MEDICAL PRACTICE

*Bone and Joint Diseases***Current state of total joint replacement**

M A R FREEMAN

British Medical Journal, 1976, 2, 1301-1304**Prostheses available****HIP**

The hip joint was the first to be totally replaced. The procedure was first carried out in Britain by McKee of Norwich, who used a prosthesis of which both the acetabular and femoral components were of cobalt-chrome and were fixed to the skeleton without using polymethylmethacrylate cement. This technique proved unsuccessful—as in the long run has the combination of cobalt-chrome against cobalt-chrome. In the late 1960s Charnley introduced the use of polymethylmethacrylate cement to bond prosthetic components to the skeleton. This technique has stood the test of time and is almost universally used as the bonding technique today. Charnley's first total replacement of the hip used stainless steel for the femoral component and teflon for the acetabular component. The wear-rate of Teflon proved unacceptably high, and in 1962 Charnley switched to using ultra-high molecular weight polyethylene. This material has proved satisfactory in clinical use, and it is now almost universally used as one of the two components of total joint replacement prostheses.

There are currently many slightly different prostheses composed of an implantable metal alloy for the femoral component and ultra-high molecular weight polyethylene for the acetabulum. The various prostheses and the procedures by which they are inserted have certain advantages and disadvantages, but all of these are relatively minor and do not broadly affect the clinical outcome. The choice between one prosthesis and another and one surgical approach and another is very much a matter of

surgical training and habit. Broadly, replacement of the hip should now provide a comfortable, mobile joint on which a patient can carry out all everyday activities including non-contact sports, such as golf, without pain. The actual range of movement obtained depends to some extent on the range pre-operatively while obviously the patient's exercise capacity depends on various factors other than the affected hip. In the absence of preoperative local infection, almost every hip can be replaced regardless of the nature of the original condition.

The only important disadvantage to the currently available prostheses for total hip replacement is that they transgress the general principle of surgery that healthy tissue should not be sacrificed. On the acetabular side this principle is met since relatively little bone from the pelvis has to be removed. On the femoral side, however, the whole of the femoral head and neck are removed, and the prosthesis is attached via an intermedullary stem to the proximal third of the femoral shaft. Attachment in this way means that not only are the head and neck sacrificed, but that the upper third of the femur is prejudiced should the prosthesis become infected or need to be removed for some other reason. In Britain and other countries in the past few years prostheses have been developed that replace the hip to give clinical results that appear similar to those of conventional prostheses but without sacrifice of bone on the femoral side; such prostheses simply resurface the head of the femur. It is as yet too early to say whether they will function as satisfactorily in the long term as do the conventional implants.

KNEE

The knee has been replaced for about as long as has the hip. The initial prostheses took the form of hinges (designed by Shiers in Britain, Waldius in Scandinavia, and Young in the USA). These devices were not, however, widely used since, firstly, some of them sacrificed unacceptable amounts of healthy tissue making arthrodesis in the event of failure difficult, and, secondly, the early results were not encouraging.

Department of Mechanical Engineering, Imperial College of Science and Technology, London SW7 2BX

M A R FREEMAN, MD, FRCS, consultant orthopaedic surgeon

In the early 'seventies mechanically unlinked devices replacing the surfaces of the knee and composed of metal against ultrahigh molecular weight polyethylene were developed in several centres, and since then there has been an explosion of development. Four kinds of device are now available: hinges, the modern generation being lined with ultra-high molecular weight polyethylene and sometimes allowing a little rotational movement of the tibia as well as flexion and extension; devices that replace both the condyles and the tissues in the midline of the knee but which, although not linked by an axle in the same way as is a hinge, are nevertheless linked to prevent some or all of the unwanted movements (abduction, adduction, or rotation of the knee); devices that (like the second category) replace the whole width of the knee but which are not linked mechanically; and, finally, devices that simply replace the condyles. Few of these prostheses have been in clinical use for five years, and there is a convention in orthopaedic publishing that full descriptions of clinical results should await a five-year follow-up. Thus at the moment it is impossible to compare the clinical outcome of these different devices or indeed to say in other than general terms what the results may be.

Generally, however, it may be said, firstly, that devices in the first three categories may be used to replace severely damaged as well as mildly damaged knees, but that those in the first two categories tend to intrude into or remove healthy bone and hence transgress the general principle of not sacrificing healthy tissue. Secondly, although the quality of the result after knee replacement is not as good as that after hip replacement, most procedures now offer a 90-95% chance of pain relief save, possibly, on stairs; an ability to walk for an hour or more and carry out the activities of a sedentary life but not to walk across uneven ground or engage in golf as may be done after hip replacement; and a range of movement up to about 90°. Thirdly, the failure rate is not known exactly but is currently almost certainly higher than that for hip replacement. Although they may fail, the modern generation of prostheses can be revised or converted to an arthrodesis. These results are improving, and it seems reasonable to hope that in five years' time the results may match those obtained with hip replacement 10 years after its inception.

THE ANKLE

The ankle was first replaced four years ago by two groups working independently in Britain and Germany. Since then several different implants have been developed in Continental Europe and the USA. It is still too early to say whether this operation offers any advantages over arthrodesis. Even if it does the number of patients needing the procedure will be small. At the moment it would appear that a comfortable mobile ankle can be produced but how reliably this can be done and how long the results will last it is impossible to say.

OTHER JOINTS OF THE FOOT

None of the other joints of the foot have been replaced on a big scale, and indeed the need for their replacement is slight. The talonavicular joint has been replaced experimentally as also has the metatarsophalangeal joint of the great toe. The latter joint is often the seat of degenerative changes but almost always as part of a degenerative forefoot so that the arguments for its replacement are marginal. In any event the well-known procedures such as Keller's operation offer a satisfactory, if imperfect, solution to the problem in the elderly.

SHOULDER

Several different prostheses are available for the shoulder, but none of them have been used on a large scale (because arthritis of the shoulder is uncommon), and there is insufficient published

information to make any general statements possible. The principal problem has been attachment of the glenoid component, but several prostheses are now available (or will shortly become so) that may have solved this problem.

ELBOW

As at the shoulder, few elbows need replacing; the principal indication is in rheumatoid arthritis when damage to other joints makes pain, instability, and stiffness at the elbow particularly crippling. The osteoarthrotic elbow is rare, occurring virtually only after trauma, and although stiffness is disabling it is not a disaster if the other arm is intact and full movement is retained at the ipsilateral wrist and shoulder. Furthermore, patients with monarticular osteoarthritis of the elbow tend to seek socially unrestricted function from the elbow after replacement, and no device currently available can offer this. Indeed, there is no device that is clearly a satisfactory solution even for the rheumatoid elbow.

Earlier implants taking the form of hinges attached to the ulna and humerus with intramedullary stems were associated with an unacceptably high incidence of loosening and have now been abandoned. (When they became loose they were difficult to repair, substantial parts of the humerus having been removed in the original procedure.) A new generation of elbow replacements in which only the surfaces of the humeroulna joint are replaced are under study, but they have not yet been used on a widespread clinical scale.

WRIST

Wrist replacement in Britain is rarely carried out. Two replacements for the wrist have, however, been developed in Switzerland and are available should surgeons wish to use them. In practice, arthrodesis of the radiocarpal joint leaves a near-negligible disability so that there would seem to be little indication for this procedure.

Pronation and supination occur at the superior and inferior radioulnar joints. Strictly, neither the prostheses available for the elbow nor for the wrist deal with these articulations, but either or both may be treated by excision arthroplasty.

HAND

The second to fifth metacarpophalangeal joints and the proximal interphalangeal joints have been replaceable for some years. The first implants used were rigidly linked hinges, but these proved unsatisfactory since they tended to loosen. Implants made of silastic that were sufficiently flexible to act as hinges were then introduced, but joints replaced in this way have not functioned entirely satisfactorily. Other implants based on somewhat similar principles have also proved relatively unsuccessful.

It is not entirely clear to what extent failure has been due to the unsatisfactory design of the implants themselves and to what extent it has been due to the fact that the pathological process for which this procedure is usually required, rheumatoid arthritis, includes substantial damage to the extra-articular structures of the hand as well as the articulations themselves. In so far as the latter may be responsible for failure, possibly no prosthesis will offer entirely satisfactory function. On the other hand efforts are still continuing to produce better prostheses, and some of the new unlinked prostheses, based on the same principles as have proved successful at the knee, may solve this problem.

Indications for surgery

The indication for surgery depends on the state of development of replacement procedures for the different joints. Thus at

the hip the indication is simple; it is merely that the patient is sufficiently disabled by arthritis of the hip for him to feel that he would prefer to undergo major surgery rather than endure his disability. Since few hips are technically unreplaceable, the decision hardly depends on the physical signs nor on the x-ray picture.

The indication for surgery is the same for the knee as for the hip in those centres where this operation has been carried out for several years. Knee replacement, however, is not yet as widely available as is hip replacement so that some surgeons reserve the operation only for certain categories of knee disease. Obviously the patient cannot be offered satisfactory function postoperatively with the same confidence before knee replacement as he can before hip replacement.

Replacement of the ankle should be considered only if the patient has already agreed to arthrodesis. If this is the case arthroplasty may be offered as an avowedly experimental procedure which, if it fails, can at any rate theoretically be converted to arthrodesis. If the patient declines to accept arthrodesis it is unwise to subject him to the hazards of ankle replacement. A similar set of arguments apply for the shoulder save that in rheumatoid arthritis the argument for arthrodesis is less strong. At the elbow replacement surgery should be considered only if the patient's disability is overwhelming, a condition that arises only in rheumatoid arthritis. At the wrist it is to be doubted whether at the moment there is an indication for replacement. Replacing the joints of the hand is controversial, some surgeons using replacement only for severely damaged joints while others think that by this stage in the disease no procedure is likely to improve function and that replacement (if it is to offer anything) should be used earlier.

Hazards

VENOUS THROMBOSIS

Foremost among the hazards of total joint replacement (at least at the hip) is venous thrombosis leading to pulmonary embolism and death. Considerable effort has been expended in the past few years in an attempt to prevent venous thrombosis after hip surgery. So far no prophylactic regimen has proved successful, and the peculiar, as yet unexplained, fact has emerged that prophylactic regimens that appear effective in the general surgical context do not offer protection at the hip. It is hoped that this problem will be resolved in the next few years, since this would substantially reduce the risks of this operation. Happily, clinically significant venous thrombosis and pulmonary embolism do not appear to be such a major problem after replacing other joints in the leg and, as might be expected, they are almost non-existent after replacing arm joints.

INFECTION

Three important local complications can mar the clinical results and one of them, sepsis, may ultimately endanger the patient's life if unchecked. Infection proved a major problem in the early days of joint replacement with sepsis rates at the hip of about 7% being reported. Largely because of Charnley's efforts, these rates have been substantially reduced by improving operating technique. Charnley himself has concentrated on using special clothing for the surgeons and special ventilation systems to eliminate airborne contamination. Since there is current controversy as to the usefulness of these measures provided that an optimum surgical technique of a conventional kind is employed (near-zero sepsis rates having been reported in several series of some hundreds of hips operated on conventionally), a multicentre trial of these measures is now being conducted by the Medical Research Council.

Sepsis may show itself not only in the immediate postoperative period but also years after operation. Such late infections are a

rarity in other forms of surgery, although they have been recorded in vascular implant work. They may arise either from the introduction of bacteria at the time of operation or by blood-borne contamination at any time postoperatively. The latter seems to be particularly likely in rheumatoid arthritis, where "spontaneous" bacteraemic septic arthritis is a well-recognised complication. Theoretically the likelihood of later bacteraemic infection would be reduced if prostheses could be made smaller in size since this would reduce the size of the vascular bed touching the prosthesis.

Unfortunately infection is extremely difficult to eradicate if the prosthesis remains in place. This cure often means removing the prosthesis and hence the loss of the functional gain that was hoped for from the procedure. Even after the prosthesis has been removed it may prove difficult to sterilise the bone; if sterilisation fails persistent sinus formation must be faced as a long-term complication.

LOOSENING OF COMPONENTS

The freedom from pain and satisfactory function that patients have come to expect from joint replacement are achieved only so long as the components remain firmly anchored to the skeleton. The causes of loosening are numerous and are technical as well as biological. It is impossible to give an overall figure for the incidence of loosening since this depends so much upon technical factors, the prosthesis in question, the joint in question, the nature of the patients' activity, etc. Generally, however, a loosening rate of over 5% would be regarded as unacceptable. Loose prostheses can be revised by removing the component and recementing it to the skeleton; a procedure easy to describe but not always so easy to execute.

WEAR DEBRIS

Finally, the prosthesis may wear out or generate wear debris that is biologically dangerous. Currently it appears that the wear debris from metal-*v*-polyethylene prostheses—that is, mainly particulate polyethylene—is biologically innocuous while the wear rate of polyethylene (at least at the hip) is such as to suggest a wear life for most modern prostheses of about 50 years.

Magnitude of the clinical problem

Paradoxically, the clinical success of joint replacement, particularly at the hip, has sown the seeds of its major problem. It has been calculated that merely to cope with the demands for hip replacement generated by an aging population would need the construction of a new 300-bedded hospital every year for the population of Britain alone. As joint replacement technology advances from the hip to other joints it becomes impossible to estimate the number of patients who might benefit from this procedure. Clearly if beds for replacement of other joints are added to those needed for the hip, Britain (and indeed other countries) face a completely impossible problem: there is no prospect that all the patients needing joint replacement will in fact be able to have their joints replaced in the foreseeable future. This in turn is going to raise difficult questions of "rationing." Is it right that the severely crippled patient with rheumatoid arthritis should have six joints replaced in order to remain just independent if this means that six otherwise healthy patients with monarticular arthrosis in one hip are denied surgery? Is it right to replace the hip of a patient of 75 if this means that a man of 60 is denied surgery? Currently these questions are neither faced nor answered, but the magnitude of the problem is shown by the length of the surgical waiting lists for these procedures; waiting lists for admission up to five years in length are by no means unknown in Britain today.

A particular aspect of the problem posed by the overwhelming number of joints needing replacement is that of which surgeon should carry out the operation. Joint replacement procedures are not always technically simple, and it is reasonable to think that the failure rate expressed as a percentage of all joints operated on would be lower if the operations were to be confined to surgeons specialising in these procedures. On the other hand, if this were to be done the number of operations performed in the National Health Service annually would fall. If as happens at present all surgeons (including registrars at the start of their training in

orthopaedics) were to be pressed into service to carry out these operations, the total number of procedures done would be greater but the failure rate expressed as a percentage of the total of operations carried out would be higher. The choice may be summarised by saying that for 100 patients needing a joint replacement the first approach to the problem might provide successful surgery for 59, failure for one, and no surgery at all for 40. The second approach to the problem might provide successful surgery for 90 and unsuccessful surgery for 10. Which is to be preferred?

General Practice Observed

Nurses and nursing in primary medical care in England

B L E C REEDY, P R PHILIPS, D J NEWELL

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Summary

In 1974 we sent questionnaires on attachment and employment of nurses to 9214 general practices in England. There were 7863 replies (85%), of which 551 were excluded from the study. A total of 2654 nurses were directly employed by 24% (1774) of the practices, and 68% (4972) had attached nurses. Practices in health centres were larger and had greater nursing resources than those in other premises. We suggest that practices may employ nurses to compensate for ineffective nursing attachments, and we conclude that general-practice-employed nurses are becoming "professionalised."

Introduction

Since the concept of "the team" emerged in primary care in about 1967^{1,2} an apparent ambiguity in its nursing structure has become increasingly evident. Apart from the now widespread "attachment" to general practices of nurses employed by area health authorities, general practitioners have themselves recruited and employed nurses, and since 1966 have received reimbursement of 70% of these "practice" nurses' salaries from the National Health Service. Extensive studies³ of the work of both kinds of nurse have shown that health authority nurses have worked mainly in patients' homes, whereas practice nurses have worked mainly in surgeries and health centres.⁴

We did not know how many practice nurses there were, and we assumed that they might be employed mainly in practices with no attached health authority nurses. Returns made by

general practitioners in England and Wales since 1968 indicate that the total hours worked by practice nurses have increased yearly by 18%, on average,⁵ while the total hours worked by health authority nurses increased yearly by only 5%.⁶

A new feature of the work of health authority nurses became apparent in 1973 when the number of first treatments given by them in health centres and general practices to patients aged under 65 was found to be almost double the number given in patients' homes,⁷ with an increase of 31% over 1972. Thus it was surprising that the number of full-time-equivalent practice nurses was also rapidly increasing and that they seemed to be developing a corporate identity and aspirations towards specialised training and standardised terms of employment.⁸

Because of these apparent anomalies we decided to investigate the nursing, reception, and administrative duties of qualified nurses employed by general practitioners in England.

Method

After carrying out a pilot study of 152 practices in Scotland, in the autumn of 1974 we sent a short questionnaire to each partnership, group practice, and single-handed practice on the lists of family practitioner committees in England asking for as complete an enumeration as possible of the nurses they employed. We used a computer to handle the data returned, to organise the sequential posting of the 9214 questionnaires in eight weekly batches, and to monitor the returning questionnaires. This greatly simplified sending to non-responders a first and a second reminder 23 and 46 days respectively after each posting. We telephoned a 10% random sample of the remaining non-responders to ask for the necessary information.

Results

Questionnaires were returned by 7863 of the 9214 practices, giving a response rate of 85.3%. After we had excluded 551 returns that were duplicate or from special practices, such as those in universities, we found that 88% (6435) of the remaining 7312 practices occupied privately owned premises, while 12% (877, with 2911 principals) were based in health centres. Fifty-seven practices occupying both types of premises were treated as health-centre practices in our analyses. Health-centre practices had on average 3.4 principals, while practices in other premises had 2.4 principals per practice. We used the number of principals as an estimate of practice size.

A total of 2654 practice nurses were directly employed by 24% (1774) of the 7312 practices. Two-thirds of the practices employed

Medical Care Research Unit, University of Newcastle upon Tyne, Newcastle upon Tyne NE2 4AA

B L E C REEDY, MB, MRCP, senior lecturer in the organisation of health care

P R PHILIPS, BSC, PHD, lecturer in medical data processing

D J NEWELL, MA, PHD, professor of medical statistics