

Orthopaedics

JOINT ARTHROPLASTY is arguably the most successful operation in modern times. Orthopaedics of the future, however, will focus on new strategies for contemporary problems that integrate advancing technology and basic science with surgery.

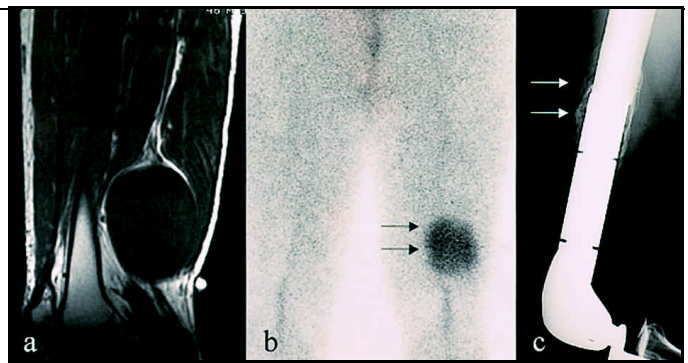
Diagnosis. Orthopaedics relies heavily on accurate anatomical imaging. Developments in soft-tissue contrast using magnetic resonance imaging (MRI) and the ability to demonstrate inflammation, hypervascularity and accurate anatomy has enhanced non-invasive diagnosis of such conditions as meniscal tears, labral tears in the hip, and occult fractures. MRI has been particularly valuable in assessing resectability of primary bone and soft-tissue malignancies when planning surgical margins and assessing the appropriateness of amputation or limb preservation. Future diagnostic modalities will combine anatomical with functional imaging, such as positron emission tomography, to improve the assessment of bone and soft-tissue lesions.

Molecular biology and cytogenetics play increasing roles in the diagnosis of orthopaedic conditions, of which a substantial number have a genetic basis (eg, Marfan's syndrome, osteopetrosis and osteogenesis imperfecta). Identifying subcellular anomalies also clarifies aetiological mechanisms and helps to plan strategies for treatment and genetic counselling. Many sarcomas also display characteristic cytogenetic abnormalities¹ with prognostic and tumorigenic significance. Future genetic studies of musculoskeletal tumours are likely to define subsets of patients who are good and poor responders to therapy, as well as identifying the genes responsible in many syndromes, dysplasias and cancers.²

Treatment. Delayed healing and non-union of fractures are responsible for protracted disability and pain. A variety of growth factors, such as the bone morphogenetic proteins (BMPs),³ are now known to be important in stimulating bone formation. Synthetic growth factors for treating problem fractures can now be mass produced using recombinant-DNA technology. Future strategies are likely to include coating prostheses with factors that stimulate bone formation to enhance the biological fixation of these devices. This would be particularly relevant for joint arthroplasty in young patients, for whom aseptic loosening of cementless prostheses is the commonest reason for revision surgery.

Recently, factors that stimulate and inhibit osteoclast formation and function have been identified. Regulation of these factors by genetic manipulation or introduction of synthetic analogues may have important applications in treating conditions that have a genetic basis.

Explantation of tissue, its manipulation and subsequent reimplantation into the body is a novel method for treating acquired musculoskeletal defects. Some articular cartilage defects can be treated by harvesting the patient's own articular cartilage cells, culturing them *in vitro* and then reimplanting them into the articular defects during surgery to obliterate the defect. Future strategies may include cloning explanted cells with genes that enhance their growth



and production of cartilage matrix before reimplantation. Guided engineering of other tissues, such as muscle, ligaments and bone, is likely to extend the armamentarium of reconstructive surgeons for patients with post-traumatic or resection defects.⁴

Despite intensive chemotherapy, 30% of patients with osteosarcoma succumb to metastatic disease. The targets for future treatment are likely to be identified from studies of the metastatic cascade. For example, proteolysis is known to be important in tumour progression, and the expression of the urokinase plasminogen activator system during the growth of osteosarcoma has been identified.⁵ By genetically manipulating the expression of components of the urokinase plasminogen system in an animal model of osteosarcoma we have significantly inhibited the behaviour of osteosarcoma, paving the way for developing non-toxic strategies for treating this tumour.

Prevention. In contrast to the advances in diagnosis, progress in improving prevention through genetic information has been slow. Conditions for which this has been successful include X-linked hypophosphataemic rickets and osteogenesis imperfecta.

With over 40 000 joint replacements performed each year in Australia and a failure rate of 1% per year, techniques to reduce the failure rate from misalignment of the prosthesis are likely to have a major impact on clinical outcome and resource utilisation. Computer-assisted, image-guided surgery will improve the accuracy of surgical technique in the future, and may be extended to facilitate minimally invasive surgery.

Important features of orthopaedics in the future will be multidisciplinary collaboration and reliance on high technology. The markedly increased safety in anaesthesia will allow more and bigger surgical procedures to be performed on an ageing population.

Peter F M Choong

Director, Department of Orthopaedics, St Vincent's Hospital
41 Victoria Parade, Fitzroy, VIC, 3065
sarcomasurgeon@ozemail.com.au

Figure: (a) MRI scan of a popliteal tumour gives excellent contrast to help plan surgical margins. (b) Increased metabolic activity on functional scanning (arrows) reflects either a high-grade tumour or a poor response to adjuvant therapy. (c) In future, growth factors may be used to enhance bone formation around prostheses (arrows) to increase their biological fixation and longevity.

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