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This prospective cohort study aimed to investigate the relationship between developmental dysplasia of the hip and mode of delivery in 571 consecutive breech infants using a modified Graf's static morphological method to grade the severity of dysplasia.

In this group, 262 infants were born by planned Caesarian section, 223 by emergency section and 86 vaginally. Taking all grades of hip dysplasia into account (Graf types II, III and IV), there was no statistical difference in the incidence of dysplasia between the groups (elective section 8.4%, emergency section 8.1% and vaginal delivery 7.0%). However, when cases with Graf type II dysplasia, which may represent physiological immaturity, were excluded, the rate of type III and IV hips, which we consider to be clinically relevant, increased in the vaginally delivered group (4.7%) compared with the elective section group (1.1%), with a relative risk of approximately 1:4 (95% confidence interval 1.03 to 15.91). No difference was observed between the emergency and elective section groups, or between the emergency section and vaginally delivered groups.

This study supports previous published work, with the added value that the diagnoses were all confirmed by ultrasound.

The incidence of developmental dysplasia of the hip (DDH) is one to three per 1000 live births, but the condition encompasses a wide clinical spectrum of severity, from minor acetabular dysplasia to irreducible dislocation of the hip. Breech presentation has long been recognised as a risk factor for DDH, with a relative risk of 1:27,3; 3% to 4% of pregnancies reach term with the fetus in the breech position.4,5 However, at 28 weeks' gestation 20% of fetuses are lying in the breech position, so the majority spontaneously turn to the cephalic position before term.6

The Canadian Term Breech Trial, reporting in 2000, found significant reduction in perinatal and neonatal mortality, and serious neonatal morbidity if the breech presentations at 37 weeks were delivered by planned Caesarean section, rather than by vaginal delivery.6

The effect of mode of delivery of breech infants on the incidence of DDH has been unclear, with some studies reporting an increased risk following vaginal and emergency Caesarean section births3,7 and others reporting no such association.8,9 Lowry et al2 suggested that vaginal and emergency section deliveries were associated with an increased risk of DDH, but the degree of severity of the dysplasia was not stated or discussed, nor was the difference between true clinical instability and minor dysplasia, which may be a manifestation of physiological immaturity rather than a pathological entity.

Our study analysed the rates of clinical and sonographically confirmed instability of the hip and sonographically diagnosed DDH in neonates lying in the breech position born at term and by emergency Caesarean section, elective Caesarean section or spontaneous vaginal delivery.

Patients and Methods
For 18 years, the Royal Blackburn Hospital has had an established targeted sonographic screening programme. Referrals to the senior author’s (RWP) paediatric hip clinic include those with neonatal clinical instability of the hip and those with risk factors for DDH, including breech presentation, a family history and deformity of the foot.10 Referrals are regularly audited and follow set protocols.

Over a four-year period (1 January 2006 to 31 December 2009) a prospective consecutive cohort study was conducted of all breech-presenting neonates referred to this clinic. All were examined by the senior author, using the Barlow and Ortolani tests of reducibility and dislocatability of the hip11 and using...
ultrasound by a modified Graf’s static morphological method and Harcke’s dynamic method. Infants with or suspected of having a syndrome, such as Down’s syndrome, were excluded.

Hips were classified according to the modified Graf classification: type I, α angle > 60° (normal); type II, α angle 43° to 60°; type III, α angle < 43°; type IV, subluxable/irreducible. Graf types III and IV were considered to be pathological. This method has been validated by Rosendahl and Toma. Infants with suspected instability on initial evaluation by the paediatric clinic screening programme were examined in the hip clinic and the hips assessed by ultrasound within two weeks, but clinically stable hips with risk factors were usually assessed between six and eight weeks after birth. This was in general agreement with the United Kingdom Neonatal and Infant Physical Examination draft recommendations, which were formalised in 2008.

Graf type II hips were not treated by splintage but were observed, and only treated if they progressed to type III or type IV. It has been shown that approximately 90% of Graf type II hips resolve spontaneously as immature/physiological hips. Graf type III and IV hips are generally considered ‘pathological’, and so splintage is advised.

Treatment of these hips with a Pavlik harness commenced as soon as the diagnosis was confirmed by ultrasound. This treatment regimen could result in significant confounding factor(s) as a minority of Graf type III hips may resolve spontaneously, and 70% to 90% of neonatal unstable Graf types IV hips may stabilise. This could not be avoided, as current United Kingdom national and some international guidelines advise that these pathological hips should be treated.

There were local hospital guidelines and protocols at the East Lancashire Hospitals NHS Trust on the mode of delivery for breech presentation (spontaneous vaginal delivery, elective or emergency Caesarean section), based on the recommendations of the Royal College of Obstetricians and Gynaecologists and the National Institute for Clinical Excellence (NICE). At 36 to 38 weeks’ gestation the options to be discussed included external cephalic version, spontaneous vaginal delivery and elective Caesarean section. All individual cases were managed and discussed with the consultant obstetrician responsible.

**Statistical analysis.** Statistical analysis was performed using chi-squared or Fisher’s exact test as appropriate, and the relative risk was calculated between groups. StatsDirect Ltd software (http://www.statsdirect.com, England) was used. A p-value < 0.05 was considered statistically significant.

**Results**

Over the four-year period, 578 infants were breech deliveries; of these seven syndromic infants were excluded; 262 were born by planned Caesarean section, 223 by emergency Caesarean section and 86 vaginally. Males and females were evenly distributed between the three groups; however, the rate of prematurity was significantly higher in the emergency section and vaginally delivered groups (p < 0.01), although between these two groups there was no difference (p = 0.97). There was no difference in family history between the groups (p = 0.42). Other findings are shown in Table I. There were 48 infants from twin pregnancies, including 15 breech/breech pairs, and a further 18 from breech/vertex pairs (the vertex-presenting infant was not included in this study). The incidence of foot deformities is comparable to that in a previous study. The numbers appear low but are correct, as they include only those foot deformities in babies born by breech delivery. Breech delivery occurs in only 3% to 4% of pregnancies.
Overall, 46 children had at least one abnormal hip according to Graf’s modified sonographic method, 12 of whom had a Graf type III or IV dysplasia of one or both hips. All but one of these 12 infants was female. Table II shows the distribution of modified Graf types (I to IV) in all hips.

A total of 15 breech infants with clinically detected instability on Barlow and Ortolani testing were referred by the paediatric department, and of these, seven were clinically stable when reviewed in our clinic, although only three had normal hips. Table III shows the results in this group.

No differences between the groups could be observed from the abnormal ultrasound examinations (Graf Type II, III and IV), the incidence of dysplasia was similar (Table II), and this was confirmed by relative risk and Fisher’s test analysis. However, when only Graf types III and IV were analysed, differences were observed. No difference in risk was found between the elective and the emergency Caesarean section groups, nor between the emergency section and vaginal groups, but the vaginally delivered neonates showed a more than fourfold increase in Graf type III or IV dysplasia compared with the elective Caesarean section deliveries (relative risk 1.40.6, 95% confidence interval 1.03 to 15.91), which approached significance (p = 0.07) (Table IV). This relationship reached significance when twins were excluded from the group (p = 0.05). Relative risks between elective and emergency Caesarean section, and emergency Caesarean section and vaginal groups included the value 1.0 in the 95% confidence limits, and were therefore statistically not significant.

**Discussion**

Our study confirms that spontaneous vaginal delivery of breech babies increases the risk of hip pathology and instability (Graf types III and IV) compared to elective Caesarean section. However, when vaginal delivery was compared with emergency Caesarean section, although the rates of DDH were doubled, this did not reach statistical significance.

Based on previous studies by the senior author, we believe that a strong family history and breech presentation are the two most significant risk factors for instability and pathological dysplasia of the hip (Graf types III and IV), and this is supported by other similar studies and by the United Kingdom National Guidelines. Chan et al and Lowry et al both noted the increased risk of DDH following vaginally delivered and emergency Caesarean section births of breech babies over those delivered by elective caesarean. However,
both of these studies included the full range of dysplasias, including the physiological Graf type II. The assessment of DDH in Lowry’s study was mainly by clinical instability rather than sonographic evaluation. This may be more subjective and prone to false positive results than hips that are also assessed sonographically, as demonstrated in our study. Lowry et al looked at a cohort of 941 breech infants, finding an increased risk of DDH with emergency Caesarean section and vaginal delivery. The retrospective study by Chan et al looked at perinatal risk factors in 1127 cases, finding an increased risk with breech presentation, emergency Caesarean section and vaginal delivery, in order of increasing magnitude. Despite using different methods, our study agrees with the findings of these two studies. We have chosen not to include Graf type II sonographic dysplasias unless they progressed to types III or IV, as the majority of these improve spontaneously.

Claussen and Nielsen, who found no difference in DDH following different modes of delivery, used clinical examination and whether or not infants had been treated as their outcome measures but it is unclear as to whether their assessments were confirmed with ultrasound.

Why hip dysplasia and instability should be associated more with certain modes of delivery of the breech baby remains unclear. Wilkinson suggested that it results from a combination of ligamentous laxity and stretching of the hip capsule due to the flexed position of the hip during breech delivery. It is recognised that instability of the hip may not necessarily be due to delivery forces alone. Hsieh et al, who found no difference following vaginal and Caesarean births, felt that congenital dislocation of the hip was not related to the method of delivery but instead to the breech position, and described it as part of a ‘breech deformation complex’ which included torticollis and facial anomalies. Chan et al felt that DDH was an in utero occurrence in late gestation, aggravated during vaginal delivery. This would seem to be the logical conclusion based on current evidence.

Other factors that have been postulated in the development of pathological DDH include female joint laxity and increased uterine pressure in the active phase of labour, although these are not likely to be the sole causes, as in our study there was little difference between those born by emergency Caesarean section and those by spontaneous vaginal delivery. The difference in the prevalence of pathological DDH could be due to the different criteria for elective or emergency Caesarean section (see Patients and Methods). The treatment of pathological DDH may affect the natural history of Graf type III or IV hips. Spontaneous resolution may occur, but the extent of this could not be assessed in this study and this could therefore be a confounding factor. However, as most guidelines advocate the treatment of Graf type III and IV hips, it was thought unethical to simply observe and not treat such hips. The different timing of ultrasound examinations between clinically unstable hips and those at risk could also be a confounding factor. However, this was in accordance with national guidelines and therefore unavoidable.

A total of 76% of infants with an abnormal hip were female and 92% (11 of 12) infants with modified Graf grade III or IV hips were female. The only male infant affected was delivered vaginally and presented late, at 17 weeks, owing to external factors. Of these 12, eight were referred because they were clinically unstable. It is therefore arguable that all breech female infants and breech males with clinical evidence of instability should be referred for screening; however, this may be controversial and further evidence is needed before it can be advocated.

We accept that the mode of delivery in breech presentation could be a confounding factor, and that the results could have been unintentionally biased due to other complex factors, such as gender, birth weight, prematurity, age at ultrasound assessment and spontaneous resolution. It may be impossible to separate all these potential factors in a longitudinal observational study, which by nature is prone to bias. There were established local hospital guidelines on the mode of delivery for breech presentations, based on the recommendations of the Royal College of Obstetricians and Gynaecologists and NICE. This inevitably resulted in selection bias within the study, however it was representative of current practice. The main recommendations include:

1. External cephalic version: may be used/attempted in singleton pregnancy, sonographic imaging confirming breech position and in the absence of significant uterine or fetal abnormalities.

2. Spontaneous vaginal delivery: to be considered if the mother and baby were of normal proportions, the presen-
The benefit of elective Caesarean section remains to reduce infrequent but treatable condition, is probably unnecessary. In order to reduce the incidence of what is essentially an elective Caesarean section should be performed for breech delivery in all neonates. Despite this, to state that elective NICE guidelines. The main reasons were an immediate DDH, with sonographically confirmed diagnoses and grading in all neonates. In summary, we believe that this study supports previous studies on the effect of mode of delivery on pathological DDH, with sonographically confirmed diagnoses and grading in all neonates. Despite this, to state that elective Caesarean section should be performed for breech deliveries, in order to reduce the incidence of what is essentially an infrequent but treatable condition, is probably unnecessary. The benefit of elective Caesarean section remains to reduce mortality and morbidity in the mother and the infant.

References