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Early detection of Hip Dysplasia: A Screening tool evaluation

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Abstract:

The purpose of this study is to compare the results with hips graded by Graf classification using ultrasonography (US) in order to assess the diagnostic efficacy of radiography for developmental dysplasia of the hip (DDH) in infants younger than six months. Radiography may offer more comprehensive insights for screening programs and improve diagnostic precision, even if US is the standard for screening and diagnosing DDH in this age range. 100 hips from 497 newborns and babies under six months old who had hip US and radiography for DDH screening between August 2020 and September 2021 were included in this retrospective study. To find DDH indications, radiographs were reevaluated by a skilled pediatric orthopedic surgeon.

The Graf classification was used to classify hips, and the main result was the accuracy of the diagnosis. Of the 100 hips examined, 71 (or 14.3%) of the right and 51 (10.3%) of the left hips displayed DDH radiograph indications. Radiographs of 43 (8.7%) right and 47 (9.5%) left hips revealed Graf grades IIa to IV, which allowed for a correct diagnosis of right- and left-sided DDH with specificity values of 87.0% and 92.4%, respectively. The radiographs of 7 (1.4%) right and 14 (2.8%) left hips showed Graf grades IIb to IV, which, when combined, allowed for the specificity of 86.1% and 91.1%, respectively, in the diagnosis of right- and left-sided DDH.

The findings of our study suggest that radiography may not be able to diagnose DDH in newborns and babies during the first six months of

Key words: infantile, dysplasia of the hip, radiography, ultrasound, sensitivity, and specificity.

Introduction

The most prevalent congenital condition affecting the musculoskeletal system in infants is called Developmental Dysplasia of the Hip (DDH), which can cause anything from a simple flattening of the acetabular cavity to a total dislocation of the femoral head. DDH can cause early hip osteoarthritis and, in extreme situations, a limp with major functional restrictions from a young age if treatment is not received. For the best results and to lower the chance of developing hip osteoarthritis in adulthood, early diagnosis is essential for prompt treatment. Starting treatment within the first month of life, or better yet, in the early days of life, maximizes its effectiveness. This publication, which was produced through collaboration between pediatricians, radiologists, and paediatric orthopedics, aims to provide guidelines for the early diagnosis, treatment, and management of hip developmental dysplasia. (DDH) [1].

Hip dysplasia, subluxation, dislocatable, and dislocated hips are among the anomalies that fall under the umbrella of developmental dysplasia of the hip (DDH), which is caused by irregularities in the positioning of the femoral head and acetabulum. Prolonged discomfort, reduced walking ability, and early degenerative joint disease can all result from DDH. Although the precise origin of DDH is yet unknown, a combination of environmental and genetic factors, including female gender, breech presentation, vaginal birth, fetal crowding, and family history, are thought to be involved. Newborns should be screened for hip dysplasia to avoid the need for postponed treatment, which can lead to arthritis, gait abnormalities, and long-term hip deformities [2].

Different populations have varying incidences of DDH, ranging from 1 to 7% in neonates; these variations are influenced by cultural customs and genetic predisposition. Better diagnostic techniques, such as The number of reported cases has significantly increased as a result of clinical and sonographic screening, raising the likelihood of overdiagnosis. Because ultrasonography is safe, affordable, and can distinguish between the cartilage in the hip joint and the surrounding soft tissues, it is the primary diagnostic method for DDH. Ultrasonography can be performed at a younger age than radiography, which allows for early detection and the start of treatment [3].

To sum up, the timely identification and treatment of DDH are essential for minimizing invasive procedures and attaining positive long-term results. There are disagreements over whether clinical

examinations or ultrasonography is more effective in detecting DDH in neonates, but a decision has not yet been made. For diagnosing DDH in infants older than six months, radiography is still the recommended modality; however, some support its use in younger infants as well. This study uses the hips graded by Graf classification utilizing ultrasonography to assess the diagnostic effectiveness of hip radiography in identifying DDH in newborns and infants under six months [4].

Methods

Research Plan :

The 100 babies served as the study's material for this retrospective analysis. Using a Sonoline G60S ultrasound system (SIEMENS, Erlangen, Germany) with a 7.5 MHz linear probe. Hips were graded based on Graf classification. Accordingly, mature, normal, and healthy hips were categorized as grade 1 hips, and immature and pathological hips and hips with DDH were categorized as grade IIa to IV hips15,22,23. The pelvic radiographic images were reviewed by one pediatric orthopedic surgeon (A.S.S.) with at least ten years of experience in DDH. For each hip, the acetabular index (AI) and the acetabular depth ratio (ADR) were measured as recommended by Tönnis21. The femoral head’s positioning in the outer quadrant formed by the Hilgenreiner and Perkins lines and the disruption of the Shenton’s line in radiographs, and AI values higher than the previously defined age- and The study's primary outcome was the diagnostic accuracy of pelvic/hip radiographs for DDH with reference to hips graded by Graf classification using the US. Based on gender-based reference values, it was determined that DDH pathology7,20,21,24. As a result, each hip was classified as compatible or not compatible with DDH. The ossific nucleus within the femoral head was also noted in cases where it was evident. Variables Data on the demographic and clinical variables, including AI and ADR data, ossification of the head of the femur, and Graf grades of the hips, were obtained from the hospital information system and patients' medical files.

Based on Graf classification to identify pathological hips: (i) hips graded IIa through IV, and (ii) hips graded IIb through IV. The descriptive statistics obtained from the collected data were expressed as mean ± standard deviation values for continuous variables determined to conform to

the normal distribution, as median with minimum-maximum values for continuous variables determined not to conform to the normal distribution, and as numbers and percentages for categorical variables. The normal distribution characteristics of the numerical variables were analyzed using the Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests. Based on Graf classification, specificity and sensitivity values, negative predictive values (NPV), and positive predictive values (PPV) were calculated for radiographs for DDH.

Results

One hundred pediatric patients who were included in this study. The patients' ages ranged from under six months to 34 males and 66 females. With a mean of, the lowest age was 4 weeks, and the highest age was 25 weeks and 3 days (Table 1) and Fig. (1).

Table1. Sex and Age distribution of cases.

Sex/Age	**≤ 6 months**	**> 6 months**	**Total**
Male	20	14	34
Female	38	28	66
Total	58	42	100

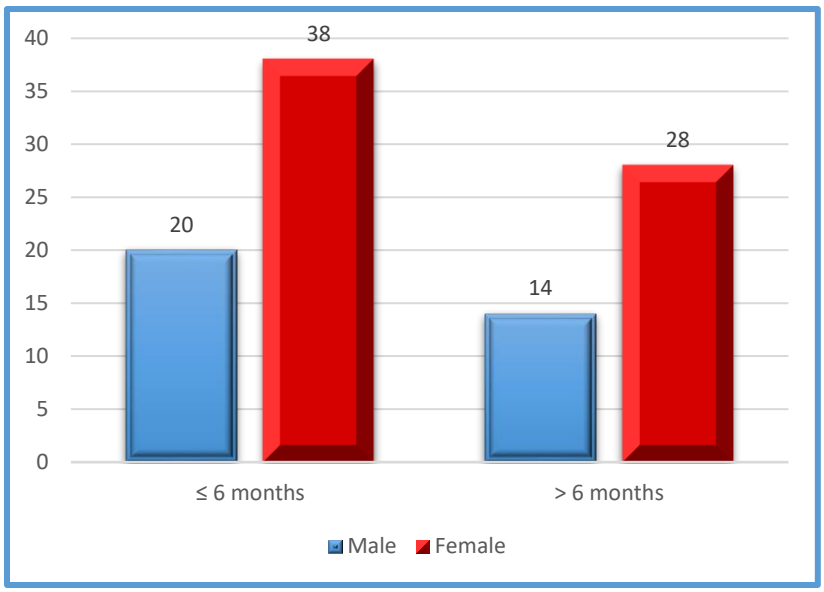

Fig.1 Sex and Age distribution of cases.

The most prevalent referral cause (44%) among the several hip US referral causes (risk factors) was a positive Barlow test, which was the least common at 4%. The other referral causes and their percentages were as follows (Table 2).

Table 2. The percentages of the various hip US referral causes.

Cause of Referral	No.	%
family history Positively of similar condition	8	16%
Congenital abnormalities	6	12%
Maternal DM	6	12%
Oligohydramnios	11	22%
Cesarean section	22	44%
Limitation of abduction	8	16%
Positive Barlow tests	2	4%

Abnormal skin crease	5	10%
Twin	4	8%

According to the sonography Graf grades, 3 (6.0%) right and 3 (6.0%) left hips were classified as grade IIa through IV (immature/pathological), and 88.0% of the right and 90.5% of the left hips were classified as grade I (normal/mature). 2 right and 2 (0.20%) left hips among the hips found to be immature and diseased were classified as grade IIb. It was shown that 14 (2.8%) left hips and the remaining seven (1.4%) right hips were compatible with DDH. Table 3 displays the hip distribution by Graf grades.

Table 3.Sonography categorization based on Graf technique.

	Types					Pathological hips based on Graf types:	
	I	**IIa**	**IIb**	**IIc**	**D-III and IV**	**From IIa to IV**	**From IIb to IV**
Right hip (n = 50)	44(88.0)	3 (6.0)	2 (1.0)	1 (0.2)	0	43 (8.7)	7 (1.4)
Left hip (n = 50)	45(90.5)	3 (6.0)	1 (0.2)	1 (0.2)	0	47 (9.5)	14 (2.8)

Tables 4 and 5 display the distribution of the diagnostic parameters by hip category based on the Graf grades, including sensitivity, specificity, NPV, PPV, and accuracy. With regard to the hips classified as IIa through IV and thus defined as pathologic in terms of US-based Graf classification, the pelvic/hip radiographs diagnosed right-sided and left-sided DDH with specificities of 87.0% and 92.4%, respectively (Table 4).

Table 4. Association of radiological diagnosis of DDH with pathological imaging findings using the Graf method (types from IIa to IV).

Hip	Radiological Diagnosis	Sensitivity (%)	Specificity (%)	NPV (%)	PPV (%)	Accuracy (%)
Right	Normal	87	92.7	16.9	81.9	81.9
	DDH	-	-	-	-	-
Left	Normal	92.4	93.3	33.3	87.1	87.1
	DDH	-	-	-	-	-

DDH: Developmental dysplasia of the hip, NPV: negative predictive value, PPV: positive predictive value.

For the right hip, the total diagnosis accuracy was 81.9%, and for the left hip, it was 87.1%. Right-sided DDH was detected in hips graded IIb through IV with 86.1% specificity, and left-sided DDH with 91.1% specificity, omitting grade IIa hips. According to Table 5, the diagnostic accuracy for the right and left hips was 85.5% and 90.1%, respectively.

Table 5. Association of radiological diagnosis of DDH with pathological imaging findings using the Graf method (types from IIb to IV).

Hip	Radiological Diagnosis	Sensitivity (%)	Specificity (%)	NPV (%)	PPV (%)	Accuracy (%)
Right	Normal	86.1	99.1	4.2	85.5	85.5
	DDH	-	-	-	-	-
	Normal	91.1	98.7	15.7	90.1	90.1

Left	DDH	-	-	-	-	-

DDH: Developmental dysplasia of the hip, NPV: negative predictive value, PPV: positive predictive value.

Table 6 shows the correlation between the radiographic state of the acetabulum and the hip graft grades. There were notable discrepancies between the radiological and ultrasonographic diagnoses in cases with grade IIa and IIb hips, despite the fact that the diagnoses from both sources were consistent in all cases with grade IIc and III hips.

Table 6. Radiographic classification of Graf type pathologic hips.

Graf Type	Overall (n)	Right Hip	Left Hip
IIa	69	Normal: 51, DDH: 18	Normal: 27, DDH: 9
IIb	16	Normal: 10, DDH: 6	Normal: 4, DDH: 2
IIc	3	Normal: 0, DDH: 3	Normal: 0, DDH: 1
III	2	Normal: 0, DDH: 2	Normal: 0, DDH: 0

Discussion

According to the study's findings, the accuracy of pelvic/hip radiographs in diagnosing DDH in newborns and babies up to six months ranged from 88.0% to 90.5%, depending on the hip's side

and Graf grade. The The diagnoses derived from the radiographs were in agreement with the US for hips categorized as IIc and III in the Graf classification scheme. However, for hips classified IIa and IIb, there were significant differences in the diagnoses given based on radiographs and the US. Rapid and low-radiation digital X-ray imaging could eventually replace other techniques as the go-to supplemental method for DDH diagnosis and tracking in 3-6 month infants16. Because ossific hip joints do not exist, pelvic Radiography is not advised for newborns under four months old. [5].

However, the positioning of children during imaging, the ability to see the secondary ossification centers within the femoral heads and the osseous acetabular morphology, and the repeatability of DDH anteroposterior pelvic radiographs all affect how effective pelvic/hip radiography is as a diagnostic tool [6].. Inappropriate Misdiagnoses resulting from patient posture could be both false-positive and false-negative. Furthermore, neonates and infants younger than three months of age typically do not begin to exhibit ossification. To diagnose DDH, the radiographs were reevaluated in this study. Almost half of the photos had to be excluded due to inadequate imaging quality and inappropriate exposure to the pelvic anatomic landmarks. As a result, the technical problems could reduce the accuracy of the findings. One of the first medical professionals to report on the connection between DDH and radiographic characteristics was Tönnis (1976). For infants, AI levels of 30° or less have been considered normal, while for children older than a year, AI values of 22° or less have been considered normal. AI cut-off values broken down by age and gender, as reported by In this investigation, Tönnis(1976). was utilized to identify the cases with higher AI values.

If the Tönnis (1976) categorization system is to be utilized as a reference, an ossification center is necessary [7]. Therefore, the Tönnis system cannot be used in every situation since ossification does not occur in newborns younger than three months of age2. As a result, the photos of the newborns and babies were classified by the updated International Hip Dysplasia Institute to determine if the acetabulum was dysplastic or normal2,28. In this instance, the cutoff values published by Tönnis et al. (1976) in this investigation were employed in conjunction with the updated International Hip Dysplasia Institute categorization.

In their investigations, Doski et al. and Li et al. explored the usefulness of radiography in the diagnosis of DDH in various age groups. [7].

In a single of these investigations, Doski et al., (2022) examined how well the revised International Hip Dysplasia Institute Classification system identified DDH in children between the ages of three and twenty-two months. They did not, however, divide the patients into age groups. In a different study, Li et al., (2022) examined the diagnostic performance of different imaging modalities in children with suspected DDH, including those with acetabular dysplasia, femoral head subluxation, and total femoral head dislocation.

Three age groups were created for the patients: younger than six months, older than twelve months, and 7 to 12 months. They thus concluded that the overall diagnostic accuracy of X-ray radiography for DDH was 78.9%. By contrast, radiography's diagnostic precision in identifying problematic DDH—that is, hips rated IIb through IV—is inferior.were 85.5% and 90.1% for the right and left hips, respectively, according to the Graf classification. Despite using universal screening to all children with suspected DDH, unlike our trial, they also discovered similar diagnostic accuracy of radiography in DDH diagnosis. [8].

However, they found that none of the patients in their patient group had late DDH, and they came to the conclusion that it is not necessary nor cost-effective to use X-rays on 5-month-old children who are being released from the clinic.

Others24 demonstrated that, when used as a follow-up modality for 6-month-old children who have already had DDH treatment, the US is a useful substitute for X-rays. A small number of research compares the US's radiography's diagnostic efficacies. Despite the noteworthy methodological Despite the variations in these investigations, radiography produced outcomes that were similar to the US as a whole. Parallel to the findings of this investigation, Atalar et al. (2021) found that, in comparison to the US, plain radiography identified DDH in children between the ages of 4 and 50 weeks with a sensitivity of 61% and a specificity of 87%. The results of this study, when combined with the data from the literature, recommend utilizing plain radiography in infants with IIa and IIb grade hips. In some circumstances, this technique may even yield better results when paired with clinical findings and follow-up data. The effectiveness of delayed ultrasound between three and five months in clinically stable hips by contrasting the use of radiography in 5-month-olds with the standard 12-week ultrasound in neonates at risk for DDH. [9].

When it came to diagnosing persistent DDH in children older than 18 months, they could not discover any appreciable differences between the two approaches. In babies with undeveloped hips 4-6 months old, Tudor et al.'s analysis of the US and X-ray's diagnostic efficacies for DDH revealed a substantial difference in DDH incidence between the two techniques. Anteroposterior radiographs were used in a study22 that took place between 2003 and 2005 to identify the hips that needed therapy. As a result, the number of hips that needed treatment dropped from 51.75 per 1,000 hips to 30.77 per 1,000 hips. As a result, they suggested radiography be done for every infant older than three months who has received a DDH diagnosis from the US. Studies contrasting these two imaging modalities ought to offer further information. [10].

Conclusive evidence, given that the US is a commonly used DDH screening method. In the US, Atalar et al.16 looked at the utility of pelvic anteroposterior radiographs in babies (ages 4 to 6 months) who had normal hip findings and risk factors for DDH. They came to the conclusion that the US might not be enough to diagnosis DDH in their patient group and proposed that radiography could be used to diagnose DDH in infants who were at risk for the condition and were younger than six months old, even if the US revealed a normal hip. Since the effectiveness of radiography in detecting DDH in infants under six months of age was evaluated with reference to hips graded by Graf, the two modalities' efficacy could not be compared in this study. [9].

categorization based on US standards. Weinstein et al. (2014) divided DDH into various categories according on the results of the radiography. Consequently, they divided DDH into groups based on different imaging results, including dysplasia, subluxation, and displacement. They gave subcategorization based on US standards.

Weinstein et al. (2014) divided DDH into various categories according on the results of the radiography. [11]. Consequently, they divided DDH into groups based on different imaging results, including dysplasia, subluxation, and displacement. They gave sub The accuracy of radiography on Graf type IIa-III and IIb-III hips within the same study group has never been revealed before, until now. The age difference between the research groups may account for the notable discrepancy in radiography accuracy between Graf type IIa-III and IIb-III hip. Given that the age of the infants is the main distinction between Graf types IIa and IIb hips), the greater radiography accuracy on Graf types IIb-III hips may be explained by this age difference. [12].

Conclusion

In this retrospective study, the diagnostic utility of radiography in comparison to ultrasonography using the Graf classification was assessed for developmental dysplasia of the hip (DDH) in infants under six months of age.

According to the results, radiography could be a useful addition to US in the diagnosis of DDH in this age group, especially for hips with Graf types IIb through IV classifications. Radiography can provide more information and increase the accuracy of the diagnosis, even though US is still the main screening method. In hips categorized as IIb through IV, radiography was found to have an 86.1% sensitivity and a 99.1% specificity for detecting DDH. For the right hip and the left hip, the diagnostic accuracy was 85.5% and 90.1%, respectively.

But the research also revealed some In hips categorized as IIb through IV, radiography was found to have an 86.1% sensitivity and a 99.1% specificity for detecting DDH. For the right hip and the left hip, the diagnosis accuracy was 85.5% and 90.1%, respectively.

However, the study also emphasized some of radiography's drawbacks, including the possibility of technical errors and its reliance on the ossification of the femoral head. The study was further constrained by its small sample size and retrospective approach.

To further substantiate radiography's function in the early diagnosis of DDH in babies, higher sample sizes and prospective study methods are required.

References

1. Lehmann H.P., Hinton R., Morello P. and Santoli J.(2000): Developmental dysplasia of the hip practice guideline: Technical report. Committee on Quality Improvement and Subcommittee on Developmental Dysplasia of the Hip. Pediatrics, 105 (4),.
2. Atalar H, Dogruel H, Selek H, Tasbas BA, Bicimoglu A, Gunay C. A(2013) comparison of ultrasonography and radiography in the management of infants with suspected developmental dysplasia of the hip. Acta Orthop Belg; 79: 524-529.
3. Bakti K, Lankinen V, Helminen M, Välipakka J,Laivuori H and Hyvärinen A.(2022) Clinical and sonographic improvement of developmental dysplasia of the hip: analysis of 948 patients. J Orthop Surg Res , 17: 538.
4. Barrera CA, Cohen SA, Sankar WN, Ho-Fung VM, Sze RW and Nguyen JC.(2019) Imaging of developmental dysplasia of the hip: ultrasound, radiography, and magnetic resonance imaging. Pediatr Radiol ; 49: 1652-1668.

5. Shipman A., Helfand M.,Moyerv. A. and Yawn B. P.(2006): Screening for developmental dysplasia of the hip: A systematic literature review for the U.S. Preventive Services Task Force. Pediatrics, 117 (3): e557-76.
6. Barrera CA, Cohen SA, Sankar WN, Ho-Fung VM, Sze RW and Nguyen JC.(2019) Imaging of developmental dysplasia of the hip: ultrasound, radiography, and magnetic resonance imaging. Pediatr Radiol ; 49: 1652-1668.
7. Tönnis D. (1976)Normal values of the hip joint for the evaluation of X-rays in children and adults. Clin Orthop Relat Res; 119: 39-47.
8. Doski J, Mosa L, and Hassawi Q.(2022) An upgrade of the international hip dysplasia institute classification for developmental dysplasia of the hip. Clin Orthop Surg; 14: 141-147.
9. Atalar H, Dogruel H, Selek H, Tasbas BA, Bicimoglu A, Gunay C. A(2013) comparison of ultrasonography and radiography in the management of infants with suspected developmental dysplasia of the hip. Acta Orthop Belg; 79: 524-529.
10. Tudor A, Sestan B, Rakovac I, Luke-Vrbanić TS, Prpić T, Rubinić D, Dapić T. (2007)The rational strategies for detecting developmental dysplasia of the hip at the age of 4-6 months old infants: a prospective study. Coll Antropol; 31: 475-481.
11. Weinstein SL, Mubarak SJ and Wenger DR.(2014) Fundamental concepts of developmental dysplasia of the hip. Instr Course Lect; 63: 299-305.
12. Jung HW and Jang WY. (2020)Effectiveness of different types of ultrasonography screening for developmental dysplasia of the hip: A meta-analysis. Medicine (Baltimore); 99: e23562.