AVASCULAR NECROSIS OF THE CAPITAL EPIPHYSIS FOLLOWING OSTEOMYELITIS OF THE PROXIMAL FEMORAL METAPHYSIS


In this paper we wish to emphasise the danger of avascular necrosis of the capital femoral epiphysis arising as a late complication of osteomyelitis of the intertrochanteric region. This necrosis is primarily aseptic and is believed to follow interference with the vulnerable vascular channels supplying the capital femoral epiphysis rather than spread of infection into the joint. If, however, the infection is inadequately treated in the early stages, spread of the inflammatory process may inflict further damage to the avascular epiphysis. We believe that awareness of this hazard should prompt the surgeon to be aggressive in the management of infection in this situation.

The radiological signs closely resemble those of Legg-Perthes' disease and, indeed, Kidner (1916, 1923), having observed this similarity in two patients with osteomyelitis of the femoral neck, proposed infection as the cause of Legg-Perthes' disease. It is interesting to record that Legg (1910) in his original description included among his five patients a child in whom epiphysial necrosis followed a staphylococcal osteomyelitis of the proximal femur. McWhorter (1924) was the first to recognise the distinction between these two varieties of necrosis of the capital epiphysis. He described a patient with staphylococcal osteomyelitis of the femoral neck who at operation was noticed to have a sterile effusion within the hip joint. Although the intra-osseous lesion healed the boy subsequently developed clinical and radiological features resembling Legg-Perthes' disease.

THE NATURE OF CAPITAL NECROSIS AFTER INTERTROCHANTERIC OSTEOMYELITIS

The arrangement of the vascular supply to the capital femoral epiphysis renders it vulnerable to interruption in two ways. First, the vascular circle formed by the ascending branches of the circumflex femoral vessels lies around the distal capsular attachment close to the infected area and is at risk from compression or septic thrombosis. Secondly, these vessels give origin to the cervical branches which traverse the joint cavity to reach the capital femoral epiphysis. They are susceptible to compression if a sterile sympathetic effusion causes a rise in the intra-articular pressure. In a previous paper (Kemp 1973) it was shown experimentally in puppies that intracapsular pressures as low as 40 millimetres of mercury could cause venous occlusion.

Either event may be followed by aseptic ischaemic necrosis which is only recognisable radiologically six to eight weeks after the onset of infection. After two to three months the epiphysis may display a generalised increase of density, followed by fragmentation and collapse. Healing occurs with variable residual deformity presenting both clinically and radiologically in a similar, though not necessarily identical, manner to Legg-Perthes' disease.

If, however, the inflammatory process is inadequately controlled, infection may spread to involve the joint. When this happens the consequences are likely to be grave because the inflammatory process will spread rapidly in the avascular epiphysis, and ankylosis and deformity may follow.

CLINICAL MATERIAL

We have encountered eight patients in whom infection of the proximal femur has been followed after an interval by aseptic necrosis in the femoral capital epiphysis. In a further

* Institute of Orthopaedics, Royal National Orthopaedic Hospital, London and Stanmore.
† The Hospital for Sick Children, Great Ormond Street, London.
five patients this necrosis was complicated by a spread of infection from the primary focus. The causative organism was shown to be staphylococcus pyogenes in eight and mycobacterium tuberculosis in two: the organism was unidentified in three. We propose to describe briefly the salient features of relevant cases. It should be emphasised that not all of these patients exhibited all the signs commonly associated with avascular necrosis.

CASE REPORTS

PATIENTS WITH ISCHAEMIC NECROSIS WITHOUT EVIDENCE OF INFECTIVE EPIPHYSITIS

Case 1—A boy aged three presented with a three weeks' history of pain in the right knee. He was febrile (temperature 40 degrees Celsius) and the leucocyte count was 11,000. On

Fig. 1
Case 1—Anterior and lateral views of the hip showing juxta-epiphysial cavitation and segmental density of the epiphysis.

Fig. 2
Case 1—Four months later, there is lateral displacement of the epiphysis, apparent increase in the joint space and slight flattening of the epiphysis.

examination there was local tenderness but no obvious swelling over the right hip. All movements were limited. Radiographs showed a juxta-epiphysial lesion of the metaphysis (Fig. 1). Ten days later the lesion was explored: a cavity was found containing granulation
tissue, which on culture was sterile. The patient subsequently developed avascular changes in the femoral head (Fig. 2). These changes eventually resolved and after five years the only radiological abnormality was slight coxa magna.

**Case 2**—A boy aged four presented with an indeterminate history of nocturnal pain in the right hip. On clinical examination there was slight limitation of hip movement. All laboratory investigations were normal. The child was kept under observation and when seen six weeks later was completely free from symptoms. The pain recurred at the twelfth week and on examination he was found to have a marked antalgic limp with a fixed flexion deformity of the right hip; all hip movements were extremely limited. The leucocyte count was 5,600 with 70 per cent lymphocytes. The Mantoux test was strongly positive at 1/1,000. Radiographs showed a metaphysial lesion in the upper end of the femur (Fig. 3). Culture of aspirate
confirmed that it was due to mycobacterium tuberculosis. The patient was immobilised in a plaster spica and treated with sodium para-aminosalicylate and streptomycin for two years. During this period, radiographs showed evidence of avascular changes in the femoral head. Seventeen years later, radiographs showed changes in the mature femoral head similar to those seen in healed Perthes' disease (Fig. 4). There was no evidence of the original inflammatory lesion.

![Fig. 5](image1)
![Fig. 6](image2)

**Case 3**—A boy aged eleven was admitted to hospital with a history of high temperature and multiple joint pains for one week. He had been treated during this period with oral penicillin. He was still febrile (38·9 degrees Celsius), and the right elbow and wrist, both knees and both ankles were painful. Movements of all these joints were severely limited. He complained of pain over the front of the left thigh, though on examination movements of the hip were full and painless. The erythrocyte sedimentation rate was 37 millimetres in the first hour and the leucocyte count was 20,000. Blood cultures and throat swabs showed the causative organism to be a coagulase positive staphylococcus, sensitive to erythromycin and cloxacillin. When treated with massive doses of these drugs he responded slowly. Four weeks after admission radiographs confirmed the presence of multifocal osteomyelitis. Shortly afterwards an abscess pointed in the left femoral triangle, but although the area was tender on palpation there was neither restriction of hip movement nor radiological evidence of a lesion of the femur. The abscess was repeatedly aspirated and cloxacillin was instilled into the cavity. Eight weeks after the onset of symptoms, radiographs showed a metaphyseal lesion (Fig. 5). At twelve weeks there was generalised limitation of hip movements. Radiographs showed collapse of the lateral aspect of the metaphysis. There was an apparent increase in the joint space. The epiphysis was laterally displaced and exhibited patchy density (Fig. 6). Although the radiographs at this stage showed changes that have been interpreted as showing infective epiphysitis, when healing eventually occurred the reparative changes resembled those observed in Legg-Perthes' disease.

**Case 4**—A boy aged six who six months previously had been treated by varus osteotomy for Perthes' disease of the right hip, was admitted to hospital with an irritable left hip. He had been febrile and complained of pain in the hip for the previous two months. Radiographs
showed an osteolytic lesion in the left intertrochanteric region (Fig. 7). The lesion was explored on the day after his admission: staphylococcus pyogenes was isolated. The wound discharged for three weeks after operation but ultimately healed, and the child had a full range of movement. Five months after the original episode the child developed limitation of movement of the hip and radiographs showed ischaemic necrosis of the femoral head (Fig. 8). A year after the original episode a varus osteotomy was performed to contain the head within the acetabulum. This patient is of interest in that the onset of symptoms and signs of avascular necrosis was late. It is a matter for speculation whether the lesion was caused by infection or represented contralateral Perthes' disease in a child who had previously demonstrated susceptibility. However, the advanced radiological changes in the affected epiphysis suggest that the lesion was precipitated by the inflammatory process. Furthermore, the child later developed ankylosis of the hip in flexion and adduction.
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PATIENTS WITH ISCHAEMIC NECROSIS COMPlicated BY INFECTION

Case 5—A girl aged three presented with a history of an irritable hip for one week, associated with pyrexia and anorexia. Before the onset of symptoms she had been treated for two weeks with intramuscular penicillin for recurrent boils. On examination her temperature was 38.3 degrees Celsius. The right hip was held in flexion and lateral rotation, movements being painful and limited. An abscess was palpable anterior to the hip. No abnormality was observed radiologically. The abscess was drained a day later and it was noted that there was thickening of the periosteum, which was elevated from the metaphysis. No attempt was made to drain the femur. Staphylococcus pyogenes was grown from the pus. The child was placed on an abduction frame and treated with oxytetracycline. By the second week there was radiological evidence of osteomyelitis of the intertrochanteric region. At six weeks the femoral epiphysis was dense and displaced laterally (Fig. 9). Subsequently the child developed suppurative arthritis of the hip with sequestration of the affected epiphysis.

Case 6—A boy aged eleven complained of severe pain in the right hip. There was a history of trivial injury a few hours before the onset. The temperature was 37.8 degrees Celsius, and the erythrocyte sedimentation rate was 45 millimetres in the first hour. The leucocyte count was 11,500. The Mantoux test was negative. There was tenderness on palpation over the hip joint and all movements were severely restricted by pain. Radiographs taken on admission showed no abnormality. A tentative diagnosis of osteomyelitis of the femoral neck was made, the affected limb was immobilised on a Thomas splint and the patient was treated with penicillin. The infection failed to respond and the boy remained anorectic and in pain. Four days later tetracycline was substituted for penicillin. The infection responded but the drug was discontinued after four days. The boy again became febrile, his temperature rising to 39 degrees Celsius. He was then given chlorotetracycline without benefit. Four weeks from the onset he developed an abscess over the anterior aspect of the hip. This was aspirated. Culture of the pus showed staphylococcus pyogenes sensitive to penicillin, resistant to tetracycline and only slightly sensitive to chlorotetracycline. At this stage high dosages of penicillin were given and the patient's general condition improved, but the radiograph taken four weeks later showed rarefaction of the femoral metaphysis (Fig. 10). It was now obvious that the patient had established chronic osteomyelitis of the proximal femur. He was transferred to the Royal National Orthopaedic Hospital and treatment with antibiotics and immobilisation.

Fig. 9
Case 5—Six weeks after the onset of symptoms there is extensive metaphysial infection with probable joint involvement. The marked subluxation suggests capsular damage. The slight increase in density is indicative of avascular necrosis and the subsequent deposition of new bone.
Case 6—Four weeks after the onset of symptoms there is rarefaction of the metaphysis. Periosteal reaction is seen on the medial aspect of the neck and there is lateral displacement of the epiphysis. The femoral head seems dense, because of the related rarefaction of the metaphysis.

Case 6—At seven weeks, there is a true increase in the radiological density of the epiphysial nucleus due to the deposition of new bone on the dead trabeculae.

Case 6—At eleven weeks, there is evidence of an infraction extending into the metaphysis. There is involvement of the roof of the acetabulum indicating spread of infection into the joint. Figure 13—Seven months later, the sequestrated fragment has been absorbed. The sclerosed margins and healing of the metaphysial lesion indicate that the infection has been controlled.
was continued. Radiographs taken seven weeks after the presentation of the abscess showed obvious density of the femoral head (Fig. 11). The hip remained relatively uninvolved clinically until approximately the eleventh week, when there was radiological evidence of infraction through the epiphysis extending into the infected area (Fig. 12). In consequence infection spread into the joint which subsequently was largely destroyed (Fig. 13).

Case 7. Figure 14—Radiograph two weeks after operation showing diaphysial drill holes. There is no evidence at this stage to suggest that the epiphysis has been affected by avascular changes. Figure 15—Six weeks after operation there is evidence of a mild periosteal response. There is a very slight increase in epiphysial density.

Case 7—At the completion of growth the femoral head is only slightly flattened. However, due to premature fusion of the growth plate, the femoral neck is short.

**THE MANAGEMENT OF ACUTE INTERTROCHANTERIC OSTEOMYELITIS**

We believe that the danger of ischaemic necrosis demands an aggressive approach to the management of intertrochanteric osteomyelitis. We agree with De Palma (quoted by Tronzo and Dowling 1962) that this condition should be treated as a surgical emergency, whatever the merits of an expectant attitude in other situations. Operation should not only
drain the primary focus but should include inspection of the joint capsule. If this is distended it should be incised to decompress the joint cavity.

We would suggest that if there is any doubt regarding the site of infection, it would be justifiable in future to use radioactive isotope scintigraphy as a diagnostic aid (Kemp, Johns, McAlister and Godlee 1973).

The relatively successful management of infection in the intertrochanteric region is illustrated by the following case report.

**CASE REPORT**

**Case 7**—A girl aged eight fell from a tree four days before admission. Two days later she developed a left sided limp and was miserable, listless and febrile. The following day she complained of frontal headaches and of pain over the left thigh. On admission she was delirious and irrational. The temperature was 40·6 degrees Celsius, the leucocyte count was 40,000. The erythrocyte sedimentation rate was 40 millimetres in the first hour. All movements of the hip were severely restricted by pain. There was no swelling or tenderness over the hip joint. Blood culture grew a penicillin-sensitive staphylococcus pyogenes. The child was treated by traction and given penicillin six-hourly. Although she responded initially, her temperature rose again after twenty-four hours to 39·4 degrees Celsius. At this stage there was tenderness on palpation over the hip but the radiograph was normal. At operation the hip joint was aspirated: six millilitres of fluid were obtained but the fluid was sterile on culture. The proximal femur was then drilled and pus evacuated. Treatment with antibiotics was continued for a further two weeks and traction for four weeks (Fig. 14). Subsequent radiographs showed a transient and minimal increase in the density of the femoral epiphysis but there were no other signs in the hip (Fig. 15). Apparent retardation of growth and premature closure of the growth plate was therefore an unexpected development. Nevertheless the joint remained seemingly normal in spite of some shortening of the femoral neck (Fig. 16).

**CONCLUSIONS**

We suggest that after the usual investigations and the exhibition of suitable antibiotics, a focus of osteomyelitis in the intertrochanteric region be explored and decompressed forthwith. As a preliminary, we recommend that the hip be aspirated, and if fluid is withdrawn an incision should be made in the capsule to prevent the intra-articular pressure from rising. We believe that in this way it may be possible to reduce not only the incidence and degree of circulatory disturbance but also the more serious complication of extension of the inflammatory process into the hip joint.

**SUMMARY**

1. Attention is drawn to the danger of avascular necrosis developing in the capital femoral epiphysis as a complication of osteomyelitis in the intertrochanteric region.
2. This necrosis is commonly aseptic. It is believed to be caused by compression or thrombosis of the epiphysial vessels.
3. The situation will be aggravated if infection spreads to involve the joint.
4. We believe that prompt decompression of both the joint and the bone is indicated in order to reduce the incidence and severity of these complications.

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REFERENCES


