Trabecular bone structure parameters from cone beam computed tomography data

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Short Summary:

15 bone samples from the radius were examined by CBCT. Micro CT was used as reference when quantifying trabecular bone structures. All parameters from CBCT were strongly correlated to μCT, with correlation above 0.90. CBCT overestimated BV/TV and Tb.Th more than three times compared to μCT. Tb.Nd, Tb.Sp and Tb.N were underestimated.

Purpose/Objectives:

CBCT is a clinical equipment, used in mandible, maxillofacial and temporal bone imaging. As the mandible is known to be involved in osteoporosis, objective calculations of bone structure parameters in the mandible may be useful in diagnosing osteoporosis. The aim of this in vitro study was to develop a method for quantitative assessment of trabecular bone micro architecture by using three-dimensional image processing to data acquired with CBCT using micro-computed tomography (μCT) as reference.

Methods and Materials:

15 bone samples from the radius, which like the mandible consists of trabecular bone enclosed in compact bone, were examined in the CBCT device Accuitomo FPD. Imaging protocols differed in tube current and voltage settings, rotation degree, voxel size, imaging area and rotation time. After segmentation, bone structure parameters; bone volume (BV/TV), trabecular thickness (Tb.Th), trabecular separation (Tb.Sp), trabecular number (Tb.N), trabecular nodes (Tb.Nd) and trabecular termini (Tb.Tm) were quantified. The calculations were performed on an ordinary PC with a MATLAB code developed in-house. Radiation doses were measured using a KAP-meter.
**Results:**

CBCT overestimated BV/TV and Tb.Th more than three times compared to μCT. On the other hand Tb.Nd, Tb.Sp and Tb.N were underestimated. Tb.Tm was overestimated by the 80 μm voxels and underestimated by the 125 μm voxels. All parameters from CBCT were strongly correlated to μCT, with correlation coefficients above 0.90 for all studied parameters. The protocol with 180 degree rotation and 80 μm voxels showed the weakest correlation parameters. The radiation doses varied between 269 and 1284 mGycm². The protocol most often used in our clinical practice; 80 μm voxels, 40x40 mm volume, 85 kV, 5 mA and 360 degree rotation showed strong correlations with μCT and low dose.

**Conclusion:**

The strong correlation between CBCT and micro CT regarding bone structure parameters indicates the possibility to quantify and monitor changes of trabecular bone microarchitecture by CBCT also in vivo.

**Keywords:** CBCT, Trabecular bone, Image processing, Micro CT, Osteoporosis