Accuracy of VIBE and TSE for High Resolution Imaging of the Mandibular Nerve

Jakob Kreutner[1], Andreas J. Hopfgartner[2], Julian Boldt[3], Kurt Rottner[3], Ernst J. Richter[3], Peter M. Jakob[1,2], and Daniel Haddad[1]

[1]MRB-Research Center Magnetic-Resonance-Bavaria, Würzburg, Germany, [2]Experimental Physics 5, University of Würzburg, Würzburg, Germany, [3]Prosthodontics, Dental School, University of Würzburg, Würzburg, Germany

Introduction: The course of the mandibular canal can often be a barrier in maxillo-facial surgery, e.g. by limiting the size of implants or the risk of damaging the nerve in the case of tooth extraction. Recent studies have proven that MRI is a reliable imaging technique for localizing the mandibular nerve[1-3]. A widely used protocol encompasses a 3D VIBE sequence with anisotropic voxel size[2,3] and it has been shown further, that the obtainable precision is as good as with cone beam computed tomography (CBCT). If only one lateral side of the dental arc is the region of interest, probably for a surgery, it might be advantageous to take look at this specific side at higher resolution. To this purpose, an alternative protocol using a turbo spin echo (TSE) sequence in combination with local look technique[4] has already been introduced[5]. Yet, no quantitative comparison with respect to precision between the new method and the commonly used VIBE sequence has been presented. Hence both sequences were deployed on volunteers and the precision of the methods was evaluated.

Materials and Methods: As an initial study four volunteers underwent MRI examination using a 3D VIBE (TR=9.7ms,TE=2.9ms) in combination with regional saturation bands in order to avoid aliasing artifacts as well as a 3D TSE (TR=500ms, TE=9.7ms, TF 8) with an implemented local look technique. The nominal resolution of both sequences was 0.5x0.5x0.5mm³ with a scan time of 6.5 min for each sequence. All measurements were performed at a 1.5T system (Magnetom Avanto, Siemens, Germany) in combination with a 4+4 channel multifunctional coil array (NORAS MRI products, Germany) that was placed on each side of the volunteers' mandible and served as a fixture to avoid motion artifacts.

The images have been postprocessed using Amira (VSG, USA) and were interpolated to an isotropic voxel size of 0.25mm. For each image set a surface model of the nerve canal was calculated by a manual segmentation for each sequence. To quantify the difference of both sequences a two-sided surface distance was calculated and the root-mean-squared (RMS) difference was taken as a measure of equality.

Results: Figure 1 shows a representative segmented surface of the nerve canal resulting from a TSE image. The color map applied to the surface represents the local difference to the surface of the VIBE data. A slice of the underlying data set can be seen in the background. The overall match is quite high as represented by the large areas of blue. A list of observed RMS differences for four volunteers can be seen in Tab. 1. None of the observed RMS differences is much higher than the nominal resolution of the data. Furthermore, the TSE images exhibit a higher signal to noise ratio, which is clearly recognizable in the region of the upper jaw.

Discussion: Both sequences allow a good distinction of the mandibular nerve canal from the surrounding bone marrow and the teeth's components. The average difference is only on the same order as the voxel size and therefore both methods yield very identical results. The higher SNR in the TSE images shows that there is still potential in improving either resolution or scan time, e.g. by applying partial Fourier scanning.

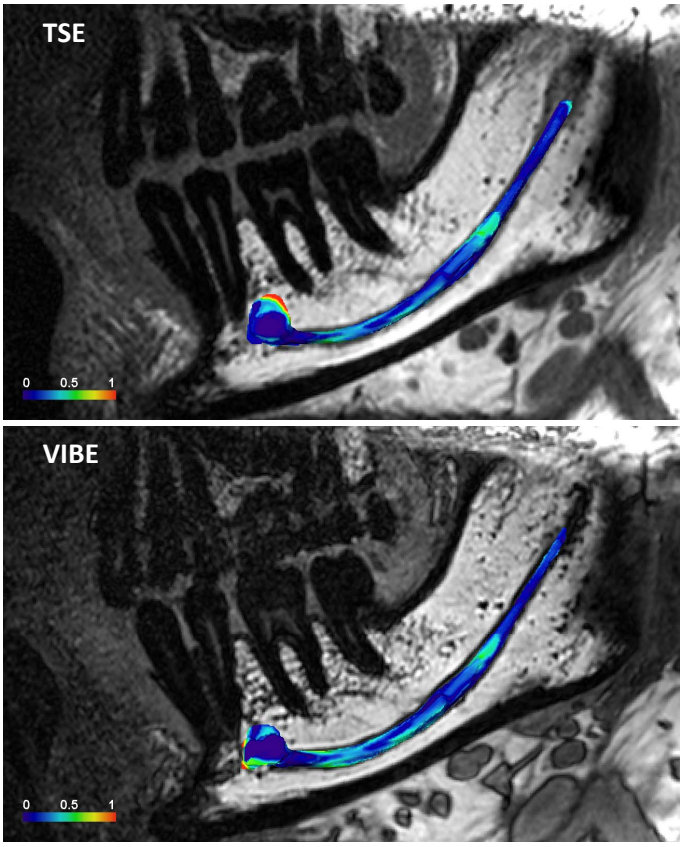

Fig. 1: Surface reconstruction of the nerve canal (colored) and a representative slice of the underlying image data set (background) from the same volunteer (top: TSE, bottom: VIBE). The color of the surface represents the local distance to the surface reconstructed from the other data set. The RMS difference is 0.42 in this case.

Conclusion: Our data suggest that a TSE sequence provides the same precision in depicting the mandibular nerve canal as a VIBE sequence. Furthermore the higher SNR from TSE can be transformed in even shorter acquisition times. The local look technique allows for an easy setup of the protocol due to the fact that no additional regional saturation bands have to be placed carefully. Since all relevant anatomical structures, including dents and pulp are very well depicted MRI can be used as an alternative to CBCT without ionizing radiation providing good tissue contrast and high resolution.

Patient	RMS Difference [mm]
1	0.42
2	0.54
3	0.24
4	0.42

Tab. 1: Root-mean-squared surface difference.

Acknowledgments: This work was funded by the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology (BayStMWIVT) and received grants from the EC as part of FP7-Health project 242175 "VascuBone".

References

1. Eggers G. et al. Dentomaxillofac Rad., 2005;34:285-291
2. Goto T. et al. OOOOE, 2007;103:550-559
3. Chau A. et al. Clin. Oral. Impl. Res, 2012;23:253-256
4. Feinberg, D. et al. Radiology, 1985; 155:437-442
5. Kreutner J, et al. Proc. Intl. Soc. Mag. Reson. Med. 2013; 21:2395