Ridge Augmentation in Irradiated Rabbit Mandible with a Composite Combining Collagen Membrane plus MBCP and Post-radiation Total Bone Marrow Graft.

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INTRODUCTION

Oral carcinomas are frequently treated with a marginal mandibulectomy plus radiotherapy. The decrease of ridge height and the consequences of radiation on bone and soft tissue healing lead to compromising condition for dental rehabilitation. We have recently tested the concept of a post radiation total bone marrow graft as a means of adding osteoinductive properties to MBCP® implanted under irradiated conditions in small defects, with good results according to bone ingrowth. The aims of this study was to regenerate a non segmental defect in rabbit mandible and produce a significant augmentation of the alveolar ridge in an oncological management schedule.

MATERIALS AND METHODS

Composite: 2 mm³ MBCP granules HAβ-TCP 20:80 (MBCP®, Biomatlante, Vigneux de Bretagne, France) + A microstructured porcine collagen membrane (EZ CURE®, Biomatlante, Vigneux de Bretagne, France). Animals: 12 white adult New Zealand rabbits (Charles River, Saint-Aubin les Elboeuf, France).

Defect: horizontal full-thickness and bicortical. Collagen membrane was sized to cover the defect and granules.

Bone marrow grafting: aspirate from humeral epiphysis injected into the center of the implants by percutaneous puncture under radioscopic control.

Radiation delivery: Energy 300KVP (PANTAK, Gulmay Medical, UK). Total dose of 32 Gy delivered at a rate of 2 Gy/Dy, 4Dy/Wk, 4Wk.

Calculating ridge height: Volume of calcified tissue in the implanted area was calculated with image analysis (CTAn®) from 2D Xray microCT (top) along the defect (double arrow). Maximum height was calculated (Image J®) from SEM sagittal sections at the center on either bone alone or bone with ceramics (bottom).

Explant analysis: X-Ray microtomograph with image analysis (CTAn®, Movat’s staining and SEM (BSE) with image analysis (ImageJ®). Statistical analysis: t-test.

RESULTS

This is the first study to focus on alveolar ridge augmentation with a radiation delivery schedule. This study confirmed the feasibility of an experimental animal model of marginal mandibulectomy with post reconstruction irradiation as a means of simulating oral oncological conditions. The composite was able to reconstruct the defect created with no adverse effects for the mucosa and made possible significant alveolar ridge augmentation in comparison to the control group.

Two major problems must be taken into account for implantation in irradiated patients. Radiation leads to significant marginal bone loss. Implant osseointegration failure may be increased especially for low-dose irradiation. Total colonization of the material is not necessary for obtaining good outcomes for implant osseointegration. When used as an osteoinductive material, a number of investigators have reported good results using marrow as a source of substitute for bone-grafting material, although the results of others have been more controversial. Recently, under irradiated conditions, total bone marrow grafts were found to enhance bone growth when combined with MBCP® granules in small defects, and good results were also obtained in segmental critical size defects in high weight-bearing bones in rabbits.

The results of this study have implications for dental rehabilitation in patients with oral cancer. Additional animal studies on mandible segmental defect models with implant placement and higher doses of radiation would provide further preclinical information.

DISCUSSION

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References