The effect of limited MR field of view in MR/PET attenuation correction.

Abstract:
A critical question in the development of combined MR/PET scanners is whether MR can provide the tissue attenuation data required for PET reconstruction. Unfortunately, MR images are often unable to encompass the entire patient. The resulting truncation in the transverse plane leads to incomplete attenuation maps, causing artifacts in the reconstructed PET image. This article describes the experiments performed to quantify these artifacts. A method to compensate the missing data was evaluated to determine whether software correction is possible or whether additional transmission hardware has to be included in the scanner. Three studies were made. First, simulated PET data were used to quantify the bias due to an incomplete attenuation map. A set of spherical lesions was simulated in the lungs and mediastinum of a patient. The data were reconstructed with complete and partial attenuation maps and the uptake differences were evaluated. Second, clinical data from PET/CT oncology patients were used. To reproduce the expected conditions in an MR/PET scanner, only patients scanned with the arms resting along the body were considered. These scans were then used to create maps of the reconstruction bias due to field of view (FOV) limitations. Lastly, a PET reconstruction with incomplete attenuation data was evaluated as a means to obtain attenuation information beyond the MR FOV. The patient outline was automatically
segmented with a three-dimensional snake algorithm and used to fill the truncated data in the attenuation map. Average bias up to 15% and local biases up to 50% were estimated when PET data were reconstructed with incomplete attenuation information. Completing the attenuation map with data extracted from a PET prereconstruction globally reduced these biases to below 10%. This correction proved to be tolerant to inaccuracies in positioning and attenuation values. However, local artifacts up to 20% could still be found near the edges of the MR FOV. MR FOV restrictions can indeed make the reconstructed PET data unacceptable for diagnostic purposes. Biases can be globally compensated by automatic preprocessing of the attenuation map. However, inaccuracies in the correction will result in small artifacts near the periphery of the image that could lead to false-positive findings.