ULTRASOUND AND CONGENITAL DISLOCATION OF THE HIP

THE IMPORTANCE OF DYNAMIC ASSESSMENT

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One-hundred newborn children at high risk of hip instability were prospectively assessed clinically and by ultrasound. The decision to treat was based only on the clinical examination. At the age of three months all the children were evaluated clinically and with an anteroposterior radiograph of the pelvis. None of the standard ultrasound measurements of acetabular depth and femoral head cover correlated with the outcome at three months. Dynamic assessment of stability was the only ultrasound technique that had a significant relation with outcome.

Early diagnosis and treatment of congenital dislocation and dysplasia of the hip (CDH) are important to ensure a successful outcome. Early diagnosis remains difficult: neither clinical examination nor plain radiographs of the pelvis are reliable indicators of dysplasia of the hip (Zieger and Schulz 1987). Ultrasound as a diagnostic aid was popularised by Graf (1980, 1981); many subsequent papers have claimed the usefulness of this technique for early diagnosis (Clarke et al 1985; Clarke 1986; Langer 1987).

Because there is now confidence in ultrasound assessment, protocols for treatment have been described, dependent upon geometric analyses of the ultrasound picture. We are concerned that the natural history of the maturing neonatal hip has not been established ultrasonically. Furthermore it is not clear whether accurate predictions of outcome can be made from early ultrasound examination. Since treatment carries risks of hip damage, care must be taken to ensure that unnecessary therapy is avoided.

We have used ultrasound to examine prospectively the hips of 100 babies referred with possible CDH. The decision to observe or to treat these babies was made on the clinical assessment alone, following a well-established protocol (Bradley, Wetherill and Benson 1987). Subsequent analysis allowed us to judge whether early ultrasound evaluation should have modified our treatment.

PATIENTS AND METHODS

One-hundred infants aged under three months were investigated. They were consecutive referrals to a special children's hip clinic. Each was referred with a clinical abnormality, a history of breech delivery, or a family history of congenital hip disease. Patients with known chromosomal disorders or neuromuscular diseases were excluded. Most patients were referred from the maternity unit of the John Radcliffe Hospital, Oxford, the remainder being referred by general practitioners or other specialists. The babies were born between June 1987 and April 1988. In this period 5,079 babies were born at the John Radcliffe Hospital and a total of 125 were referred to the hip clinic. The first 100 of these babies with complete clinical data, ultrasonic and radiographic measurements were included in this study.

At the infant’s first attendance details of the pregnancy, labour, family history, and the clinical findings were recorded. On the basis of the orthopaedic examination each hip was designated as normal, clicking, subluxatable, dislocatable, reducibly dislocated, or irreducibly dislocated (Bradley et al 1987). Children with irreducibly dislocated hips were not treated in early infancy. Those with reducibly dislocated hips were splinted with either von Rosen or Pavlic appliances. Children with subluxatable or dislocatable hips were
splinted only if they did not gain clinical stability by three weeks of age.

Ultrasonography was performed at the first visit. The technique used was based on the principles described by Graf (1984, 1986). A Disonics DRF-100 realtime sector scanner was used with a 10 MHz transducer (Les Ulis, France). The ultrasound examination was performed in the coronal plane with the transducer positioned on the lateral aspect of the flexed, slightly abducted hip (Fig. 1). This method produces a sonogram that resembles an anteroposterior radiograph of the right hip (Figs 2 to 5). Two images were recorded for each hip. For stability testing the hip was slightly adducted, exerting longitudinal pressure along the thigh (Barlow’s test). Movement of the femoral head of more than 1 mm away from the acetabulum indicated ultrasonic instability.

Graf’s classification (1986) of hip dysplasia is based on morphological aspects and angle measurements (alpha and beta angles) (Fig. 6). The original classification consisted of four major types which have since been subdivided (Table I) (Langer 1987). To test reproducibility of the measurement all angles were remeasured by the same observer at a later date. In addition the amount of the femoral head covered by the bony acetabulum was measured on the sonograms, by the method described by...
Morin, Harcke and MacEwen (1985) and Zieger, Hilpert and Schulz (1986) (Fig. 7). The amount of femoral head covered by the labrum was expressed as a ratio calculated as follows: two lines were drawn parallel to Graf's base line, one through the tip of the labrum and the other through the most lateral aspect of the femoral head. Distances were measured at right angles to the base line and expressed as ratios.

Follow-up after the initial assessment depended on the clinical problem. Children in splints were regularly monitored. Those with mild clinical instability were reassessed both clinically and ultrasonically. Splintage was checked weekly. Ultrasound examination confirmed hip reduction and was repeated at splint removal. All children, even those found to be clinically normal, were reviewed and radiographed at three months. Plain anteroposterior radiographs were used to assess the alignment, centreing of the femoral head, and the maturity of the bony roof measured as an acetabular index (Morin et al 1985).

The babies were then classified in four groups by outcome:

*Group 1.* Normal hips on clinical examination (stable with full movement); pelvic radiograph showing normally centred hips with acetabular angles of 25° or less.

*Group 2.* Normal hips on clinical examination; radiologically immature with acetabular angles greater than 25°.

*Group 3.* Hips which had been splinted for clinical instability, but at three months were clinically normal and radiologically mature with acetabular angles of 25° or less.

*Group 4.* Hips in which further treatment was necessary because of clinical instability or radiological dysplasia. Coefficients of correlation were calculated with the chi-squared test or Fisher's exact test for contingency tables with smaller numbers.

### RESULTS

There were 64 girls and 36 boys. Delivery had been induced in 29 and a Caesarean section done in 29. The presentation was by extended breech in 30 and by breech in eight. No correlation could be found between these variables and the final outcome. The length of labour, the sequence of the child in the family, or a family history of CDH were unrelated to outcome.

Most babies were referred by paediatricians. Table II shows the diagnosis of the referring physician. One or two weeks usually elapsed between referral and orthopaedic assessment. The high spontaneous resolution of minor instability is reflected in the finding of more stable hips by the orthopaedic surgeon (Barlow 1962). Fifteen of this high risk group of 100 babies were splinted, 14 in von Rosen splints and one in a Pavlic harness. Thus the treatment incidence was about 3 per 1 000.

The mean age for the first ultrasound examination was 25 days (range 5 to 81). Tables III and IV show the results of the ultrasound measurements based on Graf's criteria (1984).

The average difference between the original measurement of the bony acetabular angle (alpha) made at the clinic examination and that at review was 2.3° (s.d. 10°). The difference in the cartilage roof measurements was greater, with a mean of 3.6° (s.d. 16°).

The pelvis was radiographed at a mean age of 98 days (range 73 to 205). Table V shows the radiographic measurements.

As a result of the clinical and radiographic evaluation 54 babies were discharged after hip normality was confirmed at three months (group 1); 30 had clinically
normal hips, but bony immaturity on radiographs indicated the need for further follow-up (group 2); 12 had been splinted for six to 12 weeks during the first three months, but then proved to have clinically and radiographically normal hips (group 3). Four had hips that needed further treatment at three months (group 4); in all four a further period in a Pavlic harness was judged necessary.

All hips classified as Graf type I had a successful outcome, as did many of types II and III. However, there was no statistically significant correlation between any of the ultrasound measurements and the final outcome. Specifically, the Graf angles, Graf type, Morin acetabular depth measurements, and labrum cover ratios showed no correlation with the radiographic and clinical findings at three months. This reflects the frequency of a satisfactory outcome despite a poor ultrasound classification. Dynamic ultrasound testing correlated with the orthopaedic surgeon's initial clinical assessment for the left hip (p < 0.01), but not with that of the right hip. The results of the dynamic component of the ultrasound examination for both hips showed a strong predictive value when compared with the outcome. Stable hips had a significantly better outcome than unstable hips (p < 0.001).

**DISCUSSION**

There has been increasing recognition that clinical examination alone, even in the hands of dedicated experts, will not detect all cases of hip instability at birth. The diagnosis may be even more elusive in the days and weeks after delivery. Ultrasound promised, simply and non-invasively, to increase the accuracy of diagnosis, thereby reducing the number of babies treated and also the number that slip through the screening net (Berman and Klenerman 1986). Our study does not address the question of population screening, rather it concerns the value of ultrasound criteria in predicting the clinical outcome. To this end we deliberately selected a high-risk group and the overall incidence of abnormality should be taken in the context of the 5 079 children born during the study period. Several techniques for analysing the hip by ultrasound have been evaluated. In our hands, only ultrasound dynamic stability testing assisted the clinical decision whether to treat or just observe a newborn with suspect hips.

If the numbers in the various Graf types in our study (Table IV) are compared with that of a normal postpartum distribution (Langer 1987), it is clear that we achieved our aim of studying a group at high risk of hip instability. Langer reported 0.85% of hips with Graf-type IIC or worse in an unselected population; we found 64% of the hips to be IIC or worse. Allowing for the total number of deliveries from which our patients were selected, the figures are much the same. The average difference between the Graf angles measured on review and those from the original observations was small. However, it is notable that there was a fairly wide scatter, with differences of 10% for the roof angle and 16% for the cartilaginous labrum angle being within one standard deviation of the mean.

We did not find any significant correlation between the Graf types and outcome. Graf (1986) claims that hips of type IIC or worse have such poor osseous development (alpha > 43°) that they require treatment irrespective of age. This practice seems also to be that recommended by Langer (1987). If we had followed this advice 80 infants would have been treated. However, on the basis of the clinical examination, we found that only 15 babies needed treatment.

Graf's (1986) classification system, with eight groups of sonographic appearance, is complicated. Therefore, other ways of assessing the hip by ultrasound have been developed. The ratio that expresses the proportion of the femoral head covered by the bony acetabulum measured in our study has been used by Morin et al (1985) and Terjesen, Bredland and Berg (1988). They claim that this ratio is equally accurate and easier to measure. The unstable hips in our study did not have a significantly

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<th>Table II. Assessment of clinical stability by referring physician and by orthopaedic surgeon</th>
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<td><strong>Referring physician</strong></td>
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lower ratio than the stable ones, which is contrary to the findings of Terjesen et al (1988). The ratio depicting cover of the femoral head by the cartilaginous labrum likewise bears no relation to clinical outcome.

We could not show any significant correlation between the alpha angle on the initial ultrasound and the acetabular index at three months, which is in accordance with the findings of Morin et al (1985).

Although there was a significant correlation between clinical and ultrasonic examination of the left hip this was not matched in the right hip. A right-handed observer may be less accurate in detecting minor instability of the hip examined by the non-dominant hand. Ultrasound highlights minimal displacement: 1 to 2 mm of movement are easily detectable.

Our study suggests that in early infancy Graf's classification and Morin's ratios do not reliably predict the need for splintage. In our hands, the only ultrasound assessment which related to the clinical outcome was dynamic testing of the hip. This concurs with the findings of Saies, Foster and Lequesne (1988).

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REFERENCES


