Is ultrasound screening for DDH in babies born breech sufficient?

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Abstract

Purpose To review our incidence of developmental dysplasia of the hip (DDH) in breech infants referred for ultrasound screening and to determine if subsequent follow-up radiographs are necessary in these patients with normal clinical and ultrasound examinations.

Methods A review of the clinical data and imaging studies of all children with the risk factor of breech presentation that were referred for orthopedic evaluation over a 5-year period was conducted. All patients were examined by a fellowship-trained pediatric orthopedic surgeon and all ultrasounds were done at approximately 6 weeks of age by an experienced ultrasonographer. Ultrasounds were evaluated using the dynamic method as described by Harcke. As per our protocol, all patients with normal screening ultrasounds were brought back for a final clinical examination and radiographic check at 4–6 months. Acetabular dysplasia was indicated by radiographic parameters—if there was severe blunting of the sourcil, abnormal acetabular index for age, or if there was significant asymmetry of acetabular

indices side-to-side—in the setting of clinical parameters—if there was greater than 10° difference in side-to-side abduction or symmetric abduction of less than 60°.

Results Three hundred patients with the risk factor of breech presentation were included. Thirty-four patients had clinically unstable hips; 266 had clinically stable hips and were screened by ultrasound. Sixty-four percent were female and 36% were male. Twenty-seven percent of these breech patients had abnormal screening ultrasounds and were subsequently treated. Of the remaining 73% with normal ultrasounds, who were returned per protocol at a mean of 5 months, 29% had evidence of dysplasia and underwent treatment. The diagnosis of dysplasia following a normal ultrasound was based on both radiographic and clinical parameters. Of the hips treated with a Pavlik harness, 62% had acetabular indices at least two standard deviations from the age-corrected average versus 26% of patients not treated. The average length of follow-up was 10 months.

Conclusions Retrospectively, we found that, at approximately 6 weeks of age, ultrasound screening of breech patients with clinically stable hips produces an incidence of DDH of 27%. In those patients with a normal ultrasound, 29%, at 4–6 months radiographic follow-up, were found to have dysplasia requiring treatment. This data supports breech as the most important risk factor for hip dysplasia and we, therefore, recommend careful and longitudinal evaluation of these patients with: a careful newborn physical examination, an ultrasound at age 6 weeks, and an anteroposterior (AP) pelvis and frog lateral radiograph at 6 months, as the risk of subsequent dysplasia is too high to discharge patients after a normal ultrasound.

Keywords Developmental dysplasia of the hip · Ultrasound · Breech presentation

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Introduction

Ultrasound is currently commonly used to evaluate infants' hips for developmental dysplasia of the hip (DDH), especially in patients with recognized risk factors, such as family history, positive clinical examination, and breech presentation [1]. However, the necessity and details of subsequent follow-up in patients with normal ultrasound examinations is not entirely clear. There have been several recent studies recommending no further follow-up for patients with risk factors for DDH and normal screening ultrasound examination [2–4]; none have specifically looked at patients that are born breech. Previously at our institution, patients born breech that were referred for hip evaluation were not routinely returned for X-rays if the screening ultrasound was normal. However, after noting several cases of hip dysplasia on follow-up radiographs, we began recommending that babies born breech with a normal screening ultrasound return at age 4–6 months for plain radiograph; this has been our practice for the last several years. The purpose of this study, therefore, is to retrospectively review the incidence of DDH in breech infants referred for ultrasound screening at our institution and to determine if subsequent follow-up radiographs are necessary in these patients with normal clinical and ultrasound examinations to pick up late, subtle dysplasia.

Methods

A retrospective review was conducted on all patients over a 5-year period that underwent ultrasound screening for DDH; those patients with the risk factor of breech presentation were identified. The clinical data and imaging studies were reviewed—all physical examinations were performed by a fellowship-trained pediatric orthopedist and all ultrasounds were done by an experienced, trained ultrasonographer. The hips were sonographically evaluated

by the dynamic method described by Harcke et al. [5, 6]. Patients with clinically unstable hips (i.e., Ortolani-positive hip) and/or abnormal ultrasounds were placed into a Pavlik harness. Patients who were considered 'normal' had clinically stable hips, full, symmetric abduction, and normal ultrasounds; they were brought back at 4–6 months for repeat physical examination and plain radiographic evaluation. At the 4–6-month follow-up visit, treatment with a Pavlik harness was determined based on a combination of radiographic parameters—severe blunting of the sourcil, abnormal acetabular index for age, or significant asymmetry of acetabular indices between sides [7, 8]—and clinical parameters—a 10° or greater difference in side-to-side abduction or symmetric abduction of less than 60° (Figs. 1 and 2).

Results

A total of 314 breech patients were identified over a 5-year period. Fourteen patients were excluded from further study—2/14 patients had comorbid conditions (arthrogryposis), 9/14 had insufficient medical records, and 3/14 had Pavlik treatment initiated elsewhere and we were unable to evaluate their initial ultrasound. Of the remaining 300 patients, 25 had an Ortolani- or Barlow-positive hips (unstable) and 9 had irreducible dislocations and treatment with a Pavlik harness was initiated. Therefore, 266 patients had clinically stable hips and were screened sonographically. Sixty-four percent were female and 36% were male, with an average age of initial examination and screening ultrasound of 6 weeks. Seventy-three patients (27%) had abnormal initial screening ultrasound, often associated with abnormal hip abduction, and were placed into a Pavlik harness as treatment. One hundred and ninety-three (73%) breech patients had normal initial ultrasounds and were asked to follow-up at age 4–6 months for a repeat clinical examination and plain radiograph. Sixty-two of these 193

Fig. 1 Case example #1. Twin male, breech position, with normal ultrasound at age 6 weeks. Follow-up X-ray at age 6 months (**a**, **b**) shows normal acetabular index, well-defined sourcil, sharp corners.

Examination was 70° of symmetric abduction. The patient was subsequently discharged

Fig. 2 Case example #2. First-born female, breech position, with normal ultrasound (**a**, **b**) at age 6 weeks with symmetric clinical abduction of 75°. Follow-up examination at age 4 months demonstrated abduction of 80° on the right, 70° on the left. Anteroposterior

(AP) and frog pelvis (**c**, **d**) demonstrate slightly increased acetabular index on the left as well as rounded corners, particularly on the frog-leg view (see *arrow*). The patient was placed into a Pavlik harness at this visit

(23% of the total number of patients) cases were lost to follow-up. The remainder returned at an average of 5 months; 93 of 131 patients (71%) had normal clinical examinations and radiographs and were discharged (Fig. 3). Thirty-eight patients (29%) were considered to be dysplastic based on clinical and radiographic evaluation and were placed into a Pavlik harness (Fig. 4). Although treatment was initiated based on the global assessment of both clinical and radiographic criteria, we noted that 62% of patients with normal ultrasounds ultimately treated with a Pavlik harness had acetabular indices at least two standard deviations greater than age-adjusted controls, as described by Scoles et al. [7] versus 26% of those not treated. In addition, underscoring the importance of clinical examination (hip abduction) in decision-making, 27% of patients treated with a Pavlik harness had greater than 10° difference in side-to-side abduction versus only 5% of patients not treated and 15% had symmetric abduction of less than 60° versus 5% of those patients not treated.

Discussion

The aim of our study was to evaluate the incidence of DDH in breech patients referred to our institution for screening ultrasound and to determine what, if any, radiographic

Fig. 3 Flow diagram of our results

follow-up is necessary. Breech presentation is a well-known risk factor for DDH, and rates in the literature vary based on the definition of dysplasia and the method of its determination. Suzuki and Yamamuro [9] reported an overall incidence of DDH among 6,559 infants as 0.7%, but 2% in footling presentation and 20% in single-breech presentation. DDH in their study was diagnosed clinically, with a

Fig. 4 Example of abnormal X-ray AP (a) and frog pelvis (b). Note the rounded corners, especially on the left (see arrow). Clinical abduction was 70° on the right and 80° on the left

positive Barlow examination. Holen et al. [10] reported a 6.1% incidence of neonatal hip instability in breech patients determined by clinical examination and confirmed by dynamic ultrasonography. An additional 3.7% had normal clinical examinations, but abnormal dynamic ultrasounds. In our current study, 9% of patients had a positive Barlow and/or Ortolani examination at the time of initial evaluation. When the diagnosis was based on ultrasonographic criteria, in the setting of abnormal hip abduction, we found that 27% of referred patients were considered to be dysplastic and were treated with a Pavlik harness. For those patients with an initially normal clinical examination and screening ultrasound, we found that 29% were considered to be dysplastic based on plain radiographs and clinical abduction. Other studies have reported frequencies of neonatal hip instability in breech newborns from 12 to 24% [9–13].

Ultrasound is known to be a safe and effective screening tool for hip dysplasia in infants, especially before the appearance of the femoral head ossific nucleus, and has been advocated to decrease the incidence of late-detected hip dysplasia. However, the recommendations regarding the radiographic follow-up of hips deemed normal by screening ultrasound are less clear. Several authors have suggested that patients can be discharged following a normal screening ultrasound. Jellicoe et al. [3] identified 226 ‘at-risk’ infants (click, family history, breech, abnormal skin creases, clubfoot, and unstable hips) referred to their institution over a 3-year period for screening. They classified their patients based on ultrasound into four groups: normal, shallow but stable, shallow and unstable, and dislocated. One hundred and thirty-nine patients were considered to be normal and were reviewed by X-ray at 12 months. Forty failed to follow-up or refused X-ray. All of the remaining patients were considered normal at 12 months. Of the 69 hips considered to be shallow but stable, 61 improved with observation and serial ultrasounds; seven did not improve and were placed into a Pavlik harness. One was lost to follow-up for 3 months and was noted to have developed a

dislocated hip upon return, requiring closed reduction; 12% of their ‘shallow but stable’ patients required treatment. Our results were quite similar in our number of patients with normal screening ultrasounds being treated as well. However, despite 12% of patients in their study receiving treatment, and even one patient requiring surgery, the authors recommended discharge following a normal ultrasound examination [3].

Arumilli et al. [2] evaluated 100 patients with a family history of DDH referred for screening; all had normal clinical examinations and normal screening static ultrasounds. Of the 89 available for final review, 71 had normal radiographs at 6–8 months and the remainder had normal radiographs by 24 months of age. They also recommend the discharge of patients with a family history of DDH and normal screening static ultrasound. Their results and recommendations correspond with those reported by Osarumwense et al. [4] on 181 children with a family history of DDH and normal screening ultrasounds. Two of those patients had abnormal radiographs at 9–12 months of age, but both resolved with observation.

However, hip dysplasia is known to be an evolving condition that often improves, but may also worsen, over time. Rafique et al. [14] published a case report of a female patient born breech at 35 weeks that had a normal clinical examination at 4 days of age and a normal static ultrasound. She was deemed ‘normal’ at 8 months, but was re-referred by her pediatrician at 12 months and was found to have a dislocated right hip. Jones et al. [15] reported seven dislocations at follow-up radiographs in five patients with initially normal dynamic and static ultrasound; they recommended a pelvic radiograph at 4–6 months in patients with a normal ultrasound to prevent these late misses.

In our review, we identified 266 patients with the risk factor of breech presentation and stable clinical examination; 27% of these patients had abnormal screening ultrasounds and were subsequently treated with a Pavlik harness. We prefer to use the Harcke dynamic method for infant hip

ultrasound. It has been shown that the interobserver and intraobserver agreement ratios of the Graf classification are only 51% and 65%, respectively [16] and that dynamic assessment is a more reliable predictor of radiographic outcome [17]. Of the 131 infants with normal screening ultrasound who returned at an average of 5 months follow-up, 29% had abnormal findings and were treated. Although the decision to treat was made in the setting of both clinical and radiographic evaluation, the percentage of patients with normal ultrasounds who were treated at the 4–6-month mark that had acetabular indices at least two standard deviations greater than age-adjusted normal values [7] was 62% versus 26% of those patients ultimately discharged. Consistent, non-rotated pelvic radiographs can be difficult to obtain in this patient population, and the measurement error of acetabular indices ranges from 2° to 6° [18–20]. We, therefore, take both anteroposterior (AP) and frog-leg pelvis X-rays in an attempt to capture the best possible view of the hips, which we find especially helpful in evaluating the quality of the sourcil and measuring the acetabular index. The decision to treat is based on clinical abduction, as well as radiographic parameters, at our institution; upon retrospective review, we found that, at the visit where the decision to treat was made, 27% of patients placed in a Pavlik harness had a greater than 10° side-to-side difference in abduction and 15% had symmetric abduction of less than 60°. In summary, we do not base treatment decisions exclusively on X-ray measurements, but, rather, on a more global evaluation of the patient's physical and radiographic examination.

There are several limitations to our study. It is retrospective and has a limited follow-up of only 10 months, on average, an age when the hip joint is still developing. There is the possibility that we are over-treating, and some of these hips may have ultimately normalized. However, the treatment of mild dysplasia at a young age with a harness is fairly simple and has relatively low morbidity in comparison to the surgical treatment of an older child with missed or persistent dysplasia. Therefore, at our institution, we treat patients with clinically stable but subtly radiographically dysplastic hips with a Pavlik harness based on the belief that every attempt should be made to ensure the development of a normal hip joint that will last a lifetime. Weinstein has written, “the only guarantee of a lifetime of normal hip function is a completely normal radiographic appearance of the hip” [21]. As many authors have shown, subtle dysplasia not detected in adolescence and early adulthood can lead to significant morbidity in later life [22–27]. It remains to be evaluated by further study what the optimal detection and treatment of these patients in infancy may be, and, if early, aggressive bracing treatment will decrease the development of later dysplastic acetabulae requiring pelvic osteotomies in young adulthood.

The findings of our study support those of others that breech presentation is the most important environmental risk factor for hip dysplasia [28] and that these patients require more vigilant evaluation. Our current protocol for breech patients, in addition to a careful newborn physical examination, is to screen with physical examination and dynamic ultrasound at 6 weeks of age and, if normal, to follow-up at 6 months for an evaluation of abduction, as well as AP pelvis and frog-leg lateral radiographs. This was developed after noting a small, but not insignificant, rate of acetabular dysplasia in those patients that followed up. At this point, we feel that the risk of subsequent dysplasia is too high to discharge patients after normal ultrasound, but further longitudinal studies will need to be done to validate any one protocol in this patient population.

References

1. Committee on Quality Improvement, Subcommittee on Developmental Dysplasia of the Hip. American Academy of Pediatrics (2000) Clinical practice guideline: early detection of developmental dysplasia of the hip. *Pediatrics* 105:896–905
2. Arumilli BR, Koneru P, Garg NK, Davies R, Saville S, Sampath J, Bruce C (2006) Is secondary radiological follow-up of infants with a family history of developmental dysplasia of the hip necessary? *J Bone Joint Surg Br* 88:1224–1227
3. Jellicoe P, Aitken A, Wright K (2007) Ultrasound screening in developmental hip dysplasia: do all scanned hips need to be followed up? *J Pediatr Orthop B* 16:192–195
4. Osarumwense D, Popple D, Kershaw IF, Kershaw CJ, Furlong AJ (2007) What follow-up is required for children with a family history of developmental dysplasia of the hip? *J Pediatr Orthop B* 16:399–402
5. Harcke HT, Clarke NM, Lee MS, Borns PF, MacEwen GD (1984) Examination of the infant hip with real-time ultrasonography. *J Ultrasound Med* 3:131–137
6. Clarke NM, Harcke HT, McHugh P, Lee MS, Borns PF, MacEwen GD (1985) Real-time ultrasound in the diagnosis of congenital dislocation and dysplasia of the hip. *J Bone Joint Surg Br* 67:406–412
7. Scoles PV, Boyd A, Jones PK (1987) Roentgenographic parameters of the normal infant hip. *J Pediatr Orthop* 7:656–663
8. Tönnis D (1976) Normal values of the hip joint for the evaluation of X-rays in children and adults. *Clin Orthop Relat Res* 119:39–47
9. Suzuki S, Yamamuro T (1986) Correlation of fetal posture and congenital dislocation of the hip. *Acta Orthop Scand* 57:81–84
10. Holen KJ, Tegnander A, Terjesen T, Johansen OJ, Eik-Nes SH (1996) Ultrasonographic evaluation of breech presentation as a risk factor for hip dysplasia. *Acta Paediatr* 85:225–229
11. Bache CE, Clegg J, Herron M (2002) Risk factors for developmental dysplasia of the hip: ultrasonographic findings in the neonatal period. *J Pediatr Orthop B* 11:212–218
12. Dunn PM (1976) Perinatal observations on the etiology of congenital dislocation of the hip. *Clin Orthop Relat Res* 119:11–22
13. Bower C, Stanley FJ, Krickler A (1987) Congenital dislocation of the hip in Western Australia. A comparison of neonatally and postneonatally diagnosed cases. *Clin Orthop Relat Res* 224:37–44
14. Rafique A, Set P, Berman L (2007) Late presentation of developmental dysplasia of the hip following normal ultrasound examination. *Clin Radiol* 62:181–184

15. Gwynne Jones DP, Dunbar JD, Theis JC (2006) Late presenting dislocation of sonographically stable hips. *J Pediatr Orthop B* 15:257–261
16. Omeroğlu H, Biçimoğlu A, Koparal S, Seber S (2001) Assessment of variations in the measurement of hip ultrasonography by the Graf method in developmental dysplasia of the hip. *J Pediatr Orthop B* 10:89–95
17. Portinaro NM, Murray DW, Bhullar TP, Benson MK (1995) Errors in measurement of acetabular index. *J Pediatr Orthop* 15:780–784
18. Engesaeter LB, Wilson DJ, Nag D, Benson MK (1990) Ultrasound and congenital dislocation of the hip. The importance of dynamic assessment. *J Bone Joint Surg Br* 72:197–201
19. Boniforti FG, Fujii G, Angliss RD, Benson MK (1997) The reliability of measurements of pelvic radiographs in infants. *J Bone Joint Surg Br* 79:570–575
20. Broughton NS, Brougham DI, Cole WG, Menelaus MB (1989) Reliability of radiological measurements in the assessment of the child's hip. *J Bone Joint Surg Br* 71:6–8
21. Herring JA (2008) Developmental dysplasia of the hip. In: Herring JA (ed) *Tachdjian's pediatric orthopaedics*, 4th edn. Saunders Elsevier, Philadelphia, p 649
22. Weinstein SL, Mubarak SJ, Wenger DR (2004) Developmental hip dysplasia and dislocation: part II. *Instr Course Lect* 53: 531–542
23. Harris WH (1986) Etiology of osteoarthritis of the hip. *Clin Orthop Relat Res* 213:20–33
24. Solomon L (1976) Patterns of osteoarthritis of the hip. *J Bone Joint Surg Br* 58:176–183
25. Stulberg SD, Harris WH (1974) Acetabular dysplasia and development of osteoarthritis of the hip. In: Harris WH (ed) *The hip: Proceedings of the Second Open Scientific Session of the Hip Society*. CV Mosby, St. Louis, MO, pp 82–93
26. Cooperman DR, Wallenstein R, Stulberg SD (1983) Acetabular dysplasia in the adult. *Clin Orthop Relat Res* 175:79–85
27. Ganz R, Leunig M, Leunig-Ganz K, Harris WH (2008) The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clin Orthop Relat Res* 466:264–272
28. Carter CO, Wilkinson JA (1964) Genetic and environmental factors in the etiology of congenital dislocation of the hip. *Clin Orthop Relat Res* 33:119–128