The use of X-ray at 5 months in a selective screening programme for developmental dysplasia of the hip

Kathryn R. Price · Rosemary Dove ·
James B. Hunter

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Abstract

Background The methods used for any screening programme for developmental dysplasia of the hip (DDH) can be controversial. This was an opportunistic audit of our selective ultrasound screening programme using an X-ray at 5 months to prevent inappropriate discharge due to the learning curve of ultrasound.

Methods Between 1990 and 2004 in Nottingham, UK, out of a total population of 108,500 births, approximately 11,500 neonates were screened using ultrasound. Any child with an ultrasound scan showing Graf α -angles greater than 60° (Graf Type I) with the hip in joint were discharged from the clinic. All of those discharged were subsequently X-rayed at 5 months in order to cover the learning curve of ultrasound. The X-rays were reviewed by a consultant radiologist and referred back to orthopaedics if there was lateralisation of the femoral head or an acetabular index above 30°.

Results Of approximately 11,000 X-rays performed, only 53 patients were referred back to orthopaedics, of which 47 had a complete data set. Of these 47 children, only 8 (17%)

required intervention. On review of the original ultrasounds, Graf's α -angle did not seem to correlate well with the need for intervention, as all were Type I hips. The femoral head cover (FHC) appeared to be more predictive of the need for treatment. There have been no late presentations to our unit of DDH following a normal 5-month X-ray.

Conclusions We now check the Graf α -angle, FHC and dynamic stability in the ultrasound assessment and only perform X-ray at 5 months if there was a low α -angle or low FHC. Since this change, there have been no late presentations of DDH from the population screened by ultrasound.

Keywords DDH · Hip · Screening · Ultrasound · X-ray

Introduction

Screening for developmental dysplasia of the hip (DDH) was first described in the 1930s. Clinical screening now consists of the physical examination of newborns using the techniques described by Ortolani [1] and Barlow [2]. The results of clinical screening have been extremely variable. The sensitivity of these tests varies greatly with the experience level of the examiner. This has been reported to be as low as 13–24% in inexperienced hands [3, 4], and only improving to 53–60% with experienced examiners [3, 5, 6]. A noted problem with clinical examination is that, even with experience, there is under-diagnosis of irreducible dislocated hips [4]. The ideal system would comprise of a few experienced examiners performing all examinations in order to improve reliability. This is not always practical in a busy hospital and raises issues for training [7].

K. R. Price (✉)
Specialty Registrar in Trauma and Orthopaedics,
Nottingham University Hospital, 1 Bessemer Drive,
Mansfield, Nottinghamshire NG18 4FY, UK
e-mail: kattwilliams@doctors.org.uk

R. Dove
Associate Specialist in Paediatrics,
Nottingham University Hospital,
Derby Road, Nottingham NG7 2UH, UK

J. B. Hunter
Consultant in Paediatric Orthopaedics,
Nottingham University Hospital, Derby Road,
Nottingham NG7 2UH, UK

The use of ultrasound for DDH screening has greatly reduced the need for arthrogram [5] and allowed earlier accurate diagnosis and treatment [8–10]. Ultrasound has increased screening sensitivity to 97% in comparison with 13–60% for clinical examination [4]. Early diagnosis is important, as the magnitude of treatment increases with age due to increasing soft tissue contractures, bony deformity and reduced remodelling potential [3, 5, 8–11]. Early application of flexion–abduction bracing has been shown to improve the outcome and reduce splintage duration [3, 8–11]. In 2008, Peled et al. assessed the use of Pavlik’s method for the treatment of Graf Type III and IV hips. They found that 46 of 48 Type III and 8 of 13 Type IV hips converted to Graf Type I with no cases of avascular necrosis [10]. This followed Taylor and Clarke, reporting a 95.7% reduction rate using a Pavlik harness in 370 dysplastic hips. The initial ultrasound assessment showed 65.8% to be displaced and 17.9% to be dislocated. They report that 16 hips (4.3%) failed to reduce, requiring further treatment, 7 hips (3.2%) showed continued dysplasia at 5 years and 0.3% had mild avascular necrosis [12]. The use of ultrasound during splintage also allows the monitoring of the adequacy of treatment, identifying failure early in order to allow a change in management [13]. The use of ultrasound during treatment also reduces the necessary duration of splintage.

An important question for any screening programme is “who should be screened and when?” There has been ongoing debate regarding universal versus selective ultrasound screening programmes for years. Universal screening has been recommended by a number of authors, as they feel that selective screening does not eliminate late presentations [5, 14–17]. Many late presentations do not have risk factors for DDH and have been cleared by clinical examination. Apart from the additional expense of universal screening, there are concerns that it could potentially lead to over-diagnosis and treatment, with all of its associated complications [11]. The timing of screening is important, as 90% of dysplastic hips will be radiologically normal by 9 weeks. This study used the technique described by Marks et al. and assessed the femoral head coverage within 48 h of referral for the majority of children [18]. For this reason, many authors prefer the use of selective screening programmes assessing those with clinical instability or risk factors for DDH [6, 13, 15, 19]. It has been recommended that screening should occur at 6–10 weeks for those with dysplasia, to allow spontaneous resolution to occur and prevent over-treatment [6, 20]. This has been widely accepted as being the best use of resources to minimise late presentation and prevent over-diagnosis and treatment.

Another factor supporting selective ultrasound screening is cost. Financial analysis has shown that the use of ultrasound did not increase costs [11, 21], and one analysis actually showed a cost benefit of \$15,000 CAN/1,000 infants

screened [8]. Furthermore, the use of ultrasound in a selective screening programme for DDH has been recommended by the UK National Screening Committee since 2002 [22]. It has also been recommended that children over the age of 4 months are screened by means of an X-ray [11].

The technique used for ultrasound screening varies. Static ultrasound as described by Graf [23] has been widely utilised [14, 17, 24–26] and has been shown to have good inter- and intra-observer reliability [25]. Graf states that the α -angle alone is sufficient for Graf Type I hips, but advocates the use of the β -angle for further assessment of Type II hips or greater [27]. The femoral head cover (FHC) was originally described by Morin et al. [28] and later popularised by Terjesen [19, 24–26, 28]. This technique has also been shown to have a good inter- and intra-observer reproducibility [25] and has been shown to correlate with clinical outcome in some studies [25, 28]. More recently, dynamic ultrasound screening has become popular [3, 8, 14, 17, 26]. Some authors have found that the use of dynamic ultrasound is more predictive of outcome than static ultrasound [26] and has allowed a reduction in treatment rates to 0.18% without any late presentations [3]. There is currently no consensus of opinion as to which method is best.

The question of whether or not children cleared by ultrasound in the first 6 weeks of life need further monitoring has been widely debated. Vedantam and Bell published a protocol for selective ultrasound with a screening X-ray at 5 months for any child cleared by ultrasound at 6 weeks [13]. They did not pick up any abnormalities from these X-rays. This issue was also discussed at the 2006 meeting of the British Society of Children’s Orthopaedic Surgery (BSCOS). Of 89 surgeons surveyed, only 35% said that they would routinely follow up children with an X-ray at 5 months if they had been previously cleared by ultrasound [29]. This highlights the disparity of opinion regarding the screening protocol.

In Nottingham in 1990, we implemented a new selective screening programme for DDH using static ultrasound. To cover the learning curve of ultrasound, we introduced a 5-month check X-ray to ensure that no children had been inappropriately discharged. We have used this opportunity to assess the adequacy of selective ultrasound screening, the need for an X-ray at 5 months and the features seen at the time of ultrasound that correlate with the need for intervention.

Methods

In Nottingham, a selective ultrasound screening programme for DDH was instigated in 1990. The patients that we have used for this study include any child born within the boundaries of the old Nottingham health authority.

There was universal clinical screening of all neonates in the first few days of life using the techniques of Ortolani [1] and Barlow [2], and then again at 6–10 weeks, in accordance with national guidelines. A further hip check was performed at 3–5 months to coincide with the second immunisations. Ultrasound assessment was carried out for any child identified as having clinical hip instability or risk factors for DDH (foot deformities, breech presentation, oligohydramnios or family history). Static ultrasound assessment was performed by radiographers to assess Graf's α -angle. This assessment was performed in a dedicated clinic supervised by a paediatrician with access to a paediatric orthopaedic surgeon.

The protocol used by the hip instability clinic is shown in Fig. 1. Any child with a Graf Type I hip was discharged from the clinic. Any Graf Type III hips were referred for orthopaedic review. Those with Graf Type IIa–c hips were followed-up with a repeat ultrasound at 6–10 weeks. Persistent abnormalities were referred for orthopaedic assessment and those that had remodelled to Graf Type I hips were discharged.

To cover the learning curve of ultrasound, an X-ray was taken at 5 months for any child discharged from the clinic on the basis of a normal ultrasound. All X-rays taken were reviewed by a consultant radiologist and referred to orthopaedics if there was lateralisation of the femoral head or an acetabular index greater than 30° .

This was an opportunistic audit to see whether or not the X-ray at 5 months was necessary in a selective screening programme for DDH. We reviewed the notes, scans and X-rays of all patients referred back to orthopaedics to evaluate the need for this X-ray. The Graf α -angles and FHC were measured on the ultrasound pictures to look for any correlation between these measurements and clinical outcome.

Results

In Nottingham, there were approximately 108,500 births between 1990 and 2004. Of these 11,425 were referred for ultrasound assessment. Approximately 11,000 were

discharged from the clinic and underwent a screening X-ray at 5 months of age. On the basis of this X-ray, 53 children were referred back to orthopaedics, of whom 47 had a complete data set.

Treatment

The treatment that the 47 children received is shown in Fig. 2. Thirty patients (64%) were observed until normal hip development was seen on X-ray or repeat ultrasound. Nine patients (19%) had an arthrogram and were then observed until hip maturity. Only 8 patients (17%) required treatment for DDH.

Graf's α -angles

All of the patients were deemed to have Type I hips on discharge from the clinic, so should have no differences between treatment groups. We looked at each of the patients' ultrasound pictures to see if any patterns could be found. We did not find a correlation between the α -angle and the need for intervention.

FHC

We also assessed the FHC for all patients. This did show a better correlation with the need for surgical intervention. These results are shown in Fig. 3. These results suggest that there is a higher prevalence of poor FHC in the groups requiring intervention.

The 5-month X-ray

The 5-month X-ray picked up all children that needed treatment for DDH. There have been no late presentations from those cleared on the basis of this X-ray to this date. If we look at the number of X-rays performed, this demonstrates that the screening of all patients is not indicated (see Fig. 4).

Fig. 1 Flow chart showing the hip instability clinic protocol for referral to orthopaedics following ultrasound screening

Fig. 2 Bar chart showing treatment received following referral to orthopaedics after the 5-month X-ray

Fig. 3 Bar chart showing the percentage of patients within each treatment group that showed <50% femoral head coverage (FHC)

Fig. 4 Flow chart showing the results of the 5-month X-ray

Discussion

Our screening programme has been running since 1990 using selective ultrasound screening. Using this system and the initial cover of a 5-month X-ray, we have not had any

late presentations. The ultrasound scan is performed as soon after birth as possible for those with clinical instability to allow the early treatment of obviously pathological hips, as is supported in the literature [3, 5, 8–11, 13]. Those children with Graf Type IIa–c hips are monitored with a repeat ultrasound at 6–10 weeks before any treatment is implemented. This prevents over-treatment, as 90% of dysplastic hips will resolve by this stage [18]. Delaying treatment by a few weeks does not adversely affect the outcome, but allows a reduction in treatment rates and all of its associated complications. Many parents can be reassured after the second scan and the child discharged without intervention.

With regards to the ultrasound procedure itself, our radiologists screened around 11,500 children using static ultrasound. Until 1998, we only assessed the Graf α -angle, and not the FHC or dynamic stability. Although the α -angle is reliable [25], it has not been shown to correlate with the need for intervention [26]. This has been shown to be the case in our study patients. There was no real difference between the α -angles in any of the treatment groups. It should be noted that patients with abnormal α -angles at earlier screening visits had already been referred for assessment under our protocol, so abnormal 5-month X-rays were identified in a population that had been declared to have normal α -angles.

The FHC has also been shown to be reliable [25], and to have a better correlation with clinical outcome than the α -angle in some studies [25, 28]. Our results suggested that an FHC of <50% was associated with an increased risk of needing intervention. We felt that adding FHC to our standard screening procedure would improve the sensitivity of screening. The ultimate improvement, however, would be the addition of dynamic screening, which has been widely reported as being very effective in the literature [3, 8, 14, 17, 26]. One centre, exclusively using dynamic screening, has been able to reduce their treatment rate significantly without having any late presentations [3]. We believe that combining the α -angle, FHC and dynamic assessment of stability is the most effective screening procedure, and this has been our policy since 1998. We have not had any missed diagnoses since this time.

The X-ray at 5 months was only implemented as a safeguard to cover the learning curve of ultrasound. The use of X-ray has been discussed in the literature previously [13, 29], but no consensus of opinion appears to have been reached. We have found that screening all infants discharged from the clinic on the basis of a normal ultrasound is not cost-effective or necessary. The results of the 5-month X-ray are shown in Fig. 4. Our results suggest that it is safe to only follow up those children with a reduced α -angle or FHC of <50%. We changed our policy for screening following this work to include the α -angle, FHC

and dynamic assessment. This is the method agreed by Clarke, Harcke and Graf at the consensus meeting in Paris in 1991 [30]. We believe that this is suitably accurate to allow the discharge of all hips felt to be normal at screening but advise X-ray or repeat ultrasound for those with an α -angle of less than 60° or FHC $<50\%$ at 6–10 weeks.

Conclusions

The use of X-ray at 5 months for all patients discharged from the clinic is not cost-effective or indicated. X-ray or repeat ultrasound should only be performed where the femoral head cover (FHC) is less than 50% or the α -angle is $<60^\circ$ at 6–10 weeks. The use of dynamic ultrasound assessment is very useful in assessing the stability of the joint and should be used as a standard part of ultrasound screening.

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