The management of avascular necrosis after slipped capital femoral epiphysis

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Avascular necrosis is a serious complication of slipped capital femoral epiphysis (SCFE) and treatment is difficult. The incidence of AVN in this condition varies considerably depending on the stability and severity of the slip and the intervention undertaken. Most cases develop within a year of the diagnosis of SCFE. So-called unstable slips, in which the patient is unable to bear weight, have been shown to have the highest incidence of AVN. The aims of treatment are to maintain an acceptable range of movement of the hip and to prevent deformity. Collapse of the femoral head can lead to deformity and secondary changes in the joint resulting in a reduced range of movement and shortening of the limb. The treatment of this condition can be difficult and unrewarding. Currently there are no clear guidelines for treatment.

We have used examination under anaesthesia and dynamic arthrography to investigate avascular necrosis and to determine the appropriate method of treatment. We present 20 consecutive cases of avascular necrosis in patients presenting with slipped capital femoral epiphysis and describe the results of treatment with a mean follow-up of over eight years (71 to 121 months). In patients who were suitable for joint preservation (14), we report a ten-year survivorship of the hip joint of 75% and a mean Harris hip score of 82 (44 to 98).

Patients and Methods

Between 1988 and 1997, we identified 100 cases of SCFE in 70 consecutive patients presenting to our unit (Fig. 1). AVN developed in 20 patients in this group, all within 13 months of the primary displacement. The patients were investigated by examination under anaesthesia and dynamic arthrography under the supervision of the senior author (AC). Under anaesthesia the fixed deformities were assessed and the range of movement determined. Dynamic arthrography was used to define the shape and size of the femoral head and joint congruity. Dynamic screening determined the presence of unstable movement such as hinge abduction and the most congruent position of the femoral head within the acetabulum, the position of “best-fit” (Fig. 2). Hinge abduction occurs when a flattened and deformed femoral head impinges on the lateral edge of the acetabulum during abduction, causing decentering of the head and pooling of the contrast medium in the acetabulum. Three methods of treatment were used based on the findings of dynamic arthrography:

1. In two patients with early AVN with no significant collapse of the femoral head but lateral overgrowth of cartilage, a lateral shelf acetabuloplasty was performed. The shelf allowed the whole head to be contained within the acetabulum and prevented subsequent hinge abduction (Fig. 3).

2. When there was evidence of hinge abduction and dynamic arthrography showed a congruent position of the joint with rota-
tional stability, patients were offered a proximal valgus realignment osteotomy with additional flexion or extension and correction of rotation (Fig. 4).

3. When unstable movement was demonstrated but no satisfactory congruent position of the hip could be found, patients were offered an arthrodesis with the future possibility of conversion to an arthroplasty (Fig. 5).

The patients were assessed before and at one year after operation using the Harris hip score. This is heavily weighted for pain and function, which we consider to be relevant factors in this group. The patients were followed up on a regular basis and were assessed most recently in June 2004, at a mean follow-up of over eight years (71 to 121 months). Subsequent interventions and any further complications were noted. The end-points for our study were either arthrodesis or total hip arthroplasty.

There were nine boys and 11 girls with a mean age at diagnosis of SCFE of 12.6 years. The mean age for girls was 11.3 years (10 to 13.4) and for boys 13.5 years (12.4 to 15.7). Nineteen of the slips were classified as unstable and one as stable. All were severe with a Southwick angle of more than 60°.
The mean time for the diagnosis of AVN from that of SCFE was 7.3 months (2 to 13). In all cases the AVN was at least Ficat grade 3\(^4\) (Fig. 4). This severity reflects our referral base as a tertiary centre. As a result we have tended to receive only complex cases or those which have suffered from complications of SCFE. With this skewed population, we can make no comment on the incidence or pattern of AVN in this condition in the population as a whole.

All patients underwent arthrography. The mean pre-operative Harris hip score was 36 (22 to 56).

**Results**

Twelve patients were treated within 48 hours of the diagnosis of SCFE being made and the remainder within a week. The primary treatments were pin or screw fixation in 13, Angel-Dunn osteotomy\(^5\) in five and cuneiform osteotomy (Fish procedure)\(^6\) in two. None of the Dunn or Fish osteotomies was performed within the first 24 hours.

Of the 20 patients 18 underwent salvage surgery at a mean age of 16.7 years (14 to 22). The operations were performed at a mean of 3.6 years (1.7 to 9.1) after the diagno-
sis of AVN. Lateral shelf acetabuloplasty was carried out in two patients at seven and ten months after diagnosis. Proximal femoral osteotomy was undertaken in 12 patients and arthrodesis in four.

Two patients did not have salvage surgery. In one with Down’s syndrome, removal of a protruding screw was sufficient to reduce symptoms significantly. The other patient declined surgery. The first of these patients underwent a proximal femoral osteotomy some 74 months after the diagnosis of AVN, but is not included in our analysis as she declined the initial treatment. The second patient underwent total hip arthroplasty 56 months after the diagnosis of AVN.

The 14 patients who underwent joint-preserving surgery (lateral shelf acetabuloplasty or osteotomy) had a pre-operative Harris hip score of 39 (30 to 44). Their ranges of movement are shown in Table I. One of the femoral osteotomies was revised for delayed union and one of the dynamic hip screws used for arthrodesis was revised for failure of the implant. In both cases satisfactory union occurred.

At follow-up one year from operation, the mean Harris hip score was 72 (52 to 96) (Wilcoxon test, p < 0.05). The range of movement is shown in Table I. Of the 14 patients who underwent joint-preserving surgery, three have had further proximal femoral osteotomies. One patient had a timed contralateral epiphysiodesis and one had contralateral femoral shortening. Five of these 14 patients, including the individual who had undergone a second proximal femoral osteotomy, underwent total hip arthroplasty because of pain and limitation of activities of daily living. The mean time to arthroplasty from the initial procedure was 108 months (60 to 120). Using conversion to arthroplasty as an end-point, survival analysis according to the method of Murray, Carr and Bulstrode, was carried out for these 14 patients (Fig. 6).

The remaining nine were reviewed in June 2004 and had a mean follow-up of eight years and seven months (71 to 121 months). Their mean Harris hip score was 82 (44 to 98; sd 18; Wilcoxon test, p < 0.05). The mean leg-length discrepancy was 1.25 cm (0 to 2.5). Eight of these nine were able to walk more than one mile and three, all male, undertook sporting activities, one semi-professionally. None of these patients took regular analgesics and only three needed

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**Table I.** The function of the hip before and at one year after joint-preserving surgery in 14 patients

<table>
<thead>
<tr>
<th></th>
<th>Pre-operative</th>
<th>Post-operative</th>
</tr>
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<tbody>
<tr>
<td>Mean Harris hip score (range)</td>
<td>39 (30 to 44)</td>
<td>72 (52 to 96)</td>
</tr>
<tr>
<td>Mean flexion (˚)</td>
<td>80</td>
<td>81</td>
</tr>
<tr>
<td>Mean abduction (˚)</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Number of patients with fixed deformity</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

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**Fig. 5a**

Radiographs showing arthrodesis in a case where the joint could not be preserved a) pre-operatively and b) post-operatively.

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**Fig. 5b**

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them on an occasional basis. Only one patient felt unable to perform her job as a shelf stacker because of problems with her hip. The others were employed as a paintsprayer, waitress and a rugby league coach.

Discussion

AVN as a complication of SCFE can lead to considerable pain, deformity of the femoral head and increasing disability. Treatment should be aimed at preventing this progression. Our management of these patients is based on the findings of examination under anaesthesia and dynamic arthrography.

We have used salvage surgery in the form of proximal femoral osteotomy, shelf acetabuloplasty and arthrodesis in this group of patients with good improvement of symptoms. Proximal femoral osteotomy aims to produce congruency of the hip in the neutral position of weight-bearing and the patients who underwent this procedure maintained hip flexion and increased their range of abduction.

It is remarkable to see the extent of the remodelling which can occur if stable movement can be obtained in the neutral position of weight-bearing (Fig. 7). Lateral shelf acetabuloplasty was undertaken in two patients and was successful in preventing further collapse and deformation of the head and in maintaining movement, including abduction. Other treatments such as arthrodiastasis\(^18\) are available. Lateral shelf acetabuloplasty is a simpler and less demanding procedure. Although well known for the management of late cases of Perthes’ disease, it has not previously been described for the treatment of this condition.

All three patients who underwent arthrodesis had advanced deformity with considerable restriction of movement and instability demonstrated at arthrography. Good relief of symptoms was obtained and none of these patients, after union of the arthrodesis, has, as yet, required further surgery. Arthroplasty remains an option when the patient is older.

In the remaining nine patients there has been a satisfactory improvement in relief from pain and hip function. The residual leg-length discrepancies in this group are all well corrected by orthotics. Overall, our results are comparable at a mean of ten years seven months to those reported by Bankes, Catterall and Hashemi-Nejad\(^19\) for Perthes’ disease. Both series had a survival of ten years of around 75% and similar functional outcomes. Although the numbers in each category are small, these results appear to support our strategy for the management of the difficult problem of AVN after SCFE. It can buy time in younger individuals before other procedures are required, and maintains good movement. Our interventions in the remaining patients have had good results, enabling them to participate in most activities with minimal symptoms. We also believe that this strategy delayed total hip arthroplasty in the five patients who have so far required this operation.

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


