Real time Interscan Alignment in the abdomen using a fast spiral Navigator (ISAN): Initial Results

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Introduction

In abdominal applications, differences in the respiratory positions typically introduce difficulties in the comparability of scans acquired with various contrasts such as diffusion weighted (DW), T2 weighted and in (IP) / out of phase (OP) scans. Current Navigator methods allow a prospective detection and correction of respiratory positions. However scans within an examination are typically aligned with respect to an arbitrary breathing position at the start of the scan. While post processing techniques may be applied to align the different scans, the appearance of small structures such as small lesions may depend on the choice of the slice thickness, the respiratory position and respective intra voxel dephasing effects. Interscan registration methods have been introduced for neuro applications using a spherical navigator [1] to prospectively align scans within an exam. The purpose of this study was to validate a prospective **I**nter**S**can **A**lignment method using a fast spiral **N**avigator acquisition technique for abdominal applications (ISAN). This approach was applied to various respiratory methods, such as breath hold (BH), respiratory belt triggered (BeltTrig) and navigator triggered (NavTrig) and gated (NavGat) methods. Hereby a navigator acquisition incorporated at the start of a scan was used to align subsequent scans to a common breathing reference.

Methods

Figure 1 illustrates the principle of scan alignment within an examination. A reference position is measured in a calibration scan at the beginning of the exam. In subsequent BH or triggered scans, navigators are acquired and the imaging volume is aligned or shifted with respect to the initial reference position. All experiments were performed on Philips 1.5T and 3.0T clinical scanners using a 16-channel Torso receive coil. A volunteer and patient study was performed on more than 20 subjects aligning BH and NT scans within an exam. For the volunteer study the method was applied to 2D sequences, including T2w SPAIR, T2w long TE, OP, IP and DW as well as 3D sequences, including contrast enhanced Dixon FFE. The technique was validated for inspiration (insp-BH) and expiration breath holds (exp-BH), as well as BeltTrig, NavTrig or NavGat sequences. For the patient study the comparison was applied to NavTrig transverse T2w SPAIR and T2w long TE sequences as well as OP and IP acquisitions using end exp-BHs.

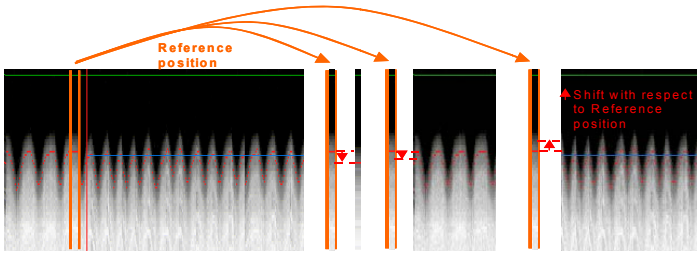

Figure 1: Navigator exam alignment principle: The initial scan is used to register a reference position, respective successive breath hold and triggered scans are aligned with respect to this reference position.

Results

2D and 3D sequences are nicely aligned using ISAN. Results from the patient study are shown in Figure 2. Note the precise and detailed information in all slices that is seen in the triggered T2w SPAIR and T2w long TE as well as BH OP, IP images consistently. Comparison of the end expiration triggered, gated and BH scans show a good alignment of slices with a precision of a mm. Despite the good overall alignment, insp-BH scans show a larger variation in the appearance of small structures like vessels versus exp-BH scans.

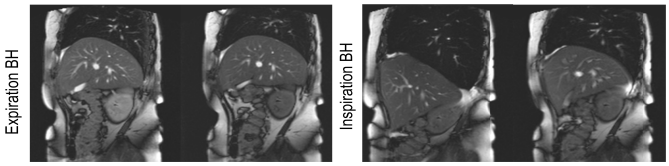

Figure 3: Sagital images from the same volunteer illustrating 2 different exp-BH states on the left and 2 different insp-BH states on the right. Note the large feet head difference in the dome level that can be corrected for with ISAN. Variations in the appearance of the vessels seen on insp-BHs in this volunteer can be explained by rotation and deformation of part of the volume

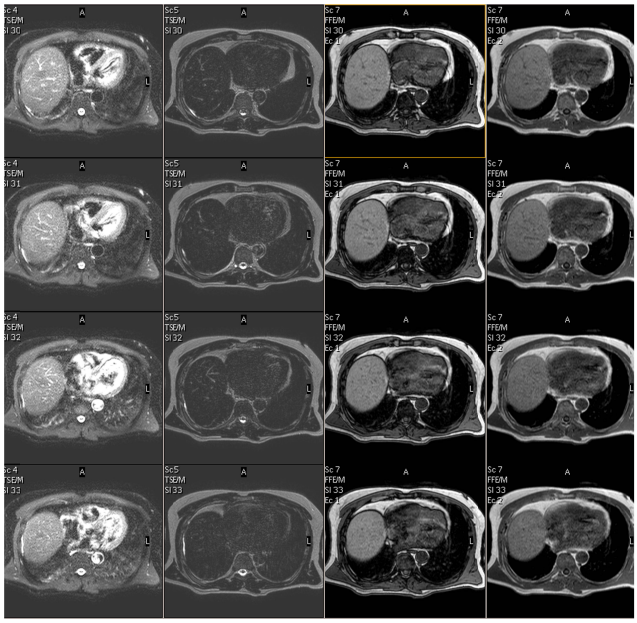

Figure 2: Transverse images of a patient with various image contrasts (column) for the different slices (rows). From left to right NavTrig T2w SPAIR and NavTrig T2w long TE and BH OP, IP slices real time aligned using ISAN

Discussion / Conclusion

In oncology there is a high interest in investigating suspicious lesions over different MR contrasts. In the abdomen breathing motion and BH variations are the main issues that restrict the direct comparison of lesions across different scans which makes the classification of those lesions more difficult. ISAN provides both real time intra- and inter-scan alignment. This allows a direct comparison of lesions across BH or free breathing triggered scans within an examination. End expiration triggered and BH scans show a good consistency over the different contrast scans which were tested. While for insp-BHs the large feet head difference in the dome level is corrected for using ISAN, variations in the appearance can be larger in some subjects. Figure 3 illustrates the problem in a worse case volunteer. Next to a large translational motion component, rotation and deformation of the volume of interest is seen and suggests the use of exp-BHs only in this volunteer. In the current study ISAN was applied to imaging sequences. In the future ISAN can be encorporated in spectroscopy scans and calibration scans, such as image based shimming or F0 determinations which could reduce respective motion induced adjustment errors.

References

[1] Welch EB et al., MRM 52:1448-1452 (2004)