In vivo Testing of Large Porous Constructs in a Reusable Bone Chamber
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Introduction - Bone chambers are used to study in situ the growth of bone tissue into scaffolds or grafts [1]. Reusable bone chambers have the advantage of being able to test materials consecutively and minimize the number of experiment animals [2]. Therefore they reduce the inter-animal variability in the experiment. The goal of the present study was the implantation of large scaffold dimensions (6 mm diameter and 12 mm length) of different porous materials into a newly developed repeatable bone chamber system.

Materials and Methods - The developed system was used to implant scaffolds made from PLA/calcium phosphate glass composite (n=12), calcium phosphate glass ceramics (n=12) and nickel-titanium (NiTi) (n=8). The bone chamber consisted of an inner removable cage, holding the scaffold, an external chamber which was implanted stationary and a protective cap (see Fig. 1).

Fig. 1: Schematic of a longitudinal cut through the designed bone chamber system.

Internal and external chamber had four apertures to allow tissue ingrowth into the scaffolds. A space between internal and external chamber allowed to cut out the sample after implantation and insert a new scaffold. The implantation procedure was tested in dog cadaver tibia. The in vivo study protocol was approved by the Regional Ethics Committee for Animal Research. Six beagle dogs, about 2 years old and 20 kg weight, were enrolled in the study. 12 bone chambers were implanted in the tibiae of the dogs and were left for 3 month for osteointegration. After this period, scaffolds were inserted with internal cages into the chambers for 4 and 12 weeks. After sample extraction, samples were dehydrated and embedded in glycol methacrylate and benzoyle peroxide, sectioned and stained with Levai-Laczko tinction. Cuts were analysed for new bone volume (NBV) and bone-implant contacts (BIC).

Results – Implantation surgeries succeeded without complications or wound infections. Two dogs presented bone fracture around one implant each. The rest of the animals recovered satisfactorily and showed no signs of discomfort or lameness. The histology of the extracted samples showed tissue ingrowth into the bone chambers. The tissue was a combination of newly formed bone, bone marrow and fibrous tissue. The analysis of NBV and BIC did show no difference between different scaffold types and implantation times.

Discussion and Conclusions - A reusable bone chamber has been developed and applied in vivo in dogs. The implantation experiments conducted over several weeks showed tissue ingrowth into all scaffold types. The found tissue indicated that new bone formation in the scaffolds was beginning, but the defect size and presence of unabsorbed scaffold material affected the velocity and structure of ingrowing tissue and bone formation.

References