Dental Restorations – Crowns, Bridges and Inlays – Produced Using In Vivo Dental MRI

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Introduction

The MRI-based contrast-enhanced method of tooth surface digitization was recently suggested as an alternative approach of making dental impressions [1]. This technique is based on the contrast between the teeth and surrounding contrast medium in the mouth of the patient. The obtained negative impression of the tooth surface can be directly used for production of dental restorations by means of CAD/CAM technology. It was shown in a phantom study [2] that tooth surface digitization with an accuracy sufficient for production of dental restorations is feasible using a clinical whole-body MRI scanner. A dedicated intraoral RF coil was developed to achieve high SNR *in vivo* [3,4]. The purpose of this study was to produce dental restorations using MRI-based tooth surface digitization *in vivo*.

Subjects and Methods

The study involved four volunteers with six damaged teeth prepared for dental restorations: two for crowns, two for a bridge and two for inlays. The volunteers were examined on a 1.5 T whole-body MRI scanner (Magnetom Avanto; Siemens Medical Solutions, Erlangen, Germany) using an intraoral RF coil and agar-based oral contrast medium [3,4]. A 3D TSE was used with TR/TE=400 ms/12 ms, TF=5, average FoV=60x30x17 mm^3 and nominal resolution 310x310x350 μm^3, reconstructed to 60x60x70 μm^3 by means of Fourier interpolation. The scan time was 8 min. The obtained datasets were segmented and the surface of the teeth was reconstructed in STL format (Amira; ZIB, Berlin, Germany). Dental restorations were modeled for the MRI surfaces and produced using CAD/CAM technology. Fit of the restorations was evaluated using a dental silicone material.

Results

As an example, Fig.1 shows (a) teeth prepared for a bridge, (b) one slice from a 3D MRI dataset, (c) the reconstructed tooth surface and (d) the bridge produced for this surface using CAD/CAM. For all six measured teeth the average fit of the restorations was below 100 µm. The bridge manufactured using the MRI data showed a better fit than the bridge made using the conventional procedure.

Discussion and Conclusion

For the first time dental restorations were produced using *in vivo* MRI-based tooth surface digitization. The resulting fit of the restorations demonstrates feasibility of the *in vivo* technique. For clinical use further optimizations are required with respect to patient motion, contact between tooth surface and soft tissues, as well as artifacts caused by dental materials.

Acknowledgements

References

[1]Tymofiyeva O et al, 2007, Proc. ISMRM/ESMRMB, Berlin, Germany, abstract 3007.
[2] Schmid F *et al*. Proc. ICMRM, Aachen, Germany, 2007, abstract P103.
[3] Tymofiyeva O *et al*. Proc. ICMRM, Aachen, Germany, 2007, abstract P19.
[4] Tymofiyeva O *et al*. Concept Magn Reson B: Magn Reson Eng 2008, 33B, p. 244-251.
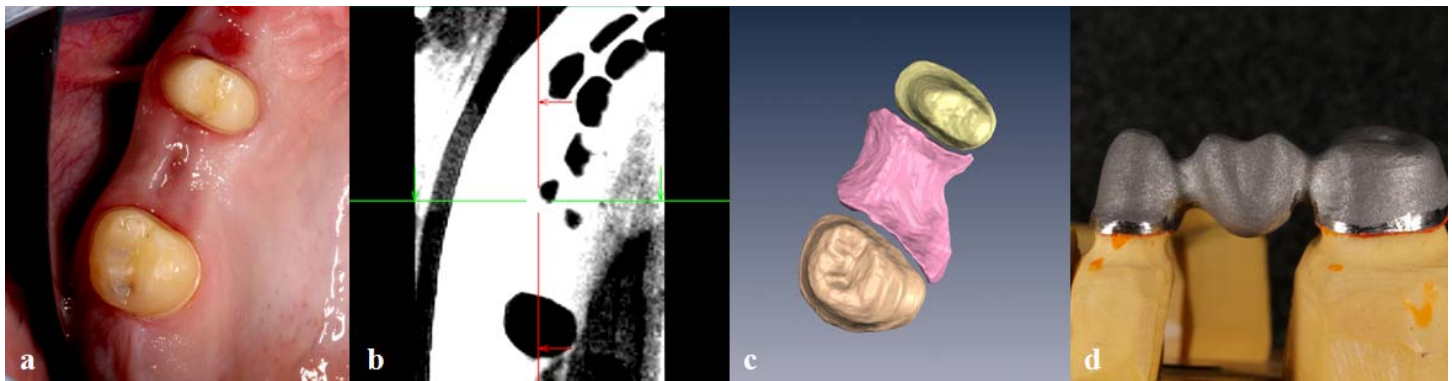
Fig. 1. (a) Teeth prepared for a bridge. (b) Slice from a 3D MRI dataset acquired *in vivo* within 8 min. (c) 3D rendering of the tooth surface. (d) CAD/CAM bridge produced using the MRI data.