AAOS
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

Adapted by:
The American Academy of Orthopaedic Surgeons Board of Directors
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Endorsed by:

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Disclaimer

This Clinical Practice Guideline was developed based on a systematic review of the current scientific and clinical information and accepted approaches to treatment and/or diagnosis. This clinical practice guideline is not intended to be a fixed protocol, as some patients may require more or less treatment or different means of diagnosis. Clinical patients may not necessarily be the same as those found in a clinical trial. Patient care and treatment should always be based on a clinician's independent medical judgment, given the individual patient's clinical circumstances.

Disclosure Requirement
In accordance with AAOS policy, all individuals whose names appear as authors or contributors to the clinical practice guideline filed a disclosure statement as part of the submission process. All panel members provided full disclosure of potential conflicts of interest prior to voting on the recommendations contained within this clinical practice guideline.

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FDA Clearance
Some drugs or medical devices referenced or described in this clinical practice guideline may not have been cleared by the Food and Drug Administration (FDA) or may have been cleared for a specific use only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or device he or she wishes to use in clinical practice.

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2022 REPORT FOR THE UPDATE OF THE 2014 CLINICAL PRACTICE GUIDELINE ON THE DETECTION AND NONOPERATIVE MANAGEMENT OF PEDIATRIC DEVELOPMENTAL DYSPLASIA OF THE HIP IN INFANTS UP TO SIX MONTHS OF AGE

This guideline is greater than 5 years old and is reviewed every five years. New studies have been published since this guideline was developed, however the AAOS has determined that these studies are not sufficient to warrant changing the guideline scope at this time. Due to the paucity of evidence and the relevance of the existing scope, this guideline was approved to be updated via the AAOS Rapid Update Methodology. The 2022 additions to this document are outlined below and reflect additions based on newly available evidence relevant to the original PICO questions and resulting guideline recommendations. Only the recommendations have been updated, and all other information (e.g., the methods, work group roster, recommendation rationales) remain that of the original 2014 guideline. For the full AAOS Clinical Practice Guidelines Rapid Update Methodology please visit: aaos.org/quality

OVERVIEW OF 2022 UPDATES TO THE 2014 ORIGINAL GUIDELINE

1. Updated the strength of recommendation of the following recommendations based on new evidence:
    a. Evaluation of Infants with Risk Factors for DDH (upgraded from Moderate to Strong)
    b. Surveillance After Normal Infant Hip Exam (upgraded from Limited to Moderate)
    c. Type of Brace for the Unstable Hip (upgraded from Limited to Moderate)
2. Addition of the following supporting evidence:
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    b. Ayanoglu, T., Ataoglu, M. B., Tokgoz, N., Ersoz, E., Atalar, H., Turlani, S. Assessing the risk of asymptomatic dysplasia in parents of children with developmental hip dysplasia. *Acta Orthop Traumatol Turc* 2019; 5: 346-350
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SUMMARY OF RECOMMENDATIONS

The original guideline on the Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants Up to Six Months of Age (DDH) was published in 2014 and had nine recommendations of varying strengths. Based on the current procedure for updating AAOS guidelines, the Medical Librarian ran a preliminary search to identify literature that could address and possibly change the original recommendations. The AAOS Department of Clinical Quality and Value then used the inclusion criteria from the original guideline to determine if any articles published after the final literature search date of the original guideline were relevant to the original recommendations.

The following is a summary of the recommendations in the AAOS' clinical practice guideline on the Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants Up to Six Months of Age (DDH). This summary does not contain rationales that explain how and why these recommendations were developed nor does it contain the evidence supporting these recommendations. All readers of this summary are strongly urged to consult the full guideline and evidence report for this information. We are confident that those who read the full guideline and evidence report will also see that the recommendations were developed using systematic evidence-based processes designed to combat bias, enhance transparency, and promote reproducibility. This summary of recommendations is not intended to stand alone.

UNIVERSAL ULTRASOUND SCREENING

Moderate evidence supports not performing universal ultrasound screening of newborn infants.

Strength of Recommendation: Moderate 

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

EVALUATION OF INFANTS WITH RISK FACTORS FOR DDH

Strong evidence supports performing an imaging study before 6 months of age in infants with one or more of the following risk factors: breech presentation, family history, or history of clinical instability.

Strength of Recommendation: Strong 

Description: Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.

IMAGING OF THE UNSTABLE HIP

Limited evidence supports that the practitioner might obtain an ultrasound in infants less than 6 weeks of age with a positive instability examination to guide the decision to initiate brace treatment.

Strength of Recommendation: Limited 

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

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IMAGING OF THE INFANT HIP

Limited evidence supports the use of an AP pelvis radiograph instead of an ultrasound to assess DDH in infants beginning at 4 months of age.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

SURVEILLANCE AFTER NORMAL INFANT HIP EXAM

Moderate evidence supports that a practitioner re-examine infants previously screened as having a normal hip examination on subsequent visits prior to 6 months of age.

Strength of Recommendation: Moderate ★★★☆

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

STABLE HIP WITH ULTRASOUND IMAGING ABNORMALITIES

Limited evidence supports observation without a brace for infants with a clinically stable hip with morphologic ultrasound imaging abnormalities.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

TREATMENT OF CLINICAL INSTABILITY

Limited evidence supports either immediate or delayed (2-9 weeks) brace treatment for hips with a positive instability exam.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

TYPE OF BRACE FOR THE UNSTABLE HIP

Moderate evidence supports use of the von Rosen splint over Pavlik, Craig, or Frejka splints for initial treatment of an unstable hip.

Strength of Recommendation: Moderate ★★★☆

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

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MONITORING OF PATIENTS DURING BRACE TREATMENT

Limited evidence supports that the practitioner perform serial physical examinations and periodic imaging assessments (ultrasound or radiograph based on age) during management for unstable infant hips.

Strength of Recommendation: Limited 

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

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INTRODUCTION

OVERVIEW

This clinical practice guideline is based upon a systematic review of published articles related to the detection and early management of hip instability and dysplasia in typically developing children less than 6 months of age. This guideline provides practice recommendations for the early screening and detection of hip instability and dysplasia and also highlights gaps in the published literature that should stimulate additional research. This guideline is intended towards appropriately trained practitioners involved in the early examination and assessment of typically developing children for hip instability and dysplasia.

GOALS AND RATIONALE

The purpose of this clinical practice guideline is to improve the ability of practitioners to detect and manage hip instability and hip dysplasia in typically developing children less than 6 months of age based upon the current best evidence. Current evidence-based medicine (EBM) standards call for physicians to use the best available evidence in their clinical decisions. This clinical practice guideline includes a systematic literature review of treatment and diagnostic articles related to developmental dysplasia of the hip (DDH) published in or after 1966 and incidence/natural history articles published in or after 1950. This review demonstrates where there is good evidence, where evidence is lacking, and what topics future research must target in order to improve early screening, detection and the treatment of typically developing children less than 6 months of age with developmental dysplasia of the hip. AAOS staff and an interdisciplinary clinician work group systematically reviewed the available literature and wrote the following recommendation based upon a rigorous standardized process.

Many different providers may provide musculoskeletal care in many different settings. We created this guideline as an educational tool to guide qualified practitioners through a series of treatment decisions in an effort to improve the quality and efficiency of care. This guideline should not be construed as including all proper methods of care or excluding methods of care reasonably directed to obtaining the same results. The ultimate judgment regarding any specific procedure of treatment must be made in light of all circumstances presented by the patient and the needs and resources particular to the locality or practice setting.

INTENDED USERS

This guideline is intended for use by appropriately trained practitioners involved in the medical evaluation of typically developing children less than 6 months of age. This would include pediatricians, family physicians, qualified mid-level practitioners with appropriate physician oversight, radiologists who perform diagnostic imaging of children, and orthopedic surgeons. Typically, physicians will have completed medical training, a qualified residency in their specialty area and some may have completed additional sub-specialty training. Mid-level providers would have completed a qualified training program in their specialty and would have additional training in the assessment of pediatric patients with appropriate supervision by a qualified physician pursuant to the laws of their practice environment. This guideline is not intended for use as a benefits determination document. Making these determinations involves many factors not considered in the present document, including available resources, business and ethical considerations, and need.

The early diagnosis and management of DDH is based upon the assumption that shared and informed decisions are made by the patient's guardians and the practitioner based upon a mutual communication and understanding of the available treatments and procedures applicable to the individual patient. Practitioner input based upon experience and knowledge of interpretation of clinical and imaging findings,

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conservative and surgical management options, and of additional accessible expertise increases the probability of optimally matching the right intervention to the right patient at the right time.

PATIENT POPULATION

This clinical practice guideline is applicable to the detection and management of DDH in typically developing children less than 6 months of age. It is not intended for use for children who have teratologic hip abnormalities or hip abnormalities associated with neuromuscular, genetic, or acquired complex musculoskeletal or developmental abnormalities.

BURDEN OF DISEASE

DDH is a spectrum of anatomic abnormalities of the femoral head and acetabulum of the hip joint. There is inconsistent terminology used to describe these abnormalities and a lack of clarity around which recognized abnormalities of the hip in the newborn and early infancy periods are progressive and pathologic versus self-resolving and potentially within a range of normal development. While clinical terms such as "click, clunk, dislocatable, subluxatable, reducible, dysplastic, asymmetric thigh folds, and limited hip abduction" are common in papers related to this topic, no clear or widely accepted clinical definitions exist by which to compare patient populations to each other. In particular, the term "click" has been problematic as it has been used in screening literature as a term describing a range of situations from a normal snapping sensation to a surrogate for clinically detectable hip instability. Similarly, discussion of risk factors for terms such as "foot deformities, talipes, family history, first born, female, and intrauterine crowding/oligohydramnios" have been applied in a retrospective manner without specificity and without consideration of other variables. Imaging criteria are similarly vague. Included papers for this review demonstrated consistency of use of the Graf criteria for grading severity of sonographic hip dysplasia, but consistent radiographic criteria for defining dysplasia or dislocation were lacking.

Early detection and early management of DDH must take into account the early natural history of physiologic hip development. As a part of the development of this clinical practice guideline, the workgroup included a search for articles that defined the natural history of early clinical instability and early hip dysplasia as determined by either ultrasound or radiograph.

An estimation of the true incidence of the disorder is therefore uncertain. The reported incidence ranges are as high as 1:100 newborns for clinically detectable hip instability to 1-28:1000 newborns for clinically and/or radiographic hip dislocation that prompted an intervention [I-1, I-2]. Recent large ultrasound screening studies place the incidence of ultrasound detectable abnormalities leading to intervention at 5-7% of all newborns [I-3, I-5]. In the United States, there were approximately 3,952,940 live births in 2012 [I-6] suggesting a potential impact from 4,000 up to 276,700 newborn children/year in the United States.

The true prevalence of adult hip pathology attributable to DDH is unknown. It is widely believed that DDH is a condition that can lead to impaired function and quality of life for children and adults [I-2, I-8, I-10] and that detection of this condition in early childhood may allow interventions that can alter this. It is also believed that earlier treatment creates less potential harm to the child than later treatment with the aggregate risk of those harms being less than the risk of impaired function and quality of life of the untreated condition [I-4, I-11, I-18].

Current and evolving practice standards call for a musculoskeletal evaluation of all newborn children and also demand that practitioners be good stewards of health care resources in making such assessments and decisions for management. These methods may involve both clinical and imaging resources. In clinically normal hips imaging evaluation would be the only viable method to assess for hip problems that could have a potential to evolve into a future pathologic condition with adverse impact upon an individual's

quality of life. Population screening using ultrasound has been practiced in Europe [I-3, I-10, I-19, I-20] and with an uncertain role in North America [I-1. I-2, I-8].

NATURAL HISTORY

Published works on the topic of DDH have used inconsistent terminology to describe abnormalities and have not clarified which recognized abnormalities of the hip in the newborn and early infancy are progressive and pathologic versus self-resolving and potentially within a range of normal development. As a part of the development of this clinical practice guideline, the workgroup attempted to identify as best as possible, the natural history of clinically unstable or ultrasound or radiographically abnormal hips detected in infancy with the natural duration of self-correction. The details of the review are listed in the natural history of DDH appendix within this CPG. The long-term natural history of DDH appears to be related to the type and severity of the hip abnormality. Mild dysplasia may never manifest clinically or become apparent until adult life, whereas severe dysplasia can present clinically with functional limitations during childhood. Interventions to alter the long- term natural history of DDH have included early bracing and a progressive range of manipulative and surgical options with advancing age of the child [I-31 to I-43]. In this review, included articles were examined specifically for information related to the resolution of clinical instability or ultrasound and radiographic hip dysplasia in untreated infants. All of the studies identified for this review indicate that most DDH discovered during the newborn period appear to represent hip laxity and immaturity. Approximately 60%–80% of abnormalities identified by physical examination and more than 90% identified by ultrasound (US) appear to resolve spontaneously in early infancy raising significant questions about whether or not such hips should be treated with bracing and at what age such treatment should be optimally applied.

ETIOLOGY

The etiology of DDH in typically developing children is unknown. Both genetic and environmental influences appear to play a role in the development of this condition [I-10, I-21]. Absence of a femoral head from within an acetabulum and alteration of proximal femoral anatomy has been linked to progressive changes of the acetabulum over time [I-22]. Risk factors for the development of progressive hip abnormality have been reported in observational series and are reported in the next section.

RISK FACTORS

The terminology used in defining risk factors for the presence of DDH is not precise in the published literature. Hip physical examination findings associated with DDH have semantic challenges, limited knowledge of normal ranges, and knowledge that the examination findings change over time. Case control and observational studies have suggested that "breech positioning at delivery, family history of DDH, limited hip abduction, talipes, female gender, swaddling, large birth size, and first born" have been associated with a higher probability of finding DDH [I-2, I-8, I-23].

EMOTIONAL AND PHYSICAL IMPACT

The emotional impact upon a family of detecting a non-apparent musculoskeletal problem in a newborn is unknown. There may be emotional impact upon parents who are given false positive screening information [I-24].

POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS

Most treatments are associated with known risks. In the case of screening and early intervention programs, potential harms may be related to either over diagnosis with increased rates of further evaluation and treatment that may be unnecessary and to under diagnosis that can lead to a late diagnosis with progression of deformity. Clinician input based upon experience decreases the probability of harms in both scenarios.

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Intervention with splintage devices, more frequent visits to providers and increased rates of imaging occur in observational and case control series where the diagnosis of DDH is given [I-11, I-20, I-25, I-26, I-27, I-28, I-29]. Treatment of all forms for DDH has been associated with varying rates of avascular necrosis that represent a possibility of harm to individual patients.

Observational and case control studies suggest that the management of children who present with DDH at walking age or older has greater risk of being managed by open surgical hip reduction with its attendant risks of avascular necrosis, infection, hip stiffness, and early onset osteoarthritis as an adult [I-1, I-4, I-8, I-9, I-18, I-30, I-31]. The harms of late diagnosis with no treatment are not established. This guideline only addresses children up to six months of age.

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METHODS

The methods used to perform this clinical practice guideline were employed to minimize bias and enhance transparency in the selection, appraisal, and analysis of the available evidence. [8,9] These processes are vital to the development of reliable, transparent, and accurate clinical recommendations for detection and nonoperative management of pediatric developmental dysplasia of the hip in infants up to six months of age. To view the full AAOS clinical practice guideline methodology please visit the eAppendix or https://www.aaos.org/additonalresources/.

To develop the original guideline, the work group initially met in an introductory meeting on June 11-12, 2012, to establish the scope of the guideline and systematic review. Upon completion of the systematic review the work group participated in a two-day recommendation meeting on October 4-6, 2013, at which the final recommendations were written and voted on. The resulting draft guidelines were then peer-reviewed, subsequently sent for public commentary, and then sequentially approved by the AAOS Committee on Evidence Based Quality and Value, AAOS Council on Research and Quality, and the AAOS Board of Directors (see the eAppendix for a description of the AAOS bodies involved in the original approval process).

GUIDELINE UPDATE

The original guideline and systematic review were prepared by the AAOS Detection and Nonoperative Management of Developmental Dysplasia of the Hip in Infants up to 6 Months of Age physician work group with the assistance of the AAOS Clinical Practice Guidelines Unit. Based on the current procedure for updating AAOS guidelines, the Medical Librarian ran an updated search to identify literature published after the original search for the 2014 guideline that could address and possibly change the original recommendations. The AAOS Committee on Evidence-Based Quality and Value in conjunction with the Department of Clinical Quality and Value then used the inclusion criteria from the original guideline to determine if any articles published after the final literature search date of the original guideline were relevant to the recommendations.

LITERATURE SEARCHES

The medical librarian conducted a comprehensive search of PubMed, Embase, and the Cochrane Central Register of Controlled Trials based on key terms and concepts from the systematic literature review development group's preliminary recommendations. Bibliographies of relevant systematic reviews were hand searched for additional references. The 2022 update to the 2014 guideline searched for all articles published between January 1, 2014, and April 16, 2020.

STUDY SELECTION CRITERIA

TYPES OF STUDIES

The original guideline development group developed *a priori* article selection criteria for the review. Specifically, to be included in the systematic review an article had to be a report of a study that:

- Study must be of Developmental Dysplasia of the Hip
- Article must be a full article report of a clinical study
- Study must appear in a peer-reviewed publication
- Study must be published in English
- Study must be published in or after 1950
- Study must be of humans
- Study must not be an in vitro study

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- Study must not be a biomechanical study
- Study must not have been performed on cadavers
- Study should have 10 or more patients per group
- All study follow up durations are included
- Study results must be quantitatively presented
- For any given follow-up time point in any included study, there must be ≥ 50% patient follow-up
- Retrospective non-comparative case series, medical records review, meeting abstracts, historical articles, editorials, letters, and commentaries are excluded
- Case series studies that give patients the treatment of interest AND another treatment are excluded
- Case series studies that have non-consecutive enrollment of patients are excluded
- All studies of "Very Low" strength of evidence are excluded
- Quantitatively presented results

When a study's "duration of symptoms" is not the same as those examined by the work group (i.e., 0-2 weeks, 2-6 weeks, etc.) the study will be assigned to the appropriate "duration of symptoms" group based upon the mean duration of symptoms. If a range rather than mean is provided, the higher end of the range will dictate which "duration of symptoms" group the study will be assigned to. For example, a study reporting patient symptom of 0-4 weeks would be included in the time frame "2-6 weeks" created by the work group.

DEFINING THE STRENGTH OF THE RECOMMENDATIONS

Judging the strength of evidence is only a steppingstone towards arriving at the strength of a systematic literature review recommendation. The strength of recommendation (Table 1) also takes into account the quality, quantity, and the trade-off between the benefits and harms of a treatment, the magnitude of a treatment's effect, and whether there is data on critical outcomes. Table 2 addresses how to interpret the strength of each recommendation.

VOTING ON THE RECOMMENDATIONS

The recommendations and their strength were voted on by the guideline development group members during the final meeting. If disagreement between the guideline development group occurred, there was further discussion to see whether the disagreement(s) could be resolved. Recommendations were approved and adopted in instances where a simple majority (60%) of the guideline development group voted to approve.

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INTERPRETING THE STRENGTH OF EVIDENCE

Table 1. Strength of Recommendation Descriptions

Strength	Overall Strength of Evidence	Description of Evidence Quality	Strength Visual
Strong	Strong	Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.	
Moderate	Moderate	Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention.	
Limited	Limited or Conflicting Evidence	Evidence from two or more "Low" quality studies with consistent findings **or** evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.	
Consensus	No Evidence	There is no supporting evidence. In the absence of reliable evidence, the systematic literature review development group is making a recommendation based on their clinical opinion.	

Table II. Clinical Applicability: Interpreting the Strength of a Recommendation

Strength of Recommendation	Patient Counseling (Time)	Decision Aids	Impact of Future Research
Strong	Least	Least Important, unless the evidence supports no difference between two alternative interventions	Not likely to change
Moderate	Less	Less Important	Less likely to change
Limited	More	Important	Change possible/anticipated
Consensus	Most	Most Important	Impact unknown

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REVIEW PERIOD

The original draft of the guideline and evidence report were peer reviewed by an expert outside advisory panel that was nominated by the physician work group prior to the development of the guideline (eAppendix). In addition, the physician members of the AAOS Committee on Evidence Based Quality and Value provided peer review of the draft document. Peer review was accomplished using a structured peer review form. (eAppendix) We forwarded the draft guideline to a total of twenty-seven reviewers and fifteen returned reviews. The disposition of all non-editorial peer review comments was documented and accompanied this guideline through the public commentary and the following approval process.

After modifying the draft in response to peer review, the original guideline was subjected to a thirty-day period of "Public Commentary." Commentators consist of members of the AAOS Board of Directors (BOD), members of the Research and Quality Council, members of the Board of Councilors (BOC), and members of the Board of Specialty Societies (BOS). Based on these bodies, over 200 commentators had the opportunity to provide input into the development of this guideline. Of these, five returned public comments.

THE AAOS CLINICAL PRACTICE GUIDELINE APPROVAL PROCESS

This final clinical practice guideline draft must be approved by the AAOS Committee on Evidence-Based Quality and Value, the AAOS Research and Quality Council, and the AAOS Board of Directors. These decision-making bodies are described in the eAppendix. Their charge is to approve or reject its publication by majority vote.

REVISION PLANS

This clinical practice guideline represents a cross-sectional view of current treatment and may become outdated as new evidence becomes available. This clinical practice guideline will be revised in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology. This clinical practice guideline will be updated, re-issued, or withdrawn in five years.

SYSTEMATIC LITERATURE REVIEW DISSEMINATION PLANS

The primary purpose of the present document is to provide interested readers with full documentation of the best available evidence for various procedures associated with the topic of this review. Publication of most systematic literature reviews is announced by an Academy press release, articles authored by the systematic literature review development group and published in the *Journal of the American Academy of Orthopaedic Surgeons*, and articles published in *AAOS Now*.

Selected clinical practice guidelines are disseminated by webinar, AAOS Online Learning, the Orthopaedic Video Theater (OVT), Media Briefings, and by distributing them at relevant Continuing Medical Education (CME) courses and at the AAOS Resource Center.

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RECOMMENDATIONS

UNIVERSAL ULTRASOUND SCREENING

Moderate evidence supports not performing universal ultrasound screening of newborn infants.

Strength of Recommendation: Moderate ★★★☆

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

RATIONALE

There is moderate evidence to not do universal screening of all infants for DDH. Two moderate strength studies showed no statistical difference between universal and selective ultrasound screening of the infant hip for diagnosis of late presenting DDH (Holen 2002, Rosendahl 1994). Holen (2002) augmented clinical screening with either universal or selective (risk) ultrasound. The rate of late cases in Holen's (2002) study was 0.13/1000 with universal ultrasound screening and 0.65/1000 with selective (risk) screening. The difference in late detection was not statistically significant. Rosendahl (1994) used three matched study groups: general ultrasound screening, risk factor screening and only clinical screening. Late cases identified by group were 0.3/1000, 0.7/1000 and 1.3/1000 respectively and these differences were not statistically significant.

Screening of all infants with ultrasound has the potential to lead to over-treatment. Rosendahl's (1994) study found that general ultrasound screening resulted in a higher treatment rate (3.4%) than either selective ultrasound screening (2.0%) or clinical screening (1.8%). The higher rate with universal screening is statistically significant. Universal ultrasound screening requires considerable diagnostic and therapeutic effort and these studies which involve large numbers of newborns indicate that such a commitment of resources will not significantly impact the prevalence of late cases.

RISKS AND HARMS

There is a potential to miss a case of DDH in an infant with a normal clinical examination and no risk factors. This could lead to a late diagnosis with concerns for a potential of higher rate of treatment complications as a result of late diagnosis.

2022 UPDATE ADDITIONAL EVIDENCE

1. Gokharman, F. D., Aydin, S., Fatihoglu, E., Ergun, E., Kosar, P. N. Optimizing the Time for Developmental Dysplasia of the Hip Screening: Earlier or Later? *Ultrasound Q* 2019; 2: 130-135
2. Burnett, M., Rawlings, E. L., Reddan, T. An audit of referral time frames for ultrasound screening of developmental hip dysplasia in neonates with a normal antenatal clinical examination. *Sonography* 2018; 2: 61-66
3. Geertsema, D., Meinardi, J. E., Kempink, D. R. J., Fiocco, M., van de Sande, M. A. J. Screening program for neonates at risk for developmental dysplasia of the hip: comparing first radiographic evaluation at fiveÂ months with the standard twelveÂ week ultrasound. A prospective cross-sectional cohort study. *Int Orthop* 2019; 8: 1933-1938
4. Guler, O., Seker, A., Mutlu, S., Cerci, M. H., Komur, B., Mahirogullari, M. Results of a universal ultrasonographic hip screening program at a single institution. Acta Orthop Traumatol Turc 2016; 1: 42-8
5. Gyurkovits, Z., Sohar, G., Baricsa, A., N, G., Orvos, H., Dubs, B. Early detection of developmental dysplasia of hip by ultrasound. *Hip Int* 2019; 0: 1120700019879687

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6. Kolb, A., Schweiger, N., Mailath-Pokorny, M., Kaider, A., Hobusch, G., Chiari, C., Windhager, R. Low incidence of early developmental dysplasia of the hip in universal ultrasonographic screening of newborns: analysis and evaluation of risk factors. *Int Orthop* 2016; 1: 123-7
7. Laborie, L. B., Engesaeter, IO, Lehmann, T. G., Eastwood, D. M., Engesaeter, L. B., Rosendahl, K. Screening strategies for hip dysplasia: long-term outcome of a randomized controlled trial. *Pediatrics* 2013; 3: 492-501
8. Laborie, L. B., Markestad, T. J., Davidsen, H., Bruras, K. R., Aukland, S. M., Bjorlykke, J. A., Reigstad, H., Indrekvam, K., Lehmann, T. G., Engesaeter, I. O., Engesaeter, L. B., Rosendahl, K. Selective ultrasound screening for developmental hip dysplasia: Effect on management and late detected cases. A prospective survey during 1991-2006. *Pediatr Radiol* 2014; 4: 410-424
9. Munkhuu, B., Essig, S., Renchinnyam, E., Schmid, R., Wilhelm, C., Bohlius, J., Chuluunbaatar, B., Shonkhuuz, E., Baumann, T. Incidence and treatment of developmental hip dysplasia in Mongolia: a prospective cohort study. *PLoS One* 2013; 10: e79427
10. Olsen, S. F., Blom, H. C., Rosendahl, K. Introducing universal ultrasound screening for developmental dysplasia of the hip doubled the treatment rate. *Acta Paediatr* 2018; 2: 255-261
11. Tan, S. H. S., Wong, K. L., Lim, A. K. S., Hui, J. H. The earliest timing of ultrasound in screening for developmental dysplasia of the hips. *Ultrasonography* 2019; 4: 321-326
12. Westacott, D. J., Butler, D., Shears, E., Cooke, S. J., Gaffey, A. Universal versus selective ultrasound screening for developmental dysplasia of the hip: a single-centre retrospective cohort study. *J Pediatr Orthop B* 2018; 5: 387-390

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EVALUATION OF INFANTS WITH RISK FACTORS FOR DDH

Strong evidence supports performing an imaging study before 6 months of age in infants with one or more of the following risk factors: breech presentation, family history, or history of clinical instability.

Strength of Recommendation: Strong ★★★★
Description: Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.

RATIONALE
If the risk factors of family and/or breech presentation are present, there is moderate evidence to support selective ultrasound screening between 2-6 weeks of age for infants who otherwise have a normal clinical hip examination or an AP radiograph at 4 months of age. There were two studies of moderate strength that confirm significance for selective prospective screening by ultrasound in infants with history of possible clinical instability and/or risk factors: breech and family history to prevent late dislocations and need for surgery (Paton 2005, Paton 1999).

Of the 10 studies of low strength, the various risk factors included were: breech, family history, sex, combination of sex and breech, combination of sex and family history, hip click, first born, swaddling, and talipes.

Breech literature included six studies all of low study strength. The results of these studies were meta-analyzed and the meta-analysis overwhelmingly supported breech presentation as a risk factor for neonatal instability. The literature terminology on breech is: breech at birth, breech delivery, and breech position at the third trimester; there is no literature to substantiate a particular duration of breech positioning as a risk factor.

Family history included four articles of low strength all showing statistical significance for family history as a risk factor for DDH (Bache 2002, Baronciani 1997, Jones 1989, Rosendahl 1996). There was one study which showed no statistical significance (Akman 2007).

One study compared treatment for dislocatable hips (at age less than one week) with no treatment for stable hips with positive family history (Burger 1990). The outcome was residual dysplasia at five months and was noted to be significant for the no treatment category. The authors further treated these patients from the no treatment category at age five months and compared them with the original cohort of Barlow positive patients treated at age less than one week. This time around, the outcome parameter was residual dysplasia at two years and was again noted to be significant. Other outcome measures included AVN at two years, which was not significant, and treatment failure, which was noted to be significant. This study did not have a true comparative group for analysis. There was a combination of dislocated and dislocatable hips in the Barlow positive category, which confounds the analysis.

The literature definitions of family history of DDH range from unspecified hip disorders to hip dislocation and from first degree relative (parents and siblings), to any relative (even if distant or vague) with hip problems or DDH (all other articles). Three articles listed family history but did not specify the relationships or specific hip problems (Akman 2007, Baronciani 1997, Boo 1989).

One study compared ultrasound screening in infants who had risk factors alone with those who had

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"doubtful" clinical instability (Paton 1999). Rate of detection of dislocation as confirmed by ultrasound was 13/1000 (7 to 24) vs 87/ 1000 (57 to 126/1000) respectively.

There is no substantiation in the literature of the optimal age for imaging studies in these infants with risk factors (Burger 1990). One study performed hip radiographs at 4 months of age. Two studies performed ultrasound between 2-6 weeks of age (Khan 1992, Kian 1996).

Examination of other quoted risk factors was done. Evidence was not found to include foot abnormalities, gender, oligohydramnios, and torticollis as risk factors for DDH.

RISKS AND HARMS

There is a potential risk of over diagnosis and treatment.

2022 UPDATE ADDITIONAL EVIDENCE

1. Arti, H., Mehdinasab, S. A., Arti, S. Comparing results of clinical versus ultrasonographic examination in developmental dysplasia of hip. J Res Med Sci 2013; 12: 1051-5
2. Custovic S., Custovic K. The predictive value of the clinical sign of excessive hip abduction for developmental dysplasia of the HIP (DDH). *Acta Medica Saliniana* 2018; 1: 32-35
3. Custovic, S., Sadic, S., Vujadinovic, A., Hrustic, A., Jasarevic, M., Custovic, A., Krupic, F. The predictive value of the clinical sign of limited hip abduction for developmental dysplasia of the hip (DDH). *Med Glas (Zenica)* 2018; 2: 174-178
4. D'Alessandro, M., Dow, K. Investigating the need for routine ultrasound screening to detect developmental dysplasia of the hip in infants born with breech presentation. *Paediatr Child Health* 2019; 2: e88-e93.
5. Gokharman, F. D., Aydin, S., Fatihoglu, E., Ergun, E., Kosar, P. N. Optimizing the Time for Developmental Dysplasia of the Hip Screening: Earlier or Later?. *Ultrasound Q* 2019; 2: 130-135
6. Schams, M., Labruyere, R., Zuse, A., Walensi, M. Diagnosing developmental dysplasia of the hip using the Graf ultrasound method: risk and protective factor analysis in 11,820 universally screened newborns. *Eur J Pediatr* 2017; 9: 1193-1200
7. Ayanoglu, T., Ataoglu, M. B., Tokgoz, N., Ersoz, E., Atalar, H., Turlani S. Assessing the risk of asymptomatic dysplasia in parents of children with developmental hip dysplasia. *Acta Orthop Traumatol Turc* 2019; 5: 346-350
8. Davies, R., Talbot, C., Paton, R. Evaluation of primary care 6- to 8-week hip check for diagnosis of developmental dysplasia of the hip: a 15-year observational cohort study. *Br J Gen Pract* 2020; 693: e230-e235
9. Guler, O., Seker, A., Mutlu, S., Cerci, M. H., Komur, B., Mahirogullari, M. Results of a universal ultrasonographic hip screening program at a single institution. *Acta Orthop Traumatol Turc* 2016; 1: 42-8
10. Gyurkovits, Z., Sohar, G., Baricsa, A., Nemeth, G., Orvos, H., Dubs, B. Early detection of developmental dysplasia of hip by ultrasound. *Hip Int* 2019; 0: 1120700019879687
11. Kolb, A., Schweiger, N., Mailath-Pokorny, M., Kaider, A., Hobusch, G., Chiari, C., Windhager, R. Low incidence of early developmental dysplasia of the hip in universal ultrasonographic screening of newborns: analysis and evaluation of risk factors. *Int Orthop* 2016; 1: 123-7
12. Kyung, B. S., Lee, S. H., Jeong, W. K., Park, S. Y. Disparity between Clinical and Ultrasound Examinations in Neonatal Hip Screening. *Clin Orthop Surg* 2016; 2: 203-9
13. Laborie, L. B., Markestad, T. J., Davidsen, H., BrurÃ¥s, K. R., Aukland, S. M., BjÃ¸rlykke, J. A., Reigstad, H., Indrekvam, K., Lehmann, T. G., EngesÃ¦ter, I. O., EngesÃ¦ter, L. B., Rosendahl, K.

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Selective ultrasound screening for developmental hip dysplasia: Effect on management and late detected cases. A prospective survey during 1991-2006. *Pediatr Radiol* 2014; 4: 410-424
14. Munkhuu, B., Essig, S., Renchinnyam, E., Schmid, R., Wilhelm, C., Bohlius, J., Chuluunbaatar, B., Shonkhuuz, E., Baumann, T. Incidence and treatment of developmental hip dysplasia in Mongolia: a prospective cohort study. *PLoS One* 2013; 10: e79427
15. Olsen, S. F., Blom, H. C., Rosendahl, K. Introducing universal ultrasound screening for developmental dysplasia of the hip doubled the treatment rate. *Acta Paediatr* 2018; 2: 255-261

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IMAGING OF THE UNSTABLE HIP

Limited evidence supports that the practitioner might obtain an ultrasound in infants less than 6 weeks of age with a positive instability examination to guide the decision to initiate brace treatment.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

RATIONALE

If faced with an unstable hip examination, there is limited evidence to support the use of sequential ultrasound to aid in determining when to initiate brace treatment for infants up to 8 weeks of age. Fewer children may undergo brace treatment with no difference in the occurrence of late dysplasia. One moderate quality study (Elbourne 2002) met the inclusion criteria and compared infants with clinical hip instability who were evaluated with ultrasoniographic hip examination or clinical assessment alone. This study evaluated outcomes in a total of 629 infants across 33 centers (total patients in both evaluation groups). There was no statistically significant difference in outcomes for the need for surgical treatment for developmental hip dysplasia, but fewer children in the group which was assessed using ultrasonography required abduction splinting in the first 2 years than those in the group which received a clinical assessment alone. Initially this study was graded as high strength but was downgraded to moderate strength because the rate of splint treatment was not the primary outcome. Additionally, it is unclear that all subjects were normal infants with DDH and no confounding diagnoses.

In this study, infants with hips that had minor instability were not immediately treated. Experienced doctors performed the clinical examinations. Even though there is even distribution between the groups in terms of number of history of instability, subgroup analysis of dislocated versus dysplastic hip results were not available.

RISKS AND HARMS

There is a potential delay of necessary treatment.

2022 UPDATE ADDITIONAL EVIDENCE

1. Burnett, M., Rawlings, E. L., Reddan, T. An audit of referral time frames for ultrasound screening of developmental hip dysplasia in neonates with a normal antenatal clinical examination. *Sonography* 2018; 2: 61-66.
2. Lussier, E. C., Sun, Y. T., Chen, H. W., Chang, T. Y., Chang, C. H. Ultrasound screening for developmental dysplasia of the hip after 4 weeks increases exam accuracy and decreases follow-up visits. *Pediatr Neonatol* 2019; 3: 270-277

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IMAGING OF THE INFANT HIP

Limited evidence supports the use of an AP pelvis radiograph instead of an ultrasound to assess DDH in infants beginning at 4 months of age.

Strength of Recommendation: Limited 

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

RATIONALE

There is limited evidence that an AP pelvis radiograph is preferred to the use of ultrasound to assess for DDH in infants from 4-6 months of age. This evidence does not distinguish between children with normal or abnormal physical examinations or between children with and without risk factors for DDH. One moderate-strength study (Tudor 2007) investigated the radiographic assessment of every ultrasound positive hip in children four to six months of age. Seventy-four infants with ultrasound positive hips for acetabular dysplasia who met criteria for treatment received an AP pelvis radiograph. Of these 74 infants, 30 were found to have satisfactory acetabular indices and did not receive treatment.

Limitations of this study include the lack of long-term follow-up of the infants to determine if the radiographic assessment altered outcome and failed to address the optimal time of conversion from ultrasound to radiographic assessment in infants with DDH.

RISKS AND HARMS

Radiographs involve exposure to ionizing radiation.

2022 UPDATE ADDITIONAL EVIDENCE

1. Geertsema, D., Meinardi, J. E., Kempink, D. R. J., Fiocco, M., van de Sande, M. A. J. Screening program for neonates at risk for developmental dysplasia of the hip: comparing first radiographic evaluation at five months with the standard twelve week ultrasound. A prospective cross-sectional cohort study. *Int Orthop* 2019; 8: 1933-1938

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SURVEILLANCE AFTER NORMAL INFANT HIP EXAM

Moderate evidence supports that a practitioner re-examine infants previously screened as having a normal hip examination on subsequent visits prior to 6 months of age.

Strength of Recommendation: Moderate 

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

RATIONALE

If faced with a child who has a normal physical examination, there is limited evidence that performing subsequent hip physical examination screening of children up to 6 months of age will detect additional children with DDH. The reviewed literature does not include the screening of children up to walking age when other examination findings such as gait abnormalities may allow for detection of additional children with DDH. One low strength study (Myles 1990) presented evidence that repeated studies at three months were productive in identifying late diagnosed DDH. Another low strength study (Cooke 2011) noted that exams at eight months of age had a high rate of false positives, but no yield of true positives.

There is no literature to define the optimal frequency or duration of follow-up surveillance.

RISKS AND HARMS

There is a potential risk of over diagnosis and treatment.

2022 UPDATE ADDITIONAL EVIDENCE

1. Gokharman, F. D., Aydin, S., Fatihoglu, E., Ergun, E., Kosar, P. N. Optimizing the Time for Developmental Dysplasia of the Hip Screening: Earlier or Later? *Ultrasound Q* 2019; 2: 130-135
2. Davies, R., Talbot, C., Paton, R. Evaluation of primary care 6- to 8-week hip check for diagnosis of developmental dysplasia of the hip: a 15-year observational cohort study. *Br J Gen Pract* 2020; 693: e230-e235.

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STABLE HIP WITH ULTRASOUND IMAGING ABNORMALITIES

Limited evidence supports observation without a brace for infants with a clinically stable hip with morphologic ultrasound imaging abnormalities.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

RATIONALE

For an infant with a normal physical examination and ultrasound abnormalities, there is limited evidence to support observation without treatment of that infant with serial ultrasound evaluation up to 6 weeks of age. One low-strength study (Wood 2000) evaluated a group of at-risk patients who were evaluated by ultrasound between two and six weeks of age with clinically stable hips showing ultrasonographic abnormalities that were randomized to treatment with Pavlik harness or observation. The two primary outcome measures were the acetabular coverage on ultrasound and acetabular index on radiograph. While acetabular coverage, measured ultrasonographically, improved in both groups, and was statistically better in the splinted group at the final three-month follow-up, there was no difference in acetabular index.

RISKS AND HARMS

The risk of implementing this recommendation is that necessary treatment could be delayed.

2022 UPDATE ADDITIONAL EVIDENCE

1. Burnett, M., Rawlings, E. L., Reddan, T. An audit of referral time frames for ultrasound screening of developmental hip dysplasia in neonates with a normal antenatal clinical examination. *Sonography* 2018; 2: 61-66
2. Donma, M. M., Dogru, M., Demirkol, M., Ozcaglayan, O., Topcu, B., Ozcaglayan, T. I. K., Gonen, K. A., Nalbantoglu, B., Nalbantoglu, A., Dogru, R., Ulucan, H., Karakoyun, O., Erol, M. F., Guzelant, A. Y., Donma, O. What Is the Important Point Related to Follow-Up Sonographic Evaluation for the Developmental Dysplasia of the Hip?. *Journal of Child Science* 2017; 1: e123-e126
3. Kim, H. K. W., Beckwith, T., De La Rocha, A., Zepeda, E., Jo, C. H., Sucato, D. Treatment Patterns and Outcomes of Stable Hips in Infants With Ultrasonic Dysplasia. *J Am Acad Orthop Surg* 2019; 2: 68-74
4. Laborie, L. B., Markestad, T. J., Davidsen, H., BrurÃ¥s, K. R., Aukland, S. M., BjÃ¸rlykke, J. A., Reigstad, H., Indrekvam, K., Lehmann, T. G., EngesÃ¦ter, I. O., EngesÃ¦ter, L. B., Rosendahl, K. Selective ultrasound screening for developmental hip dysplasia: Effect on management and late detected cases. A prospective survey during 1991-2006. *Pediatr Radiol* 2014; 4: 410-424
5. Larson, J. E., Patel, A. R., Weatherford, B., Janicki, J. A. Timing of Pavlik Harness Initiation: Can We Wait?. *J Pediatr Orthop* 2019; 7: 335-338
6. Tan, S. H. S., Wong, K. L., Lim, A. K. S., Hui, J. H. The earliest timing of ultrasound in screening for developmental dysplasia of the hips. *Ultrasonography* 2019; 4: 321-326

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TREATMENT OF CLINICAL INSTABILITY

Limited evidence supports either immediate or delayed (2-9 weeks) brace treatment for hips with a positive instability exam.

Strength of Recommendation: Limited 

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

RATIONALE

For infants with a positive hip instability exam, there is conflicting evidence about whether a period of observation or immediate brace treatment leads to a difference in later dysplasia or persistent hip instability leading to later brace treatment. One moderate strength and three low strength studies looked at radiographic differences between an early versus late brace treatment group (Gardiner, 1990, Gardiner, 1992, Molto, 2002, Paton, 2004, Wilkinson, 2002). None of these studies differentiate dislocated from dislocatable hips.

Gardiner (1992) found a significant difference in the radiographic appearance of the femoral capital epiphysis and delayed iliac indentation at 6 months for a no treatment group compared to a brace group. Twenty-nine percent of the non-treatment group had cross-over and were treated at two weeks. Limitations were not defining the femoral capital epiphyseal ossification subcategories and iliac indentation and not explaining the relevance of either.

Molto (2002) compared von Rosen splinting immediately after birth to splinting after two weeks. The outcome criterion was acetabular index. They noted a significant improvement in the acetabular index at 15 months in the immediate treatment group (76 patients) as compared to the 27 patients in the second group treated after two weeks.

Paton (2004) reported on 75 hips in 2 groups, including 37 patients (59 hips) in the early splint treatment group versus 11 patients (16 hips) in the late splint treatment group. Outcome measures included continued instability that required late splint treatment after six weeks, radiographic abnormality, AVN, or surgical intervention at walking age. Authors noted no significant differences when treatment started at less than one week in the early treatment group versus nine weeks on average in the delayed treatment group. This study included both dislocatable and dislocated hips with outcome measures not specifically correlated to the nature of the instability.

RISKS AND HARMS

The risks/harms of this recommendation are overtreatment and the potential complications and burden of care.

2022 UPDATE ADDITIONAL EVIDENCE

1. Bruras, K. R., Aukland, S. M., Markestad, T., Sera, F., Dezateux, C., Rosendahl, K. Newborns with sonographically dysplastic and potentially unstable hips: 6-Year follow-up of an RCT. *Pediatrics* 2011; 3: e661-e666.
2. Cook, K. A., Schmitt, M., Ingram, M., Larson, J. E., Burgess, J., Janicki, J. A. Pavlik Harness initiation on Barlow positive hips: Can we wait? *J Orthop* 2019; 5: 378-381.

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3. Larson, J. E., Patel, A. R., Weatherford, B., Janicki, J. A. Timing of Pavlik Harness Initiation: Can We Wait?. *J Pediatr Orthop* 2019; 7: 335-338.

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TYPE OF BRACE FOR THE UNSTABLE HIP

Moderate evidence supports use of the von Rosen splint over Pavlik, Craig, or Frejka splints for initial treatment of an unstable hip.

Strength of Recommendation: Moderate 

Description: Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study for recommending for or against an intervention.

RATIONALE

There are no high-quality comparative effectiveness studies between different types of braces for the treatment of DDH. Limited evidence suggests that rigid braces may have higher rates of resolution of hip dysplasia than non-rigid braces. Two low strength studies (Heikkila 1988, Wilkinson 2002) compared rigid bracing to soft bracing for initial treatment of unstable hips in infants. Heikkila (1988) compared the Frejka pillow with the von Rosen splint. There were 920 patients treated with Frejka pillow and 180 patients treated with von Rosen splint. Fifty-five of 920 from the Frejka pillow group had treatment failure, while 1 out of 180 from the von Rosen splint group failed treatment. These differences were significant. A limitation of this study is that it was a historical comparative study of two cohorts over two time periods. AVN rates were inadequately reported. The authors did not differentiate between dislocated and dislocatable hips.

Three splints were compared in the Wilkinson (2002) study: Craig, Pavlik, and von Rosen. Four of 28 in the Craig splint group, 13 of 43 in the Pavlik group, and 0 of 26 in the von Rosen group required further treatment in the form of plaster or operation.

This recommendation is based on the braces that were studied, but other similar fixed-position braces may or may not work as well as the braces mentioned in the evidence.

RISKS AND HARMS

Nineteen percent of the patients in the rigid brace group experienced skin irritation(Heikkila 1988). There is a potential risk of AVN with all bracing; the relative risk is unknown between rigid and soft bracing.

2022 UPDATE ADDITIONAL EVIDENCE

1. Azzoni, R., Cabitza, P. A comparative study on the effectiveness of two different devices in the management of developmental dysplasia of the hip in infants. *Minerva pediatrica* 2011; 5: 355-361
2. Ran, L., Chen, H., Pan, Y., Lin, Q., Canavese, F., Chen, S. Comparison between the Pavlik harness and the Tubingen hip flexion splint for the early treatment of developmental dysplasia of the hip. *J Pediatr Orthop B* 2019; 0:
3. Zidka, M., Dzupa, V. Pavlik harness and Frejka pillow: compliance affects results of outpatient treatment. *Arch Orthop Trauma Surg* 2019; 11: 1519-1524

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MONITORING OF PATIENTS DURING BRACE TREATMENT

Limited evidence supports that the practitioner perform serial physical examinations and periodic imaging assessments (ultrasound or radiograph based on age) during management for unstable infant hips.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

RATIONALE

If brace treatment is initiated, there is limited evidence that episodic serial physical and imaging reassessments during the treatment cycle can lead to changes or duration of the treatment plan. Two low strength studies (Cashman 2002, Swaroop 2009) report monitoring of brace treatment using physical exam, ultrasound, and radiography following the appearance of the ossific nucleus. Both studies identified failure of reduction or persistent dysplasia in patients undergoing brace treatment. These findings necessitated a change in treatment plan or duration. No parameters for optimal timing or frequency of imaging were established by research protocol.

RISKS AND HARMS

Radiographs involve exposure to ionizing radiation.

FUTURE RESEARCH

This clinical practice guideline is focused on early detection by the clinical and imaging screening of populations of infants and on the early management of DDH. The grades of recommendations for this clinical practice guideline range from limited to moderate strength. Of 3990 citations on the topic of DDH, 42 articles were ultimately included as evidence related to the recommendations in this guideline and 18 articles met our inclusion criteria for an assessment of the natural history for DDH in infancy. It has a large potential impact due to the size of populations to be screened and the functional limitations that can be created by late diagnosis and management of individuals with this condition.

We found significant gaps in the evidence that can be used to derive practice guidelines for the early diagnosis and management of DDH. There is considerable confusion related to the terminology and definitions that have been used in research related to DDH and about what defines a pathologic condition versus an expected developmental variation based upon the age and status of a child is needed. There are additional gaps in knowledge of the basic pathophysiology of DDH, understanding of the long-term impact of DDH upon the health status and well-being of affected individuals, the appropriateness of DDH for public health screening programs as they are practiced today, the optimal diagnostic tools to be used to detect the condition, and the relative efficacy and value of recommended interventions. Additional research is needed to create clarity in these areas. The large numbers of patients who need to be assessed and the severity of functional limitations that can be created by late diagnosis and management of individuals with this condition suggests that research inclusive of comparative effectiveness research design would be of great advantage.

Specifically, future research areas should attempt to:

- Establish clear, widely accepted, reproducible criteria and definitions for:

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    - Clinical terms that describe hip stability
    - Radiographic and ultrasound criteria for dysplasia and dislocation based upon age.
    - Historical and clinical risk factors to be assessed for all children that are related to DDH.
    - What constitutes "standard" brace treatment of DDH
    - What are outcomes criteria that define successful or failed treatment for DDH
- Establish universally accepted and reproducible ranges of normal values across ages for sonographic and/or radiographic hip measures or any future surrogates for normal hip development.
- Establish clear relationships between these surrogates for hip development and demonstrate long-term functional limitations that are correlated to surrogate values that fall outside of the normal ranges.
- Define the benefits and harms of late diagnosis of DDH
- Define the harms of early diagnosis and treatment of DDH
- Standardize follow-up times after bracing to improve objective testing of outcomes

Provide research design that is applicable to routine practice situations and allows for comparison of alternative methods of diagnosis and treatment.

2022 UPDATE ADDITIONAL EVIDENCE

1. Donma, M. M., Dogru, M., Demirkol, M., Ozcaglayan, O., Topcu, B., Ozcaglayan, T. I. K., Gonen, K. A., Nalbantoglu, B., Nalbantoglu, A., Dogru, R., Ulucan, H., Karakoyun, O., Erol, M. F., Guzelant, A. Y., Donma, O. What Is the Important Point Related to Follow-Up Sonographic Evaluation for the Developmental Dysplasia of the Hip? *Journal of Child Science* 2017; 1: e123-e126

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Included Studies

Universal Ultrasound Screening

1. Burnett, M., Rawlings, E. L., Reddan, T. An audit of referral time frames for ultrasound screening of developmental hip dysplasia in neonates with a normal antenatal clinical examination. Sonography 2018; 2: 61-66
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Evaluation of Infants with Risk Factors for DDH

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