

**Developmental Dysplasia of the Hip—Child
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Castelein RM, Sauter AJ. Ultrasound screening for congenital dysplasia of the hip in newborns: its value. <i>J Pediatr Orthop</i> 1988; 8(6):666-670.	10	307	To determine the prevalence of US abnormalities at birth in an unselected population of newborns, and the significance of sonography in detecting of cases of Congenital Dysplasia of the Hip (CDH) that would have escaped clinical diagnosis at routine neonatal screening.	82 hips (13.4%) had US abnormalities. Of these, 3 developed definite hip dysplasia. The remaining 79 hips became clinically and sonographically normal within 12 weeks. US visualized and recorded the dislocation-reposition maneuver of 3 other hips that were clinically dislocatable at birth.	2
2. Clarke NM, Clegg J, Al-Chalabi AN. Ultrasound screening of hips at risk for CDH. Failure to reduce the incidence of late cases. <i>J Bone Joint Surg Br</i> 1989; 71(1):9-12.	10	448	To evaluate the effect of US screening on infants at risk for CDH.	<ul style="list-style-type: none"> • 17 required treatment (3.7 per 1,000); no clinical abnormality was found in 5 of them. • 81 babies had US abnormalities but did not require treatment, although US showed hip displacement in 17 of them. 	2
3. Gardiner HM, Dunn PM. Controlled trial of immediate splinting versus ultrasonographic surveillance in congenitally dislocatable hips. <i>Lancet</i> 1990; 336(8730):1553-1556.	8	79	Possibility of delaying the treatment of dislocatable hips for 2 weeks to allow for spontaneous resolution. To elucidate the natural history of CDH, the clinical significance of the US morphological findings, and the value, reliability, and practicality of US in screening and diagnostic.	The low specificity (70%) of US examination in the first week of life makes it an unsatisfactory primary method of screening at birth, but it is a most useful adjunct to the clinical screening and management of congenital dislocation of the hip.	2
4. Marks DS, Clegg J, al-Chalabi AN. Routine ultrasound screening for neonatal hip instability. Can it abolish late-presenting congenital dislocation of the hip? <i>J Bone Joint Surg Br</i> 1994; 76(4):534-538.	10	14,050	To determine whether routine US screening for neonatal hip instability can prevent late-presenting congenital dislocation of the hip.	Routine US has detected cases which would have been presented late.	2
5. Terjesen T, Holen KJ, Tegnander A. Hip abnormalities detected by ultrasound in clinically normal newborn infants. <i>J Bone Joint Surg Br</i> 1996; 78(4):636-640.	13	306	To follow progress of newborn infants in whom US examination showed abnormalities in hips.	Newborn infants with abnormal and suspicious US findings who are normal on clinical examination do not need treatment from birth.	2
6. Andersson JE, Funnemark PO. Neonatal hip instability: screening with anterior-dynamic ultrasound method. <i>J Pediatr Orthop</i> 1995; 15(3):322-324.	10	4,430	To evaluate the effect of a screening program with an anterior dynamic US approach for hip dislocation.	5 dislocated and 1 dislocatable hips on 4 neonates. 59 dislocatable hips in 44 neonates (4 neonates received treatment). Radiograph obtained at 18 weeks. Decisions made on the basis of US. Treatment rate 0.18% compared to 1.7% without US screening. Sensitivity if clinical exam pediatrician 0.24 and 0.54 technicians. Specificity 99.3% and 99.0% respectively. US the gold standard.	2

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7. Place MJ, Parkin DM, Fritton JM. Effectiveness of neonatal screening for congenital dislocation of the hip. <i>Lancet</i> 1978; 2(8083):249-250.	13	N/A	To examine effectiveness of neonatal screening for CDH.	The results show the effectiveness of neonatal hip testing in an urban area in which no previous special studies have been performed. Re-examination of all infants at 3-6 months is proposed to reduce the number of missed cases and so minimize late sequelae. The incidence of late diagnosed CDH is 0.78/1,000.	3
8. Poul J, Bajero J, Sommernitz M, Straka M, Pokorny M, Wong FY. Early diagnosis of congenital dislocation of the hip. <i>J Bone Joint Surg Br</i> 1992; 74(5):695-700.	13	35,550 neonates	Prospective 5 year duration to determine the effectiveness of clinical exam by orthopedic surgeon. Radiograph at 3 months of every patient with a stable hip.	775 hips unstable or dislocated. 21 (0.6/1,000) hips missed early by clinical exam and 327 acetabular dysplasia (0.9%) found at 3 months by radiograph. Clinical evaluation by a skilled examiner is a valuable method of diagnosing developmental dysplasia of the hip (DDH) in neonates.	1
9. Garn SM, Rohmann CG, Silverman FN. Radiographic standards for postnatal ossification and tooth calcification. <i>Med Radiogr Photogr</i> 1967; 43(2):45-66.	15	66 references	Review on radiograph standards for appraisal of skeletal development.	Skeletal assessment is most reliable and valid for children from the population for which the standards were developed—children who are neither much more retarded nor much more advanced than expectancy.	4
10. Bertol P, Macnicol MF, Mitchell GP. Radiographic features of neonatal congenital dislocation of the hip. <i>J Bone Joint Surg Br</i> 1982; 64(2):176-179.	13	271	Retrospective analysis of radiographic features of neonatal congenital dislocation of the hip.	The medial gap, a measure of separation between the proximal femur and the pelvic wall was found to be significantly increased >5 mm in dislocated hips.	2
11. Kay RM, Watts HG, Dorey FJ. Variability in the assessment of acetabular index. <i>J Pediatr Orthop</i> 1997; 17(2):170-173.	13	360 readings	To assess the interobserver and intraobserver variability associated with the assessment of acetabular index.	Variability was increased for the radiographs that were deemed poorly reproducible by the independent observer. Interobserver variability exceeded intraobserver variability. The results of this study cast doubt on the reliability of the acetabular index based on a single reading.	2
12. Spatz DK, Reiger M, Klaumann M, Miller F, Stanton RP, Lipton GE. Measurement of acetabular index intraobserver and interobserver variation. <i>J Pediatr Orthop</i> 1997; 17(2):174-175.	13	25 children (aged 6 months to 2 years)	To evaluate the intraobserver and interobserver variation associated with the measurement of acetabular index.	Interobserver measurements were found to vary \pm 3.0 degrees, whereas the intraobserver variation was \pm 3.6 degrees. This error reflects only measurement error and does not consider error introduced with different positioning of the pelvis.	3
13. Graf R. The diagnosis of congenital hip-joint dislocation by the ultrasonic Compound treatment. <i>Arch Orthop Trauma Surg</i> 1980; 97(2):117-133.	10	N/A	To investigate the effectiveness of using US diagnostic devices to diagnose congenital hip-joint dislocation (CHD).	Major difficulties are small size of the object under examination and poor resolving power of ultrasonoscopes. The methods are good diagnostic tools.	3

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14. ACR practice guideline for the performance of the ultrasound examination for detection of developmental dysplasia of the hip. <i>In: Practice Guidelines and Technical Standards</i> . Reston, Va: American College of Radiology; 2007:997-1001.	15	N/A	Practice guideline for the performance of the US examination for detection of DDH. Purpose of guideline is to assist practitioners performing sonographic studies for DDH.	N/A	3
15. Graf R. <i>Guide to Sonography of the Infant Hip</i> . New York, NY: Thieme Medical Publishers Inc.; 1987.	15	N/A	Book chapter.	N/A	N/A
16. Dias JJ, Thomas IH, Lamont AC, Mody BS, Thompson JR. The reliability of ultrasonographic assessment of neonatal hips. <i>J Bone Joint Surg Br</i> 1993; 75(3):479-482.	13	209 neonates	Evaluate reliability of US assessment of neonatal hips.	US of a neonatal hip is much better than radiography in defining the cartilaginous femoral head and acetabulum and can be repeated with no additional risks.	2
17. Engesaeter LB, Wilson DJ, Nag D, Benson MK. Ultrasound and congenital dislocation of the hip. The importance of dynamic assessment. <i>J Bone Joint Surg Br</i> 1990; 72(2):197-201.	10	100	Prospective study to determine importance of US (dynamic assessment) in CDH. Test the reproducibility of the measurement of all US angles.	The results of the dynamic component of the US examination for both hips show a strong predictive value. US dynamic stability testing assisted the clinical decision whether to treat or just observe a newborn with suspect hips.	2
18. Jomha NM, McIvor J, Sterling G. Ultrasonography in developmental hip dysplasia. <i>J Pediatr Orthop</i> 1995; 15(1):101-104.	10	58 hip 29 infants	To document the repeatability and reliability of the measurements taken from the US.	The ICC were $\alpha=0.03$, $\beta=0.12$, and the percent coverage = -0.02 . The ability of examiners was important. The radiologist dealt with US very frequently, and was noted to be the most repeatable observer with an ICC ranging between 0.82 and 0.89. Reliability among the 3 examiners was not consistent. If a α cutoff of 55 degrees was implemented, then treatment would have changed 39 of 144 times within the examiners' individual measurements. Even the most consistent examiner (the radiologist with an α ICC of 0.89) would have changed his treatment 8 of 48 times. Highly reliable examiners would alter their management decisions 17% of the time.	2

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19. Rosendahl K, Aslaksen A, Lie RT, Markestad T. Reliability of ultrasound in the early diagnosis of developmental dysplasia of the hip. <i>Pediatr Radiol</i> 1995; 25(3):219-224.	13	3 groups of infants 206, 74 and 78	To determine interobserver and intraobserver agreement in assessing hip morphology and stability by US.	Interobserver: There was moderate agreement classifying hips subjectively into four morphologic categories ($\kappa=0.5$) or objectively by recording Graf angle ($\kappa=0.3$). Same observer (206 infants, $\kappa=0.7$ and 0.8 for the two observers, respectively). There was a moderate interobserver agreement in determining hip stability (70 infants, $\kappa=0.4$). Interobserver and intraobserver agreement in producing the scans is poorer than for reading. Stability and morphology may be evaluated differently by different examiners even when considerable effort is invested in standardizing procedures.	3
20. Harcke HT, Grissom Le. Infant hip sonography: current concepts. <i>Semin Ultrasound CT MR</i> 1994; 15(4):256-263.	12	N/A	Description of the Dynamic Standard Minimum Sonographic Examination of the infant hip. Also reviews the classification and management of infant hip disorders.	Whereas US is used increasingly to manage developmental dislocation and/or dysplasia of the hip, there is no agreement on the use of sonography for universal newborn screening.	3
21. Shipman SA, Helfand M, Moyer VA, Yawn BP. Screening for developmental dysplasia of the hip: a systematic literature review for the US Preventive Services Task Force. <i>Pediatrics</i> 2006; 117(3):e557-576.	11	N/A	Gather and synthesize the published evidence regarding screening for DDH by primary care providers.	Clinical examination and US identify somewhat different groups of newborns who are at risk for DDH. A significant proportion of hip abnormalities identified through clinical examination or US in the newborn period will spontaneously resolve. All surgical and nonsurgical interventions have been associated with avascular necrosis of the femoral head, the most common and most severe harm associated with all treatments of DDH.	3
22. Clinical practice guideline: early detection of developmental dysplasia of the hip. Committee on Quality Improvement, Subcommittee on Developmental Dysplasia of the Hip. American Academy of Pediatrics. <i>Pediatrics</i> 2000; 105(4 Pt 1):896-905.	15	N/A	DDH guideline from the American Academy of Pediatrics.	N/A	3
23. Dezateux C, Rosendahl K. Developmental dysplasia of the hip. <i>Lancet</i> 2007; 369(9572):1541-1552.	12	N/A	Assess the problem of DDH in adults and newborns.	Need for high quality studies of the adult outcomes of DDH and the childhood origins of early degenerative hip disease and randomized trials to assess the effectiveness and safety of neonatal screening and early treatment.	4

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24. Patel H. Preventive health care, 2001 update: screening and management of developmental dysplasia of the hip in newborns. <i>Cmaj</i> 2001; 164(12):1669-1677.	12	N/A	Review the effectiveness of, and make practice recommendations for, serial clinical examination and US screening for DDH in newborns.	Fair evidence: <ul style="list-style-type: none"> 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, to exclude general US screening for DDH from the periodic health examination of infants, to exclude selective screening for DDH from the periodic health examination of high-risk infants, to exclude routine radiographic screening for DDH from the periodic health examination of high-risk infants. Insufficient evidence to evaluate the effectiveness of abduction therapy but good evidence to support a period of close observation for newborns with clinically detected DDH.	3
25. Holen KJ, Tegnander A, Bredland T, et al. Universal or selective screening of the neonatal hip using ultrasound? A prospective, randomised trial of 15,529 newborn infants. <i>J Bone Joint Surg Br</i> 2002; 84(6):886-890.	8	15,529	Prospective study to evaluate whether universal (all neonates) or selective (neonates belonging to the risk groups) US screening of the hips should be recommended at birth.	One late-detected hip dysplasia was seen in the universal group; 5 in the subjective group, representing a rate of 0.13 and 0.65 per 1,000, respectively. The difference in late detection between the two groups was not statistically significant ($p=0.22$). Recommend selective US screening for neonates with abnormal or suspicious clinical findings and those with risk factors for hip dysplasia.	1
26. 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. <i>Pediatrics</i> 1994; 94(1):47-52.	8	11,925	To assess the effect of US screening on primary diagnosis, management and prevalence of late cases of DDH.	Higher treatment rate: 3.4% US, vs 2% US high risk and 1.8% no US. For infants not subjected to treatment, US resulted in a higher follow-up rate (13%, 1.8% and 0%). Late DDH 0.3, 0.7 and 1.3 per 1,000 ($p=.11$). No support for generalized screening with US, clinical examiner is experienced. US may reassure and diminish the need for repeated clinical follow-up. US may have a marginal effect on late DDH.	2

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27. Woolacott NF, Puhan MA, Steurer J, Kleijnen J. Ultrasonography in screening for developmental dysplasia of the hip in newborns: systematic review. <i>Bmj</i> 2005; 330(7505):1413.	11	23 databases	Assess the accuracy and effectiveness of US screening of all newborn infants for DDH.	US screening: sensitivity 88.5%; specificity 96.7%, PPV 61.6%; NPV 99.4%. Compared with clinical screening, general US screening in newborns may increase overall treatment rates.	3
28. Hensinger RN. Treatment in early infancy: birth to two months. In: Tachdjian MO, ed. <i>Congenital Dislocation of the Hip</i> . New York, NY.: Churchill Livingstone; 1982:159-171.	15	N/A	Book chapter.	N/A	N/A
29. Garvey M, Donoghue VB, Gorman WA, O'Brien N, Murphy JF. Radiographic screening at four months of infants at risk for congenital hip dislocation. <i>J Bone Joint Surg Br</i> 1992; 74(5):704-707.	13	357	Report on a radiographic screening program at 4 months of age for infants who were clinically normal at neonatal exam but were considered to be “at risk” for CDH because of their family history, breech presentation, or persistent click.	Radiography of the hip at 4 months is a valuable adjunct to neonatal screening for infants at increased risk of CDH.	2
30. Lowry CA, Donoghue VB, Murphy JF. Auditing hip ultrasound screening of infants at increased risk of developmental dysplasia of the hip. <i>Arch Dis Child</i> 2005; 90(6):579-581.	10	5,485	To determine the efficiency of hip sonography in detection of DDH in those without clinically dislocated hips.	Among the population of infants at increased risk of DDH, the hip screening program identified 18 cases among 5,485 infants; a rate of 3.2 per 1,000.	1
31. Tonnis D, Storch K, Ulbrich H. Results of newborn screening for CDH with and without sonography and correlation of risk factors. <i>J Pediatr Orthop</i> 1990; 10(2):145-152.	10	1,310 examined by Ortolani’s and Barlow’s manual test, 2,587 evaluated by sonography	To investigate the efficiency of US in the evaluation of DDH.	Twice as many abduction pillows were ordered. A total of 6.54% treated patients. 52.25% of the sonographically pathological hips had no signs of instability, nor Ortolani or dislocation.	2

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32. Boeree NR, Clarke NM. Ultrasound imaging and secondary screening for congenital dislocation of the hip. <i>J Bone Joint Surg Br</i> 1994; 76(4):525-533.	10	26,952 screened, 1,894 evaluated with US	Prospective evaluation of a screening program for CDH which uses US to provide delayed selective screening to complement neonatal clinical screening.	Treatment rate of 4.4 per 1,000. Of those referred with clinical instability, 35% did not require treatment. Dislocation or subluxation was detected in 17 of 643 infants referred only because they fell within one of three risk categories: breech presentation, foot deformity and family history. All 17 had normal clinical examinations. Six children presented with CDH after 12 weeks of age, giving a late presentation rate of 0.22 per 1,000 births. All had normal clinical examinations within 24 hours of birth and none was in a risk category. Surgery has been required in ten children, giving a surgical treatment rate of 0.37 per 1,000 births.	3
33. Teanby DN, Paton RW. Ultrasound screening for congenital dislocation of the hip: a limited targeted programme. <i>J Pediatr Orthop</i> 1997; 17(2):202-204.	10	4,000	To evaluate US of abnormal hips.	The incidence of late CHD was not reduced by extending the US program to include “at risk groups” and morphologic assessment of the hips.	2
34. Roovers EA, Boere-Boonekamp MM, Mostert AK, Castelein RM, Zielhuis GA, Kerkhoff TH. The natural history of developmental dysplasia of the hip: sonographic findings in infants of 1-3 months of age. <i>J Pediatr Orthop B</i> 2005; 14(5):325-330.	13	5,170	To examine US findings of DDH in infants.	Of the normal hips at 1 month of age, 99.6% were still normal at 3 months of age. Of the immature type IIa/IIa+ and type IIa-, if untreated, 95.3% and 84.4% had become normal, respectively. Of the infants with type IIc, D and III/IV hips at the age of 1 month, 70%, 58.3% and 90.9% were treated, respectively.	2
35. Paton RW, Hinduja K, Thomas CD. The significance of at-risk factors in ultrasound surveillance of developmental dysplasia of the hip. A ten-year prospective study. <i>J Bone Joint Surg Br</i> 2005; 87(9):1264-1266.	10	2,578	A prospective study of the hips of newborns with at-risk factors for developmental dysplasia. Hips were imaged by US to determine the importance of using US on all newborns.	The incidence of type-III dysplasia and hip dislocation or dislocatability in the groups with clinical instability, family history, breech position and possibly postural foot deformity as risk factors could justify a program of selective US imaging. (British population).	2
36. Elbourne D, Dezateux C, Arthur R, et al. Ultrasonography in the diagnosis and management of developmental hip dysplasia (UK Hip Trial): clinical and economic results of a multicentre randomised controlled trial. <i>Lancet</i> 2002; 360(9350):2009-2017.	8	629	Assess clinical effectiveness and net cost of US compared with clinical assessment alone, to provide guidance for management of infants with clinical hip instability.	Use of US in infants with screen-detected clinical hip instability allows abduction splinting rates to be reduced, and is not associated with an increase in abnormal hip development, higher rates of surgical treatment by 2 years of age, or significantly higher health-service costs.	1

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37. Gray A, Elbourne D, Dezateux C, King A, Quinn A, Gardner F. Economic evaluation of ultrasonography in the diagnosis and management of developmental hip dysplasia in the United Kingdom and Ireland. <i>J Bone Joint Surg Am</i> 2005; 87(11):2472-2479.	8	629	Prospective analysis to assess costs of clinical neonatal hip screening in association with US for the diagnosis and management of neonatal hip instability.	The average overall health-service cost per patient (and standard deviation) was \$1298 ± \$2168 in the ultrasonography group and \$1488 ± \$2912 in the group that underwent clinical assessment alone, a net difference of -\$190 (95% confidence interval, -\$630 to \$250).	1
38. Dunn PM, Evans RE, Thearle MJ, Griffiths HE, Witherow PJ. Congenital dislocation of the hip: early and late diagnosis and management compared. <i>Arch Dis Child</i> 1985; 60(5):407-414.	13	23,002 infants	Comparison of early and late diagnosis and management of CDH.	Late CDH diagnosed after the neonatal period in infants born to women in Avon during the same decade (n=103 431) 91 cases were detected (0.88 per 1,000 births), 10 in the university cohort (0.44 per 1,000) and 81 in the non-university group (1.00 per 1,000) (<i>P</i> less than 0.01).	2
39. Burger BJ, Burger JD, Bos CF, Obermann WR, Rozing PM, Vandenbroucke JP. Neonatal screening and staggered early treatment for congenital dislocation or dysplasia of the hip. <i>Lancet</i> 1990; 336(8730):1549-1553.	13	14,264	Prospective study to establish if neonatal screening and early treatment prevent dislocation, or dysplasia without dislocation. The possible complications of early treatment as well as the risk factors and the prevalence of a positive Barlow test and radiographically detected dysplasia.	Dislocation was missed at screening in 0.02%. Dysplasia was seen at 5 months in 15% of Barlow-children with a+ family history and in 2%-3% of the reference group children. Test is efficient in the identification of dislocation but probably has no value for dysplasia. Of the babies in whom treatment was started immediately 17% had relapse dysplasia after withdrawal of therapy, 3% had avascular necrosis, and 78% were normal at 2 years. When treatment was started at 5 months we found no relapse dysplasia, only 1% avascular necrosis, and 53%-63% success at 2 years. In children with dislocatable hips we propose a wait-and-see treatment strategy, with early US or radiography at 5 months.	1
40. Gardiner HM, Duncan AW. Radiological assessment of the effects of splinting on early hip development: results from a randomised controlled trial of abduction splinting vs sonographic surveillance. <i>Pediatr Radiol</i> 1992; 22(3):159-162.	8	79	Report on radiological data from newborns with dislocatable hips that were randomized either to immediate splinting or to sonographic surveillance that examines the influence of early splinting on hip development.	Epiphyseal maturation (EM), iliac indentation (II) and acetabular angle (AA) were assessed radiographically at 6 months, blind to the treatment group; hips with normal sonograms at birth had greater EM and II and smaller AA. Whilst clinically unstable Graf type 1 and 2A hips were radiologically similar at 6 months, those splinted showed poorer EM and II compared with nonsplinted hips.	1

Evidence Table Key

Study Type Key

Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
 - a. Cohort
 - b. Cross-sectional
 - c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews

8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.