Bone induction by equine COLLOSS® E-filled titanium scaffolding material

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Statement of Purpose: The bovine extracellular matrix product COLLOSS® has been shown to contain native Bone Morphogenetic Proteins (BMPs), and thus has osteoinductive properties in animals [1]. Additionally, a recent case report highlighted the suitability of COLLOSS® material in a human clinical setting [2]. However, the use of bovine products is considered a risk factor for Transmissible Spongiform Encephalopathy (TSE) [3-4]. To overcome such problems recently an equine-derived version was developed, named COLLOSS® E. The purpose of this current study was to prove osteoinductivity of COLLOSS® E in a subcutaneous rat implantation model.

Methods: Disc-shaped (6mm diameter, 1 mm thickness) and tube-shaped (5 mm outer diameter, 3 mm inner diameter, and 10 mm length) implants were manufactured from titanium fiber mesh. The discs were impregnated with 2mg of COLLOSS® E material and subsequently lyophilized. The central space of tubes was filled with 20mg of COLLOSS® E material. To assess osteoinduction, both types of implants, as well as non-loaded control specimens, were implanted subcutaneously into the back of 18 young adult male Wistar rats. After implantation periods of two, eight and twelve weeks, the implants were retrieved with surrounding tissues, and sections were made for histological and histomorphometrical analyses.

Results / Discussion: Histology showed a thin fibrous capsule surrounding the titanium mesh and a very mild tissue reaction towards the fibers. The disc-shaped implants, loaded or non-loaded, showed no evidence of bone formation. Apparently the handling, which involved dissolution and lyophilization, was inadequate to retain functionality of the material.

For the tubular shaped implants a similar favorable reaction towards the titanium fibers was observed. In the COLLOSS® E-loaded tubular implants also the formation of bone-like tissue was evident, characterized by the presence of osteoblasts, and osteocytes embedded in a calcified extracellular matrix. Within this tissue, sometimes bone marrow-like tissue could be observed, characterized by the presence of fatty tissue and abundant haematopoietic cells. The newly formed bone tissue was mostly adjacent to the titanium material (Fig 1). Nevertheless, also some separate islands of bone tissue inside the central tube space could occasionally be observed.

Histomorphometry showed at two weeks of implantation 60% of the loaded tubes were positive for bone formation with a mean of 0,3 mm^2 newly formed bone-like tissue per histological section. After eight weeks this had increased to 0,7 mm^2. Finally after 12 weeks all implants showed newly formed bone like tissue, with an average area of 1,0 mm^2 per section.

In the non-loaded control tubes only connective tissue ingrowth was seen.

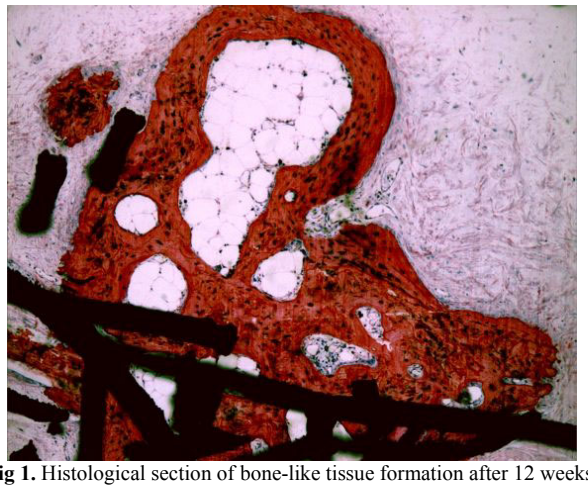

Fig 1. Histological section of bone-like tissue formation after 12 weeks. Note the presence of bone marrow-like tissue, and the adjacent titanium fibers.

Conclusions: In conclusion, it was demonstrated that the novel equine COLLOSS® E material, loaded in a titanium fiber mesh tube, exhibits osteoinductive properties, similar to the earlier used bovine variety of COLLOSS® [1]. It remains to be seen whether the effect on bone formation is depending on the amount of COLLOSS® E. The effect of COLLOSS® E has to be further investigated in large animal studies, in order to assess the possible clinical application of COLLOSS® E for bone reconstruction and bone tissue engineering procedures.

References:

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