Postprocessing of whole-body MR images with homomorphic filter – impact on image and diagnostic quality.

M. P. Lichy[1], C. M. Mueller-Horvat[1], V. Jellús[2], B. Kiefer[2], C. Pfannenberg[1], M. Horger[1], C. D. Claussen[1], F. Schick[1], H-P. Schlemmer[1]

[1]Dep. of Radiologic Diagnostics, University of Tuebingen, Tuebingen, n.a., Germany, [2]MR-Application Development, Siemens AG Medical Solutions, Erlangen, n.a., Germany

Purpose

Spatial inhomogeneities of coil sensitivities can cause a reduction in image quality. This is especially of high relevance in whole-body imaging where large field of views are recorded and coil sensitivity variations are more severe than in dedicated examinations of a single organ. Purpose of this study was to improve image quality by applying a modified homomorphic filter in whole-body MRI.

Materials and Methods

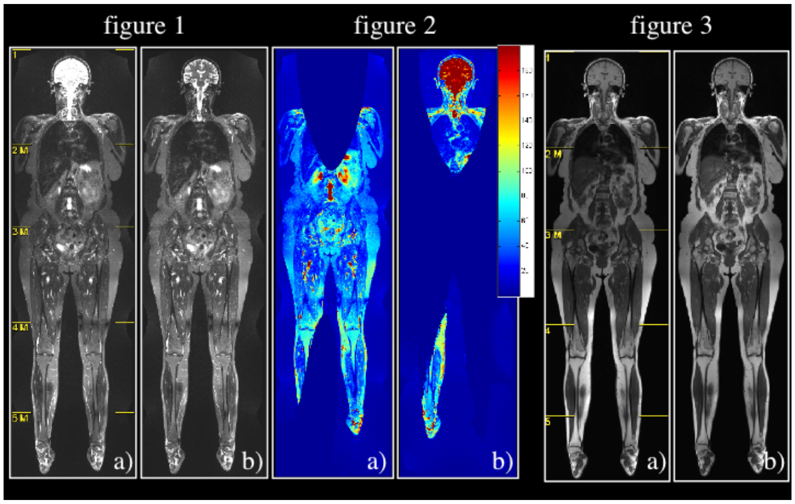
Until now, two healthy volunteers and 32 patients were examined with a 1.5T whole-body MR scanner (Magnetom Avanto, Siemens Medical) using a combination of up 76 coil elements covering the whole body (TIM system). In 25 patients MRI was performed for staging of a known malignancy (n=8 plasmocytomas, n=1 prostate cancer, n=4 lymphoma, n= 11 melanoma). Sequences used for evaluation of the modified homomorphic filter were: whole body coronal T2w STIR-TSE (TR/TE = 8540/87 ms, 5 steps, acquisition time approximate 14 min), sagittal T2w STIR-TSE (TR/TE = 6670/68 ms, 2 segments, acquisition time approximate 5 min) and sagittal T1w TSE (TR/TE = 476/11 ms, fat suppression, 2 steps, acquisition time approximate 3 min). In case of plasmocytoma or prostate cancer, the protocol included additionally coronal T1w TSE whole-body MRI (TR/TE = 441/11 ms, 5 steps, measurement time approximate 8 min). All segments were composed and postprocessed with the available software provided by the manufacturer. Postprocessing by the filter includes: 1) preparation of a copy of the original MR image by a special processing to exclude areas with very low signal intensities inside the image and the background, 2) calculation of a spectrum of the logarithm of the image (cepstrum), 3) application of a notch filter and backwards transformation of the cepstrum, 4) use of an exponential functionand finally, 5) the ratio of the filtered image and the input one is used for an estimation for bias field correction and used for normalisation of the original MR image. The resulting images were compared with the original image data by two experienced radiologists (consensus). Evaluation included presence of artefacts and differentiation of the lesions as well as homogeneity of signal contribution. Additionally, variations of signal intensities by the filter were calculated pixel by pixel and visualised (MatLab®).

Results

In all cases, application of the modified homomorphic filter resulted in a more homogeneous signal contribution compared to the unfiltered original images. Best results were achieved for coronal and sagittal T2w STIR-TSE images. Only marginal variations of local signal intensities were caused by the applied filter and visualisation of pathologic structures was consequently not affected. In one patient with strong susceptibility artefacts from metallic implants the filter clearly improved signal homogeneity and image quality.

Conclusion

The used modified homomorphic filter for coil sensitivity correction was able to homogenise the signal contribution in composed whole-body MRI without compromising image quality and diagnostic value. This is essential for a fast evaluation and demonstration of whole-body MRI examinations e.g. for interdisciplinary conferences.



Figures

Figure 1: Coronal multi-step T2w STIR-TSE MRI (5 steps) in a patient with plasmocytoma a) without and b) with application of the homomorphic filter. Figure 2: Miscoloured visualisation of the relative signal intensity changes by the applied filter: a) pixels with raised and b) pixels with reduced signal intensity. Figure 3: In this patient also a coronal T1w TSE multi-stage whole-body scan was performed (5 steps): a) original images and b) filtered images.

Reference

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