MRI visualization of applicators for skin HDR brachytherapy

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INTRODUCTION

In common practice for surface high-dose-rate (HDR) brachytherapy, CT is employed for treatment planning including catheter detection. Some clinical cases may benefit from the better soft tissue contrast provided by MRI for detecting depth of plaques and spread of disease, but the employed applicators are not visible on standard MR protocols.

AIM

Our goal was to optimize MR sequences for detection of spheres and catheters in **Freiburg flap** (**FF**) skin brachytherapy applicators.

METHOD

FF applicators placed around a cylindrical phantom or around the forearm of a healthy male volunteer were scanned in a 3T Siemens Vida using an UltraFlex18 and a spine matrix array coil.

A 3D **Dixon** (TR\TE 4.02\1.23 ms, FOV 200 x 200 mm^2, 1.6 x 1.6 x 1.4 mm^3 voxels, bandwidth 1347 Hz/px, acquisition time: 16 s) and a 3D Pointwise Encoding Time Reduction with Radial Acquisition (**PETRA**) sequence (TR\TE 3.32\0.07 ms, FOV 280 x 280 mm^2, 0.8 x 0.8 x 0.8 mm^3 voxels, bandwidth 400 Hz/px, acquisition time 6.3 min) were optimized for detection of the applicator components. Images were utilized for generation of treatment plans.

For the human subject, mean signal intensity was extracted from ROIs on the FF spheres and on the underlying forearm muscle and from points on the catheters. Signal intensity ratios (**IR**) of spheres and catheters relative to the muscle were calculated.

RESULTS

Figure 1 shows an axial acquisition and its reconstructions for the water-only (**a**) and fat-only Dixon (**b**), and PETRA (**c**) at the same position for the volunteer forearm. 3D acquisition allowed for accurate reconstruction in all three planes and for treatment plan generation without the need to use any other imaging modality.

FF silicon spheres appeared bright on both fat-only and water-only Dixon images ($IR_{sphere/muscle}$ = 0.44 ± 0.51 and 14.67 ± 0.64, respectively), but showed less signal and dark borders on PETRA images ($IR_{sphere/muscle}$ = 1.19 ± 0.39).

Inserted catheters could be traced through the spheres from their lack of signal on Dixon fat-only and water-only images and from their elevated signal intensity inside the spheres on PETRA images ($IR_{catheter/muscle}$ = 0.19 ± 0.55, 2.80 ± 0.56, 1.35 ± 0.19, respectively).

The two sequences offer the option of using positive or negative contrast for FF sphere and catheter detection.

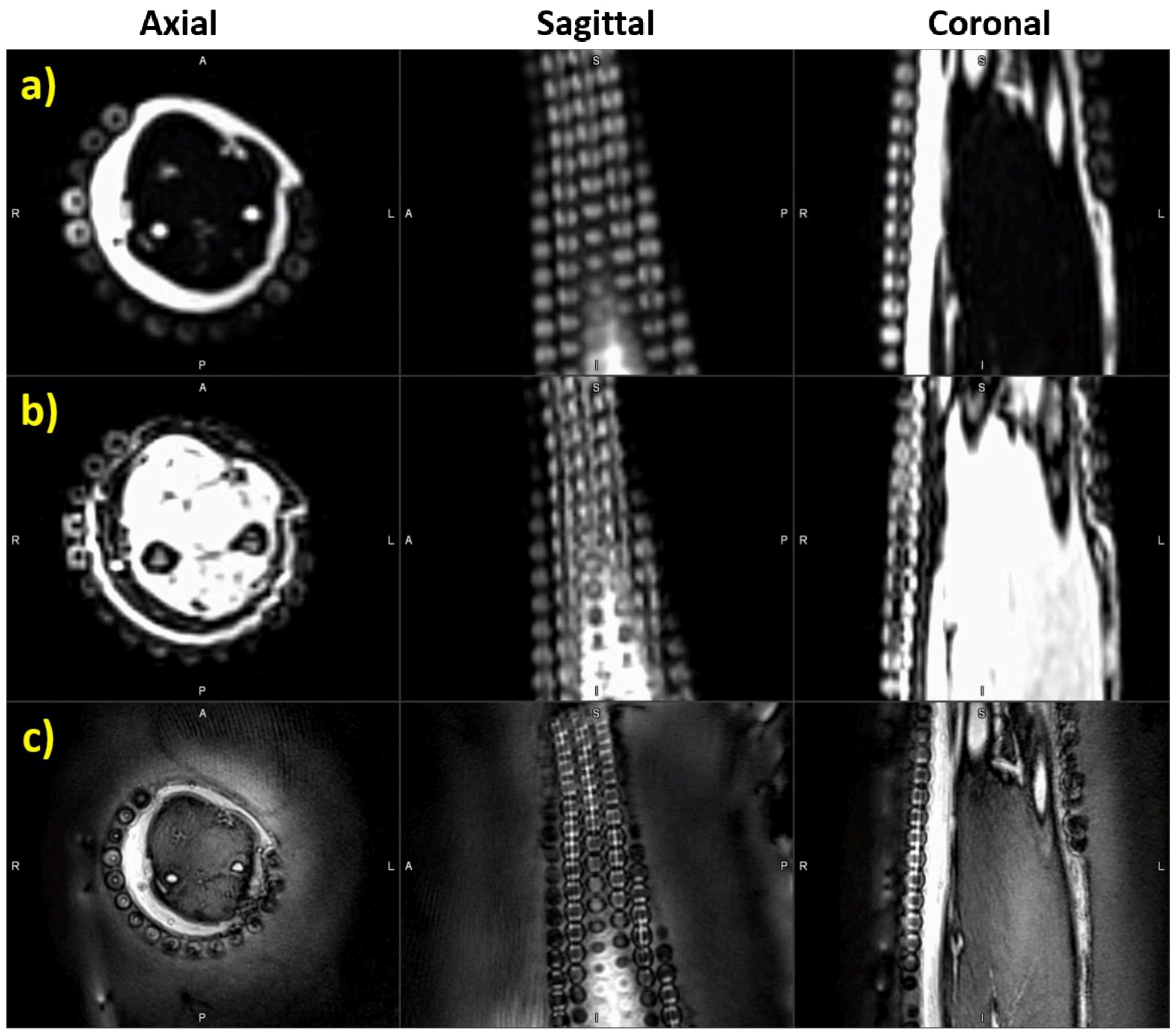

Figure 1. Acquired axial and reconstructed sagittal and coronal images (zoomed) of a Freiburg flap applicator with 16 channels wrapped around the left forearm of a healthy volunteer: **a) 3D Dixon water-only, b) 3D Dixon fat-only, c) 3D PETRA.** All slices are shown at the same position.
The Freiburg flap silicon spheres appear bright on the **Dixon** images while catheter position can be deduced from the signal voids inside them. On **PETRA**, plastic catheters appear bright inside the spheres which demonstrate intermediate signal and darker borders.

CONCLUSIONS

This is the **first time Freiburg flap applicators for surface HDR brachytherapy were detected using MRI**.

Two different clinical product sequences, 3D DIXON and 3D PETRA, imaged the catheters inserted in silicon spheres with negative or positive contrast, in a few seconds or minutes, respectively. Acquired 3D images can be reconstructed well in all 3 orientations and utilized for generation of treatment plans without the need to employ any other imaging modality.

An MR protocol for treatment planning including such sequences can eliminate the need for CT in the future, paving the way for **MR-only treatment planning.**

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