Healing Large Bone Defects

Large bone defects and non-union fractures, especially in the diaphysis, represent a challenging and complex interaction of mechanical and biological factors. Fortunately, many of these problem fractures can be successfully managed by stabilization and autologous cancellous bone grafting. However, in some patients autologous cancellous bone graft collection can be associated with morbidity, or limited by availability of graft material. So, there is a considerable ongoing research effort focused on understanding the fracture healing process, and on ways in which it can be optimized and stimulated without reliance on autologous bone grafting.

The importance of fracture stabilization to successfully treat hypertrophic non-union in the dog was demonstrated in research conducted in Switzerland by Müller and colleagues half a century ago (1). After bone plate stabilization, fibrocartilaginous callus in hypertrophic non-union was remodelled to woven and lamellar bone that bridged the fracture gap. However as we know so well, the provision of stability to fractures is not a simple matter, and our understanding about the optimal degree and timing of stabilization that is required for fracture healing is constantly evolving.

Moreover, stabilization alone may not be sufficient in large ‘critical-size’ bone defects; bone grafting or other materials are needed to fill the defect. A host of different materials have been tried as defect fillers, such as frozen allograft bone, demineralized bone, coral, calcium phosphate implants, polymers and various other biomaterial implants. The discovery by Marshall R. Urist that bone induction stimulated by bone morphogenetic protein (BMP) proved to be a major breakthrough in orthopaedics; rhBMP-2 is now used clinically to stimulate bone healing. However, rhBMP-2 has to be applied in conjunction with a carrier material or biomaterial implant. Some of the characteristics of an ideal defect filler would be that it is non-antigenic, allows early load bearing, is resorbable and is then completely replaced by normal bone. In this issue of VCOT, Minier and colleagues have reported their findings of a study of a hydrogel combined with biphasic calcium phosphate to deliver rhBMP-2 in a critical size defect (2). Readers will be interested that their findings suggested that this combination could promote bone regeneration with similar performance to autologous cancellous bone grafts.

Fabrication of customized implants to rebuild bone defects by bio-printing is one of the latest initiatives in the field of bone defect restoration. I have just been reading with interest about such a program at the University of Liverpool led by Rob Pettitt who is one of our VCOT reviewers (3). Not only are these customized bio-printed implants valuable as scaffolds for new bone formation, they can also be osteo-inductive, or else be loaded with mesenchymal stem cells and growth factors such as vascular endothelial growth factor (4). The latter is important in promoting vascularisation of bio-printed implants, and allows long-term conversion to normal tissues. This is an exciting field, and one that I am sure will further revolutionize our ability to improve patient care in the future.

As this is the final issue of VCOT for this year, I want to sincerely thank our readers, authors, reviewers, editorial team, affiliated societies and commercial sponsors for their tremendous support. I wish you the very best for the New Year.

References