Combination of micro computed tomography and histology for the investigation of bone grafting

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INTRODUCTION: Bone grafting is often an inevitable procedure to ensure the required bone offer for the successful insertion of dental implants. In clinical studies, bone grafting is usually analysed by histology. In the present study we additionally investigated bone grafting by means of synchrotron radiation-based micro computed tomography (SRμCT) and multimodal imaging[1].

METHODS: The extraction defect was filled with a Bio-Oss® block (Geistlich Pharma AG, Wolhusen, Switzerland) and covered with a Bio-Gide® collagen membrane (Geistlich Pharma AG, Wolhusen, Switzerland). After eleven months the biopsy was harvested. The synchrotron radiation tomogram was acquired at the beamline W2 operated by HZG at DORIS III (DESY, Hamburg, Germany) in absorption-contrast mode with a photon energy of 25 keV and a pixel size of 2.2 μm. Subsequent to the SRμCT, histological slices were prepared and toluidine-blue stained. Finally, the corresponding tomographic slice was selected from the volumetric SRμCT data. Due to the limited information in the two-dimensional (2D) histology with respect to the three-dimensional (3D) SRμCT data, first a pre-selection of the corresponding μCT slice was performed - manually and automatically - followed by 2D-2D non-rigid registration.

RESULTS: After grafting material insertion and healing period, there was sufficient bone to place the implant. Figure 1 shows the joint histogram of the histology slice and the corresponding tomogram as well as the related slices. The distinct attenuation coefficients of bone, grafting material and soft tissue/embedding material give rise to three well-defined clusters. The histogram of the μCT data set allowed distinguishing the biopsy components by intensity-based segmentation (thresholding). The specimen included 14.2 vol% newly formed bone (gray), 57 vol% soft tissue/embedding material (black) and 25.7 vol% bone augmentation material (white).

DISCUSSION & CONCLUSIONS: The SRμCT directly allowed for the segmentation of bone augmentation material and newly formed bone. Previous studies[2,3] have shown that this is not always the case. Often, the grafting material cannot readily be distinguished from forming bone based on attenuation alone. In these cases, the combination of histology and CT allows to master this challenge.

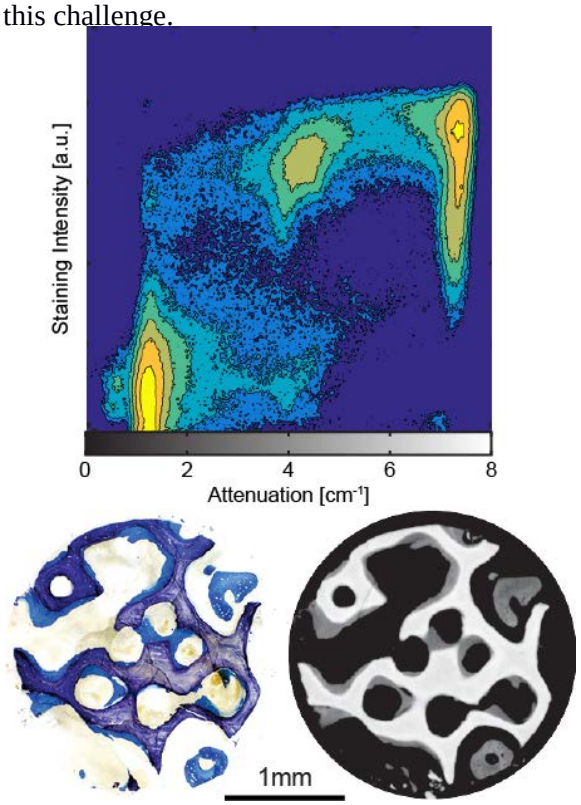

Fig. 1: Joint-histogram (top) of a histology slice (ordinate) and a SRμCT slice (abscissa). The related slices are displayed on the bottom.

In this study the discrimination between the less mineralized, newly formed bone and the fully mineralized bone is easier in the SRμCT data than in the histology data.

REFERENCES: [1] G. Schulz et al. (2012) *Scientific Reports* **2**: 826. [2] B. Ilgenstein et al. (2012) *Proc SPIE* **8506**: 85060M. [3] A. Stalder et al. (2014) *Int J Mat Res* **105**: 679-691