TOTAL REPLACEMENT OF THE HIP JOINT
A Review of a Thousand Operations

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Total replacement of the hip joint has become a widely accepted procedure in the treatment of arthritis, and the results reported over the last few years confirm that these artificial joints can restore a high level of functional activity that is well maintained. The effects of a successful operation by any of the standard techniques are remarkably similar, the materials are well tolerated and wear is slight. The value of each procedure must therefore be measured by the proportion of patients achieving a satisfactory result, and by the number and nature of the failures.

In the absence of a generally accepted method of hip assessment the comparison of results is difficult. The problem is eased, however, by the practice of expressing the outcome, not in terms of clinical improvement but in terms of normal hip function. Most patients treated by an established technique find that the joint is stable, painless, and freely mobile; such a result can be regarded as excellent. Some are left with a little residual discomfort, or minor restriction of movement, or the need for use of a stick; they can be assessed as good, but lack the full potential of a total joint replacement. Failure may be either partial and correctable by further reconstructive surgery, or total.

In 1964 we started using an uncemented metal-to-metal articulation, both parts being made of cobalt-chrome alloy. The development of the prosthesis and the early results have been reported previously in this Journal (Ring 1968) and elsewhere (Ring 1971). Four varieties of femoral component are now in current use, a longer and a shorter with a standard neck angle of 135 degrees, and a similar pair with a valgus angle of 150 degrees (Fig. 1). Each has a head 40 millimetres in diameter. The cups are all the same and interchangeable; the screw by which the cup is fixed to the pelvis is now tapered. A Leinbach femoral component has occasionally been used in the revision of an osteotomy (Fig. 2), and a femoral component designed for fixation by cement has been introduced to deal with the loose prosthesis (Fig. 3).

This paper deals with the results of the first 1,000 replacements, performed over a period of eight years. In no patient was acrylic cement used in the course of a primary operation, and even when the bone was grossly osteoporotic or the acetabulum deficient, a stable articulation was achieved. Although many of the patients had had bilateral replacement, mostly under the same anaesthetic, the results have in general been recorded as numbers of hips treated rather than numbers of patients. We have not reported separately patients whose hips had been treated primarily in other ways before coming to total replacement, because the nature of the earlier operation appears to play little part in the final result.

Throughout this study we have found no evidence of any local or systemic change which might be of significance in limiting the use of a cobalt-chrome implant of this type.

INDICATIONS FOR OPERATION

With the passage of years our indications for this procedure have become fairly clearly defined.

Osteoarthritis—Routinely in unilateral cases over the age of sixty; routinely in bilateral cases with both hips severely affected over the age of fifty; and selectively in younger patients when arthrodasis or osteotomy seems contra-indicated.

Rheumatoid arthritis—Routinely at all ages when symptoms demand surgical treatment.

Congenital dislocation of the hip—Routinely in adults with degenerative changes on both sides; selectively as for osteoarthritis in unilateral cases.
FIG. 1
To show the four varieties of femoral component in current use.

FIG. 2
Figure 2—To show a Leinbach femoral prosthesis with an acetabular component. Figure 3—
To show the type of femoral prosthesis used for revisional purposes with cement.
Old injuries—Selectively in cases of old femoral neck fracture where the state of the acetabulum contra-indicates replacement only of the head and neck; routinely for degenerative arthritis in cases of old acetabular fracture or fracture-dislocation of the hip.

Ankylosing spondylitis—Routinely at any age.

Revisional surgery—Selectively for failed osteotomy or cup arthroplasty, and very occasionally, failed arthrodesis.

The diagnoses before operation are indicated in Table I. The proportion of patients falling into the rheumatoid category is relatively low, because under this heading we have included only those patients with marked rheumatoid changes elsewhere or with sero-positive tests.

**TABLE I**

<table>
<thead>
<tr>
<th>Diagnosis before Operation</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoarthritis</td>
<td>890</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>37</td>
</tr>
<tr>
<td>Congenital dislocation with secondary osteoarthritis</td>
<td>7</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>1,000</td>
</tr>
</tbody>
</table>

The ages of the patients are indicated in Figure 4. Old age is no bar to total hip replacement, provided the physical and mental condition is acceptable. Youth, however, must still be regarded with caution. The few patients in their thirties were severely disabled, mainly by rheumatoid arthritis, and were not amenable to other forms of treatment.

Contra-indications—The only absolute contra-indication is recent infection of the operative site. Septic arthritis or osteomyelitis in early life has not been regarded as a contra-indication to replacement in the mature adult. In a few patients, particularly after previous operations, the configuration of the bone has been such that no form of total replacement was possible. Such patients are rare.

**PROBLEMS AT OPERATION**

In most patients with degenerative or rheumatoid arthritis exposure of the hip and insertion of the prosthesis present no particular difficulties. Access to the acetabulum is occasionally awkward, particularly if the femoral shaft cannot be thrown forward, but free release of the capsule, especially its inferior part, and even partial division of the femoral insertion of gluteus maximus, will usually overcome this problem.

Accurate location of the pelvic component is essential for a stable articulation. Repeated checks are necessary throughout all stages of insertion to make certain that the screw thread lies centrally within the ilio-pubic buttress of bone. The cup must be centred in the acetabulum and countersunk as deeply as possible, using the large matching reamer for this purpose. In most patients it should lie fully supported around the rim.

The selection of the femoral component is dictated by the size of the femoral shaft and the configuration of the head and neck. The femoral component should fill the trochanteric region and the canal of the femur as far as possible, and the angle of the head and neck should resemble that of the articulation it replaces. The use of a prosthesis with a valgus neck in a patient with a marked
coxa vara will usually result in a limp. The match between the cut surface of the femur and the flange of the prosthesis should be good, but stripping of the neck of the femur to aid this match may be followed by necrosis of the calcar. The blood supply of the femoral neck must be preserved.

Figure 5—To show the relieving bone incision over the greater trochanter, made when the prosthesis is tight. Figure 6—To show cobalt-chrome screws used to secure a crack of the inner surface of the femur.

Figure 7—The radiograph of a case of protrusio acetabuli taken before operation. Figure 8—A radiograph of the same case taken after operation.

Variations in the density of bone are common. Marked osteoporosis demands very limited reaming of the canal in the pelvis, and the grip of the tapered screw is then good. Dense bone on the
other hand requires full insertion of the tap and careful preparation of the pelvic track, and considerable force may be required to insert the prosthesis. No particular difficulties have been encountered in Paget's disease on the pelvic side of the articulation.

Osteoporosis on the femoral side demands limited penetration by the femoral rasp and often selection of the larger femoral component. When the femoral bone is dense, it is better to err on the side of caution and insert the smaller of the prostheses; a relieving incision over the greater trochanter, permitting it to hinge outwards, may avert a catastrophe (Fig. 5). Small cracks in the femur can be secured by the insertion of one or two cobalt chrome screws (Fig. 6), and even wide fissuring can be salvaged provided the fragments can be suitably transfixed. 

Coxa magna—When the head of the femur and the acetabulum are grossly enlarged, full countersinking of the cup will limit joint movement by femoral impingement; either the cup must be left proud or the margins of the acetabulum must be trimmed. A large femoral canal demands selection of the widest available prosthesis.

Central protrusion—A cup placed in the floor of a deep socket of this type will inevitably face horizontally and have a vertical stem; fortunately its insertion in this position is virtually impossible. The guide must be introduced towards the outer aspect of the acetabulum so that the cup is eventually sited in the roof and countersunk as deeply as possible. In these hips support is always deficient medially and there may be a gap of one or two centimetres between the medial margin of the cup and the floor of the acetabulum (Figs. 7 and 8). The restoration of joint architecture inevitably lengthens the femoral neck and reduction of head into socket is always difficult. It is therefore advisable to section the femoral neck a little lower than normal.

Congenital dislocation of the hip—It is important that the acetabulum should be sited as near the position of the true acetabulum as possible. This entails the removal of bone below the false acetabulum until a satisfactory position can be achieved (Figs. 9 and 10). Lengthening up to 4 centimetres can be gained without difficulty, and any contracture will pull out with a few days of traction. Nevertheless this technique is inappropriate for a really high dislocation when the femoral head lies on the wing of the ilium and the limb is perhaps 7 or 8 centimetres short. In these patients the ilio-pubic bar of bone is undeveloped and a satisfactory seating of the pelvic component cannot be achieved.

Old pelvic fractures—Insertion of the acetabular component demands a reasonably normal pelvic architecture. A fracture that has involved the greater sciatic notch may disturb both this and the landmarks that are essential for successful introduction. The presence of fibrosis over the inner wall of the pelvis may prevent the guarding finger from being inserted to ensure that neither drill nor screw

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**Figure 9**—The radiograph of an old case of congenital dislocation of hip before operation.  
**Figure 10**—A radiograph of the same case taken after operation.
Figure 11—The radiograph of a case of ununited fracture of the femoral neck previously treated by osteotomy. Figure 12—The radiograph taken after resection of the head and neck and insertion of a Leinbach prosthesis.

Figure 13—A radiograph showing a widely displaced femoral osteotomy with internal fixation by an Osborne-Ball appliance. Figure 14—A radiograph of the same case taken soon after revision by realignment of the femur and transfixion by the femoral component.
penetrate. This method of replacement can therefore be used only with extreme caution in these patients.

*Replacement after femoral osteotomy*—Displacement of the shaft of the femur by half a diameter or less does not usually cause difficulties, but greater displacement, and particularly displacement with angulation, may do so. On three occasions the shaft fractured during insertion of the femoral component but was held by two or three circumferential wires. In each case traction was maintained for six weeks before walking was permitted.

The risk of fracture is smaller when the straight-stem Leinbach component is used, and this also permits section of the femur at a lower level (Figs. 11 and 12). Occasionally the displacement of a previous osteotomy is so great that the femur must be sectioned again and realigned, and the prosthesis threaded across the gap and down the femoral shaft (Figs. 13 and 14).

| TABLE II |
| DETAILS OF THE SERIES |
| Model of prosthesis | Period of review (years) | Number of hips | Lost to review | Remaining |
| Early | 5 to 8 | 193 | 24 | 169 |
| Current | 1 to 5 | 569 | 34 | 535 |
| | Under 1 | 238 | 0 | 238 |
| Totals | 1,000 | 58 | 942 |

| TABLE III |
| ASSESSMENT OF HIPS REPLACED BY EARLY MODELS OF PROSTHESIS (FIVE TO EIGHT YEAR REVIEW) |
| Grading | Number | Percentage |
| Excellent | . . . | 75 | 45 |
| Good | . . . | 49 | 29 |
| Fair | . . . | 16 | 10 |
| Poor (including revisions) | . | 29 | 16 |
| Totals | . | 169 | 100 |

| TABLE IV |
| ASSESSMENT OF HIPS REPLACED BY CURRENT MODELS OF PROSTHESIS (ONE TO FIVE YEAR REVIEW) |
| Grading | Number | Percentage |
| Excellent | . . . | 369 | 69 |
| Good | . . . | 115 | 21 |
| Fair | . . . | 32 | 6 |
| Poor (including revisions) | . | 19 | 4 |
| Totals | . | 535 | 100 |
RESULTS

The patients included in this study fall into two groups—those treated between 1964 and 1968 with one of the early prostheses, and those treated since 1968 with one of the prostheses in current use (Table II). Each patient has been assessed before operation and a year later, but inevitably there have been some lost to review by death from intercurrent disease, or change of residence. The total of 1,000 has been used to assess the frequency of early complications. Late complications have been assessed in relation to the 704 patients still under review, excluding 204 who have not yet completed a year.

Three factors have been considered in the assessment—pain, range of movement, and stability. These factors have been co-ordinated to give a final assessment of excellent, good, fair and poor.

Pain—This has been recorded as one of four grades—none, slight, moderate and severe. Discomfort may occur in the early stages of rehabilitation if activity is resumed too rapidly, and it is now our practice to restrain patients from prolonged walking and the resumption of any occupation involving heavy manual labour until the end of the third month.

Some patients, particularly in the first year, complain of discomfort in the thigh on first starting to walk after sitting for a prolonged period. This discomfort, which resolves after three or four steps, appears to be due to a temporary failure of lubrication after prolonged flexion. It rarely occurs after rest in recumbency.

Continuous discomfort around the articulation, or pain on weight-bearing, may indicate infection, loosening, or the formation of new bone around the articulation. Loosening of the pelvic component usually causes discomfort in the sacro-iliac region and buttock; loosening of the femoral component causes pain in the antero-lateral aspect of the thigh on weight-bearing. New bone formation, which may progress to ankylosis of the artificial joint, may be painless, but during the onset of stiffness may cause aching around the hip and in the groin.

Range of movement—The return of joint movement is normally a uniform process in the different directions, and we have therefore recorded only the range of flexion. Four grades have been used—more than 90 degrees, 60 to 90 degrees, 30 to 60 degrees, and less than 30 degrees.

There is in general a direct relationship between the range of movement before and after operation. If the other hip is stiff, the mobilisation of the replaced joint is usually impaired.

Flexion or adduction contractures after operation have been rare, in spite of the fact that no tenotomies have been performed.

Stability—The ability to walk independently is associated with the restoration of the normal centre of joint movement when this has been disturbed, an effective gluteal mechanism, and a well-embedded articulation. Stability has been assessed by examination of the gait, by the Trendelenberg test, and by the need for one or more sticks. Three grades have been used—normal, dependence upon one stick, or upon two.

Overall assessment—In order to be graded as excellent, a hip had to be painless and to have a range of flexion of 90 degrees or more and a corresponding range of abduction, and the patient had to be able to walk easily without a stick. The replacement had to permit activity normal for the age of the patient. In the presence of one adverse feature, such as slight residual discomfort, less than 90 degrees of flexion or dependence upon a stick, the grading was regarded as good. Patients with two or more adverse factors were graded as fair or poor; in the latter category were also placed those patients who subsequently underwent revision, even if the final result was satisfactory.

Early models—One hundred and sixty-nine of these hips remain for assessment after five to eight years (Table III); 45 per cent are excellent, 29 per cent good, 10 per cent fair and 16 per cent poor. The “poor” hips have all been revised, mainly for loosening.

Current models—Of 773 hips, 238 have not reached one year, though none of these has yet required any revisional surgery. Of 535 followed for one to five years, 69 per cent are excellent,
21 per cent good, 6 per cent fair, and 4 per cent poor (Table IV). Most of the latter have been revised, for either loosening or infection.

COMPLICATIONS

Mortality—Any major surgery in the elderly carries some mortality, and total joint replacement is no exception. There have been no deaths during the operation or in the immediate post-operative period, but eleven patients (1·1 per cent) died in hospital. These deaths were due to coronary thrombosis, gastro-intestinal haemorrhage, cerebral thrombosis and pulmonary embolism (Table V). The risk with bilateral replacement under the same anaesthetic is higher than with unilateral operation (Table VI), but the physical disability in such patients is undoubtedly greater.

| TABLE V |
| CAUSES OF ELEVEN DEATHS IN HOSPITAL AFTER OPERATION |
| Pulmonary embolism | 7 |
| Cerebro-vascular accident | 1 |
| Myocardial infarction | 2 |
| Acute peptic ulcer | 1 |

| TABLE VI |
| ANALYSIS OF ELEVEN DEATHS IN HOSPITAL |

<table>
<thead>
<tr>
<th>Operation</th>
<th>Hips</th>
<th>Patients</th>
<th>Deaths</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral</td>
<td>702</td>
<td>702</td>
<td>6</td>
<td>0·8</td>
</tr>
<tr>
<td>Bilateral</td>
<td>298</td>
<td>149</td>
<td>5</td>
<td>3·4</td>
</tr>
</tbody>
</table>

Pulmonary embolism is a particular hazard. Prophylactic anticoagulants have not been used routinely but only in patients with a previous history of a thrombosis or with marked varicose veins. Dextran 70 in saline has been given during the operative period and for the three following days; there is some evidence that this has diminished the incidence both of venous thrombosis and of pulmonary embolism.

General morbidity—Some of the morbidity in this elderly group of patients was probably not connected with the operation. Thus two patients had cerebral thrombosis, one at ten days and the other at three weeks. There were five patients with severe gastro-intestinal haemorrhage, possibly related to analgesics taken before operation. Clinical evidence of deep vein thrombosis was found in 7 per cent of patients, and in 1·5 per cent this was associated with non-fatal pulmonary embolism.

Dislocation—There were three cases of dislocation in the series, two in patients unconscious from cerebro-vascular accidents with gross lower limb spasm, the third immediately after operation. All three were easily reduced and the joints remained stable. The rarity of dislocation in this type of replacement is attributable to two features: 1) the automatic orientation of the cup when the pelvic component is inserted along the correct axial line; and 2) the relatively large size of the femoral head.

Joint infection—These operations were carried out in three general surgical theatres with no special ventilation. Prophylactic antibiotics were used routinely for one day before and five
days after operation. In unilateral operations a combination of Cloxacillin and Ampicillin has been used, for bilateral replacements intravenous Keflin. Chloramphenicol powder has occasionally been applied to a wound exposed for a long period. All wounds were closed with suction drainage.

Deep-seated infection may become manifest at any time after total hip replacement but mostly in the first year; such cases indicate infection at the time of operation. There were two examples of late onset infection, one of which ended fatally in septicaemia (Fig. 15). The overall infection rate is 0.7 per cent.

The diagnosis of infection may be difficult, and is not necessarily associated with changes in the radiographs, the blood count or the sedimentation rate. Occasionally exploration is needed before the diagnosis can be made. The first evidence of infection in one patient was a stress fracture in the floor of the acetabulum which failed to unite.

Six of the seven infected hips were treated by removal of the implant and a pseudarthrosis; the seventh patient died of septicaemia without further operation. The infections were brought under control in five patients, the sixth being left with a persistent sinus.

Prosthetic failure—There have been no metal failures on the femoral side, but the stem of the earlier pelvic component, which had a parallel screw, fractured in five cases. This complication can only occur if the screw thread remains firmly embedded proximally in the pelvis and if in addition the cup is not fully countersunk. The fracture was prone to occur about 2 centimetres proximal to the junction of screw and cup and eventually these joints became painful and required revision. No particular difficulties have been found in removing the prosthesis and inserting one with a thicker stem, although a special extractor is required to deal with the tightly embedded screw thread.

Loosening of the prosthesis—Some movement must occur at the interface of prosthesis and bone because of their different elasticities. In addition the tight fit obtained at the time of insertion may be followed by absorption of bone at points of high loading as activity increases. Areas that are no longer exposed to their normal stresses may atrophy and as a result intimate contact with the implant may be lost. In most patients these factors, acting alone or in conjunction, do no more than cause the development of a thin fibrous envelope which by its elasticity may add resilience to the articulation. In some patients, however, this interface movement may progress slowly or rapidly to frank loosening.

**RADIOLOGICAL FEATURES OF LOOSENING**

In spite of these theoretical considerations most uncemented metal replacements do not produce any radiological change in the surrounding bone. In a minority one or more of the following changes may be apparent.  

**Halo effect**—The implant is surrounded by a zone of translucency 1 or 2 millimetres wide, outlined by an area of marginal sclerosis. Such changes are rarely associated with symptoms and the function of the replacement is not impaired.  

**Tip sclerosis**—The ends of the two implants remote from the articulation may become surrounded by a thick band of cancellous bone. On the pelvic side this indicates that some of the weight is borne through the screw thread of the stem; it has no effect on function. On the femoral side the zone of new bone formation usually extends across the shaft, sealing the medullary cavity. In any revisional procedure it is important to perforate this bar of bone with a drill and so re-establish medullary continuity.
Absorption of the femoral neck—Osteoporosis and finally resorption of the femoral neck may be due to excessive periosteal stripping at the time of operation, and is sometimes compatible with good function because part of the load is transmitted through the femoral stem. More commonly, progressive femoral absorption is associated with sinking of the prosthesis (Fig. 16) and leads to frank loosening. The greater trochanter stands relatively higher, the joint is unstable, and usually the limb becomes painful on weight-bearing.

Tilting of the femoral prosthesis—A prosthesis that is inserted towards the lateral border and fails to fill the trochanteric region can migrate medially. This tendency is greater when the prosthesis has the standard configuration of head and neck, and is less with the valgus configuration. Such migration can be restricted by the use of a long femoral stem filling the medullary canal adequately: with the passage of time bone forms within the fenestrations.

Figure 16—A radiograph showing absorption of the femoral neck. Figure 17—A radiograph showing erosion of calcar and tilting of the femoral component.

Tilting is evidence, not of loosening, but of movement having occurred. It is often self-limiting because the prosthesis comes to lie upon the calcar and again locks firmly in bone. Erosion of the calcar by a prosthesis drifting medially is rare but always painful (Fig. 17).

Pelvic loosening—There has been no major displacement of the pelvic component in the absence of infection, but a progressive increase in the halo effect around the stem is a positive indication of loosening. Symptoms nevertheless may be absent.

Generalised osteoporosis—Loss of bone density following total hip replacement indicates poor joint function and is often associated with pain. Other radiological evidence that the implant is loose may be absent.

THE ETIOLOGY OF LOOSENING

Three factors appear to play some part in the incidence of loosening—operative technique, implant design and friction.

The pelvic component should bear weight through the margins of the cup, not through its stem. It must therefore be countersunk deeply into the acetabulum so that it is supported by bone around most of the lip. The tapered screw thread serves only to draw the cup deeply and tightly into its cone, not to bear weight. The femoral component must fill the medullary
canal as completely as possible, and because most of its load is transmitted through the flange, the match between this and the cut surface must be good. Reaming of the femur must be minimal so as to keep a tight fit.

Design of the femoral component has been shown to be of vital importance in the reduction of femoral loosening. The length of the stem and the width of the trochanteric component are of greater importance than the configuration of head and neck. It is vital to fill both the trochanteric and medullary regions of the femur as fully as possible. A valgus neck-shaft angle theoretically diminishes both the tendency of the prosthesis to tilt and for its flange to slide medially, but because the glutei are at a disadvantage because of the medial displacement of the trochanter, the mechanical gain is largely illusory. Joint loading is undoubtedly increased and the rotational stresses almost certainly become greater.

Frictional torque is an important factor in the initiation of loosening. Improvements in surface finish and sphericity and the adoption of the central bearing have all contributed to an increase in the stability of the metal-upon-metal bearing.

| TABLE VII |
| Analysis of Thirty-five Revisions for Loosening |

<table>
<thead>
<tr>
<th>Number of hips</th>
<th>Revisions</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early models, 5 to 8 years</td>
<td>169</td>
<td>23</td>
</tr>
<tr>
<td>Current models, 1 to 5 years</td>
<td>535</td>
<td>12</td>
</tr>
<tr>
<td>Current models, under 1 year</td>
<td>238</td>
<td>0</td>
</tr>
<tr>
<td>Lost to review</td>
<td>58</td>
<td>—</td>
</tr>
<tr>
<td>Totals</td>
<td>942</td>
<td>35</td>
</tr>
</tbody>
</table>

**Clinical features**—Certain symptoms are characteristic but not diagnostic of loosening of one or other component. Pain is the commonest feature: when derived from the pelvic side of the articulation it radiates up towards the sacro-iliac joint, from the femoral side into the antero-lateral aspect of the thigh, occasionally as far as the knee. This pain is characteristically present only on weight-bearing, or perhaps with unguarded twisting movements at night. Some loss of quality of the articulation, such as dependence upon a stick or an increasing limp, is rarely the subject of comment but again suggests this fault. Loss of movement is rare.

Loosening is essentially an early complication of total hip replacement and rarely occurs in an implant that has been entirely satisfactory for the first year or two. The symptoms, however, are often slight, and in the early stages are not necessarily progressive; a short period of rest from weight-bearing may produce permanent relief, even in the presence of well-marked radiological changes. Most revisions for painful loosening have been during the second year. After the third year they have been relatively infrequent, but even in such patients the characteristic symptoms have almost always appeared within a few months of the operation.

**Incidence**—Thirty-five of the 942 patients reviewed have required revision for loosening, an overall incidence of 3.7 per cent. There was no relationship to osteoporosis, nor was the risk greater in rheumatoid arthritis even in patients treated with steroids.

There was a definite relationship between the risk of femoral loosening and the size and shape of the femoral component. No fewer than 14 per cent of the hips replaced by early models, with a short narrow femoral stem, eventually required revision (Table VII). By using a broader and longer femoral component in the current models, revision for loosening in 535 patients followed for one to five years has been reduced to 2 per cent. There is no evidence that a valgus neck-shaft angle diminishes the risk.
Revision has been performed either with an oversize prosthesis or by using cement. Two patients required revision twice before stability was achieved. In one cemented revision infection occurred and the prosthesis was eventually removed.

REPLACEMENT ANKYLOSIS

The formation of new bone, particularly on the lateral aspect of the total replacement, is not uncommon but generally causes only slight restriction of movement. In six hips, however, new bone formation all round the implant resulted in ankylosis. These hips were very stiff before operation but mobilised well during the first two or three months and then started to lose movement; ankylosis was complete at six months. Late onset ankylosis has not occurred.

Of the six hips involved, four were in two patients undergoing replacement of both hips at the same time, and the distribution of new bone was identical. This suggests that the factors governing new bone formation are constitutional rather than local. The early onset of the ankylosis does not suggest a reaction to cobalt-chrome alloy, which might be expected to be much later and more gradual. We have not yet found remedial surgery of any value for this particular complication.

DISCUSSION

Replacement of the hip joint has become the procedure of choice in the treatment of arthritic changes in the elderly, and has been cautiously extended to younger patients who cannot be treated satisfactorily in any other way. Whichever method is selected, replacement can restore an almost normal level of functional activity, and this in a high proportion of patients.

The uncemented replacement under discussion has the advantage of simplicity and speed, and the mortality and morbidity appear to be low. Both hips can be treated under the same anaesthetic, though not without a considerable increase in the operative risk.

In this series most patients presented for surgical treatment for the relief of pain, and in the majority relief has been complete. In most of the others the residual symptoms have been mild, the commonest, particularly in the first year after operation, being discomfort felt in the hip on first starting to walk. No single cause can be cited for such discomfort, nor for pain over the antero-lateral aspect of the thigh. In some patients such symptoms are associated with the formation of some new bone around the articulation and may only be transitory; in others it may indicate loosening of one or other component; and in two we found the cause in a large adventitious bursa behind the articulation. Persistent pain may suggest a low grade infection, and the exclusion of this possibility, particularly if revision is contemplated, may be difficult prior to re-exploration.

Restoration of joint movement after a total hip replacement is rarely a problem. There is in general an inverse relation between the extent of the stiffness before operation and the range of movement finally achieved; an ankylosed hip will rarely regain more than 70 or 80 degrees of flexion. Flexion and adduction contractures can be overcome by a short period of skin traction, except when the other hip lies in a position of marked deformity. Bilateral flexion contracture is a strong indication for replacement of both hips, either at the same time or with a short interval.

Radiographic evidence of some new bone formation around a total hip replacement is common, but may not cause a significant restriction of joint movement. This bone lies well outside the articulation. Ankylosis is a rare but definite risk of this type of surgery, and in patients subjected to bilateral procedures the profuse new bone may be distributed uniformly around each of the joints.

The need for a stick, or a gross limp without one, suggests at first sight that the articulation is unsound, either because the implant is loose or because the mechanics of the new articulation cannot permit a normal gait. The use of a prosthesis with a valgus neck may produce a limp;
the shaft of the femur is displaced medially, the line of weight transmission is altered, and the 
greater trochanter lies so much nearer the axis of joint motion that the mechanical efficiency 
of the glutei is reduced. Some patients cannot redevelop these muscles enough to deal with this 
load. There is a close association between the use of a stick after operation and pre-existing 
joint stiffness and deformity: the patient with a flexion and adduction deformity, particularly 
if the joint is stiff, may depend on a stick for a year or more before the muscles redevelop 
sufficiently to permit independent walking with a good gait. Some patients limp because the 
new articulation has been sited too far posteriorly, causing the line of weight transmission 
to fall in front of the centre of the joint.

Infection is the worst complication of total joint replacement. The rate we have recorded 
is low (0·7 per cent). McKee (1971), using a cemented metal-on-metal articulation, recorded 
a rate of 3 per cent in his first 300 patients. Patterson and Brown (1972), using McKee's 
technique, found infection in 8 per cent of 403 patients. Charnley (1972) cited a rate of 3·8 per 
cent in a five-year review of over 500 cases using a cemented metal-on-plastic articulation. 
Harris, Lightowler and Todd (1972) and Todd, Lightowler and Harris (1972), using Charnley's 
technique, quoted rates of 5·3 per cent in osteoarthritis and 10·8 per cent in rheumatoid arthritis.

It is uncertain whether acrylic cement plays a direct part in increasing the risk of joint 
infection, or whether this is due to nothing more than the introduction of a larger mass of 
foreign material and a longer operating time. The heat of polymerisation may well play an 
important part, and the use of a specially ventilated enclosure within the operating suite may 
prove essential for reducing the rate of infection of cemented articulations.

All hip replacements have a problem of loosening, which is undoubtedly greater using 
metal-on-metal articulations than metal-on-plastic. Charnley (1972), in a group of patients 
followed five or more years after operation, had to revise no more than 1 per cent for loosening, 
all of the acetabular component. McKee (1971) revised 3 per cent of his first 300 patients, 
and Wilson, Amstutz, Czerniecki, Salvati and Mendes (1972), using a similar technique, revised 
9 per cent of their first 100 cases. Loosening of the uncemented articulation is undoubtedly a 
problem, but by attention to operative technique and by establishing a range of femoral 
components to ensure a tight fit, we have been able to bring down the rate of revision for 
loosening to 2 per cent. Nevertheless there are some additional patients with symptoms that 
are probably due to loosening but not severe enough at the moment to justify revision, and 
this rate with the passage of time may well increase a little.

The cause of pain from a loose prosthesis still remains uncertain. There is no doubt 
that many patients with uncemented replacements present characteristic radiological changes 
of loosening but nevertheless have good joint function and no pain. There is certainly no 
clear relationship between the extent of the loosening process, provided this does not progress to 
actual migration, and the intensity of symptoms. In this respect the uncemented prosthesis 
differs markedly from the cemented one, in which loosening is almost invariably painful and 
usually progressive.

There is increasing pressure to extend the use of replacements to younger patients. While 
this extension must be gradual and founded upon a continuing satisfactory clinical experience, 
it is important to note that over the last ten years the paucity of late complications hardly 
warrants such caution. Wear in the metal-on-metal joint is slight, and the products of wear 
are probably inert. There is therefore good reason to extend this type of treatment slowly 
to a somewhat younger group of patients, provided the risks of total and partial failure can 
be kept low.

SUMMARY

1. A thousand arthritic hips have been replaced by an uncemented metal-on-metal prosthesis, 
and 942 followed by annual review. The mortality of the operation has been 1·1 per cent, the 
rate of deep-seated infection 0·7 per cent and the incidence of dislocation 0·3 per cent.
2. Of 169 hips replaced by an earlier type of the prosthesis and followed for five to eight years, 45 per cent have remained excellent and 29 per cent good, but 14 per cent have required revision, mainly for loosening of the femoral component.
3. The current types of prosthesis, now used for five years, have given excellent results in 69 per cent and good results in 21 per cent of 535 patients followed for one to five years. Revision for loosening has been necessary in 2 per cent.
4. The improvement in results has been obtained by the introduction of a tapered screw thread on the pelvic component, and by a range of femoral components that ensures a good cortical fit.

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REFERENCES


