ARTHRODESIS OF THE KNEE AFTER FAILED KNEE REPLACEMENT

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Arthrodesis of the knee is sometimes needed for failed total knee replacement, but fusion can be difficult to obtain. We describe a method of arthrodesis that uses the simple, inexpensive, Portsmouth external fixator. Bony union was obtained in all six patients treated with this technique. These results are compared with those obtained by other methods of arthrodesis.

The variety of knee prostheses now available and the steady improvement in the results of total replacement have encouraged surgeons to replace the painful knee earlier than was previously thought wise (Arden 1973; Blundell Jones 1973).

One major problem with knee replacement is the management of failure, especially when complicated by infection. It is generally agreed that arthrodesis is preferable to amputation or to the long-term use of a caliper. Unfortunately, arthrodesis after the removal of a prosthesis has not always been successful. Shea, Wynn Jones and Arden (1981) reported their results after removal of 32 knee prostheses, most of which were in patients with rheumatoid arthritis; the principal indication for removal was infection. Three patients simply had the prosthesis removed, but arthrodesis was attempted in 29 knees with bony union being achieved in only five. In the remaining 24, fibrous ankylosis was obtained; 19 of these required external support with a caliper. Each patient spent an average of five months in hospital as a result of complications. Other orthopaedic centres have confirmed the difficulty in obtaining sound fusion (Phillips 1973; Deburge and Guepar 1976).

Successful arthrodesis after total knee replacement depends on the type of prosthetic components used, for these determine the volume and strength of the remaining bone; complete removal of cement and dead bone, the extent of any infection, and the accuracy and rigidity of fixation are also important. Walldius (1960) reported fusion in all five of his patients, and Blundell Jones (1970) in all eight of his undergoing arthrodesis after removal of the Walldius uncemented hinge prosthesis because of infection. Such satisfactory rates of fusion are rare after removal of cemented prostheses of modern design, although Skolnick et al. (1976) reported union in all 15 patients requiring removal in a series of 500 polycentric knee replacements (but they did not describe the technique they used).

Hagemann, Woods and Tullos (1978) reported 17 cases of failed knee replacement treated by various methods of compression arthrodesis; of the 14 cases they were able to follow-up, only 9 had obtained sound union. They considered that the use of double clamps and good bone contact were important factors in successful fusion.

We have found that two strong external fixation devices of the type used for tibial fractures (Edge and Denham 1981), with multiple transfixed pins held by acrylic cement, are effective in obtaining solid fusion after failed knee replacement. This method has been successful in a small series and has reduced both the time the patients spent in hospital and the period of their disability.

MATERIAL AND METHODS

Information relating to arthrodesis after failed total knee replacement was collected from four orthopaedic centres; in each case the type of prosthesis removed, the presence of infection, the method of arthrodesis and the results were recorded. These results were compared with those of six patients whose knees we had arthrodesed using the Portsmouth external fixator; we describe this method of arthrodesis in detail.

The operation. The long anterior incision in the skin is similar to that used for the original joint replacement. A cruciate incision is made in the tendinous tissue over the patella and the four flaps reflected to allow patellectomy. The patella is retained for use as a graft. The collateral ligaments are divided and the knee is flexed to a right angle. The components of the prosthesis are exposed and removed with care so as to avoid further damage to the remaining cancellous bone of the condyles. Removal of cement from the femur requires the use of fine chisels, gouges, a flexible light and a sucker; the cement should be removed in small fragments. When all the foreign
material, fibrous tissue and dead bone has been removed, the direction and position of the saw cuts are planned to give maximal contact of cancellous bone with the knee in good position. (The knee should be arthrodesed in almost full extension for there is usually significant loss of bone and flexion would shorten the leg even more.) The soft tissues are then protected before thin slivers of bone are cut from the ends of the femur and tibia (a broad-bladed amputation-saw is preferred for this). Viable fragments of cancellous bone obtained from the femur, tibia and patella are cleared of cortical bone and of fibrous and necrotic tissue; these cancellous fragments are used as grafts to fill the defects in the ends of the long bones.

The flat, raw surfaces of the knee are held in a trial reduction; this will show if further bone resection is needed to give correct alignment. The points of entry and directions of the pins are planned. These positions are not critical with the Portsmouth external fixator because cement is used to hold the carriages and the pins together. The pins, therefore, can be placed in convenient positions where the bone is strongest and where the skin is of good quality; care is taken to avoid neurovascular structures. The position of reduction should not be held while the pins are being inserted; in this way damage to the porotic cancellous bone can usually be avoided. We advise the use of five or six long (6 mm) unthreaded transfixion pins. When these have been inserted, the surgeon holds the limb in the correct position for arthrodesis with maximal bone contact. The assistant cements the pins to the four carriages of the two Portsmouth bars (Figs 1 to 3). When the cement has set, compression can be applied.

The advantages of this method are that perfect reduction can be obtained easily, the raw surfaces can be pressed together to improve stability, and all six pins are loaded equally so that the tendency to cut through bone is reduced.

An uninfected wound may be closed in layers with suction drainage. An infected knee should be left open and if skin grafting or secondary suture is needed, this can be done later when the infection has settled; appropriate antibiotics should be continued. A plaster backslab is not necessary, and early physiotherapy is advised.
Convalescence is usually uncomplicated, although the wound may take a few weeks to heal completely. The patient can sit out of bed with the leg supported after three days and is able to stand and walk with a frame after about 10 days (Figs 4 and 5). A shoe-raise may be needed and elbow-crutches can be used once balance has been regained. The patient is encouraged to walk bearing full weight as soon as possible as activity increases blood flow to the limb, encouraging union and consolidation.

Compression at the arthrodesis is maintained by tightening the nuts on the carriage bars at regular intervals so that the pins remain slightly bowed. The arthrodesis may be solid in 12 weeks but if a large volume of cancellous bone has been lost and the contact area is small, the bars and pins may have to be retained longer. If the Mark 2 threaded Denham bars have been used for arthrodesis, the progress of union can be assessed: these bars can be removed from the carriages for a trial period leaving the pins and cement in place; if all is well, the pins can be removed but if there is any doubt about union, the bars can be reattached and compression re-established for a further period. With accurate reduction and fixation with two Portsmouth bars, “six pins for six months” should ensure success even when a large volume of the tibiofemoral condyles has been lost.

Table I shows that the success of the fusion operation in different centres varied from 31% to 100% and that the different techniques used for arthrodesis have an important influence upon the results.

Table I. Results of arthrodesis from four orthopaedic centres

<table>
<thead>
<tr>
<th>Centre</th>
<th>Number of knee replacements</th>
<th>Number of arthrodeses</th>
<th>Number with solid fusion</th>
<th>Method of arthrodesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>2</td>
<td>2</td>
<td>Portsmouth</td>
</tr>
<tr>
<td>2</td>
<td>151</td>
<td>16</td>
<td>7</td>
<td>Charnley</td>
</tr>
<tr>
<td>3</td>
<td>176</td>
<td>16</td>
<td>5</td>
<td>Day</td>
</tr>
<tr>
<td>4</td>
<td>167</td>
<td>4</td>
<td>4</td>
<td>Portsmouth</td>
</tr>
<tr>
<td>Total</td>
<td>554</td>
<td>38</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

In a retrospective study using material from four orthopaedic centres, 554 knee replacements were reviewed; 38 had been subjected to arthrodesis after failure and removal of the prosthesis. In 31 of these, the Charnley technique of arthrodesis was used, in 6 the Portsmouth external fixator and in 1 the Day external frame. One patient who was treated in a plaster cylinder without external fixation failed to unite despite weight-bearing, and amputation was performed. One patient refused arthrodesis and a fibrous ankylosis supported by a caliper was accepted. Tables I to III summarise these results.

Table II shows that the Charnley compression arthrodesis was successful in 39% of cases irrespective of the type of prosthesis removed, the use of cement, or the presence of infection. The Portsmouth external fixators were successful in all six cases and the Day frame produced bony fusion in the one case in which it was used.
Table III lists the type of replacement prosthesis and the method used to secure fusion. Results suggest that it is easier to obtain fusion after removal of an uncemented prosthesis such as the Walldius replacement.

Table II. Results of three different types of arthrodesis

<table>
<thead>
<tr>
<th>Method of arthrodesis</th>
<th>Number attempted</th>
<th>Successful fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charnley</td>
<td>31</td>
<td>12/31 (39%)</td>
</tr>
<tr>
<td>Portsmouth</td>
<td>6</td>
<td>6/6 (100%)</td>
</tr>
<tr>
<td>Day</td>
<td>1</td>
<td>1/1 (100%)</td>
</tr>
</tbody>
</table>

The Denham knee replacement preserves a substantial amount of cancellous bone, and after removal there have been no problems with fusion using the Portsmouth compression technique. The Attenborough, Freeman–Swanson and Shiers designs all seemed to do badly when fusion was attempted by the Charnley method; but fusion of one Freeman–Swanson knee using the Day external fixator was successful. Similarly, after removal of one of the Shiers prostheses, fusion was achieved using a Portsmouth fixator.

Table IV lists the results in the six knees which we arthrodesed using the Portsmouth external fixator bars. Fusion was delayed initially in Patients 1 and 5 because the number of pins used and the period of compression were inadequate; but all knees fused satisfactorily after good fixation for between four and six months.

Infection is said to be an important factor in success or failure of arthrodesis after removal of a knee prosthesis. In the cases we studied, infection did not appear to influence the result; the type of prosthesis and the method of fusion were much more important. We believe that infection does not inhibit sound fusion if the method of arthrodesis is satisfactory: all the cases arthrodesed using the Portsmouth external fixator were infected and yet they all fused.

Table IV. Results of arthrodeses using Portsmouth external fixation in our six patients whose total knee replacements had failed due to infection

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Indication for TKR</th>
<th>Date of TKR</th>
<th>Infecting organisms</th>
<th>Date of removal and arthrodesis</th>
<th>Fusion obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62</td>
<td>F</td>
<td>OA</td>
<td>1975</td>
<td>Unknown</td>
<td>March 1979</td>
<td>At 10 months. At first too few pins were used, but at the third attempt sound union was achieved</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>F</td>
<td>RA</td>
<td>June 1976</td>
<td>Staphylococcus aureus</td>
<td>March 1980</td>
<td>At 3 months</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>F</td>
<td>RA</td>
<td>July 1977</td>
<td>Staphylococcus, Streptococcus, Enterococcus</td>
<td>August 1978</td>
<td>At 2 months</td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>M</td>
<td>RA</td>
<td>August 1978</td>
<td>Pseudomonas</td>
<td>October 1978</td>
<td>At 2 months</td>
</tr>
<tr>
<td>5</td>
<td>47</td>
<td>F</td>
<td>RA</td>
<td>October 1979</td>
<td>Pseudomonas</td>
<td>February 1980</td>
<td>At 8 months. A second attempt at re-compression after 4 months gave a good final result</td>
</tr>
<tr>
<td>6</td>
<td>73</td>
<td>M</td>
<td>OA</td>
<td>March 1980</td>
<td>Pseudomonas, Coliforms</td>
<td>August 1980</td>
<td>At 4 months</td>
</tr>
</tbody>
</table>

TKR, total knee replacement; OA, osteoarthritis; RA, rheumatoid arthritis

DISCUSSION

Thirty-eight (7%) of the 554 knee replacements we reviewed required removal of the prosthesis and fusion. It seems likely that arthrodesis as a salvage procedure may be needed more often in the future. Bony union can be obtained in a number of ways, but the most successful techniques require accurate reduction and secure fixation with compression (Morris and Mosiman 1951). The compression technique was first introduced by Key in 1932, refined by Charnley in 1948 and 1952, and more recently extended by using multiple pins and various fixators (Phillips and Mears 1980; Brooker and Hansen 1981). Green, Parkes and Stinchfield (1967) reviewed several different techniques with and without fixation, compression, sliding and fibular grafts, Rush nails, and intramedullary rods. They reported good results with all the recognised techniques where these were used for
uncomplicated primary arthrodesis. Other authors have
found that operation for failed total knee replacement
generally gave poor results (Blundell Jones 1973; Phillips
1973; Deburge and Guepar 1976; Vahvanen 1979; Shea

Fidler (1983) has reported the use of Charnley
compression clamps combined with a Wagner compres-
sion apparatus and has illustrated four successful cases.
His technique requires two separate pieces of apparatus,
and seems to have two drawbacks: first, it seems difficult
to use in heavily infected cases where the skin needs to
be left open before secondary closure; and secondly, full
weight-bearing by the patient is not allowed.

Arthrodesis after total knee replacement is even
more difficult to obtain when the arthroplasty and the
cement have sacrificed or damaged large volumes of
cancellous bone. Likewise movement of a loose prosthesis
destroyes cancellous and sometimes cortical bone, leaving
less for arthrodesis. Fracture of the bone surrounding the
prosthesis will reduce bone stock and sometimes makes
shortening of the bone necessary before attempts are
made to match the femur and the tibia. It is important to
excise the wound in the manner used for infected
compound fractures. All dead material should be re-
moved, cavities drained and important tissues protected;
the correct antibiotics should be used locally and
systemically, and the wound packed and allowed to
granulate.

We believe that the method of external fixation used
in Portsmouth has the following advantages: (1) the pins
can be inserted in safe positions at the most convenient
angles, through the best skin, and into the strongest bone
without due concern for their exact alignment; (2)
extremely accurate reduction is easily obtained by the
surgeon who holds the reduction while his assistant
cements the pins to the carriages; (3) equal compressive
force can be exerted by all pins and maintained until
union has taken place; (4) the apparatus is cost effective
allowing each orthopaedic unit to keep several sets of
equipment; and (5) the fixator is strong and light enough
to allow early mobilisation and discharge from hospital.

This review suggests that uncemented knee prostheses and those which require the removal of
minimal bone during implantation are easier to ar-
throdesis after failure. Infection does not prevent fusion
if accurate reduction is followed by secure fixation and
continued compression with multiple pins. The use of
Charnley compression clamps is not as effective as the
multiple pin external fixator in achieving fusion in
difficult cases.

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REFERENCES