

## ULTRASOUND EVALUATION OF HIP JOINT IN NEWBORN WITH HIP CLICK AS SCREENING FOR HIP DYSPLASIA

By

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### ABSTRACT

Developmental dysplasia of the hip joint is spectrum of anatomical abnormalities of the hip joint, in which the femoral head has an abnormal relationship with the acetabulum. **The study conducted** to correlate between hip click and its ultrasound finding, as a screening for developmental dysplasia of the hip joint. A prospective study included 40 infants, age ranging from 3 to 17 weeks of age, during the period from January 2019 to December 2019 at Misurata Medical Center. Coronal ultrasound views obtained for both hips, alpha and beta angles were measured, then the degree of joint stability were evaluated by Graf's criteria. Among the 40 referred infants with hip click, 12 infants show positive ultrasound results (Graff classification rather than type I) four of the positive infants had other risk factors. Eight infants had hip click as isolated risk factor. **The study shows that**, the presence of hip click can be considered as an important indicator for developing developmental dysplasia of the hip, and underscores the importance of early detection and intervention. It is strongly recommended that, infants with isolated hip click should undergo ultrasound screening or be referred to an orthopedic specialist for further evaluation particularly when associated with other risk factors.

**KEYWORDS:** Ultrasound hip evaluation, Newborn infant, Hip click

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### INTRODUCTION

Developmental dysplasia of the hip (DDH) is spectrum of anatomical abnormalities of the hip joint, in which the femoral head has an abnormal relationship with the acetabulum [1]. Early diagnosis of the DDH is crucial as delayed diagnosis leads to increased morbidity, complexity of treatment and a sevenfold increase in short-term costs. Furthermore, a delayed diagnosis is also associated with poor outcome and the development of early degenerative hip disease[2]. For those reasons, early diagnosis is crucial to reduce invasive treatment and complications. Previously, this abnormality was

known as congenital dislocation of the hip, but this has been replaced by the term “developmental dysplasia of the hip” as it describes the full range of abnormalities affecting the immature hip more accurately, although some children may have a normal femoro-acetabular relationship at birth, but on later stage it may develop a dysplastic hip [1]. In infants, hip dislocation can be easily reduced during examination by a simple manipulation where a stabilization occurs as the soft tissues tighten. Moreover a dislocated or unstable hip may also stabilize spontaneously [3]. When femoral head is aligned with center of the

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acetabulum, the dysplastic acetabulum often normalizes within the first few months of life. If the hip remains dislocated, soft tissue contractures develop rapidly, and surgery is likely to be required to obtain and maintain joint reduction. The longer the hip is left in an abnormal position, the more the anatomy changes, developing abnormalities of both the proximal femur and the acetabulum, therefore dysplastic or dislocated hip identified before the age of 3 months can be treated conservatively [4]. While children identified after 3 months usually require invasive treatment with increased risk of early joint degeneration [5].

Hip dislocation affects 1-3 newborns per 1000 live births, while hip instability affects 20 newborns per 1000 according to the Global Hip Dysplasia Registry. This indicates that 2–2.6 million infants worldwide are impacted annually, according to estimates. Although these numbers imply a small number of general populations, delay diagnosis of newborn with hip dislocation will cause greater disability and morbidity to the affected individual and have psychological and social cost. 28.8% of total hip replacements under 60 years of age are caused by DDH [6]. In 1980, Reinhard Graf, an Austrian orthopaedic surgeon, published the original paper on examination of the infant hip using ultrasound [7]. Graf showed that the anatomy of the infant hip joint, due to the predominantly cartilaginous infant femoral head, could be clearly detailed by ultrasound. Over the next 2 decades, several publications detailed various other US methods for the assessment of the infant hip. Differences among these methods included imaging planes used and views obtained.

Ultrasound scanning is widely accepted to be the investigation of choice to evaluate developmental dysplasia of the

hip in infants younger than six months of age. This approach is useful in the diagnosis of subtle forms of the disorder especially when the clinical exam is equivocal and it leads to lower the need for surgical treatment [8,9]. The recommendations for either universal or selective ultrasonography programs is still in debate [10–12].

Traditionally, radiographic assessment of pediatric hips has long been in use for diagnosis of hip dysplasia. However, the x-ray lacks 3D information, sensitivity for determining precise osseous landmarks, and ability to diagnose early coxarthrosis. Furthermore, suboptimal positioning during imaging can possibly lead to considerable measurement mistakes [13].

X-ray evaluation of hip dislocation usually becomes visible after 3 months of age when the acetabulum has ossified and the upper femur starts to develop. To assess the immature hip, certain traditional lines are used: Hilgenreiner's line, Perkin's line, and Shenton's line. Hilgenreiner's line crosses the tri-radiate cartilages, Perkin's line is perpendicular to Hilgenreiner's line on the lateral margin of the acetabulum, while Shenton's line is a continuous curve along the inner surface of the femoral neck and the inner margin of the superior pubic ramus. In a normal hip, the femoral head should be located in the lower, inner quadrant formed by the intersection of Perkin's and Hilgenreiner's lines. The Shenton's line should appear smooth without any step-off [1].

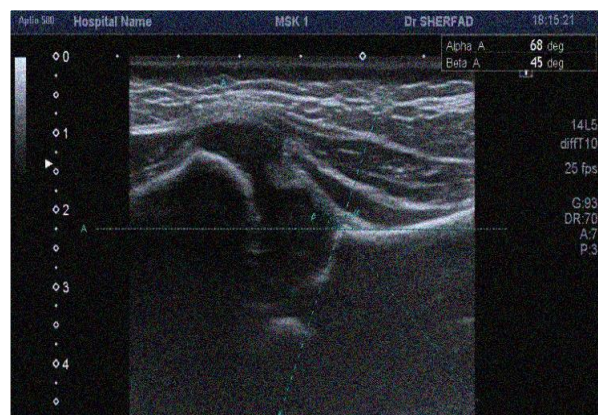
Early diagnosis of DDH primarily depends on physical examination by experienced healthcare professionals and ultrasound screening using appropriate probes. However, in underdeveloped communities with limited access to expertise, diagnosis is particularly crucial due to lack of knowledge among primary care

physicians in rural areas and the unavailability of expert ultrasound screening. Additionally, traditional swaddling practices may further complicate the diagnosis [14], late diagnosis occurs more in children having no risk factors as children with risk factors are assessed more closely at birth making the diagnosis early [15]. Furthermore, it is important to address the uncertainty about considering isolated hip click as potential risk factor for DDH screening. For instance, Kamath and Bramley (2005) investigated the role of clicky hip as a risk factor in DDH and found that clicky hip as a risk factor would not reduce the incidence of missed cases [16]. Similarly, Marson et al. assessed the value of the clicky hip in selective screening for DDH and reported conflicting findings [17]. A more recent study conducted by Morris et al. suggested that infants with isolated hip click, as identified by their pediatricians, had higher rates of dysplasia than previously reported [18]. These studies show conflicting findings and emphasize the necessity for more investigation to clarify the actual significance of hip click in relation to newborn infant DDH screening. In light of the continuous discussion and conflicting evidence concerning the importance of a solitary hip click as a potential risk factor for DDH, this study aims to investigate the importance of implementing screening ultrasound for infants presenting with isolated hip click, and if it aids in the early identification of DDH.

## METHODS AND MATERIALS

This prospective study included 40 infants with positive hip click, it was carried out in the Radiology Department, Misurata Medical Center, during the period from January 2019 to December 2019. Ethical clearance for this study was obtained from the

Radiology Department, ensuring compliance with relevant ethical guidelines and the safety of the participating infants. Infants enrolled were those between 3 to 17 weeks of age. Infants with neuromuscular disorders or aged less than 3 weeks or more than 6 months were excluded. All infants referrals were made from the pediatric clinic, Misurata Medical Center, based on clinical assessment using Barlo and Ortolani maneuvers. Expert radiologists used Graf's hip ultrasound technique, with a lateral approach. A nurse assisted in positioning the patient in a lateral position with a semi-flexed hip, while a linear ultrasound probe (frequency >10 MHz) on an Aloka Alpha 6 machine was used to obtain coronal plane images. Beta ( $\beta$ ) and alpha ( $\alpha$ ) angles were measured, and images were printed (figure 1).



**Figure 1: Standard coronal image with alpha and beta angle measurements**

In some cases, a dynamic stress test was performed to assess hip stability. The ultrasound images clearly displayed the bones and cartilaginous components of the hip joint and evaluated the coverage of the femoral head by the acetabulum. The same steps were taken on the other side. After that coronal ultrasound views obtained and alpha and beta angle were measured, then the degree of joint stability was evaluated by Graf's

criteria (Table 1). Infants with abnormal ultrasound findings suggestive of developmental dysplasia of the hip, were referred to a specialist for management. The alpha angle formed by the acetabular roof and the vertical cortex of the ilium, thus reflects the

depth of the bony acetabular roof. This corresponds to 90 minus the acetabular angle. The beta angle formed by the cartilaginous roof to the vertical cortex of the ilium and thus reflects the femoral head cartilaginous coverage.

**Table 1. Graf's classification**

Grade	Definition
Type I	a mature hip with $\alpha$ angle $>60^\circ$ . It is divided into two subgroups: type 1a, with $\beta$ angle $>55^\circ$ ; and type 1b with $\beta$ angle $<55^\circ$ .
Type IIa	the physiologic immature hip in which $\alpha$ is between $50^\circ$ and $59^\circ$ in an infant younger than 12 weeks of age.
Type IIb	If type 2a morphology persists beyond 12 weeks, it is termed as type 2b (acetabular dysplasia) where $\alpha$ is between $50^\circ$ and $59^\circ$
Type IIc	a hip in the critical range $\alpha = 43^\circ - 49^\circ$ . It is divided into two subgroups: Type 2c stable and Type 2c unstable.
Type D	the $\alpha$ angle is in the same range as in the Type 2c hip; however, the Type D is decentered and has a $\beta$ angle $>77^\circ$
Type III & Type IV	Hips are both decentered hips, with $\alpha <43^\circ$ and $\beta >77^\circ$ in each. Determination of the position of the cartilaginous roof is crucial for the differentiation of Type 3 and 4, which is pushed cranially in Type 3 hips, and caudally in Type 4 hips. Type 3 hip is further divided into two subgroups according to the echogenicity of the cartilaginous roof. In Type 3a hips, the roof is hypoechoic, whereas, in the Type 3b hip, the hyaline cartilage is deformed, and appears hyperechoic.

**RESULT**

A total of 40 infants (16 males and 24 females) were included in the study, all with positive hip click. Eighty hips were examined by B- ultrasonography mode. At presentation, the infants mean age was 8 weeks. Infants with hip click on both sides were 9 cases (23%), left side were 24 cases (60%), and on right side were 7 cases (17%) (Figure 2). The number of infants with normally stable hips (Graf Type I a+) were 28 (70%); 12 females and 16 males. Infants with abnormally unstable hips (Graf type II a, II b, II c, type III a and type IV), were 12 cases (30%) cases, all were females. Out of those, 5 cases (12.5%) were bilateral, 1 (2.5%) on the right side, and

6 (15%) on the left side, according to ultrasound scanning (figure 3).

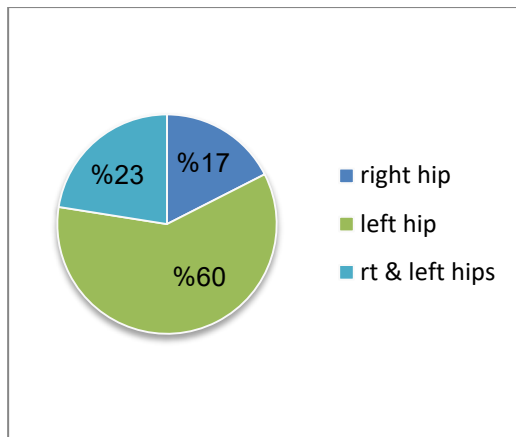


Figure 2: Side of hip click

The number of infants that shows isolated hip click without any other risk factors were 33.

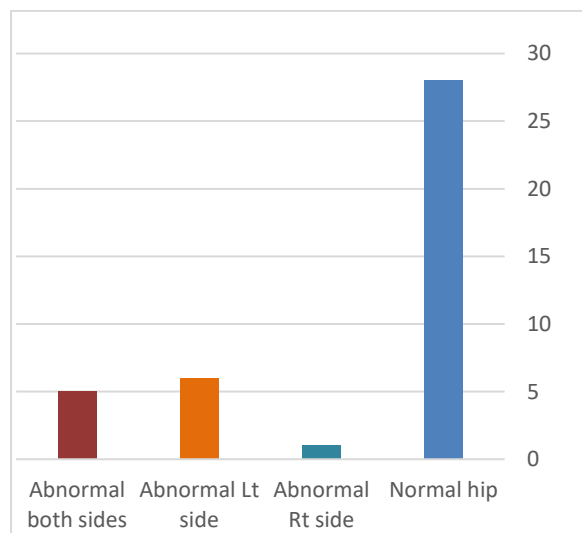


Figure 3: Infants with positive findings

Eight of them (20 %) were positive hip click. While infants with risk factors

(family history, cesarean section, breech presentation) were 7, four of them show positive hip click (10%) This emphasize that 67% of infants with positive hip click had no risk factor, while 33% had associated other risk factors (figure 4). A frequency table for the Graff classification of the right and left hips is presented in (Table 2). The most common Graff classification was type 1a, observed in 54.5% of right hips and 63.6% of left hips.

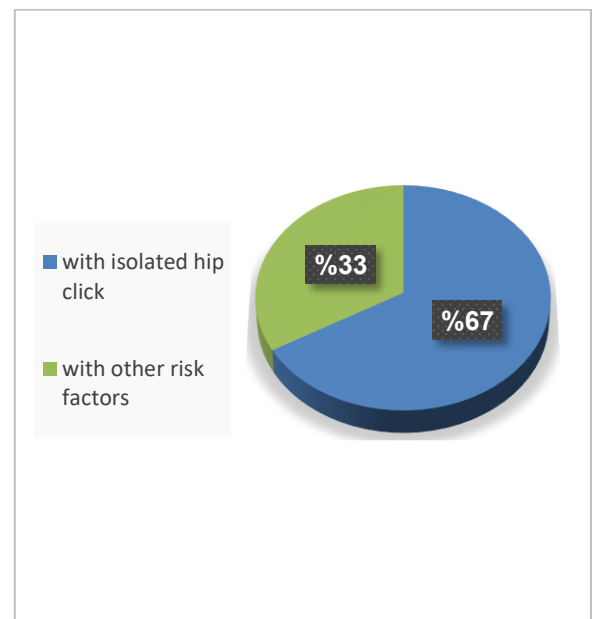


Figure 4: isolated hip click versus association risk factors

Table 2: Frequency table for Graff classification of right and left hips

Graff Type	Right hip		Left hip		
	Frequency	Percentage	Graff Type	Frequency	Percentage
1a	18	45%	1a	21	52.5%
2a	4	10%	2a	4	10%
2b	1	2.5%	2b	1	2.5%
2c	1	2.5%	4	2	5%
4	1	2.5%	4a	1	2.5%

The cross-tabulation of risk factors and Graff classification is shown in Table 3. Most infants (14 out of 33) with no

identified risk factors had a Graff type 1a classification in both hips.

Table 3: Cross-tabulation of risk factors and Graff classification

Risk Factor	1a	2a	2b	2c	4	4a
C/S	3	2	0	0	0	0
Breach	2	1	0	0	0	0
FH	0	0	0	0	1	0
No Risk	14	1	1	1	2	1

## DISCUSSION

The presence of a hip click in newborn infants appears to be a significant screening tool for developmental dysplasia of the hip (DDH). The data shows that 30% of infants with a hip click either isolated (20% of case) or associated with other risk factor (10% of cases) had ultrasound findings consistent with DDH (Graf type IIa or higher), this confirms the findings, which highlight a strong relationship between hip click found during clinical assessment and positive hip dysplasia detected by ultrasound scan. This is in line with earlier studies in the field that have also shown a relation between DDH and hip click[19]. An important aspect to consider in this study is the use of Graf's hip ultrasound technique and Graf's criteria for assessment of infant hips, specifically the measurement of alpha and beta angles, were used to assess joint stability and identify abnormal ultrasound findings. Graf's technique is widely accepted and used in the evaluation of DDH in infants. The use of this standardized technique enhances the reliability and comparability of the study results. The study found that a significant proportion of infants with isolated hip click had positive ultrasound findings suggesting hip dysplasia. This highlights the importance of considering hip click as a screening risk factor for early detection and management.

Furthermore, the study examined the relationship between hip click and other risk factors for DDH, such as family history, breech presentation, and

cesarean section. The results showed that infants with hip click, and additional risk factors may further increase the likelihood of positive ultrasound findings. This emphasizes the importance of considering multiple risk factors in the assessment and management of DDH in newborn infants.

It is worth noting that the study had a relatively small sample size, which may limit the generalizability of the findings. Further research with larger sample sizes is needed to confirm these results and provide more robust evidence on the association between hip click and DDH.

## CONCLUSION

In conclusion, this study adds to the existing body of research supporting the correlation between isolated hip click detected on clinical examination and developmental dysplasia of the hip (DDH) in newborn infants. The positive ultrasound findings in infants with hip click indicate an increased risk of DDH and emphasize the need for early detection and intervention.

Based on the results of this study and other similar research, it is highly recommended to screen infants with isolated hip click using ultrasound or refer them to an orthopedic specialist. This approach ensures a thorough evaluation and early detection of developmental dysplasia of the hip (DDH) in these infants. By following this recommendation, healthcare providers can improve the management

of DDH and enhance outcomes for at-risk infants.

Further research with larger sample sizes is warranted to validate these findings and provide stronger evidence on the association between hip click and DDH.

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