Lateral shelf acetabuloplasty in Perthes’ disease
A REVIEW AT THE END OF GROWTH
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The surgical treatment of Perthes’ disease by femoral or innominate osteotomy is not as effective in those over the age of eight years as it is in the younger child. This has prompted the search for other types of management in those who are older. The preliminary results of the use of a lateral shelf acetabuloplasty for such cases have shown encouraging results at two years. The concern with such an operation is that it might interfere with the growth of the outer aspect of the acetabulum and so prejudice the long-term outcome. We describe a review at maturity of 26 children presenting with early disease after the age of eight years who were treated by lateral shelf acetabuloplasty. The results suggest that the outcome is improved; 22 of 27 hips were rated as Stulberg groups 1 to 3. Poor results occurred in children, particularly girls, presenting with Group-4 disease over the age of 11 years.

The natural history of Perthes’ disease presenting in a child over the age of eight years is poor without treatment. The results after treatment are not as good at this age as those in children who are seen between the ages of five and eight years. After femoral osteotomy, although the head has an acceptable shape, some results have to be downgraded because of persisting coxa vara and shortening. In 1992, Willett, Hudson and Catterall2 described the early results after two years of treatment by lateral shelf acetabuloplasty in the older child. They were generally satisfactory. Heyden and Tongerloo3 gave an account of their results with lateral shelf acetabuloplasty in 1982, although Kruse, Guille and Bowen4 had carried out this operation for Perthes’ disease in the 1950s. In both of these reports the operation was not restricted to the older child. When undertaking the operation at this age there is concern that the growth plate of the lateral acetabular epiphysis may be damaged and hence undo the good short-term results. We have reviewed our experience of children presenting over the age of eight years with early Perthes’ disease treated by lateral shelf acetabuloplasty.

Patients and Methods
Between 1986 and 1992, 26 children over the age of eight years with early Perthes’ disease were referred to the Children’s Unit of the Royal National Orthopaedic Hospital for further assessment and treatment.

There were 23 boys and three girls with 27 involved hips (12 right and 15 left). Four hips were part of bilateral disease, and one patient had bilateral operations. Using the Catterall classification, three hips were in Group 2, 17 in Group 3, and 7 in Group 4. A total of 13 showed two or more signs of the ‘head at risk’. The mean follow-up was 5.9 years (2.6 to 9.9). The mean age at the onset of symptoms was 9.8 years (8 to 12.10). The mean age at operation was 9.95 ± 1.54 years with 16 of the 27 hips in children aged over ten years (Table I). The mean delay to operation was 0.58 ± 0.45 years.

Clinical assessment. A careful clinical history was taken, which included the onset of symptoms, the presence of pain and a limp. Clinical examination assessed fixed deformity at the hip, shortening and the range of movement. The sign of ‘flexion with abduction’, if present, was recorded.

Radiological assessment. Plain anteroposterior and ‘frog’ lateral radiographs of both hips were assessed for the extent of radiological involvement,1 the presence of two or more ‘at-risk’ signs, and evidence of a subchondral fracture line. Standard radiological measurements were made. These included the centre-edge (CE) angle of Wiberg, Sharp’s

Table I. The number of children in each age group at operation

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<tr>
<th>Age at operation (yrs)</th>
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<td>&lt;9</td>
<td>11</td>
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<td>&lt;10</td>
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acetabular angle, the medial joint space, the percentage of cover of the femoral head, and the epiphyseal and acetabular quotients. The overall length of the shelf and its extraosseous portion were measured in the postoperative radiographs and at the last follow-up (Fig. 1). In the films taken at the final follow-up the true angles were measured together with a ‘false angle’ which included the additional bone of the shelf (Figs 1 and 2).

**Dynamic arthrography.** This investigation was carried out in all patients. It identified the overall shape of the cartilaginous femoral head. The hip was moved in flexion, abduction, and rotation, and the range of movement compared with the state before anaesthesia. The presence of a ‘reducible subluxation’ was confirmed by screening the hip under the image intensifier and demonstrating that the femoral head would centre within the acetabulum in abduction without the presence of unstable movement or so-called ‘hinge abduction’.

**The indications for operation.** Lateral shelf acetabuloplasty was advised for those in Groups 2, 3 or 4 with evidence of a reducible subluxation on the dynamic arthrogram. It was contraindicated in children who showed unstable movement with ‘hinge abduction’. The operation was carried out in a standard way with an approach through an anterolateral incision. The gluteus medius and the tensor fascia lata were elevated from the outer table of the ilium. The reflected head of the rectus femoris was detached from the straight head and mobilised on its capsular attachment. A proximally based flap of bone was elevated from the outer table of the ilium. The reflected head of the rectus femoris was detached from the straight head and mobilised on its capsular attachment. A proximally based flap of bone was elevated from the outer table of the ilium directly above the acetabulum, and a slot cut directly above the lateral acetabular growth cartilage. Corticocancellous strips of bone were obtained from the ilium and inserted into the precut slot to cover the prominence of the femoral head anterolaterally. In addition, bone was inserted under the elevated flap above the bone already inserted. The position was stabilised by reattaching the reflected head of the rectus femoris to the straight head. After surgery, the child was immobilised for nine weeks in a hip spica, after which full weight-bearing was allowed, initially with the use of crutches.

**Last follow-up.** In addition to the radiological measurements mentioned above, the Stulberg grading at the last follow-up and the total range of movement were recorded. All patients were skeletally mature at this time.

**Results**

**Stulberg grading.** At the last follow-up 2, 12 and 8 hips were classified as Stulberg 1, 2 or 3, respectively, and were considered acceptable in the long term. Three were rated as Stulberg 4 and two as Stulberg 5, and were considered unsatisfactory.

**Changes in the femoral head.** The details of the epiphyseal height and width are shown in Table II. The lower epiphyseal height on the involved side implies early collapse of the head. At the last follow-up, there had been little change in epiphyseal height, but a marked increase in epiphyseal width. Overgrowth of the head occurs even at this age but an important conclusion is that there is little potential for an increase in epiphyseal height. Once this is lost it is unlikely to be regained, and operation should therefore be advised at an early stage of the disease.

**Acetabular measurements.** Sharp’s angle, which is a measure of acetabular dysplasia (Table III), remained almost unchanged over the period of follow-up, but was reduced when the effect of the shelf was added. The acetabular quotient (Table II) was almost unchanged on the involved side, while that on the normal side increased, reflecting the increased depth of the cavity as the lateral part of the socket developed. On the involved side, the acetabular width was increased at all stages compared with the normal.

These observations suggest that the acetabulum is capable of responding to the changes in the femoral head by adaptive growth, which is greater in width than in depth.
Radiographs of a boy aged 9.5 years who presented with a three-month history of pain in the left hip and increasing limp. There was no history of injury and his general health was otherwise normal. Figure 2a – AP and lateral radiographs of the left hip showing the typical changes of Perthes’ disease. There is already some loss of epiphyseal height and widening of the inferomedial joint space. The hip lies slightly adducted. There is an early break in Shenton’s line. The lateral view shows that Group-3 changes are present with a subchondral fracture line reaching into the posterior portion of the epiphysis. There is no major metaphyseal reaction. Figure 2b – The arthrogram shows that the deformity of the femoral head is more obvious than on the plain radiographs. There is overgrowth of the articular cartilage laterally. The hip will centre in abduction although the flattening of the femoral head is seen better. There is a ‘reducible subluxation’. Figure 2c – Radiographs at the time of removal of the plaster after the lateral shelf acetabuloplasty and 11 months after operation. Figure 2d – The sequential appearances three and five years after operation. There is considerable remodelling of the femoral head, together with the incorporation of the shelf into the pelvis as a result of the continued growth of the acetabulum. The result is graded as Stulberg 2.
The acetabular shelf. The overall length of the bone graft applied to the acetabulum was measured, together with that portion which covered the femoral head outside the acetabulum (Fig. 1). The shelf appeared to reduce over time (Table IV). As the overall length remained unchanged, this apparent resorption reflects incorporation of the graft into the pelvis as the result of continued growth of the lateral acetabular structures (Fig. 2d). This answers one of the fundamental concerns raised by placing such a shelf on the edge of the growing acetabulum.

Joint congruity. The indices which measure this important aspect of joint function are shown in Table III. Widening of the medial joint space, which is an early manifestation of subluxation, was increased on average by 1 mm when the child was first seen, but did not increase. Coverage of the femoral head by the bony acetabulum fell from 83% to 75%. This was due to the presence of a coxa magna, as shown by an increase in epiphyseal width (Table II). When the length of the shelf outside the acetabulum was added, it increased to 105%. This suggests that an enlarged femoral head is well seated in the acetabulum in the long term. The CE angle remained unchanged on the involved side, while that on the uninvolved side increased by 2°. Children with Perthes’ disease are known to have a CE angle in the low normal range, and our findings are consistent with this.

The low measurement on the involved side reflects the coxa magna, with minimal enlargement of the inferomedial joint space. It is, in itself, not seriously abnormal, but is brought well within the normal range by the addition of the shelf.

Discussion

Although the natural history of Perthes’ disease is, in general, benign, most authors agree that when it begins after the age of eight years it has a poor prognosis in the long term. Surgical treatment at this age is not always successful. Coates et al., reporting a review of cases at maturity treated by femoral osteotomy, had to downgrade the results in children presenting over the age of eight years because of a persisting coxa vara and shortening. This confirmed the earlier studies of Clothier, who observed that the potential for remodelling of the femoral neck was reduced at this stage. Innominate osteotomy may fail to control or reduce the subluxation, with loss of movement. Lateral shelf acetabuloplasty was introduced to overcome these problems.

The major concern with the use of the lateral shelf acetabuloplasty in the growing child is of possible damage to the lateral acetabular epiphysis. This structure is responsible for approximately 20% of lateral acetabular growth. Good early results may be compromised by later failure of growth at this site.

Our review has attempted to address these problems. In general, the good preliminary results have been confirmed at maturity. Many reports use the classification of Stulberg as an indicator of long-term prognosis. We consider that children fulfilling the criteria for the Stulberg groups 1, 2 and 3 have an acceptable result in the long term and 22 of the 27 hips achieved this. A Stulberg 4 or 5 outcome was considered unsatisfactory. In their original report, Stulberg et al. suggested that children over ten years of age when first seen had the worst outcome (group 5), developing ‘a square peg in a round hole’ because of the failure of the acetabulum to remodel to the flattened femoral head. Our findings have shown an improvement in this natural history, although girls over the age of 11 years with Group-4 disease were not helped by this operation. They remain an unresolved problem. Delay in operation is commonly associated with a poor result, but this does not seem to be a
significant factor in our series. Treatment must be initiated early as once epiphyseal height is lost it is seldom regained. At this age, it is possible to establish the extent of the involvement at an early stage using the length of the subchondral fracture line. The tendency to wait and see must be resisted because subluxation and flattening of the femoral head occur rapidly and can prejudice the result.

Lateral shelf acetabuloplasty does not alter the neck-shaft angle, thus overcoming the objections to femoral osteotomy while allowing good long-term remodelling. The corticocancellous graft is inserted obliquely just above the lateral acetabular growth plate and is carefully positioned to cover the anterolateral aspect of the femoral head. The bulge of cartilaginous overgrowth can be palpated at the time of operation and a graft of sufficient size to cover it is positioned over ‘the lump’. We have confirmed the continuing downward growth of the acetabular roof, which progressively takes up the shelf into the bone of the pelvis. This may explain why movement is not restricted in the long term.

Another interesting observation is the ability of the acetabulum and the femoral head to remodel. Both tend to be larger than the opposite side at maturity, indicating that even in the older child there is an overgrowth associated with the remodelling.

The mechanism by which the operation produces its effect is not understood. There is no doubt that subluxation can be controlled by this procedure, and this may be its mode of action. Free movement is an important requirement for long-term remodelling. In our study a stiff hip was rarely seen and may be the reason for the success. Kruse et al4 confirmed the good long-term remodelling after lateral shelf acetabuloplasty. In their series the operation was carried out at any stage of the disease, provided that there was a reducible subluxation on the dynamic arthrogram. If it is undertaken late, progressive subluxation is not a problem, but maintenance of free movement depends on the potential for remodelling. Nine weeks in a hip spica may also be important since this period of immobilisation may allow the necrotic bone and the subchondral fracture to heal. If the progressive subluxation is controlled, the process of repair is able to produce a satisfactory shape of the femoral head even at this age. The operation of lateral shelf acetabuloplasty seems to fulfil the principles of treatment which are the restoration and maintenance of free movement, the correction of subluxation, reduction of forces through the hip and revascularisation of necrotic bone with union of the subchondral fracture.

An analysis of the unsatisfactory results is required to refine further the indications for operation. The Stulberg grading was correlated with age at operation, delay in surgery, group, and gender (Table V). The only conclusion that could be reached was that there was a high chance of a poor result in girls presenting over the age of 11.5 years with Group-4 disease. This procedure does not provide a worthwhile answer for these unfortunate children. It would seem to be a useful operation for those presenting with early disease between the ages of eight and 11 years and offers a better outcome in the long term than either femoral or innominate osteotomy.

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.

References

![Table V. Correlation of Stulberg type with age at operation, delay in operation, group and gender](image)