



Evaluation and Referral for Developmental Dysplasia of the Hip in Infants

Brian A. Shaw, MD, FAAOS, FAAP, Lee S. Segal, MD, FAAOS, FAAP, SECTION ON ORTHOPAEDICS

Developmental dysplasia of the hip (DDH) encompasses a wide spectrum of clinical severity, from mild developmental abnormalities to frank dislocation. Clinical hip instability occurs in 1% to 2% of full-term infants, and up to 15% have hip instability or hip immaturity detectable by imaging studies. Hip dysplasia is the most common cause of hip arthritis in women younger than 40 years and accounts for 5% to 10% of all total hip replacements in the United States. Newborn and periodic screening have been practiced for decades, because DDH is clinically silent during the first year of life, can be treated more effectively if detected early, and can have severe consequences if left untreated. However, screening programs and techniques are not uniform, and there is little evidence-based literature to support current practice, leading to controversy. Recent literature shows that many mild forms of DDH resolve without treatment, and there is a lack of agreement on ultrasonographic diagnostic criteria for DDH as a disease versus developmental variations. The American Academy of Pediatrics has not published any policy statements on DDH since its 2000 clinical practice guideline and accompanying technical report. Developments since then include a controversial US Preventive Services Task Force “inconclusive” determination regarding usefulness of DDH screening, several prospective studies supporting observation over treatment of minor ultrasonographic hip variations, and a recent evidence-based clinical practice guideline from the American Academy of Orthopaedic Surgeons on the detection and management of DDH in infants 0 to 6 months of age. The purpose of this clinical report was to provide literature-based updated direction for the clinician in screening and referral for DDH, with the primary goal of preventing and/or detecting a dislocated hip by 6 to 12 months of age in an otherwise healthy child, understanding that no screening program has eliminated late development or presentation of a dislocated hip and that the diagnosis and treatment of milder forms of hip dysplasia remain controversial.

abstract

FREE

This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

Clinical reports from the American Academy of Pediatrics benefit from expertise and resources of liaisons and internal (AAP) and external reviewers. However, clinical reports from the American Academy of Pediatrics may not reflect the views of the liaisons or the organizations or government agencies that they represent.

The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

All clinical reports from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

DOI: 10.1542/peds.2016-3107

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2016 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they do not have a financial relationship relevant to this article to disclose.

FUNDED: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

To cite: Shaw BA, Segal LS, AAP SECTION ON ORTHOPAEDICS. Evaluation and Referral for Developmental Dysplasia of the Hip in Infants. *Pediatrics*. 2016;138(6):e20163107

INTRODUCTION

Early diagnosis and treatment of developmental dysplasia of the hip (DDH) is important to provide the best possible clinical outcome. DDH encompasses a spectrum of physical and imaging findings, from mild instability and developmental variations to frank dislocation. DDH is asymptomatic during infancy and early childhood, and, therefore, screening of otherwise healthy infants is performed to detect this uncommon condition. Traditional methods of screening have included the newborn and periodic physical examination and selected use of radiographic imaging. The American Academy of Pediatrics (AAP) promotes screening as a primary care function. However, screening techniques and definitions of clinically important clinical findings are controversial, and despite abundant literature on the topic, quality evidence-based literature is lacking.

The AAP last published a clinical practice guideline on DDH in 2000 titled “Early Detection of Developmental Dysplasia of the Hip.”¹ The purpose of this clinical report is to provide the pediatrician with updated information for DDH screening, surveillance, and referral based on recent literature, expert opinion, policies, and position statements of the AAP and the Pediatric Orthopaedic Society of North America (POSNA), and the 2014 clinical practice guideline of the American Academy of Orthopaedic Surgeons (AAOS).¹⁻³

DEFINITIONS

A contributing factor to the DDH screening debate is lack of a uniform definition of DDH. DDH encompasses a spectrum of pathologic hip disorders in which hips are unstable, subluxated, or dislocated and/or have malformed acetabula.¹ However, imaging advancements,

primarily ultrasonography, have created uncertainty regarding whether minor degrees of anatomic and physiologic variability are clinically significant or even abnormal, particularly in the first few months of life.

Normal development of the femoral head and acetabulum is codependent; the head must be stable in the hip socket for both to form spherically and concentrically. If the head is loose in the acetabulum, or if either component is deficient, the entire hip joint is at risk for developing incongruence and lack of sphericity. Most authorities refer to looseness as instability or subluxation and the actual physical deformity of the femoral head and/or acetabulum as dysplasia, but some consider hip instability itself to be dysplasia. Further, subluxation can be static (in which the femoral head is relatively uncovered without stress) or dynamic (the hip partly comes out of the socket with stress). The Ortolani maneuver, in which a subluxated or dislocated femoral head is reduced into the acetabulum with gentle hip abduction by the examiner, is the most important clinical test for detecting newborn dysplasia. In contrast, the Barlow maneuver, in which a reduced femoral head is gently adducted until it becomes subluxated or dislocated, is a test of laxity or instability and has less clinical significance than the Ortolani maneuver. In a practical sense, both maneuvers are performed seamlessly in the clinical assessment of an infant’s hip. Mild instability and morphologic differences at birth are considered by some to be pathologic and by others to be normal developmental variants.

In summary, there is lack of universal agreement on what measurable parameters at what age constitute developmental variation versus actual disease. Despite these differences in definition, there is universal expert agreement that a

hip will fare poorly if it is unstable and morphologically abnormal by 2 to 3 years of age. It is the opinion of the AAP that DDH fulfills most screening criteria outlined by Wilson and Jungner⁴ and that screening efforts are worthwhile to prevent a subluxated or dislocated hip by 6 to 12 months of age.

The Ortolani maneuver, in which a subluxated or dislocated femoral head is reduced into the acetabulum with gentle hip abduction by the examiner, is the most important clinical test for detecting newborn hip dysplasia.

INCIDENCE, RISK FACTORS, AND NATURAL HISTORY

Incidence

The incidence of developmental dislocation of the hip is approximately 1 in 1000 live births. The incidence of the entire spectrum of DDH is undoubtedly higher but not truly known because of the lack of a universal definition. Rosendahl et al⁵ noted a prevalence of dysplastic but stable hips of 1.3% in the general population. A study from the United Kingdom reported a 2% prevalence of DDH in girls born in the breech position.⁶

Risk Factors

Important risk factors for DDH include breech position, female sex, incorrect lower-extremity swaddling, and positive family history. These risk factors are thought to be additive. Other suggested findings, such as being the first born or having torticollis, foot abnormalities, or oligohydramnios, have not been proven to increase the risk of “nonsyndromic” DDH.^{3,7}

Breech presentation may be the most important single risk factor, with DDH reported in 2% to 27% of boys and girls presenting in the breech position.^{6,8,9} Frank breech

presentation in a girl (sacral presentation with hips flexed and knees extended) appears to have the highest risk.¹ Most evidence supports the breech position toward the end of pregnancy rather than breech delivery that contributes to DDH. There is no clear demarcation of timing of this risk; in other words, the point during pregnancy when the DDH risk is normalized by spontaneous or external version from breech to vertex position. Mode of delivery (cesarean) may decrease the risk of DDH with breech positioning.¹⁰⁻¹² A recent study suggested that breech-associated DDH is a milder form than DDH that is not associated with breech presentation, with more rapid spontaneous normalization.¹³

Genetics may contribute more to the risk of DDH than previously considered “packaging effects.” If a monozygotic twin has DDH, the risk to the other twin is approximately 40%, and the risk to a dizygotic twin is 3%.^{14,15} Recent research has confirmed that the familial relative risk of DDH is high, with first-degree relatives having 12 times the risk of DDH over controls.¹⁶⁻¹⁸ The left hip is more likely to be dysplastic than the right, which may be because of the more common in utero left occiput anterior position in nonbreech infants.¹ The AAOS clinical practice guideline considers breech presentation and family history to be the 2 most important risk factors in DDH screening.³

A lesser-known but important risk factor is the practice of swaddling, which has been gaining popularity in recent years for its noted benefits of enhancing better sleep patterns and duration and minimizing hypothermia. However, these benefits are countered by the apparent increased rates of DDH observed in several ethnic groups, such as Navajo Indian and Japanese populations, that have practiced traditional swaddling techniques.

Traditional swaddling maintains the hips in an extended and adducted position, which increases the risk of DDH. However, the concept of “safe swaddling,” which allows for hip flexion and abduction and knee flexion, has been shown to lessen the risk of DDH (<http://hipdysplasia.org/developmental-dysplasia-of-the-hip/hip-healthy-swaddling/>). Parents can be taught the principles of safe infant sleep, including supine position in the infant’s own crib and not the parent’s bed, with no pillows, bumpers, or loose blankets.¹⁹⁻²⁴ The POSNA, International Hip Dysplasia Institute, AAOS, United States Bone and Joint Initiative, and Shriners Hospitals for Children have published a joint statement regarding the importance of safe swaddling in preventing DDH.²⁵

In general, risk factors are poor predictors of DDH. Female sex, alone without other known risk factors, accounts for 75% of DDH. This emphasizes the importance of a careful physical examination of all infants in detecting DDH.⁶ A recent survey showed poor consensus on risk factors for DDH from a group of experts.²⁶

In general, risk factors are poor predictors of DDH. Female sex, alone without other known risk factors, accounts for 75% of DDH.

Natural History

Clinical and imaging studies show that the natural history of mild dysplasia and instability noted in the first few weeks of life is typically benign. Barlow-positive (subluxatable and dislocatable) hips resolve spontaneously, and Barlow himself noted that the mild dysplasia in all 250 newborn infants with positive test results in his original study resolved spontaneously.²⁷⁻³²

Conversely, the natural history of a child with hip dysplasia at the more

severe end of the disease spectrum (subluxation or dislocation) by walking age is less satisfactory than children treated successfully at a younger age. Without treatment, these children will likely develop a limp, limb length discrepancy, and limited hip abduction. This may result in premature degenerative arthritis in the hip, knee, and low back. The burden of disability is high, because most affected people become symptomatic in their teens and early adult years, and most require complex hip salvage procedures and/or replacement at an early age.

SCREENING AND DIAGNOSIS

The 2000 AAP clinical practice guideline recommended that all newborn infants be screened for DDH by physical examination, with follow-up at scheduled well-infant periodic examinations. The POSNA, the Canadian Task Force on DDH, and the AAOS have also advocated newborn and periodic screening. A 2006 report by the US Preventive Services Task Force (USPSTF) resulted in controversy regarding DDH screening. By using a data-driven model and a strong emphasis on the concept on predictors of poor health, the USPSTF report gave an “I” recommendation, meaning that the evidence was insufficient to recommend routine screening for DDH in infants as a means to prevent adverse outcomes.^{1-3,33-35} However, on the basis of the body of evidence when evaluated from the perspective of a clinical practice model, the AAP advocates for DDH screening.

In its report, the USPSTF noted that avascular necrosis (AVN) is the most common (up to 60%) and severe potential harm of both surgical and nonsurgical interventions.³³ Williams et al³⁶ reported the risk of AVN to be less than 1% with screening, early detection, and the use of the Pavlik harness. In a long-term follow-up study of a randomized controlled

trial from Norway, the authors reported no cases of AVN and no increased risk of harm with increased treatment.³⁷ The USPSTF also raised concerns about the psychological consequences or stresses with early diagnosis and intervention. Gardner et al³⁸ found that the use of hip ultrasonography allowed for reduction of treatment rates without adverse clinical or psychological outcomes. Thus, the concerns of AVN and psychological distress or potential predictors of poor health have not been supported in literature not referenced in the USPSTF report.

In 2 well-designed, randomized controlled trial studies from Norway, the prevalence of late DDH presentation was reduced from 2.6 to 3.0 per 1000 to 0.7 to 1.3 per 1000 by using either selective or universal hip ultrasonographic screening. Neither study reached statistical significance because of the inadequate sample size on the basis of prestudy rates of late-presentation DDH. Despite this, both centers have introduced selective hip ultrasonography as part of their routine newborn screening.^{39,40} Clarke et al³² also demonstrated a decrease in late DDH presentation from 1.28 per 1000 to 0.74 per 1000 by using selective hip ultrasonography in a prospective cohort of patients over a 20-year period.

The term “surveillance” may be useful nomenclature to consider in place of screening, because, by definition, it means the close monitoring of someone or something to prevent an adverse outcome. The term surveillance reinforces the concept of periodic physical examinations as part of well-child care visits until 6 to 9 months of age and the use of selective hip ultrasonography as an adjunct imaging tool or an anteroposterior radiograph of the pelvis after 4 months of age for infants with identified risk factors.^{3,5,32,41}

Wilson and Jungner⁴ outlined 10 principles or criteria to consider

when determining the utility of screening for a disease. The AAP believes DDH fulfills most of these screening criteria (Table 1), except for an understanding of the natural history of hip dysplasia and an agreed-on policy of whom to treat. The 2006 USPSTF report and the AAOS clinical practice guideline provide a platform to drive future research in these 2 areas. Screening for DDH is important, because the condition is initially occult, easier to treat when identified early, and more likely to cause long-term disability if detected late. A reasonable goal for screening is to prevent the late presentation of DDH after 6 months of age.

Physical Examination

The physical examination is by far the most important component of a DDH screening program, with imaging by radiography and/or ultrasonography playing a secondary role. It remains the “cornerstone” of screening and/or surveillance for DDH, and the available evidence supports that primary care physicians serially examine infants previously screened with normal hip examinations on subsequent visits up to 6 to 9 months of age.^{3,41-44} Once a child is walking, a dislocated hip may manifest as an abnormal gait.

The 2000 AAP clinical practice guideline gave a detailed description of the examination, including observing for limb length discrepancy, asymmetric thigh or gluteal folds, and limited or asymmetric abduction, as well as performing Barlow and Ortolani tests.¹ It is essential to perform these manual tests gently. By ~3 months of age, a dislocated hip becomes fixed, limiting the usefulness and sensitivity of the Barlow and Ortolani tests. By this age, restricted, asymmetric hip abduction of the involved hip becomes the most important finding (see video available at <http://www.aap.org/sections/ortho>).

TABLE 1 World Health Organization Criteria for Screening for Health Problems

1.	The condition should be an important health problem
2.	There should be a treatment of the condition
3.	Facilities for the diagnosis and treatment should be available
4.	There should be a latent stage of the disease
5.	There should be a suitable test or examination for the condition
6.	The test should be acceptable to the population
7.	The natural history of the disease should be adequately understood
8.	There should be an agreed-on policy on whom to treat
9.	The total cost of finding a case should be economically balanced in relation to medical expenditures as a whole
10.	Case finding should be a continuous process

Diagnosing bilateral DDH in the older infant can be difficult because of symmetry of limited abduction.

Although ingrained in the literature, the significance and safety of the Barlow test is questioned. Barlow stated in his original description that the test is for laxity of the hip joint rather than for an existing dislocation. The Barlow test has no proven predictive value for future hip dislocation. If performed frequently or forcefully, it is possible that the maneuver itself could create instability.^{45,46} The AAP recommends, if the Barlow test is performed, that it be done by gently adducting the hip while palpating for the head falling out the back of the acetabulum and that no posterior-directed force be applied. One can think of the Barlow and Ortolani tests as a continuous smooth gentle maneuver starting with the hip flexed and adducted, with gentle anterior pressure on the trochanter while the hip is abducted to feel whether the hip is locating into the socket, followed by gently adducting the hip and relieving the anterior pressure on the trochanter while sensing whether the hip slips out the back. The examiner should

not attempt to forcefully dislocate the femoral head (see video available at <http://www.aap.org/sections/ortho>).

“Hip clicks” without the sensation of instability are clinically insignificant.⁴⁷ Whereas the Ortolani sign represents the palpable sensation of the femoral head moving into the acetabulum over the hypertrophied rim of the acetabular cartilage (termed neolimbus), isolated high-pitched clicks represent the movement of myofascial tissues over the trochanter, knee, or other bony prominences and are not a sign of hip dysplasia or instability.

Radiography

Plain radiography becomes most useful by 4 to 6 months of age, when the femoral head secondary center of ossification forms.⁴⁸ Limited evidence supports obtaining a properly positioned anteroposterior radiograph of the pelvis.³ If the pelvis is rotated or if a gonadal shield obscures the hip joint, then the radiograph should be repeated. Hip asymmetry, subluxation, and dislocation can be detected on radiographs when dysplasia is present. There is debate about whether early minor radiographic variability (such as increased acetabular index) constitutes actual disease.³¹ Radiography is traditionally indicated for diagnosis of the infant with risk factors or an abnormal examination after 4 months of age.^{1,2,8,49}

Ultrasonography

Ultrasonography can provide detailed static and dynamic imaging of the hip before femoral head ossification. The American Institute of Ultrasound in Medicine and the American College of Radiology published a joint guideline for the standardized performance of the infantile hip ultrasonographic examination.⁵⁰ Static ultrasonography shows coverage of the femoral head by the

cartilaginous acetabulum (α angle) at rest, and dynamic ultrasonography demonstrates a real-time image of the Barlow and Ortolani tests.

Ultrasonographic imaging can be universal for all infants or selective for those at risk for having DDH. Universal newborn ultrasonographic screening is not recommended in North America because of the expense, inconvenience, inconsistency, subjectivity, and high false-positive rates, given an overall population disease prevalence of 1% to 2%.³ Rather, selective ultrasonographic screening is recommended either to clarify suspicious findings on physical examination after 3 to 4 weeks of age or to detect clinically silent DDH in the high-risk infant from 6 weeks to 4 to 6 months of age.^{1,2,35,50} Two prospective randomized clinical trials from Norway support selective ultrasonographic imaging when used in conjunction with high-quality clinical screening.^{39,40}

Roposch and colleagues^{51,52} contend that experts cannot reach a consensus on what is normal, abnormal, developmental variation, or simply uncertain regarding much ultrasonographic imaging, thereby confounding referral and treatment recommendations. Several studies have demonstrated that mild ultrasonographic abnormalities usually resolve spontaneously, fueling the controversy over what imaging findings constitute actual disease requiring treatment.^{5,30,51,53–56}

The concept of surveillance for DDH emphasizes the importance of repeated physical examinations and the adjunct use of selective hip ultrasonography after 6 weeks of age or an anteroposterior radiograph of the pelvis after 4 months of age for infants with questionable or abnormal findings on physical examination or with identified risk factors. Ultrasonography is not necessary for a frankly dislocated hip (Ortolani positive) but may be

desired by the treating physician. Physiologic joint capsular laxity and immature acetabular development before 6 weeks of age may limit the accuracy of hip ultrasonography interpretations.^{39,40} There is no consensus on exact timing of and indications for ultrasonography among expert groups.^{26,57} However, ultrasonographic imaging does have a management role in infants younger than 6 weeks undergoing abduction brace treatment of unstable hips identified on physical examination.³

REFERRAL, ADJUNCTIVE IMAGING, AND TREATMENT

Referral

Early detection and referral of infants with DDH allows appropriate intervention with bracing or casting, which may prevent the need for reconstructive surgery. Primary indications for referral include an unstable (positive Ortolani test result) or dislocated hip on clinical examination. Because most infants with a positive Barlow test result at either the newborn or 2-week examination stabilize on their own, these infants should have sequential follow-up examinations as part of the concept of surveillance. This recommendation differs from the 2000 AAP clinical practice guideline.¹ Any child with limited hip abduction or asymmetric hip abduction after the neonatal period (4 weeks) should be referred. Relative indications for referral include infants with risk factors for DDH, a questionable examination, and pediatrician or parental concern.¹

Adjunctive Imaging

Recommendations for the evaluation and management of infants with risk factors for DDH but with normal findings on physical examination continue to evolve. The 2000 AAP clinical practice guideline recommended hip ultrasonography

at 6 weeks of age or radiography of the pelvis and hips at 4 months of age in girls with a positive family history of DDH or breech presentation. The AAP clinical practice guideline also stated that hip ultrasonographic examinations remain an option for all infants born breech.¹ The recent AAOS report found that moderate evidence supports an imaging study before 6 months of age in infants with breech presentation, family history, and/or history of clinical instability.^{3,58-60}

Consider imaging before 6 months of age for male or female infants with normal findings on physical examination and the following risk factors:

1. Breech presentation in third trimester (regardless of cesarean or vaginal delivery)
2. Positive family history
3. History of previous clinical instability
4. Parental concern
5. History of improper swaddling
6. Suspicious or inconclusive physical examination

Refinement in the term “breech presentation” as a risk factor for DDH is needed to determine whether selective hip ultrasonography at 6 weeks or radiography before 6 months of age is needed for an infant with a normal clinical hip examination. More specific variables, such as mode of delivery, type of breech position, or breech position at any time during the pregnancy or in the third trimester, have received little attention to date. The AAOS clinical practice guideline reported 6 studies addressing breech presentation, but all were considered low-strength evidence.³ Thus, the literature is not adequate enough to allow specific guidance. The risk is thought to be greater for frank breech (hips flexed, knees extended) in the last trimester.¹

Lacking expert consensus of risk factors for DDH,²⁶ the questions of whether to obtain additional imaging studies with a normal clinical hip examination is ultimately best left to one’s professional judgment. One must consider, however, that the overall probability of a clinically stable hip to later dislocate is very low.

Because of the variability in performance and interpretation of the hip ultrasonographic examination and varying thresholds for treatment, the requesting physician might consider developing a regional protocol in conjunction with a consulting pediatric orthopedist and pediatric radiologist. Specific criteria for imaging and referral based on local resources can promote consistency in evaluation and treatment of suspected DDH. Realistically, many families may not have ready access to quality infant hip ultrasonography, and this may determine the choice of obtaining a pelvic radiograph instead of an ultrasound.⁶¹

Treatment

Recommendations for treatment are based on the clinical hip examination and the presence or absence of imaging abnormalities. Infants with a stable clinical hip examination but with abnormalities noted on ultrasonography can be observed without a brace.^{3,56}

The initiation of abduction brace treatment, either immediate or delayed, for clinically unstable hips is supported by several studies.^{3,62-64} In a randomized clinical trial, Gardiner and Dunn⁶² found no difference in hip ultrasonography findings or clinical outcome for infants with dislocatable hips treated with either immediate or delayed abduction bracing at 6- and 12-month follow-up. The infants in the delayed group (2 weeks) were treated with abduction bracing if hip instability persisted or the hip

ultrasonographic abnormalities did not improve.⁶²

RISKS OF TREATMENT

Treatment of clinically unstable hips usually consists of bracing when discovered in early infancy and closed reduction with adductor tenotomy and spica cast immobilization when noted later. After 18 months of age, open surgery is generally recommended.

As previously noted, the 2006 USPSTF report noted a high rate of AVN, up to 60% with both surgical and nonsurgical intervention.³³ Other studies have reported much lower rates of AVN.^{36,37} One prospective study reported a zero prevalence of AVN by 6 years of age in mildly dysplastic hips treated with bracing.³⁰

However, abduction brace treatment is not innocuous. The potential risks include AVN, temporary femoral nerve palsy, and obturator (inferior) hip dislocation.⁶⁵⁻⁶⁷ One study demonstrated a 7% to 14% risk of complications after treatment in a Pavlik harness. The risk was greater in hips that did not reduce in the brace.³³ Precautions such as avoiding forced abduction in the harness, stopping treatment after 3 weeks if the hip does not reduce, and proper strap placement with weekly monitoring is important to minimize the risks associated with brace treatment.^{68,69} Double diapering is a probably harmless but ineffective treatment of true DDH.

What remains controversial is whether the selective use of ultrasonography reduces or increases treatment. A randomized controlled study from the United Kingdom showed that approximately half of all positive physical examination findings were falsely positive (ie, normal ultrasonography results) and that the use of ultrasonography in clinically suspect hips actually

reduced DDH treatment.⁶⁰ However, in the United States and Canada,²¹ the reverse appears to be true. In the current medicolegal climate that encourages a defensive approach, liberal use of ultrasonography in the United States and Canada has clearly fostered overdiagnosis and overtreatment of DDH, despite best-available literature supporting observation of mild dysplasia.^{33–35,70}

MEDICOLEGAL RISK TO THE PEDIATRICIAN

Undetected or late-developing DDH is a liability concern for the pediatrician, generating anxiety and a desire for guidance in best screening methodology.⁷¹ Unfortunately, this fear may also provoke overdiagnosis and overtreatment. “Late-presenting” DDH is a more accurate term than “missed” to use when DDH is first diagnosed in a walking-aged child who had appropriate clinical examinations during infancy.^{72,73}

Although there is no universally recognized DDH screening standard, the AAP endorses the concept of surveillance or periodic physical examinations until walking age, with selective use of either hip ultrasonography or radiography, depending on age. The AAP cautions against overreliance on ultrasonography as a diagnostic test and encourages its use as an adjunctive secondary screen and an aid to treatment of established DDH. Notably, no screening program has been shown to completely eliminate the risk of a late-presenting dislocated hip.⁶⁹

The electronic health record can be used to provide a template, reminder, and documentation tool for the periodic examination. It also can be useful in the transition and comanagement of children with suspected DDH by providing effective information transfer between consultants and primary care physicians and ensuring follow-up. Accurate documented

communication between providers is important to provide continuity of care for this condition, and it is also important to explain to the parent(s) and document those instances when observation is used as a planned strategy so it is less likely to be misinterpreted as negligence.

BEST PRACTICES AND STATE OF THE ART

1. The AAP, POSNA, AAOS, and Canadian DDH Task Force recommend newborn and periodic surveillance physical examinations for DDH to include detection of limb length discrepancy, examination for asymmetric thigh or buttock (gluteal) creases, performing the Ortolani test for stability (performed gently and which is usually negative after 3 months of age), and observing for limited abduction (generally positive after 3 months of age). Use of electronic health records can be considered to prompt and record the results of periodic hip examinations. The AAP recommends against universal ultrasonographic screening.
2. Selective hip ultrasonography can be considered between the ages of 6 weeks and 6 months for “high-risk” infants without positive physical findings. High risk is a relative and controversial term, but considerations include male or female breech presentation, a positive family history, parental concern, suspicious but inconclusive periodic examination, history of a previous positive instability physical examination, and history of tight lower-extremity swaddling. Because most DDH occurs in children without risk factors, physical examination

remains the primary screening tool.

3. It is important that infantile hip ultrasonography be performed and interpreted per American Institute of Ultrasound in Medicine and the American College of Radiology guidelines by experienced, trained examiners. Developing local criteria for screening imaging and referral based on best resources may promote more uniform and cost-effective treatment. Regional variability of ultrasonographic imaging quality can lead to under- or overtreatment.
4. Most minor hip anomalies observed on ultrasonography at 6 weeks to 4 months of age will resolve spontaneously. These include minor variations in α and β angles and subluxation (“uncoverage”) with stress maneuvers. Current levels of evidence do not support recommendations for treatment versus observation in any specific case of minor ultrasonographic variation. Care is, therefore, individualized through a process of shared decision-making in this setting of inadequate information.
5. Radiography (anteroposterior and frog pelvis views) can be considered after 4 months of age for the high-risk infant without physical findings or any child with positive clinical findings. Age 4 to 6 months is a watershed during which either imaging modality may be used; radiography is more readily available, has a lower rate of false-positive results, and is less expensive than ultrasonography but involves a very low dose of radiation.
6. A referral to an orthopedist for DDH does not require

ultrasonography or radiography. The primary indication for referral includes an unstable (positive Ortolani test result) or dislocated hip on clinical examination. Any child with limited hip abduction or asymmetric hip abduction after the neonatal period (4 weeks of age) should be referred for evaluation. Relative indications for referral include infants with risk factors for DDH, a questionable examination, and pediatrician or parental concern.

7. Evidence strongly supports screening for and treatment of hip dislocation (positive Ortolani test result) and initially observing milder early forms of dysplasia and instability (positive Barlow test result). Depending on local custom, either the pediatrician or the orthopedist can observe mild forms by periodic examination and possible follow-up imaging, but actual treatment should be performed by an orthopedist.
8. A reasonable goal for the primary care physician should be to diagnose hip subluxation or dislocation by 6 months of age by using the periodic physical examination. Selective ultrasonography or radiography may be used in consultation with a pediatric radiologist and/or orthopedist. No screening program has been shown to completely eliminate the risk of a late presentation of DDH. There is no high-level evidence that milder forms of dysplasia can be prevented by screening and early treatment.
9. Tight swaddling of the lower extremities with the hips adducted and extended should be avoided. The concept of “safe” swaddling, which

does not restrict hip motion, minimizes the risk of DDH.

10. Treatment of neonatal DDH is not an emergency, and in-hospital initiation of bracing is not required. Orthopaedic consultation can be safely obtained within several weeks of discharge for an infant with a positive Ortolani test result. Infants with a positive Barlow test results should be reexamined and referred to an orthopedist if they continue to show clinical instability.

ACKNOWLEDGMENTS

The authors thank Charles Price, MD, FAAP, Ellen Raney, MD, FAAP, Joshua Abzug, MD, FAAP, and William Hennrikus, MD, FAAP, for their valuable contributions to this report.

LEAD AUTHORS

Brian A. Shaw, MD, FAAOS, FAAP
Lee S. Segal, MD, FAAP

SECTION ON ORTHOPAEDICS EXECUTIVE COMMITTEE, 2014–2015

Norman Y. Otsuka, MD, FAAP, Chairperson
Richard M. Schwend, MD, FAAP, Immediate Past Chairperson
Theodore John Ganley, MD, FAAP
Martin Joseph Herman, MD, FAAP
Joshua E. Hyman, MD, FAAP
Brian A. Shaw, MD, FAAOS, FAAP
Brian G. Smith, MD, FAAP

STAFF

Niccole Alexander, MPP

ABBREVIATIONS

AAOS: American Academy of Orthopaedic Surgeons
AAP: American Academy of Pediatrics
AVN: avascular necrosis
DDH: developmental dysplasia of the hip
POSNA: Pediatric Orthopaedic Society of North America
USPSTF: US Preventive Services Task Force

REFERENCES

1. American Academy of Pediatrics. Clinical practice guideline: early detection of developmental dysplasia of the hip. Committee on Quality Improvement, Subcommittee on Developmental Dysplasia of the Hip. *Pediatrics*. 2000;105(4 pt 1):896–905
2. Schwend RM, Schoenecker P, Richards BS, Flynn JM, Vitale M; Pediatric Orthopaedic Society of North America. Screening the newborn for developmental dysplasia of the hip: now what do we do? *J Pediatr Orthop*. 2007;27(6):607–610
3. American Academy of Orthopaedic Surgeons. *Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants Up to Six Months of Age. Evidence-Based Clinical Practice Guideline*. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2014
4. Wilson JMG, Jungner G. *Principles and Practice of Screening for Disease*. Geneva, Switzerland: World Health Organization; 1968
5. Rosendahl K, Dezateux C, Fosse KR, et al. Immediate treatment versus sonographic surveillance for mild hip dysplasia in newborns. *Pediatrics*. 2010;125(1). Available at: www.pediatrics.org/cgi/content/full/125/1/e9
6. Bache CE, Clegg J, Herron M. Risk factors for developmental dysplasia of the hip: ultrasonographic findings in the neonatal period. *J Pediatr Orthop B*. 2002;11(3):212–218
7. Barr LV, Rehm A. Should all twins and multiple births undergo ultrasound examination for developmental dysplasia of the hip? A retrospective study of 990 multiple births. *Bone Joint J*. 2013;95-B(1):132–134
8. Imrie M, Scott V, Stearns P, Bastrom T, Mubarak SJ. Is ultrasound screening for DDH in babies born breech sufficient? *J Child Orthop*. 2010;4(1):3–8
9. Suzuki S, Yamamuro T. Avascular necrosis in patients treated with the Pavlik harness for congenital dislocation of the hip. *J Bone Joint Surg Am*. 1990;72(7):1048–1055
10. Fox AE, Paton RW. The relationship between mode of delivery and

- developmental dysplasia of the hip in breech infants: a four-year prospective cohort study. *J Bone Joint Surg Br*. 2010;92(12):1695–1699
11. Lowry CA, Donoghue VB, O’Herlihy C, Murphy JF. Elective Caesarean section is associated with a reduction in developmental dysplasia of the hip in term breech infants. *J Bone Joint Surg Br*. 2005;87(7):984–985
 12. Panagiotopoulou N, Bitar K, Hart WJ. The association between mode of delivery and developmental dysplasia of the hip in breech infants: a systematic review of 9 cohort studies. *Acta Orthop Belg*. 2012;78(6):697–702
 13. Sarkissian EJ, Sankar WN, Baldwin K, Flynn JM. Is there a predilection for breech infants to demonstrate spontaneous stabilization of DDH instability? *J Pediatr Orthop*. 2014;34(5):509–513
 14. Dodinval P. Hérité de la maladie luxante de la hanche (MLH) [Heredity in congenital dislocation of the hip]. *Acta Orthop Belg*. 1990;56(1 pt A):7–11
 15. Tönnis D. Inheritance. In: Tönnis D, ed. *Congenital Dysplasia and Dislocation of the Hip in Children and Adults*. Berlin, Germany: Springer-Verlag; 1984:61–62
 16. Stevenson DA, Mineau G, Kerber RA, Viskochil DH, Schaefer C, Roach JW. Familial predisposition to developmental dysplasia of the hip. *J Pediatr Orthop*. 2009;29(5):463–466
 17. Schiffen AN, Stevenson DA, Carroll KL, et al. Total hip arthroplasty, hip osteoarthritis, total knee arthroplasty, and knee osteoarthritis in patients with developmental dysplasia of the hip and their family members: a kinship analysis report. *J Pediatr Orthop*. 2012;32(6):609–612
 18. Carroll KL, Schiffen AN, Murray KA, et al. The occurrence of occult acetabular dysplasia in relatives of individuals with developmental dysplasia of the hip. *J Pediatr Orthop*. 2016;36(1):96–100
 19. Mahan ST, Kasser JR. Does swaddling influence developmental dysplasia of the hip? *Pediatrics*. 2008;121(1):177–178
 20. van Sleuwen BE, Engelberts AC, Boere-Boonekamp MM, Kuis W, Schulpen TW, L’Hoir MP. Swaddling: a systematic review. *Pediatrics*. 2007;120(4). Available at: www.pediatrics.org/cgi/content/full/120/4/e1097
 21. Wang E, Liu T, Li J, et al. Does swaddling influence developmental dysplasia of the hip? An experimental study of the traditional straight-leg swaddling model in neonatal rats. *J Bone Joint Surg Am*. 2012;94(12):1071–1077
 22. Gerard CM, Harris KA, Thach BT. Physiologic studies on swaddling: an ancient child care practice, which may promote the supine position for infant sleep. *J Pediatr*. 2002;141(3):398–403
 23. Oden RP, Powell C, Sims A, Weisman J, Joyner BL, Moon RY. Swaddling: will it get babies onto their backs for sleep? *Clin Pediatr (Phila)*. 2012;51(3):254–259
 24. Canillas F, Delgado-Martos MJ, Martos-Rodriguez A, Quintana-Villamandos B, Delgado-Baeza E. Contribution to the initial pathodynamics of hip luxation in young rats. *J Pediatr Orthop*. 2012;32(6):613–620
 25. Pediatric Orthopaedic Society of North America, International Hip Dysplasia Institute, American Academy of Orthopaedic Surgeons, United States Bone and Joint Initiative, Shriners Hospitals for Children. Position Statement: Swaddling and Developmental Hip Dysplasia. Rosemont, IL: Pediatric Orthopaedic Society of North America; 2015. Available at: www.aaos.org/uploadedFiles/PreProduction/About/Opinion_Statements/position/1186%20Swaddling%20and%20Developmental%20Hip%20Dysplasia%281%29.pdf. Accessed January 12, 2016
 26. Roposch A, Liu LQ, Protopapa E. Variations in the use of diagnostic criteria for developmental dysplasia of the hip. *Clin Orthop Relat Res*. 2013;471(6):1946–1954
 27. Barlow TG. Early diagnosis and treatment of congenital dislocation of the hip. *J Bone Joint Surg Br*. 1962;44B(2):292–301
 28. Barlow TG. Congenital dislocation of the hip in the newborn. *Proc R Soc Med*. 1966;59(11 part 1):1103–1106
 29. Barlow TG. Neonatal hip dysplasia—treatment, results and complications. *Proc R Soc Med*. 1975;68(8):475
 30. Brurås KR, Aukland SM, Markestad T, Sera F, Dezateaux C, Rosendahl K. Newborns with sonographically dysplastic and potentially unstable hips: 6-year follow-up of an RCT. *Pediatrics*. 2011;127(3). Available at: www.pediatrics.org/cgi/content/full/127/3/e661
 31. Mladenov K, Dora C, Wicart P, Seringe R. Natural history of hips with borderline acetabular index and acetabular dysplasia in infants. *J Pediatr Orthop*. 2002;22(5):607–612
 32. Clarke NM, Reading IC, Corbin C, Taylor CC, Bochmann T. Twenty years’ experience of selective secondary ultrasound screening for congenital dislocation of the hip. *Arch Dis Child*. 2012;97(5):423–429
 33. Shipman SA, Helfand M, Moyer VA, Yawn BP. Screening for developmental dysplasia of the hip: a systematic literature review for the US Preventive Services Task Force. *Pediatrics*. 2006;117(3). Available at: www.pediatrics.org/cgi/content/full/117/3/e557
 34. US Preventive Services Task Force. Screening for developmental dysplasia of the hip: recommendation statement. *Pediatrics*. 2006;117(3):898–902
 35. Patel H; Canadian Task Force on Preventive Health Care. Preventive health care, 2001 update: screening and management of developmental dysplasia of the hip in newborns. *CMAJ*. 2001;164(12):1669–1677
 36. Williams PR, Jones DA, Bishay M. Avascular necrosis and the Aberdeen splint in developmental dysplasia of the hip. *J Bone Joint Surg Br*. 1999;81(6):1023–1028
 37. Laborie LB, Engesæter IØ, Lehmann TG, Eastwood DM, Engesæter LB, Rosendahl K. Screening strategies for hip dysplasia: long-term outcome of a randomized controlled trial. *Pediatrics*. 2013;132(3):492–501
 38. Gardner F, Dezateaux C, Elbourne D, Gray A, King A, Quinn A; Collaborative Hip Trial Group. The hip trial: psychological consequences for mothers of using ultrasound to manage infants with developmental hip dysplasia. *Arch Dis Child Fetal Neonatal Ed*. 2005;90(1):F17–F24

39. Rosendahl K, Markestad T, Lie RT. Ultrasound screening for developmental dysplasia of the hip in the neonate: the effect on treatment rate and prevalence of late cases. *Pediatrics*. 1994;94(1):47–52
40. Holen KJ, Tegnander A, Bredland T, et al. Universal or selective screening of the neonatal hip using ultrasound? A prospective, randomised trial of 15,529 newborn infants. *J Bone Joint Surg Br*. 2002;84(6):886–890
41. Hagans JF, Shaw JS, Duncan P, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents, Third Edition. Pocket Guide*. Elk Grove Village, IL: American Academy of Pediatrics; 2008
42. Catterall A. The early diagnosis of congenital dislocation of the hip. *J Bone Joint Surg Br*. 1994;76(4):515–516
43. Wirth T, Stratmann L, Hinrichs F. Evolution of late presenting developmental dysplasia of the hip and associated surgical procedures after 14 years of neonatal ultrasound screening. *J Bone Joint Surg Br*. 2004;86(4):585–589
44. Myles JW. Secondary screening for congenital displacement of the hip. *J Bone Joint Surg Br*. 1990;72(2):326–327
45. Moore FH. Examining infants' hips—can it do harm? *J Bone Joint Surg Br*. 1989;71(1):4–5
46. Jones DA. Neonatal hip stability and the Barlow test. A study in stillborn babies. *J Bone Joint Surg Br*. 1991;73(2):216–218
47. Bond CD, Hennrikus WL, DellaMaggiore ED. Prospective evaluation of newborn soft-tissue hip “clicks” with ultrasound. *J Pediatr Orthop*. 1997;17(2):199–201
48. Scoles PV, Boyd A, Jones PK. Roentgenographic parameters of the normal infant hip. *J Pediatr Orthop*. 1987;7(6):656–663
49. Karmazyn BK, Gunderman RB, Coley BD, et al; American College of Radiology. ACR Appropriateness Criteria on developmental dysplasia of the hip—child. *J Am Coll Radiol*. 2009;6(8):551–557
50. American Institute of Ultrasound in Medicine; American College of Radiology. AIUM practice guideline for the performance of an ultrasound examination for detection and assessment of developmental dysplasia of the hip. *J Ultrasound Med*. 2009;28(1):114–119
51. Roposch A, Wright JG. Increased diagnostic information and understanding disease: uncertainty in the diagnosis of developmental hip dysplasia. *Radiology*. 2007;242(2):355–359
52. Roposch A, Moreau NM, Uleryk E, Doria AS. Developmental dysplasia of the hip: quality of reporting of diagnostic accuracy for US. *Radiology*. 2006;241(3):854–860
53. Burger BJ, Burger JD, Bos CF, Obermann WR, Rozing PM, Vandembroucke JP. Neonatal screening and staggered early treatment for congenital dislocation or dysplasia of the hip. *Lancet*. 1990;336(8730):1549–1553
54. Dunn PM, Evans RE, Thearle MJ, Griffiths HE, Witherow PJ. Congenital dislocation of the hip: early and late diagnosis and management compared. *Arch Dis Child*. 1985;60(5):407–414
55. Sampath JS, Deakin S, Paton RW. Splintage in developmental dysplasia of the hip: how low can we go? *J Pediatr Orthop*. 2003;23(3):352–355
56. Wood MK, Conboy V, Benson MK. Does early treatment by abduction splintage improve the development of dysplastic but stable neonatal hips? *J Pediatr Orthop*. 2000;20(3):302–305
57. Shorter D, Hong T, Osborn DA. Screening programmes for developmental dysplasia of the hip in newborn infants. *Cochrane Database Syst Rev*. 2011;(9):CD004595
58. Paton RW, Srinivasan MS, Shah B, Hollis S. Ultrasound screening for hips at risk in developmental dysplasia. Is it worth it? *J Bone Joint Surg Br*. 1999;81(2):255–258
59. Paton RW, Hinduja K, Thomas CD. The significance of at-risk factors in ultrasound surveillance of developmental dysplasia of the hip. A ten-year prospective study. *J Bone Joint Surg Br*. 2005;87(9):1264–1266
60. Elbourne D, DeZateux C, Arthur R, et al; UK Collaborative Hip Trial Group. Ultrasonography in the diagnosis and management of developmental hip dysplasia (UK Hip Trial): clinical and economic results of a multicentre randomised controlled trial. *Lancet*. 2002;360(9350):2009–2017
61. Pacana MJ, Hennrikus WL, Slough J, Curtin W. Ultrasound examination for infants born breech by elective cesarean section with a normal hip exam for instability [published online ahead of print October 21, 2015]. *J Pediatr Orthop*. Doi:10.1097/BPO.0000000000000668
62. Gardiner HM, Dunn PM. Controlled trial of immediate splinting versus ultrasonographic surveillance in congenitally dislocatable hips. *Lancet*. 1990;336(8730):1553–1556
63. Paton RW, Hopgood PJ, Eccles K. Instability of the neonatal hip: the role of early or late splintage. *Int Orthop*. 2004;28(5):270–273
64. Lorente Moltó FJ, Gregori AM, Casas LM, Perales VM. Three-year prospective study of developmental dysplasia of the hip at birth: should all dislocated or dislocatable hips be treated? *J Pediatr Orthop*. 2002;22(5):613–621
65. Suzuki S, Kashiwagi N, Kasahara Y, Seto Y, Futami T. Avascular necrosis and the Pavlik harness. The incidence of avascular necrosis in three types of congenital dislocation of the hip as classified by ultrasound. *J Bone Joint Surg Br*. 1996;78(4):631–635
66. Murnaghan ML, Browne RH, Sucato DJ, Birch J. Femoral nerve palsy in Pavlik harness treatment for developmental dysplasia of the hip. *J Bone Joint Surg Am*. 2011;93(5):493–499
67. Rombouts JJ, Kaelin A. Inferior (obturator) dislocation of the hip in neonates. A complication of treatment by the Pavlik harness. *J Bone Joint Surg Br*. 1992;74(5):708–710
68. Mubarak S, Garfin S, Vance R, McKinnon B, Sutherland D. Pitfalls in the use of the Pavlik harness for treatment of congenital dysplasia, subluxation, and dislocation of the hip. *J Bone Joint Surg Am*. 1981;63(8):1239–1248
69. Kitho H, Kawasumi M, Ishiguro N. Predictive factors for unsuccessful treatment of developmental dysplasia of the hip by the Pavlik harness. *J Pediatr Orthop*. 2009;29(6):552–557

70. Sucato DJ, Johnston CE II, Birch JG, Herring JA, Mack P. Outcome of ultrasonographic hip abnormalities in clinically stable hips. *J Pediatr Orthop*. 1999;19(6):754–759
71. McAbee GN, Donn SM, Mendelson RA, McDonnell WM, Gonzalez JL, Ake JK. Medical diagnoses commonly associated with pediatric malpractice lawsuits in the United States. *Pediatrics*. 2008;122(6). Available at: www.pediatrics.org/cgi/content/full/122/6/e1282
72. Davies SJ, Walker G. Problems in the early recognition of hip dysplasia. *J Bone Joint Surg Br*. 1984;66(4):479–484
73. Ilfeld FW, Westin GW, Makin M. Missed or developmental dislocation of the hip. *Clin Orthop Relat Res*. 1986; (203):276–281

Evaluation and Referral for Developmental Dysplasia of the Hip in Infants

Brian A. Shaw, Lee S. Segal and SECTION ON ORTHOPAEDICS

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-3107 originally published online November 21, 2016;

Updated Information & Services

including high resolution figures, can be found at:
<http://pediatrics.aappublications.org/content/138/6/e20163107>

References

This article cites 68 articles, 18 of which you can access for free at:
<http://pediatrics.aappublications.org/content/138/6/e20163107.full#ref-list-1>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):
Section on Orthopaedics
<http://classic.pediatrics.aappublications.org/cgi/collection/section-on-orthopaedics>
Orthopaedic Medicine
http://classic.pediatrics.aappublications.org/cgi/collection/orthopaedic_medicine_sub

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
<https://shop.aap.org/licensing-permissions/>

Reprints

Information about ordering reprints can be found online:
<http://classic.pediatrics.aappublications.org/content/reprints>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Evaluation and Referral for Developmental Dysplasia of the Hip in Infants

Brian A. Shaw, Lee S. Segal and SECTION ON ORTHOPAEDICS

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-3107 originally published online November 21, 2016;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/138/6/e20163107>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

