NEONATAL HIP STABILITY AND THE BARLOW TEST

A STUDY IN STILLBORN BABIES

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Ten normal neonatal hips were examined in stillborn babies. At first, forcible Barlow manoeuvres did not produce subluxation or dislocation, but by repeated examination a previously stable joint could be rendered unstable. Dissection of the hips showed that the vacuum fit between the femur and the acetabulum was an important factor in neonatal hip stability. The posterior capsule was not a strong or, in itself, an important structure.

It is postulated that the capsule and the labrum act together as 'O' rings to maintain the vacuum fit; it is possible that repeated examinations, by producing an effusion, could break the seal and allow instability.

It is difficult to explain why some older infants are found to have congenital dislocation of the hip (CDH), despite having been examined as neonates and found normal by competent examiners (Davies and Walker 1984). There are three possible explanations:

- 1) the abnormality was present but was not detected;
- 2) the abnormality was not detectable by clinical examination, but may have been demonstrable by ultrasound (Burman and Klenerman 1986);
- 3) a normal hip has become abnormal.

Despite screening programmes, there appears to have been an increase in the late presentation of CDH (Catford, Bennet and Wilkinson 1982). It has been claimed that either the natural incidence of the condition is increasing (which seems unlikely), or there is some adverse environmental factor at play. Is it possible that the performance of the Barlow provocative test provides such a factor? Although the evidence for this is largely circumstantial, it is fairly convincing (Moore 1989). In order to investigate this theory, the hips of five stillborn babies were dissected and manipulated.

MATERIALS AND METHODS

Ten hips were studied in five stillborn babies, whose intra-uterine death had been due to 'placental insufficiency'. No other abnormalities had been found at post-mortem examination. All tests were carried out within 24 hours of birth.

Specimens 1, 2 and 3 were at 40, 28 and 38 weeks gestation respectively. The hips were dissected by a Smith-Petersen approach, dividing psoas and rectus femoris, but taking care to preserve an intact capsule. In all six hips both Ortolani and Barlow signs were negative. They remained negative even after forcible repetition of the Barlow test some five to 10 times.

In *specimen 4*, of full-term gestation, after 30 forcible Barlow manoeuvres, both hips became lax as gas appeared in the joint spaces. The source of the gas was not clear; there were no obvious holes in the capsule. The femoral head could then be dislocated posteriorly with ease, its movement being limited by the ligamentum teres rather than the capsule.

In *specimen 5*, also full term, a limited anterior dissection was made to expose the hip capsule. A forcible Barlow test showed that the hip was stable. A syringe and fine needle were used to inject 1 ml of air into the joint at the junction of the labrum and the joint capsule. This caused the capsule to bulge, and only slight traction was required to subluxate the hip. The femoral head could then be moved freely backwards and forwards; Barlow's test was strongly positive.

Each hemipelvis and femur was then dissected free, retaining the capsules.

Each femoral head was freely mobile (Fig. 1) after the air had been introduced and the posterior capsule was seen to be a thin, translucent structure. However, some stability could be restored by pressing the femoral head back into the acetabulum and re-establishing the 'suction effect'. After a few minutes rest the Barlow manoeuvre did not produce subluxation. Only traction in a direction away from the acetabulum, allowing air again to enter the joint, restored the free subluxation. It seemed that the tight fit and clinging effect of the capsule at the

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edge of the labrum was important in re-establishing and maintaining the vacuum effect.

A CT scan of the specimen (Fig. 2) shows that the bony acetabulum is extremely shallow; most of it is made up of soft tissue. The capsule is seen to be very thin.

DISCUSSION

Is it possible to dislocate a normal hip? It has been reported that the femur will fracture before the hip can be dislocated by force (Dunn 1969). This was confirmed in principle, though the force used was insufficient to cause a fracture. However, as soon as the vacuum seal is abolished, it becomes very easy to dislocate the hip. Repeated movements were more successful in producing subluxation of a normal hip than one large forceful movement.

The vacuum seal. A vacuum fit has not previously been considered to be an important factor (Stanisavljevic 1964). Ogden (1982) injected air into the joint, mainly as a way of demonstrating the extent of the non-osseous acetabulum, but he also reported that the air broke the

suction effect and produced laxity in neonatal hips which were normally formed. Dunn (1969) after dissecting normal neonatal hips stated "even after the muscles protecting the joint and the capsule itself had been divided, considerable force was necessary to break the vacuum created by the snug fit of the head of the femur within the acetabulum. Whilst this was particularly true when the thigh was in a position of abduction, it was less the case when it was adducted and internally rotated, for in this position the head of the femur is rotated out of the acetabulum to be opposite the posterior aspect of the joint, making the vacuum within the latter much easier to break".

Crelin (1976) considered that the ligamentum teres was important in preventing dislocation. He transected the ligament through a small opening in the antero-inferior part of the joint. In doing so he probably released the vacuum and reached the incorrect conclusion that "negative pressure plays no part in stabilising the hip joint". The vacuum phenomenon was also mentioned by Palmén (1984) who stated that "repeated examination might result in the provocation of a so-called vacuum

Fig. 1a

Fig. 1b

Photographs to show the instability of the hip in *specimen 5* after air had been injected into the joint. Figure 1a – Anterior view with the femoral head pushed posteriorly. AIC, anterior iliac crest; AC, anterior capsule; Pu, pubic bone. Figure 1b – Posterior aspect of the joint with the femoral head pushed forward. IT, ischial tuberosity; PC, posterior capsule; GT, greater trochanter.

Fig. 2

CT scan of *specimen 5* to show the thin posterior capsule: b, bone; cl, cartilaginous labrum; lt, ligamentum teres.

phenomenon in the joint. Thus a change of pressure causes gas to be formed in the synovial fluid, possibly leading to minor instability".

Hypothesis. A theoretical model is presented (Fig. 3). The intrinsic stability of the neonatal hip may depend to a large extent on the vacuum fit of the acetabulum and the proximal capsule on the femoral head, and this is influenced by any factor which would tend to reduce the quality of the fit, such as a shallow or deformable acetabulum, or excessive tissue laxity. If the vacuum is broken the posterior capsule is unable to retain the femoral head.

It seems that both the capsule and the acetabular

Fig. 3a

Fig. 3b

Figure 3a – Diagram to show the sites of the constriction rings discussed in the text. Figure 3b – Cross-section at the line showing the potential joint space at the performance of the Barlow test.

labrum have important functions, acting as 'O' washers which seal the vacuum fit around the head of the femur. Arthrographic studies have demonstrated that there are two zones of constriction in the joint (Tönnis 1987). One is at the level of the acetabular labrum (particularly posteriorly) and the other is at the level of the zona orbicularis of the capsule. These zones of constriction may act functionally as 'O' rings and decrease the chance that any fluid within the joint will compromise the vacuum fit.

It is therefore suggested that a vacuum-fit phenomenon is an important factor in the stability of the neonatal hip. It is possible that this suction fit could be compromised by fluid or by gas if the hip is examined too roughly during a forcible and repeated Barlow manoeuvre.

Whilst it is possible to bring gases out of solution by severe traction on a joint, it is difficult to believe that this phenomenon could occur in practice during a Barlow

test. It is more credible that the Barlow test, done repeatedly, could produce an effusion in the hip which could have an adverse effect on the vacuum fit, rendering it *potentially* unstable. If such a hip is then exposed to an adverse postnatal position with the legs adducted, dislocation could result. It is unlikely that a few repetitions of the Barlow test, even if done forcibly, could produce such conditions, but if it is done during numerous and repeated examinations it seems possible that an effusion may be produced. Further studies of this phenomenon are proposed, using liquid instead of air.

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