ROUTINE ULTRASOUND SCREENING FOR NEONATAL HIP INSTABILITY

CAN IT ABOLISH LATE-PRESENTING CONGENITAL DISLOCATION OF THE HIP?

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We have undertaken routine ultrasound screening for neonatal hip instability in Coventry since June 1989. Of the 14 050 babies scanned during the first three years, 847 (6%) had ultrasound abnormalities. A grading system, based on the percentage of femoral head coverage, is presented. The proportion of abnormal hips decreased gradually so that by nine weeks, 90% had normal ultrasound appearances. Abnormality was more common in babies with a family history of CDH and in breech presentations. All babies with clinically abnormal hips had an abnormal first ultrasound examination.

Five babies not diagnosed by clinical examination and with no risk factors had abnormal ultrasound appearances and were subsequently found to have clinically abnormal hips.

Routine ultrasound screening has detected cases which would otherwise have presented late.

J Bone Joint Surg [Br] 1994; 76-B:534-8.

Received 10 January 1994; Accepted 2 March 1994

Screening of newborn infants for congenital dislocation of the hip (CDH) has usually relied on clinical methods of detection (Barlow 1962; Von Rosen 1956). Since the use of ultrasound was reported by Graf (1980), it has rapidly gained acceptance as a means of diagnosing neonatal hip instability as well as monitoring subsequent progress and management.

The success of routine clinical screening, not in abolishing but in reducing the incidence of late-presenting CDH, is well documented (Hadlow 1988; Macnicol 1990; Krikler and Dwyer 1992; Poul et al 1992; Tredwell 1992).

Ultrasound examination has been advocated as a screening method for babies considered to be at high risk of hip dysplasia (Engesaeter et al 1990; Jones and Powell 1990) but if its use is restricted solely to these groups it may fail to reduce the overall incidence of late-presenting CDH (Clarke, Clegg and Al-Chalabi 1989). Castelein and Sauter (1988) suggested that ultrasound screening of all babies during their first days of life may be better at detecting CDH than clinical assessment.

We established a routine ultrasound neonatal hip-screening programme on 1 June 1989 and we have now screened more than 21 000 babies, 98% of all those born in Coventry since that date. We present the results of the first three years with a minimum follow-up period of 22 months. Since the programme began, no late case of CDH has presented to our unit in a baby born in Coventry.

PATIENTS AND METHODS

Between 1 June 1989 and 31 May 1992 there were 14 332 live births at the Coventry Maternity Unit. We screened 14 050 of these, 83% of them within 48 hours of birth.

The service operates only on weekdays, and therefore babies born at the weekend are not scanned unless they are detained in hospital until the following Monday. The parents of such babies are contacted and arrangements are made for them to attend for a scan at the weekly follow-up clinic. Despite our repeated efforts, 282 babies (2%) were not scanned. They were almost all born at the weekend and represent about 5% of the weekend babies.

Screening is carried out by one of a team of five experienced senior radiographers using an Aloaka SSD 500 machine (Aloaka of Japan. UK distributor: Keymed, Southend-on-Sea, UK) with a 7.5 MHz short-focus linear array transducer. Two images of each hip are made and recorded by thermal image printing for weekly review by the senior author (JC). We use the technique of Harcke et al (1984). With the baby supine and the pelvis flat, the coronal/flexion view (Fig. 1) is taken with the hip and knee flexed to 90° and the transducer aligned at 90° to the femur. The transverse/neutral view (Fig. 2) is obtained with the hip and knee extended and the transducer rotated through 90°, that is perpendicular to the long axis of the body.

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0301-620X/94/4837 \$2.00

Fig. 1

The scanning position to obtain the coronal flexion view.

Fig. 2

The scanning position to obtain the transverse neutral view.

Grade 1

The femoral head is well contained in the acetabulum.

Mean bony rim percentage $69.3 \pm 2SD 6.85$.

Grade 2

The femoral head is in the acetabulum but not in contact with the floor.

Mean bony rim percentage $60.2 \pm 2SD 7.14$.

Grade 3

The acetabulum appears shallow in the coronal view, but there is only a small gap on the transverse view.

Mean bony rim percentage $51.6 \pm 2SD 6.92$.

Fig. 3a

No formal provocation test is carried out and no clinical examination is made by the radiographer. Any risk factors for CDH (a family history or breech presentation) are recorded on the scans. No measurements of distances or angles are made. The parents of all babies

with abnormal scans are offered a review appointment. The frequency of further attendance is determined by the grade of ultrasound abnormality. In general the more severe grades (4 and 5) are seen weekly whilst grades 2 and 3 are seen at between 3 and 6 weeks.

Fig. 3b

Ultrasound scans and diagrammatic representations of the grading system used in the routine screening for neonatal hip instability. Figure 3a – Grades 1 to 3. Figure 3b – Grades 4 and 5. The coronal flexion view is shown on the left and the transverse neutral view on the right.

Grading system. We use a grading system based on the degree of femoral head coverage as described by Morin, Harcke and MacEwen (1985) and later refined by Terjesen, Bredland and Berg (1989). The femoral head must be clearly demonstrated and its position in relation to the acetabulum determines the grade.

Once mastered, this technique is well suited to the numbers involved in a routine screening programme as it allows rapid and consistently reproducible scans to be taken.

We have retrospectively calculated the bony rim percentage (BRP) (Terjesen et al 1989) for each of the abnormal scans and found a statistically significant difference between the mean values for each grade.

Diagrammatic representations of each grade, together with scan examples and the calculated BRP are shown in Figure 3.

RESULTS

There were 847 babies (6%) whose first scan was abnormal (644 female, 203 male) and who were seen for follow-up. They are referred to hereafter as the 'study group'. Of these 450 had bilateral abnormality. In the other 397, the right hip was abnormal in 156 and the left in 241. Thus, the right hip was affected in 71.5% and the left in 81.7%. The result of the initial scan is given in Table I.

Some babies with abnormal scans were not followed up to normal ultrasound appearance. This was due to several factors: failure to attend for repeated examinations,

moving to another area, or delivery and hence scanning in Coventry of babies from outside the area. The total number was 169 babies but none of the severe grades (4 and 5) were lost to follow-up.

By the time of the second scan (mean 4.2 weeks; range 1 to 24), 657 of the 847 babies in the study group had become normal to ultrasound (grade 1), 79.7% of the abnormal right hips and 75.5% of the abnormal left hips. These figures rose to 91% (right) and 88.7% (left) at the time of the third scan (mean 9.1 weeks; range 2 to 40).

In the remaining 86 babies, in whom 9% of right hips and 11.3% of left hips were still abnormal, all but 0.16% and 0.29% respectively became normal by the time the eighth scan was performed (mean 15.2 weeks; 7 to 54). Two babies (three hips) remained abnormal despite treatment and these, together with all those treated, will be discussed later.

Table I. Ultrasound grade of the initial scan of both hips in the study group in which one or both hips was abnormal

Ultrasound grade	Right hip (number)	Left hip (number)	Proportion (per cent)
5	10	16	1.5
4	220	268	28.8
3	267	272	31.8
2	109	136	14.5
1	241	155	23.4
Total	847	847	100

Figure 4 shows the progress towards normality of the ultrasound appearance of these hips.

Babies in the following high-risk groups for CDH, and in whom the initial scan was abnormal, were reviewed. **Family history.** Of the 14 050 babies scanned there were 84 with a family history of CDH (0.6%). Of the 847 babies in the study group, 37 (4.37%) had a family history; thus 44% of all the babies who had a family history of CDH had some degree of ultrasound abnormality on their first scan. The distribution of the abnormalities by grade was little different to that for the study group as a whole (Table II). Both the grade-5 hips were clinically abnormal but there was no detectable clinical abnormality in any of the other hips.

Breech presentation. The incidence of breech presentation in Coventry is 2.36%. Of the 847 babies in the study group 74 (8.74%) had been born by breech delivery or by caesarean section for breech presentation. The incidence of grade-4 and grade-5 abnormalities in this group was higher than in the study group as a whole ($p < 0.001$) and the abnormalities were more severe (Table III).

Clinical abnormality. In the study group 22 babies (2.6%) had clinically abnormal hips, either a dislocation or a subluxation, when first seen in the hip-screening clinic, 90% at less than three weeks of age. All had an abnormal first ultrasound scan: 85% were grade 5; 12.5% grade 4; and 2.5%, grade 3. Fifteen (68%) had been diagnosed as clinically normal at their paediatric postnatal examination.

Treated cases. We treated 34 babies with 59 ultrasonographically abnormal hips in a Pavlik harness during the three years, a treatment rate of 2.42 per 1000. Of these 34 babies, 22 (65%) were clinically abnormal, but the other 12 were treated on the basis of persistent ultrasound abnormality alone. The treatment rate on ultrasound findings alone is thus 0.85 per 1000 babies. All babies treated in a harness are seen on a weekly basis for a scan to monitor progress. A physiotherapist supervises adjustment and weaning from the harness. Only three hips treated in this way failed to recover to normal. They ultimately required arthrography, closed adductor tenotomy and immobilisation in a hip spica.

DISCUSSION

In 1956, Von Rosen advocated routine clinical screening of all newborn babies for the early diagnosis of CDH. The efficacy of clinical screening tests is highly dependent on the experience and vigilance of the examiner. As no permanent record of this subjective assessment exists, re-evaluation of the results of the examination at a later date is impossible. While experienced clinicians have been able to reduce the incidence of late-presenting CDH, they have failed to abolish it entirely by clinical screening programmes.

If an alternative method of screening is to be

Fig. 4

Improvement of abnormal scans with time. Note that at each interval those which had become normal were no longer included.

Table II. Grades of abnormality of the first ultrasound scan in 37 babies (74 hips) with a family history of CDH

Ultrasound grade	Number	Per cent	Clinically abnormal
5	2	2.7	Yes (2)
4	10	13.5	No
3	26	35.1	No
2	14	18.9	No
1	22	29.7	No

Table III. Grades of abnormality of the first ultrasound scan in 74 babies (148 hips) with breech presentation

Ultrasound grade	Number	Per cent	Clinically abnormal
5	6	4.0	Yes (2) No (4)
4	67	45.3	Yes (12) No (55)
3	29	19.6	No
2	24	16.2	No
1	22	14.9	No

considered it must be more effective, harmless, reproducible and cost-effective. We think that routine ultrasound screening meets these criteria. We use the technique of Harcke et al (1984) and have found ultrasound screening to be more sensitive than clinical examination in detecting hip instability. No baby who had a normal scan at birth developed clinical instability and, conversely, ultrasound abnormalities were detected 15 times more often than was clinical abnormality.

A criticism of ultrasound screening in the first few days of life is that it detects minor degrees of abnormality which spontaneously resolve and need no treatment. This is confirmed by our figures which show that nearly 90%

of all such babies became normal within nine weeks. Logistically, however, it is necessary to perform the scans before the babies leave hospital to achieve the goal of screening the entire population. In fact 2% of the babies discharged from hospital before they were scanned failed to attend for a later scan. A screening programme can only be completely successful if it is applied to the whole population.

In addition to detecting those with clinical instability, we found 12 babies in whom there was persistent severe ultrasound abnormality in the absence of clinical abnormality. We treated these babies, at an average age of six weeks, by the Pavlik harness method and the ultrasound abnormality resolved in them all. As the natural history of such hips is unknown, we do not know how it was modified by our treatment. Others who have followed similar but untreated babies through to later childhood (Berman and Klenerman 1986; Castelein et al 1992) report that they may show radiographic signs of abnormality, although the significance of these is also unknown. We treated 0.85 per 1000 babies in a harness solely on the basis of an ultrasound abnormality. No patient treated in this way has developed avascular necrosis of the femoral head.

Whether ultrasound screening is cost-effective is a difficult question. Our programme requires a team of five radiographers to work the rota for daily scanning and radiographers and physiotherapists to assist at the weekly hip-screening clinic. The running cost is probably in excess of £20 000 per annum or about £4.30 per baby for the initial scan. This sum should be balanced against the cost of treating babies who might otherwise present with late CDH. This figure has not been calculated in the UK but in Canada it was estimated to be \$12 739 per patient for the first four years of life (Tredwell 1990).

During the three years under consideration, five babies with eight ultrasonographically abnormal hips were seen in the review clinic and found to have clinically subluxating or dislocated hips. All had had a normal postnatal paediatric clinical examination of the hips and no risk factors for CDH. This gives a rate for the detection of subluxation or dislocation by ultrasound alone of 0.57 per 1000 live births. This figure compares closely with the 0.68 per 1000 which we reported as the incidence of late-presenting CDH in our area (Clarke et al 1989). It represents 2.67 hips per annum which would otherwise have gone undetected.

It is now 22 months since the last baby included in these figures was born. None has presented with late CDH.

We are still concerned that a baby from within the 2% group which was not scanned may present later with

a dislocated hip. We have made additional efforts to ensure that all neonates have routine ultrasound screening. We accept that parental anxiety may be caused during the period of repeated scans, but this must be weighed against the far greater distress caused by the diagnosis of late-presenting CDH.

Conclusions. Ultrasound screening for CDH can detect cases of instability not diagnosed at birth by routine clinical examination and in patients who have no risk factors for CDH. These cases would otherwise present late with the prospect of lifelong disability. Routine ultrasound screening of neonatal hips should make it possible to lay to rest the spectre of late-presenting CDH.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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