Quantitative evaluation of an elastic 3D motion correction applied to high resolution breast MRI

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Introduction

Motion artefacts can occur in MR breast imaging even with very cooperative patients and highest care in patient positioning, for example due to progressive relaxation of the pectoral muscles. Moreover, as subtractions are routinely calculated for data sets acquired several minutes apart from each other, several motion correction algorithms have been introduced, e.g. [1-3]. In this work, the performance of a 3D elastic motion correction [4] to high resolution breast MR data is described. As opposed to previous publications [5,6] we have tried to identify quantitative measures on high resolution data sets rather than criteria such as image quality scores that have been applied to the time resolved dynamic measurement.

Methods

All experiments were performed on 1.5T Siemens Magnetom scanners (Avanto or Espree) using a Siemens breast array coil. As part of the routine clinical breast exam two high-resolution sagittal T1-weighted FLASH data sets are acquired using two excitation slabs, 0.4x0.4x2 mm^3 voxel size, 25deg flip angle, TR 21ms and 4.7ms echo time. These scans are performed in the beginning and at the end of the exam, i.e. before and after the transversal dynamic protocol and are used to additionally assess the lesion morphology. These data sets in particular are prone to significant motion artefacts because of their large time interval (approx 15 minutes). The data sets were subtracted and the motion correction was performed using commercially avaible software packages (*syn*go VB13, BRACE motion correction). The algorithm computes the local cross correlation of corresponding areas around each point. Intensity varations caused by the uptake of a contrast agent are taken into account by a similarity measure across the complete volume which is maximized using a conjugate gradient method.

As a measure of the motion the maximum appeareant skin thickening artefact (due to the subtration of translated volumes) was evaluated in the central sagittal plane as well as the largest diameter of the subtraction artefact of the greater pectoral muscle in the image that showed the largest subtraction artefact. Independent values were taken for both breasts for 24 out of 31 consecutive patients.

Results and Discussion

Fig. 1 displays an example for the evaluation of motion artefacts in a subtracted image (before BRACE motion correction). Seven data sets did not pass the algorithms quality check. For the remaining data sets, the mean values of the skin motion artefact were originally 2.7mm (std deviation 1.1mm) and 0.7(0.89) mm after performing the correction. The averaged values for the muscle motion artefact was 4.8(2.95) mm before and 2.04(2.18) mm after the correction. Overall, a complete correction i.e. no remaining measureable artefact was achieved in 23 out of 47 times for skin motion respective 23 out of 48 times for muscle motion artefact. Further analyses, e.g. a comparison with the motion correction on the dynamic data sets are in preparation. We assume that the incorrectable data sets were rejected because of too much motion out of or into the imaging volume, so that local volume changes were larger than a tolerance threshold.

References

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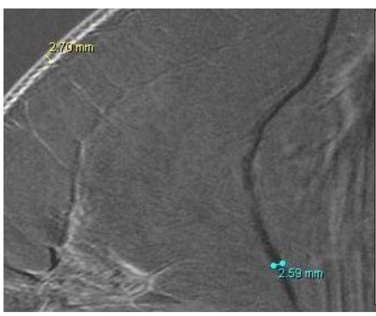

Fig.1: Measurement of skin and muscle motion artefact..

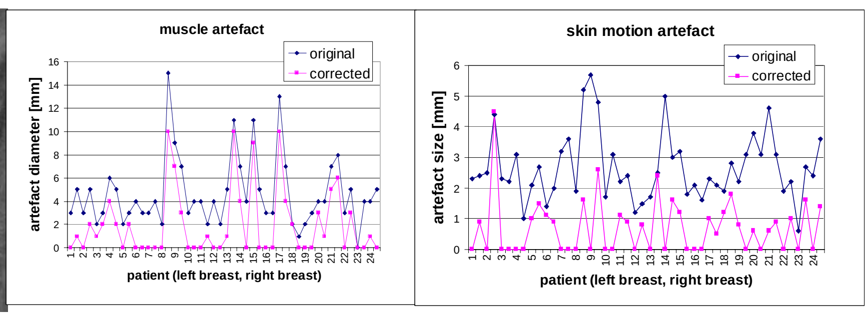

Fig. 2,3: Muscle(left) and skin(right) motion artefacts before (blue) and after (red) motion correction. Connecting lines added between data points for better visibility.

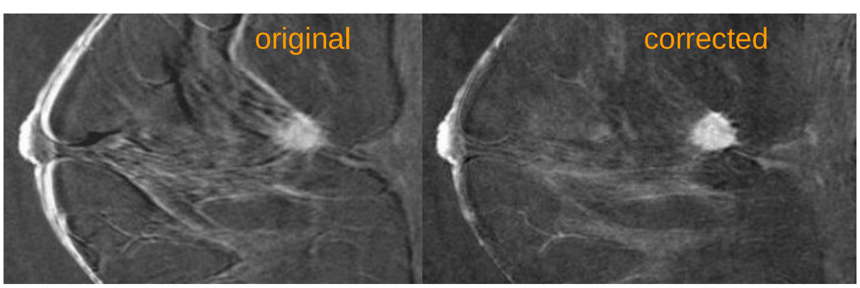

Fig 4,5: image example of original and corrected subtracted data sets.