GUIDED TISSUE REGENERATION AND THE USE OF PERIOSTEAL GRAFTS IN MANDIBULAR DEFECTS

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Introduction
Soft tissue collapse into large bony defects can limit bony healing. Protection of the defect using bioresorbable meshes presents a viable option in guided tissue regeneration as it has the advantage of ultimately being replaced by native tissues. This study investigated guided tissue regeneration in a sheep mandibular defect model using a bioresorbable mesh. It also examined the role of periosteal grafts harvested from the scalp as a potential means of enhancing bone regeneration.

Methods
A unilateral, full thickness 25mm segmental defect in the mandibles of 20 adult sheep was performed following ethical approval (01/130). Defects were created in the naturally occurring anterior edentulous region of the mandible, thus ensuring all surgery was kept extra-oral. All mandibles were plated for fixation. With this basic model, animals were divided into 5 different surgical groups of four: Group 1 – defect with intact periosteum; group 2 – defect with periosteum removed; group 3 – defect protected by a bioresorbable mesh (Macropore, Biosurgery, San Diego, CA) and periosteum intact; group 4 – defect protected by a bioresorbable mesh cage and periosteum removed; group 5 – as per group 4 but with a periosteal graft harvested from the scalp.

Animals were sacrificed at 12 weeks. Mandibles were then assessed with x-rays, bone mineral density measurements using a Lunar DPXL dual energy x-ray absorptiometry scanner and histological analysis.

Results:
No animals developed complications during the course of the study, with all animals tolerating the surgery well and none experiencing weight loss. X-rays showed that all groups developed some form of bony regeneration within the defect at 12 weeks. Most bony growth occurred from the bony ends, with a significant contribution occurring from the surrounding periosteum in those that had their periosteum intact.

The least amount of regeneration occurred in those animals that did not have the defect protected, and had their native periosteum removed. This group failed to heal, thus supporting this as a critical sized defect. This is in contrast to the group without defect protection and with intact periosteum which had a significant amount of bone regeneration.

Most regeneration was noted in the group with the defect protected by a mesh cage with intact periosteum (figures 2 & 3). In contrast, the group with defect protection but no periosteum had a notable lack of healing. However, when we placed a periosteal graft into this group, bone regeneration to the levels noted with intact periosteum was found.

Discussion:
The use of tissue engineering techniques to enhance bone regeneration, or ideally create bone where it normally wouldn’t occur, is the challenge to numerous researchers internationally. Such research often involves the use of autologous stem cells, complex cell culturing techniques, and various growth factors. While this vial research for the holy grail of tissue engineering goes on, suitable large animal models need to be established. Additionally, the basics of normal tissue regeneration need to be kept in mind. Previous research using large animal models to investigate bone regeneration through the generation of segmental bony defects, have almost always left the periosteum intact. However, the loss of bone in the clinical setting is always associated with the loss of its attached periosteum. As it is well recognized that the periosteum is an important part of normal bone healing, with one of its roles being a source of mesenchymal stem cells, the conclusions from such research must be questioned.

This study investigated the effects of the periosteum on mandibular bone regeneration in a large animal model. When we compared those groups with and without their native periosteum, a difference in the amount of regeneration was found. The group without defect protection, and without native periosteum failed to develop any significant new bone within the defect. This critical sized defect -25mm full thickness mandibular defect without native periosteum - is a clinically relevant model for further research into bone regeneration. Additionally, the impact of the periosteum was reinforced in this study in the group with periosteal grafts. This raises the possibility of its use in the clinical setting.