THE ATTENBOROUGH TOTAL KNEE REPLACEMENT

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The stabilised gliding knee prosthesis is a compromise between hinged joints and condylar prostheses. It is a two-piece implant designed to allow normal gliding movements of flexion and extension and which, stabilised by a connecting rod between the femoral and tibial components, allows a designed laxity of rotation and lateral movements.

A modification of the original femoral component is described. Two hundred and forty-five knee replacement operations have been done between January 1973 and September 1977 and the results are reported. The results using this prosthesis are at least equal to those using hinged or condylar prostheses. So far there has been no case of spontaneous loosening of the components and the implant can be used in patients who, because of severe deformities and instability, are unsuitable for condylar prostheses.

The stabilised gliding knee prosthesis (Fig. 1) is one of the third generation of knee implants. It is a compromise between the restrained hinges and the unconnected surface prostheses. It is a two-piece prosthesis with the normal gliding movements of flexion and extension and has a stabilising rod between the femoral and tibial components which allows some lateral and rotational laxity whilst acting in place of the cruciate ligaments and in place of or in addition to the collateral ligaments. The components are so designed that when rotation or lateral movements occur the joint "opens" and tightens the soft tissues. This produces a gradual deceleration of the movements instead of a sudden block which might be a cause of loosening. Only a minimal length of bone has to be removed. The implant has a self-lubricating mechanism. Distraction of the joint is possible with this design without straining the cement–bone fixation. Details of the design and of the technique of insertion have been published previously (Attenborough 1974, 1976, 1977).

During development and clinical testing some difficulties have been experienced when inserting the femoral component of the prosthesis. It is not always easy to link the two components while inserting the femoral stem and not infrequently cement may reach the space behind the prosthesis despite precautions. This cement, as with many other knee implants, is difficult to remove. A modified femoral component has therefore been designed in which the stabilising rod is supplied separately from the main femoral component (Figs. 2 and 3). The femoral component is now inserted before the linking with the tibial component and, in the absence of the stabilising rod, the gap between the femoral condyles is utilised to remove all cement from the back of the joint. Once the cement has been cleared, the stabilising rod is inserted and held in place with a high-density polyethylene circlip (Figs. 4, 5 and 6), the design of which is such that, once in place, it cannot be removed except by destruction. This new component has greatly simplified the insertion of the prosthesis.

A few patients have developed patellofemoral pain at an interval after operation. In ten of these the pain has been sufficiently severe to warrant a second operation to


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Figure 2—The components of the total knee prosthesis. Figure 3—The femoral component seen from behind with the separate stabilising rod and circlip.

Figure 4—The femoral component with the stabilising rod in position and the circlip in its groove before punching into its final position. Figures 5 and 6—The femoral component with the circlip fully inserted.
insert a high-density polyethylene lining into the back of the patella. The exposure of the knee to insert a patellar implant is almost as great as that required at the first operation and it now seems justifiable to reline the back of the patella as a routine part of the initial procedure.

The complete modified implant, known as the Attenborough total knee prosthesis, is shown in Figure 7.

A further development of this prosthesis has been its use as a salvage procedure in those cases where at a previous operation a considerable length of bone has been removed, for instance with some hinged prostheses. The main problem here is the extreme laxity of the knee after removing the previous prosthesis. This has been overcome by the use of a high tibial component to fill the gap between the bone ends (Fig. 8).

INDICATIONS
The implant has been used only for osteoarthritis and rheumatoid arthritis and the indications have been pain and loss of function in that order. The pain before operation has, in all cases, been severe and, if it has also been spontaneous, the need for operation has been obvious. When pain has been relieved by rest, the criterion of loss of function has been used. Careful assessment is required since many patients will accept pain felt on walking providing it is relieved by rest, but when the disability makes walking very difficult, it must be remembered that, in the elderly, loss of function will mean loss of independence (Devas 1976).

MATERIAL
Between January 1973 and September 1977, 245 total knee replacement operations have been done at Hastings using this prosthesis. Until the end of 1976 the original stabilised gliding prosthesis was used but from the beginning of 1977 the modified prosthesis including a relining of the patella has been used as a routine. Most of the results which are reported are therefore with the original prosthesis without a routine patellar implant; the ten cases in whom the patella was relined at a subsequent operation are included. In this total of 245 knees there were thirty in men and 215 in women. One hundred and twenty-six operations were done for rheumatoid arthritis and 119 for osteoarthritis. The youngest patient with osteoarthritis was fifty-one years old and with rheumatoid arthritis thirty-four years old. The oldest patient was eighty-eight and the average age was sixty-eight years.

Twenty-four knees have been lost from follow-up because of death. This includes two deaths within a few weeks of operation from pulmonary emboli which were the only ones directly due to the operation. The remaining deaths have been due to conditions unrelated to the operation and the rather large number is due to the high proportion of elderly patients.
COMPLICATIONS

Infection. Four knees have been lost to follow-up because of arthrodesis after sepsis or other loosening. With the exception of the first five, all the patients have been operated on in a Charnley Howorth Ultra Clean Air Unit, using antibiotic cover. There has been no case of infection immediately after operation at Hastings but one patient, operated on at another hospital and who had had two previous operations, after at least one of which there had been some sepsis, developed an immediate deep infection. This prosthesis was subsequently removed and the knee arthrodesed at another hospital. There have been three cases of late infection, two of which were probably metastatic since one followed a cystitis and the other an abscess on the ipsilateral foot. In the remaining patient, the femoral and tibial components loosened one year after the initial operation at the same time as a patellar implant, which had been inserted six months after the initial operation. In this patient no organism was cultured and no metal sensitivity could be detected. A low-grade infection remains the most likely cause.

Arthrodesis. In four of the infected knees, arthrodesis was subsequently performed. No details are available for the patient who was arthrodesed at another hospital but in the others a painless stable knee was achieved. One of these patients had had rheumatoid arthritis and, after attempted arthrodesis, she has been left with a rigid painless fibrous ankylosis, does not have to wear any form of external support, can walk long distances and is free of symptoms. Both the other patients were osteoarthritic and in each a bony arthrodesis was obtained (Figs. 9, 10 and 11).

Loosening. There has been no clinically or radiologically detectable spontaneous loosening of a femoral component. In two knees the tibial component has loosened due to a large amount of residual cement in the back of the knee causing a sudden block to flexion. In one of these the tibial component broke across one of the grooves at the level of the lower end of the stabilising rod. These grooves are no longer used and the rod has been lengthened in the modified prosthesis. An overweight patient who had been left with 10 degrees of varus deformity later developed a stress fracture of the medial tibial condyle and the tibial component subsequently broke. Two further patients developed stress fractures of the femoral condyles but both healed with no loosening of the prostheses.

Radiolucent line. A number of patients have been seen with a radiolucent line between the cement and the bone around the proximal 2 to 3 centimetres of the tibial component. This has always developed within one year of the operation, has never exceeded 2 millimetres in width and has not appeared wider in subsequent films. It appears to be similar to the line seen around the acetabular prosthesis in some cases of total hip replacement and should probably not be considered as a loosening unless there are symptoms accompanied by a progressive widening of the radiolucency.

Deep vein thrombosis. There have been two deaths due to pulmonary emboli but, unlike total hip replacement, there have been few other instances of clinically detectable deep vein thrombosis. This may be related to the use of a tourniquet in knee replacement.

RESULTS

The results are set out in Tables I, II and III. Apart from the knees lost because of death or arthrodesis, all the knees were personally reviewed.

One hundred and sixty-six knees were operated on more than one year previously. This number was reduced by death or arthrodesis to 158.

One hundred and seven knees were operated on more than two years previously. After loss by death or arthrodesis the number available for review was ninety-three.
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*The design of the prosthesis does not allow any material instability

For details of grades, see page 309.
Fifty-five knees were operated on more than three years previously. Thirty-nine were reviewed, the remainder being lost by death or arthrodesis.

Where the patients were lost to review because of death their notes have been reviewed and in each case the last attendance showed a result that was within the average obtained from the other knees reviewed.

The criteria most important to the patient, on which the results of knee replacement should be judged are the range of movement, the ability to walk and the relief of pain.

The histograms (Figs. 12 to 15) show that in the longer term results there is no significant fall off in grading except in the ability to walk. Here there has been a 10 per cent reduction of those in grade 4 but no change in the combined total of grades 3 and 4. This change is in nearly every case unrelated to the operated knee and is due to deterioration taking place in other joints.

**DISCUSSION**

The stabilised gliding prosthesis has the stability of a hinge but has certain advantages. The removal of less bone length and the short stems make a salvage procedure easier. The femoral component allows a polycentric flexion and extension which is closer to that found in the normal knee. Although the stability is excellent, the rotation and lateral laxity make loosening of the components less likely.

Surface prostheses are not always effective when correcting severe deformities or in knees with pre-
existing ligamentous damage. The stabilised gliding prosthesis has been used in patients with up to 80 degrees of valgus deformity and 60 degrees of flexion deformity and with gross ligamentous laxity. There has been excellent stability after operation.

Many hinges and the majority of surface prostheses do not replace the patellofemoral joint. In the original stabilised gliding prosthesis, one side of the patellofemoral joint was always replaced and the pain was significantly reduced. In the modified prosthesis, a high-density polyethylene implant for the back of the patella has been made available and it is probable that the total replacement of the patellofemoral joint will make patellofemoral pain even less likely.

The stabilised gliding principle differs from some other stabilised prostheses in that an attempt has been made to provide for a gradual deceleration of rotational and lateral movements by designing the joint to "open" when these movements take place to allow the soft tissues to tighten. This eliminates a sudden deceleration of rotational movements which are limited solely by tightening of the soft tissues. In lateral movements the soft tissues also act as the breaking force but as the capsule and collateral ligaments may be grossly deficient, particularly when a marked deformity has been corrected, it has been necessary to provide an inbuilt "stop" to marked lateral movement.

The design of the modified prosthesis has eliminated the problem of residual cement in the back of the knee.

This review of knee replacement with the stabilised gliding prosthesis has shown that the results in terms of relief of pain, preservation or increase in range of movement and improvement in function are equal to those obtained using either hinged or surface prostheses. The implant can be used successfully in patients where condylar prostheses would certainly fail due to their lack of inbuilt stability. The restrained hinge concept of total joint replacement may cause loosening in the bone and is now mainly of historical interest. Time will tell whether the designed rotation and lateral laxity of the stabilised gliding knee prosthesis will be an improvement but, so far, there has been no case of spontaneous loosening of a component.

I would like to thank my orthopaedic colleagues Mr M. B. Devas and Mr B. L. Hinves for permission to review their patients. My thanks are also due to the technicians of the orthopaedic workshop in the Royal East Sussex Hospital, Hastings, for their work in the development of this prosthesis; to Mr R. F. Ruddick of the Photographic Department of The London Hospital for some of the illustrations and to the orthopaedic research secretary Mrs E. M. Pallot for her work in recording these patients and for the typescript.

REFERENCES


