MR artifact reduction for dental alloys using MAVERIC sequences

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Purpose

PET/MR has been shown to have a high potential for staging in patients with oropharyngeal cancer [1]. Dental alloys cause substantial artifacts in the oral cavity and therefore might impair the diagnostic accuracy for the determination of the local extent of malignancies. Furthermore MR-based attenuation correction (AC) might also be affected substantially [2], since MR attenuation correction is generally based on T1-weighted dual-echo gradient echo pulse sequences. The aim of our study was to test new sequences for MR artifact reduction in the oropharynx, comparing a high-bandwidth T1 fast spin echo (FSE) sequence with MAVRIC and an optimized MAVRIC sequence, in patients with dental alloys.

Methods

Eleven patients referred for an oncology examination were scanned using a tri-modality setup, consisting on a GE Discovery 750w 3T MR system located in an adjacent room to a Discovery 690 PET/CT. Patients were transported between the two systems with a dedicated transfer device, enabling consistent patient placement between the scans. For AC a dual-echo gradient echo pulse sequence (LAVA-Flex) decomposed with a Dixon-based processing into in-phase, water-only and fat-only contrasts were used. Of those the in-phase images were used as reference. For comparison a T1 - FSE sequence with increased bandwidth (3.2 minutes) was implemented as well as a MAVRIC sequence (6 minutes: TR 4000 ms, with phase acceleration of 2) and an optimized MAVRIC sequence for shorter acquisition time (3.5 minutes, TR 3000 ms with phase acceleration of 3) with 7.2 cm axial and 24 cm transaxial field-of-view was acquired, with a resolution of 0.6x0.9x3 mm^3. The signal void was measured in mm^2 for every implant in all 4 sequences. The relative and absolute reduction in signal void was calculated.

Results

There was a substantial reduction of signal void from LAVA sequences to the T1 weighted FSE sequences of median 2.7 cm^2 (range 0.03-12.8 cm^2) (Figure 1) this could even be improved by MAVRIC with a reduction in signal void of median 2.9 cm^2 (range 0.12-13.5 cm^2) and MAVRIC fast with median 3 cm^2 (range 0.4-13.4 cm^2). The relative reduction in signal void was significantly larger for MAVRIC compared to T1 FSE ($p = 0.001$) and even significantly higher for MAVRIC fast ($p = 0.004$) compared to MAVRIC (Figure 2).

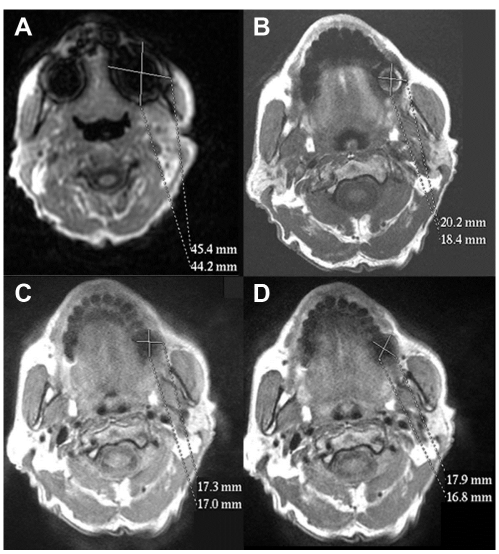

Fig. 1: A) LAVA in-phase axial of the maxilla with large signal voids in two molar areas due to dental alloy. B) T1 FSE with marked reduction in signal void. C) MAVRIC with further reduced signal void compared to T1 FSE and D) MAVRIC fast with a scan time of only 3 minutes has a similar image quality and signal void reduction compared to MAVRIC.

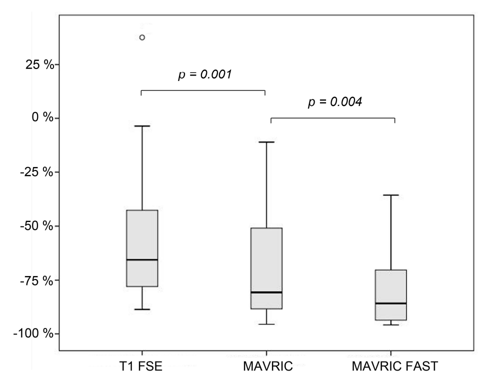

Fig. 2: Relative decrease in signal void for all three MR sequences compared to LAVA-Flex acquired for routine MR attenuation correction.

Discussion

PET/MR acquisition for AC should be performed during PET data acquisition. Usually only 2 minutes per bed position are intended to be spent on AC data collection. Therefore fast gradient echo sequences allowing for tissue differentiation have been proposed[3]. However they are well known to have large metal artifacts. With an additional 3.5 minute scan using MAVRIC fast, the jaw could be imaged with only minimal signal void caused by dental alloys.

Conclusion

This results show that MAVRIC could be used for PET/MR in patients with dental alloys to reduce metal artifacts in the jaw. This could increase diagnostic accuracy and also improve MRI based AC.

References

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