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Screening of Developmental Dysplasia of the Hip by Clinical and Ultrasound

Dr. Aseel Mohammed Wadi[1], Dr. Huda Mahmood Othafa[2], Dr. Zinah Anas Salman[3], and Dr. Ali Qais Abdulkafi[4]and Dr. Tareq Jawad kadem Al-Rubayee[5]

[1]M.B.Ch.B., C.A.B.P., \ (Pediatrics), Iraqi Ministry of Health, Basra Health Department, AL-Sayab Teaching Hospital, Basra, Iraq

[2]M.B.Ch.B., C.A.B.M.S., \ (Radiology), Iraqi Ministry of Health, Basra Health Department, Al-Zubair General Hospital, Basra, Iraq

[3]M.B.Ch.B., F.I.B.M.S. (Pediatric), Iraqi Ministry of Health, Basra Health Department, Basrah Maternity and Pediatric Hospital, Basrah, Iraq

[4]M.B.Ch.B., D.C.H. \ (Pediatrics), Iraqi Ministry of Health, Kirkuk Health Department, Kirkuk Teaching Hospital, Kirkuk, Iraq

[5]M.B.Ch.B., M.R.C.S., Ireland, Diploma General Surgery,Ministry of Higher Education and Scientific Research, AL-Rasheed University College, Department of Pharmacy, Baghdad, Iraq

Abstract: **Background:** Developmental dysplasia of the hip (DDH) is a condition where the femoral head is positioned abnormally due to looseness or improper alignment in the hip joint. **Objective:** This study analysed clinical outcomes related to screening infants who have DDH using ultrasound techniques. **Patients and methods:** A clinical outcomes were enrolled data of infant patients suffering from developmental dysplasia of the hip, which included 80 patients less than 80 days old, which were collected from Baghdad – Iraq hospitals within the period ranged from July 7, 2022, to August 25, 2023. These results showed the common types of presentation for infant patients at birth, which included breech cephalic, transverse, and determined hip angles in patients with DDH on the right and left sides. Also, this study was presented an ultrasound technique in discovering of developmental dysplasia of the hip in infants, which shown all of the items, which are sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy. **Results:** Our results were distributed by frequency of age among infant patients, with patients with an age of less than 20 days having the highest rate (95%). The presentation of infants' outcomes showed that cephalic was a common factor with 72 cases, breech had 5 cases, and transverse had 3 cases. Our findings detected the most common risk factors by ultrasound technique, which are oligohydramnios, breech, cephalic, limited hip abduction, and congenital muscular torticollis. In addition, our results enrolled clinical outcomes of hip dysplasia based on the Graf scale where the left where alpha was 52.13 ± 4.25, and Beta was 42.02 ± 6.81, which indicates into hip dysplasia in the right side while Alpha was 51.23 ± 3.70 and Beta was 49.46 ± 3.57 which indicate into hip dysplasia in the left side. **Conclusion:** Our study indicated that ultrasound technology is an influential factor in detecting developmental dysplasia of the hip earlier and with better accuracy, which results in identifying risk factors and treating the disease.

Keywords: Developmental dysplasia of the hip (DDH); Ultrasound; Presentation of infants; and Graff classification.

INTRODUCTION

Distal distal humerus (DDH) is a medical condition characterized by the presence of femoral head looseness or incorrect placement in respect to the acetabulum. The spectrum of manifestations may vary, which includes the flattening shape of the acetabulum, acetabular dysplasia, and severe dislocation of the femoral head beyond the joint [Dezateux, C. *et al*., 2007; Shorter, D. *et al*., 2013].

Given that some of these features may not be evident at birth, the term "developmental dysplasia" has been used to describe the biological characteristics of this condition better accurately rather than attributing it to a congenital cause [Kural, B. *et al*., 2019; US Preventive Services Task Force, 2006]. According to the literature, CDD is the most common bone disease that occurs during the perinatal period. Its frequency ranges from 1/1000 live newborns to 6% [Al-Essa, R. S. *et al*., 2017].

Besides to that, the patient population is mostly female, with a ratio of 6:1. Bilateral involvement is noted in around 50% of instances, and in situations when it is unilateral, the left hip is affected three times more than the right hip. In 95% of cases, the dislocations are posterior in nature. The formation of the hip starts within the uterus and concludes in adulthood; hence, congenital hip dysplasia (CDD) might manifest before to birth, throughout the early stages of pregnancy, or even during youth [Paton, R. W. *et al*., 2017; Sulaiman, A. *et al*., 2011]. It is crucial to acknowledge that hips that exhibit stability at birth may not necessarily progress to normal hip development due to the delayed onset of clinical manifestations associated with DDC. Consequently, it is imperative to conduct a pediatric physical examination during the neonatal period and at regular monthly check-ups until the age of 12 months. [Patel, H. *et al*., 2001; American Academy of Pediatrics, 2017]

***Corresponding Author:** Dr. Aseel Mohammed Wadi

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The use of ultrasonography for hip assessment has emerged as a novel technique that has garnered significant recognition in recent times [Loder, R. T. *et al*., 2011; Jackson, J. C. *et al*., 2014]. Ultrasound plays a crucial role in the field of pediatrics by providing valuable insights into the identification in developmental dislocation as well as hip dysplasia, formerly known as congenital hip dislocation. This condition often presents themselves during the first year of an individual's existence [Yang, S. *et al*., 2019]. The use of real-time ultrasonography enables the evaluation of the hip in several planes, encompassing both stationary and mobile conditions. [Health Quality Ontario, 2021; Gardner, F. *et al*., 2005]

The current clinical case pertains to a female patient who is two months old, ten days old, and seven days old. The patient has a medical history of being delivered at full term by dystocic delivery, a prior cesarean section, and is experiencing dystocia (podalic) without any difficulties [Jacobino, B. C. *et al*., 2012-Lowry, C. A. *et al*., 2005]. Physical examination: Registered Nurse participating in the treatment [American College of Radiology, 2013]. Examining the folds of the lower limbs for symmetry. There is no novelty in the moves used by Barlow and Ortolani. The female patient had a hip ultrasound in order to exclude any potential abnormalities, taking into account her significant personal and familial medical history related to hip dysplasia [von Kries, R. *et al*., 2012]. Demonstrating the luxation of the left hip and confirming the compatibility of the acetabular covering with a luxable hip. [Synder, M. *et al*., 2006]

PATIENTS AND METHODS

Our study was shown as a cross-sectional study for neonatal patients with DDH and included 80 patients younger than 80 days of age. Clinical data for patients was collected from different hospitals in Iraq, and the period ranged from July 7, 2022, to August 25, 2023, in terms of age, gender, and causative factors, which include oligohydramnios, gestational diabetes, family history, swaddling, maternal high blood pressure, and the operation, caesarean section.

This study reported the results of the common presentation of infants at birth, which defined each of (breech, cephalic, and transverse) patients with developmental dysplasia of the hip.

Furthermore, patients underwent hip angle determination at DDH on both the right and left sides. Besides that, this research looked at the distribution of secondary outcomes of developmental dysplasia of the hip linked to Graf's classification on both the right and left side, which were graded as I, IIA+, and IIC. Also, this study included the accuracy rate and quality of ultrasound in detecting developmental dysplasia of the hip in newborn patients, which included sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy.

The use of Graf's approach for static ultrasound imaging for the hips in neonates is a commonly employed practice. Conducting this test in a systematic and repeatable way has significant importance.

Equipment: The inspection is conducted using a linear array probe with a high frequency. Alternatively, one might use a specialized cradle to ensure that the neonates remain immobile. **Positioning:** When the newborn is in a lateral posture, it is recommended to put the hip in its natural position, with a flexion range of 15-20° or 90°. The transducer is placed in the lateral side, requiring a posterior rotation of 10-15° (relative to the superior edge on the transducer). This arrangement allows for the depiction of the infant's hip in a coronal perspective, as shown in Figure 1.

The imaging plane: To get accurate measurements, it is necessary to create a standard picture (Fig. 2) that depicts the iliac bone in a horizontal straight line. There are three anatomical landmarks that have been identified:

Measurements: 1. Initially, the depth and steepness of an osseous acetabular roof are assessed by the measurement of the Graf ±-angle. The angle in question refers to the angle formed by a horizontal line passing through the lateral side to the iliac bone (baseline, as shown in Figure 2) and a line passing over the bony acetabular rim as well as the triradiate cartilage (acetabular line, located between landmarks 1 and 2, as shown in Figure 2). An aberrant Graf α-angle of less than 60° indicates which the osseous acetabulum was insufficiently deep, hence increasing the likelihood of femoral dislocation. It is essential to acknowledge that the osseous rim of the acetabulum may not consistently exhibit sharpness but rather may manifest as blunt or rounded, particularly in those below the age of three months. In instances of this kind, it is necessary to position the landmark at the location wherever the bony acetabulum is made a concave shape, which may not consistently align

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with the iliac baseline. 2.) Additionally, we provide an account of the femoral head's placement, namely whether it is situated centrally inside the acetabulum or at an eccentric orientation. Thirdly, the labrum's location is determined by the measurement of the Graf β-angle. The inclination line among landmarks 1 and 3 in Figure 2 represents the angle formed between the bony acetabular rim as well as the cartilaginous acetabular labrum. The line of inclination should intersect the central region of the labrum, namely via its most prominent echo. An aberrant Graf β-angle greater than 55° indicates that the labrum is raised as a result of femoral dislocation. It is important to highlight that all three lines seldom intersect at a single place (Fig. 2).

This study reported identifying outcomes associated with a one-sided analysis of risk factors affecting patients with developmental dysplasia of the hip. This study analyzed and quantified the clinical outcomes of newborn patients with developmental dysplasia of the hip using SPBS software, version 22.0. This study distributed exclusion and inclusion criteria, as the inclusion criteria included all newborn patients who were less than 80 days old and who underwent an ultrasound examination, while the exclusion criteria included patients who had other diseases or underwent risky surgeries.

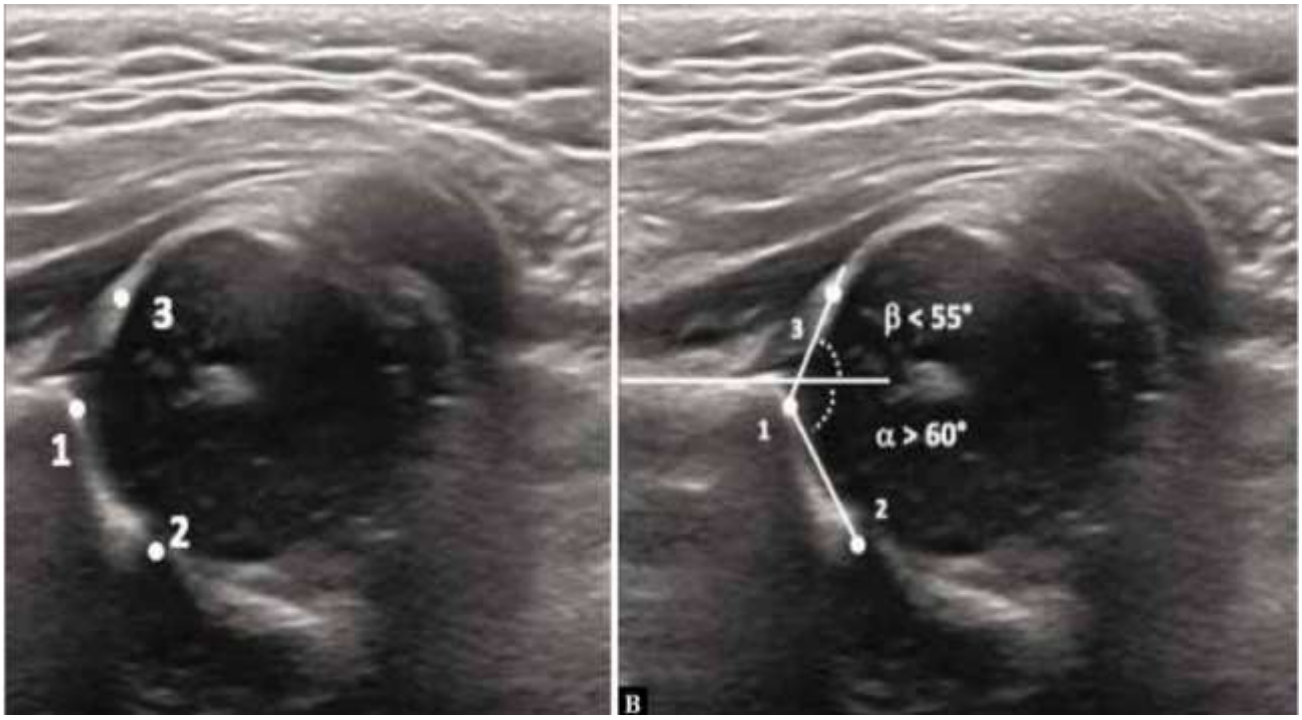

Figure 1: Identify clinical examination of Ultrasound of a normal Graf 1 hip for patients with DDH.

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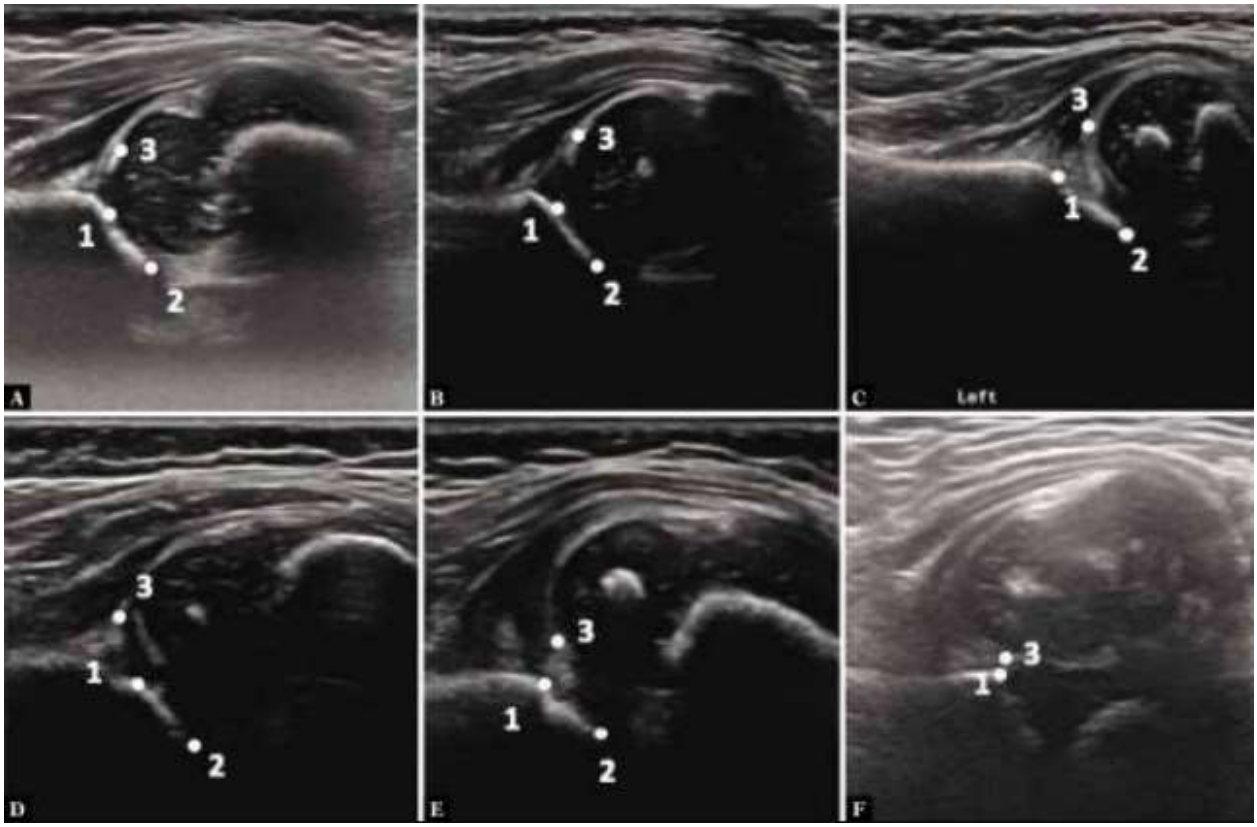

Figure 2: Determining clinical outcomes into Staging of DDH according to Graf based on A. Graf 2A; B. Graf 2B; C. Graf 2C; D. Graf D; E. Graf 3; F. Graf 4

RESULTS

Table 1: Distribution of age related to patients with DDH.

Age in days	Frequency [80]	Percentage [%]
< 20	76	95%
20 – 30	3	3.75%
> 30	1	1.25%
Our results were distributed frequency of age on infant patients, where patients with age less than 20 days were the highest rate with 95%.		

Table 2: Distribution of sex related to patients with DDH.

Sex	Frequency [80]	Percentage [%]
Male	48	60%
Female	32	40%
The results showed that the rate of males was the greatest, with 60%, while females were 40%.		

Table 3: Distribution of causative factors related to patients with DDH.

Parameters	Frequency [80]	Percentage [%]
Oligohydramnios	20	25%
Gestational diabetes	10	12.5%
Family history	25	31.25%
Swaddling	14	17.5%
Maternal hypertension	6	7.5%
Cesarean-section	5	6.25%
Our findings were determined causative factors associated with DDH infants where family history was a high influenced factor with 25 cases, followed by oligohydramnios had 20 cases, and swaddling had 14 cases.		

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Table 4: Identify the common presentation of infant patients at the time of birth.

Sex	Frequency [80]	Percentage [%]
Breech	5	6.25%
Cephalic	72	90.0%
Transverse	3	3.75%
The presentation of infants' outcomes was enrolled that cephalic as a common factor with 72 cases, breech had 5 cases, and transverse had 3 cases.		

Table 5: Determine the hip angle in DDH patients.

Types of angles	Mean ± SD
Right	
Alpha	52.13 ± 4.25
Beta	42.02 ± 6.81
Left	
Alpha	51.23 ± 3.70
Beta	49.46 ± 3.57
Our outcomes were defined as hip angle in DDH patients, which enrolled all of both right and left where alpha was 52.13 ± 4.25, and Beta was 42.02 ± 6.81, which indicates into hip dysplasia in the right side while Alpha was 51.23 ± 3.70 and Beta was 49.46 ± 3.57 which indicate into hip dysplasia in the left side.	

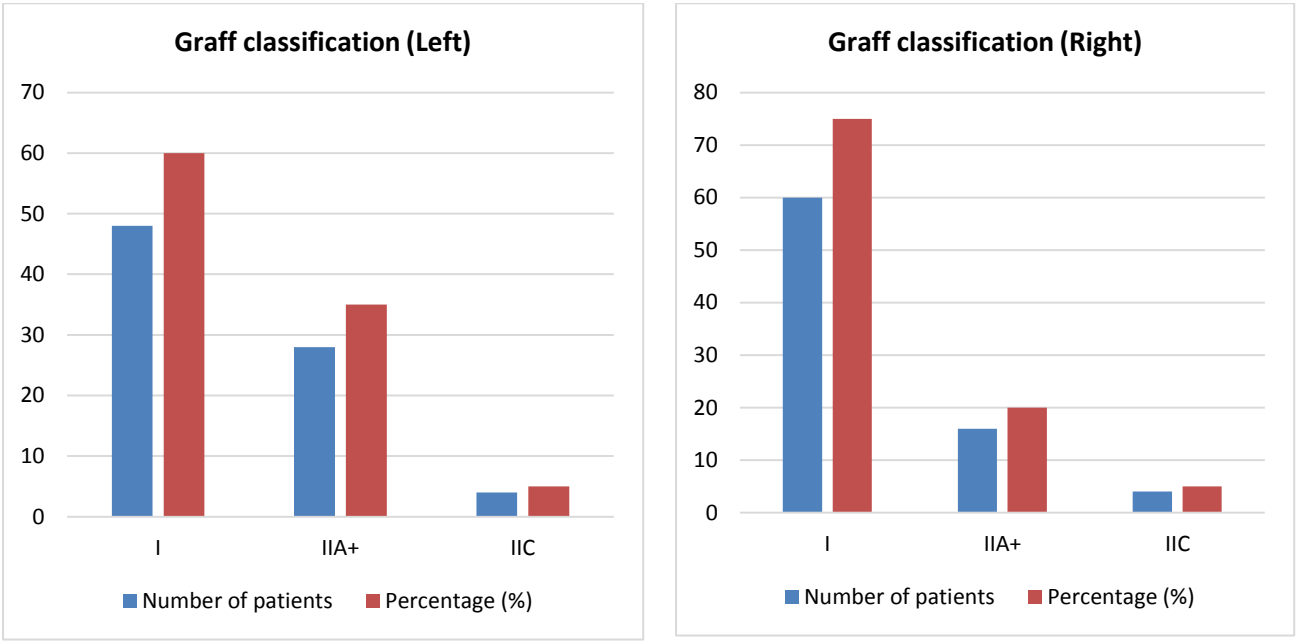

Figure 3: Secondary outcomes of developmental dysplasia of the hip related to Graff classification in both right and left

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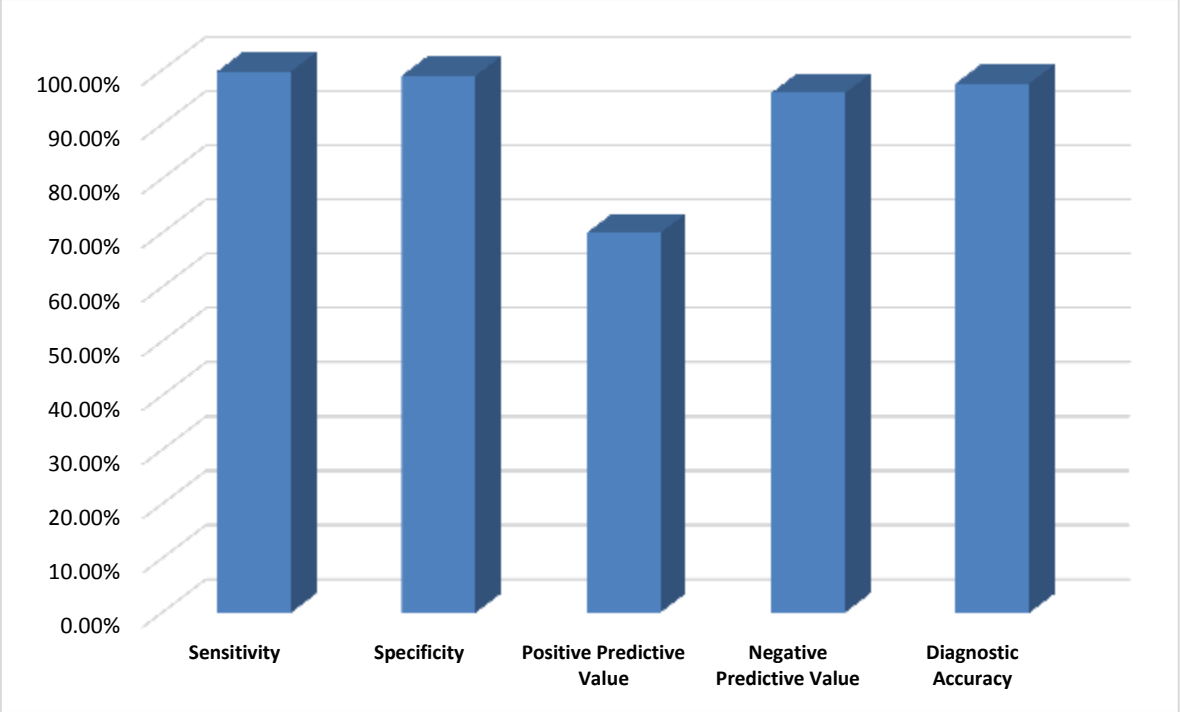

Figure 4: Clinical outcomes associated with accuracy and quality of ultrasounds

Our results enrolled quality of the ultrasound technique, which include sensitivity was 99.80%, specificity was 99.02%, positive predictive value was 70%, negative predictive value was 95.82%, and diagnostic accuracy was 97.60%.

Table 6: Unilateral analysis of risk factors affecting patients with developmental dysplasia of the hip.

Risk factors	Odds Ratio (OR)	Confidence Interval (CI)
Sex	2.23	1.25 – 4.30
Multiple pregnancy	3.80	1.16 – 14.52
Oligohydramnios	2.60	1.43 – 5.34
Swaddling	3.79	1.18 – 16.34
Breech	2.93	1.20 – 7.10
Cephalic	2.72	2.52 – 4.16
Congenital muscular torticollis	7.85	1.24 – 45.38
Limited hip abduction	31.28	10.58 – 81.92
Our results were detected the most common risk factors by ultrasound technique, which are oligohydramnios, breech, cephalic, limited hip abduction, and congenital muscular torticollis.		

DISCUSSION

The last studies were confirmed that (DDH) has a higher prevalence in females compared to males, where the disorder is thought to have several causes, with a greater occurrence in females owing to a mix of hormonal and mechanical reasons, which it is believed that female sex hormones have an impact on the looseness of the ligaments around the hip joint, which increases the vulnerability of females to DDH [Toma, P. *et al*., 2001]. Furthermore, the occurrence of breech placement during pregnancy and a family's medical background were influential variables in the formation of developmental dysplasia of the hip (DDH) where it. Made in order to avoid long-term consequences, it is essential to diagnose and treat DDH at an early stage. [Peled, E. *et al*., 2008]

(DDH) was defined as a congenital disorder characterized through abnormal development of the hip joint in infants and young children. It can result in instability and even dislocation of the hip joint, but timely identification and action are crucial for achieving favorable outcomes in therapy. [Dogruel, H. *et al*., 2008]

Ultrasound was determined as crucial in terms of identifying developmental dysplasia of the hip (DDH) in infants. Which magnetic resonance imaging (MRI) was a non-invasive and secure imaging modality that enables healthcare

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professionals to evaluate the alignment of the hip joint and the growth of the hip socket [Karmazyn, B. K. *et al*., 2009]? In contrast, ultrasound was shown to an especially beneficial in infants and young children due to their incomplete hip joint development, which poses challenges for evaluating using other imaging methods such as X-rays. Ultrasound may be used to assess the risk factors associated with DDH, including breech presentation at delivery, a family history of hip dysplasia, and certain genetic variables. [Gharedaghi, M. *et al*., 2011]

CONCLUSION

This study concluded that clinical examination and ultrasound have an effective role in the early detection of disease in newborn patients with developmental dysplasia of the hip, which helps ultrasound detect the disease and the risk factors affecting and causing the formation of this disease in a faster and better manner, which allows ultrasound to intervene and treat infants, which results in improvement and development in the clinical outcomes of newborn patients.

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