Vena Cava Filter (VCF) With Integrated Resonator For MR Guided Implantation And Intravascular MR Imaging

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Introduction

Implant: vena cava filter (VCF)
The purpose of vena cava filters is to prevent pulmonary embolisms by intercepting thrombotic material within the inferior vena cava.

Advantages and disadvantages of imaging methods

**X-ray angiography**

- ionising radiation
- iodine contrast agents

**MR imaging**

- susceptibility artifacts
- electro-magnetic shielding of the inside

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Anthéor, Boston Scientific
Technique Spotlight 1996

Anthéor, Boston Scientific
1.5 T, flash2D, TR 300 ms, TE 6 ms, FA 40°, FoV 180mm/256

TrapEase, Cordis
**Materials & Methods**

**Production of VCF prototypes**

- coils are equipped with capacitances to tune the resonators to the Larmor frequency of the used MRT
- VCF prototypes “without diodes” (transmit & receive amplification)
- VCF prototypes “with diodes” (receive-only coil)

**Results**

**Contrast measurements (0.2 Tesla MR-Tomograph)**

- regions of “blood” and “fat” dependent on the flip-angle (resonant circuit in function)
- regions of “blood” and “fat” dependent on the flip-angle (resonant circuit out of function)
- reference photo of the real object layer
“in-vitro” and “in-vivo” experiments (1.5 Tesla MRT)

- development of a temporary MR active vena cava filter
  - “in-vitro” MR guided VCF implantation and extraction within a flow phantom, MR imaging of the filter and thrombus within
  - “in-vivo” VCF implantation in a 50 kg swine, MR imaging of the filter and thrombus within

- development of a laser cut Nitinol MR active vena cava filter
  - in current project: integration of a biocompatible capacitance

Results

amplification factor “blood”, “fat” and “blood-fat” contrast

- amplification factor “blood”
- amplification factor “fat”
- comparison factor “outside”
- amplification factor “contrast”
Comparison between MR images “resonant circuit out of function”, “resonant circuit in function” and the reference photo.

Further developments: MR active VCFs for the use in a 1.5 Tesla MRT

- high field MRT, horizontal main magnetic field (SIEMENS Magnetom Vision)

GRE sequence: fl2d_11b65; TR = 300 ms; TE = 11 ms; SL = 5 mm; FA = 20°; AC = 4; FoV = (coronar): 110*110 /256*256, (transverse): 180*180 /256*256; head coil

...and MR guided extraction of a temporary MR active vena cava filter.
Thrombus depiction in “in-vitro” experiments within a vena cava flow phantom

1.5 Tesla Philips NT, Dept. of Radiology, University Hospital Aachen, Germany

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“in-vivo” experiments with a 50 kg swine, MRI thrombus depiction within the VCF and verification with DSA

balanced FFE, TR = 5 ms, TE = 2.5 ms,
FA = 15°, FoV = 500 mm/ 512

1.5 Tesla Philips NT, Dept. of Radiology, University Hospital Aachen, Germany

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X-ray angiography, mobile unit
Development of a Nitinol MR active VCF

- high field MRT, horizontal main magnetic field of 1 Tesla (SIEMENS Magnetom Harmony)

laser cut Nitinol VCF prototyp, polymer coated, with SMD capacitance
in cooperation with EUROflex Schuessler GmbH, Pforzheim, Germany

sagittal view, GRE sequence: fl2d, TE = 4,6 ms, TR = 500 ms, SL = 4 mm, FoV 256*256/190*190, FA = 20, AC = 2, head coil

Summary

- The integration of MR coils within the intravascular implant vena cava filter for MRI has been successfully realized.

- The experiments have shown the improvement of MRI of the VCF implant and its inside material.

- The application and enhanced imaging of an MR active VCF was shown in “in-vitro” and “in-vivo” experiments.

main goal:
- The thrombus could be easily visualized within the vena cava filter with the advantages of MR imaging, with minimal susceptibility artifacts only and without RF shielding effects of the filter implant.