EDITORIALS

JOINT REPLACEMENT IN THE 1990s

Whatever the present shortcomings of artificial joint replacement, few would question that it generally provides a reliable solution to the severe pain and disability of arthritic conditions. For example, in a study of almost 10,000 cases of total knee replacement there was a 97% probability of implant survival at 10 years in primary cases in the elderly patient group [1]. The equivalent survivorship for cemented total hips is usually at least 95% based on numerous follow-up studies. Even for the upper extremity joints which are used in far less numbers than knees and hips the long-term results are remarkably good [2].

But despite these results, there is no reason for complacency. In the hip, of the surviving implants, many are not performing optimally due to being loose. Radiolucency at the cement–bone interface, regions of osteopenia or bone resorption due to stress shielding, and osteolytic cavities along the implant–bone interface due to the accumulation of wear particles, are frequently observed. Deterioration of the results in the subsequent years is the inevitable result. Furthermore, published results are generally from centres performing large numbers where a more consistent performance might be expected [3]. Knee replacements, often considered inferior in reliability to total hips, actually show greater promise for long-term survival. For the standard condylar replacement designs, even when loosening occurs, the bone destruction is relatively small and allows for easier revision. However, if the primary treatment is delayed, the long-term results are significantly poorer, particularly if a more constrained device is needed [1]. For both total hips and total knees, the long-term results in the younger and more active patients are inadequate, in the very group where long-term reliability is particularly needed [1,4]. Wear in total knees has not been reported as a problem in several series with 10 years of follow-up. Unfortunately, some of the designs which have been introduced in more recent years have suffered serious wear problems. The problem is evidently a combination of low femoral–tibial conformity, insufficient plastic thickness, and inadequate processing methods [5]. Perhaps the most dramatic wear problem in recent years was the widespread failure of metal-backed patella components. The trend to modularity in knees without adequate testing has led to mechanical failures in some designs as well as to particulate debris from metal-on-metal fretting.

Of the two main limitations of total joints, loosening and wear, the former has received by far the most attention. Cementing techniques which ensure more intimate cement–bone interdigitation have been shown to produce an improved radiographic appearance and may usefully delay the onset of loosening [6]. However, most of the effort into improving fixation has been into achieving a permanent interlock using porous coatings. The lack of consistent success has not been due to any lack of viability of the bone ingrowth phenomenon, but rather due to the inability to avoid gaps around a sizeable fraction of the interface, and the interface micromotions which occur due to elastic deformations of the materials, especially trabecular bone, during weight-bearing activities. Notwithstanding, some designs of uncemented total hips and knees, even designs relying on macro-interlock rather than on porous coating, have shown a success rate only slightly lower than for cemented designs, and significantly, most of the failures have occurred early, usually due to imprecise fit or misalignment [3].

There has been some concern that serious bone remodelling will occur with uncemented hip stems due to the altered stress and strain patterns, although theoretically the situation is better than for cemented stems [7]. While proximal osteopenia and distal hypertrophy have been observed, they have tended to be non-progressive after a few years [8]. Of the various methods to improve uncemented fixation perhaps the use of hydroxyapatite (HA) coating is the most significant [9]. Numerous laboratory studies have shown the rapid formation of bone on to HA-coated surfaces with high shear strength, consistent with the histologically observed direct bone–implant bond [10]. The clinical experience to date has been suggestive of a similar phenomenon occurring with a parallel improvement in clinical results. Of the second limitation of total joints, polyethylene wear, despite the fact that it is a major cause of loosening as well as a reason for mechanical failure of the joint, relatively little research has been carried out. A significant finding has been that ceramic heads have led to a reduction in socket wear by a factor of almost four [11]. Ceramic-on-ceramic has produced a wear rate of only 0.25 μm per year compared with that of metal on polyethylene of 100 μm per year [12]. However, ceramic heads have not become generally popular due to the lack of confidence in their strength properties and to the additional cost. In the knee, several theoretical and experimental laboratory studies, as well as examination of retrieved components, have clearly demonstrated that the wear is significantly reduced if the stresses on the plastic are minimized. It is important in any comparison of the wear rates of different materials that particle size, chemical composition, and cellular response are carefully considered.

Will there be any significant changes in practice in the 1990s? It ought to be as simple as identifying the most successful features of the present designs and techniques, eliminating the unsatisfactory elements and selectively introducing improvements. For
example, the latest model of automobile is, generally speaking, clearly an advantage over its predecessor. Unfortunately, the field of joint replacement is not so straightforward. A major problem is that when anything new is introduced, it is difficult to demonstrate with a high degree of certainty that it will provide an improvement in the long term. For this reason it is likely that conventional design forms of cemented total hips and total knees will continue to be used for the elderly patient group. For the hip, more stem sizes will become available while modular femoral heads will encourage the use of the mid-range of ball diameters, 26–28 mm, which are the best compromise for friction, wear and stability [2]. For knees, modularity of tibial components and simpler yet more accurate instrumentation will improve the quality and consistency of results. Femoral–tibial geometries with better conformity will replace those with low conformity and excessive laxity, in order to reduce the wear and instability problems to tolerable levels.

However, patients in the younger age groups, and all those requiring a more active lifestyle, will justifiably make increasing demands for improved designs. For this reason, the quest to develop reliable uncemented implants will continue at an even higher level than before. There are already a number of promising designs in use, with potential benefits over cemented designs. Recent advances in preclinical design methodologies and methods for obtaining early indicators of performance in the patient, should act as a further spur to the use of uncemented devices. Iterative finite element analysis for comparing hip stem designs on the basis of bone remodelling change has now been developed [13]. Photoelastic coating [14] and holographic techniques for determining surface strains, and micro-motion studies for predicting interface behaviour [15] are now being used for design comparison and optimization. The RSM method, whereby small beads are inserted into the bone in order to monitor accurately component–bone motion over time, may well offer an early indicator of long-term performance for a particular design [5]. Research into such design and evaluation techniques should be encouraged in an effort to develop implants in a more scientific and methodical way than hitherto.

While porous coatings will feature on many of the newer designs, there will be an expanded use of hydroxyapatite coating, both with and without porous coating. Other types of coating will receive increasing attention in order to reduce the egress of metallic ions and protect the surface from fretting wear (Pilliar). One particular example is diamond-like carbon coating, which provides a highly compatible and inert surface [16]. The opposite approach, to provide a bioactive surface, will attract interest, based on results showing that growth hormone at an interface can accelerate bone growth and osseointegration [17]. The investigations of polymeric composites for hip stems, which has been on the agenda of major orthopaedic companies for many years, will result in the emergence of several experimental designs. Candidate materials include polysulphone or polyetherketone reinforced with carbon fibres or polyamide fibres. However, the complexity of the biomechanical and biomaterials problems [18] is such that widespread usage in the next decade is unlikely.

The application of CAD–CAM technology for the customization of hip stems in order to provide a more accurate fit, will receive increasing application. Because of the evidence that close fit results in improved performance and conversely that failures are frequently associated with poor fit, individualized CAD–CAM stems possibly with HA coatings, will find an application not only in femurs with unusual geometries, such as JRA and CDH, but in the younger arthritic patients as well. Another application of this technology is for revision cases where a progressive approach depending on the severity of the case is called for. The reducing costs of such techniques and the use of accurate radiographic imaging techniques will lead to an expansion of usage in the coming years.

Notwithstanding the advances that will be made in uncemented component design, the problem of polyethylene wear is unlikely to be resolved. There are evidently no apparent successors to UHMWPE with demonstrably superior wear properties on the immediate horizon. Because of this, the use of ceramic femoral heads will show a modest but well deserved expansion in use. Nevertheless, there will be an upsurge of research support for investigating polymeric materials, or alternate bearing designs, for reduced wear. Up till now the wear problem in total knees has been addressed mainly by the mobile bearing or sliding meniscus designs such as the Oxford and New Jersey. While the evidence is that they do indeed offer reduced wear and deformation of the plastic, several factors will limit their widespread application. First, the evidence is that if a fixed bearing design with moderate to high conformity is used, wear is not a major problem in the relatively older patient group. Second, with the present mobile bearing designs, the low inherent stability requires adequate ligamentous and muscular stability, not always present in arthritic patients, and difficult to achieve reproducibly at surgery. Nevertheless, recognizing that plastic wear is a major limitation in total knees, research into advances in the mobile bearing concept should continue and may well result in expanded use in the future.

The demand for joint replacement for the more specialized applications such as for revisions and for bone tumours will continue to grow in the coming years. Off-the-shelf implants will serve the need for many of these cases. For example, many modern knee systems include modular stems and spacers, making it both convenient and relatively inexpensive. Long-stemmed hip components and metallic acetabular shells, many with porous and hydroxyapatite coating, will serve the needs of many cases for uncemented application. However, the possibilities of individualized or custom components will receive increasing attention because of their potential for more accurate reconstructions. Indeed many types of case, including
CDH, revision of devices with loose intramedullary stems or failed bearings, can only be reconstructed with any degree of soundness and restoration of normal geometry and mechanics by use of an individualized approach. Rationalization of designs by using an Expert System approach can speed the design and manufacturing time and minimize costs. With such potential benefits, the actual expansion in usage will depend upon the willingness of surgeons to provide appropriate radiographic and clinical data, and to confront more exacting surgical procedures. A degree of specialization is indicated in this type of surgery. Because these specialized joint replacements, from off-the-shelf uncemented coated implants to more complex individualized devices, are more costly than standard devices, it is essential that this is recognized in equipment budgets. The modest increase in costs should not become a barrier to the patients with these more serious problems, where the technology for treatment exists.

Finally, a steady increase in standards will rely on a continuing education process not only among the surgical community, but also of scientists, designers, manufacturers and those in government and regulatory agencies. Hence, appropriate courses and conferences must play an increasing role in the future. Because advances in joint replacement are now played out on a global scale, the importance of international participation in such educational events cannot be overemphasized. In conclusion; it is proposed that joint replacement has already provided immense benefits to patients, and is undoubtedly the most effective way forward for yet further advances in the treatment of disabling conditions of joints.

P. S. Walker

Department of Biomedical Engineering, Institute of Orthopaedics, University College, London, Stanmore HA7 4LP

REFERENCES

VISITING OTHER DEPARTMENTS

RHEUMATOLOGY in the United Kingdom is being practised in an ever-changing NHS where new consultants must not only be competent clinicians but are expected to run, develop and be financially responsible for the organization of their service. How often are trainees in rheumatology taught these management skills and can it be improved to nurture the rheumatologists of tomorrow? Some Regional Health Authorities organize general management courses as do others outside the NHS (Business Schools, King's Fund, Open University). However, visits to units provide a more realistic picture to complement the formal courses. The BSR Travelling Fellowship scheme is one method by which this is facilitated. It allows trainees the opportunity to observe services, both clinical and managerial, in a different demographic setting to their own training scheme.

Annually since 1986 BSR have sponsored visits by a party of four Fellows to various UK rheumatology centres for a period of one week. The programme aims
to expose them to all aspects of the service, from the Ward Clerk to the Unit Manager and from the Professor in a large academic unit to the single-handed rheumatologist in a DGH. It aims to provide the opportunity to discuss areas of the service, informally identifying problems that have been encountered, and, when possible, how these can be solved or avoided. Although local circumstances often dictate the type of service that has developed, certain common practical issues can be discussed, such as: clinic organization, use of inpatient beds, negotiation of junior doctors' time, responsibility for drug monitoring, the use of remedial practitioners.metrologists, the development of audit and dealing and coping with management within the new NHS structure. All this occurs in a 'non-threatening environment'. Observation will also reveal the relationship of rheumatology to rehabilitation and general medicine, and the liaison with primary care and the closely allied hospital departments of orthopaedics, physiotherapy and occupational therapy. The diversity of research interests and how they have been organized will become evident. Not only can views on these topics be discussed with the hosts, but debating them with one's travelling companions is important. The hosts should aim to make the programme as varied and flexible as possible and not provide an endless stream of lectures on their most recent research.

In this issue of the Journal there is a report from the 1990 Travelling Fellowship who visited departments in and around London [1]. This and previous reports have been praiseworthy of this venture and its popularity is reflected in an ever-increasing number of applications. The BSR Educational Database provides an additional method by which trainees may informally visit departments. The database provides information on many departments in the UK, detailing what they have to offer, not only their research areas but also service interests. It is naive to think that a single training scheme can cater fully for every individual.

These unique opportunities enable rheumatology trainees to broaden their educational experience by visits to other departments and to learn from the experience of others on how to run a service and tackle problems. In addition, the travelling fellowship provides potentially lifelong friendships by enabling contact with contemporaries outside their immediate sphere. Its popularity reflects its success as an adjunct to training schemes and it is a medium that should be developed and encouraged by all involved in postgraduate training. The benefit to the visitors and hosts is dependent on their own input and enthusiasm, particularly during informal sessions. Some departments may wonder 'who is observing whom' at these visits but the two-way passage of information should greatly benefit both sides. Perhaps such visits should also be considered for established consultants.

Information and details about the Travelling Fellowship and Educational Database are available from the BSR office. Access to the database is not confined to UK graduates and enquiries from overseas are welcome.

P. T. Dawes
Chairman, BSR Education Committee, Staffordshire Rheumatology Centre, Haywood Hospital, High Lane, Burslem, Stoke-on-Trent ST6 7AG

REFERENCE