KNEE REPLACEMENT
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INTRODUCTION

Every joint replacement will eventually fail if it is used enough. This is due to either wear of the (Polyethylene) components, or to loosening of the components' fixation to the skeleton, and we now know that the former can accelerate the latter.1 This pessimistic statement of fact was well understood by Sir John Charnley when he introduced his new hip joint replacement in the early 1960s; he insisted that it was only used in patients over the age of 68. His thinking changed within ten years, and Wrightington Hospital now have 10-15 year results for hip replacements put in to patients under the age of 30.2 Because the public know that the short and medium term results of hip replacement are so dramatically good, patients of whatever age with disabling hip arthritis plead for their operation despite the caution outlined above, which is given to all the relatively young and active ones.

Arthritis of the knee is more common than arthritis of the hip, although not quite as disabling, in that if there is stiffness it is more disabling in a hip than a knee. When the public becomes aware of the success of knee replacements, (as it did for the hip in the 1970s) the demand will probably increase to a greater level. Some hospitals in the UK already perform as many knee as hip replacements, and in Lancaster the percentage of knees replaced has risen from 11% of the total number of joints replaced in 1989, to 29% in 1990 and 34% in 1991.

The time has therefore come to ask the following questions: Is knee replacement as good as hip replacement in the short, and long, terms? What are the relative costs? What are the principles involved? Is there a difference in rehabilitation between hip and knee replacement? Which patients will benefit? Can any deformity and/or ligamentous laxity be corrected? What are the complications? What can be done if things go wrong? Is there any place for single compartment replacement (medial or lateral only) in the younger patient with limited arthritis?

HISTORY OF DESIGN AND PRINCIPLES

The modern knee replacement is as successful in relieving the pain of arthritis as hip replacement is for the hip. The recovery of function is also as good, although the level of activity to be expected afterwards is less (see Rehabilitation). It has just taken longer to work out the best design and principles involved for the knee. Reasonable hip replacements were around before Charnley developed his model. His popularisation of the operation was mainly as a consequence of his introduction of the use of acrylic cement, which enabled secure fixation of the components to the skeleton.

The earliest knees were hinges, which appeared in the early 1950s. They tended to loosen due to a "pistoning" effect on bending, and required significant bone removal. They were totally "constrained", having no play between the tibial and femoral components. As the constraint of knee designs has decreased, so have the forces on the bone/cement/component interfaces and therefore so has the tendency to loosen. Modern designs replace the condyles of tibia and femur only (Fig.1), and depend mainly on collateral ligament balance for stability. They are all based on the "Total Condylar" design of Insall and Burstein,3 used since 1974, which in turn was an improvement on Freeman and Swanson's model of 1969. Thus the basic design of virtually all knee replacements currently used has been unchanged for 18 years. This contrasts with hip replacements, about which arguments still occur concerning the best shape, surface texture and material for the femoral stem.

Figure 1. A modern "total-condylar" knee replacement, replacing only the surfaces of tibio-femoral and patello-femoral compartments, (although the latter is missing here), with minimal constraint between the components.
The principles of the operation are simple:-
1. To obtain a straight line between hip, knee and ankle joint centres (mechanical axis).
2. To obtain adequate, and equal tension in medial and lateral collateral ligaments, at least in full extension.
3. To place the tibial component at right angles to the mechanical axis. These three things are technically quite easy to accomplish with correct instrumentation and some experience.

It should perhaps be mentioned here that the use of a thin layer of cement under each component enhances fixation, and as it is easy to remove if necessary, the question of cementless fixation does not arise.

**REHABILITATION AND EARLY RESULTS**

The achievement of good function following knee replacement requires much more effort on the patient’s (and physiotherapist’s) part than following hip replacement, and they must be aware of this. The quadriceps muscle is usually wasted through chronic inhibition by pain, and becomes acutely inhibited along with the hamstrings by postoperative pain. If the operation has been done “by the book”, the collateral ligaments do not slacken through their arc of flexion, and so flexion can be hindered. The theoretical basis of keeping the collateral ligaments taut in flexion is to prevent antero-posterior movement in the flexed position, although function on stairs for example is not impeded if there is such movement. The long-term result of putting a knee in “slack” in flexion have not been studied.

Relief of the arthritic pain is excellent, easily as good as with the hip. The return of function (strength and flexion) is more variable and depends on three main factors: the technique of operation (tight or slack) as discussed; the pre-operative state; and personality, which sometimes appears to change for the worse post-operatively! The pre-operative state is important. Some knees are “tight”, which occurs in most men with osteoarthritis, and some are “slack” especially females and most rheumatoids. The tighter the knee the poorer the pre-operative range of movement, the worse will be the post-operative movement. I generally aim for the patient to achieve a 90 degree bend before hospital discharge, as below this angle, rising from chairs, access to vehicles, and managing stairs prove difficult. Audit of 90 of my patients here has shown that only 45% obtain 90 degrees of flexion by discharge, (but most are very near) and this improves to 82% by three months and 90% by six months. Seven of the 90 patients could not flex to 60 degrees pre-operatively, and all managed 90 degrees afterwards, the minimum improvement being 35 degrees.

The use of continuous passive motion machine helps some patients regain flexion more quickly, but is no substitute for effort as it does nothing for quadriceps or hamstring strength.

As mentioned, the level of activity expected after knee replacement is less than expected after hip replacement. The knee is much easier to damage than the hip, as it is on the end of two long levers and is only free to move in one main direction, whereas the hip is free to move in all directions. Thus tennis is feasible (although unwise) following hip replacement, but less feasible and certainly more unwise following knee replacement. Serious cycling is not recommended at all, and as some people can cycle all day with destroyed knees but cannot walk a hundred yards, one has to caution cyclists about knee replacement. Golf is permitted following either operation.

For the above reasons the age for consideration of knee replacement in a patient with no other constraints on function, such as other joint involvement, is still higher than for the hip.

Patients nearly always find difficulty in kneeling, due to tenderness over the tuberosity and/or from a reluctance to stress their replaced and “foreign” patello-femoral joint, the latter being a healthy, protective feeling in my opinion. Gardening is thus made difficult.

**LONGEVITY**

The 15-year overall success rate for the basic “Total Condylar” replacement of Insall and Burstein has recently been reported as 90.5%, with a ten year rate for a slightly modified type of 97.5%. It is important to note that the success rate for the original “Total Condylar” remained the same from 10 to 15 years post insertion. One might expect results to be that good in a “Hospital for Special Surgery”, but results from a District General Hospital nearer home, Derby, show a 96% cumulative survival at 11 years, with the biggest single cause of failure being infection and not loosening.

This compares with a 15-year survival possibility for a Charnley hip of 89% in a North American Centre, which reports a linear rather than exponential increases of failure with time. It is unfortunate that Wrightington hospital, as Charnley’s original centre and therefore with the longest follow-up of his hips, do not publish survivorship figures. I have made direct enquiry about such figures and have been unsuccessful. However, one article indirectly gives a 6% revision rate for survivors over a 15 to 21 year period.

One can interpret the above facts almost anyway one likes, but I take them to mean that knee replacements last at least as long as hip replacements. Obviously the success rate will vary for both operations between different hospitals, as skills and facilities do differ, but proper audit of results has only just started in most places and will take at least 12 years to mean anything. It is self-evident that such audit is meaningless unless every patient is followed up, which means an increase in our current outpatient workload. If patients are to be treated following contracting with distant places, lifelong follow-up has to be part of the contract, otherwise true comparisons of hospitals’ results will not be possible.

**COST AND VALUE**

The cost of a knee replacement, like everything else, has yet to be accurately determined. It is about £5000 for the NHS. Of which £800 or so is for the parts, which is about twice that of a hip. On average the patients stay in hospital two days longer than for a hip. If the cost of a day in hospital is £200, which is almost certainly an overestimate, then a knee costs about £800 (16%), more than a hip.

From the above early results and longevity sections it can be seen that for the treatment of arthritic joints a knee replacement has an equal value to hip replacement. The latter procedure is one of the few having a large waiting list for which costs per quality adjusted life year (QALY) have been
calculated, and it comes “near the top of the league.” Therefore when or if such league table is made, replacement of the knee will not be far behind that of the hip.

WHICH PATIENTS?

Almost any patient with disabling arthritis can be considered. Youth without any constraint (no other joints involved), is a serious relative contraindication as discussed. Otherwise poor mobility due to causes other than arthritis, (e.g. senility, general frailty) are the main contraindications. Medical unfitness is not an absolute bar. I let the patient decide, after carefully explaining the risk of mortality. This starts at about 1% for all comers (see below), and would be 5% “1 in 20” or higher in poor risk cases. It is very unusual for this to put off patients with pain at rest after or 100 yards of hobbling, and “indigestion” from their latest NSAID.

Adverse psycho-social factors do not play a large part in obtaining pain relief following knee replacement, as they do following back surgery, for example. They can, however, affect the functional recovery.

WHICH KNEES?

Laxity of deformed arthritic knees, even if gross, is not usually a contraindication. For example, in a varus knee with mainly medial cartilage and bone loss, there may be apparent lateral laxity seen as a varus “thrust” on weight bearing as the medial surfaces approximate more than normally, with corresponding medial laxity on static testing. These laxities are taken up by “jacking out” with the prosthesis, after a special tensing device has ascertained how much bone needs to be cut to do this, and by how much the medial ligament (in this example) needs to be released to balance the two sides. Pre-operative antero-posterior laxity is not important, as this is taken up by correct tensioning of the collateral ligaments in extension and flexion. In fact I routinely cut the posterior cruciate ligament (the anterior cruciate always has to be cut) in order to do this part of the operation correctly.

Bone loss with deformity is not a contraindication. If it is severe, the deficit can be made up with cement, metal wedges or bone graft, and figures 2-7 show a local example of bone grafting (graft taken from bone normally cut to do this operation) to make bilateral severe medial tibial defects.

The only absolute contraindications are: an arthrodesed (fused) knee effected by surgical but not spontaneous means; and a knee below a chronically (congenitally) dislocated and apparently painless hip. The latter reason constitutes a seemingly illogical trap into which I have fallen in Lancaster, giving me one of my two failures to relieve pain out of a total of 102 knees.

COMPLICATIONS

The most serious and frequent is venous thromboembolism. The national figures suggest there is a 1 per cent mortality from this cause, which is about the same for the hip. Obesity, varicose veins, smoking and previous episodes

Figure 2. Local patient with bilateral varus knees, 1990.

Figure 3. X-ray of the left knee in Fig. 2, showing medial tibial bone loss.
Figure 4. X-ray of the left knee in Figs. 2 & 3, post-operatively, showing medial tibial bone graft (from femoral cuts at operation) held with horizontal screws.

Figure 5. X-ray of the right knee in Fig. 2, showing similar medial tibial bone loss to the left.

Figure 6. X-ray of the right knee in Figs. 2 & 5, post-operatively, showing medial tibial bone graft held with vertical screw.

Figure 7. Same patient as Fig. 2, following bilateral knee replacements, March 1992. Walking unaided, manages stairs nearly normally.
of deep vein thrombosis increase the risk. There is some recent evidence that low molecular weight heparin may reduce the incidence and mortality, and could be our best prophylaxis.

Infection is a constant threat, both early, ie implanted at the time of operation (risk about 1 per cent or less nationally and locally), and late from distant sources. We have decided locally that prophylaxis for routine catheterisation or dental extraction is not required after the early stages, but certainly any significant bacteraemia should be promptly treated in any patient with a joint prosthesis, to obviate this ultimately devastating complication. It is devastating because the only way to “cure” an infected replacement is by removal and debridement; antibiotics will suppress but not eradicate such infection. I say “ultimately” because the vast majority of infections are caused by otherwise totally harmless organisms, which survive around the foreign materials and cement, the latter being an active inhibitor of normal phagocytic activity. A joint thus infected is a “time bomb”, and can be largely asymptomatic for a long time. The effects of such chronic infection take months or more usually years, depending on the pathogenicity, to cause loosening and hence symptoms. Acute type abscess formation occurs in a few cases only.

Loosening has been dealt with, but patello-femoral complications merit some comment. One in two orthopaedic surgeons replace the articular surface of the patella, believing that cartilage/bone bearing against metal will eventually give pain, the figure quoted being between 15 and 50 per cent. I am a believer. The other half deny these figures and quote high rates of patellar fracture, component fracture, wear and loosening after replacement. Everyone agrees that correction of any maltracking at operation is essential.

**SALVAGE**

Revision surgery for aseptic or septic failure is as good an option as for the hip. It is also technically easier, unless long stems have been used with cement pushed up the medullary canals of tibia and femur, as occurred with the old hinged prostheses.

It is safer to perform revision for sepsis in two stages: removing the infected parts and thorough debridement; followed by continuous, appropriate antibiotics and the use of a knee brace and crutches, until reimplantation when all signs of infection (especially a raised ESR) have gone. The modern final salvage for a failed knee is an arthrodesis. Amputation for failure is a thing of the past; I have never seen or heard of one, with the exception of failure due to vascular deficiency.

**UNI-COMPARTMENTAL REPLACEMENT**

There is a current fashion for this supposedly simpler operation, which replaces just one of the tibio-femoral compartments. After such an operation the joint is said to feel more “natural” than after a total replacement.

I am not in favour of this operation for three reasons. Firstly, although arthritis is often severe in one compartment only, I have never seen a knee in which it was confined entirely to one compartment, which makes me worry about the quality of pain relief in the long-term. Studies of the long-term (only 12 years) results of such knees come from countries which may have different criteria for operation than here, and I remain cautious. Secondly, it is technically a more difficult operation to “get right”, with some disagreement on the technique, the Oxford School disagreeing with the North Americans on whether to restore the mechanical axis or not in every case, and how to balance ligament tension. Thirdly, we know what happens to this kind of knee replacement, as the use of two such components to replace both sides of the tibio-femoral joint constituted the “second generation” of replacement after hinges. They failed mainly because of lack of skeletal support, especially on the tibial side. Although an 82% 11-year survival rate of unicompartmental knees has been reported, some results are much worse, and this probably reflects how difficult it is to “get right”.

I still prefer osteotomies, to realign the mechanical axis, as the surgical option for mainly uni-compartmental tibio-femoral osteoarthritis in the patient under 60 years. Patellectomy is the surgical option for mainly patello-femoral osteoarthritis, as total replacement is not contraindicated subsequently.

**CONCLUSION**

Knee replacement is as good as hip replacement in relieving the pain and disability of arthritis and lasts as long (or as short!). It costs about 16% more and requires more effort in rehabilitation. The main complications are similar. Demand for the procedure will increase to equal or surpass that for hip replacement, and this is starting to happen locally. Because all will fail if used enough, and technique is important for longevity, lifetime follow-up for audit is required.

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<thead>
<tr>
<th>HIP vs KNEE REPLACEMENT</th>
<th><strong>Summary of differences</strong></th>
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<tbody>
<tr>
<td>Relief of pain and disability</td>
<td>Equal</td>
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<tr>
<td>Ten-15 year survival and results</td>
<td>Similar</td>
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<tr>
<td>Rehabilitation inpatient</td>
<td>Longer (2 days) harder work.</td>
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<tr>
<td>Age limit</td>
<td>Generally older</td>
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<tr>
<td>Activity expected subsequently</td>
<td>Generally less</td>
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<tr>
<td>Complications</td>
<td>Similar Except:</td>
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<tr>
<td>Dislocation up to 5%</td>
<td>Dislocation extremely rare.</td>
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<tr>
<td>Cost</td>
<td>£4200? £5000?</td>
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REFERENCES


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LEESE BEQUEST

A sum of money in the region of £2000 per annum is available from the Leese Bequest to further medical education pertaining to diseases of the chest and heart.

In the recent past this money has been used to purchase:

BOOKS and JOURNALS on respiratory and cardiac medicine

EQUIPMENT for the PGMC

and to fund:

TRAVELLING SCHOLARSHIPS to attend meetings or pursue research relevant to diseases of the heart and lung.

LEESE MEMORIAL LECTURES

If you have any suggestions as to how the money may be spent in the coming year, please contact:

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