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Developmental Dysplasia of the Hip: An Audit of the Ultrasound Screening Programme

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Abstract

Aims

Developmental dysplasia of the hip (DDH) is an important cause of disability in children and young adults. Early diagnosis and treatment can help avoid more invasive interventions and long-term morbidity. This study examines the ultrasound screening programme conducted in University Hospital Waterford (UHW), and the outcomes for infants with DDH in the Southeast of Ireland.

Methods

We conducted an audit of all the DDH screening ultrasounds performed in UHW in the year 2020, a total of 992 infants. Data included referral and ultrasound times, screening results, interventions, and outcomes.

Results

Of those screened, 255 (26%) were referred to the Orthopaedic clinic, with a significant female majority of nearly 3:1. At the time of writing, only two infants were ultimately referred for further management of persistent DDH, the rest being successfully treated by less invasive interventions such as harnessing and bracing. There were no babies scanned within the recommended 6 weeks who later presented with a dislocated hip or required tertiary referral for DDH management.

Conclusion

The ultrasound screening programme in UHW is shown to be successful in the prompt diagnosis and early treatment of DDH. This plays a significant role in avoiding the lifelong disabling outcomes of untreated DDH, and the invasive surgical procedures required in the management of late-stage disease.

Introduction

Developmental dysplasia of the hip (DDH) is the most common orthopaedic disorder in neonates. It is characterised by capsular laxity and mechanical instability of the hip which results in a spectrum of disease encompassing hip dysplasia, subluxation and finally dislocation. It has a reported incidence of 1/100 for dysplasia and 1/1000 for dislocation.[1] There is a significant female predominance, by a factor of 6 compared to males. Other risk factors include positive family history and breech positioning during the latter part of pregnancy. At the neonatal examination, all babies routinely undergo a clinical examination for the detection of DDH, using the Barlow and Ortolani manoeuvres. A hip that is truly dislocated should be detected by this method. However, most cases are subclinical and will not be identified reliably by physical examination alone.[2] DDH is also a dynamic disease and can develop only after birth.

This condition is an important cause of permanent disability in children and young adults. However, if diagnosed early it can be successfully treated using less invasive methods. In children under 6 months of age with clinically reducible hips, a Pavlik harness is the initial management, often for a minimum of 6 weeks.[1] This is successful in approximately 70-95% of cases, but when hip instability persists a fixed abduction brace is trialled.[3] Surgical reduction and/or osteotomy is reserved for older children or previous unsuccessful conservative treatments. Avascular necrosis is a well-recognised and serious complication of all DDH treatments.[1]

Austria introduced universal sonographic screening for DDH in 1992 using the standardised Graf method. Subsequent evidence suggests that this has led to reduced rates of operative interventions and hospital admissions associated with DDH.[4] However, the role of screening remains controversial, and different strategies have been implemented across several countries. A review for the US Preventative Services Taskforce in 2006[5] concluded that while screening can identify those at increased risk for DDH, the overall benefits are unclear due to both the high rates of spontaneous resolution of neonatal hip instability and the lack of evidence linking intervention to improved functional outcomes.

Ireland has adopted a similar approach to that performed in the United Kingdom. A subgroup under the Review of the Child Health Model steering group published recommendations in 2016 on the national programme for screening for DDH. Their Implementation Pack[6] recommends that all infants with a positive risk factor (first-degree family history or breech position) and/or abnormal clinical exam should be referred to the Selective Ultrasound Screening Programme. These at-risk children should all have an ultrasound performed by 6 weeks of age, at which point they will be referred to the Orthopaedics clinic for assessment and harnessing in the event of a positive result. Any child with positive clinical findings for DDH within 72 hours of birth should have an ultrasound by 2 weeks of age, and a follow-up scan at 6 weeks should this be negative. Babies with an abnormal clinical examination at the recommended 6-week check should also have an ultrasound performed within 2 weeks of the assessment.

Ultrasound of the hip was first described by Prof Reinhard Graf in 1980[7] and is the first-line imaging modality below the age of 3-6 months. The Graf technique grades the degree of hip dysplasia using angles measured from a standardised coronal view through the acetabulum.[8] Ultrasound becomes less effective after ossification of the femoral head, after which time pelvic radiographs become the modality of choice. The Graf classification is graded I - IV, starting with I as normal and then rising in increasing degrees of dysplasia. Graf IIa hips are classified as "immature" and should be reimaged at 12 weeks to confirm resolution or progression to DDH. Therefore, all hips other than Graf I and IIa should be referred for prompt Orthopaedic assessment.

Babies with ultimately normal ultrasounds can be discharged, according to the recommendations. However, the Southeast programme practice differs from the guidelines in that all at-risk babies who have a normal ultrasound are then followed up with an additional radiograph at 6 months. This is based on the findings of a recent study[9] in a similar population which showed that 8% of these sonographically normal infants were subsequently found to have evidence of dysplasia on their 6-month radiographic evaluation.

Methods

University Hospital Waterford (UHW) provides a targeted DDH ultrasound screening service for all infants born in Waterford, Kilkenny, Wexford, and South Tipperary hospitals. A comprehensive database is kept of all children referred to the UHW screening programme and is continuously updated with details including imaging results, treatments, and outcomes. This audit looks at the data obtained on all referrals made to UHW in 2020, and studies several of the Key Performance Indicators as outlined in the Implementation Pack.

Results

There were 1031 referrals made to the Selective Ultrasound Screening Programme for DDH in UHW in 2020, of which a total of 992 infants were scanned. Reasons for the 39 not imaged include non-attendance, cancellation and age greater than 6 months at referral time. "Breech position", "family history" and "clinical concern" accounted for nearly all (99%) of the referral indications to the clinic.

641 infants (64.6%) were imaged within the recommended 6 weeks of age, with 351 being scanned after this point. The majority of these delayed cases were either late referrals or postponed due to COVID-19. The DDH Screening service in UHW was suspended from mid-March to mid-June in 2020 due to COVID-19 restrictions, as per hospital policy. The service was moved to an off-site location in June and extra screening sessions were then undertaken in an effort to work through the resultant backlog of referrals.

In total 255 patients were referred to the Orthopaedic clinic, 26% of those screened. We noted a significant female majority of referrals of just under 75% (n = 188). 161 babies were referred with abnormal ultrasounds, while the remaining 94 were sonographically normal and were referred due to a clinical or radiographic suspicion. 198 infants were subsequently treated for DDH, 122 of these with harnessing initially. Four babies did not continue clinic attendance. Most babies (n = 122) had an ultrasound performed within the recommended 6 weeks, and all of these have been successfully treated with harnessing and/or bracing with no operative management required as of yet.

With 992 infants screened, a total of 1984 hips were scanned, the Graf grading results of which can be viewed in Table 1. These figures are for individual hips, with 74 babies having an abnormality detected in both hips. There were 127 infants with sonographically dysplastic hips, all of whom were referred to the clinic and treated for DDH. At the time of writing, only two infants of the 127 had been referred to on to a tertiary centre for further opinion of their DDH management. Their progress is being followed by the Orthopaedic team on an ongoing basis and to date neither have undergone surgical intervention. Of note, neither had imaging performed within the recommended first 6 weeks of life. This compares favourably with a study of the same Southeast population performed in 2013,[10] prior to formalised ultrasound screening. In contrast, they recorded 56 cases of DDH in infants born in 2009, with 14 of these subsequently referred for surgery.

Table 1: *Ultrasound results.*

Graf type	**Number** (Total 1984)	**Percentage of total**
I	1749	88.2%
IIa	134	6.75%
IIb	26	1.3%
IIc	33	1.7%
IId (D)	17	0.9%
III	24	1.2%
IV	1	0.1%

There were 864 infants with normal ultrasounds, however 71 of these were subsequently treated in the Orthopaedic clinic, of which there were three who did not comply with treatment. Two babies were treated despite normal radiographs, both with abnormal examination findings and clinical concern. One patient, mentioned above, discontinued clinic attendance prior to treatment or radiographs but had an abnormal examination. The remaining babies all had dysplastic radiographic findings. None of these infants have been referred for surgery to date.

43 infants were referred to the clinic with Graf IIa "immature" hips. On the recommended follow-up imaging, 6 of these patients had Graf IIb "developmentally delayed" hips and underwent treatment. 33 babies had normal follow-up scans, and 24 were discharged. However, 9 of these babies subsequently required treatment for DDH based on abnormal examinations or radiographs. Three infants were treated for DDH prior to their follow-up ultrasound, based on examination and/or radiographic findings, and so have been included in the True positive group. One baby was lost to follow up and has not been included in the calculations.

The sensitivity of ultrasound for the diagnosis of DDH is calculated at 64.1% from our data (Table 2). All treated babies are assumed to have DDH based on imaging and examination findings, giving a specificity and positive predictive value of 100%. The negative predictive value is 91.8%.

Table 2: *Ultrasound examination performance statistics.*

True positive	127	**Sensitivity**	64.1%
False positive	0	**Specificity**	100%
True negative	793	**Positive predictive value**	100%
False negative	71	**Negative predictive value**	91.8%

Discussion

The required prompt diagnosis and management of DDH necessitates a capable screening programme. The ultrasound screening programme in Ireland selectively targets infants with either a positive risk factor or abnormal clinical examination. UHW provides this service for the whole Southeast region of Ireland. It manages large patient volumes through both the Radiology and Orthopaedic departments, with nearly 200 infants treated in 2020. There were notable delays in both screening referral and scanning times, however the significant limitations inflicted by the global COVID-19 pandemic likely played a large role in this.

There were 71 babies who were found to have DDH despite a normal screening ultrasound, 8% of the total normal ultrasound results. This is not an unexpected finding given the previously mentioned study by Mulrain et al,[9] and our results mirror theirs in this regard. Because of the inherent developmental nature of the condition, it is possible that some babies who have a normal ultrasound result at 6 weeks of age may go on to develop the condition later on. There have also been reports in the literature of inconsistencies between hip maturation demonstrated on ultrasound and subsequent dysplastic radiographic hip development.[11] For these reasons, at-risk babies in the Southeast Screening programme undergo an additional radiographic examination at 6 months of age.

Our quoted 100% specificity and positive predictive value infers that all infants with a positive ultrasound who were treated in the clinic were confirmed cases of DDH, an assumption that must be made in the absence of an alternative standard.

The true successful marker of the Southeast DDH Screening programme is that no baby who had a screening scan at or before the recommended 6 weeks of age ended up with a late-presenting hip dislocation, and any required treatment was achieved using non-invasive techniques. Therefore, the screening programme has achieved its primary goals of the early detection and treatment of DDH and ultimately avoiding surgical intervention. It is worth noting that of the 198 infants treated in the clinic, there were no significant treatment complications such as avascular necrosis. This provides reassurance that we can continue to offer non-invasive treatment with a relatively low threshold in order to avoid the potential disabling harms from under treatment.

At the time of writing, only two children have required further Orthopaedic opinion for their DDH, and neither has undergone surgical intervention. This outcome highlights the organised referral pathway leading to expedient imaging and appropriate treatment.

Declaration of Conflicts of Interest:
The authors have no conflicts of interest to declare.

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References:

1. Ahn L, Souder C. Developmental Dysplasia of the Hip (DDH) – Pediatrics – Orthobullets [Internet]. Orthobullets.com. 2021 [cited 24 November 2021]. Available from: https://www.orthobullets.com/pediatrics/4118/developmental-dysplasia-of-the-hip-ddh
2. Paton RW. Screening in developmental dysplasia of the hip (DDH). the surgeon. 2017 Oct 1;15(5):290-6.
3. Swarup I, Penny CL, Dodwell ER. Developmental dysplasia of the hip: an update on diagnosis and management from birth to 6 months. Current Opinion in Pediatrics. 2018 Feb 1;30(1):84-92.
4. Thallinger C, Pospischill R, Ganger R, Radler C, Krall C, Grill F. Long-term results of a nationwide general ultrasound screening system for developmental disorders of the hip: the Austrian hip screening program. Journal of children's orthopaedics. 2014 Feb 1;8(1):3-10.

5. Shipman SA, Helfand M, Moyer VA, Yawn BP. Screening for developmental dysplasia of the hip: a systematic literature review for the US Preventive Services Task Force. Pediatrics. 2006 Mar 1;117(3):e557-76.
6. Tarrant A, Mason Mohan C, McDonald H, Murphy J, O'Beirne J, Turner G. National Selective Ultrasound Screening Programme for Developmental Dysplasia of the Hip in Infants Implementation Pack [Internet]. 2017 [cited 24 November 2021]. Available from: https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/radiologyddhimplementaionpack.pdf
7. Graf R. The diagnosis of congenital hip-joint dislocation by the ultrasonic Combound treatment. Archives of orthopaedic and traumatic surgery. 1980 Sep;97(2):117-33.
8. Robben S, Smithuis R. The Radiology Assistant : Developmental Dysplasia of the Hip [Internet]. Radiologyassistant.nl. 2017 [cited 24 November 2021]. Available from: https://radiologyassistant.nl/pediatrics/hip/developmental-dysplasia-of-the-hip-ultrasound
9. Mulrain J, Hennebry J, Dicker P, Condren J, O'Driscoll D, O'Beirne J. A normal screening ultrasound does not provide complete reassurance in infants at risk of hip dysplasia; further follow-up is required. Irish Journal of Medical Science (1971-). 2021 Feb;190(1):233-8.
10. Phelan N, Thoren J, Fox C, O'Daly BJ, O'Beirne J. Developmental dysplasia of the hip: incidence and treatment outcomes in the Southeast of Ireland. Irish Journal of Medical Science (1971-). 2015 Jun;184(2):411-5.
11. Atalar H, Gunay C, Turanli S, Koktener A. Discrepancy between ultrasonographic and radiographic findings in patients treated for developmental dysplasia of the hip; hip maturation on ultrasonography may not be consistent with radiographic hip maturation. Journal of Pediatric Orthopaedics B. 2020 May 1;29(3):228-34.