Bone augmentation for inserting oral implants

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INTRODUCTION: Oral implants have been a vital part of reconstructive dentistry. The insertion of dental implants is a well-established procedure performed in many offices. Nevertheless, the successful osseointegration of dental implants depends on the proper implant surface and the bone-offer. Frequently, local bone defects result from tooth extraction or pathological absorption so that the insertion of an implant is impossible. In these cases, bone augmentation is required before implantation. The reconstruction with autologous bone, which is still the gold standard, is often difficult for surgeon and patient, as it has to be taken from intra- or extra-oral donor sites. Therefore, bone substitutes are playing a more and more important role in augmentation surgery. Their composition and microstructure is responsible for the osseo-integration and osseo-conduction of the implants. In this communication, we evaluate bone augmentation materials of established suppliers.

MATERIALS & METHODS: Synchrotron radiation-based micro computed tomography (SRμCT) has been developed to a complementary method to histological sectioning. Because bone augmentation treatments using artificial calcium phosphate phases need months, one aims to identify the most effective biomaterials for bone augmentation. Here, we compare a set of specimens from patients, who obtained comparable treatments with different ceramic biomaterials. Before implant insertion, the oral surgeon prepares the hole for the implant by means of a hollow drill, which enables storing the specimens for detailed SRμCT-measurements and -analysis. One typical bone augmentation material is easy-graft™ (Degradable Solutions AG, Schlieren, Switzerland). Such a specimen has been harvested after about six months and embedded for SRμCT measurements at the beamline W2 (HASYLAB at DESY, Hamburg, Germany), which is operated by the Helmholtz Centre Geesthacht, Germany. Using a photon energy of 25 keV, 900 radiographs between 0 and 180° were recorded. The pixel size after two-fold binning corresponds to 4.3 μm. The reconstruction by means of the filtered back-projection algorithm provided a tomography with a size of 1526 × 1526 × 835 voxels. VG Studio Max 2.1 (Volume Graphics, Heidelberg, Germany) served for the visualization of the virtual slices.

RESULTS: Fig. 1 shows three virtual cuts perpendicular to each another through the tomogram of the PMMA-embedded easy-graft™ biopsy. The bright spherically shaped features belong to the augmentation material and are not yet fully absorbed. The gray-coloured parts are newly formed bony tissues with characteristic morphologies.

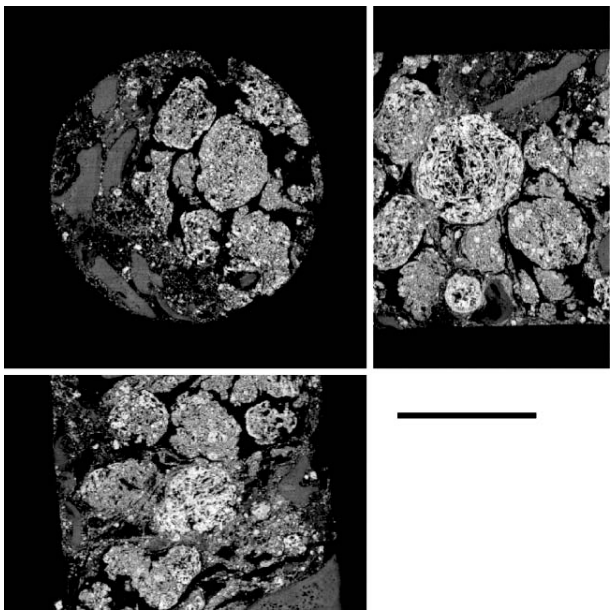

Fig. 1: Three orthogonal virtual cuts through the tomogram of a biopsy extracted from human jaw six months after augmentation material placement. The bar corresponds to 1 mm.

DISCUSSION & CONCLUSIONS: SRμCT provides three-dimensional data that allow for the quantification of newly formed bone and absorbed augmentation material. Furthermore, one can determine the contact areas between bone and biomaterial to characterize the established materials for bone augmentation. The present study, which includes different research teams, finally aims to identify bone augmentation materials with optimized performance.

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