



Original Research Article

Comparative Study of Ultrasound vs. MRI in Diagnosing Pediatric Hip Dysplasia

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Abstract: **Background:** The timely and precise diagnosis of hip dysplasia in children is vital to avert disability in the long term, but the question of the most appropriate method of ultrasound or MRI is disputable. Ultrasound is very common in the first-screening process and MRI provides excellent imaging of the cartilaginous and soft-tissue structures. **Objective:** This study compared the diagnostic performance of ultrasound and MRI in identifying features of hip dysplasia in infants and young children. **Methodology:** The research took place in the Department of Radiology in the KMU hospital and Research center Peshawar, between the months of June 2023 to June 2024. Eighty-two children (0 to 24 months) with a clinical suspicion of hip dysplasia were taken through ultrasound as well as MRI. The Chi-square tests and kappa agreement statistics were used to analyze diagnostic findings, measurement parameters, and management impact. **Results:** The ultrasound identified dysplasia in 63.4 percent of the participants, and MRI identified 57.3 percent. The sensitivity (95.5) and specificity (75.7) of ultrasound were high and moderate respectively against MRI as a reference standard. MRI proved to be better in detecting labral abnormalities and structural instability and resulted in a change in clinical management in 23.2 percent. **Conclusion:** Ultrasound is still a useful first-line agent to make early diagnosis, whereas MRI can be used to offer clarification to the borderline or complex cases. A stepwise method of using both modalities enhances more precise diagnosis and informed clinical decision making.

Keywords: Pediatric hip dysplasia, ultrasound, MRI, Graf classification, femoral head coverage, diagnostic accuracy

INTRODUCTION

Pediatric hip dysplasia is one of the musculoskeletal

disorders that are the most prevalent during infancy and, when not treated, may cause gait anomalies, long-term pain, and early osteoarthritis. Identification at an early stage is hence very

important and imaging has become a key central figure in the process of ruling out clinical suspicions. The use of ultrasound has long been the first method of diagnosis during the first few months of life as it allows visualization of the cartilaginous structures, non-radiation, and is easily applicable to the screening programs provided on a regular basis [1-3]. Although it has its benefits, ultrasound has known shortcomings. The precision of diagnostics can be affected by operator dependence, positioning and distinguishing mild dysplasia and physiological immaturity. MRI, however, offers a clear picture of the acetabular cartilage, labrum and the coverage of the femur head without overly depending on the position of the patient. Due to these reasons, MRI is also increasingly utilized as a test in cases of the borderline, incongruent ultrasound results and more detailed anatomical analysis is needed in determining treatment [4-6].

It is important to compare the strengths of both modalities in order to establish how they can be combined in the diagnostic pathways. There have been previous studies indicating variability in sensitivity and specificities and the extent of MRI changing clinical management is a significant factor of consideration [7-9]. This paper attempted to give a renewed comparison of ultrasound and MRI with a prospective cohort of infants and young children and not only compare their diagnostic performance but also their effects on decisions of treatment.

MATERIAL AND METHODS

This was a prospective comparative diagnostic study that will be done in the Department of Radiology in the KMU hospital and Research center Peshawar within a 1 year time span between June 2023 and June 2024. The purpose of the research was to compare the diagnostic accuracy of ultrasound and magnetic resonance imaging (MRI) to determine the presence of pediatric hip dysplasia.

Eighty two children (82) who had a clinical suspicion of hip dysplasia were enrolled consecutively. The children age 0-24 months included in the study had referred to imaging examination because of reduced hip abduction, asymmetry of skin folds, hip instability, or a positive clinical screening test (e.g., Ortolani/Barlow).

Inclusion Criteria

- Children aged 0–24 months
- Clinical suspicion of hip dysplasia
- Referred for both ultrasound and MRI during the study period
- Parental/guardian consent obtained

Exclusion Criteria

- Previous hip surgery
- Congenital syndromes affecting musculoskeletal development
- Incomplete imaging or missing clinical data

An ultrasound was done with high frequency linear transducer. Classification was done using the Graf method where measurements were made in terms of the a-angle, b-angle and categorization based on the types of Graf (I-IV). The interpretation of all scans was done by a pediatric musculoskeletal imaging radiologist.

MRI was performed with the use of a standard pediatric hip protocol. Major parameters of MRI measures were coverage of the femoral head, labral morphology, acetabular cartilage arrangement, joint effusion, and reduction. The use of sedation was minimized to the point of minimization of motion artifact.

The demographic variables (age, sex, side affected) and the clinical findings were noted. Two radiologists were blinded to avoid bias because the image results of ultrasound and MRI were recorded independently.

MRI was considered to be the reference standard. The performance of the ultrasound diagnostic was evaluated by computing: Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV), overall accuracy and Cohen kappa agreement.

The SPSS version 26 was used to analyze data. Chi-square tests were used to compare the categorical variables, and p-values less than 0.05 were taken to be statistically significant. The continuous variables were presented in the form of mean +standard deviation. The kappa statistic was used to determine the agreement between ultrasound and MRI.

RESULTS

Eighty two children who had ultrasound and MRI assessment were studied and assessed to have suspected pediatric hip dysplasia. The proportion of instances detected as dysplasia by ultrasound was larger than that detected by MRI, but MRI offered greater degree of visualization of the acetabular cartilage and labral morphology. Demographic characteristics, findings of imaging and diagnostic performance are summarized in the following tables.

Early screening trends were evident with majority of children being below one year old. There was a female slight

over preponderance which is in line with established epidemiology of hip dysplasia. A bilateral participation was found in almost 1/3 of the sample.

Table 1. Demographic Profile of Study Participants (n = 82)

Variable	Category	Frequency (%)
Age group	< 6 months	38 (46.3%)
	6–12 months	29 (35.4%)
	> 12 months	15 (18.3%)
Sex	Male	31 (37.8%)
	Female	51 (62.2%)
Side affected	Right	28 (34.1%)
	Left	27 (32.9%)
	Bilateral	27 (32.9%)

Higher percentages of hips were deemed to be dysplastic according to α -angle and type of Graf by ultrasound. MRI, in its turn, proved to be better at visualizing labral abnormalities and femoral head coverage. There were statistically significant differences between detection of structural abnormalities ($p < 0.05$).

Table 2. Imaging Findings on Ultrasound and MRI

Imaging Variable	Ultrasound Positive n (%)	MRI Positive n (%)	p-value
Hip dysplasia present	52 (63.4%)	47 (57.3%)	0.041
Abnormal α-angle (< 60°)	49 (59.8%)	–	–
Abnormal femoral head coverage (< 50%)	–	45 (54.9%)	–
Labral abnormality	18 (22.0%)	32 (39.0%)	0.012
Subluxation / Dislocation	14 (17.1%)	21 (25.6%)	0.049

The reference standard of diagnostic accuracy comprised MRI. The ultrasound showed a sensitivity level of high with a moderate specificity showing a tendency to overcall mild dysplasia. The general diagnostic agreement was good (0.72).

Table 3. Diagnostic Accuracy of Ultrasound (Using MRI as Reference)

Parameter	Value
True Positive (TP)	43
True Negative (TN)	28
False Positive (FP)	9
False Negative (FN)	2
Sensitivity	95.5%
Specificity	75.7%
Positive Predictive Value (PPV)	82.7%
Negative Predictive Value (NPV)	93.3%
Overall Accuracy	86.5%
Kappa Agreement (κ)	0.72
p-value	0.001

MRI results changed the course of treatment among some children that were initially mild or borderline on ultrasound. This was a statistically significant change that was clinically relevant. Further complicated intervention was to be used in case of more severe structural anomalies detected by MRI.

Table 4. Change in Clinical Management after MRI

Variable	Yes n (%)	No n (%)	p-value
Management changed after MRI	19 (23.2%)	63 (76.8%)	0.028
Escalation to spica or surgery	11 (13.4%)	71 (86.6%)	0.044

Figure 1. Comparison of Ultrasound vs MRI Findings in Pediatric Hip Dysplasia (n=82)

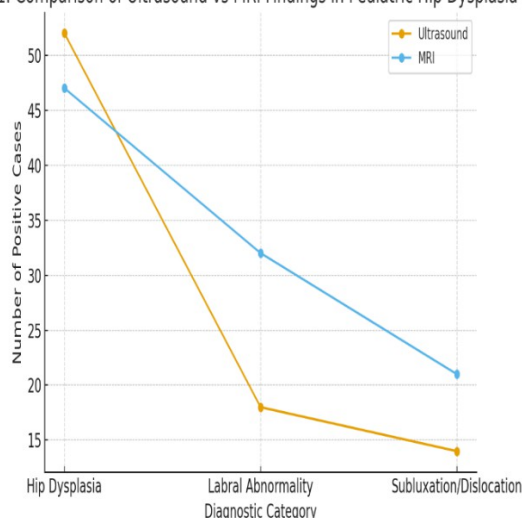


Figure 1. Comparison of Ultrasound and MRI Findings in Pediatric Hip Dysplasia (n = 82).

Figure shows the occurrence of positive cases identified by ultrasound and MRI in three categories of diagnoses related to hip dysplasia, labral abnormalities, and subluxation/ dislocation. MRI found more labral abnormalities and cases of subluxation and ultrasound found slightly more hips dysplastic in general.

DISCUSSION

This comparative study compared the diagnostic capabilities of ultrasound and MRI in pediatric hip dysplasia within a period of one year and gained an insight into the complementary advantages of the two modalities. A higher percentage of the dysplastic hips was detected by ultrasound, which is sensitive to the initial cartilaginous changes, and which is the initial imaging method of a child. MRI was however found to be more proficient in describing more deep-lying structural abnormalities especially labral morphology and acetabular cartilage arrangement leading to more sophisticated severity evaluations [10-12].

The result that ultrasound had high sensitivity (95.5) with moderate specificity (75.7) is consistent with the literature that reported that early hip immaturity may be overdiagnosed as dysplasia particularly in borderline cases of Graf categories. As the reference standard, MRI reclassified a number of borderline and mild cases by detailing the coverage and status of the reduction of the femoral head. This is the reason why the percentage of cases (23.2) in which MRI results changed the clinical management plan is huge and particularly in infants who need to be escalated to bracing, closed reduction, or surgery [13-15].

The fact that MRI is better able to identify labral abnormalities (39% vs. 22% on ultrasound) highlights its usefulness in the evaluation of cases in which the results of ultrasound remain unclear or do not coincide with the clinical picture. As labral hypertrophy or inversion may affect stability and treatment choices, MRI can not be replaced since the

symptoms may not disappear despite the normal or questionable ultrasound findings. Simultaneously, the non-invasive aspect, absence of radiations, portability and high accessibility of ultrasound render it as the best first line of investigation in large scale screening [16-18].

Although MRI provided more anatomical details, it is more expensive, time consuming to acquire and requires sedation in some cases, which reduces its clinical usage. Thus, a screening approach with ultrasound and a complex or treatment-resistant case with MRI seems to be the most suitable [19, 20]. This complementary nature is supported by the good correspondence between the two modalities (0.72) and this justifies the use of ultrasound as a primary diagnostic tool with MRI added to determine the severity and management as required.

CONCLUSION

Ultrasound still forms a very sensitive and useful first-line imaging method of diagnosing pediatric hip dysplasia and especially in infancy. Despite the less accessibility, MRI has the advantage of giving critical anatomy and enhancement of diagnostic assurance in cases of borderline, complex, or treatment-planning. The structured stepwise utilization of both modalities leads to better accuracy, confined misclassification, and aids in better clinical decision-making in the development of the hip in young children.

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