Audit

The 'true' acetabular index in children with cerebral palsy

JD Spencer, MS Sait

Orthopaedic Department, Guy's Hospital, Guy's & St Thomas' NHS Trust, London, UK

Introduction: The acetabular index is a measurement used to determine whether or not an acetabular osteotomy may be required at the time of hip reconstruction in children.

Methods: A retrospective analysis of pre- and postoperative values of the acetabular index was carried out on two groups of children. One group of children had an acetabuloplasty and the other did not during hip reconstruction, the decision being made at the time of open reduction, based on lack of hip congruity.

Results: When the pre-operative acetabular index measurements were reviewed, the mean difference between the two groups was only 7°. Range of measurements was similar between the two groups.

Conclusions: The acetabular index is difficult to measure in some children with cerebral palsy. The bony landmarks are difficult to standardise. This may explain the similar pre-operative values between the two groups of children in this study. We, therefore, recommend that before hip reconstruction in children with cerebral palsy, the measurement of the acetabular index should be abandoned. Decisions as to whether to undertake an acetabuloplasty or not should be made at the time of open reduction.

Key words: Acetabular index – Children – Cerebral palsy – Acetabuloplasty

Measurement of the acetabular index has traditionally been used when open reduction of the hip is contemplated, in children with cerebral palsy or developmental dysplasia of the hip. We have in the past routinely and serially measured the migration percentage of the hip and the acetabular index¹ in all children with hip problems in cerebral palsy (Fig. 1). The accuracy of this pre-operative measurement (*i.e.* the acetabular index) has not been assessed when attempting to decide who may or may not need an acetabular osteotomy during hip reconstruction. Therefore, in a series of 25 children, we have reviewed the acetabular index measurements before and

after hip reconstruction where the decision to undertake an acetabuloplasty was made only at the time of open reduction.

Patients and Methods

Study group

Included in the study were 25 consecutive children with cerebral palsy undergoing hip reconstruction with or without an acetabular osteotomy between 1996 and 1998. There was a wide age range (Table 1). In these 25 children,

Correspondence to: JD Spencer, Emeritus Consultant Orthopaedic Surgeon, Thomas Guy House, Guy's Hospital, London SE1 9RT, UK. Tel: +44 (0) 207 955 5000 (ext. 5606); Fax: +44 (0) 207 955 2759

Figure 1 Tracing of a pelvic X-ray where arrows indicate the difficulties of delineating bony landmarks.

Table 1 The study group

	Hip reconstruction	Acetabuloplasty and hip reconstruction
No. of patients new	13	12
No. of hip reconstructions	13	13
Average age	8 years	9.5 years
Range	3–16 years	3–17 years

Figure 2 Radiograph of the pelvis before operation showing both hips dislocated.

29 hip reconstructions were carried out and, retrospectively, the children were divided into two groups. In one group, 12 patients (13 hips) had a pericapsular acetabular osteotomy; in the other group, 13 patients (16 hips) did not. In all children and adolescents, the triradiate cartilage was open at the time of surgery. A wide lateral

Figure 3 The postoperative results. AP radiograph of the pelvis showing the results of open reduction of both hips with proximal varus femoral derotation osteotomies and the outer angle of the acetabulum marked by a stainless steel suture. The other suture is on the cut end of psoas and is superimposed on the bony roof of the acetabulum (left peri-acetabular osteotomy only).

Table 2 Acetabular index results

	Hip reconstruction	Hip reconstruction and acetabuloplasty
Mean pre-operative acetabular index	28° (50–18°)	35° (55–17°)
Mean postoperative acetabular index	26° (40–15°)	23° (33–5°)
Mean postoperative acetabular index to suture marker	17° (27–3°)	11° (27–0°)

approach was used and the femoral head was inspected for signs of damage. To facilitate reduction, the ligamentum teres was excised, iliopsoas divided and the medial capsular attachments of the acetabulum to the proximal femur were also released. A stainless steel suture marker was placed in the proximal cut end of the iliopsoas and also in the acetabular labrum at its superior and outer angle in the acetabular roof (Fig. 3). This would enable later radiographic measurements to be more accurately made with regard to the extent of the acetabular roof and the acetabular index itself. Under the image intensifier, a proximal femoral varus derotation osteotomy was carried out and then an attempt at open reduction under direct vision performed. If it was deemed necessary to reconfigure the acetabular roof, a peri-acetabular osteotomy was carried out, again under radiographic control using three osteotomes and femoral bone graft.

Methods

Pre-operative and postoperative acetabular index measurements were carried out² in a serial fashion at every out-patient attendance and the patient was placed in a standard position with the pelvis transverse, and the legs in neutral rotation and neutral abduction/adduction for the anteroposterior view (Fig. 2). In a few children, pre-operative demonstration of the acetabular roof was only possible when Thomas' test was performed with the opposite hip being fully flexed.³ In children with cerebral palsy, this obliterated the lumbar lordosis and unflexed the pelvis to allow a clearer outline of the acetabular roof to be shown on the plain X-ray.

Results

In those children who simply had a proximal varus femoral derotation osteotomy and an open reduction of the hip, the highest value of the acetabular index was 50° pre-operatively and without any acetabular surgery this fell to 40° (Table 2). The lowest acetabular indices in this group changed very little after surgery. The mean postoperative acetabular index to the outer angle of the bony acetabulum visible on the plain radiograph, was 26° (range, 40–15°). However, the same measurement made to the suture marker in the acetabular labrum was 17° (range, 27–3°).

The mean pre-operative acetabular index in the group of children who underwent an additional peri-acetabular osteotomy was 35°. The range (55–17°) was almost identical to that of the group of children who did not require a peri-acetabular osteotomy at open reduction (*i.e.* 50–18°) (Table 2). The postoperative acetabular index to the outer bony margin of the acetabulum was very similar again in both groups – 23° in those who had an acetabuloplasty and 26° in those children that did not.

However, acetabuloplasty produced a drop of the mean acetabular index, from a pre-operative mean of 35° to 11° if measured to the suture marker. The ranges of acetabular index measurements to the acetabular suture marker in both groups of children after operation were very much the same.

Discussion

The incidence of hip dislocation in children with cerebral palsy is 10%,⁴ but it is more common in the non-ambulant, quadriplegic child^{5,6} and may well result from muscle imbalance. Early adult hip arthritis and scoliosis, are associated with unilateral hip dislocations.^{4,7,8} The objective of hip reconstruction is to prevent early-onset osteoarthritis of the hip, pelvic obliquity and possible scoliosis. Above all, this operation is undertaken to treat the painful hip joint of children with cerebral palsy.

Although this is a retrospective study, we have highlighted a number of problems that are confusing with respect to acetabular index measurements. There is, for example, a wide range of measurements in the two groups of children. In addition, in one child who had at open reduction, good congruity of the acetabular roof and the femoral head, the pre-operative acetabular index was 50°. This was unexpected and, surprisingly, postoperatively this measurement at 50° reduced to a figure of 40° without any acetabular surgery whatsoever. The acetabular index was again further reduced postoperatively when measured to the acetabular labral suture marker and resulted in a reading of 27° despite the fact that this child did not have surgery to the acetabulum. In this individual case, the acetabular index seems to have been misleading.

Acetabular index mean values demonstrated in this retrospective study that children who needed an acetabuloplasty at the time of open reduction had, overall, a 7°

greater acetabular index pre-operatively than the group of children who did not require an acetabuloplasty. This indicates that the pre-operative acetabular index may not be helpful in pre-operative planning, *i.e.* which child does/does not require an acetabuloplasty.

Confusion can also occur because in the acetabuloplasty group, there were children whose pre-operative acetabular index was considered normal. However, at operation they were found to have a deficient acetabular roof after reduction of the femoral head. The fact that the two groups of children at the extremes of their ranges of pre- and postoperative acetabular index measurements, were so similar indicates that this measurement may not predict which child prior to operation will need an acetabuloplasty and which child will not.

In developmental dysplasia of the hip,⁹ it has been noted that there is significant intra- and interobserver variability when measuring the acetabular index. If the same individual measures the acetabular index on different occasions, there may be a difference of 6.1°; in addition, there is an interobserver error of 5.5%. Cadaveric studies¹⁰ have shown that the acetabular roof in children contains a substantial cartilaginous epiphysis, which on X-ray is radiolucent. The limbus and acetabular epiphysis may form a significant part of the acetabular roof¹⁰ and this must be taken into account when interpreting plain X-rays of the pelvis before operation. In addition, surgical care needs to be taken at the time of pericapsular acetabular osteotomy.¹¹ If not, an osteotome might well enter the cartilaginous epiphysis of the outer angle of the acetabulum. This will damage growth and shape of the acetabulum. To avoid making this mistake, probing may be helpful in dealing with the junction between iliac bone and the acetabular epiphysis using the image intensifier.

The acetabular index measurement does not take into account the full extent of the acetabular roof. When measured in children of different age groups,¹² a figure of about 20° is given as the mean of the normal range. It would not be surprising if this figure might reduce considerably were the acetabular index measured, as in this series of children, to the acetabular labral suture marker. This marker indicates the full extent of the acetabular roof. Whilst it may be that the measurement of the acetabular index on plain anteroposterior radiographs at the pelvis are considered⁴ to be an accurate predictor of developmental dysplasia of the hip in children between the ages of 2 and 4 years, we believe that in children with cerebral palsy there is not merely the possibility of intra- and interobserver error, but also a major potential for inaccuracy arising from mal-positioning of the pelvis. This may well not occur at all in children with developmental dysplasia of the hip; however,

if the pelvis is flexed or extended, on plain radiographs it may be very difficult to judge the full extent of the acetabular roof and, therefore, its angle.

For all of the above reasons, we believe that the decision as to whether or not to carry out a pericapsular acetabular osteotomy in a child with cerebral palsy undergoing hip reconstruction should only be made at the time of open reduction. The lateral approach to the hip gives excellent vision of the acetabulum to enable this decision to be made. Surgeons should be aware of the difficulties in obtaining accurate preoperative measurements of the acetabular index, and that it is best to make a decision for or against acetabular surgery at the time of the open reduction of the hip. There is a strong case to be made for not measuring the acetabular index before operation, as we have found that it does not, in retrospect, predict who is or who is not going to need a pericapsular acetabular osteotomy.

Acknowledgements

Our thanks are due to Nigel Morgan, Locum Orthopaedic Registrar, for help in the decision to use a suture marker for the acetabular index measurements. We wish also to thank Mrs P Lucas for all her help in the typing of the manuscript.

References

1. Scrutton D. The early management of hips in cerebral palsy. *Dev Med Child Neurol* 1989; **31**: 108–16.
2. Reimers J. The stability of the hip in children; a radiological study of the results of muscle surgery in cerebral palsy. *Acta Orthop Scand* 1980; **184** (Suppl): 1–100.
3. Cornell MS, Spencer JD, Boyd R, Baird G. Imaging the acetabulum in children with cerebral palsy. *J Bone Joint Surg Br* 1994; **76**: 982–3.
4. Cooke PH, Cole WG, Carey RPL. Dislocation of the hip in cerebral palsy. Natural history and predictability. *J Bone Joint Surg Br* 1989; **71**: 441–6.
5. Mubarak SJ, Valencia FG, Wenger DR. One stage correction of the spastic dislocated hip. *J Bone Joint Surg Am* 1992; **74**: 1347–57.
6. Bleck EE. The hip in cerebral palsy. *Orthop Clin N Am* 1980; **11**: 79–104.
7. Cooperman DR, Bartucci D, Miller EA. Hip dislocation in spastic cerebral palsy. *J Pediatr Orthop* 1987; **7**: 268–76.
8. Gamble JG, Rinskey LA, Bleck EE. Established hip dislocations in children with cerebral palsy. *Clin Orthop* 1990; **253**: 90–9.
9. Broughton NS, Brougham DI, Cole WG, Menelaus MB. Reliability of radiological measurements in the assessment of the child's hip. *J Bone Joint Surg Br* 1989; **71**: 6–8.
10. Ponseti IV. Growth and development of the acetabulum in the normal child: anatomical, histological and roentgenographic studies. *J Bone Joint Surg Am* 1978; **60**: 575–85.
11. Singh S, Ree H-T, Low Y-P. Significance of the lateral epiphysis of the acetabulum to hip joint stability. *J Pediatr Orthop* 2000; **20**: 344–8.
12. Tönnis D. Congenital dysplasia in dislocation of the hip in children and adults. *Clin Orthop* 1976; **119**: 39–47.