Preventive health care, 2001 update: screening and management of developmental dysplasia of the hip in newborns

Research

Recherche

Hema Patel, with the Canadian Task Force on Preventive Health Care

Abstract

Objective: To review the effectiveness of, and make practice recommendations for, serial clinical examination and ultrasound screening for developmental dysplasia of the hip (DDH) in newborns. The effectiveness of selective screening of high-risk infants with hip and pelvic radiographs and treatment with abduction therapy are also examined.

Options: Screening: serial clinical examination, ultrasound screening, radiographic evaluation. Treatment: abduction therapy.

Outcomes: Rates of operative intervention, abduction splinting, delayed diagnosis of DDH (beyond 3–6 months), treatment complications and false diagnostic labelling. Long-term functional outcomes were considered important.

Evidence: MEDLINE was searched for relevant English-language articles published from 1966 to November 2000 using the key words "screening," "hip," "dislocation," "dysplasia," "congenital" and "ultrasound." Comparative and descriptive studies and key reviews were retrieved, and their bibliographies were manually searched for further studies.

Benefits, harms and costs: Because most infants will have spontaneous resolution of nonteratologic DDH, early identification and intervention results in unnecessary labelling of newborns as having the problem and unnecessary treatment. Ultrasound screening is a highly sensitive but poorly specific measure of clinically relevant DDH. Abduction splinting is associated with a variety of problems, and its effectiveness in treating DDH is not clearly known. At least 20% of infants requiring operative intervention have had splint therapy. The harms of labelling, repetitive investigations, unnecessary splinting and resource consumption associated with screening are substantial.

Values: The strength of evidence was evaluated using the evidence-based methods of the Canadian Task Force on Preventive Health Care.

Recommendations:

- There is fair evidence to include serial clinical examination of the hips by a trained clinician in the periodic health examination of all infants until they are walking independently (level II-1 and III evidence; grade B recommendation).
- There is fair evidence to exclude general ultrasound screening for DDH from the periodic health examination of infants (level II-1 and III evidence; grade D recommendation).
- There is fair evidence to exclude selective screening for DDH from the periodic health examination of high-risk infants (level II-1 and III evidence; grade D recommendation).
- There is fair evidence to exclude routine radiographic screening for DDH from the periodic health examination of high-risk infants (level III evidence; grade D recommendation).
- There is insufficient evidence to evaluate the effectiveness of abduction therapy (level III evidence; grade C recommendation), but good evidence to support a period of close observation for newborns with clinically detected DDH (level I evi-

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A list of the members of the task force appears at the end of the article.

This article has been peer reviewed.

CMAJ 2001;164(12):1669-77

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dence; grade A recommendation). However, there is insufficient evidence to determine the optimal duration of observation (level III evidence; grade C recommendation).

Validation: The members of the Canadian Task Force on Preventive Health Care reviewed the findings of this analysis through an iterative process. The task force sent the final review and recommendations to selected external expert reviewers, and their feedback was incorporated in the final draft of the manuscript.

Sponsors: The Canadian Task Force on Preventive Health Care is funded through a partnership between the Provincial and Territorial Ministries of Health and Health Canada.

Developmental dysplasia of the hip (DDH) refers to a spectrum of anatomical abnormalities of the hip joint arising from a deviation in normal hip development during embryonic, fetal and infantile growth periods (Table 1).[1–5] Although in most affected infants the problem resolves spontaneously in the first several months of life, persistent DDH may result in chronic pain, gait abnormalities and degenerative arthritis.[5–16]

In 1994 the Canadian Task Force on the Periodic Health Examination (now the Canadian Task Force on Preventive Health Care) recommended serial clinical examination as part of well baby care, but it made no recommendation regarding ultrasound screening or screening of high-risk infants.[17] Since that review, one large controlled trial on the effectiveness of ultrasound screening for DDH has been published,[6] and 27 descriptive reports and 9 expert opinion papers have helped to clarify some of the related issues. This article evaluates the effectiveness of screening and therapy for DDH in newborns at normal and high risk. Outcomes of interest are the rates of functional disability and operative intervention, false-negative and false-positive diagnoses, and the benefits and harms of abduction therapy.

Table 1: Definitions of conditions associated with developmental dysplasia of the hip (DDH)[2]

Term	Definition
Dislocated hip	A hip in which the articulating bones (i.e., the femoral head in the acetabulum) are displaced, which leads to separation of the joint surfaces.[4] There are 2 types of dislocation: typical and teratologic.[3,4] Typical dislocation occurs in neurologically normal infants; teratologic dislocation is less common and is associated with neuromuscular abnormalities such as arthrogryposis and myelomeningocele.[4] Dislocated hips due to developmental dysplasia are reducible in infants up until about 3 months of age
Dislocatable hip	A hip that can be reduced into the normal position with external flexion and abduction or, conversely, that can be provoked out of the normal position with adduction
Subluxed hip	A dislocatable hip that has partial contact between the femoral head and the acetabulum[4]
Subluxable hip	A hip that is usually located correctly at rest but that can be provoked into the position of partial articulation with external manoeuvres
Dysplasia alone	The anatomy or growth, or both, of the developing articulating surfaces is abnormal; this may present radiographically as a shallow or irregularly shaped acetabulum or as an abnormality of the proximal femur[2–5]

Burden of suffering

Most developed countries report an incidence of 1.5 to 20 cases of DDH per 1000 births, the variation due in part to differences in diagnostic method and timing of evaluation.[18] The long-term morbidity of DDH is unclear, but complications observed in case series include leg length discrepancy, gait abnormalities, chronic pain and osteoarthritis.[2,4] Some adults may have little or no functional disability; those with bilateral dislocations or a well-developed "false acetabulum" may have good clinical function.[2,19]

Prolonged hip subluxation may predispose adults to degenerative joint disease, but there is no clear association between acetabular dysplasia (without clinical instability) and degenerative osteoarthritis.[2] Measurement of true long-term morbidity is complicated by variation in the severity of DDH, long lag time between birth and symptom development in late adulthood, and the relatively recent use of ultrasound screening. Except for rates of operative intervention and abduction splinting, information is lacking for all other morbidity measures, and functional outcomes are rarely reported. There are no standardized criteria for operative intervention, and the definition of "operative intervention" differs between centres. Prospective studies of the long-term morbidity of DDH are long overdue.[1,20]

Risk factors

More than 60% of infants with DDH have no identifiable risk factors.[16] Infants with the following features have been considered to be at high risk for DDH, although these risk factors have not been validated: first-degree relative with DDH, breech delivery or clinical evidence of joint instability.[1,6,16,21–23] Also, females are more predisposed than males to DDH.[6,15,24–27] Less widely accepted risk factors include persistent "click" on clinical examination, congenital postural or foot deformities, and fetal growth retardation.[16,21,23] Certain ethnic and geographic populations have also been identified as being at high risk for DDH (e.g., Aboriginal Canadians[19]).

Methods

A MEDLINE search for articles published from 1966 to November 2000 was conducted using the following key words: "screening," "hip," "dislocation," "dysplasia," "congenital" and "ultrasound." Articles were limited to English-language ones concerning infants or children. All comparative and descriptive studies of screening manoeuvres were selected. Reference lists of retrieved articles were manually searched for further studies. Pediatric orthopedic textbooks and their reference lists were examined. Editorials indicating expert opinion were reviewed; abstracts and letters to the editor were not.

Outcome measures related to screening included rates of operative intervention, abduction splinting, delayed diagnosis of DDH (beyond 3–6 months), complications of splinting (e.g., avascular necrosis of the femoral head) and false diagnostic labelling. Long-term functional outcomes were considered important. It was noted a priori that the diagnostic (incident) and splinting rates were codependent; that is, they were strongly influenced by the age of the infant at the time of evaluation. The operative rate was also subject to variability, because there is no clear standardization of reporting guidelines.

The evidence was reviewed systematically using the methodology of the Canadian Task Force on Preventive Health Care.[28] In brief, the principal author rated the quality of the evidence using the methodological hierarchy (Appendix 1) and circulated a preliminary draft of the manuscript to the task force members. The task force met in October 1998 and January 1999, at which time the final recommendations were arrived at unanimously by an expert panel and the principal author. Feedback from 2 independent experts was incorporated into a final draft of the manuscript before submission for publication. Procedures to achieve adequate documentation, consistency, comprehensiveness, objectivity and adherence to the task force's methodology were maintained at all stages during review development, the consensus process and production of the final manuscript.

Results

Most of the evidence for the effectiveness of specific screening manoeuvres was in the form of expert opinion and survey results of screening programs (Table 2).

Screening

Serial clinical examination

Serial clinical examination includes the Ortolani and Barlow tests during the first several months of life and testing for limited hip abduction or leg length discrepancy in older infants and children. The Ortolani test involves flexion and abduction of the hips. This movement relocates the dislocated hip into the normal acetabular position and is accompanied with a palpable "clunk."[2–4] The Barlow test is a provocative test of dislocation of the hip joint. The hips are tested individually, both in the flexed position. The tested hip is adducted, with gentle pressure exerted on the upper femur in a posteriolateral direction. Key components of the serial clinical examination include leg length discrepancy (Galeazzi sign), limitation of normal abduction of the hip and asymmetry of posterior thigh or gluteal folds.[2–4]

For the diagnosis of hip dislocation, the Barlow test has been associated with a high negative predictive value (0.99) but a low positive predictive value (0.22).[39] When the Ortolani and Barlow tests are combined, they show high specificity (0.98–0.99) in the diagnosis of hip dislocation or subluxation.[25,29,39,40] Sensitivity varies by the skill of the examiner and by the number of examinations performed.[30–32] With experienced examiners, sensitivity is between 0.87 and 0.99.[25,29,39] The Ortolani and Barlow tests become less sensitive in older infants, in part because of the larger size and muscle bulk and the development of hip contractures.[1,3,63,64]

Serial clinical examination by a trained examiner appears to be an effective screening strategy. In the preclinical screening era, the incidence of dislocation or subluxation ranged from 1 to 2 cases per 1000 infants;[7,23,26,29,31] the operative rate was also 1 to 2 per 1000 infants,[8,29,65] which suggests that most infants with DDH were probably identified too late for nonsurgical therapy to be effective. In clinically screened populations, the detection rate of hip joint instability at birth has ranged from 5 to 20 cases per 1000 infants, depending mainly on age at testing and examiner experience.[16,21,23,25–27,33,34,39] In parallel, the rate of abduction splinting has increased.[16,21,23,25–27,29,31,39] Several researchers have suggested that this post-screening increase in the splinting rate reflects false overdiagnosis, because DDH rates have markedly exceeded the rates in the preclinical screening era.[5,10]

With serial clinical examination, the operative rate for DDH has decreased by more than 50%, to 0.2–0.7 per 1000.[8,26,30,33,34,39] This favourable decline needs to be balanced with the increase in false-positive results (infants unnecessarily treated, usually with abduction splinting) and false-negative results (infants with normal findings on clinical examination who present later with other clinical signs).

Table 2: Studies included in the systematic review of the effectiveness of screening and therapy for DDH in newborns, by manoeuvre

Manoeuvre	Design (and no. of studies)
Clinical examination	Descriptive study (12)[19,23,25–27,29–35] Editorial (1)[14]
Radiographic evaluation	Descriptive study (1)[21] Reliability study (1)[36]
Ultrasound screening	Controlled trial (1)[6] Before–after study (1)[37] Decision analysis (1)[38] Descriptive study (13)[8,9,13,15,22,24,39–45] Other* (17)[5,10,12,46–59]
Abduction splinting	Randomized controlled trial (1)[11] Descriptive study (6)[27,33,42,60–62]
Other	General review (6)[1–4,16,20]

*Includes editorials and reports of ultrasound performance characteristics and of cost-effectiveness.

Ultrasound screening

Ultrasonography is a noninvasive method of visualization of the cartilaginous hip joint. Diagnosis has been defined by (static) morphologic testing and by dynamic assessment of stability of the femoral head in the acetabulum. Graf's standardized morphology criteria are widely used.[46] No standard criteria for the dynamic assessment of joint stability exist, but the infant is usually examined in the lateral position with a Barlow manoeuvre.[6,36] Hips are classified as sonographically stable (little or no separation) or unstable (varying degrees of separation).[6,36] The dynamic assessment has been criticized as being excessively operator-dependent.[2] Evaluation of the measurement properties of both methods shows moderate to good intrarater reliability (kappa coefficient = 0.46–0.83) and poor interrater reliability (kappa = 0.09–0.30).[47,48]

The best evidence for evaluating ultrasound screening is the large controlled trial by Rosendahl and colleagues.[6] Newborns (n = 11 925) were assigned to 1 of 3 groups: general ultrasound screening (n = 3613), selective ultrasound screening of newborns found to be at high risk (n = 4388) and no ultrasound screening (n = 3924). Patients were assigned to groups by convenience. All infants were allocated to the no-screening group when the ultrasonographer was absent. Infants were assigned to the other 2 screening groups by the location of their mother's postpartum room. The high-risk group included infants with hip dislocation, dislocatable hip, breech position or a family history (1 first-degree or 2 second-degree relatives with DDH). All infants were screened during the first 2 years of life with serial clinical examinations (Ortolani and Barlow tests). Infants in the no-screening group had clinical examinations at "frequent intervals," as compared with those in the other 2 groups, in which the clinical examinations were supplemented with ultrasound assessments. In accordance with the practice standard at the research centre, all high-risk infants were referred for radiographs of the hips at 4 to 5 months of age.

Infants who underwent ultrasound screening had both morphologic and dynamic hip testing (24–48 hours after birth). One ultrasonographer completed all studies (intrarater reliability on 211 scans, kappa = 0.832). Modified Graf criteria were used to classify hips.[5] Infants were treated with abduction splints if the hips were persistently dislocated or dislocatable. Hips with "major dysplastic morphology" were also treated, whether or not there were clinical findings of instability. "Mildly dysplastic" hips were treated only if they were found to be unstable clinically or ultrasonographically. Hips with only ultrasound evidence of instability were not treated. "Immature or slightly dysplastic" hips were followed by ultrasonography and clinical examinations every 4 weeks.

A 6-fold reduction (relative risk 6) in the prevalence of late DDH between the clinical screening and general ultrasound screening groups was considered clinically relevant. There was 52% power (α = 0.05) to show such a difference. Because operative intervention for DDH is rare, regardless of screening strategy, any screening program would require extremely large numbers of infants in order to detect statistically significant differences with adequate power. For example, to show a relative risk of 4, with an α value of 0.05 and a β value of 0.20, each group would require 12 533 infants.

Table 3 shows the intervention and DDH rates per 1000 infants. There was an obvious increase in the intervention rate in the general ultrasound screening group compared with both the selective ultrasound screening

Table 3: Results of a controlled trial[6] of the effect of ultrasound screening for DDH on treatment rates and prevalence of late cases of DDH

	Study group; rate per 1000 infants		
Variable	General ultrasound screening *n = 3613*	Selective ultrasound screening (high-risk infants only) *n = 4388*	No ultrasound screening *n = 3924*
Abnormal finding on clinical examination*	24	18	18
Abnormal finding on ultrasound only	9	3	–
Abduction therapy†	34¶	20	18
No therapy but case followed up‡	130	18	–
Late§ subluxation or dislocation	0.3	0.7	1.3
Late§ DDH not requiring operative intervention	1.4	1.9	2.1
Late§ DDH requiring operative intervention	0.0	0.2	0.5
All late§ DDH	1.4	2.1	2.6

*Abnormal Barlow test result at birth, with or without abnormalities (morphologic or dynamic) on ultrasound.
†Complication rates not reported.
‡Follow-up involved serial ultrasound examination every 4 weeks. In 97% of the cases the problem resolved spontaneously by 3 months of age; the remaining 3% of cases were clinically normal but abduction splinting was used at 3 months of age. At least 97% of the infants were falsely or unnecessarily labelled as having a clinically relevant abnormality when in fact no intervention was required.
§All "late" diagnoses were made after 1 mo of age (range 2.5–18 mo).
¶The higher rate of splinting therapy in this group reflects the high proportion of infants unnecessarily labelled as having a clinically relevant problem and unnecessarily treated.

and the no-screening groups. Of significance, general ultrasound screening identified 130 cases per 1000 clinically normal infants as having abnormalities requiring further follow-up but no abduction splinting. Of these, 97% showed spontaneous resolution by 3 months of age. Each infant had 3 to 5 ultrasounds before being declared to have normal hips. The harms of labelling, repetitive investigations, unnecessary splinting and resource consumption associated with screening are substantial. The results of this study are supported by those of cohort and case studies, as shown in Table 4, which compares results of ultrasound screening with those of clinical screening programs. There was no clinically or statistically significant difference in operative rates between the 2 groups. Neither was there a significant difference in the rates of late DDH.

The study by Rosendahl and colleagues[6] failed to show a benefit of selective ultrasound screening of high-risk infants. This may have been due to an actual lack of benefit or to the fact that most infants with DDH have no risk factors.[12,16,49] In their study, 4388 infants were in the selective screening group; of these, 518 were considered to be at high risk and underwent ultrasound screening. No cases of subluxation or dislocation were found. Selective ultrasound screening did not decrease the rate of late DDH or the rate of operative interventions compared with clinical screening alone. These results are similar to those previously reported in cross-sectional surveys.[32,41,49,67]

Radiographic screening

For radiographic screening, anteroposterior films of both hips are taken between 3 and 5 months of age in otherwise asymptomatic high-risk infants.[6,21] This screening strategy is problematic because of the lack of consensus on the definition of clinically relevant DDH on radiographs,[2] although the following features are used: increased acetabular index, disruption of Shenton's line, widened pelvic floor, delayed appearance of femoral ossific nucleus and decreased femoral head coverage.[1,2,20,36] Inter- and intraobserver reliability are low,[36] and sensitivity and specificity have not been adequately reported. Although radiography is a noninvasive technique, the radiation exposure (estimated at 22 μGy) to young infants requires consideration, particularly when repeated radiographs are performed.

Table 4: Comparison of results of clinical examination and ultrasound screening for DDH

	Screening method; rate per 1000 infants	
Comparison	Clinical examination	Ultrasound screening
DDH at birth	5–20[6,16,21,23,26,29,31,39]	Morphology: 17–159[6,9,15,41,66] Dynamic stability: 24–60[15,66]
DDH at 1 mo	0.3–5.0[6,16,29,31]	Selective screening: 2.1[6,8,41] General screening: 1.4[6,37]
DDH at 3 mo	–	9[9]
Abduction splinting	5–20[6,21,26,27,30,32,33,37]	Selective screening: 4–18[6,8,41] General screening: 34–44[6,37]
Late DDH (various definitions used)	0.2–1.1[2,25,26,30–32,39,67]	0.2–1.3[6,8,37,41]
DDH requiring operative intervention	0.2–0.7[6,8,26,30,33,39]	0.0–0.4[6,8,15]

Treatment

Spontaneous resolution

The natural history of DDH indicates that abnormalities present at birth are actively modulated by ongoing growth of the femur and the acetabular cartilage.[2,3,12] High rates of resolution without intervention (90%–97%) have been reported in multiple observational studies.[6,9,15,18]

Abduction therapy

Abduction positioning, using double or triple diapering, a variety of pillows or splints for several weeks to months, has been routinely recommended "as soon as possible" in newborns with DDH,[2] commonly with the Pavlik harness.[4] In the absence of adequate data, the true effectiveness of abduction therapy may be overestimated. Observational studies have reported that 20%–100% of infants (n = 20–468) who did have early abduction therapy eventually required operative intervention.[26,27,33,34,42]

Abduction splinting is associated with a variety of problems. Avascular necrosis of the femoral head has been observed in 1%–4% of all treated infants[27,39,42] (up to 73% in one centre[60]), and the risk of this outcome is higher among younger infants, when the growth plates may be more vulnerable to vascular damage.[25,39,42] Pressure sores, epiphysitis, femoral nerve palsy, inferior dislocation of the hip and medial instability of the knee joint have also been reported.[2,3,12,14,39,42,61] The morbidity of false diagnostic labelling is real but has not been quantified.

The timing of diagnosis requires careful consideration so that the majority of infants with DDH, whose condition will spontaneously resolve in the first weeks of life, are not harmed by unnecessary intervention. One randomized controlled trial involving infants with dislocatable hips showed no differences detected clinically or ultrasonographically at 6 and 12 months between the 41 infants who had immediate splinting and the 38 who were observed for 2 weeks and then, if necessary, underwent splinting.[11] In one cohort study, the rates of operative intervention did not differ between infants treated at 5 months of age (diagnosed "late") and those who underwent splinting since birth.[39]

Summary

Table 5 shows the number of infants needed to be screened by ultrasonography to prevent 1 case of DDH.[6,68] For each infant found to have subluxation or dislocation requiring intervention, 1003 infants would require ultrasound screening. Of these, at least 126 would be unnecessarily labelled as having DDH and followed up. The upper limit of the 95% confidence interval (–4105) indicates that 1 true case of subluxation or dislocation requiring intervention would be missed for every 4105 infants screened.

It is interesting to compare the rates of persistent hip instability in 3 eras: in the preclinical screening era, 1–2 infants per 1000 were found to have late DDH, usually at 6–18 months of age, and almost all of these infants required operative intervention.[7,8,24,26,29,31] The advent of clinical screening reduced the operative rate to 0.2–0.7 per 1000, but in so doing it increased the splinting rate to 5–20 per 1000. That is, in order to reduce the operative rate by 0.3–1.8 per 1000, probably 3–19 infants per 1000 were unnecessarily labelled as having the problem and unnecessarily treated. The reduction in the operative rate in the general ultrasound screening era compared with the preclinical screening era is 0.6–1.8 per 1000. Again, in making this reduction, 32–43 infants per 1000 are treated unnecessarily, with far more infants being falsely labelled but not treated.

It is apparent that ultrasound screening, whether based on morphologic or dynamic criteria, whether conducted in general populations or high-risk ones, falsely identifies many more infants as having DDH than does serial clinical examination. The minimal decreases in the rates of late DDH or of operative intervention do not justify either the increased burden of treatment or of labelling. At the centre of this screening issue is the fact that clinically relevant hip dysplasia has not been defined, either morphologically or by functional impact. Clear distinction is lacking between infants' hips that are normal, developmentally immature and dysplastic.[5,50]

Ultrasound screening appears to be a highly sensitive, but poorly specific, measure of clinically relevant DDH. Because of the low population prevalence of DDH, the positive predictive value of ultrasound screening is low and the negative predictive value high. Until clinically relevant hip dysplasia can be explicitly defined, the specificity of ultrasound screening will remain low.

Finally, the timing of any screening manoeuvre for DDH requires careful consideration of the natural history of the condition. Ideally, the screening should occur at an age when further spontaneous resolution of DDH is unlikely but before abduction therapy becomes ineffective.

Recommendations

By the Canadian Task Force on Preventive Health Care

The recommendations for screening newborns for DDH are summarized in Table 6.

General screening

- There is fair evidence to include serial clinical examination of the hips to detect DDH in the periodic health examination of all infants (grade B recommendation). This manoeuvre should be performed by a trained clinician during the first week of life, in the first month and then at 2, 4, 6, 9 and 12 months of age. If an abnormality is detected, consultation with a pediatric orthopedist is indicated, as are focused hip imaging studies (ultrasound in infants younger than 5 months and radiography in older infants).
- There is fair evidence to exclude ultrasound screening for DDH from the periodic health examination of infants (grade D recommendation).

Important note: The effectiveness of screening is highly dependent on the skill of the evaluator. Clinicians should be adequately trained, with opportunities for reassessment of skills. The limited availability of appropriate ultrasound equipment and adequately trained ultrasonographers further limits the use of ultrasound screening for DDH in many areas of Canada.

Screening of high-risk infants

- There is fair evidence to exclude selective ultrasound screening for DDH from the periodic health examination of high-risk infants (grade D recommendation). Until proposed risk factors have been validated, physicians may opt to examine more frequently infant girls

Table 5: Number of infants needed to be screened by ultrasonography to prevent 1 case of DDH

	Outcome; no. needed to be screened (and 95% CI)		
Screening population	All DDH	Subluxation or dislocation requiring intervention	DDH requiring operative intervention
General (all infants)	859 (318 to –1212)	1003 (447 to –4105)	1962 (822 to –5088)
Selective (high-risk infants only)	2000 (389 to –636)	1693 (513 to –1303)	3550 (895 to –1805)

Note: CI = confidence interval. Negative numbers needed to screen should be interpreted as numbers needed to harm (e.g., –1212 means that, for every 1212 infants screened, the procedure will miss 1 case of DDH).

born in the breech position and infants with a family history of DDH. Although robust evidence is lacking, clinicians may opt to follow the recommendations of the American Academy of Pediatrics for these infants (see next page).
- There is fair evidence to exclude routine radiographic screening for DDH from the periodic health examination of high-risk infants (grade D recommendation).

Treatment

- There is insufficient evidence to evaluate the effectiveness of abduction therapy (grade C recommendation) and good evidence to support a supervised period of observation for newborns with clinically detected DDH (grade A recommendation). However, there is insufficient evidence to determine the optimal dura-

Table 6: Summary table of recommendations for screening newborns for DDH

Manoeuvre	Effectiveness	Level of evidence*	Recommendation*
Screening			
Infants at normal risk			
Repeated serial clinical examination by trained examiners (Ortolani and Barlow tests in younger infants and surveillance for limitation in abduction, leg length discrepancy in older infants)	Serial clinical examinations decrease the operative rate from 1–2 per 1000 infants to 0.2–0.7 per 1000, with a concomitant increase in the abduction splinting rate, to 4–19 per 1000	Level III[19,23,25–27,29–35]	Fair evidence to include serial clinical examination of the hips by a trained clinician in the periodic health examination (PHE) of all infants until they are walking independently (grade B)
	Rates of late DDH or operative intervention did not differ between infants undergoing ultrasound screening and those undergoing clinical examination	Level II-1[6]	
Ultrasound screening (static or dynamic method)	General ultrasound screening programs significantly increase the rates of intervention (splint therapy), repeat evaluations and false-positive diagnoses, without a decrease in the rates of late DDH or operative intervention	Level II-1[6] and level III[8,9,13,15,22,24,38–45]	Fair evidence to exclude general ultrasound screening for DDH from the PHE of infants (grade D)
Infants at high risk			
Selective screening in high-risk infants (breech birth, clinical evidence of joint instability, family history of DDH)	Because most infants with DDH have no risk factors, selective screening is ineffective in reducing the operative rate	Level II-1[6] and level III[32,41,67]	Fair evidence to exclude selective screening for DDH from the PHE of high-risk infants (grade D)
Radiographic examination of hips and pelvis in infants aged 3–5 mo	There is no consensus on the radiographic definition of DDH, and the clinical correlation to functional outcomes is lacking. Low sensitivity and poor interrater reliability have been reported	Level III[2,21,36]	Fair evidence to exclude routine radiographic screening for DDH from the PHE of high-risk infants (grade D)
Treatment			
Abduction therapy (Pavlik harness or other abduction devices)	The true effectiveness of abduction therapy is unknown. Studies have been confounded by the naturally high spontaneous resolution rate of DDH in infants		Insufficient evidence to evaluate the effectiveness of abduction therapy (grade C)
	Early splint therapy is not always effective. At least 20% of infants requiring operative intervention had splint therapy started shortly after birth	Level III[27,33,34,42,62]	
	Abduction splinting is associated with a variety of adverse events, including avascular necrosis of the hip (in 1%–4% of treated infants)	Level III[39,42,60,61]	
Timing of abduction therapy (early intervention)	Given the high rate of spontaneous resolution of DDH, the optimal timing of early intervention is not immediately after birth	Level I[11] and level III[18,39]	Good evidence to support a supervised period of observation for newborns with clinically detected DDH (grade A)
			Insufficient evidence to determine the optimal duration of observation (grade C)

*See Appendix 1 for definitions of the levels of evidence and grades of recommendations.

tion of observation (grade C recommendation).

- There is no evidence to support the use of double or triple diapering as an abduction therapy strategy in infants with DDH.

By other organizations

The Canadian Paediatric Society does not have an official statement regarding screening for DDH in newborns. The American Academy of Pediatrics has recently published guidelines for the evaluation of DDH.[69] It recommends serial clinical examination of the hips by a trained examiner as the current best method of screening for DDH. General ultrasound screening is not recommended.

For high-risk infants, the American Academy of Pediatrics recommends that infant girls born in the breech position have hip imaging either with ultrasound at 6 weeks of age or radiographs at 4 months of age. Hip imaging is optional in boys born in the breech position and in girls with a positive family history of DDH. Serial clinical examination alone is recommended for boys with a positive family history and for all other asymptomatic girls.[69]

Research agenda

Further study is required to understand (a) the optimal timing and effectiveness of abduction splinting, (b) the measurement of long-term functional outcomes, (c) the validity of high-risk factors, (d) the clinical significance of mild to moderate asymptomatic hip dysplasia and (e) the role of ultrasound testing in clinically equivocal instances and in the follow-up care of infants with DDH.

Competing interests: None declared.

Contributors: Dr. Patel, as primary author, was responsible for all aspects related to initiating the topic, reviewing the evidence, drafting the original manuscript for review by the Canadian Task Force on Preventive Health Care and making subsequent revisions following input from the task force and the external reviewers. The task force had 2 main roles: first, each task force member thoroughly reviewed the draft systematic review at several meetings, providing feedback to the author on the evidence review, and deliberated with the author to arrive at practice recommendations; second, the task force office managed the committee analytical process, arranged external expert review and supported the author in preparing literature searches, drafting tables or other supplementary materials, and revising the various drafts of the manuscript.

Acknowledgments: The Canadian Task Force on Preventive Health Care thanks Dr. William Cole, Department of Surgery, Hospital for Sick Children, Toronto, and Dr. Carol Dezateux, Department of Epidemiology and Public Health, Institute of Child Health, London, England, for reviewing a previous draft of this article. The views expressed in this report are those of the author and the task force and do not necessarily reflect the positions of the reviewers.

References

1. Weinstein SL. Natural history of congenital hip dislocation (CHD) and hip dysplasia. *Clin Orthop* 1987;225:62-76.
2. Weinstein SL. Developmental hip dysplasia and dislocation. In: Morrissy RT, Weinstein SL, editors. *Lovell and Winter's pediatric orthopaedics*. 4th ed. Philadelphia: Lippincott–Raven; 1996. p. 903-43.
3. Tachdjian MO. Congenital dysplasia of the hip. In: Tachdjian MO, editor. *Pediatric orthopedics*. 2nd ed. Vol 1. Philadelphia: WB Saunders; 1990. p. 297-526.
4. Mooney JF, Emans JB. Developmental dislocation of the hip: a clinical overview. *Pediatr Rev* 1995;16(8):299-303.
5. Clarke NMP. Diagnosing congenital dislocation of the hip. *BMJ* 1992;305:435-6.
6. 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.
7. Barlow TG. Early diagnosis and treatment of congenital dislocation of the hip. *J Bone Joint Surg Br* 1962;44:292-301.
8. Boeree NR, Clarke NMP. Ultrasound imaging and secondary screening for congenital dislocation of the hip. *J Bone Joint Surg Br* 1994;76(4):525-33.
9. Castelein RM, Sauter AJM. Ultrasound screening for congenital dysplasia of the hip in newborns: its value. *J Pediatr Orthop* 1988;8(6):666-70.
10. Dodenhoff RM. Role of ultrasound and harness treatment in the management of developmental dysplasia of the hip. *Ann R Coll Surg Engl* 1996;79:157-8.
11. Gardiner HM, Dunn PM. Controlled trial of immediate splinting versus ultrasonographic surveillance in congenitally dislocatable hips. *Lancet* 1990;336:1553-6.
12. Hansson G, Jacobsen S. Ultrasonography screening for developmental dysplasia of the hip joint. *Acta Paediatr* 1997;86(9):913-5.
13. Holen KJ, Terjesen T, Tegnander A, Bredland T, Saether OD, Eik-Nes SH. Ultrasound screening for hip dysplasia in newborns. *J Pediatr Orthop* 1994;14(5):667-73.
14. Dwyer NS. Congenital dislocation of the hip: To screen or not to screen? *Arch Dis Child* 1987;62(6):635-7.
15. Marks DS, Clegg J, Al-Chalabi AN. Routine ultrasound screening for neonatal hip instability. Can it abolish late-presenting congenital dislocation of the hip? *J Bone Joint Surg Br* 1994;76(4):534-8.
16. Standing Medical Advisory Committee, Standing Nursing and Midwifery Advisory Committee Working Party for the Secretaries of State for Social Services and Wales. Screening for the detection of congenital dislocation of the hip. *Arch Dis Child* 1986;61(9):921-6.
17. Feldman W. Well baby care in the first 2 years of life. In: Goldbloom R, editor. *The Canadian guide to clinical preventive health care*. Vol 1. Ottawa: Canada Communications Group; 1994:258-66.
18. Bialik V, Bialik GM, Blazer S, Sujov P, Wiener F, Berant M. Developmental dysplasia of the hip: a new approach to incidence. *Pediatrics* 1999;103(1):93-9.
19. Walker JM. Congenital hip disease in a Cree-Ojibwa population: a retrospective study. *CMAJ* 1977;116(5):501-4.
20. Wedge JH, Wasylenko MJ. The natural history of congenital disease of the hip. *J Bone Joint Surg Br* 1979;61(3):334-8.
21. Garvey M, Donoghue VB, Gorman WA, O'Brien N, Murphy JFA. Radiographic screening at four months of infants at risk for congenital hip dislocation. *J Bone Joint Surg Br* 1992;74(5):704-7.
22. Jones DA, Powell N. Ultrasound and neonatal hip screening. A prospective study of "high risk" babies. *J Bone Joint Surg Am* 1990;72(3):457-9.
23. Jones DA. Importance of the clicking hip in screening for congenital dislocation of the hip. *Lancet* 1989;1:599-601.
24. Sochart DH, Paton RW. Role of ultrasound assessment and harness treatment in the management of developmental dysplasia of the hip. *Ann R Coll Surg Engl* 1996;78(6):505-8.
25. Poul J, Bajerova J, Sommernitz M, Straka M, Pokorny M, Wong FYH. Early diagnosis of congenital dislocation of the hip. *J Bone Joint Surg Br* 1992;74(5):695-9.
26. Tredwell SJ, Bell HM. Efficacy of neonatal hip examination. *J Pediatr Orthop* 1981;1(1):61-5.
27. Lennox IAC, McLauchlan J, Murali R. Failures of screening and management of congenital dislocation of the hip. *J Bone Joint Surg Br* 1993;75(1):72-5.
28. Woolf SH, Battista RN, Anderson GM, Logan AG, Wang E, Canadian Task Force on the Periodic Health Examination. Assessing the clinical effectiveness of preventive maneuvers: analytic principles and systematic methods in reviewing evidence and developing clinical practice recommendations. *J Clin Epidemiol* 1990;43(9):891-905.
29. Fulton MJ, Barer ML. Screening for congenital dislocation of the hip: an economic appraisal. *CMAJ* 1984;130(9):1149-56.
30. Dunn PM, Evans RE, Thearle MJ, Griffiths HED, Witherow PJ. Congenital dislocation of the hip: early and late diagnosis and management compared. *Arch Dis Child* 1985;60(5):407-14.
31. Lehmann ECH, Street DG. Neonatal screening in Vancouver for congenital dislocation of the hip. *CMAJ* 1981;124(8):1003-8.
32. Macnicol MF. Results of a 25-year screening programme for neonatal hip instability. *J Bone Joint Surg Br* 1990;72(6):1057-60.
33. Krikler SJ, Dwyer NSP. Comparison of results of two approaches to hip screening in infants. *J Bone Joint Surg Br* 1992;74(5):701-3.
34. Godward S, Dezateux C. Surgery for congenital dislocation of the hip in the UK as a measure of outcome of screening. *Lancet* 1998;351(9110):1149-52.
35. Place MJ, Parkin DM, Fritton JM. Effectiveness of neonatal screening for congenital dislocation of the hip. *Lancet* 1978;2(8083):249-50.
36. Broughton NS, Brougham DI, Cole WG, Menelaus MB. Reliability of radiological measurements in the assessment of the child's hip. *J Bone Joint Surg Br* 1989;71(1):6-8.
37. Tonnis D, Storch K, Ulbrich H. Results of newborn screening for CDH with and without sonography and correlation of risk factors. *J Pediatr Orthop* 1990;10(2):145-52.
38. Hernandez RJ, Cornell RG, Hensinger RN. Ultrasound diagnosis of neonatal congenital dislocation of the hip. A decision analysis assessment. *J Bone Joint Surg Br* 1994;76(4):539-43.

39. Burger BJ, Burger JD, Bos CFA, Obermann WR, Rozing PM, Vandenbroucke JP. Neonatal screening and staggered early treatment for congenital dislocation or dysplasia of the hip. *Lancet* 1990;336:1549-53.
40. Anderson JE, Funnemark PO. Neonatal hip instability: screening with anterior-dynamic ultrasound method. *J Pediatr Orthop* 1995;15(3):322-4.
41. Clarke NMP, Clegg J, Al-Chalabi AN. Ultrasound screening of hips at risk for CDH. Failure to reduce the incidence of late cases. *J Bone Joint Surg Br* 1989;71(1):9-12.
42. Bradley J, Wetherill M, Benson MKD. Splintage for congenital dislocation of the hip: Is it safe and reliable? *J Bone Joint Surg Br* 1987;69(2):257-62.
43. Berman L, Klenerman L. Ultrasound screening for hip abnormalities: Preliminary findings in 1001 neonates. *BMJ* 1986;293(6549):719-22.
44. Boere-Boonekampe MM, Kerkhoff THM, Schuil PB, Zielhuis GA. Early detection of developmental dysplasia of the hip in the Netherlands: the validity of a standardized assessment protocol in infants. *Am J Public Health* 1998;88(2):285-8.
45. Poul J, Garvie D, Grahame R, Saunders AJS. Ultrasound examination of neonates' hip joints. *J Pediatr Orthop B* 1998;7(1):59-61.
46. Graf R. Fundamentals of sonographic diagnosis of infant hip dysplasia. *J Pediatr Orthop* 1984;4(6):735-40.
47. Dias JJ, Thomas IH, Lamont AC, Mody BS, Thompson JR. The reliability of ultrasonographic assessment of neonatal hips. *J Bone Joint Surg Br* 1993;75(3):479-82.
48. Jomha NM, McIvor J, Sterling G. Ultrasonography in developmental hip dysplasia. *J Pediatr Orthop* 1995;15(1):101-4.
49. Catterall A. The early diagnosis of congenital dislocation of the hip. *J Bone Joint Surg Br* 1994;76(4):515-6.
50. Donaldson JS. The use of sonography in screening for developmental dysplasia of the hip. *AJR Am J Roentgenol* 1994;162(2):399-400.
51. Harcke HT. Screening newborns for developmental dysplasia of the hip: the role of sonography. *AJR Am J Roentgenol* 1994;162(2):395-7.
52. Hernandez R, Hensinger RN. Developmental dysplasia of the hip and ultrasound: More is less? *Arch Pediatr Adolesc Med* 1995;149(6):641-2.
53. Cheng JCY, Chan YL, Hui PW, Shen WY, Metreweli C. Ultrasonographic hip morphometry in infants. *J Pediatr Orthop* 1994;14(1):24-8.
54. Gerscovich EO. A radiologist's guide to the imaging in the diagnosis and treatment of developmental dysplasia of the hip. *Skeletal Radiol* 1997;26(8):447-56.
55. Davids JR, Benson LJ, Mubarak SJ, McNeil N. Ultrasonography and developmental dysplasia of the hip: a cost-benefit analysis of three delivery systems. *J Pediatr Orthop* 1995;15(3):325-9.
56. Rosendahl K, Markestad T, Lie RT, Sudmann E, Geitung JT. Cost-effectiveness of alternative screening strategies for developmental dysplasia of the hip. *Arch Pediatr Adolesc Med* 1995;149(6):643-8.
57. Zieger M, Hilpert S, Schulz RD. Ultrasound of the infant hip. Part I: Basic principles. *Pediatr Radiol* 1986;16(6):483-7.
58. Zieger M. Ultrasound of the infant hip. Part II: Validity of the method. *Pediatr Radiol* 1986;16(6):488-92.
59. Zieger M, Schulz RD. Ultrasonography of the infant hip. Part III: Clinical application. *Pediatr Radiol* 1987;17(3):226-32.
60. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of congenital dislocation of the hip. *J Bone Joint Surg Am* 1980;62(6):876-87.
61. Langkamer VG, Clarke NMP, Witherow P. Complications of splintage in congenital dislocation of the hip. *Arch Dis Child* 1991;66(11):1322-5.
62. Suzuki S. Ultrasound and the Pavlik harness in CDH. *J Bone Joint Surg Br* 1993;75(3):483-7.
63. Novacheck TF. Developmental dysplasia of the hip. *Pediatr Clin North Am* 1996;43(4):829-48.
64. Harcke HT. Developmental dysplasia of the hip: a spectrum of abnormality. *Pediatrics* 1999;103(1):152.
65. Von Rosen S. Early diagnosis and treatment of congenital dislocation of the hip joint. *Acta Orthop Scand* 1956;26:136.
66. Rosendahl K, Markestad T, Lie RT. Ultrasound in the early diagnosis of congenital dislocation of the hip: the significance of hip stability versus acetabular morphology. *Pediatr Radiol* 1992;22(6):430-3.
67. Moore FH. Examining infants' hips — Can it do harm? *J Bone Joint Surg Br* 1989;71(1):4-5.
68. Rembold CM. Number needed to screen: development of a statistic for disease screening. *BMJ* 1998;317(7154):307-12.
69. Committee on Quality Improvement, Subcommittee on Developmental Dysplasia of the Hip. Clinical practice guideline: early detection of developmental dysplasia of the hip. *Pediatrics* 2000;105(4 Pt 1):896-905.

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Appendix 1: Canadian Task Force on Preventive Health Care levels of evidence and grades of recommendations

Levels of evidence	
I	Evidence from at least one well-designed randomized controlled trial
II-1	Evidence from well-designed controlled trials without randomization
II-2	Evidence from well-designed cohort or case–control analytic studies, preferably from more than one centre or research group
II-3	Evidence from comparisons between times or places with or without the intervention; dramatic results from uncontrolled studies could be included here
III	Opinions of respected authorities, based on clinical experience; descriptive studies or reports of expert committees
Grades of recommendations	
A	Good evidence to support the recommendation that the condition or manoeuvre be specifically considered in a periodic health examination (PHE)
B	Fair evidence to support the recommendation that the condition or manoeuvre be specifically considered in a PHE
C	Insufficient evidence regarding inclusion of the condition or manoeuvre in, or its exclusion from, a PHE, but recommendations may be made on other grounds
D	Fair evidence to support the recommendation that the condition or manoeuvre be specifically excluded from a PHE
E	Good evidence to support the recommendation that the condition or manoeuvre be specifically excluded from a PHE