IDIOPATHIC NECROSIS OF THE FEMORAL HEAD IN ADULTS

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This work is based on a study of necrosis in 150 femoral heads in adults who had no evidence of such causal factors as a fracture, dislocation, caisson disease, sickle-cell anaemia or Gaucher's disease (Fig. 1). This condition has been recognised during the last ten years: but only eleven cases were seen before 1958, and no less than 139 during the next five years.

Idiopathic necrosis was described in 1925 by Haenisch and by Freund in 1939. A number of sporadic cases have been published, often with the diagnosis of osteochondritis dissecans: most of these, however, have been in adolescents with small lesions of the head of the femur. In 1936 Chandler emphasised the severity of the disease in adults and that it was often bilateral (Figs. 2 to 9), but it still seemed to be rare; thus Mankin and Brower in 1962 could find only twenty-four cases in the English literature, to which they added five.

Fig. 1
Case 1—A workman aged 49 years had had sudden onset of violent pain ten months previously with great disability in the right hip. The density and collapse of necrotic upper part of the head is shown. The joint space is preserved.

In France several quite large series have been published in recent years. In 1959 Teinturier reported our first eleven cases, while Serre and Simon (1959) and Séze, Welfling and Lequesne (1960) published thirty cases. In 1960 Coste, Delbarre, Laurent and Weissenbach reported 100 cases, and in September 1963 we presented the first results of the surgical treatment of 100 cases from the Hôpital Cochin in the Watson-Jones Lecture delivered at the Royal College of Surgeons of England (Merle d'Aubigné 1964).
In 1964 there appeared a review of fifty-two cases collected by Patterson, Bickel and Dahlin from the records of the Mayo Clinic between 1935 and 1960. Their inquiry into possible etiological factors revealed 17 per cent of alcoholics among these patients but did not give the percentage that had received steroid therapy.

Case 2—A man of 56 years. Figures 2 and 3—Two months after sudden onset of pain in both hips. There was a history of forced abduction previously. Figures 4 and 5—Although the lesions are obvious in both hips six months later, they were overlooked and the patient was sent back to work.

**CLINICAL MATERIAL**

At the time of writing the records of 125 patients were available for study at the Hôpital Cochin; 139 hips have been treated by operation and the shortest follow-up was one year. *Age and sex*—In the world literature approximately 80 per cent of the patients were men. In our series 90 per cent of the patients treated surgically were men. Their ages were from eighteen to seventy-five years, with 75 per cent between thirty and sixty years of age (Fig. 10).
Clinical features—Pain is usually the first symptom; it is often felt in the groin but may be referred to the thigh or the knee. In the beginning the pain is aggravated by standing and walking and relieved by rest; in the later stages only does the patient complain of pain at night.

A remarkable feature in the history may be the suddenness of the onset. Nearly half of the patients could remember the day and even the hour when sudden severe pain in the hip occurred and forced them to rest; in these patients the hip had been without symptoms until that moment. This sudden onset is reminiscent of visceral infarction. The effect of the pain on the function of the hip was variable. Some patients could neither stand nor walk for a few days, but most improved and the patient was able to walk, though with persistent discomfort and to a limited extent. The radiographs at this stage were often normal; the necrosis might
then be overlooked for some months—unless further radiographs were done—so that, when first seen, the lesions in the femoral head were severe. Sometimes the onset was slowly progressive with very slight symptoms to begin with, especially when both hips were affected. At times moderately severe lesions have been found in hips free of symptoms.

Progress was variable, but usually the symptoms got worse, with periods of acute pain and considerable impairment of function. Movements at the hip were greatly limited by muscle spasm during the attacks of pain. Fairly full flexion usually returned between the painful episodes, a good range being retained for months or even years. Extension was not limited in the early stages as in early osteoarthritis, though abduction and medial rotation were restricted early on.

In many patients the opposite hip became involved in a few months. In the literature both hips were involved in 35 per cent of cases. Patterson and his colleagues (1964) found bilateral lesions in 42 per cent, and an additional 22 per cent showed early signs of involvement in the hip joint thought to be sound. In our series 50 per cent of patients had both hips affected (Figs. 11 to 13); in these it is of interest that the second hip was involved at the start in 13 per cent, within six months in 24 per cent, within one year in 26 per cent and within two years in 36 per cent; in only 1 per cent was the interval more than two years.

Radiology—Excellent radiographs are essential for diagnosis. As has already been said, the head of the femur may at first appear to be normal. In the antero-posterior view the first change was a very faint line of diminished density beneath the line of subchondral bone, which should normally be dense, in the superior part of the femoral head (Figs. 14 to 20). This was characteristic and could often be seen retrospectively in radiographs that were at first thought to be normal. The contour of the femoral head was normal and the joint space was clear at this early stage. A good lateral view was necessary, because the lesion was always localised to the anterior part of the superior aspect of the femoral head, and the lateral view sometimes showed the lesion to be much more extensive than was suspected from the antero-posterior view. At a slightly more advanced stage a zone of increased density appeared in the antero-superior segment of the head of the femur which had an irregular pattern, while the lateral, inferior and posterior parts of the head remained normal. Even at this relatively early stage that part of the head that later would be severely affected, and perhaps destroyed, could be exactly identified, as if the extent of the necrosis were determined from the very beginning. The deformity of the femoral head nearly always started at the lateral border of the lesion with a slight depression of the contour; there was a break between two arcs, the lateral being normal, but the medial arc depressed as if it were hinged in the region of the fovea capitis.

Pathological examination has shown that not all the dense bone was actually necrotic. The isolated sequestrum considered to be characteristic of osteochondritis dissecans is a frequent, but far from constant, feature. As is seen later, the clear space in relation to the sequestrum has sometimes indicated its limits, but at other times it runs across the middle of the sequestrum, when it may indicate a pathological fracture of the necrotic part of the femoral head.

In the advanced case there was great deformity of the upper contour of the femoral head with, occasionally, complete absorption of the necrotic segment. It is most important to emphasise that the joint space remained normal—indeed it was often wider than
normal—except in the very late stages when secondary osteoarthritis completely altered the picture.

*Progress*—The clinical and radiographic progress of this condition has been followed in ninety patients treated at the Hôpital Cochin.

Clinical progress was variable. In unilateral disease the pain often subsided after six months or a year and relative comfort might continue for some years. But pain and disability recurred in about 25 per cent of patients during the first four years though sometimes there was a delay for as long as ten to fifteen years. With bilateral necrosis the prognosis was much more serious. Only eight out of forty-five patients followed by Coste and his colleagues (1965) kept relatively good function in the hips; in all the others symptoms were aggravated, either when the opposite hip was affected in the first or second year (twenty-four patients), or progressively (nine patients), or after a quiescent period of two to ten years (four patients).

The rate of radiographic advance was also variable, as is shown in Figure 21, in which the appearances are classified according to the degree of collapse of the head and the time from the first symptoms. During the first year much collapse occurred in about 20 per cent of hips, though 55 per cent of the femoral heads kept a normal contour. This proportion was
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reduced to 37 per cent during the second year, and after three years only 25 per cent had not collapsed. About half also showed considerable osteoarthritic change.

ETIOLOGY

In this series of "idiopathic" aseptic necrosis all patients in whom a definite or well recognised cause was found have been eliminated, including such diagnoses as impacted fractures of the femoral neck, dislocation of the hip, caisson disease, sickle-cell anaemia, Gaucher's disease and Cushing's syndrome. Every endeavour has been made to find out from the history and examination all factors that might play a role in the causation of this disorder.

Case 4—A mechanic aged 37 years. Figures 14 and 15—Four months after the first symptoms. The radiographs are normal in these views. Figure 16—A very fine clear line is visible in the lateral view of the right hip at the top of the femoral head. Figure 17—Ten months after the onset there is necrosis and depression in the right hip.
A history of a slight injury was present in about 30 per cent; in many it was only vaguely related to the onset of symptoms but sometimes there was a very clear history either of repeated injury or of a definite strain immediately before the onset of pain.

Twenty per cent of our patients were considered to be obese, and alcoholism, which has been noted by many other authors, was relatively common. Gout has been reported in a number of published series but was regarded as being very indefinite in this series.

In our patients, apart from slight injury, two factors were worth considering—congenital lesions and steroid therapy. Congenital anomalies as a possible predisposing factor are suggested by the frequent affection of both hips and by the preponderance of men. By thorough radiographic measurements in fifty-eight cases one of us (P. M.) found some anomaly of the hip in 52 per cent; but the variations were slight, being mostly coxa valga, and the part this plays is dubious.
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Steroid therapy had been given in 36 per cent of our cases, counting only those in which cortisone was administered for another condition before the pain started in the hip. This treatment was seldom prolonged nor was the high dosage given that was considered responsible for bone necrosis by Heimann and Freiberger (1960). However, steroid treatment could explain in part the rising incidence of necrosis of the femoral head, and the possibility must be kept in mind.

It may be thought that a combination of local congenital or acquired predisposing causes, with some other cause acting on the vessels of the femoral head, such as repeated slight injury, forced movements, steroids or other drugs, are necessary to induce necrosis of the femoral head.

Different hypotheses have been formulated concerning the mechanism of interruption of the blood supply to the head. Embolism, as suggested by Kahlstrom, Burton and Phemister (1939), appears unlikely; no primary site has ever been found in these patients. Venous obstruction could be responsible for bone necrosis. This theory, advanced by Chandler in 1940, may find some support in the work of Trueta and Harrison (1953), and in a recent paper by Serre and Simon (1959) venous stasis was shown by pertrochanteric phlebography in all the hips with primary necrosis that they investigated in this way.

Arterial lesions have been searched for and it has been noted that necrosis of the femoral head is rare in patients with arteriosclerosis, nor was arteriosclerosis found in any of our patients. Endarteritis, however, was found in one case by Phemister (1934) and in the ligamentum teres by Hirsch (1938) and Chandler (1948). In our hips the ligamentum teres always seemed normal; however, as will be shown, in two of our hips the histology of the capsule showed definite lesions of endarteritis in the antero-superior part.

**PATHOLOGY**

So far it has been assumed that the lesion really is an ischaemic necrosis. The pathology has demonstrated this without any doubt.

The extent and severity of the lesion and the age of the patient necessitated prosthetic replacement of twenty-one hips. These provided an opportunity for pathological examination.
of the femoral head. In all of them microradiography of thin sections of bone was done as a supplement to macroscopic and microscopic examination (Figs. 28 to 32). In order to define exactly the limit of the necrosis as compared with the radiographic appearances and the vitality of the peripheral parts of the head, some patients were given an injection of phosphorus$^{32}$ before operation and autoradiographs of the head were obtained. For the same reason other femoral heads were examined by the succino-deshydrogenase test. When the distal insertion of the capsule could be removed with the femoral head, the vessels were searched for and injected by Trueta’s method (Fig. 33).

It is well known that when the hip has been opened and the femoral head exposed the cartilage appears normal but it can be depressed over the superior and anterior aspects of the
femoral head. An incision at the edge of that part which can be depressed leads into a sort of cavity lying under a partly detached sequestrum; the floor of the cavity also appears necrotic. Even in advanced cases (Fig. 13) the cartilage, though buckled, was in good condition.

The full extent and nature of the lesion, however, can only be determined precisely by cutting the head in a frontal plane (Fig. 20). In such sections the lesion was seen to occupy the upper part of the head; the necrotic part appeared as a hard white area surrounded by a reddish zone and by a zone of dense bone. The inferior limit of the lesion was variable but lay in the vicinity of the fovea. When the necrosis was superior to the fovea it was limited to the upper third of the head; on the other hand when the necrosis extended distally it might reach the axis of the femoral neck, but it always spared the area of the fovea and the inferior part of the head.

Part of the necrotic area may have been detached from the rest of the head, but this was not constant. This separation, when present, did not always appear between the living and the necrotic bone; indeed it often looked like a fracture of the necrotic part: it may have occurred very near to the cartilage, but it always left a thin layer of subchondral bone. At other times it was found near the deeper limit of the necrotic portion.

**Histology**—On microscopic examination the lesion appeared almost constantly to consist of different layers (Figs. 28 to 30).

*The articular cartilage*—This was always alive and often thicker than normal with proliferation of chondrocytes (Fig. 30).

*The subchondral bone*—This was necrotic; the osteocytes had disappeared but the architecture of the bone was normal. This is a strong argument in favour of a sudden deprivation of the blood supply. One or two cracks may have separated the sequestrum either from the remaining part of the head or from the articular cartilage. But it is worth while to note that if the cracks were superficial a fine layer of necrotic but otherwise normal bone was always adherent to the cartilage (Fig. 29): when the crack was deep the bone forming the floor was never normal. *The zone of bone destruction*, where bone tissue was nearly completely absent with fibrosis of the medullary spaces, was an active and highly vascular region, with many blood vessels. Numerous osteoclasts were actively destroying the trabeculae of necrotic bone (Figs. 31 and 32). Zones of newly formed cartilage were often present superficially under the necrotic bone but
never over the deep aspect of the sequestrum as in true "osteochondritis dissecans." This zone of destructive osteoporosis may have been the initial lesion preceding the necrosis. *The zone of osteosclerosis and vascular proliferation* was characterised by many blood vessels in the viable cancellous bone of the femoral head, with new trabeculae of a complex pattern at the limit of the zone of bone destruction. In all our cases the part of the femoral head around the insertion of the ligamentum teres was not affected by necrosis but was a part of the reactive and highly vascular osteogenetic peripheral zone.

The intensity of vascularisation of the zones underlying the necrotic bone and the new bone formation therein suggested that it was an area of active reconstruction. This idea was
strongly supported by special tests—vascular injection and microradiography, autoradiography with phosphorus 32, and the succino-deshydrogenase test.

Vascular injection and microradiography—In four cases it was possible to find vessels going to the femoral head in the capsule and to inject them with a coloured medium; in each case the reactive vascular zone was found to be deeply coloured (Figs. 33 to 38). On microradiography, the sequestrum was seen to have normal architecture but no blood vessels, whereas the zone of osteosclerosis was hypervascular.

Autoradiography with phosphorus 32—In several cases phosphorus 32 was given two days before the operation in amounts of 100 to 150 microcuries (Fig. 37). Autoradiography of slices of femoral head showed no fixation of phosphorus in the necrotic zone, but heavy concentration of the isotope in the underlying osteosclerotic reactive zone.

The succino-deshydrogenase activity test—This test uses Gomori’s reaction with succinate and tellurite of sodium. It showed intense activity in the reactive zone (Fig. 39).

Four observations suggested that the zone underlying the necrosis was one of very active tissue probably capable of reconstruction: the hypervascularity shown both by histology and by injection, the active fixation of phosphorus 32, and the strongly positive succino-deshydrogenase test. These findings suggested certain methods of treatment.

Lesions of capsular vessels—In six cases the ligaments of the joint were removed together with the head. In four of the six hips vascular lesions were found. In two there were perivascular inflammatory changes, the causative role of which is subject to discussion (Figs. 40 and 41). But in two hips considerable alterations of the arterial wall were found in the arteries of the
Case 2—The superior artery of the capsule has been injected with india ink. The dye has entered the head and has reached the ligamentum teres. The active zone underlying the avascular sequestrum has been well filled.

Case 8—This patient was prepared before operation by an injection of phosphorus 32. Figure 34—Radiograph of the whole specimen. The limitation of necrosis is not clearly seen. Figure 35—Microradiography of a slab of the head. The thin subchondral layer of necrotic bone is detached from the remainder of the sequestrum. The osteolytic and sclerotic zones are also shown well. Figure 36—An injection of radio-opaque material into the postero-superior pedicle. The vessels are injected in the active zone from the lateral part of the head to the ligamentum teres. Figure 37—Autoradiography shows strong fixation of radioactive phosphorus in the active zone beneath the sequestrum.
Case 8. Figure 38—A colour photograph of the head after injection of the vessels with methylene blue. Case 9. Figure 39—Succino-deshydrogenase test. Immediately after removal the head was cut in the frontal plane and was immersed in a solution of tellurite and succinate of sodium. Activity is shown in the vascular zone underlying the sequestrum.

Case 10—Vascular lesions in idiopathic avascular necrosis. Figure 40—An artery belonging to the antero-superior pedicle of the head. The elastic membrane shows a severe lesion with thickening of the sub-endothelial layer and partial obliteration of the vessel. (Haematoxylin and eosin, × 50.) Figure 41 shows another artery from the same specimen with alteration of the elastic membrane and giant cells. (Haematoxylin and eosin, ×150.)

antero-superior pedicle of the femoral head. Both the media, and even more the interna, of the arteries were involved in a pathological process consisting of thickening of the interna with rupture of the elastic layer. These lesions resemble those of temporal arteritis. Having been found in the antero-superior artery, which is the main nutrient artery to the head, they are more convincing than the rather similar lesions found by Chandler and by Hirsch in the ligamentum teres.

To summarise the pathology, this condition is not infrequent and is a serious disease affecting one or, more often, both hips of men during their active life. It is undoubtedly a
primary necrosis of the upper part of the head of the femur. This leads to severe destruction of the antero-superior segment of the head. The process is progressive but is limited by a vigorous vascular and osteogenetic reaction of the underlying sound part of the femoral head.

TREATMENT

There is little to be found in the literature about the results of treatment. Patterson, Bickel and Dahlin (1964), reviewing thirty-six operations at the Mayo Clinic, using a prosthesis, a cup or arthrodesis, found twelve excellent or good results and fourteen improved. Conservative procedures were used in only two patients (one curettage, one osteotomy), both with improvement.

We are able to report here the results of a series of 139 operations on ninety patients: 133 hips have been followed up for a year or more (Table I).

<table>
<thead>
<tr>
<th>Operation</th>
<th>Number of Operations</th>
<th>Number of Results Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varus osteotomy</td>
<td>65</td>
<td>56</td>
</tr>
<tr>
<td>McMurray osteotomy</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Arthrodesis</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Prosthesis</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Cup arthroplasty</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Curettage and graft</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Temporary fixation</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tenotomy</td>
<td>1</td>
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<tr>
<td>Total</td>
<td>139</td>
<td>128</td>
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*139 operations were done on 122 hips, of which 58 were unilateral. Thirteen operations were done after failure of the previous operation.

Arthrodesis—This was used for fifteen hips, including three in which it was done after failure of another operation. Bony fusion was obtained in only eight cases, including two in which a second grafting operation was necessary. Two of the five unsound fusions were painless; two others are too recent to assess.

With our present improved technique we hope to obtain better results, for we believe that there may be a clear indication for arthrodesis in a confirmed unilateral case with a history of three years or more, and in some bilateral cases after successful arthroplasty on the other side. Prosthesis—Thirty-four prostheses have been inserted in twenty-eight patients. Most of the patients were over sixty, but in some younger patients with bilateral destruction of both femoral heads there was no better procedure available. Apart from two acrylic prostheses used before 1952 and four of Judet’s new type, all the prostheses were of the Austin Moore pattern.

In four patients a prosthesis was used after failure of one cup arthroplasty and three osteotomies. Of these four, three were failures and the prosthesis was removed because of persistent pain in two hips and because of sepsis in one. Up to date the results have been very satisfactory in twenty-eight cases. Practically all these patients have obtained a painless and stable hip four to six months after operation. No deterioration has so far been observed with a Moore’s prosthesis, but the longest follow-up is only five years.
Cup arthroplasty—Ten cups were used in nine advanced cases with four good results, three fair and three failures where persisting pain demanded another operation. These failures were caused by excessive resorption of the head and severe secondary changes in the acetabulum.

Arthrodesis, prosthetic replacement, or cup arthroplasty can only be considered when there is severe and advanced necrosis of the head, and then preferably in elderly patients. In a patient under fifty with early necrosis, only conservative measures can be considered. Of these we will mention medical treatment, curettage, temporary fixation, interposition of a cup, and osteotomy.

Medical treatment—Bed rest with continuous traction relieves pain in the early acute phase of the disease; but it will not prevent collapse of the head in severe cases even when followed by a prolonged period of freedom from weight bearing. Figures collected by Coste et al. (1960) showed that only 27 per cent of the heads preserved their normal contour after two to three years while 72 per cent underwent extensive collapse. The addition to medical treatment of combinations of tenotomies, generally referred to as "hanging hip" operations, does not seem to improve the results. We have used such a procedure only once, and this was a failure.

Curettage and graft—In four patients with five hips affected, the lesion was exposed by anterior arthroscopy, the overlying sound cartilage was elevated, the necrotic bone was removed by curettage and replaced by cancellous grafts from the ilium. In three hips the pain was not relieved and radiographs showed progressive collapse of the femoral head. One patient was clinically improved but his radiographs were not. In one hip there was both clinical and radiological improvement but an osteotomy was done at the same time.

It is not considered that a graft, which is, after all, only another piece of necrotic bone, will provide any better opportunity for cure. But what has been learned from the pathology and the radiological evolution raises the hope of spontaneous healing by penetration of the necrotic bone by the numerous blood vessels we have seen in the active zone underlying the sequestrum. With this in mind it has been our aim mainly to protect the head from the mechanical forces causing fractures in the altered portion of the head. If revascularisation can take place in a head of normal shape, it is conceivable that a normal hip could be restored. But to achieve such restoration it is necessary to protect the head for months or even for years. After an unsuccessful attempt with temporary fixation, we believe that this aim may be obtained by osteotomy or by interposition of a cup.

Temporary fixation—In five hips protection of the diseased femoral head was achieved by a special device with three stout screws fixed round the acetabulum and thrusting against a plate fixed on to the femur. Complete relief of pressure on the head was proved by the widened joint space.

The device became loose in two hips and had to be removed after six months but three patients tolerated it for one year, walking on crutches. One has preserved a normal contour of the head and in the others a slight collapse has not progressed. Two patients have no pain and the other has improved but with some loss of mobility from periarticular new bone formation.

Interposition of a cup—In early cases with no collapse or only slight collapse of the head, protection during the process of revascularisation might be obtained by an exact-fitting Vitallium cup and allowing it to move in the normal acetabulum. The follow-up is too short in the five hips where this procedure has been used to allow any conclusions to be drawn.

Osteotomy—In all known cases the necrosis affects the same part of the head—the anteroinferior aspect. Hirsch's (1964) experimental measurement of pressures on the femoral head have shown that this region corresponds to the zone of greatest pressure, whatever the position of the lower limb. It is hoped that osteotomy, by transferring the pressure to a sound part of the head, will relieve the affected part and give better conditions for spontaneous healing. It has been proved, moreover, that osteotomy provokes hypervascularisation of the upper part of the femur (Lemoine, Ecoffier and Juster 1959). McMurray's osteotomy was used in four
cases but we do not think it a logical procedure because the greatest pressure still remains on the affected part of the femoral head.

With the aim of transferring the body weight on to a sound part of the femoral head two kinds of osteotomy have been performed: Pauwels's varus type in twenty-nine hips and a combined varus and rotation osteotomy in twenty-seven hips (Table II).

### TABLE II

<table>
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<th>Operation</th>
<th>Definitely worse</th>
<th>Slightly worse</th>
<th>Unchanged</th>
<th>Slightly better</th>
<th>Total</th>
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<tr>
<td>Varus osteotomy</td>
<td>5</td>
<td>4</td>
<td>16</td>
<td>4</td>
<td>29</td>
</tr>
<tr>
<td>Rotation osteotomy</td>
<td>2</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>13</td>
<td>28</td>
<td>12</td>
<td>60</td>
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Pauwels's medial wedge osteotomy, by putting the neck in a varus position, reduces in some way the pressure on the head when full weight is taken on that side, and it brings the intact lateral portion of the femoral head and its overlying intact articular cartilage more into the acetabulum. With the technique of oblique osteotomy (Merle d'Aubigné and Vaillant 1961) anteverision can be corrected at the same time and a sound anterior segment of the head brought into the acetabulum (Fig. 42).

In other cases a modified oblique section osteotomy has been done perpendicular to the axis of the neck. If the shaft of the femur is placed in flexion before fixation, it brings the weight of the body on to the posterior sound part of the head; if it is placed in extension, the anterior part of the head takes the place of the sequestrum. By an oblique osteotomy a varus effect can be obtained at the same time.

The results are available in fifty-six hips with twenty-nine varus osteotomies and twenty-seven flexion or extension osteotomies. Twenty-six patients have been reviewed between three and ten years after operation, thirty-six between two and three years, and fifty-six cases between one and two years (Fig. 43).

### FUNCTIONAL RESULTS OF OSTEOTOMY

Of these fifty-six hips, twelve have not improved. In five persisting pain and progressive collapse of the head required a second operation (three arthroplasties failed again, but one resection of head and neck and one arthrodesis were relatively successful). As for the seven other failures, five patients accept the persistent moderate pain and the consequent limitation of activity; two have severe pain for which arthrodesis has been proposed.

In forty-seven out of fifty-nine osteotomies, however, the patient has enjoyed much or complete relief of pain. Twenty-four are classified under...
Grade 6 (no pain at all) and twenty-three are Grade 5 (occasional slight pain). Movement remains good and the gait in most cases is normal.

The follow-up is short in many. But after two or three years even stabilisation with slight pain can be considered as a success, because the study we have made of control cases not operated on shows that spontaneous remissions of symptoms is rare and progressive aggravation the rule. Moreover, as shown in Figure 44, good results appear to be permanent: in nineteen cases more than four years after osteotomy we have found only two poor results. Compared with the control cases (Fig. 45) the osteotomised hips show a large proportion of painless cases and a very small number with pain.

Radiographic results—Osteotomy was done only when the collapse of the necrotic portion was absent or moderate (Grades 1 and 2). The assessment of the radiographic result was based essentially on the contour of the head.
In most cases where collapse is prevented or stopped one can find apparently favourable changes in the altered architecture of the femoral head. But because this process is very slow and in our experience never restores a normal pattern, it has not been taken into account.

Those cases with marked collapse (Grade 3) were not selected for osteotomy. Thirty-three Grade 2 cases showed moderate collapse. In twenty-three the contour of the head was normal or only slightly flattened.

A comparison of the radiographs before operation with the last ones obtained, one to eight years after operation, is shown in Table II. The two types of osteotomy do not appear to give significantly different results. Further collapse has been seen in only seven cases out of sixty (11 per cent). In forty cases (66 per cent) the appearance of the head was unchanged or slightly improved.
Case 7—A woman of 60 years with necrosis of the right femoral head (Fig. 51). Complete relief after adduction osteotomy (Fig. 53), with apparent revitalisation of the head, which is almost normal after eight years (Fig. 55). But rapid destruction has taken place on the left side and a prosthesis had to be inserted (Figs. 52, 54 and 56).
We know that cases not treated by operation sometimes retain the normal contour of the femoral head for three years or more. But Figure 46, in which the evolution from the first symptoms in cases treated conservatively has been compared with that after osteotomy shows a great disparity and strongly suggests that osteotomy prevents gross collapse of the head of the femur (Figs. 47 to 56).

*Other types of osteotomy*—Five osteotomies more or less of the McMurray type were done on three patients with a very good result after six years in one unilateral case. In the two patients with both hips affected, one has two good hips and the other patient one very good hip; failure on the other side necessitated the insertion of a prosthesis.

**CONCLUSIONS**

In the present state of our knowledge it appears that spontaneous stabilisation of the lesion and tolerance of the clinical state cannot be expected in more than 25 per cent of cases of idiopathic necrosis. Medical treatment is ineffective, but osteotomy appears to arrest the progress of collapse and deformity of the head, provided two requirements are filled: no marked collapse and not too extensive lateral spread of the necrotic zone. At present osteotomy appears to be the best treatment. When destruction of the head is severe and very extensive, prosthetic replacement is indicated and gives good results when the acetabulum is intact. In young patients the interposition of a well fitting cup may be preferable to a prosthesis but the results are not yet available.

When secondary arthritis has led to alteration of the acetabulum arthrodesis may be the choice for unilateral necrosis in an active man.

**SUMMARY**

1. Idiopathic necrosis of the femoral head is generally considered to be a rare disease but it appears to be rather frequent in France in view of the fact that 139 cases were recorded in the orthopaedic clinic of Hôpital Cochin between 1959 and 1963. Ninety cases treated by operation have been analysed in this paper. Men are nearly exclusively affected between the ages of eighteen and seventy, with the highest incidence between thirty and fifty years of age. Both hips are affected in 52 per cent of cases.

2. The etiology is unknown, but steroid therapy was noted in 36 per cent of the cases and some history of slight injury in 30 per cent. The sudden onset of pain in half the cases suggests the obliteration of one of the blood vessels supplying the femoral head.

3. Radiographs are often normal at the time of onset of the symptoms but later they show increased density of the head localised to the antero-superior aspect, and later still collapse of this weight-bearing region. The extent of the lesion appears to be determined from the very beginning rather than to be progressive. The superior joint space is never reduced and may in fact be widened.

4. Pathological examination of the head and neck confirms necrosis of the cancellous bone and the integrity of the overlying cartilage, but shows deep to the necrotic region a highly reactive zone characterised by hypervascularity and raised metabolism. These features have been demonstrated by injection of the blood vessels and also by the uptake of phosphorus 32 and by the succino-deshydrogenase test.

5. In six cases microscopic vascular lesions were found in the antero-lateral pedicle of the femoral head.

6. The high degree of activity of the tissue deep to the necrotic zone gives some hope for revascularisation of the necrotic segment. For this reason protection from pressure may be the way to prevent dramatic collapse of the head. Rest, medical treatment and freedom from weight bearing, however, do not achieve adequate protection. Varus or rotation osteotomy of the femoral neck not only gives relief from pain but appears to prevent collapse of the femoral head.
7. When destruction of the head has already taken place good results may be expected from the insertion of a metallic prosthesis, provided the acetabulum is sound. The results are less favourable when the acetabulum has been altered by secondary arthritic change, and arthrodesis may have to be considered if the disease is unilateral or when a prosthesis has been successfully inserted on the other side.

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REFERENCES


