Resolving Arterial Phase in Dynamic Breast MRI using a Fast TWIST Acquisition during Injection Delay

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Introduction

Vascularisation is an important marker for the diagnosis of breast tumors. MR Mammography (MRM) is therefore used as a non-invasive, versatile method to characterize both microvessel density and macroscopic vascularity [1]. Although there is ample evidence that the overall vascularity is an indicator for tumor type and grade, separation of arteries from venous vessels is often hindered due to the distribution of the contrast agent in the vasculature and the loss of temporal information about the first-pass. However, the ability to resolve the first-pass dynamics, while still acquiring contrast-enhanced data following established protocols, might further improve the specificity of the method.

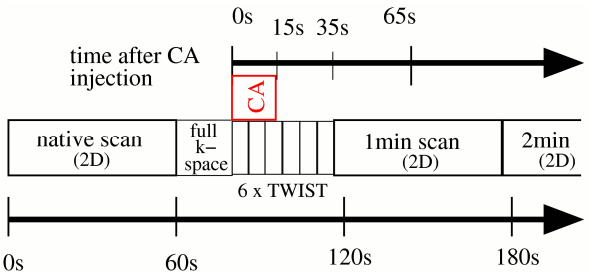

Fig 1: Schematic timing diagram of the routine contrast enhanced breast MRI protocol with the fast TWIST-sequence inserted during the injection delay. The lower time arrow indicates the time after the start of the scan protocol, the upper arrow indicates the time after contrast agent application

Material and Methods

MR mammography is conventionally conducted with a standard dynamic protocol consisting of a native scan, with a typical acquisition time of 1min, followed by a delay of approximately 35s during which the contrast agent (CA) is applied. Subsequently, multiple post CA acquisitions follow (TA=60 s, see. Fig. 1). The waiting period can be utilized to acquire additional dynamic first-pass data. To achieve a high temporal resolution without sacrificing spatial resolution a FLASH-TWIST sequence [2, 3] was used with a matrix size of 384 × 384, 88 slices of 1.5 mm thickness, FoV= 350 mm, TE = 1.68 ms, TR = 3.83 ms, α = 20°, a bandwidth of 380 Hz/px, GRAPPA factor 2 and partial fourier and phase resolution of 6/8 in both phase encode and slice direction. After the initial acquisition time of 26.1s, a complete data volume is reconstructed every 5.7s by the TWIST sequence (see Fig. 1). The TWIST-sequence was tested on 5 patients undergoing routine breast MRM examinations. The patients were referred to MRI with previously known lesions, suspicious mammographic findings or after treatment.

Results

As shown in Fig. 2, the high temporal resolution of 5.7 s made it possible not only to resolve the filling of arterial vessels (a) but also to monitor the passage of the CA through the inflammatory carcinoma (b,c) and drainage into the venous vessels (c). The standard dynamic sequence starts 35 s after CA injection and a MIP of the first post-CA subtraction is shown in (d). The lesion supplying arterial vessel is clearly visible in (a) but very difficult to differentiate in (d).

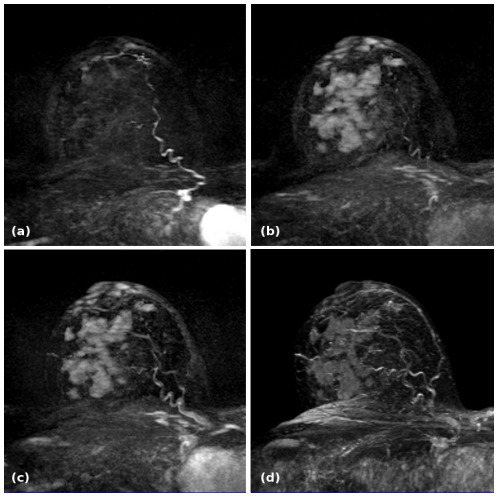

Fig 2: MIP images of a patient with an inflammatory carcinoma acquired with the TWIST-sequence (a-c) and a standard 2D sequence (d) at time points (a) 15.3 s, (b) 21 s, (c) 26.7 s and (d) 65 s after injection of the contrast agent.

Discussion

Applying the viewsharing technique of TWIST high temporal as well as spatial resolution can be achieved by utilizing the waiting period of the injection delay of a routine MRM examination. Although the current implementation of the TWIST protocol has still some limitations concerning in-plane resolution and image sharpness due to undersampling (partial Fourier, phase resolution), the additional gain in temporal information of the enhancement dynamics is remarkable and should help to improve lesion characterization.

References

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