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Positive visualization of nitinol stent-grafts by post-processing

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Introduction

The emergence of new MR-compatible nitinol-based stent-grafts [1] allows follow-up MRI of patients with these devices to assess stent-graft and wall apposition, or monitoring endovascular aneurysm repair. In particular, the soft-tissue contrast provided by MRI holds benefit over CT and was shown to be more sensitive to endoleak detection [2]. However, sometimes the susceptibility artifact caused by stent graft may be confused with other sources of negative contrast. Recently, Vonken *et al*. proposed positive visualization based on susceptibility gradient mapping (SGM) [3]. However SGM calculates the susceptibility gradient over neighboring pixels and thus requires MR-images with very high-resolution (0.3-0.7 mm isotropic) that cannot be achieved in clinical practice. In this work we investigated the use of a new positive contrast method that maintains the original resolution and allows selective visualization of devices from the clinical MR-data.

Purpose

This study focuses on the feasibility for positive visualization of nitinol stent-grafts by post-processing.

Methods

Our technique maps the echo-shift in k-space associated with the susceptibility difference from the stent-graft by applying a filter in a sequential manner in k-space. The k-space shift was determined by analyzing the drop in the Fourier transform of the filtered signal.

A GoreTAG® endovascular stent-graft was deployed to treat aneurysm formation in chronic aortic dissection. MRI was conducted with blood-pool agent post-surgery on a 3 T clinical scanner (Achieva, Philips Healthcare): 3D TFE; FOV = 251 × 400 × 156 mm^3; FA = 20°; TE/TR = 2.7/5.6 ms; resolution = 1 × 1.5 × 3.0 mm^3. A positive contrast image was obtained by mapping the k-space shift in each direction and use of the magnitude at each pixel (Fig. 1). The positive contrast by post-processing was thus fused with MR images (OsiriX Imaging Software), without requiring registration. A rough mask was also applied based on the aorta to remove unrelated positive contrast.

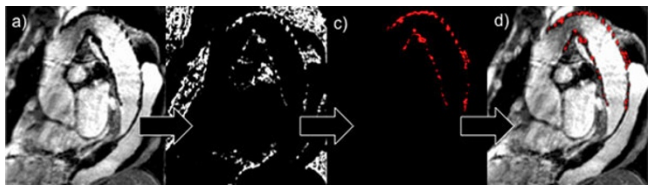

Figure 1
The same MR-data from the negative contrast image (a) was used to calculated a positive contrast map (b) from the k-space shift due to susceptibility gradients. A mask is applied to the positive contrast based on the aorta (c) and then fused with the original image (d).

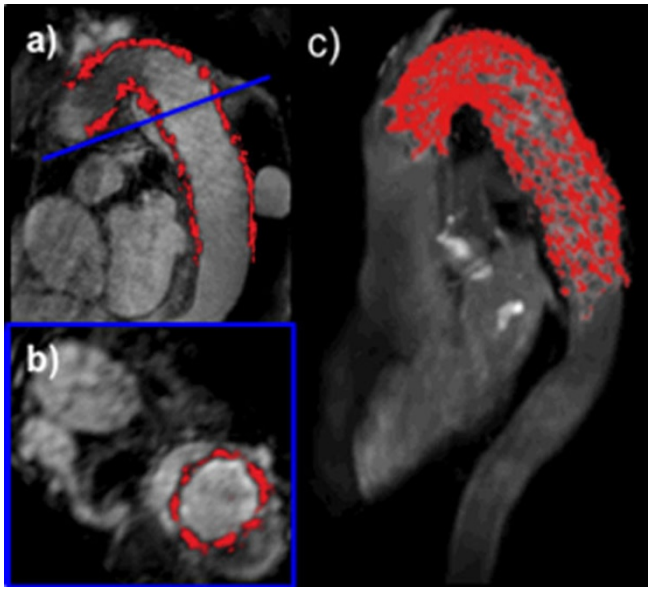

Figure 2
(a) Saggital section demonstrating a good proximal seal with some residual filling of the false lumen. (b) Poor medial apposition of the stent-graft to the wall. (c) Positive contrast fused with data from MR-angiography allows 3D visulization.

Results

Proximal apposition of the stent-graft to the wall is seen between the positive and negative contrast images (Fig. 2). The distal extent and length of the device may also be assessed easily.

Conclusion

Application of this positive contrast technique permitted improved visualization of the stent-graft as well as the aortic lumen and wall. The poor stent-graft - wall apposition proximally and the continued perfusion of the false lumen distally provided an early non-invasive assessment of the endovascular repair and guided the clinical workflow. The proposed post-processing method does not require any additional scan and provides better depiction of a post-implant stent-graft.

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