Preface

Joint replacement is still one of the major successes of modern medical treatment, transforming the lives of the increasing number of older individuals in the population as well as now offering a realistic return to normality in younger patients with problem joints. The expectations of patients as well as their surgeons continue to rise in terms of the ability to restore function, relieve pain and provide excellent long-term performance. Success in the hip has been followed in fairly short order by similarly good outcomes in the knee, with other joints not so far behind. The position gradually being reached is that restorative implantation surgery will provide answers for those debilitated by disease in the hand and foot, the ankle and the upper limb joints, as well as the spine. Each of these joints has its own unique characteristics in terms of the requirements to be met in achieving a successful replacement device and procedure. Apart from the basic principles, the solutions applicable in one anatomical site may not necessarily have relevance to another. There may also be a real, and perfectly natural, tendency for those involved in developing and implanting a replacement for a particular joint not to look at the answers provided at another. In terms of the outcome for the patient and the high level of competence of the surgeon, such specialisation in orthopaedics has great benefits. The same must be true for the material scientists, engineers and industrial partners involved in artificial joint development. However, this narrowly focused approach may have an accompanying disadvantage in that there could be less awareness of what is happening in terms of problem solving and innovation in other fields.

The aim of this book is to provide an update on progress in the technology of joint replacement for the medical and scientific world. The book should be useful not only to the engineering and materials scientific communities but also to surgeons seeking the best treatment for their patients. The contribution of different scientific disciplines in providing successful prosthetic devices has long been recognised, and there are those, the editor included, who feel that this truly interdisciplinary research is the key to success. It has been a great personal privilege to work closely with colleagues from other branches of science and medicine in developing novel biomaterials and trying to

understand the biological response to these. While this interdisciplinary work brings great rewards, it also presents certain challenges, not least of which is the need for effective communication. The balance between overusing technical terms on one hand and having enough simple words to enable proper understanding is sometimes difficult to achieve. One person's specialist language may seem like jargon to another, while painstaking explanation has a danger of seeming facile and even patronising.

The concept for the first edition of *Joint Replacement Technology* was to provide contributions explaining basic principles of various scientific disciplines followed by a section with authors describing developments in the production of suitable materials for implantation and fixation to the skeleton. The second half of the book concentrated more on the biological and clinical aspects of joint replacement in more general terms and then with experts describing the challenges of working in a particular anatomical location. Hopefully it fulfilled some useful role in cross-fertilisation of ideas between disciplines. When the question of a second edition arose, it was decided to retain the same basic structure and most of the previous authors were invited to provide an update of their chapters. Nearly all agreed, though some declined because they did not feel that there had been sufficient change in their area to merit a revision. Some new authors have been recruited either to produce replacement chapters or to assist the original contributors with their updates. Comparison with the first edition will reveal where these changes have occurred. It will also show how some chapters have been substantially reworked. In addition, the oversight in the first edition of not including a chapter on imaging methods has been corrected. At the time of planning the original book, straight X-ray examination was more or less the only way of viewing the implanted device. Advances in investigative radiology are now providing increasingly sophisticated images and it is a privilege to be able to include a detailed and authoritative contribution on this area of endeavour.

Deciding on whom to invite as authors was an interesting exercise first time round and the use of bibliometrics was included to make the process less subjective. Now, a search of the literature shows how our authors have continued to play a significant role in their specialist areas and therefore remain well qualified to join in this enhancement of the book. As before, there is some overlap between parts of certain contributions, an inevitability as the same issues are addressed in the different specialist areas from which the authors are drawn. This has the advantage of providing a different viewpoint on any issue, as well as giving emphasis to that aspect by the repetition. An excellent example of this is the topic of metal against metal bearings, which has been a particular cause for concern at the hip over the last few years. This issue naturally emerges several times in the book so that we have here the latest thoughts on failure mechanisms, the biological

response to metals, recent advances in the understanding of tribology and corrosion, and consideration of the various alternative materials.

Although failure mechanisms in general are still much as they were in the time of the pioneers, there have been advances in the understanding of joint failure from the point of view of both the mechanical and biological processes involved as more sophisticated investigative methods become available. An area in which there is a need for improvement is the analysis of clinical performance. At worst, this involves the early recognition of devices which have deleterious effects. At best, the identification of factors which are predictive of outstanding long-term performance is most valuable to the individual patient and their surgeon. This whole aspect involves regulatory affairs, standardisation and registration, as well as the ability to perform meaningful meta-analysis, which is difficult to achieve with such a multiplicity of variables. The introductory chapter on regulatory affairs in the first edition has not been repeated and while the chapter on metals for joint replacement gives a thorough treatment of ISO standards, there is no individual contribution specifically addressing these issues. This has been a conscious decision by the editor.

In the last six chapters, individual authors describe the clinical challenges of replacing the joint in which they specialise and discuss the pros and cons of different designs. All are concerned with outcomes, complications and clinical management as well as the technical aspects of their field. They express an awareness of the increased expectations for the restoration of normal function on the part of their patients to which allusion has already been made above. In the end, no matter how good the technology and the science, the success of any joint replacement always depends on the skill of the surgeon. A device will only function properly when implanted correctly.

Acting as editor has been a stimulating and rewarding task. It is a privilege to be able to work again with such outstanding individuals as the contributors to this book. Thought-provoking details occur throughout. Thus, for the hip and knee joints, it is usually assumed that an individual takes one million steps (cycles) in each joint in a year, but younger and more active individuals may reach up to five million cycles per year for each lower limb joint. It was the requirement for greater functional capacity which contributed to developments in hip joint prostheses. But there is another perception provided in the new version of the first chapter of the book which now points out that *in vivo* measurements of forces at the hip on walking were made on patients with joint replacements at 2.4 body weight (BW), whereas values obtained recently for the normal healthy hip vary from 2.6 to 5.6 body weight, and this increases up to 6 times body weight on climbing stairs. Similarly, at the knee, compressive forces during normal walking of around three times body weight are increased to six times body weight on deep squatting. These are the real challenges of designing replacement joints for younger patients

and the examples given are in respect of just two joints. It has been pointed out in the chapter on the spine that with an average of two million strides and 125 000 significant bends per annum, a lumbar spine implant may be subjected to over 100 million cycles in its expected duration of implantation. Insights into the various general and specific challenges of joint replacement technology, and there are many, cannot be summarised here. No doubt individual contributors would choose different aspects of their writings than the ones mentioned here.

It is said that the accurate collection of correct data is essential to good science, but that the data then have to be analysed appropriately before there is any accessibility to real information. In turn, new information must be processed and evaluated in the light of all other information before it contributes to knowledge. Accumulated knowledge further refined in the light of practical experience provides a depth of understanding which might be referred to as wisdom. This book provides not only a great deal of information and knowledge, but also the specialist wisdom of those who have contributed. Such wisdom is not really available in scientific papers which are about information and sometimes understanding. Hopefully, we have provided a resource which will be valuable to a wider readership than might have been reached had we each been addressing our own individual fields. May this book provide for an increased understanding of the many aspects of joint replacement.

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