Comparison of Bone Ingrowth into Two Different Porous Metals in a Canine Implantable Chamber

Introduction:
Bone ingrowth into porous metal-backed orthopaedic implants has shown excellent function and durability of fixation. Novel technologies now exist for the fabrication of porous metals which allow for the adjustment of pore size and pore morphology while maintaining the porosity at a desired level. The purpose of this study was to evaluate bone response to two different porous metals in a canine implantable chamber using histological and scanning electron microscopic evaluations.

Methods:
Ten adult mongrel dogs underwent bilateral surgical implantation of chambers into the lateral aspect of the distal femur. Each chamber had multiple channels, each of which was composed of a pair of coupons of the same material type facing and separated from each other to form a 1 mm space in between.[1] Two porous metals were tested in this study: Tritanium™ (Stryker), fabricated from tantalum and Trabecular Metal™ (Zimmer), fabricated from tantalum. Four animals were sacrificed at 6 weeks and six animals were sacrificed at 12 weeks postoperatively. The chambers were disassembled and the paired coupons with ingrown bone were removed and processed.

Faxitron Morphometry: Faxitron images were taken of the whole chamber along the anterior-posterior plane to show the amount of ingrown bone. These images were digitized, and the linear penetration of bone into the channel was calculated and expressed as a percentage of the total available length of the channel.

SEM and Histomorphometric Evaluation. The coupons and varying amounts of tissue that had grown between the coupons underwent SEM at 20x magnification using 10 kV and spot size of 5. A series of images were taken to cover the whole area of the channel. The other half of the tissue block of each channel was used to make thin sections for Stevenel’s blue / van Gieson picrofuchsin staining. All images were analyzed with image analysis software. The program was calibrated with a SEM image of a standard scale slide. The threshold of area for measurement was set from 1000 to 109 μm². Metal and bone were distinguished by their different grey levels. Data is presented as a percentage.Bone ingrowth is the amount of bone that occupied the available space within the porous metal. Bone depth is the amount of bone that extended into the depth of the porous metal. Bone in channel is the amount of bone that occupied the space between the paired coupons (Fig. 1).

Results:
In all channels both SEM and histological images showed a pattern of bone ingrowth. Bone grew from both sides of the channel towards the center, and from the space within the channel into the porous metal. Measurement on Faxitron images indicated no significant difference in the percentage of bone penetration of the newly formed cancellous bone within the channels at both time points. Histomorphometric analysis found that both porous materials elicited the same response; two-way ANOVA indicated that there was no significant difference between the two groups in any parameter. Time was not a factor affecting the results (p=0.20) and there was no interaction effect between time and type of materials (p=0.18). Further analysis was performed by pooling the two-timepoint data, again showing no significant difference between the two groups (Fig. 2).

Discussion:
The two porous metals elicited the same bone response in terms of bone ingrowth, bone depth and penetration in both the porous space and the channel. Bone penetration in the channel measured on histological stained sections seems to yield higher value than on SEM images. That may be caused by the fact that SEM only showed the mature bone, while histological section could demonstrate both mineralized bone and osteoid. There was no difference in any histological parameters as a function of time during the period of this study.

Significance:
Bone ingrowth into porous metal-backed orthopaedic implants is desirable for their fixation and functional performance. This study found that Tritanium™ and Trabecular Metal™ are equivalent in eliciting bone ingrowth.

Reference: