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Universitair Medisch Centrum

m Can Advances in MRI eliminate radiation from AAA diagnosis, its endovascular treatment and its follow-up? The Zero Radiation Project (MARVY) and where it stands

marvy

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Disclosures

- Health Holland TKI-PPP grant

The MARVY project

Gamechanger: Development of MRI based endovascular procedures for Vascular surgery (MARVY)

Pilot studies to investigate the use of MRI instead of CT and US in AAA management

- Radiation dose
- Assess functional properties of the AAA and improve decision making

But MRI ≠ plug-and-play

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MARVY – comprising of different study phases

- Optimisation phase

Surveillance of the AAA

Pre-operative EVAR planning

EVAR procedure

Follow-up of the placed endograft

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Novel qMRI biomarkers and zero radiation project

Pre-operative use
Postoperative use
Interventional MRI

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Developed qMRI protocol

DWI-MRI – structural information

DCE-MRI – perfusion of the vessel wall after contrast injection

Cine MRI – distal flow over time

4D Flow MRI – flow velocity and wall shear stress

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Dixon MRI

- Late Gadolinium Enhanced Dixon MRI
- Maximum diameter, and thrombus volume

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Dynamic contrast enhanced MRI

- Perfusion of the vessel wall assessed with DCE-MRI with Gadolinium
- Assess microcirculation/perfusion
 - Supplying inflammatory cells which promote ECM breakdown [1-3]

[1] E. Chokei et al., *Arteriosclerosis, Thrombosis, and Vascular Biology*, 2006
 [2] D.C. Park et al., *Experimental & Molecular Medicine*, 2004
 [3] C. Neugebauer, *Pathobiology*, 2009

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Dynamic contrast enhanced MRI

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Cine MRI

- Distensibility of the wall
- Reduced distensibility = stiffer less elastic wall
- Increase with time to rupture [4-6]

[4] A. Redheuil et al., *Journal of American College of Cardiology*, 2014
 [5] E. A. Wilson et al., *Journal of Vascular Surgery*, 2003
 [6] A. Redheuil et al., *Hypertension*, 2010

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4D flow MRI

- Flow velocity in three directions over time
- Calculation of wall shear stress (WSS)
- Vascular endothelial cells are responsive to WSS [7]
- Normal WSS prevents AAA development [8]

[7] M. Dasi et al., *Vascular Pharmacology*, 2010
 [8] O. Tanweer, *Journal of Cardiovascular and Endovascular Neurosurgery*, 2014

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Update

- Designed and tested a qMRI scan protocol
- Total amount of patients is included and scanned at one time point
- Future: results of longitudinal study

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Follow-up imaging after EVAR

4D flow MRI
Time-resolved 3D phase contrast MRI with three-directional velocity encoding

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MRI for patients post-EVAR

- Benefits of using MRI:
 - Eliminate the radiation dose
 - Several possibilities without contrast agent
 - Visualize more than just anatomy
- But: stent within the field of view

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'Stent in the dark'

Set-up: two plastic bottles with water + bit of Dotarem + stent graft

Cook Zenith Flex
Stainless steel

Gore Excluder
Nitinol

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'Stent in the dark'

Set-up: two plastic bottles with water + bit of Dotarem + stent graft

Stainless steel

Nitinol

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What is important when using 4D flow MRI?

- VENC = velocity encoding
- Main magnetic field strength (1.5T or 3T)

flow in cm/sec
+25
forward flow
VENC = 50
0
-25
reverse flow
flow of 75 cm/sec is mismapped as 25 cm/sec

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4D flow MRI post-EVAR

- Nitinol stent grafts are needed! (No Cook + 50% of all stents placed in the AMC)
- Type I and type II endoleak and sac regression patients
- Including 20 patients

Parameters	
Reconstructed spatial resolution	1x1x1mm
Temporal resolution	±40ms
Time frames per cardiac cycle	24
TE	2.78ms
TR	4.58ms
Velocity encoding (based on 2D PC scout)	52cm/s
Scan duration	7-11 minutes

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What were the results?

- We can scan nitinol stent grafts but not stainless steel (No Cook +- 50% of all stents placed in the AMC)

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To see the anatomy better

- Segmentation of the aneurysm sac
 - 3D cine
- Visualise it with other techniques

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3D cine to segment the aneurysm sac

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MRI post-EVAR with type 1 endoleak

- Goal is 30 patients
 - 10 with sac shrinkage
 - 10 with endoleak type I
 - 10 with endoleak type II
- Inclusion ongoing
- Working on post-processing

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MRI

- Zero radiation techniques are important in future endovascular treatment
- Can be used, but needs updates with AI techniques for better visualization and usage
- MARVY including patients, next year we will have the pilot results ready

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MARVY team

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