Update on Developmental Dysplasia of the Hip

Michael Fadell, M.D.
Disclosure of Commercial Interest

Neither I nor my immediate family members have a financial relationship with a commercial organization that may have a direct or indirect interest in the following content
Current Evidence Based Medicine Recommendations on Screening and Non Operative Treatment of Developmental Dysplasia of the Hip (DDH)
DETECTION AND NONOPERATIVE MANAGEMENT OF PEDIATRIC DEVELOPMENTAL DYSPLASIA OF THE HIP IN INFANTS UP TO SIX MONTHS OF AGE

EVIDENCE-BASED CLINICAL PRACTICE GUIDELINE

Adopted by the American Academy of Orthopaedic Surgeons
Board of Directors
September 5, 2014

This guideline has been endorsed by the following organizations:

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN®

POSNA
The Pediatric Orthopaedic Society of North America
Why Perform These Reviews?

Vast majority of infants with hip dysplasia on ultrasound normalize without treatment.

Abduction splinting is not without complications.

Limited evidence linking DDH screening with a reduction in late presenting hip dysplasia and/or a reduction in corrective surgery.
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SDMS

The Society for Diagnostic Medical Sonography
APPENDIX III
STUDY ATTRITION FLOWCHART

- 4,026 abstracts screened for inclusion
- 2,434 abstracts included
- 1,592 articles recalled for full text review
- 36 articles recalled from bibliography screening
- 1,597 articles excluded
- 31 articles included
<table>
<thead>
<tr>
<th>Strength</th>
<th>Overall Strength of Evidence</th>
<th>Description of Evidence Strength</th>
<th>Strength Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>Strong</td>
<td>Evidence from two or more “High” strength studies with consistent findings for recommending for or against the intervention.</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderate</td>
<td>Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.</td>
<td>★★★★☆</td>
</tr>
<tr>
<td>Limited</td>
<td>Low Strength Evidence or Conflicting Evidence</td>
<td>Evidence from one or more “Low” strength studies with consistent findings or evidence from a single “Moderate” strength study for 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.</td>
<td>★★★☆☆</td>
</tr>
</tbody>
</table>
UNIVERSAL ULTRASOUND SCREENING
Compared newborn screening hip ultrasound of all neonates - to neonates belonging to risk groups - to clinical exam alone.

Hip development was assessed by pelvic radiograph at ~ 5 months.
STUDY POPULATION
n=11925

ultrasound available  ultrasound not available

ULTRASOUND STUDY GROUP
n=8001

GENERAL SCREENING
n=3613

SELECTIVE SCREENING
n=4388

NO SCREENING
n=3924
### TABLE 2. Distribution of Clinical Findings and of Risk Factors in the Three Study Groups

<table>
<thead>
<tr>
<th></th>
<th>General Screening</th>
<th>Selective Screening</th>
<th>No Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of infants</strong></td>
<td>3613</td>
<td>4388</td>
<td>3924</td>
</tr>
<tr>
<td>% girls</td>
<td>48.9</td>
<td>49.3</td>
<td>47.8</td>
</tr>
<tr>
<td>Positive Barlow/Ortolani*</td>
<td>57</td>
<td>64</td>
<td>71</td>
</tr>
<tr>
<td>Clinically uncertain*</td>
<td>86</td>
<td>103</td>
<td>†</td>
</tr>
<tr>
<td>Positive family history</td>
<td>305</td>
<td>309§</td>
<td>†</td>
</tr>
<tr>
<td>Breech position</td>
<td>161</td>
<td>139¶</td>
<td>†</td>
</tr>
<tr>
<td><strong>Total number with risk factors</strong></td>
<td><strong>456</strong></td>
<td><strong>518</strong></td>
<td>†</td>
</tr>
</tbody>
</table>

* Based on the first clinical examination.
† Not recorded.
§ $P = 0.02$ and ¶ $P = .003$ compared with general screening.
### TABLE 3. Distribution of Ultrasound (US) and Clinical Findings in the Three Groups

<table>
<thead>
<tr>
<th></th>
<th>General Screening</th>
<th></th>
<th>Selective Screening</th>
<th></th>
<th>No Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td><strong>Infants treated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic abnormal; US abnormal ‡</td>
<td>73</td>
<td>2.0</td>
<td>56</td>
<td>1.3</td>
<td>*</td>
</tr>
<tr>
<td>Clinic abnormal; US normal or immature</td>
<td>16</td>
<td>0.4</td>
<td>21</td>
<td>0.5</td>
<td>*</td>
</tr>
<tr>
<td>Clinic normal; US abnormal</td>
<td>34</td>
<td>0.9</td>
<td>12</td>
<td>0.3</td>
<td>*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>123</td>
<td>3.4</td>
<td>89</td>
<td>2.0</td>
<td>71</td>
</tr>
<tr>
<td><strong>Infants not treated, but followed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic normal; US immature or minor dysplastic</td>
<td>470</td>
<td>13.0</td>
<td>78</td>
<td>1.8</td>
<td>*</td>
</tr>
<tr>
<td><strong>Infants not treated or followed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic normal; US normal</td>
<td>3020</td>
<td>83.6</td>
<td>351</td>
<td>8.0</td>
<td>*</td>
</tr>
<tr>
<td>Clinic normal, US not done</td>
<td>0</td>
<td>0</td>
<td>3870</td>
<td>88.2</td>
<td>3853</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3490</td>
<td>96.6</td>
<td>4299</td>
<td>97.8</td>
<td>3853</td>
</tr>
</tbody>
</table>

* Infants not examined by ultrasound.

‡ Filling the sonographic criteria for treatment.
### TABLE 5. Distribution of Late Cases of DDH in the Three Study Groups

<table>
<thead>
<tr>
<th></th>
<th>General Screening (n = 3613)</th>
<th>Selective Screening (n = 4388)</th>
<th>No Screening (n = 3924)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LR*</td>
<td>HR‡</td>
<td>LR</td>
</tr>
<tr>
<td>Dysplasia</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Subluxation</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Dislocation</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>1.4</strong></td>
<td><strong>9</strong></td>
</tr>
<tr>
<td><strong>Rate§</strong></td>
<td><strong>0.3</strong></td>
<td></td>
<td><strong>0.7</strong></td>
</tr>
</tbody>
</table>

* Low risk.
‡ High risk.
§ Rate per 1000.
Rosendahl Conclusion

“The effect of ultrasound screening in reducing the prevalence of late DDH was at best marginal despite a considerable increase in diagnostic and therapeutic efforts.”
Compared newborn screening hip ultrasound of all neonates versus neonates belonging to risk groups

Hip development assessed by pelvic radiograph at 6 to 11 years
All newborns 
n = 15939

Excluded newborns 
n = 410

Randomised newborns 
n = 15529

Group 1 randomised to ultrasonography + clinical examination 
n = 7840

Not examined by ultrasound 
n = 351

Ultrasonography + clinical examination 
n = 7489

Group 2 randomised to clinical examination 
n = 7689

Resident outside of county 
n = 339

Parental refusal 
n = 71

Fig. 1

The trial profile for comparing universal with selective neonatal hip screening using ultrasound.
Table I. Details of the randomised neonates and the distribution of risk factors between group 1 (ultrasound and clinical examination) and group 2 (clinical examination), by number and percentage

<table>
<thead>
<tr>
<th></th>
<th>Group 1*</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>7489</td>
<td>7689</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>3673 (49)</td>
<td>3752 (48.8)</td>
</tr>
<tr>
<td>Boys</td>
<td>3816 (51)</td>
<td>3937 (51.2)</td>
</tr>
<tr>
<td>Birth rank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3490 (46.6)</td>
<td>3598 (46.8)</td>
</tr>
<tr>
<td>2</td>
<td>2644 (35.3)</td>
<td>2722 (35.4)</td>
</tr>
<tr>
<td>3 or more</td>
<td>1355 (18.1)</td>
<td>1369 (17.8)</td>
</tr>
<tr>
<td>Risk factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHI</td>
<td>73</td>
<td>66</td>
</tr>
<tr>
<td>Breech position</td>
<td>332</td>
<td>331</td>
</tr>
<tr>
<td>Family history of HD</td>
<td>351</td>
<td>338</td>
</tr>
<tr>
<td>Foot deformity</td>
<td>44</td>
<td>40</td>
</tr>
</tbody>
</table>

*351 infants, not examined by ultrasound, have been omitted from this table because of incomplete data
Treatment

Universal Screening

~ 1% were treated

Selective Screening

Just under 1% were treated
Late Detected Hip Dysplasia

Universal Screening
1/7489 (rate of 0.13 per 1000 cases)

Selective Screening
5/7689 (rate of 0.65 per 1000 cases)
“... universal ultrasound screening is not necessary, ... recommend selective ultrasound screening for neonates with abnormal or suspicious clinical findings and those with risk factors for hip dysplasia.”
UNIVERSAL ULTRASOUND SCREENING

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

Strength of Recommendation: Moderate 🔄️⭐⭐⭐⭐
EVALUATION OF INFANTS WITH RISK FACTORS FOR DDH
Compared newborn screening hip ultrasound of neonates belonging to risk groups - to infants with clinical instability - to assess for late dislocation.
20,452 Live births

1107 (5.4%) Screened by ultrasound

821 (4%) Risk factor alone

286 (1.4%) Clinical instability
### Table II. Statistics on ultrasound screening. Dislocation rates by ‘at-risk’ factor in children screened due to ‘at-risk’ factors

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Number</th>
<th>Dislocation present</th>
<th>Dislocation rate per thousand (95% CI)</th>
<th>Number needed to screen to detect one dislocation (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breech</td>
<td>532</td>
<td>9</td>
<td>17 (8 to 32)</td>
<td>59 (31 to 129)</td>
</tr>
<tr>
<td>Family history</td>
<td>58</td>
<td>1</td>
<td>17 (0.4 to 92)</td>
<td>58 (11 to 2294)</td>
</tr>
<tr>
<td>Foot abnormality</td>
<td>140</td>
<td>1</td>
<td>7 (0.2 to 39)</td>
<td>140 (26 to 5525)</td>
</tr>
<tr>
<td>Oligohydramnios</td>
<td>13</td>
<td>0</td>
<td>0 (0 to 247)</td>
<td>-              (4 upwards)</td>
</tr>
<tr>
<td>Other risk factors</td>
<td>78</td>
<td>0</td>
<td>0 (0 to 46)</td>
<td>-              (22 upwards)</td>
</tr>
<tr>
<td>Total</td>
<td>821</td>
<td>11</td>
<td>13 (7 to 24)</td>
<td>75 (42 to 149)</td>
</tr>
</tbody>
</table>
Table I. Dislocation rates at various potential screening stages. Since ultrasound screening was not performed in children without ‘at-risk’ factors or doubtful clinical instability the number needed to screen is the minimum achievable number

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Dislocation present</th>
<th>Dislocation rate per thousand (95% CI)</th>
<th>Number needed to screen to detect one dislocation (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doubtful clinical instability</td>
<td>286</td>
<td>25</td>
<td>87 (57 to 126)</td>
<td>11 (8 to 17)</td>
</tr>
<tr>
<td>Any ‘at-risk’ factor (without clinical instability)</td>
<td>821</td>
<td>11</td>
<td>13 (7 to 24)</td>
<td>75 (42 to 149)</td>
</tr>
<tr>
<td>Doubtful clinical instability or/and ‘at-risk’ factor</td>
<td>1107</td>
<td>36</td>
<td>33 (23 to 45)</td>
<td>31 (22 to 44)</td>
</tr>
<tr>
<td>No ‘at-risk’ factors or doubtful clinical instability</td>
<td>19345</td>
<td>8*</td>
<td>0.4 (0.2 to 0.8)</td>
<td>≥2418 (1225 to 5618)</td>
</tr>
<tr>
<td>Total</td>
<td>20452</td>
<td>44</td>
<td>2.2 (1.6 to 2.9)</td>
<td>≥465 (347 to 639)</td>
</tr>
</tbody>
</table>

* late dislocation, presented at more than six months of age
Paton Conclusions

“Routine ultrasound screening of the ‘at-risk’ groups on their own is of little value in significantly reducing the rate of ‘late’ dislocation in DDH ...”

“... screening clinically unstable hips alone or associated with ‘at-risk’ factors has a high rate of detection.”
The significance of at-risk factors in ultrasound surveillance of developmental dysplasia of the hip

A TEN-YEAR PROSPECTIVE STUDY

R. W. Paton, K. Hinduja, C. D. Thomas

From Blackburn Royal Infirmary, Blackburn, England

Of the 34,723 infants born between 1 June 1992 and 31 May 2002, the hips of 2,578 with clinical instability or at-risk factors for developmental dysplasia of the hip were imaged by ultrasound.

Instability of the hip was present in 77 patients, of whom only 24 (31.2%) had an associated risk factor. From the ‘at-risk’ groups, the overall risk of type-III dysplasia, instability and irreducibility was 1:15 when family history, 1:27 when breech delivery and 1:33 when foot deformity were considered as risk factors. Of those hips which were ultrasonographically stable, 88 had type-III dysplasia.

A national programme of selective ultrasound screening of at-risk factors for the diagnosis of hip dislocation or instability alone cannot be recommended because of its low predictive value (1:88). However, 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 programme of selective ultrasound imaging.
Compared newborn screening hip ultrasound of neonates belonging to risk groups - to infants with clinical instability - to assess for dislocation ... as well as high grade dysplasia on ultrasound
Live births: 34,723

Screened by ultrasound: 2578

- Risk factor alone: 2126
- Clinical instability: 452
77 dislocations

53/452 from the clinical instability group

24/2126 from the risk factor group
88 Graf type-III hips
40/400 from the clinical instability group
48/2102 with risk factors
### Table 1. Risk factors and detection rates

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Number</th>
<th>Dislocation and type-3 dysplasia</th>
<th>Rate per 1000</th>
<th>Number needed to detect one patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breech</td>
<td>1336</td>
<td>50</td>
<td>37</td>
<td>27.0</td>
</tr>
<tr>
<td>Family history</td>
<td>220</td>
<td>15</td>
<td>68</td>
<td><strong>14.7</strong></td>
</tr>
<tr>
<td>Foot deformity</td>
<td>427</td>
<td>13</td>
<td>30</td>
<td>32.0</td>
</tr>
<tr>
<td>Oligohydramnios</td>
<td>157</td>
<td>NA*</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* NA, not available
“selective ultrasound screening of at-risk factors for the diagnosis of hip dislocation or instability alone cannot be recommended”

“...in groups with clinical instability, family history, breech position (and possibly postural foot deformity) as risk factors a program of selective ultrasound imaging could be justified.”
EVALUATION OF INFANTS WITH RISK FACTORS FOR DDH

Moderate 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: Moderate ★★★★☆
Additional Topics Addressed by the AAOS

1. The use of an AP pelvis radiograph instead of an ultrasound to assess for DDH

2. Observation without a brace for infants with ultrasound abnormalities and a clinically stable hip

3. Immediate (< 2 weeks) versus delayed (> 9 weeks) brace treatment for hips with instability on exam

4. Re-examination of infants with normal results on initial screening exam

5. The use of a specific splinting device
Screening programmes for developmental dysplasia of the hip in newborn infants (Review)

Shorter D, Hong T, Osborn DA

THE COCHRANE COLLABORATION®

This is a reprint of a Cochrane review prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2011, Issue 9

http://www.thecochranelibrary.com

WILEY
1. Universal Ultrasound Screening

2. Screening Infants with Risk Factors

3. Infants with Unstable Hips

4. Infants with Mild Dysplasia on Ultrasound
Infants with Unstable Hips
Radiological assessment of the effects of splinting on early hip development: results from a randomised controlled trial of abduction splinting vs sonographic surveillance

H. M. Gardiner and A. W. Duncan

Institute of Child Health, Southmead and Bristol Maternity Hospitals, Bristol University, Bristol, UK

Received: 12 August 1991; accepted: 12 November 1991
Compared unstable hips randomized to immediate splinting versus surveillance with ultrasound

Hip development assessed by pelvic radiographs at 6 months
<table>
<thead>
<tr>
<th>Graf hip types</th>
<th>1</th>
<th>2A</th>
<th>2C</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>17</td>
<td>26</td>
<td>11</td>
<td>34</td>
<td>9</td>
</tr>
</tbody>
</table>
Hip development for both groups assessed by:

- Epiphyseal maturation (EM)
- Iliac indentation (II)
- Acetabular angle (AA)
Immediate splinting > 40

Sonographic surveillance > 36

Sonographic surveillance group re examined at 2 weeks > splinted if persistent instability or no sonographic improvement
Table 2. Effect of splinting on hip maturation of 6 months (mean [SD]): clinically unstable hips in Groups B1 and A + B2 compared

<table>
<thead>
<tr>
<th></th>
<th>Unsplinted</th>
<th>Splinted</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group B1</td>
<td>Group A + B2</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>31</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>F.C.E.</td>
<td>1.87 [0.81]</td>
<td>1.05 [1.05]</td>
<td>3.85  p &lt; 0.001</td>
</tr>
<tr>
<td>I.I.</td>
<td>2.10 [0.70]</td>
<td>1.49 [0.71]</td>
<td>3.93  p &lt; 0.001</td>
</tr>
<tr>
<td>A.A.</td>
<td>25.68 [4.85]</td>
<td>26.06 [5.26]</td>
<td>-0.34 p = ns</td>
</tr>
</tbody>
</table>

Key: F.C.E. = femoral capital epiphysis, I.I. = iliac indentation, A.A. = acetabular angle
Table 6. Clinically unstable hips assigned normal Graf type at birth: effect of splinting on hip development (mean values) at one year of age

<table>
<thead>
<tr>
<th></th>
<th>Group A (n = 11)</th>
<th>Group B (n = 9)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.C.E.</td>
<td>2.27</td>
<td>3.17</td>
<td>2.1 p &lt; 0.05</td>
</tr>
<tr>
<td>L.I.</td>
<td>2.36</td>
<td>2.56</td>
<td>0.5 p = ns</td>
</tr>
<tr>
<td>A.A.</td>
<td>24.91</td>
<td>22.64</td>
<td>1.1 p = ns</td>
</tr>
</tbody>
</table>

Key: F.C.E. = femoral capital epiphysis, I.I. = iliac indentation, A.A. = acetabular angle
“Unstable hips randomized to surveillance with ultrasound resulted in fewer patients being treated without increasing the likelihood of abnormal hip development.”
Ultrasonography in the diagnosis and management of developmental hip dysplasia (UK Hip Trial): clinical and economic results of a multicentre randomised controlled trial

Diana Elbourne, Carol Dezateux, Rosemary Arthur, N M P Clarke, Alastair Gray, Andy King, Anne Quinn, Frances Gardner, Glynn Russell on behalf of the UK Collaborative Hip Trial Group*

Summary

Background Clinical screening aims to identify and treat neonatal hip instability associated with increased risk of hip displacement, but risks failures of diagnosis and treatment (abduction splinting), iatrogenic effects, and costs to parents and health services. Our objectives were to assess clinical effectiveness and net cost of ultrasonography compared with clinical assessment alone, to provide guidance for management of infants with clinical hip instability.

Interpretation The use of ultrasonography 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.

Lancet 2002; 360: 2009–17

Introduction
Compared neonates with hip instability randomized to examination with ultrasound versus clinical assessment alone.

Subsequent hip development for both groups was assessed by pelvic radiograph at 2 years.
629 patients randomised

314 allocated to ultrasonography group

- 27 had no known radiograph at 12–14-months or at 24 months
- 5 had no hard copy of 12–14-month radiograph for panel to assess
- 22 with abnormal radiograph at 12–14 months did not have a radiograph at 24 months
- 2 had no hard copy of 12–14-month abnormal radiograph for panel to assess

258 analysed

315 allocated to no-ultrasonography group

- 15 had no known radiograph at 12–14-months or at 24 months
- 8 had no hard copy of 12–14-month radiograph for panel to assess
- 13 with abnormal radiograph at 12–14 months did not have a radiograph at 24 months
- 3 had no hard copy of 12–14-month abnormal radiograph for panel to assess

276 analysed
No ultrasonography before splint treatment

- Early prophylactic splinting
- Specialist examination

Persistently unstable

Suspicious

Stable

Monitor clinically up to 8 weeks of age

- Abnormality persists
  - Splint
- Normal
  - Leave unsplinted

Figure 2: Treatment guidelines for no-ultrasonography group
Figure 1: Treatment guidelines for ultrasonography group
<table>
<thead>
<tr>
<th>Hip treatment</th>
<th>Ultrasonography (n=314)</th>
<th>No-ultrasonography (n=315)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>167 (53%)</td>
<td>140 (44%)</td>
</tr>
<tr>
<td>Not known</td>
<td>21 (7%)</td>
<td>16 (5%)</td>
</tr>
<tr>
<td>Yes</td>
<td>126 (40%)</td>
<td>159 (50%)</td>
</tr>
<tr>
<td>Double nappies only</td>
<td>5 (2%)</td>
<td>4 (1%)</td>
</tr>
<tr>
<td></td>
<td>Ultrasonography (n=285) mean (SD)</td>
<td>No ultrasonography (n=288) mean (SD)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Cost*</td>
</tr>
<tr>
<td>Ultrasonographs</td>
<td>2.6 (2.7)</td>
<td>£42 (47)</td>
</tr>
<tr>
<td>Radiographs</td>
<td>2.2 (1.9)</td>
<td>£44 (38)</td>
</tr>
<tr>
<td>Outpatient visits</td>
<td>5.9 (3.9)</td>
<td>£322 (214)</td>
</tr>
<tr>
<td>Home visits</td>
<td>0.1 (0.9)</td>
<td>£10 (68)</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>0.3 (1.0)</td>
<td>...</td>
</tr>
<tr>
<td>Days in hospital</td>
<td>0.9 (3.4)</td>
<td>£267 (975)</td>
</tr>
<tr>
<td>Splints</td>
<td>0.4 (0.6)</td>
<td>£16 (23)</td>
</tr>
<tr>
<td>Other treatments</td>
<td>0.2 (0.7)</td>
<td>...</td>
</tr>
<tr>
<td>Days/other treatment</td>
<td>11.4 (42.8)</td>
<td>£23 (86)</td>
</tr>
<tr>
<td>Total cost</td>
<td>...</td>
<td>£724 (1178)</td>
</tr>
</tbody>
</table>
Elbourne Conclusions

Screening ultrasound in infants with clinical hip instability results in a reduction in treatment without increasing the likelihood of abnormal hip development or surgery.

Cost is not significantly higher when compared with clinical assessment alone.
Infants with Mild Dysplasia on Ultrasound
Immediate Treatment Versus Sonographic Surveillance for Mild Hip Dysplasia in Newborns

AUTHORS: Karen Rosendahl, MD, PhD,⁎⁺⁺ Carol Dezateaux, FMedSci,⁎ Kari Reine Fosse, MD,⁎ Hildergunn Aase, MD,⁎ Stein Magnus Aukland, MD,⁎ Hallvard Reigstad, MD,⁎ Terje Alsaker, MD,⁎ Dag Moster, MD, PhD,⁎ Rolf Terje Lie, PhD,⁎ and Trond Markestad, MD, PhD

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WHAT'S KNOWN ON THIS SUBJECT: Recent observational and small randomized studies have indicated that active surveillance in stable but mildly dysplastic hips is appropriate in newborns; however, data have been lacking on accurate radiological outcomes.

WHAT THIS STUDY ADDS: We report the long-term outcomes of watchful waiting for mild hip dysplasia.

abstract

OBJECTIVE: We conducted a blinded, randomized, controlled trial to examine whether mildly dysplastic but stable or instable hips would benefit from early treatment, as compared with watchful waiting.

PATIENTS AND METHODS: A total of 128 newborns with mild hip dysplasia (sonographic inclination angle [α angle] of 45°–49°) and stable or instable but not dislocatable hips were randomly assigned to receive either 6 weeks of abduction treatment (immediate-treatment group) or follow-up alone (active-sonographic-surveillance group). The main outcome measurement was the acetabular inclination angle, measured by radiograph, at 1 year of age.

RESULTS: Both groups included 64 newborns, and there was no loss to follow-up. With the exception of a small but statistically significant excess of girls in the active-sonographic-surveillance group, there were no statistically significant differences in baseline characteristics between the 2 groups. The mean inclination angle at 12 months was 24.2° for both groups (difference: 0.1 [95% confidence interval (CI): −0.8 to 0.9]), and all children had improved and were without treatment. The mean α angle was 59.7° in the treatment group and 57.1° in the active-surveillance group for a difference of 2.6° evaluated after 1.5 and 3 months (95% CI: 1.8 to 3.4; P < .001). At 1.5 months of age, the hips had improved in all treated children but not in 5 children under active surveillance (P = .06). Among the sonographic-surveillance group, 47% received treatment after the initial surveillance period of 1.5 months.

CONCLUSIONS: Active-sonographic-surveillance halved the number of children requiring treatment, did not increase the duration of treatment, and yielded similar results at 1-year follow-up. Given a reported prevalence of 1.3% for mildly dysplastic but stable hips, a strategy of active surveillance would reduce the overall treatment rate by 0.6%. Our results may have important implications for families as well as for healthcare costs. Pediatrics 2010;125:e6–e16
Cases of mild hip dysplasia randomized to immediate splinting or ultrasound surveillance

Subsequent hip development for both groups assessed by pelvic radiograph at 1 year
Clinical screening age 1-3 days

- At least one dislocatable or dislocated hip
- Neither hip dislocatable or dislocated

Risk factors:
- Family history DDH
- Breech at delivery

Ultrasound followed by clinical re-examination age 2-3 days

- Dysplasia?
  - Yes
  - No

- Dislocatable or dislocated hips?
  - Yes
  - No

Severe
- Mild
- None

Immediate treatment
- Eligible for trial
- Discharged to community
Eligible (n=140)

Ineligible (n=6)
- Consent not given (n=6)

128 randomised

Abduction splinting for at least 6 weeks (n=64) with ultrasound surveillance for 6 months
- Lost to follow-up (n=0)
- Discontinued intervention (n=0)
- Primary outcome not measured (n=0)
- Analysed (n=64)
- Excluded from analysis (n=0)

Active surveillance for 6 months (n=64)
- Follow-up at 6 weeks, 3 and 6 months and 1 year
- Lost to follow-up (n=0)
- Discontinued intervention (n=0)
- Primary outcome not measured (n=0)
- Analysis 1 year follow-up
- Analysed (n=64)
- Excluded from analysis (n=0)
<table>
<thead>
<tr>
<th>Primary End Point, °</th>
<th>Immediate-Treatment Group (n = 64), Mean (SE)</th>
<th>Active-Surveillance Group (n = 64), Mean (SE)</th>
<th>Treatment Effect (95% CI)</th>
<th>P&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al, 12 mo</td>
<td>24.2 (0.40)</td>
<td>24.2 (0.40)</td>
<td>0.1 (−0.8 to 0.9)</td>
<td>0.82</td>
</tr>
<tr>
<td>α angle, 1.5 mo</td>
<td>58.4 (0.48)</td>
<td>55.2 (0.51)</td>
<td>3.2 (2.1 to 4.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>α angle, 3 mo</td>
<td>61.0 (0.49)</td>
<td>59.0 (0.48)</td>
<td>2.0 (0.9 to 3.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Al, 6 mo</td>
<td>24.2 (0.38)</td>
<td>24.7 (0.42)</td>
<td>−0.4 (−1.3 to 0.4)</td>
<td>0.32</td>
</tr>
</tbody>
</table>

<sup>a</sup> Robust estimate accounting for correlated observations of hips of the same child.

<sup>b</sup> Estimated from original measurements by using random-effects models accounting for the correlation of hips from each child. The analyses were adjusted for gender.
Active sonographic surveillance of infants with stable but mildly dysplastic hips can reduce the use of abduction splinting treatment without increasing the risk of persistent or more severe dysplasia.
Overview of Findings of the AAOS and Cochrane Reviews
Unselected Infants
7537 infants

No significant difference in late diagnosed DDH

No significant difference in surgery

Significant increase in rate of treatment
Targeted Ultrasound Versus Clinical Examination

8312 infants

No significant difference in late diagnosed DDH

No significant difference in surgery

No significant difference in rate of treatment
Universal Ultrasound Versus Targeted Ultrasound

23,530 infants

No significant difference in late diagnosed DDH

No significant difference in surgery

Significant heterogeneity between studies reporting rate of treatment
Infants with Unstable Hips
708 infants

No significant difference in late diagnosed DDH

Significant reduction in treatment with sonographic surveillance
Infants with Mild Hip Dysplasia on Ultrasound
128 infants

No significant difference in late diagnosed DDH

Significant decrease in treatment
Implications for Future Research

1. Gaps in knowledge of the basic pathophysiology of hip dysplasia

2. Optimal diagnostic tools to be used to detect the condition

3. Benefits and harms of early and/or late diagnosis of DDH

4. Outcomes criteria that define successful or failed treatment

5. What constitutes “standard” brace treatment
Future Research

A large trial comparing ultrasound screening to clinical screening is required to determine if ultrasound is superior to clinical exam.
Thank You for Your Attention
References