Ultrasound for Infants at Risk for Developmental Dysplasia of the Hip

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The best screening method for developmental dysplasia of the hip is controversial. Ultrasonography is sensitive, but cost-effectiveness may limit its use. This study assessed whether ultrasound screening would increase in effectiveness if targeted toward infants with established risk factors for developmental dysplasia of the hip and normal findings on physical examination. All ultrasound scans performed at the authors’ institution from January 2007 through January 2011 to screen for developmental dysplasia of the hip were reviewed. Infants with risk factors for developmental dysplasia of the hip and normal findings on physical examination by orthopedic faculty or a pediatrician were selected. Of the 530 cases that were reviewed, 217 had risk factors for developmental dysplasia of the hip and normal findings on physical examination. Mean age of the 217 selected patients was 6.9 weeks. Of the patients, 83% were female, 77% had breech presentation, 30% were firstborn children, 13% had intrauterine packaging abnormalities, and 3% had a family history of developmental dysplasia of the hip. Of the 217 infants, 44 had 1 risk factor, 121 had 2 risk factors, 46 had 3 risk factors, and 6 had 4 risk factors. Dynamic ultrasound evaluation showed instability in 17 patients, for a 7.8% incidence of developmental dysplasia of the hip. All 17 patients were treated with a Pavlik harness. The results suggested that selective ultrasound screening may be effective in infants with risk factors and normal findings on physical examination. Selective ultrasound screening changed treatment management in almost 8% of patients and clinical follow-up in 6.5%. Analysis of the cost-effectiveness of screening is needed. [Orthopedics. 2015;38(8):e722-e726.]

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Developmental dysplasia of the hip is the most common hip pathology noted in infants.\(^1\) It includes a wide spectrum of abnormal relationships between the femoral head and the acetabulum. Late diagnosis may lead to early development of osteoarthritis in addition to abnormal or painful gait.\(^2\) The goal is early diagnosis. Developmental dysplasia of the hip is traditionally detected on physical examination. Early diagnosis typically leads to early treatment with a Pavlik harness.\(^3\)\(^5\)

Ultrasound has been used as a screening tool in addition to physical examination. Ultrasound evaluation has advantages over physical examination and plain radiographs, including visualization of the cartilaginous femoral head, avoidance of radiation exposure, and opportunity for dynamic examination.\(^6\) Ultrasound is considered more sensitive than physical examination in detecting developmental dysplasia of the hip\(^7\)\(^8\) and is the study of choice for equivocal examinations in patients younger than 6 months.\(^9\) However, the role of ultrasound in screening for developmental dysplasia of the hip is controversial. Some European countries, such as Germany and Austria, have universal screening.\(^10\) However, other countries, such as the United States, use a more selective screening protocol that consists of screening infants with risk factors and those with abnormal or unclear findings on physical examination. Meta-analysis of the literature showed that neither ultrasound strategy showed superior clinical outcomes, including improved late diagnosis or surgery.\(^11\) In addition, the findings of cost analysis between screening strategies are variable.\(^12\)\(^14\)

At the authors’ institution, all infants undergo physical examination performed by their pediatrician. Ultrasound evaluation is used for infants with abnormal findings on physical examination and those with normal findings who have risk factors for developmental dysplasia of the hip. Infants with abnormal findings on physical examination or ultrasound are referred to a pediatric orthopedist. Risk factors include breech presentation, first-born status, female sex, family history of developmental dysplasia of the hip, and intrauterine packing abnormalities.\(^15\)\(^19\) This study evaluated the effectiveness of ultrasound as a screening tool in this subgroup of at-risk infants with normal findings on physical examination. The hypothesis was that ultrasound evaluation in this subgroup would increase diagnosis and early treatment.

**Materials and Methods**

The institutional review board approved this clinical retrospective study. All hip ultrasound scans performed between January 2007 and January 2011 were evaluated for physical examination findings, risk factors, and ultrasound findings. Physical examination was performed by a pediatric orthopedic faculty member or resident. Hip stability was determined by findings on Barlow and Ortolani maneuvers. Inclusion criteria were normal Barlow and Ortolani findings on physical examination, no previous treatment, dynamic hip ultrasound, and risk factors for developmental dysplasia of the hip. Risk factors included breech presentation, female sex, first-born status, family history of developmental dysplasia of the hip, and intrauterine packing abnormalities, such as twins or oligohydramnios. Exclusion criteria included abnormal findings on physical examination, previous treatment with a Pavlik harness, and absence of risk factors. Abnormal examination findings included unstable findings on Barlow and Ortolani maneuvers, leg length discrepancy, hip click, asymmetric thigh folds, and decreased abduction.

Ultrasound evaluations were performed and read by a senior radiologist (L.E.S.). At the authors’ institution, instability on dynamic ultrasound was defined as dislocation or subluxation with Barlow maneuver or reduction with Ortolani maneuver. Dysplastic appearance of the hip (eg, steep acetabular roof, mild ligament laxity at rest) without instability was not considered abnormal (Figure 1). Infants were categorized into 3 groups based on chart findings. Infants with stable findings on dynamic ultrasound and normal morphologic features were categorized as normal, those with stable findings on dynamic ultrasound but dysplastic morphologic features were categorized as stable/dysplastic, and those with unstable findings on dynamic ultrasound were classified as having developmental dysplasia of the hip. In the stable/dysplastic group, the standard treatment protocol was follow-up at 3, 6, 9, and 12 months, with physical.
examination and hip radiographs at each visit.

RESULTS

From January 2007 to January 2011, 530 hip ultrasound scans were performed. Of this group, 15 patients had incomplete charts and were excluded. Of the 515 remaining ultrasound scans, 236 were performed for assessment after treatment with a Pavlik harness, 52 were performed for confirmation of abnormal findings on physical examination, and 10 were performed for evaluation of other conditions, such as septic hip. The remaining 217 patients were infants who had a stable hip on physical examination, with risk factors for developmental dysplasia of the hip. Of these 217 infants, 186 (85.7%) were classified as normal, 14 (6.5%) were classified as stable/dysplastic, and 17 (7.8%) had developmental dysplasia of the hip (Figure 2). Instability occurred on the left side in 10 patients, on the right side in 4 patients, and bilaterally in 3 patients. The average age of all 217 infants at the time of ultrasound evaluation was 6.9 weeks. Those with stable ultrasound findings and normal hip morphology were 6.9 weeks old. Those with stable ultrasound findings but dysplastic hip morphology were an average of 8.3 weeks old. Those with unstable ultrasound findings were an average of 5.2 weeks old.

Table 1 shows the risk factors present during evaluation of all infants with stable findings on physical examination categorized by findings on dynamic ultrasound (normal, stable/dysplastic, developmental dysplasia of the hip). The risk factors reviewed included breech presentation, female sex, firstborn status, family history of developmental dysplasia of the hip, and intrauterine packaging abnormalities. For all 217 infants reviewed, 76.5% had breech presentation, 83.4% were female, 30% were firstborn children, 2.8% had a family history of developmental dysplasia of the hip, and 13.4% had an intrauterine packaging abnormality, with having a twin being the most common. Of the 166 infants with stable findings on physical examination and breech presentation as a risk factor, 12 (7.23%) had developmental dysplasia of the hip and 10 (6.02%) were classified as stable/dysplastic. Of the 181 female infants, 15 (8.29%) had developmental dysplasia of the hip and 13 (7.18%) had stable/dysplastic hips. Of the 66 infants with first-born status as a risk factor, 4 (6.06%) had developmental dysplasia of the hip and 2 had stable/dysplastic hips. Only 6 infants had a family history of developmental dysplasia of the hip. Of these, 2 (33.33%) had developmental dysplasia of the hip and 1 (16.67%) was classified as stable/dysplastic. Intrauterine packaging abnormalities were found in 29 patients. Of these, 2 (6.90%) had stable/dysplastic hips and no unstable hips were found on ultrasound.

Table 2 shows the number of risk factors found on presentation in infants with stable findings on physical examination and dynamic ultrasound evaluation. Most infants had 2 risk factors (56%), 20% had 1 risk factor, and 21% had 3 risk factors. The normal and stable/dysplastic categories showed distributions similar to those of the total population. In infants with developmental dysplasia of the hip, 71% had 2 risk factors, 17.7% had 1 risk factor, and 11.8% had 3 risk factors. Of the 121 infants who had 2 risk factors on presentation, 12 (9.92%) had developmental dysplasia of the hip. Of the 44 infants with 1 risk factor, 3 (6.82%) had developmen-

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![Figure 2](image-url)
tal dysplasia of the hip. Only 2 (4.35%) of the 46 infants with 3 risk factors had developmental dysplasia of the hip. None of the 6 infants with 4 risk factors had developmental dysplasia of the hip. In infants with multiple risk factors (2 or more), 8.09% had unstable findings on dynamic ultrasound compared with 6.82% in infants with 1 risk factor.

Of the 14 infants with stable/dysplastic hips shown on ultrasound, 5 were lost to follow-up or had insufficient follow-up, 2 were not referred to an orthopedic clinic and were followed by a pediatrician, and 7 were followed for 1 year. One patient who was followed had unstable findings on physical examination at the second follow-up visit. This patient was placed in a spica cast for 3 months and transitioned to an abduction brace that was worn until 18 months of age. No other abnormal imaging or clinical findings were noted after spica cast placement.

**DISCUSSION**

Screening and diagnosis of developmental dysplasia of the hip is primarily done through clinical examination with Barlow and Ortolani maneuvers. The sensitivity and specificity of the examination, however, depend on the expertise of the evaluator. Ultrasound has been suggested as a screening tool. A study that supported ultrasound showed that only 5% of cases of dislocation were missed on initial ultrasound, whereas clinical examination missed 37% of infants with developmental dysplasia of the hip.20 However, ultrasound screening also has disadvantages. Criticism of early universal screening includes concern about overdiagnosis because mild findings may resolve spontaneously. Screening would increase the rate of treatment and, secondarily, the rate of avascular necrosis as a result of treatment with a Pavlik harness. The additional cost of screening has been suggested as a limitation of early universal screening and would add to the cost of follow-up visits for overdiagnosed infants.

Although most patients with developmental dysplasia of the hip have no risk factors,21 screening based on risk factors has been proposed to limit overdiagnosis. Currently, the United States uses selective screening of infants with risk factors; however, some European nations employ universal ultrasound screening. A recent meta-analysis reported a relative risk of 3.75 for breech presentation, 2.54 for female sex, 1.44 for firstborn status, and 1.39 for family history.22 The current study showed a similar distribution of risk factors resulting in unstable findings on dynamic ultrasound after normal findings on physical examination, with female sex and breech presentation associated with higher risk than firstborn status. Family history as a risk factor had the highest percentage of unstable findings on ultrasound, but the numbers in this category were small. Infants with multiple risk factors had a slightly higher rate of instability than those with a single risk factor. Larger studies are needed to confirm this relationship. These results suggested that ultrasound has utility in evaluating infants with risk factors; however, studies have not confirmed that selective screening is more effective than universal screening.11

**Limitations**

Limitations of this study must be acknowledged. Because this study was a retrospective review, it was not possible to ensure that all infants born with risk factors were referred for ultrasound. Although pediatricians at the authors’ institution routinely use ultrasound to screen infants with breech presentation or a family history of developmental dysplasia of the hip, in accordance with the American Academy of Pediatrics recommendations, consensus on when to image infants with other risk factors is not established and varies among pediatricians. In addition, the study findings did not address the overall effect of risk factors on developmental dysplasia of the hip. It is possible that infants with risk factors had positive findings on clinical examination and were not included in the study cohort. This study attempted to determine the number of infants who had developmental dysplasia of the hip that was missed by physical examination alone. In addition, the authors cannot make conclusions regarding the risk of developmental dysplasia of the hip in infants without risk factors. Age at the time of ultrasound may have played a role in the findings. For patients with hip instability on ultrasound, the average age...
was 5.2 weeks vs an average age of 6.9 weeks for those with stable ultrasound findings. It may be difficult to differentiate between an immature hip and developmental dysplasia on ultrasound in the early stages of disease.

**CONCLUSION**

This study found an overall change in clinical management in 14.3% of infants with risk factors for developmental dysplasia of the hip and normal findings on clinical examination after dynamic ultrasound. There was a change in treatment for 8% of infants who had developmental dysplasia of the hip on ultrasound and a change in follow-up visits in 6.3% of patients as a result of dysplastic findings on ultrasound. All infants with developmental dysplasia of the hip on ultrasound examination were treated with a Pavlik harness. Those with dysplastic but stable hips were not treated with a Pavlik harness, but these patients had follow-up with radiographs every 3 months for 1 year. The use of ultrasound in this subgroup of infants is crucial for the diagnosis of developmental dysplasia of the hip. Further prospective studies are needed to confirm these findings.

**REFERENCES**