

## EX-VIVO TRABECULAR BONE PERCOLATION SYSTEM: DEVELOPMENT FOR EVALUATION OF IMPLANT SURFACES

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**INTRODUCTION:** Numerous studies with implant materials are carried out *in vivo* using sheep models. To reduce the amount of animals used for biocompatibility studies of implant surfaces we are developing the use of a novel *ex vivo* culturing/bioreactor system for the sheep model. The system "Zetos" was devised by David Jones (Marburg, Germany) and Everett Smith (Madison, USA). Zetos is a percolated loading system that maintains trabecular bone cores viable for up to 40 days<sup>1</sup>. It is a closed cross flow perfusion system that allows vertical loading of the longitudinal axis, to mimic the *in vivo* situation. It consists of a number of individually crafted bone chambers and a computer controlled loading device. The first studies are to confirm that bone formation and resorption occurs in the system with sheep bone. At the same time the loading device will be fully calibrated so that the displacement measured on the loading device is related to the displacement that the bone receives. The system has great potential to evaluate cancellous bone - implant surface interactions.

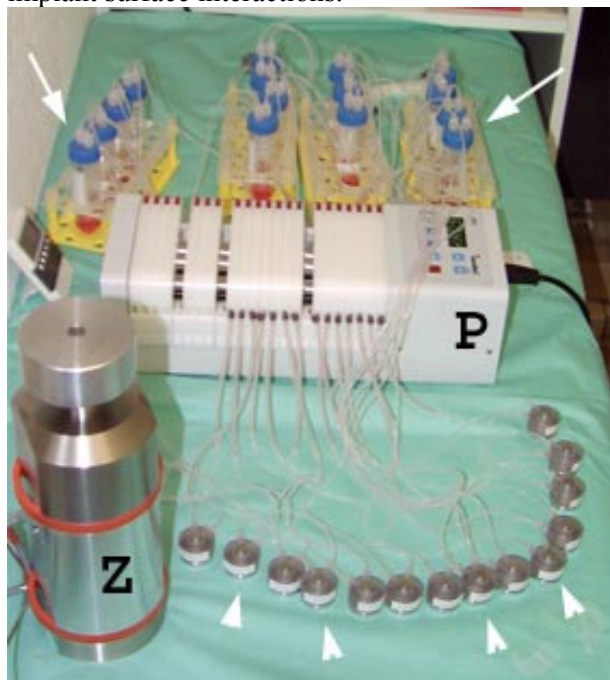


Fig. 1: Zetos System (Z) in 37°C room. Bone Chambers (arrowheads), Microprocessor controlled low pulsation dispensing pump (P), Media filled test tubes (arrows)

**METHODS:** Femurs from a Swiss Mountain sheep are excised and cut at the epicondyle into 7 mm thick sections with a band saw. Cancellous

bone cores, 10 mm in diameter, are removed and then cut parallel to the height of 5 mm with an annular saw. The bone is constantly irrigated with sterile saline to limit damage caused by heat and to stop the bone from drying out. Implants are inserted transversely or longitudinally through the bone cores, which are then washed in medium and antibiotics for 30 minutes before being inserted into the chambers. The assembled system is allowed to settle for 36 hours at 37 °C (Fig.1). Bone cores are deformed daily with compressions of 20  $\mu\text{m}$  and 5  $\mu\text{m}$  in a rectangular waveform at 1 Hz for 300 cycles. This is achieved by the expansion and contraction of a piezo stack under high voltage, placing a force on the piston of the chambers. This force, in turn causes a deformation (compression) of the bone cores that mimic *in vivo* loading patterns. The expansion/contraction of the piezo is controlled by a sensor that acts in a feedback loop to control the amount of force applied to each chamber, which in turn controls the amount of deformation the bone cores receives.

**DISCUSSION & CONCLUSIONS:** The system has been demonstrated previously to maintain bovine bone cells (osteoblasts, osteoclasts, osteocytes, bone marrow) viable for 40 days and that bone growth and resorption occurs Jones *et al* 2001<sup>2</sup>. Our preliminary results show viability of sheep bone cells, the samples currently undergoing histological analysis. The system will be used to study the effect of implant surfaces on cancellous bone ingrowth / ongrowth and resorption.

**REFERENCES:** <sup>1</sup> E. L. Smith, F. Martens, K. Koller, W. Clark, D. B. Jones. The Effects of 20 Days of Mechanical Loading Plus PTH on The E-Modulus of Cow Trabecular Bone *Abstracts 22nd annual meeting ASMBR 2000 SAP 07*<sup>2</sup> D.B.Jones, U.Boudriot, M.Kratz, F. Martens, K. Koller, E. L. Smith (2001) A Trabecular Bone and Marrow Bioreactor. *European Cells and Materials* Vol. 1. Suppl. 2, 2001 (page 53)

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