Developmental dysplasia of the hip (DDH) is a significant cause of disability in children and young adults. Early detection of this condition allows for nonoperative treatment, but the efficacy of DDH screening programs has not been clearly established. This article discusses the role of ultrasound in the diagnosis and management of DDH.

The term developmental dysplasia of the hip (DDH) encompasses a spectrum of conditions ranging from mild acetabular dysplasia to complete dislocation of the femoral head. Early detection of this condition is important, because nonoperative treatment is frequently successful if it is initiated before 6 months of age. Conversely, late diagnosis of this condition may necessitate complex surgical management. Ultrasound appears to be an ideal tool to aid in the clinical detection of DDH, because it avoids radiation exposure, does not require sedation, and can be performed on an outpatient basis.

Which Infants Are at Risk for DDH?

A number of risk factors have been implicated as having an association with DDH. Those with the strongest correlation are the presence of DDH in a first-degree relative, breech presentation, swaddling use, and congenital calcaneovalgus foot deformity [1-4]. Risk factors that show a weaker correlation with DDH include being a first-born child, female sex, and the presence of torticollis. The American Academy of Pediatrics (AAP) established DDH practice guidelines in 2000 in which imaging was recommended for female breech babies and was deemed optional for male breech babies and for female babies with a family history of DDH [5].

Regarding physical examination findings, the presence of a clicking hip (without findings of instability) is not associated with an increased likelihood of hip dysplasia [6]. In addition, the presence of asymmetric anterior thigh folds is not reliable for confirming the presence of hip dysplasia, because this finding is present in 25% of normal infants [7].

Ultrasound Screening for DDH

In 1980, Reinhard Graf published work showing that ultrasound can be used in infants to view the acetabulum and femoral head [8]. Furthermore, he demonstrated that it was possible to quantify the alterations in the morphology of these structures that occur with dysplasia. Since then, other radiologists have developed a number of modifications of the techniques described by Graf. These methods can be divided into 2 general categories: static examination, which evaluates changes in acetabular morphology; and dynamic examination, which focuses on hip instability or displacement.

The static method developed by Graf relies on the evaluation of acetabular shape and development. With the patient in the lateral position, a coronal image is acquired and the acetabular roof and bony acetabulum are visualized. The angle of acetabular inclination (the $\alpha$ angle) and the acetabular roof angle (the $\beta$ angle) are then drawn and measured. Determining the $\alpha$ and $\beta$ angles allows clinicians to classify the hip as 1 of 4 main types [9]; this classification can be helpful when deciding on treatment.

The dynamic method [10, 11], which was also developed in the 1980s, is used to evaluate the stability of the hip. Harcke's technique [10] images the hip using both lateral transverse and coronal views, and it evaluates the hip in both neutral and flexed positions. Stress maneuvers are performed to evaluate for instability, allowing visualization of the Ortolani and Barlow maneuvers. Today, both the static and dynamic methods are used to help guide treatment.

Universal Versus Selective Ultrasound Screening for DDH

In some European countries, such as Austria and Germany, clinicians perform universal ultrasound screening for DDH; in this screening paradigm, all newborn infants undergo ultrasound, regardless of clinical risk factors. However, universal ultrasound screening has not been unanimously accepted. There are concerns about the ability of such screening programs to reduce the incidence of late diagnosis of DDH [12-14]. Complicating the issue is the absence of good quality evidence linking ultrasound screening...
ing to improved outcomes. Additional concerns have to do with specificity, because mild hip dysplasia detected on ultrasound will resolve spontaneously in a high percentage of cases [15, 16].

Alternatively, many health care centers in Europe, the United Kingdom, and the United States perform selective ultrasound screening (for high-risk groups). For selective ultrasound screening programs to be successful, robust clinical screening programs must already be established. It has been suggested that medical schools and pediatric and family practice residency programs need to commit themselves more strongly to the provision of adequate instruction regarding the physical diagnosis of pediatric hip dysplasia [17]. Furthermore, the at-risk population must be properly delineated. Both the DDH Task Force Group of the European Society of Paediatric Radiology and the AAP support universal clinical screening and selective ultrasound screening for high-risk patients (those with a positive family history or breech presentation) [5, 9]. This approach has been widely adopted.

If ultrasound screening is indicated, clinicians must decide not only how to visualize the hip but also when such screening should be performed. If an infant has a normal physical examination but a significant risk factor, then ultrasound screening should be delayed until approximately 4–6 weeks of age. In most such cases, subtle abnormalities in morphology and stability that are present at birth will resolve without any intervention. This short delay in the initial screening will prevent unnecessary treatment in many infants [18].

Data to Support the Use of Ultrasound Screening for DDH

Despite the growing institution of ultrasound screening programs for DDH, there is a lack of evidence to show that patient outcomes improve as result of such programs. Rosendahl and colleagues [13] conducted a randomized controlled trial in which 11,925 newborn infants were assigned to 1 of 3 groups: one group received universal ultrasound screening for DDH; another group received selective ultrasound screening; and the third group received no ultrasound screening. This study found no statistically significant differences between the 3 groups in the prevalence of late subluxation or dislocation of the hip [13].

In a randomized controlled trial conducted by Holen and colleagues [14], 15,529 infants were randomized into 2 groups: one group received universal ultrasound screening for DDH, and the other group received selective ultrasound screening. There was no statistically significant difference between the 2 groups in the prevalence of late detection of hip dysplasia [14].

Finally, a recent Cochrane review [15] sought to determine how different DDH screening programs affect the incidence of late presentation of congenital hip dislocation. They found that, when studies compared universal ultrasound screening plus clinical screening versus clinical screening alone, the group that received universal ultrasound screening had an increased rate of treatment but no significant difference in the rate of late-detected dysplasia or surgery. This review also found that selective ultrasound screening targeting high-risk groups did not significantly increase the rate of treatment, but it also did not decrease the rate of late-detected cases or surgery. This Cochrane review concluded that, based on the available evidence, it is not possible to give clear recommendations for hip screening of newborn infants [15].

Orthopedic Treatment of DDH

When DDH is detected, the goal of treatment is to obtain and maintain a concentric reduction of the femoral head within the acetabulum, which will promote the physiologic development of both structures. Detecting DDH within the first few weeks of life is extremely valuable, because the great majority of cases will resolve with nonoperative treatment.

When Ortolani testing is positive for a dislocated hip, abduction bracing should be initiated. The Pavlik harness is a dynamic abduction orthosis that places the hip in a position of flexion and modest abduction, when it is applied properly. This position directs the femoral head toward the acetabulum and allows for physiologic motion of the hip through a safe range. Maintenance of the hip with this device promotes resolution of joint laxity; in most cases, such resolution occurs within weeks.

Newborn hips that are unstable but are not frankly dislocated may simply be observed; in the majority of these cases, the condition will resolve without treatment. Barlow and others have shown that most subluxed hips will stabilize within 3–4 weeks after birth as determined by clinical examination [16], and within 9 weeks after birth as determined by ultrasound [19].

Acetabular dysplasia without hip instability, diagnosed before 3–4 months of age, warrants ultrasound surveillance [15]. Abduction bracing for this population is controversial because of a lack of evidence that bracing is effective for dysplasia alone.

While early treatment of DDH is typically successful, DDH that is diagnosed late will likely require surgical intervention. The complication rates of treatment, particularly the rates of avascular necrosis of the hip, are higher when treatment is performed at a later age [20].

Indications for Ultrasound in the Management of DDH

Given these treatment options, ultrasound has several indications in the management of DDH (apart from its use as a screening tool):

- **To monitor the reduction of the hip during treatment in an abduction brace.** It is imperative to document that the hip has been reduced within the first 3 weeks of treatment. If the hip remains dislocated, the posterior acetabular wall morphology
may be adversely affected (a complication called Pavlik harness disease), and the success of future treatment can be compromised.

To monitor the newborn hip for resolution of subluxation within the first 4–6 weeks after birth.

To monitor infants younger than 4–6 months for the resolution of acetabular dysplasia (α angle less than 60 degrees). After 4–6 months of age, an anterior-posterior pelvis radiograph is a superior method for evaluation of residual acetabular dysplasia [21, 22] (see Figure 1).

FIGURE 1.

FIGURE 1A.
These ultrasonograms show the right hip of a female infant who had a significant risk factor for developmental dysplasia of the hip (breech presentation at birth). At age 5 weeks (left), the α angle was only 51 degrees; by age 3 months (right), the α angle had normalized to 64 degrees. The left hip (not shown) demonstrated similar findings.

FIGURE 1B.
An anterior-posterior pelvis radiograph of the same patient was obtained at age 7 months; despite the normalization of both α angles, the radiograph shows the presence of bilateral acetabular dysplasia and mild hip subluxation. Hip abduction bracing was initiated.

FIGURE 1C.
An anterior-posterior pelvis radiograph of the same patient at age 12 months shows resolution of the earlier acetabular dysplasia and hip subluxation.
Summary

Clinical screening for DDH during the first year of life is accepted as a reliable strategy for decreasing the incidence of late-diagnosed dysplasia or hip dislocation, but clinical screening alone sometimes results in late diagnosis. Thus ultrasound screening has been employed in an effort to further diminish the incidence of late diagnosis. Most ultrasound-based methods of screening for DDH rely on a combination of static morphologic assessment and dynamic evaluation for stability. The combination of universal clinical screening and selective ultrasound screening has been widely adopted worldwide. Although it is logical to assume that selective ultrasound screening of at-risk patients should decrease the late diagnosis of DDH, the available studies have failed to support this assumption. Further investigation is needed to clarify the role of ultrasound in screening for DDH.

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References