Original Article

Investigating the need for routine ultrasound screening to detect developmental dysplasia of the hip in infants born with breech presentation

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This research project originated and was conducted at Queen's University in Kingston, Ontario, Canada. Ethics was obtained from the Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (HSREB) at Queen's University.

Abstract

Objectives: Breech presentation is a recognized risk factor for developmental dysplasia of the hip (DDH). Within North America, there is a lack of consensus on screening guidelines for DDH in infants with a negative physical examination of the hips. This study evaluates the need for ultrasound screening in all breech born infants to detect DDH and whether this is influenced by gender, gestational age and mode of delivery.

Methods: A retrospective chart review was conducted to identify breech born infants who underwent routine hip ultrasound to detect DDH between 2010 and 2015. Patients were grouped by physical exam and ultrasound findings and compared based on gender, gestational age and mode of delivery.

Results: Three hundred and eighteen patients were identified (191 female, 127 male; 26 preterm, 57 late preterm, 235 term; 263 caesarean section delivery, 55 vaginal delivery). Three hundred and eight patients had a negative physical exam of which 27 were diagnosed with DDH based on screening ultrasound with females predominant ($P < 0.05$). 12.50% of females with a negative physical exam had DDH compared to 3.23% of males ($P < 0.05$). There was no difference in the rate of DDH detected by screening ultrasound based on gestational age ($P = 0.94$) or mode of delivery ($P = 0.59$).

Conclusions: The diagnosis of DDH in breech born infants by screening ultrasound in those with a negative physical exam of the hips is more predominant in females, with no apparent association with gestational age or mode of delivery. Future analyses with larger sample sizes are needed before conclusions can be made on screening protocols.

Keywords: *Developmental Dysplasia of the Hip; Congenital Hip Dislocation; Breech Presentation; Ultrasonography; Screening.*

Developmental dysplasia of the hip (DDH) comprises a spectrum of hip abnormalities including an immature hip, acetabular dysplasia, femoral head subluxation and hip dislocation (1,2). Identified risk factors for DDH include breech presentation, female gender, positive family history and being first born (3–5). There is inconsistent evidence that infants born via caesarean section may be at less risk of DDH (4–6). Prematurity was often thought to be protective, however recent evidence

suggests that premature infants are at equal risk to term infants in developing DDH (7). While up to 88% of detected hip abnormalities spontaneously resolve by 2 months of age (8), if undetected, DDH can lead to early degenerative arthritis (9) and increased need for hip arthroplasty (10,11).

Detection of DDH in infants by physical exam is classically done with the manoeuvres described by Barlow (8) and Ortolani (12). Previously, plain radiography of the hips was the

gold standard for diagnosis, however in the past several decades, a shift toward ultrasound has predominated for diagnosis in early infancy (13). The use of a Pavlik harness is the first-line treatment for DDH that does not spontaneously resolve with progression to surgical open reduction when conservative treatment is unsuccessful (14). Avascular necrosis of the femoral head is a recognized complication of treatment (15). Initial conservative treatment with a Pavlik harness is more likely to be successful, and less associated with avascular necrosis the earlier DDH is diagnosed (16,17).

The principles of screening programs aim for early detection of disease in a condition whose natural history is understood, where there is a recognized early symptomatic/latent stage of disease, for which there is acceptable treatment available (18). As early diagnosis is predictive of a more favourable outcome, screening for DDH in at risk infants is important. Development of a successful screening program, however, is challenging as only 25% (19) to 30% (20) of patients with DDH have identifiable risk factors. Furthermore, breech infants are 3.7 times more likely to experience spontaneous resolution of mild hip instability compared to nonbreech infants (21).

Currently within North America, there is a lack of consensus on screening protocols for DDH (Table 1). In 2000, the American Academy of Pediatrics (AAP) released a clinical practice guideline suggesting that all newborns should be screened by physical examination (22). They recommended that ultrasound screening should be done if the patient is both female and breech (22). Optional imaging was recommended for patients either (i) male and breech or (ii) female with a family history of DDH (22). While the Canadian Task Force in Preventative Health Care's 2001 statement supported routine physical examination, they recommended against selective ultrasound screening in high-risk infants (23). In 2006, the US Preventative Services Task Force claimed there is insufficient evidence to recommend any routine screening for DDH (24). The American Academy of Orthopedic Surgeons, in 2015, recommended imaging if the patient is breech, has a positive family history of DDH, or there is history of clinical instability (25). Lastly, the AAP released a clinical report in 2016, recommending that imaging could be considered in high-risk infants with negative physical exams, where high risk included: breech, positive family history, parental concern, inconclusive physical exam or history of tight lower extremity swaddling (26).

Table 1. Summary of North American screening guidelines for DDH

Screening guidelines for DDH	
American Academy of Pediatrics: Clinical Practice Guideline, 2000 (22)	Good evidence in favour of screening all newborns for DDH by physical exam. Fair evidence against routine ultrasound screening for DDH of all infants. Strong evidence in infants with a negative physical exam to recommend: Imaging if breech and female Optional imaging if breech and male Optional imaging if positive family history and female No imaging if positive family history and male No imaging if female gender is the only risk factor
Canadian Task Force on Preventative Health Care, 2001 (23)	Fair evidence in favour of serial clinical exam of the hips in all infants until walking independently. Fair evidence against routine ultrasound screening for DDH in all infants. Fair evidence against selective screening for DDH in high-risk infants. Fair evidence against routine radiographic screening in high-risk infants.
US Preventative Services Task Force, 2006 (24)	Insufficient evidence to recommend routine screening for DDH.
American Academy of Orthopedic Surgeons, 2015 (25)	Moderate evidence against universal ultrasound screening to detect DDH. Moderate evidence in favour of imaging when one or more of the following risk factors are present: breech, positive family history, or history of clinical instability.
American Academy of Pediatrics: Clinical Report, 2016 (26)	Recommend surveillance of all infants by physical exam. Hip ultrasound can be considered in high-risk infants with a negative physical exam. Considerations for high-risk include: female or male breech, positive family history, parental concern, inconclusive physical exam or history of tight lower extremity swaddling.

At Kingston Health Sciences Centre (KHSC), a tertiary care centre in Kingston, Ontario, Canada, the currently implemented screening protocol for DDH is that all breech born infants undergo ultrasound screening at 6 weeks of age regardless of physical examination findings. The purpose of this study was to determine if there is a need for ultrasound screening to detect DDH in all breech born infants, particularly those with a negative physical examination of the hips. Furthermore, should gender, gestational age and mode of delivery be considered when selecting appropriate patients for ultrasound screening?

METHODS

Prior to initiation of this study, ethics approval was obtained from the Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (HSREB) at Queen's University.

A retrospective chart review was undertaken to identify all breech born infants who had undergone routine ultrasound screening for detection of DDH at KHSC (formerly Kingston General Hospital at the time of data collection) between January 1, 2010 and March 23, 2015. A list of patient identification numbers was supplied to the researchers by the hospital imaging department for all children under the age of five years who had undergone hip ultrasound at KHSC between the dates specified above ($n=619$). The electronic medical records of these patients were reviewed to identify those who met the inclusion criteria of the study: (i) documented breech presentation at time of delivery, and (ii) documented ultrasound scan for detection of DDH.

The following data were extracted from the medical records of those meeting eligibility criteria: date of birth, gestational age, gender, mode of delivery, newborn physical exam findings of the hips, date of hip ultrasound and ultrasound findings. A positive physical exam was defined as: a documented positive Barlow/Ortolani maneuver, a documented hip dislocation or hip instability upon examination at time of initial newborn physical. Any other findings were considered negative, including hip clicks. Physical exams were conducted by medical students, residents and attending physicians. In situations where a trainee conducted the initial exam, it was the responsibility of the attending staff to recheck the findings to ensure accurate documentation. For categorization by gestational age, preterm was defined as less than 34 weeks, late preterm was defined as 34 to 36 weeks and 6 days, and term was considered greater than or equal to 37 weeks. Upon review of ultrasound findings, the following were considered positive: documentation of subluxation, uplifting of the labrum, inappropriate acetabular thickness, alpha angles less than 60 degrees or a definitive radiological diagnosis of DDH. All other ultrasound findings were considered negative. For patients with a positive ultrasound finding, all follow up ultrasounds were reviewed as well as all orthopaedic clinic notes to identify if treatment was provided.

Data were analyzed primarily to identify patients with a negative physical exam but positive ultrasound (group A). Secondary patient groups included: negative physical exam with negative ultrasound (group B), positive physical exam with negative ultrasound (group C), and positive physical exam with positive ultrasound (group D). Each group (A–D) was compared to the total patient population based on gender, gestational age and mode of delivery using Fisher's exact test. The rate of DDH detected by screening was also compared by gestational age, gender and mode of delivery using Fisher's exact test.

Secondary outcomes included analysis of the sensitivity and specificity of the newborn physical exam of the hips in diagnosing DDH and the need for treatment in patients identified with positive ultrasound findings.

RESULTS

A total of 318 patients met inclusion criteria for the study (Figure 1). The remainder were excluded for the following reasons: cephalic presentation at delivery ($n=207$), no documented fetal presentation at birth ($n=43$), ultrasound was not for detection of DDH ($n=32$) and patient chart consisted only of ultrasound with no other documentation ($n=19$).

Of the 318 patients included in the study, 191 were female (60.06%) and 127 were male (39.94%); 26 (8.18%) were preterm, 57 (17.92%) were late preterm, and 235 (73.90%) were term; 263 (82.70%) were delivered via caesarean section and 55 (17.30%) were delivered vaginally.

Negative Physical Exam

Three hundred and eight patients had a negative physical exam of the hips and underwent a screening ultrasound. Of these patients, 27 (23 female: 4 male) had a positive ultrasound diagnostic of DDH (Group A). The gender distribution of group A was significantly different, $P<0.05$, than the gender distribution of the total study population with females more predominant (Figure 2). A total of 281 patients (161 female: 120 male) had a negative ultrasound (Group B). The gender distribution of group B was not significantly different than that of the total population ($P=0.51$). 12.50% of the females with a negative physical exam had DDH compared to 3.23% of the males ($P<0.05$).

Positive Physical Exam

Ten patients had a positive physical exam of the hips and subsequently underwent diagnostic ultrasound. Four (three female: one male) of these patients had a negative ultrasound (Group C), and six (four female: two male) had a positive ultrasound (Group D). The gender distribution of groups C and D were not significantly different than that of the study population ($P=1$).

Figure 1. Diagram of patient distribution and flow throughout study. A, B, C and D denote patient groups as referenced throughout study. (C/S) delivery by caesarean section, (F) female, (L) late preterm gestation between 34 and 36 weeks and 6 days, (M) male, (N) number of patients, (P) preterm gestation less than 34 weeks, (T) term gestation greater than or equal to 37 weeks, (U/S) hip ultrasound, (VD) vaginal delivery.

Figure 2. Percent distribution of males and females of the total patient population compared to the percent distribution of males and females in groups A to D. Group A: negative physical exam with positive ultrasound. Group B: negative physical exam with negative ultrasound. Group C: positive physical exam with negative ultrasound. Group D: positive physical exam with positive ultrasound. (*) The gender distribution of group A is significantly different ($P < 0.05$) than that of the total population of breech births, with females significantly more predominant. (N) number of patients, (P/E) physical exam of the hips, (U/S) ultrasound of the hips, (+) positive finding, (-) negative finding.

Gestational Age and Mode of Delivery

There were no significant differences in gestational age or mode of delivery in groups A–D compared to the entire study population.

Of the patients who underwent a screening ultrasound (groups A and B), 24 were preterm, 56 were late preterm, 228 were term, 254 were delivered by caesarean section and 54 were delivered vaginally. 8.33% of the preterm infants and 7.14% of the late preterm infants in this group had DDH compared to 9.21% of term infants who had DDH ($P=0.94$). 9.45% of the infants born via caesarean section in this group had DDH compared to 5.55% of the infants born vaginally ($P=0.59$).

Patients Requiring Treatment

Seven patients (2.20%) required treatment for DDH, consisting of a Pavlik Harness or surgical reduction. Of these patients, four had an initial positive physical exam (Group D) and three had a negative exam and were detected via screening ultrasound (Group A). The patients detected via screening ultrasound were all female. Treatment was offered if at the time of orthopaedic consultation ultrasounds persistently demonstrated alpha angles less than 60 degrees. For patients with a positive ultrasound at 6 weeks who were not treated, it is assumed that there was spontaneous resolution of the dysplasia by the time the patient was seen by orthopaedics. The exception to this was with preterm infants, where treatment was provided immediately.

Sensitivity and Specificity

The sensitivity of the physical exam in detecting DDH was 18.18% (95% CI 6.98 to 35.46%). The specificity was 98.60% (95% CI 96.45 to 99.62%). The positive predictive value of the exam was 60.00% (95% CI 30.85 to 83.45%) and negative predictive value was 91.23% (95% CI 89.85 to 92.44%).

DISCUSSION

If undetected, DDH can progress to degenerative arthritis and need for hip arthroplasty at a young age (9–11). Similarly, when detected late conservative management is less successful and there is increased risk of complications such as avascular necrosis (16,17). Therefore, screening guidelines that allow for early detection of disease are warranted, particularly in patients without physical exam findings of DDH. While it is widely accepted that all infants should undergo routine physical examination of the hips to detect DDH (22,23,26), there is inconsistency amongst guidelines of who should undergo ultrasound screening in the presence of a negative physical exam despite an understanding of the risk factors associated with DDH (22–26).

The results of this study suggest that the diagnosis of DDH in breech born infants by screening ultrasound in those with a negative physical exam of the hips is more predominant in

females ($P<0.05$). Furthermore, the subset of patients that benefited from screening (Group A) had a significantly greater proportion of females compared to the study population ($P<0.05$). This supports the 2000 AAP guidelines, which recommends imaging for breech, female infants with negative physical exam (22). This is contradictory to the most recent North American guidelines that eliminate gender as discriminatory factor of what patients require ultrasound screening (25,26).

Of the patients who underwent screening ultrasound (A–B), the rate of detection of DDH was similar among the preterm, late preterm and term gestations ($P=0.94$). This suggests that gestational age does not influence the incidence of DDH. This supports previous research that concluded that the odds ratio for DDH in preterm breech infants compared to term breech infants was 1.27 (7).

Results of this study suggest no significant difference in the prevalence of DDH diagnosed by screening ultrasound based on mode of delivery ($P=0.59$). Within the literature, there is inconsistent evidence that delivery by caesarean section is protective in developing DDH with one systematic review reporting caesarean section having a relative risk of 0.87 compared to vaginal delivery (6), and a separate review reporting a nonsignificant association with an odds ratio of 1.02 (4).

The literature suggests that upwards of 88% of hip abnormalities spontaneously resolve by 2 months of age (8) and breech infants are more likely to experience this resolution (21). Of the patients in this study who were diagnosed with DDH based on screening ultrasound (Group A), only 3 of 27 patients required treatment suggesting that 89% self-resolved.

Breech presentation at birth is an established risk factor for DDH (3–5) and is hypothesized to be secondary to mechanical forces on the hips during the third trimester (22,27). The correlation between length of time spent in the breech position in utero and DDH is less understood. In this study, breech referred to position at the time of delivery. Infants who underwent successful external cephalic version (ECV) prior to delivery were not accounted for. In a study by Lambeek et al., the incidence of DDH was compared between infants who underwent successful ECV and those who did not (27). The risk of DDH was found to be lower in breech infants who underwent successful ECV compared to those who remained breech (27). In creating new screening recommendations, future work should be done to further stratify the length of time spent in the breech position in utero on overall risk for DDH.

Breech infants remain at risk of developing DDH despite a normal screening ultrasound (28,29). Imrie et al. demonstrated that 29% of breech infants with a normal 6-week hip ultrasound had hip radiographs at 4 to 6 months diagnostic of DDH, requiring treatment (28). Brusalis et al. reported a DDH detection rate of 4.3% at 6 months of age in breech infants with a normal 6-week ultrasound (29). These results highlight the importance

of routine screening all infants by physical examination despite inconsistencies in ultrasound screening guidelines.

There are limitations to this study, the first being that data were extracted from a single centre with limited sample size. Multicentre analysis would allow for a more robust population and ability to make definitive conclusions on screening guidelines. A second limitation is that individuals of various levels of training conducted the physical exams. While the policy of the hospital is for the attending physician to ensure appropriate documentation of exam results, we were unable to confirm that this occurred in all cases.

CONCLUSION

The diagnosis of DDH in breech born infants by screening ultrasound in those with a negative physical exam of the hips is more predominant in females, with no apparent association with gestational age or mode of delivery. While this is in keeping with the AAP 2000 guidelines, it contradicts the more recent statements from the American Academy of Orthopedic Surgeons (2015) and the AAP (2016) which have eliminated gender as a discriminating factor in which populations require ultrasound screening. Future multicentre analysis with a larger sample size is needed before conclusions can be made on screening guidelines. This work would allow for a CPS position statement on screening recommendations for DDH in at risk infants in Canada.

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