Evaluation of a protocol for metal artifact minimization in MR examination of patients with hip prosthesis

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PURPOSE

To compare image distortion and size of metal artifacts in MRI imaging with five different sequences optimized or designed to reduce artifacts in patients with two different hip prosthesis.

METHOD AND MATERIALS

78 patients [27 with cemented total hip prosthesis (CHP) and 51 with metal on metal (MoM) articulations were examined at 1.5 T [Siemens Avanto, equipped with new pulse sequences for implant imaging (WARP package)]. Five sequences were evaluated: TSE: T1-w turbo SE with high bandwidth, VAT: T1-w turbo SE with view-angle tilting, SEMAC: T1-w turbo SE with VAT and slice distortion correction, STIRstd: standard turbo-SE with inversion recovery, STIRopt: like STIRstd, but with matched bandwidths of all RF-pulses. The number of examined patients were 45 (TSE and VAT), 7 (SEMAC), 33 (STIRstd), and 44 (STIRopt), respectively. The area of artifact was delineated and the ilio-pubical angle measured in plane with the prosthesis head to evaluate distortion. Differences in metal artifact reduction between the sequences and the 3 prostheses groups were compared in relation to the VAT sequence.

RESULTS

For all prosthesis types, the VAT sequence produced the least artifacts. Compared to VAT, the artifact areas were 10%(CHP) and 30%(MoM) larger with TSE and SEMAC, 90%(CHP) and 200%(MoM) larger with STIRstd, and 30%(CHP) and 90%(MoM) larger with STIRopt (table. Median [mm2], Mean (SD) [mm2])

	tSE T1_opt	VAT	SEMAC	STIR	STIR_opt
MoM	3009 3509 (1386) 128%	2347 2759 (1142) 100%	2968 3357 (1258) 126%	6974 7311 (2082) 297%	4530 4823 (1418) 193%
THP	4748 4761 (1124) 112%	4212 4260 (1308) 100%	4588 4682 (912) 109%	8120 8299 (2045) 193%	5417 5686 (1562) 129%

The normal ilio-pubical angle, measured on the healthy side, was in the range of 140-170°. On the distorted side, this angle was reduced. The average angles for CHP were: TSE=125°, VAT=137° and SEMAC 151°. For the MoM prosthesis, the corresponding values were TSE=101°, VAT=127°, SEMAC=149°. No angles could be measured on STIR images due to severe artifacts (table. Median [°], Mean (SD) [°]).

	tSE T1_opt	VAT	SEMAC
MoM	98 101 (17)	130 127 (18)	149 149 (19)
THP	127 125 (21)	142 137 (18)	148 151 (8)

CONCLUSION

Metal artifacts can be significantly reduced using optimized and modified sequences, enabling visualization of pathology in the periprosthetic tissue. The image quality regarding artifact size and distortion was substantially improved in the VAT and SEMAC sequences compared to TSE. The STIR image quality was substantially improved by introducing matched RF-bandwidths. The artifacts were less in the CHP than in the MoM prosthesis.

CLINICAL RELEVANCE/APPLICATION

Sequences reducing metal artifacts in patients with hip prosthesis enable MRI visualization of periprosthetic tissue, thereby allowing early diagnosis of complications.