AVASCULAR NECROSIS OF THE FEMORAL HEAD IN SICKLE-CELL DISEASE

TREATMENT OF COLLAPSE BY THE INJECTION OF ACRYLIC CEMENT

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In ten patients with sickle-cell disease, we used a new technique of cement injection for the treatment of 16 painful hips with a radiographic crescent line or flattening of the articular surface due to avascular necrosis. The necrotic bone and overlying cartilage are elevated by the injection to restore the sphericity of the femoral head. Five days after the operation, full weight-bearing was allowed with the help of crutches for three weeks.

The time in hospital averaged eight days; the average blood loss was 100 ml. There was early pain relief and postoperative radiographs showed improvement in the shape of the femoral head.

At a mean follow-up of 5 years (3 to 7), 14 of the 16 hips were still improved although some gave slight pain. Only two hips required revision to total hip arthroplasty, at one year and two years respectively.

The increasing longevity of patients with sickle-cell disease means that avascular necrosis will be an increasing problem. Total hip replacement has a poor prognosis because of the risks of infection, high blood loss, and early loosening. Cement injection does not have these problems and allows for earlier, more conservative surgery.

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When collapse has occurred in avascular necrosis of the femoral head, it is generally agreed that the deformation will lead to osteoarthritis changes. Sickle-cell disease (SCD) is the most common cause of femoral head necrosis in black people (Hernigou et al 1989, 1991) and presents a rapidly growing problem in a disease in which life expectancy is increasing. Opinions on the treatment of avascular necrosis of the hip in SCD vary between two extremes: some suggest avoidance of all surgical treatment because of the generally poor condition of most patients, but others advise radical early surgery such as total hip arthroplasty. It has, however, been confirmed that total hip replacement has a poor prognosis in SCD.

We describe a new surgical treatment for hips at the stage of early collapse: necrotic bone and the articular cartilage overlying it are elevated by the injection of acrylic cement to restore the sphericity of the femoral head. We report the results in 16 hips in ten patients who had severe pain due to collapse caused by SCD.

PATIENTS AND METHODS

Patients. The patients suitable for this operation were selected from a group of 160 adult SCD patients who had been closely followed and investigated for bone complications. Of these, 52 had developed avascular necrosis of the hip as children and have been previously reported (Hernigou et al 1991). Twenty-one patients developed avascular necrosis of the hip as adults and were treated by cement injection. All gave their informed consent for the new procedure.

We now report the results in the ten patients (16 hips) followed up for at least three years. There were two men and eight women and their average age was 33 years (23 to 34) at the time of surgery. Six patients had HB SS disease, 3 had SC disease and one had an S-thal variant; the average follow-up is 5 years (3 to 7).

Preparation for operation. Before operation, each patient had an exchange transfusion to bring the concentration of haemoglobin S or HbS + C to less than 30%, and to raise the haematocrit to about 40%. Most of the patients were anaemic and none could have been a candidate for autotransfusion. During the operation and for the following 48 to 72 hours, intravenous hydration was maintained and oxygen was given by the nasal route. Blood-gas levels were monitored by laboratory tests and by pulse oximetry. The patients were given antibiotic prophylaxis for ten days.

Operative technique. The patient is placed in a supine position on a fracture table and the anterior capsule of the hip is exposed by a Smith-Petersen approach, using a
skin incision from about 7 cm behind the anterior superior iliac spine, along the outer lip of the iliac crest and down over the groove between sartorius and tensor fascia lata (Fig. 1a). In exposing and opening the capsule, care is taken to preserve the anterior circumferential artery. A T-shaped incision in the capsule exposes the anterior femoral neck and the anterior part of the femoral head (Fig. 1b).

The articular surface of the femoral head is then examined for alteration in its colour and contour, for erosion and for softening. The necrotic zone is usually obvious: the articular cartilage overlying it looks normal but the area is surrounded by a furrow or a fold. Gentle pressure on this cartilage, which retains its elasticity, causes depression but this recovers like a piano key or a ping-pong ball. This mobility is due to the presence of either a subchondral fracture separating articular cartilage and subchondral bone from necrotic bone, or the separation of a larger segment of necrotic cancellous bone from the living bone beneath it (Fig. 2).

A pin is then driven in from the anterior neck to reach the junction of the living bone and the necrotic segment. Leverage on this pin elevates the necrotic bone and visibly reduces the collapse (Fig. 3). The pin is removed and replaced by a cannula through which low-viscosity cement (Cerifix; Ceraver Osteal, Roissy Ch. de Gaulle, France) is injected with a cement gun. The injection is continued or repeated until the collapse of the articular cartilage has been corrected (Fig. 4). The whole periphery of the area of collapse cannot be seen, and it may be necessary to rotate the hip to expose more of the surface of the head and to repeat the injection at several sites. It may also be necessary to inject cement into the subchondral fracture (Fig. 5). When the injection is complete and the shape of the head has been restored the capsule is repaired and the wound closed in layers over a suction drain.

After operation, the patient is encouraged to mobilise the hip and weight-bearing is allowed after five days. The use of crutches continues for three weeks.
The depressed segment can be lifted by leverage on a pin driven in at the junction of living and necrotic bone.

The pin is then removed and low-viscosity cement is injected, using a cement gun. The collapsed segment is now restored to position and is stable.

Injection of cement may also be needed into the subchondral fracture superficial to the main fragment of necrotic bone. This is demonstrated in a femoral head with avascular necrosis.

Assessment. For the preoperative clinical assessment we used the Harris hip score (Harris 1969). We also measured the range of motion of the hip and the limb lengths and performed the Trendelenburg test. Imaging studies included plain radiography of all patients and tomography or CT (or both) of six patients; the last methods were used when there was difficulty in demonstrating the collapse.

We use the Ficat and Arlet (1980) staging of avascular necrosis of the femoral head, but since all 16 hips had collapse but no secondary osteoarthritis, they were all at stage III. The sphericity of the femoral
head was measured on the anteroposterior and lateral radiographs, using Mose (1980) templates and recording loss of sphericity in millimetres.

Postoperatively, we recorded improvement in the shape of the femoral head by the disappearance of the crescent line and the general improvement in shape. The postoperative radiographs were also studied for evidence of progression of the infarct, recurrence of collapse, and any degenerative changes. Degenerative changes such as the appearance of subchondral cysts, osteophytes, subchondral sclerosis, or narrowing of the joint space were graded according to the classification of Boyer, Mickelson and Ponseti (1981), on the radiographs made at the latest follow-up. The measurement of the superior joint space was taken as the distance between the cortices on a line through the mid-point of the femoral head drawn perpendicular to the line joining the lowest points of the two tear drops (Armbuster et al 1978). A superior joint space of less than 3 mm was recorded as evidence of osteoarthritis.

RESULTS

No patient had haematological complications: there were no painful sickle-cell crises, and no problems of thrombosis or anaemia. The average duration of the operation, from induction of extradural anaesthesia was one hour. The average blood loss was 100 ml (50 to 250). No patient required postoperative transfusion and there were no wound infections.

The average time in hospital was eight days, which included the time spent in haematological preparation. Clinical assessment. Before operation, the mean Harris hip score was 60 points (50 to 75). At the latest follow-up at 3 to 7 years, it was 85 (73 to 95). Of the 16 hips, two scored more than 91 points at 5 years and were regarded as having excellent results. The two worst patients had scores of 73 and 75 at one year; both required total hip arthroplasty.

The operation was particularly successful in relieving pain. All 16 hips caused severe pain before operation; the pain was relieved immediately after surgery. There has been some deterioration in the scores in eight hips since the one-year assessment but they all still show a clear improvement over their preoperative state. This decrease in hip score was mainly due to loss of hip mobility. Some patients have slight pain on walking, some have pain when they stand up from a sitting position and some complain of aching in the groin or thigh after prolonged exercise. In no case does the pain limit activity or necessitate medication. One patient had a transient increase in pain during a pregnancy. Before operation seven patients walked with a cane to relieve pain; no patient needed a cane after surgery and only four patients walked with a limp.

Before surgery, there was usually loss of hip rotation and abduction but not of flexion. The range of movement was not improved by the operation and eight hips had lost more abduction and some flexion by the time of the latest follow-up.

Radiology

Shape of the head. Preoperatively, all the femoral heads showed a crescent line and the average loss of sphericity was 3 mm (1 to 5; Fig. 6a). Postoperatively, the early radiographs showed an improvement in shape (Fig. 6b), with disappearance of the crescent line and loss of sphericity of less than 1 mm in all 16 hips. At latest follow-up, six hips showed no change from postoperative sphericity; they had the smallest infarcts in the series. Eight hips showed some flattening of the femoral head, but no crescent line, and still had a better geometrical shape than preoperatively. The other two hips had recurrent collapse (loss of sphericity of 5 mm) and required total hip arthroplasty.

Size of the infarct. In the 14 hips which did not collapse, there was no change in the size of the infarct. Degenerative changes. At the latest follow-up, eight hips showed slight degenerative changes, with reduction of the joint space to less than 3 mm in four. The two hips with recurrent collapse both had definite osteoarthritis at the time of total hip arthroplasty.

Failures. The two hips in which there was no immediate relief of pain after cement injection both required arthroplasty, at one and two years respectively. The operations were performed by the posterior approach and there were no difficulties related to the previous operation. In both cases pain relief and mobility were improved. The removed femoral heads were examined histologically and showed typical changes of avascular necrosis with sickling of red blood cells. Both showed the histopathological changes of recurrent necrosis (Inoue and Ono 1979) and also signs of old haemorrhage into the marrow (Saito, Inoue and Ono 1987). Acrylic cement was found both beneath the articular cartilage and under
the area of necrosis; the cement masses were encapsulated within a thin connective tissue membrane. Some areas of recent marrow necrosis were seen, but it was impossible to determine whether they were related to the presence of the cement or due to extension of the original pathology.

DISCUSSION

In patients with SCD, osteonecrosis of the hip is a cause of chronic severe pain and further deterioration of their quality of life. The commonest treatment has been total hip replacement; operations which preserve the femoral head (Chung and Ralston 1969) have rarely been reported, partly because these patients were thought to have a poor life expectancy. Total hip replacement, however, has a bad prognosis in SCD because of the increased risks of infection and loosening.

Recent advances in the treatment of SCD will considerably improve survival, and there will therefore be a greater place for conservative surgery when the condition of the joint still allows it. When collapse has occurred, core decompression (Ficat and Arlet 1980) and intertrochanteric osteotomy are not effective, and trans-trochanteric osteotomy (Sugioka 1978) has given poor results because of difficulties with fixation and delayed union. Some methods of reconstruction of the femoral head have been reported. These include the use of autologous iliac bone grafts combined with a muscle-pedicle bone graft (Meyers 1978), a vascularised fibular graft with multiple drilling (Judet, Judet and Gilbert 1981), and muscle pedicle bone grafts (Baksi 1991). All these techniques require a period of non-weight-bearing, and for patients with multiple medical problems and many previous hospital admissions, a simpler treatment which allows early weight-bearing seems more appropriate.

When collapse first occurs in avascular necrosis, the articular cartilage is usually macroscopically normal and the acetabulum is not affected (Crues 1977). The necrotic zone of the femoral head is easily located, commonly being surrounded by a furrow or a fold opposite the anterior edge of the acetabulum when the hip is in the extended position. The cartilage retains some elasticity and can be sprung by pressure. This mobility is due to the collapse of bone about the subchondral crescent fracture, and between the deeper necrotic bone and living ‘repair’ bone. The injection of low-viscosity cement into these spaces restores sphericity and congruity, and provides immediate immobilisation of the cartilage and necrotic bone. This is the probable explanation for the immediate symptomatic improvement, but there may be an element of decompression as well.

It may be thought that cement will have deleterious effects on bone and articular cartilage near a joint surface (Rutherford, Cardea and Jessee 1987), but cement has been used under articular cartilage before, for example after the curettage of giant-cell tumours (Eckardt and Grogan 1986), and it has in some cases been left in place for several years without adverse effects. The articular cartilage is nourished from the synovial fluid and may therefore remain histologically and biochemically normal. We think that the joint-space narrowing in our patients was not due to the presence of cement under the articular cartilage, but resulted from further collapse of the subchondral bone or mechanical failure of the cement by loosening or fracture.

The only alternative treatment for our patients would have been joint replacement, and our results should therefore be compared with those reported for total hip arthroplasty in SCD. Clarke et al (1989) reporting 17 total hip arthroplasties for SCD followed for more than two years (mean 5.5) had a revision rate of 59% (10 hips); revision was required after an average period of only 43 months. Bishop et al (1988) reported 13 total hip arthroplasties; at an average follow-up of seven years, three had needed resection arthroplasty for infection, and four others had been revised. Epps and Castro (1978) had a complication rate of 63% in 45 arthroplasties followed for 3.3 years. Other reported complication rates are 27% (Gunderson, D’Ambrosia and Shoji 1977), 100% (Hanker and Amstutz 1988), and 49% (Acurio and Friedman 1992). Our own experience of total hip arthroplasty for SCD (Hernigou et al 1989) includes 11 patients followed for between 1.5 and 10 years. Four have needed further operations, three for mechanical loosening and one for late sepsis. By contrast, at an average follow-up of five years 14 of the 16 hips treated by cement injection, had hip scores as good as those achieved by total hip arthroplasty in SCD and only two had needed revision. Cement injection and total hip arthroplasty are not competitive treatments; they should rather be viewed as complementary methods, separated in time and used for different stages of necrosis.

We conclude that for osteonecrosis of SCD with collapse but without arthritic change, cement injection can delay the loss of concentricity and congruity for several years. It provides immediate symptomatic relief and does not jeopardise later revision to total hip arthroplasty. One of the authors (PH) has used the technique for osteonecrosis from other causes (Hernigou 1990; Hernigou and Goutallier 1992).

The recent availability of CT and MRI now makes it possible to identify subchondral fractures in the early stages of avascular necrosis; early treatment may be advisable.

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REFERENCES


