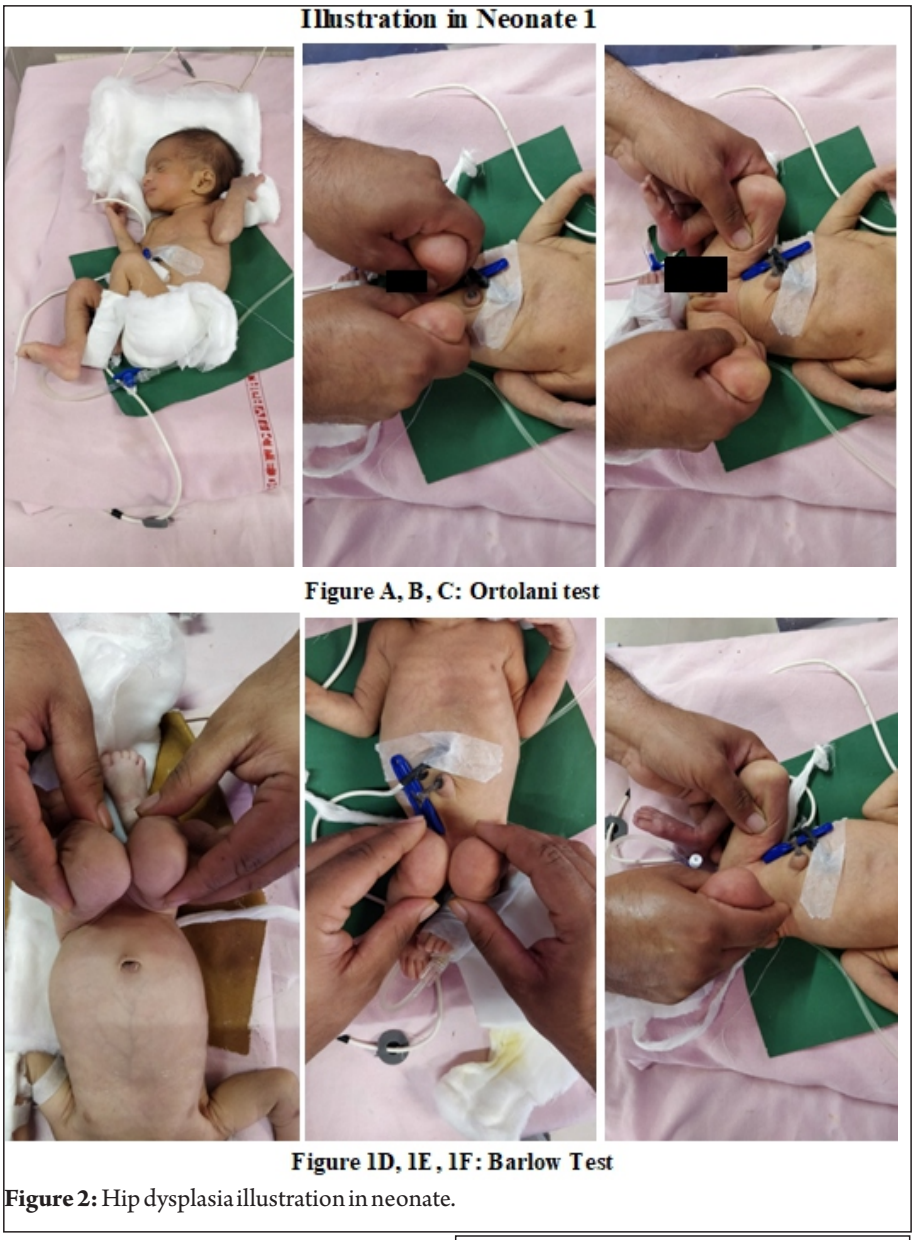

Figure 2: Hip dysplasia illustration in neonate.

Ortolani test

Each hip was examined separately. The child was placed supine with the hips flexed to 90°. The examiner identified the index and long fingers laterally over the child's greater trochanter with the thumb medially along the inner thigh near the groin crease. The examiner stabilized the child's pelvis by holding the contralateral hip while the opposite hand examined the hip. The upward and lateral force is exerted through the greater trochanter along with the gentle abduction of the hip being tested. A palpable clunk or sensation of movement is felt; it is considered as positive Ortolani [16].

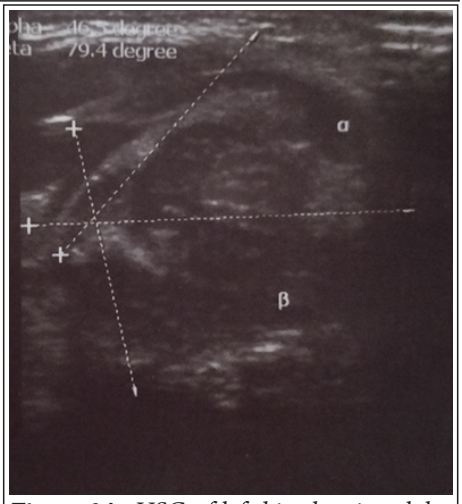

Figure 3A: USG of left hip showing alpha angle 46.2 and beta angle72.5 with Type II C DDH USG showing right side alpha angle 57.2 and beta-carotene 77.8

Barlow test

The Barlow provocative test was performed with the newborn positioned passive, and the hips flexed to 90°. The leg was then gently adducted while posteriorly directed pressure was placed on the knee. Barlow sign is positive when a palpable clunk or sensation of movement is felt at the exit of the femoral head at the posterior acetabulum [16].

Risk factors for DDH:

1. Breech presentation
2. Female sex
3. Positive family history
4. First born baby
5. Oligohydramnios

Statistical methods

Quantitative variable like age was represented as mean and standard deviation and categorical variables like gender were expressed as frequency and proportion. The Chi-square test and Fisher's t-test were used to test statistical significance ($P < 0.05$ was statistically significant) to find the association between the variables.

Diagnostic test (sensitivity and specificity)

Diagnosis of DDH through USG was considered a gold standard, and clinical diagnosis was regarded as a screening test. The specificity, sensitivity, predictive values, and diagnostic

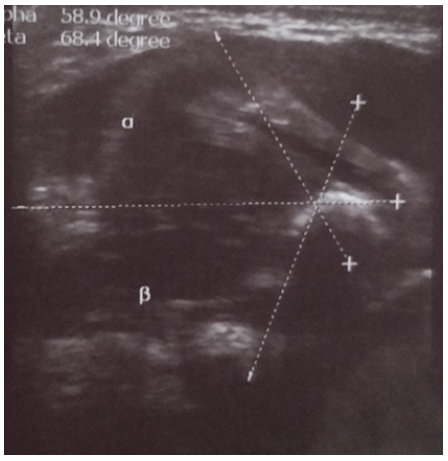

Figure 3: Ultrasonographic illustration of hip dysplasia.

Table 1: The Graf method for an ultrasound classification system

S. No.	Type of angle	Subtypes
1	Type I: Alpha angle >60° (normal)	○ Type Ia: Beta angle <55°
		○ Type Ib: Beta angle >55°
2	Type II	○ Type IIa physiologic immaturity of the hip): Alpha angle: 50–59° (>3 months of age)
		○ Type IIb: Alpha angle 50–59° (greater than 3 months)
		○ Type IIc
		▪ Alpha angle 43–49°
		▪ Beta angle 70–77°
		○ Type D (“about to decenter”)
		Alpha angle 43–49°
		Beta angle >77°
3	Type III	○ Alpha angle <43°
4	Type IV	○ Alpha angle <43°
		○ Dislocation with labrum interposed between the femoral head and acetabulum/inverted labrum

Table 2: Summary of baseline characteristics table.

Parameters	Summary
Gender	
Boys	21 (28%)
Girls	54 (72%)
Mean age	6.25±3.50
Age group (days)	
<7	51 (68%)
≥7	24 (32%)
Mode of delivery	
LSCS	70 (93.33%)
Vaginal	5 (6.67%)
Gestational age	
Term	39 (52%)
Preterm	36 (48%)
Risk factors	
Breech	64 (85.33%)
Oligohydramnios	4 (5.33%)
Clinical diagnosis of DDH	
Normal	70 (93.33%)
Pathological (left)	4 (5.33%)
Pathological (right)	1 (1.33%)
Diagnosis based on USG	
Normal	67 (89.33%)
Pathological (left)	7 (9.33%)
Pathological (right)	1 (1.33%)

accuracy of the screening test, along with their 95% CI, were calculated ($P < 0.05$ as statistically significant).

Results

A total of 75 subjects were included in the final analysis. Eight were diagnosed positive to have DDH on US, making an incidence of 10.66 %. Table 2 shows the baseline characteristics. In the present study, majority of the children were referred within 7 days of birth (68%). The majority of the babies were girls (72%), and boys constituted 28%. LSCS was the standard mode of delivery noted in the majority of the babies (93.33%). About 52% of the babies were term babies. Clinical diagnosis of DDH was positive among babies more on the left side (5.33%). Diagnosis based on USG was positive among 9.33% of the babies on the left side and 1.33% on the right side (Table 3). In the present study, USG evaluation based on Graf's test showed most of the babies with Grade IB on the left (61.33%) and right side (52%) (Table 4). The results showed that there was a high specificity (98.51%) and low sensitivity (50%) of clinical examination (Table 5).

Fig. 2 explains the illustration of hip dysplasia with the help of different tests. Fig. 3 explains the ultrasonographic illustration of hip dysplasia.

Discussion

DDH is a significant health problem, the treatment of which is easy and requires a short time and no surgery when diagnosed early. Unfortunately, there is no standardized screening program in our country [17]. In 1986, the Standing Medical Advisory Committee in the UK had advised that screening should occur within 24 h of birth, on discharge from the hospital of birth. At 6 weeks of age, a two-step technique where all newborns are clinically screened by Barlow and Ortolani maneuver and only infants with positive examination or risk factors for DDH is screened ultrasonographically is advocated [18].

The present study aims to identify the diagnostic effectiveness of clinical examination versus US immediately referred with a suspicion of DDH after

Table 3: Association between findings with the left and right side diagnosis (N=75)

Findings	Left side (N=75)	Right side (N=75)	Chi-square	P value
Barlow's test findings				
Positive	4 (5.33%)	1 (1.33%)	1.862	0.367
Negative	71 (94.67%)	74 (98.67%)		
Ortolani's test findings				
Positive	4 (5.33%)	1 (1.33%)	1.862	0.367
Negative	71 (94.67%)	74 (98.67%)		
Graf test findings				
IA	8 (10.67%)	10 (13.33%)	*	*
IB	46 (61.33%)	39 (52%)		
IIA	20 (26.67%)	19 (25.33%)		
IIC	0 (0%)	6 (8%)		
IIIC	0 (0%)	0 (0%)		
D	0 (0%)	0 (0%)		

*No statistical test was applied due to 0 subjects in the cell

Table 4: Accuracy of clinical diagnosis considering USG as the standard of reference (N=75).

DDH Based on clinical diagnosis	DDH based on USG diagnosis		Chi-square	P value
	Present (N=8)	Absent (N=67)		
Positive	4 (50%)	1 (1.49%)	27.026	<0.001
Negative	4 (50%)	66 (98.51%)		

Table 5: Predictive validity of DDH based on clinical diagnosis in predicting DDH based on USG diagnosis (N=75).

Parameter	Value	95% CI	
		Lower	Upper
Sensitivity	50.00%	15.70%	84.30%
Specificity	98.51%	91.96%	99.96%
False-positive rate	1.49%	0.04%	8.04%
False-negative rate	50.00%	15.70%	84.30%
Positive predictive value	80.00%	28.36%	99.49%
Negative predictive value	94.29%	86.01%	98.42%
Diagnostic accuracy	93.33%	85.12%	97.80%
Positive likelihood ratio	33.5	0.01	67.029
Negative likelihood ratio	0.51	0.33	1.016

birth.

While screening for the risk factors, it was found that the majority of the babies referred with the suspicion of DDH were preterm girls, and LSCS was commonly performed. There is a high propensity for DDH in females. The reason for this could be the release of maternal relaxin hormone before, after, and during the delivery, which leads to increased ligamentous laxity [19]. Breech presentation in utero was observed in referred patients as it leads to sustained hamstring forces around the hip among the study population increases the chances of DDH [20].

In the present study, diagnosis of DDH based on Barlow test and Ortolani test was more commonly positive in the majority of the babies on the left side. This could be because the left hip is adducted against the mother's lumbosacral spine, which is a common intrauterine position. Our findings corroborate with the study done by Arti et al. [12].

Physical examination of the infant's hip using Barlow and Ortolani maneuvers is part of the standard hip examinations of babies, but it is often insufficient to diagnose DDH. There are two significant limitations to this, and these maneuvers are dependent on the examiner's skill. Positive Barlow and Ortolani results are not attainable in a hip that is severely dislocated. DsThe sensitivity of the physical examination in the present study was low at 50%, and the results were concurrent with the studies done by Arti et al., Rosenberg et al., and Akgün et al. [12,21,22].

US is a very efficient imaging modality for newborn hip examination. It is a well-tolerated and non-invasive method and can provide an exquisite picture of the immature skeleton [23]. For infants younger than 4 months, screening hip US is recommended as early as 6 weeks but only for those with risk factors or positive examination findings [24]. In the present study, maximum babies were diagnosed with graft 2a (DDH) followed by two hips diagnosed with Graf 1d. The reason for this is physiologic instability noticed immediately after birth. Early US examination as a part of screening protocol in the first few weeks (before 4 weeks) after birth has not been advocated in any study as best to our knowledge. US is usually not recommended before 6 weeks of life as it leads to false-positive results given the laxity of the joint capsule which is generally self-correcting [25].

Graf advocates immediate treatment of type IIa and worse hips and recommends treating the type IIa– hips to minimize the chances of 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-month early detection of joint instability at birth can help us in surveillance of high-risk cases reducing the disease burden and preventing morbidity [14].

Based on the results of this study and relevant literature, and taking into consideration, all the possible conditions related to DDH, it may be concluded that,

1. Clinical screening along with targeted US immediately after birth at discharge or 2–3 weeks, whichever is earlier, should be performed by an experienced physician to detect clinical abnormalities.
2. If there is any doubt, an US should be performed at 6 weeks to detect a dislocated/dislocate hip.
3. In the absence of any sign of instability but with known risk factors and looking at the results of the study conducted, it is safe to perform the US at 4–5 months to detect the "true" cases of DDH and prevent overtreatment of immature stable Graf 2a hips [26].

Limitations

However, these findings cannot be generalized to the entire population and require further evaluation. The present study was a single-center study that involved a relatively smaller sample size

and did not involve all the neonates. Another primary limitation of the study was that the authors did not observe USG follow-up, which could have changed the status of the hip during that period.

Recommendations

As both US and clinical examination suffer from few drawbacks, we recommend screening and close monitoring of neonates to prevent the adverse outcome. As a part of the well-child protocol, periodic physical examinations should be conducted until 6–9 months of age and the use of selective hip ultrasonography as an adjunct imaging tool or an anteroposterior radiograph of the pelvis after 4 months of age for infants with identified risk factors [27,28].

Conclusion

Hence, it is evident from the present study that despite higher specificity, clinical examination is not much sense in the diagnosis of DDH. The sensitivity of these two clinical tests varies by the experience and skill of the examiner. Hence, there is probably a place for US in areas or centers where clinical expertise is unavailable. As clinical examination only' screening has some limitations at this stage, it is, therefore, recommended that, in addition to clinical examination, checks of both sonographic morphology and stability should be considered in screening for DDH at referral centers.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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