Neonatal Hip Dysplasia: A New Perspective
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Neonatal Hip Dysplasia: A New Perspective

A. Graham Wilkinson, MB, BS, FRCR,* Sally Wilkinson, MCSP†

Author Disclosure
Dr and Ms Wilkinson have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

Abstract
This review of neonatal hip dysplasia examines the clinical and ultrasonographic literature that has guided current practice and discusses the controversies involved in detection and treatment of the condition. We present a view that combines clinical and ultrasonographic criteria in a simple and effective treatment decision pathway. Enthusiasm, specialization, and expertise in clinical and ultrasonographic aspects, with clear communication and cooperation between these two disciplines, are necessary to achieve an effective screening program.

Objectives After completing this article, readers should be able to:
1. List risk factors for developmental dysplasia of the hip (DDH).
2. Describe appropriate neonatal hip examination procedures.
3. Discuss initial treatment for DDH.
4. Describe ultrasonographic classification of the neonatal hip.
5. State the consensus opinion on the role of ultrasonography in screening for DDH.
6. List static ultrasonographic warning signs for DDH.

Introduction
Developmental dysplasia of the hip (DDH) represents a spectrum of abnormalities that ranges from a minor self-correcting abnormality with no long-term consequences to “congenital” hip dislocation with lifelong disability. Up to 29% of hip replacements in adults younger than 60 years of age are due to DDH. (1) Although genetic and hormonal factors may play some part, the primary cause is believed to be intrauterine restriction of fetal movement in later gestation. (2) Because most fetuses spend the last few weeks of pregnancy in one position, this is the critical period. The most common position for the fetus at birth is vertex presentation, with the left leg adjacent to the mother’s spine. The spine, being less compliant than other tissues bordering the uterus, indents it posteriorly, pushing the fetus’ left hip into adduction. In adduction, the hip is less stable and the femoral head is more easily displaced superolaterally, causing pressure of the upper aspect of the femoral head on the acetabular margin. This, in turn, causes subsequent molding of the joint surfaces, which are compliant due to their cartilage not yet being ossified. Distortion of the articular surfaces and the habituation to adduction predisposes to joint laxity, instability, and dislocation postnatally. Hip dysplasia is more common on the left because this is usually the side compressed by the maternal spine. Other presentations, such as extended breech, can result in either or both hips being affected.

Risk factors for DDH encompass any cause of intrauterine restriction, including first pregnancy, oligohydramnios, and breech presentation (especially extended breech), although 75% of babies requiring treatment do not have risk factors, other than being female. (3) Female babies are affected four to eight times more frequently than males due to their sensitivity to the maternal hormone relaxin. There is a relationship of DDH with caesarean section simply because large fetuses or those that have abnormal lies may need to be delivered operatively rather than vaginally. There is also a genetic element, with babies of mothers who have hip dysplasia having a considerably increased incidence. This may be

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due to a number of factors, possibly including collagen disorders causing hypermobility or pelvic or uterine characteristics.

Ortolani is widely recognized as the pioneer of congenital hip dislocation, publishing the description of his test for hip instability in 1937, (4) but the publication was in an Italian journal and received relatively little attention for a decade. His test relies on the finding that dislocation in older babies is usually posterior, so when the hips are flexed to 90 degrees with the knees together, during progressive abduction of the hips, a dislocated hip relocates with a palpable sudden movement. In the late 1940s, hip dysplasia began to be recognized as a treatable condition in neonates, with orthopaedic surgeons, including von Rosen in Sweden (5) and Barlow in the United Kingdom, (6) describing diagnosis in the early postnatal period using Ortolani’s test or modifications of it and instituting treatment using a variety of appliances to hold the hips in abduction. With the hip stabilized in the abducted position, the femoral head is held securely in the acetabulum, and joint remodelling occurs within a few months, thereby stabilizing the hip and preventing future disability. In the United Kingdom, the incidence of hip instability requiring treatment was reported initially as about 2.5 per 1,000 births but increased to 6 to 7 per 1,000 by the 1970s. (7)

Ultrasonography to assess the morphology of the hip examination was introduced in 1980 (8) and took several decades to become widely accepted. Now it is regarded as an essential component of the diagnostic pathway for babies who have suspected dysplasia. Approximately 5 to 7 babies per 1,000 births now are treated in Scotland. The increase may be due to ultrasonography detecting lesser degrees of dysplasia but also may be related to babies being placed supine to sleep to minimize the risk of sudden infant death syndrome. (9) Controversy persists over the relative merits of clinical and ultrasonographic examination in neonatal hip screening.

This article examines the clinical and ultrasonographic aspects of DDH and gives a combined personal opinion of the authors, who colead the hip screening and treatment program in Edinburgh, United Kingdom.

**Neonatal Hip Examination**

Becoming an expert in neonatal hip examination requires evaluation of many thousands of hips and awareness of the outcomes, with some learning resulting from feedback. Such expertise requires at least a couple of years to develop and in our institution is held by specialist pediatric physiotherapists, one of whom (SW) coleads the screening program and exclusively assesses, treats, and advises on neonatal hip problems. She coordinates all of the personnel involved from the maternity unit to the orthopedic outpatient clinic. Rotational junior neonatal staff are not experts and are documented to miss more than 50% of abnormal hips. (10) In an era of increasing litigation, the expertise of the neonatal hip examiner is likely to be subject to more scrutiny than in the past, and the cost of compensation for missed diagnoses could prove to be the stimulus for improving screening programs.

In addition to the general neonatal examination performed by rotational junior medical staff, the expert physiotherapists examine as many babies as possible, giving priority to those who have known risk factors for DDH, including big first-born overdue girls, babies who have features of molding, long babies, and those in whom the junior doctor is unsure. Nursery nurses are adept at recognizing babies who may be at risk and refer these to the expert physiotherapists.

Neonatal hip examination involves knowledge of any predisposing risk factor for hip dysplasia, observation of the baby at rest and during movement, and tests of stability. The neonate should be settled, comfortable, and fed prior to the examination. Haste due to early home discharge or an unsettled and “flexed-up” baby makes hip examination a challenge. The examination starts at the head, looking for features of molding due to intrauterine restriction such as plagiocephaly or torticollis. There may be an asymmetric lie due to scoliosis or foot deformity, particularly calcaneovalgus. (11)(12) The diaper should be removed to allow the essential observation of the groin and posterior gluteal creases. The affected hip exhibits more vernix in the inguinal fold, which is deeper than the unaffected side.

Abduction of the hips should be assessed by the examiner holding both legs with the tips of the fingers overlying the greater trochanters. The hips are flexed to 90 degrees and gently simultaneously abducted to their full range. A dislocated femoral head may be felt to relocate with a “clunk” or sliding movement during abduction.

The Barlow test (6) should be performed on each hip in turn. The pelvis should be cradled in the examiner’s hand, which stabilizes the sacrum. With the hip flexed to 90 degrees, gentle posterior pressure is exerted along the length of the femur so any posterior movement of the femoral head can be appreciated by the examiner’s fingers overlying the greater trochanter. A stable hip has a firm end feel, but a subluxing hip can be felt to move posteriorly and relocate on gentle anterior traction.
A similar push-pull test can be performed in other directions: posterosuperiorly and superiorly.

The Ortolani maneuver is a combination of the two previously described tests. With the hip flexed to 90 degrees, posterior pressure is applied to the hip, which is progressively abducted. If the hip is unstable, posterior movement can be felt, and during the first few degrees of abduction, the femoral head jumps forwards, relocating into the acetabulum with a “clunk.”

An experienced examiner may use a combination of any of these tests. A hip may be unstable in one direction only, and the degree of instability varies. In neonates, hips are rarely dislocated; asymmetric lie, limited abduction, and instability on the Barlow test are the most useful signs.

Inexperienced examiners often apply too much pressure and abduct forcefully, so they are unable to appreciate the subtle sensation of small degrees of movement caused by subluxation or relocation of the femoral head. They may not realize that hip relocation occurs within the first few degrees of abduction.

There is a group of babies whose position of comfort, due to restriction in utero, is to lie to one side (more often the right) with the contralateral (usually left) leg extended and adducted. Such babies often are described as “skew” (meaning oblique, slanting, sideways, or deformed) in the United Kingdom, but a term such as molded also can be used. There may be calcaneovalgus foot deformity on the right and hip dysplasia on the left. During clinical examination of the hip, the femoral head is unstable superiorly but is stable posteriorly during the Barlow/Ortolani maneuver and is easy to miss by an inexperienced examiner.

Babies in whom abnormalities are detected by the physiotherapist are referred for ultrasonographic examination. In the interval, parents are given positioning advice to encourage symmetric abduction of the hips. This may include placing a piece of rolled fabric under the side to which a baby tends to lie or some time spent lying prone in the “frog” position when awake.

DDH seems to be relatively uncommon in preterm babies, perhaps because of less restriction in utero or because preterm babies commonly are nursed in the supine position in neonatal units. Our practice is to delay decisions on treatment until the baby is 2 to 3 weeks corrected gestational age.

**Initial Treatment**

The decision to treat is based on the clinical and ultrasonographic findings and the baby’s age. Clinical and ultrasonographic findings should agree because they are simply different methods of assessing the degree of hip instability. Because instability detected in the neonatal period may resolve spontaneously, we rarely start treatment before the age of 3 weeks. Treatment involves application of an abduction device to keep the hip flexed and abducted. In this position, the hip cannot sublux superiorly or posteriorly, so the cartilaginous labrum ceases to be deformed and can develop and ossify normally. The entire process of stabilization and ossification of the acetabular margin takes approximately 12 weeks.

We use the Pavlik harness, which consists of four straps (two on each side) connecting soft booties to a chest band (Fig. 1). The front straps flex the hips and initially should be adjusted to restrict the hip to a minimum 100 degrees of flexion. In this position, when the baby attempts to extend the leg, the hip does not move out of joint. After approximately 1 week, the hip stabilizes, and thereafter, the safe range is 90 to 120 degrees of flexion. The back (abductor) straps are adjusted so the hip cannot be adducted to less than 50 degrees of abduction. The range is 50 to 80 degrees of unforced abduction. Natural posture varies widely, and the harness must be adjusted accordingly; no one prescription fits all infants. The baby's posture often normalizes within the first few weeks of treatment, and the harness is adjusted to accommodate such action.

Upon application of the harness, the parents are instructed how to care for and position their baby and are given an advice sheet (see Appendix in the data supple-
neonatal hip dysplasia

We do treat babies from other centers whose referral may determine whether it is in or out of joint. The person applying the device must be able to examine a hip and more important than which device is used. The expertise of the person applying the device is of the Pavlik harness is not a criticism of other types of rigid splint, however, is extremely effective, and our use of the Pavlik harness or similar splint up to the age of about 16 weeks. Babies presenting later with DDH can be treated with the Pavlik harness or similar splint up to the age of about 16 weeks. Beyond this age, it is likely that closed reduction, possibly with adductor tenotomy, and serial plaster casting will be necessary. Surgery with iliac osteotomy to stabilize the hip may be needed in children presenting after 1 year of age, but this is a failure of the screening process because a normal hip cannot be achieved.

Great care must be taken not to force the hip into abduction, which may reduce the blood supply to the femoral head, causing avascular necrosis that has been reported in 5% of babies treated in Pavlik harnesses and 30% of those treated in plaster spica. Expert application of the device should minimize such risk. We have had one case of avascular necrosis out of 223 babies with radiologic follow-up available whom we have treated in a harness at our center. This occurred in a baby who had severe congenital scoliosis in whom a gentle symmetric abduction was difficult to achieve. The higher incidence of avascular necrosis in other centers may be due to treatment beginning after 6 weeks of age, when adductor contractures can make abduction difficult. Another complication of screening and treatment is parental anxiety, which usually can be managed by simple reassurance. Maternal depression and lack of bonding with the baby have been noted in a few cases, but a causal link with treatment is uncertain. Lack of parental compliance can lead to treatment failure, although this has happened only once in our experience.

Alternative Splints

Other splints, such as the von Rosen (also known as the Malmo) splint, are used effectively in many centers. These more rigid splints have decreased in popularity in recent years, perhaps because of the perceived risk of avascular necrosis or the perception by parents that the baby may be uncomfortable in them. A proper application of the device is not a criticism of other types of devices; the expertise of the person applying the device is more important than which device is used. The person applying the device must be able to examine a hip and determine whether it is in or out of joint.

Treatment should begin no later than 6 weeks of age. We do treat babies from other centers whose referral may be delayed up to the age of 12 to 14 weeks, but this is regarded as suboptimal. Our experience is that treatment before 8 weeks of age leads to a normal radiograph at 1 year in 97% of hips and mild abnormality in 3%, but a normal radiograph can be expected in only 66% of those in whom treatment began at more than 8 weeks of age. Babies presenting later with DDH can be treated with the Pavlik harness or similar splint up to the age of about 16 weeks. Beyond this age, it is likely that closed reduction, possibly with adductor tenotomy, and serial plaster casting will be necessary. Surgery with iliac osteotomy to stabilize the hip may be needed in children presenting after 1 year of age, but this is a failure of the screening process because a normal hip cannot be achieved.
sonographic image with the landmarks labeled is shown in Figure 2 and without labeling in Figure 3A. Figure 3B shows the same image with the bony (alpha) angle of Graf measured. Figure 3C shows the same image with percent femoral head coverage measured.

Dynamic Imaging

With universal availability of real-time ultrasonography in the late 1980s, the technique of dynamic ultrasonography was introduced. (21) It was suggested that the hip should be flexed to 90 degrees and posterior pressure applied to the knee to determine whether there was laxity or instability, with posterior displacement of the femoral head in the acetabulum being detected during transverse scanning. Interobserver agreement for dynamic tests, however, is poor, with treatment recommended by radiologists varying from 7.4% to 23.9% of babies in one study. (22) Interobserver agreement is better, although only moderate, for static methods, (23)(24) and use of the Graf classification leads to a large number of indeterminate results that need follow-up. (25) Throughout the past 2 decades, while this debate has continued, three possible approaches were available: classify by angles (Graf method), percentage acetabular cover (Harcke/Morin method), and dynamic testing. In most centers, one or more of these classifications was used to report findings on hip ultrasonographic examinations performed by sonographers or radiologists to help orthopaedic surgeons to decide on management.

Which Hips to Treat?

The second controversy of which hips to treat is evidenced by the considerable variation in practice, with treatment rates ranging from 2 to more than 20 per 1,000 births. Some orthopaedic surgeons took the view that only clinically unstable hips (approximately 2 per 1,000 births) needed to be treated and that ultrasonography added little. There was disagreement as to whether dysplastic but stable hips should be treated. One of a few randomized, prospective trials suggested that although ultrasonographic morphology improved more quickly in treated babies, the outcome, as assessed by plain radiographs at 3 months and 24 months, was the same as for untreated babies. (26) In a similar study of 68 babies who had “mildly unstable” hips, five failed to improve and required treatment at 4 to 5 months of age. (27) The fear was that treatment of indeterminate hips could be doing more harm than good because of the complication of avascular necrosis, (28) and a trend developed to try to reduce rates of treatment as much as possible. (29) This policy might have been harmful by omission because indeterminate hips with only mild instability were not treated when, in retrospect, treatment may have been beneficial. Some of these children may present with dislocation later in childhood (30) or with premature osteoarthritis in adulthood that requires hip replacement. The latter may be much more frequent than hitherto recognized, as evidenced by a recent study from Norway involving collection of national statistics on hip instability at birth and arthroplasty. (31) In this report, 92% of patients undergoing hip arthroplasty ages 12 to 36 years because of prior hip dysplasia were recorded as having clinically stable hips at birth. This may be the first proof of the iceberg under the surface, that is, the unknown numbers of babies who have clinically undetectable hip dysplasia and develop adult disability.

Consensus on Role of Ultrasonography in Screening

The controversy surrounding the role of ultrasonography in screening appears to have been settled to some extent, with the consensus going against whole-population ultrasonographic screening. Such screening has been successful and cost effective in small areas, but it depends on local expertise and enthusiasm, which may
Figure 3. A. Normal hip ultrasonographic image. B. Normal bony (alpha) angle. C. Normal percent femoral head coverage of Harke/Morin (%FHC).
not be widely available, (32) and it has not been generally accepted into national screening programs, (33) with the exception of a few countries, including Germany. This may be partly attributed to the only moderate interobserver agreement in performing and interpreting ultrasonographic scans, (34) which could incur costs in whole-population screening due to false-positive and false-negative diagnoses.

Germany and Austria have instituted whole-population ultrasonographic screening. However, problems, including 8% patient failure in obtaining ultrasonography and 12% false-negative rates for ultrasonographic examination, result in a rate of operation for DDH of 0.26 per 1,000 live births in Germany. (35) In the United Kingdom, clinical screening was reported to be associated with an incidence of first operation for DDH of 0.78 per 1,000 births. (10) It is widely considered that clinical screening with ultrasonography being performed only to help manage clinically detected cases is the most cost-effective option. (28)(36) The use of ultrasonography in clinically detected cases can reduce the calculated treatment rate from 8.5 to 4.9 per 1,000 births. (37) The cost for each additional case detected by whole-population ultrasonography has been estimated as £0.3m in the United Kingdom. (28) A systematic literature review for the United States Preventive Services Task Force reported simply, “Screening with clinical examination or ultrasound can identify newborns at increased risk for DDH, but because of the high rate of spontaneous resolution of neonatal hip instability and dysplasia and the lack of evidence of the effectiveness of intervention on functional outcomes, the net benefits of screening are not clear.” (38)

Ultrasonography: Personal View

Methodology Concerns

Our own experience has led us to three conclusions that alter how we assess hips ultrasonographically. First, we believe that none of the Graf, Morin/Harke, or anterior-dynamic methods described previously is adequate in isolation. Second, we believe that a number of additional static ultrasonographic signs are helpful. Third, we believe that observation of the hip during spontaneous movement of the baby is much more valuable than the applied stress test.

Experience has shown that some babies who have Graf type 1 or 2 hips have needed treatment for deterioration or failure to mature on observation, indicating a lack of sensitivity of this test in our view. The large number of babies who have percentage femoral head cover in the indeterminate range shows that this test lacks specificity. We have difficulty assessing whether the degree of movement of the hip posteriorly during anterior dynamic testing is a reliable arbiter of the need for treatment; it depends on how much force is used and is...
difficult to measure, even with the benefit of cine recall loops. One study showed that up to 6.8 mm of movement can be considered normal in neonates younger than 48 hours of age. (39) Examiners frequently use too much force, and training and experience are essential to prevent this. (40) We use only the amount of force that can be achieved easily by use of the little finger alone. The hip may be lax in the first few weeks, only to stabilize later. If the cartilaginous rim at the posterior margin is deformed by gentle stress when the baby is 6 or more weeks old, we believe the hip should be treated. Hips also can be stressed in the superior direction, but this is difficult to standardize because the pelvis cannot be fixed easily.

**Static Ultrasonographic Warning Signs**

Several static ultrasonographic warning signs may be associated with instability and are invaluable. These may be seen during a hip ultrasonographic examination in which the subluxation itself is not observed and are:

1. The notched margin. A hip may be normal and appear stable but a notch be appreciated at the superior margin in the sagittal plane. This indicates that the hip is, or has been, unstable. The notch presumably is due to pressure of the upriding femoral head on the margin that, due to repeated deformation, prevents ossification. We noted this sign independently, and only after several years of using it, discovered that it had been described several years previously. (41) It is a warning sign that an otherwise normal hip may be unstable (Fig. 4).

2. Loss of concavity of the acetabulum. This is associated with flattening of the femoral head, (42) so instead of the concentric hemispheres of the ball-and-socket joint allowing rotation without movement of the centers, part of the articulation (usually the superior part) becomes planar and allows superolateral sliding of the head in the acetabulum. This is believed to be due to postural molding of the joint in utero, when restriction of the fetus has occurred in the later stages of gestation. It is particularly evident in extended breech babies (Fig. 5).

3. Thickening and increased echogenicity of the labrum and joint capsule. This is likely to be due to deformation and stretching, respectively, during subluxation of the joint (Fig. 6).

4. The ultrasonographic vacuum phenomenon. Bubbles of vapor can form in synovial fluid when pressure is reduced below atmospheric due to rotation of adjacent incongruous articular surfaces. Bubbles appear very
bright and can be seen between the striated low echogenicity of the femoral head and the homogenous low echogenicity of the acetabular cartilage (Fig. 7). Fluid with bright bubbles “sloshing” around in the joint during movement of the baby indicates that the hip is acting like a peristaltic pump because of incongruity (see video clip 1 in the data supplement). This is an indirect sign of the flattening of the articular surfaces.

Figure 8. A. Abnormal hip ultrasonographic finding. Note the deformed labrum (arrow). B. Abnormal bony alpha angle. C. Abnormal percent femoral head coverage.
Observation of Instability Without Stress Testing

Finally, we believe that a formal stress test rarely is needed; we simply watch the hip with the ultrasonographic probe in both sagittal and coronal planes while the baby wriggles spontaneously. If there is movement of the femoral head with any deformity of the cartilaginous rim either posteriorly or superiorly, the hip should be considered unstable (see video clip 2 in the data supplement) and treated by the age of 6 weeks at the latest unless it becomes completely stable and morphologically normal by that age. This has the advantage of observing instability in physiologic conditions and should be more reliable than an applied test in which the force, direction, and pelvic stabilization vary.

Standard Procedure for Ultrasonographic Examination

Our standard procedure is as follows:
1. Perform ultrasonography without reading the clinical information to prevent bias.

Figure 9. A. Equivocal hip ultrasonographic finding. B. Equivocal bony alpha angle. C. Percent femoral head coverage within normal range.
2. Examine the baby in the true lateral position in an immobilizing foam pad.

3. Always starting with the right hip, take a static image in the standard plane and measure the alpha angle and percent acetabular cover, which are useful for assessing progress rather than for deciding whether the hip needs treatment.

4. Observe the hip during wriggling both in the sagittal and transverse planes to detect spontaneous instability (defined simply as deformation of the cartilaginous labrum). If instability is seen, this is recorded as a cine clip. If the hip is stable, this is recorded in text on the image.

5. Look for and record any of the static signs.

6. If the hip is not completely normal morphologically (alpha angle <70 degrees) and no spontaneous instability has been detected, perform an anterior dynamic stress test in the transverse plane (see video clip 3 in the data supplement) and a longitudinal stress test in the coronal plane (see video clip 4 in the data supplement).

7. Repeat steps 3 to 5 for the left hip.

A normal hip has an alpha angle of more than 70 degrees and percent acetabular cover of more than 55%, is stable, and has no static warning signs. If the physiotherapist agrees the hip appears normal, the baby can be discharged (Fig. 3). An abnormal hip has instability detected on spontaneous wriggling of the baby. If unequivocal, the baby is treated at the first visit if 2 or more weeks old (Fig. 8). An equivocal hip has no spontaneous instability but is not normal morphologically or has static warning signs or is lax or unstable on stress testing. Parents are advised to lay these babies prone (when awake), and they are reviewed at the age of 6 weeks. If the hip is not completely normal at 6 weeks, the baby should be treated (Fig. 9).

The duration of treatment depends on age and parental compliance. If treatment begins at 3 weeks of age, 6 weeks of treatment may suffice. Older babies may require up to 16 weeks in the harness. Optimally, we prefer the hips to be completely normal on ultrasonography before removing the harness, but babies who are older at the beginning of treatment may not achieve this milestone.

### Table 1. Summary of Evaluation and Treatment Process

<table>
<thead>
<tr>
<th>Neonatal Ward</th>
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<tbody>
<tr>
<td>All babies who have risk factors or molding and those whom the junior medical staff feel concern for any reason are referred to the specialist physiotherapist. The specialist physiotherapist also examines as many babies without risk factors as is possible, given time restraints.</td>
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<table>
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<tr>
<th>0 to 3 Weeks of Age</th>
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<tbody>
<tr>
<td>First assessment by specialist physiotherapist with 3 possible outcomes</td>
</tr>
<tr>
<td>● Normal clinical examination: Discharge with no further follow-up</td>
</tr>
<tr>
<td>● Molded, limited abduction or hip laxity: Positioning advice and review at 6 weeks of age in the combined clinic (expert physiotherapist and radiologist)</td>
</tr>
<tr>
<td>● Unstable hip or hips: Review in next combined clinic (at age of 3 to 6 weeks)</td>
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</table>

<table>
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<tr>
<th>3 to 6 Weeks of Age</th>
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<tbody>
<tr>
<td>Assessment in combined physiotherapist and ultrasonography clinic</td>
</tr>
<tr>
<td>● If clinically and ultrasonographically unstable, commence treatment immediately</td>
</tr>
<tr>
<td>● If 3 weeks of age and equivocal clinically or ultrasonographically, review again in combined clinic at age of 6 weeks</td>
</tr>
<tr>
<td>● If 6 weeks of age and still equivocal clinically or ultrasonographically, commence treatment</td>
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<th>Follow-up</th>
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<tr>
<td>Radiograph at 1 year and magnetic resonance imaging at 5 years for all treated babies and those who were classified initially as equivocal</td>
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</table>

### Joint View

We believe that there is potential for miscommunication between the person performing the ultrasonographic observation and assigning a classification based on angle, percentage femoral head cover, or stability and the person deciding on treatment, whose perception of this classification may be different. The ideal approach would be if the sonographer simply decided the hip fell into one of three categories: normal (no need to review), equivocal (seek clinical opinion and review after an interval), and abnormal (treat).

It was agreed in our institution that the hip assessment would be performed primarily by the specialist physiotherapist. If the result is normal, she discharges the baby without further assessment. The physiotherapist filters cases and refers for hip ultrasonography only those babies in whom she suspects hip instability. The hip ultrasonographic examinations are performed almost exclusively by one radiologist. If both physiotherapist and radiologist agreed the hips are normal, the baby is discharged. If both agree that a hip is unstable, the baby is treated without delay. If the hip findings are equivocal, we
suggest that the parents position the baby as recommended by the physiotherapist until the age of 6 weeks. A second clinical and ultrasonography examination is performed at that time, and unless the both hips are completely normal, the baby is treated. We use the cut-off of 6 weeks because, in our experience, treatment before 8 weeks of age leads to a normal hip radiograph at 1 year in 97% cases. Such findings drop to 66% if treatment is begun after 8 weeks.

In many cases, equivocal hips improve because the parents comply with the physiotherapist’s positioning advice; almost always the hips are normal at the second examination at 6 weeks of age. If the parent does not comply with positioning advice, the radiologist may see deterioration or lack of improvement, and almost invariably the physiotherapist concurs that the baby continues to lie to one side or the affected hip remains tight. Such concurrence is to be expected because the ultrasonographic and clinical assessments simply look at the same phenomenon from different perspectives. A summary of the evaluation and treatment process is provided in Table 1, and results of the screening program for 2008 to 2009 are provided in Table 2.

### Table 2. Results of Screening Program 2008 to 2009

| Birth Rate: 7,000 per year (total 14,000) | Percent examined by expert physiotherapists: 33% |
| Percent referred for ultrasonographic examination: 2.3% | Outcome (normal radiograph at 1 year): 97% of treated babies |
| Approximate cost of screening program: £100,000/year | Number of known missed hips: 2 (0.14/1,000) (neither examined by expert physiotherapist) |

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NeoReviews Quiz

1. Developmental dysplasia of the hip (DDH) is a spectrum of abnormalities that ranges from a minor, self-correcting abnormality to hip dislocation with lifelong disability. Of the following, the primary risk factor for DDH is:

A. Fetal movement restriction.
B. Genetic predisposition.
C. Hormonal influence.
D. Male sex.
E. Preterm gestation.

2. The Barlow maneuver for the diagnosis of DDH includes cradling the pelvis to stabilize the sacrum, flexing the hip to 90 degrees toward the trunk, and applying gentle posterior pressure along the length of the femur. Of the following, the most useful sign of DDH on the Barlow maneuver is:

A. Clunking sound within the acetabulum.
B. Increased vernix in the inguinal fold.
C. Leg extension contralateral to the affected side.
D. Sensation of posterior movement and relocation on gentle anterior traction.
E. Limited abduction of the hip.

3. Ultrasonographic imaging of the hip is being used increasingly in the diagnosis of DDH and in the selection of newborns for treatment. Of the following, according to Wilkinson and Wilkinson, the best ultrasonographic measure for the diagnosis of DDH is:

A. Andersson/Funnemark measurement of the posterior displacement of the femoral head in the acetabulum by dynamic scanning.
B. Graf measurement of the alpha-angle between the bony roof of the acetabulum and the baseline.
C. Graf measurement of the beta-angle between the cartilaginous roof of the pelvis and the baseline.
D. Morin/Harke measurement of the percentage of the femoral head within the bony acetabulum.
E. Spontaneous subluxation of the femoral head with deformation of the cartilaginous labrum.
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