In Vivo Study on the Healing of Bone Defects Treated with Bone Marrow Stromal Cells, Platelet-Rich Plasma, and Freeze-Dried Bone Allografts, Alone and in Combination


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Received 16 March 2005; accepted 24 October 2005
Published online 11 April 2006 in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/jor.20112

ABSTRACT: The repair of confined trabecular bone defects in rabbits treated by autologous bone marrow stromal cells (BMSC), platelet-rich plasma (PRP), freeze-dried bone allografts (FDBA) alone and in combination (BMSC + PRP; FDBA + BMSC; FDBA + PRP; FDBA + PRP + BMSC) was compared. A critical size defect was created in the distal part of the femurs of 48 adult rabbits. Histology and histomorphometry were used in the evaluation of healing at 2, 4, and 12 weeks after surgery. The healing rate (%) was calculated by measuring the residual bone defect area. Architecture of the newly formed bone was compared with that of bone at the same distal femur area of healthy rabbits. The defect healing rate was higher in PRP + BMSC, FDBA + PRP, FDBA + BMSC, and FDBA + PRP + BMSC treatments, while lower values were achieved with PRP treatment at all experimental times. The highest bone-healing rate at 2 weeks was achieved with FDBA + PRP + BMSC treatment, which resulted significantly different from PRP (p < 0.05) and BMSC (p < 0.05) treatments. At 4 weeks, the bone-healing rate increased except for PRP treatment. Finally, the bone-healing rate of FDBA + PRP, FDBA + BMSC, and FDBA + PRP + BMSC was significantly higher than that of PRP at 12 weeks (p < 0.05). At 12 weeks, significant differences still existed between PRP, BMSC, and FDBA groups and normal bone (p < 0.05). These results showed that the combination of FDBA, BMSC and PRP permitted an acceleration in bone healing and bone remodeling processes. © 2006 Orthopaedic Research Society. Published by Wiley Periodicals, Inc.


Keywords: bone defects; platelet-rich plasma; bone marrow stromal cells; bone allografts; rabbits

INTRODUCTION

In orthopedic reconstructive surgery a fresh graft of autologous cancellous bone with hematopoietic bone marrow is generally considered to be the most effective for the treatment of major bone defects. However, the clinical application of such grafts is sometimes limited and a better method would be to use some more readily available materials of either synthetic or biological origin. As far as the latter is concerned, the progress made in recent years in the transplantation of bone has been related in large part to the availability of bone allografts through well-organized tissue banks. The unlimited amount of allografts has led to the wide use of the freeze-dried bone allograft (FDBA). Freeze-drying is an advantageous method that decreases antigenicity even further, and produces no biochemical changes. It involves the removal of water from the frozen tissue, after which the tissues are vacuum-packed and can be stored at room temperature for many years. Obviously, the storage technique destroys cells and organic bone matrix, so that the osteogenic potential of FDBA is limited and thus an improvement in bioactive properties of these grafts is highly desirable.