

Developmental Dysplasia of the Hip: Universal or Selective Ultrasound Screening?

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Abstract

Developmental dysplasia of the hip (DDH) is an intriguing condition that evolves during infancy. It would be thus foolhardy to expect a screening tool at birth to be both highly sensitive and specific. Uncertainty regarding an optimal screening method is compounded by a general lack of sound epidemiological data. Clinical screening remains widely used. Some reports estimated that it did not pick up 60% of children who eventually needed surgery. Ultrasonography, it was hoped, would improve detection rates. There are 2 approaches to ultrasound; universal screening, which is adopted by some European countries, or selective screening of high-risk infants. The problems with universal ultrasound screening are high false positive rates and high costs. The benefit was a possible 6- to 10-fold reduction in surgery for late DDH. Similar reductions though had also been reported if ultrasound was used selectively for infants with clinical and historical risk factors. A literature review on this topic is presented. There are pros and cons for both screening strategies. This is reflected in the different protocols that exist among various countries. For healthcare systems that are considering their options, universal ultrasound screening is generally not cost-effective and should not be the preferred screening strategy.

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Introduction

Physical examination using the Ortolani and Barlow tests is the mainstay of screening for developmental dysplasia of the hips (DDH). Abnormalities detected through clinical screening ranged from 0.4 to 168 per 1000 newborns,¹ and the reported incidence for Singapore (4.7 per 1000)² and Malaysia (0.7 per 1000),³ which share similar demographics, also differed significantly. This heterogeneity could be due to true difference in prevalence among populations, experience of the screener⁴ as well as the exact criteria for diagnosis. Compounding this uncertainty is the intriguing nature of hip dysplasia. It most likely represents a spectrum of developmental disorders that may manifest only after the neonatal period.⁵

A practical one-point-in-time diagnostic test for DDH, which is critical to evaluating screening strategies, does not exist. This contributes to the pervasive practice of treating newborns with a positive screening result. More recently, a report based on the Medical Birth Registry of Norway which looked at total hip replacement (THR) rates for a birth cohort of more than 2 million newborns over a 38 year period found that only 8% of those who underwent THR due to dysplasia had unstable hips at birth.⁶ The authors

cast doubt on the effectiveness of clinical testing for neonatal hip instability. A similar conclusion was arrived at from an earlier United Kingdom study.⁷

To compare the effectiveness of different screening strategies, the "true" incidence of DDH also needs to be looked at. This is because the majority of newborn hip abnormalities become normal without treatment.⁸ Thus, to reliably conclude which is the best screening strategy, adequately powered randomised controlled trials are needed, with a precisely determined endpoint, true DDH.

In the astonishingly large number of studies found in the literature, true DDH was defined differently, due to the many methods of case ascertainment. Most referred to hips that were still abnormal after 4 to 6 weeks, when it was thought that the initial neonatal immaturity of the hips would have largely resolved by then. The other significant problem causing poor quality of evidence was the inadequate follow-up of newborns with a negative screening result, falsely assuming that none in this group would have developed DDH. Extended follow-up of a birth cohort, which is necessary for study validity, is not commonly incorporated in most protocols because obviously it is extremely resource-intensive.

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Universal Ultrasound Screening

The availability of ultrasound since the 1980s has helped greatly in the diagnosis and management of DDH. The methods based on Graf⁹ and Harcke¹⁰ are commonly used. Because it is non-invasive and can pick up problems in the cartilaginous hip much earlier than radiology, efforts to use it on clinically normal hips began, with the aim of reducing missed cases of DDH. Ultrasound has been used to screen whole population of newborn babies, especially in Europe. However the main problem with ultrasound screening mirrors that of physical examination, in that the vast majority of sonographically abnormal hips in the neonatal period turn out to be normal eventually.^{11,12}

Synder et al¹³ reported their experience since 1985 with universal ultrasound screening. To overcome the problem with high false positive rates if performed too early, infants were screened at 6 weeks old. They reported a gradual decrease in hip surgeries, and hence recommended universal ultrasound in populations with a very high prevalence of DDH like in Poland (68 per 1000).¹⁴ In Synder's report 1500 sonograms or more might have been needed to prevent 1 case of hip surgery.

Bialik et al¹⁵ used an algorithm to reduce unnecessary treatment for sonographically abnormal hips. As a result, only 10% out of 995 sonographically abnormal hips required treatment. Non-treated hips all developed normally at the age of 1 year. Unnecessary treatment, either surgical and non-surgical, carries a risk for avascular necrosis of the hip. Using historical controls Von Kries et al¹⁶ calculated that there was an 80% reduction in the incidence of first operative procedure for DDH since 1996 when universal ultrasound screening was made routine in Germany.

For universal ultrasound screening to work optimally, the following conditions should preferably be met:

- i) The population prevalence of DDH is high.
- ii) Infants should be screened after 6 weeks old, which means a detailed follow-up programme for a birth cohort is needed.
- iii) A protocol is used to reduce unnecessary treatment of mildly dysplastic but stable hips. A dedicated paediatric orthopedic and physiotherapy team is essential.
- iv) The cost of universal hip ultrasound, including trained radiologists, hardware and follow-up, is acceptable to the local healthcare system.

Selective Ultrasound Screening

Selective ultrasound screening strategies are generally risk factor-based, aiming to lessen the burden of screening every newborn with ultrasound. In a meta-analysis Lehmann et al¹⁷ estimated that the odds for DDH by various risk factors were 5.5 for breech delivery, 4.1 for female gender and 1.7 for a positive family history. Other commonly cited

variables are musculoskeletal abnormalities (torticollis, foot deformity, sacral dimple), abnormal hip examination (clicks, limited hip abduction) and intrauterine growth retardation. Approximately 7% to 10% of a birth cohort would have a risk factor for DDH.¹⁸⁻²⁰

Descriptive studies based on this selective, risk-based ultrasound screening strategy yielded contradictory results, with only some reporting reduced cases of late DDH.¹⁸⁻²¹ This would not be surprising because 60% of DDH infants had no associated risk factors.²² As such the only probable rationale for using the selective strategy would be for it to complement clinical screening, especially if the latter was not performed by experienced personnel.⁴

Which Strategy?

Considerations for choosing a particular screening strategy usually revolve around 2 factors, effectiveness and cost. Despite the scores of published studies on DDH, there remained a paucity of randomised controlled trials (RCTs) dealing with effectiveness of screening methods. In fact there was only 1 RCT²³ and 1 quasi-randomised study²⁴ comparing universal versus risk-based screening by ultrasound.

Rosendahl et al²⁴ allocated 11,925 newborn infants to receive either general, selective or no ultrasound screening in addition to the clinical examination. Follow-up was till 27 months old. They found that general ultrasound screening resulted in a higher treatment rate than in either the selective or in the no ultrasound screening groups (3.4%, 2.0% and 1.8%, $P < 0.0001$). For infants not subjected to treatment, ultrasound screening resulted in a higher follow-up rate because of non-conclusive early findings. Prevalence of late DDH was lower for general ultrasound screening, but the differences were not statistically significant (0.3, 0.7, 1.3 per 1000, $P = 0.11$). They concluded that "the effect of ultrasound screening in reducing ... late DDH was at best marginal despite a considerable increase in diagnostic and therapeutic efforts". About 1000 sonograms were needed to pick up 1 late DDH compared to clinical examination alone.

Holen et al²³ conducted the only true RCT comparing general versus selective ultrasound screening. After 6 to 11 years of follow-up, out of a total of 15,529 infants, there was 1 case of late DDH in the general group compared to 5 in the selective group (0.13 versus 0.65 per 1,000, $P = 0.22$). Again a large number of infants (nearly 2000) needed to be screened to detect an additional case of late DDH if general ultrasound screening was used.

Given the unexpectedly low prevalence of late DDH in the 2 studies, a much larger sample size than initially assumed would have been needed to achieve statistical significance, if at all. However, taking both studies together,

given the lower prevalence of late DDH in the general ultrasound screening groups, it would appear that this was the better strategy in terms of preventing late DDH. In health economics terms though, this advantage would come at much higher screening, follow-up and treatment costs per quality adjusted life year (QALY). Emotional anxiety of parents of false positive infants should also not be under-estimated or discounted.

In the face of considerable debate over the effectiveness of ultrasound screening, it is not surprising that very few cost studies had been done. Clegg et al²⁵ studied surgical and screening costs before and after routine universal ultrasound and found that costs were comparable. After routine ultrasound was implemented, the higher screening cost was offset by fewer number of surgeries performed, and at a lower surgical cost per surgery because they were done earlier (and as such surgically less complicated). Hernandez et al²⁶ used a decision analysis tool incorporating assumed probabilities of a particular outcome and resource expenditure to determine the utility (value) of clinical versus ultrasound screening strategies. They concluded that ultrasound screening (either selective or universal) had a lower value when compared to clinical screening alone. Brown et al estimated that costs for screening 100,000 newborns using the different methods to be £4 million for universal ultrasound, £3 million for selective ultrasound and £1 million for clinical screening alone.²⁷

Conclusion

Although limited in number, the available high quality evidence does not support using ultrasound either universally or selectively to screen for DDH, both from the effectiveness and cost perspectives. This conclusion is reflected in the various published national guidelines.²⁸⁻³⁰ As such universal or selective ultrasound screening should not be done outside a well-designed research setting. Training doctors to be proficient in clinical screening for DDH remains the priority.⁴

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