

## Fat-saturated T2-weighted Imaging with Slice Encoding for Metal Artifact Correction (SEMAC) at 3T

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**Objective:** As the frequency of spinal fusion surgery is increasing, post-operative imaging evaluation of prosthesis-related complications is becoming more important. In the presence of a metallic prosthesis, it is inevitable that metallic artifacts including signal loss, signal pile-up, and image distortion is present on magnetic resonance (MR) imaging. Advanced metal artifact-reducing MR techniques including slice encoding for metal artifact correction (SEMAC) and multi-acquisition variable-resonance image combination (MAVRIC) have proven useful in overcoming these metallic artifacts. Fat-suppressed T2-weighted images can provide higher tissue contrast by suppressing bright fat signal, which makes it easy to detect small fluid signals. Detection of pathologic tissue is enhanced with fat-saturation MR imaging, and fluid-sensitive MR imaging is able to play an important role in the postoperative evaluation of metal prosthesis-related pathology. To our best knowledge, however, fat-saturated SEMAC-corrected spinal MR images with metal artifact reduction have not been evaluated. We thought the combination of an advanced metal artifact reducing technique and fat suppression would be useful in metallic MR imaging. Considering the advantages of 3T MR imaging of the spine such as an increase in SNR with optimized diagnostic quality and improved clinical impact, implementing fat-suppressed SEMAC-corrected at 3T MR is one of the major goals in metallic MR imaging. The purpose of this study was to investigate the feasibility and usefulness of fat-saturated SEMAC-corrected MR images at 3T MR imager in minimizing metal prosthesis-related MR artifacts in patients with spinal prostheses.

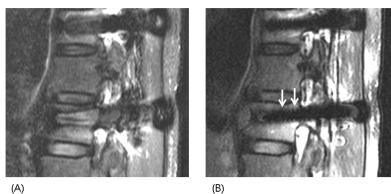
**Method:** Following institutional review board approval, 27 SEMAC-encoded spinal MR between September 2012 and October 2013 in patients with spinal metallic prostheses were analyzed. The MR images were scanned on a 3T MR system including SEMAC-corrected and uncorrected fast spin echo (FSE) T2-weighted MR images with fat-saturation. Two musculoskeletal radiologists compared the image sets and qualitatively analyzed the images using a five-point scale in terms of artifact reduction around the prosthesis, visualization of the prosthesis and pedicle, and intervertebral neural foramina. Quantitative assessments were performed by calculating of the ratio of signal intensity from the fixated vertebra and that from upper level vertebra. For statistical analyses, paired t-test was used.

**Result:** Fat-saturated SEMAC-corrected T2-weighted MR images enabled significantly improved metallic artifact reduction ( $P<0.05$ ). The conventional uncorrected fat-saturated FSE T2-weighted MR images showed metallic artifacts around the prosthesis, including prosthetic signal loss and signal pile-up. The pedicle screws were distorted with heterogeneous signal intensities. On the other hand, the fat-saturated SEMAC-corrected MR images had significantly metallic artifact reductions with good delineation of the prosthesis, pedicle, and peri-prosthetic region. The qualitative analysis of the image quality in terms of artifact, prosthesis/pedicle visualization, and neural foramen showed statistically improved on the fat-saturated SEMAC-corrected MR images (All are  $P<0.05$ ). The quantitative evaluation of signal intensity ratios of the fixated and upper level vertebral bodies to the upper level vertebra were  $2.95 \pm 1.23$  and  $2.18 \pm 1.13$ , respectively (Fig. 4,  $P=0.01$ ). However, the area of high intensity of signal pile-up, which is shown around the prosthesis, could be not completely corrected ( $219.3 \text{ mm}^2$  vs  $236.9 \text{ mm}^2$ ,  $P>0.05$ ).

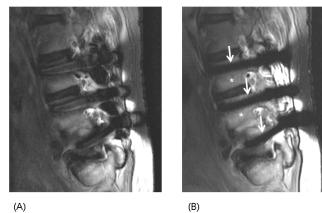
**Conclusion:** SEMAC correction in fat-suppressed T2-weighted MR images can overcome the signal loss of metallic artifacts and provide improved delineation of the pedicle screw and peri-prosthetic region. Signal pile-up, however, could not be corrected completely, therefore readers should be cautious in the evaluation of marrow around the prosthesis.

### References

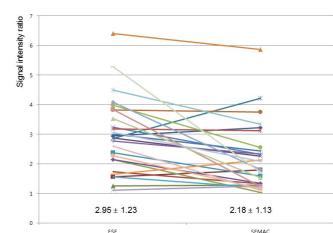
Lu et al. Magn Reson Med 2009;62:66-76 Lee et al. Magn Reson Imaging 2013;31:703-6 Cha et al. Radiology 2011;259:885-93



**Fig. 1**—A 46-year-old man with a history of posterior lumbar interbody fixation of T12-L2. (A) Fat-saturated uncorrected T2-weighted sagittal imaging shows metallic susceptibility artifact around the metallic prostheses. (B) Fat-saturated SEMAC-corrected T2-weighted MR imaging at the same level shows reduced the metallic artifact. The pedicle prostheses are clearly visualized, and the screw pitch of bone-prosthesis interfaces are sharply demarcated screw pitch (arrows). The signal intensity in the SEMAC-corrected image of the screw-fixated bone marrow was relatively higher than that in the conventional MR image (asterisks).



**Fig. 2**—A 66-year-old woman with a history of posterior lumbar interbody fixation of L3-4-5. (A) Fat-saturated uncorrected T2-weighted sagittal imaging suffers from metallic susceptibility artifact around the screws. (B) Fat-saturated SEMAC-corrected T2-weighted MR imaging at the same level shows clearly delineated pedicle screws and the bone-prosthesis interfaces are clearly delineated (arrows). However, the signal intensity in the SEMAC-corrected image was definite, and all of the bodies showed homogeneously high signal intensity (asterisks).



**Fig. 3**—The graph shows a comparison of the signal intensity ratio of screw-fixated vertebra and upper level vertebra between fat-saturated conventional and fat-saturated SEMAC-corrected MR images. Generally the signal intensity ratios were lower with the SEMAC correction. Paired t-tests were used to compare the two ratios for each individual image set.