

Accurate In Vivo Assessment of Caries Lesion Extent by UTE MRI

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Background:

Conventional X-ray (XR) imaging methods applied in clinical dentistry are known to underestimate caries lesion dimension. The extent of mineral loss does often not well correspond with the front line of bacterial infection. However, information about the true lesion size appears mandatory for planning restorative procedures and especially for the assessment of the real distance of the lesion from the nerve and root channels. The bacterial infection causes an increase of protons already at a very early stage. The formation of liquid pools with concomitant increase of T2* may enable MRI to assess the accurate extent of the lesions by means of ultra-short echo time MRI imaging techniques (UTE/ZTE/SWIFT). The objective of this study is to investigate the potential of UTE for the accurate assessment of caries lesion extent.

Methods and Materials:

Four patients were enrolled in this study. Prior to the MRI investigation, all patients underwent a conventional clinical dental investigation including optical assessment of the teeth as well as either a conventional panoramic tomography or a bite-wing XR. The MRI data was acquired on a 3-Tesla whole body system (Achieva, Philips Medical, Best, Netherlands) with a prototype two times two-element carotid artery coil sized 120 × 50 mm (Philips Research Europe, Hamburg, Germany). The coil was located on one side of the jaw aligned with the central line between upper and lower jaw and fixated with a Vac-Lok neck cushion (Medtec, USA). Acquisition parameters for the diagnostic three dimensional UTE sequence with nonselective excitation were: TE/TR = 0.05/4.7ms; spatial/reconstructed resolution = 0.8/0.5mm³; FOV = 120mm; pixel bandwidth = 800Hz. Additionally a T1 weighted spin-echo sequence was applied to classify the lesions in the categories (CI, CII, CIII) [1]. Areas showing a signal enhancement of more than two times the standard deviation of the surrounding tissue were classified as lesions.

After the MR examination all patients underwent a standard clinical dental treatment. Each step of the treatment was documented with intra and extraoral pictures and impressions before and after excavation. Pictures were taken prior to the treatment, after the fissure sealant or filling removal, after the excavation and after the filling. The impression after excavation was x-rayed and the lesion size of the impression was qualitatively compared to the results of the in-vivo MR and XR measurements.

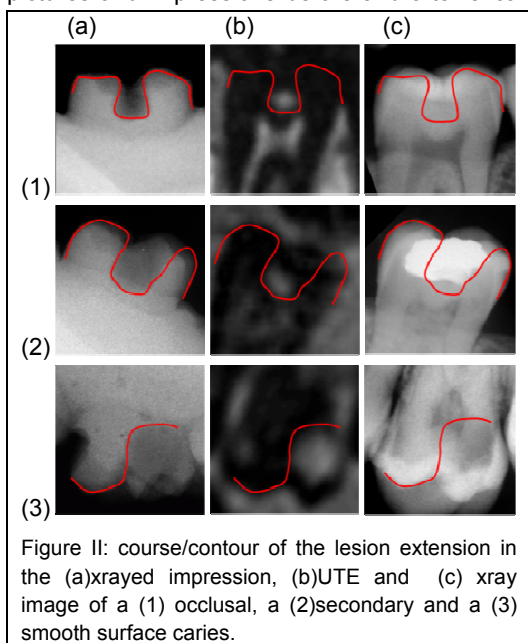


Figure II: course/contour of the lesion extension in the (a)xrayed impression, (b)UTE and (c) xray image of a (1) occlusal, a (2)secondary and a (3) smooth surface caries.

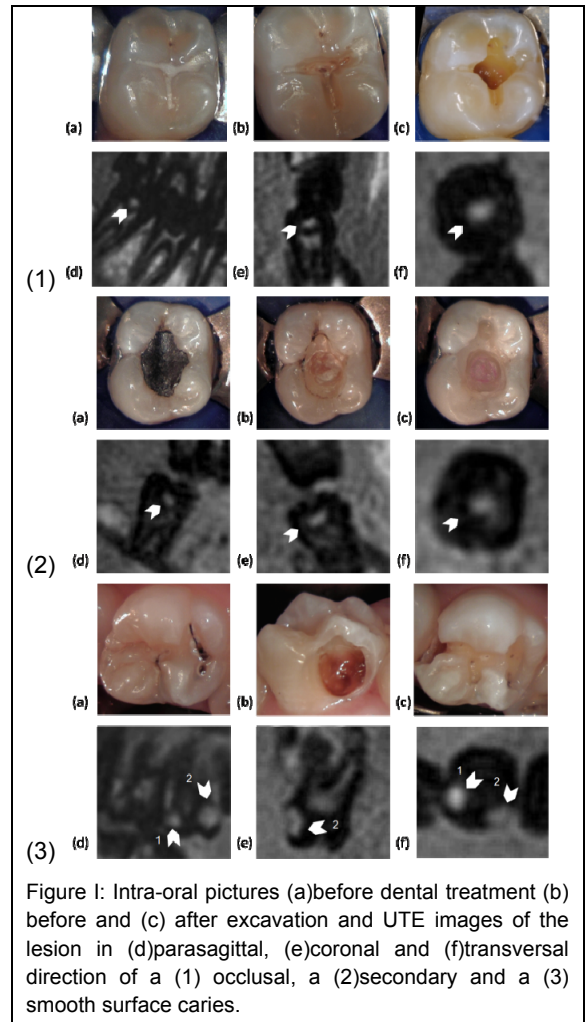


Figure I: Intra-oral pictures (a) before dental treatment (b) before and (c) after excavation and UTE images of the lesion in (d) parasagittal, (e) coronal and (f) transversal direction of a (1) occlusal, a (2) secondary and a (3) smooth surface caries.

Results:

Fig.1 shows examples of the MRI and intra-oral images of lesions, which are difficult to assess by XR imaging (fig. 2 c). For all lesions, the contour of the caries lesion in the UTE images fits excellently to the respective appearance of the lesion in the XR images of the impressions taken after excavation. As expected, the lesion size in the XR images was substantially underestimated, when compared to the size in the impressions for the CI and CII lesions. Only for a progressed CIII lesion (Figure II (3)) the size in XR image fits well with the UTE image and the imprint.

Discussion:

Ultra-short echo time imaging appears to be feasible to detect the front-line of the bacterial infection and therefore the real size of the caries lesion.

References: [1] Bracher et. al., ISMRM 2010:2974