THE EFFICACY OF VARIOUS ALLOPLASTIC BONE GRAFTS ON THE HEALING OF RAT CALVARIAL DEFECTS

+* Salih, E; +# Hung, JT; +¶ Mah, J
+Laboratory for the Study of Skeletal Disorders and Rehabilitation, Department of Orthopaedic Surgery, Children’s Hospital and Harvard Medical School;
+ Harvard School of Dental Medicine; Boston, MA 02115, (617)247-5181, (617) 236-7149 FAX
#¶ Present address: USC University of Southern California

* Corresponding author

ABSTRACT

Introduction

Surgical procedures of the craniofacial skeleton often require bone grafts or implants to provide structural and functional integrity for the promotion of fracture union in osteotomies, to fill bony defects related to trauma or surgery and bone areas in need of additional support. Autografts are considered the ‘gold standard’; however, limited graft supply particularly in pediatric patients and post-operative donor site morbidity are potential problems. Allografts in fresh frozen and demineralized bone matrix are shown to be effective, but the risk of disease transmission is a potential consequence. Surgeons are then faced with the question – ‘What is the best currently available alloplastic bone implant/repair material?’ Although many studies have been performed to compare a particular material to a few others, there has not been a comprehensive study to evaluate the major categories of these materials side by side. In this study, we have tested representative materials of the major categories of alloplastic bone graft materials which have been FDA approved and in current use.

We have utilized rat cranial defect repair model to test 6 alloplastic bone grafts for their efficacy as promoters of new bone formation. Our aims have been 1) to determine the efficacy of bone implant/repair materials in the healing of rat calvarial defects using histomorphometric and biochemical means; 2) to provide comparative data of the various implant materials and establish a ranking of effectiveness.

Materials and Methods

7 groups of 32-36 days old male Sprague-Dawley rats were used in this study (6 experimental, 1 control), each group containing 5 animals. In each rat, two full thickness cranial defects were developed (4mm in diameter), one on each hemicranium, produced with a dental bur while rinsing with a sterile lactated Ringer’s solution to clear any remaining debris, and filled with either an implant material (experimental groups) or left empty (in control group), thus totaling 10 implant sites per group. The implant materials were 1) Bio-Oss , 2) Bioplant HTR, 3) Biogran, 4) Orthomatrix–HA, 5) Interpore 200 and 6) Pro-Osteon 500R. 2 animals per group were sacrificed after a 2-month healing period yielding 4 implant sites. One implant site was used for histological assessment for comparison with the 4-month healing groups. 3 implant sites were used for biochemical analysis (Alkaline phosphatase activity). 3 animals per group were sacrificed after a 4 months healing period yielding 6 implant sites. These implant sites were used for histomorphometric analysis.

Results

Since we were using less than the critical defect (8mm in diameter), our 4mm model would spontaneously attempt to heal. This provides two-fold advantage in our experimental design: - 1) to assess if the FDA approved material enhances the new bone formation and healing, and 2) retard or delay the healing process relative to the untreated controls. Histomorphometric analysis showed that Bio-Oss and Orthomatrix–HA had the largest amount of bone formation compared to other experimental groups and controls, which was statistically significant (p<0.05).

Bio-Oss had the largest new bone formation followed by Bioplant HTR, Orthomatrix–HA, and all were statistically different (p<0.05) from the control group. Interpore 200, Biogran and Pro-Osteon 500R were similar to or worse than that of the control group in promoting healing over a 4 month period using a 4mm defect.

Discussion/Conclusions

Our study indicated that Bio-Oss (de-organified bovine bone) and an Orthomatrix HA (synthetic hydroxyapatite ceramic) showed the most significant ability to promote bridging of a 4 mm defect over a 4 month healing period which resulted in superior healing of the defect. Bioplant HTR (biocompatible composite polymer) and, Interpore 200 (naturally-derived hydroxyapatite ceramics) were also capable of promoting bone growth and incorporating with the new bone, however to a lesser degree than the above 2 materials but nonetheless, better than the control. Significant and consistent amounts of bone growth occurred from the defect edges in all groups.

From this study we conclude that Bio-Oss, Orthomatrix HA and Bioplant HTR provide the best results in terms of healing enhancement and one could recommend for use in augmenting bone healing. Whereas Biogran, Interpore 200 and Pro-Osteon 500R appear not to offer any advantage, if anything they may be hindering healing.