

Comparison of Computed Tomography and Microradiography for β -TCP Graft Evaluation after mandibular reconstruction.

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INTRODUCTION: Among the investigated synthetic bone graft substitutes ceramic materials like Hydroxylapatite (HA) or β -Tricalcium-Phosphate (β -TCP) have proved effective¹. Unfortunately, the close chemical and physical proximity to trabecular bone results in a comparable radiodensity. The reliability of non-invasive, radiological in vivo evaluation methods remains questionable². The aim of the study was to assess reliability and accuracy of computed tomography for evaluation of β -TCP grafted bone defects.

METHODS: Twelve adult black-headed sheep underwent segmental resection and reconstruction of the right hemi-mandible. Animals assigned to group I (n=6) were grafted with blood soaked β -TCP cylinders while sheep assigned to group II (n=6) received blood soaked β -TCP composites loaded with autogenous cancellous bone and bone marrow. The sheep were sacrificed twelve weeks after surgery. The cranium of each animal was scanned in a standard CT scanner and mandibular segments were resected and processed for microradiographic evaluation. Microradiographs were aligned, converted into a serial DICOM dataset and fused with the corresponding CT data (Fig. 1) to allow comparison of ceramic area estimates as well as Hounsfield Units of bone and β -TCP. The t-test and chi-square test were used to compare CT and microradiographic area measurements.

RESULTS Two animals developed inflammation of the graft side and graft dislocation that that was visible on CT images. Affected animals were excluded from further evaluation. Grafts in group I presented moderate ceramic degradation (54 ± 10 %) and incomplete osseointegration. HU estimates for ceramic material (384-1336 HU) and bony callus (436-1269 HU) were comparable. Statistical comparison of area estimates based on CT and microradiography revealed a significant bias ($p < 0.05$, t-test) and a non-significant variance. Group B achieved bony union of the defects and the β -TCP cylinders underwent profound degradation (94 ± 3 %). New bone and integrated ceramic remnants presented equal HU (ceramic: 231-981 HU; bone: 168-1356 HU). Statistical comparison of area estimates revealed no significant bias and a significant variance ($p < 0.05$, chi-square test).

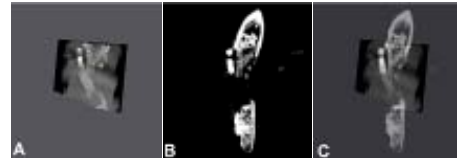


Fig. 1: Microradiograph (A), CT image (B) and Fusion of both (C).

DISCUSSION & CONCLUSION: Our results indicate that a reliable quantification of ceramic degradation or new bone deposition within a β -TCP graft is not possible with conventional CT. Both, ceramic material and bony callus present a comparable density and the resolution of standard CT images does not allow visualization of the three-dimensional microstructure. Area estimates either showed significant differences of mean values (group I) or significant variance (group II). Ceramic bone graft substitutes are already commonly used for various surgical indications but until today only one comparable study exists³. We need to continue to verify in vivo diagnostic methods for bone graft evaluation to optimize post surgical patient care.

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