Metal artifact reduction using MAVRIC in the presence of common orthodontic appliances

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Target Audience: Neuroradiologists, clinicians, physicists, and technologists performing head and/or neck MR imaging of subjects with orthodontia, and orthodontists

Purpose: Orthodontic appliances are well known to produce artifact and geometric distortion in MR imaging of the head and neck.[1] This study aimed to investigate the extent of artifact induced by several common orthodontic configurations, and to evaluate the utility of new metal artifact reduction sequences (MAVRIC[2]) for evaluating tissues near the appliances. This information is of interest to clinicians making recommendations to remove orthodontia prior to an MR exam, and to MRI departments when patients present for their MR exam with orthodontia in place. The aim of our study was to quantify the artifact reduction when utilizing MAVRIC sequences to image orthodontic appliances on an anthropomorphic phantom. This information can be used to examine the recommendations for removal of orthodontic appliances prior to MR examinations.

Methods: Vacuum formed plastic orthodontic retainers were fabricated to fit the dentition of an anthropomorphic skull obtained for use in this study. Various orthodontic appliances (stainless steel (SS) brackets, ceramic brackets with a SS insert, SS fixed retainers) were embedded within multiple sets of plastic retainers. The anthropomorphic phantom was immersed in a copper sulfate solution, and imaged with no fixtures and then with each of the three orthodontic configurations. Four scan techniques were acquired for each configuration, including T1 Cube [TR=600ms, TE=10.5ms, 180 -1mm slices, 256x256 matrix, 62.5 kHz receiver bandwidth (BW), ETL=24, 4:12 acquisition time (TA)], high BW T2-weighted FSE [TR=3000ms, TE=98ms, 27 - 3mm skip 1mm slices, 384x256, 83 kHz BW , ETL=16, 1:42 TA], MAVRICSL [TR=3200ms, TE=6.8ms, 56 -3mm slices, 320x256 matrix, 125 kHz BW, ETL=20, 8:13 TA], and a modified MAVRIC sequence "T1 MAVRIC" [TR=700ms, TE=6.8ms, 56 - 3mm slices, 320x256 matrix, 125 kHz BW, ETL=8, 6:37 TA] using an 8-channel brain coil on a GE Discovery 750 3T system at DV24 software. For each technique, the area of transverse and longitudinal signal voids was measured in units of mm^2. A healthy volunteer subject was also scanned under an IRB-approved protocol with the same four scan techniques while wearing plastic retainers with and without SS brackets to demonstrate correspondence with the anthropomorphic skull phantom.

Results: Figure 1 shows a large reduction in signal void when comparing MAVRIC to both T2 FSE and T1 Cube for all orthodontic appliances. For the ceramic brackets (white arrows, Fig. 2), the artifact area was small for all scan techniques (<30mm^2), and was not included in Fig 1. For the stainless steel brackets, there was an average artifact area reduction of 51% between T2 FSE and SL MAVRIC and an 85% reduction between T1 Cube and T1 MAVRIC. The type of orthodontic appliance had a significant impact on the size of the signal void in all scans. Our study agrees with previous work which demonstrated a significant reduction in artifact around metal prosthesis[3] and dental alloys[4] using novel MAVRIC sequences.

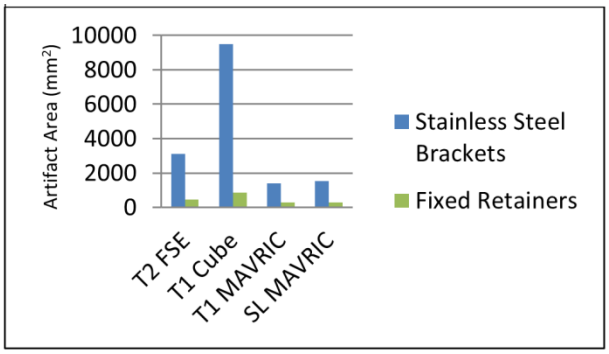

Fig. 1: Signal void for SS brackets and fixed retainer for each acquisition method obtained on an anthropomorphic skull.

Discussion and Conclusions: Metal artifact in the presence of orthodontic appliances is a significant dilemma facing both MR clinicians and orthodontists. The MAVRIC sequence displays promising results for reducing signal void and geometric distortion. Utilizing MAVRIC sequences it may be possible to decrease the frequency that orthodontic appliances need to be removed for MR imaging; therefore reducing the burden and healthcare cost of removal from both a patient and clinical perspective.

The results demonstrate the utilization of MAVRIC sequences in MR imaging of subjects with orthodontia may make it unnecessary to remove all appliances prior to image acquisition. The MAVRIC sequences used for this study could benefit from specific customization for neuro imaging, and could be used as problem solving sequences for tissues near the appliance. The determination for appliance removal would need to be based on the anatomical areas of interest as the extent of the artifact can be greatly diminished with MAVRIC.

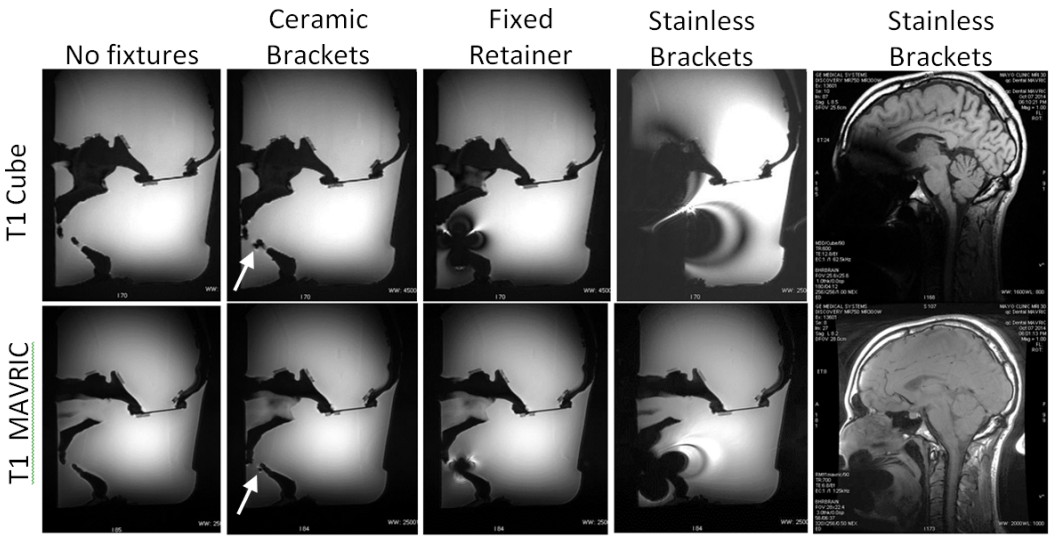

Fig. 2: T1 Cube and T1 MAVRIC sagittal scans demonstrating metal artifact for orthodontic appliances. White arrows indicate location of ceramic brackets.

References:

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