3D Stent Graft Guidance based on Tracking Systems for Endovascular Aneurysm Repair

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Conflicts of interests - disclosure

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No

2. Advisory Role or Expert Testimony

No

3. Stock Ownership

No

4. Patent, Copyright, Licensing

No

5. Honoraria

No

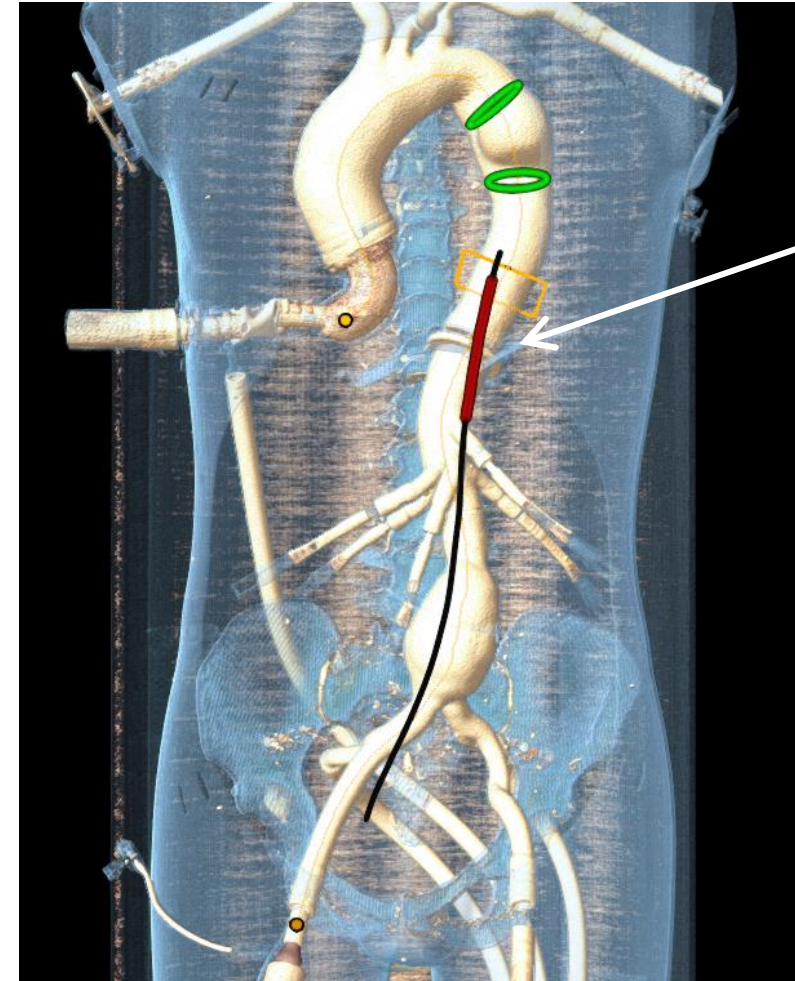**6. Financing of Scientific Research**

No

7. Other Financial Relationships

No

Motivation – stent graft guidance

3D stent graft shape

Motivation – clinical problem

- Use case: vessel repair by implanting a stent graft

- Current guidance of instruments: 2D fluoroscopy with contrast agent
  Drawbacks:

  - Missing depth information leads to challenging navigation

  - Radiation exposure of surgical team and patient (Rehani et al. 2006)

  - Contrast agent is potentially kidney damaging (Saratzis et al. 2015)

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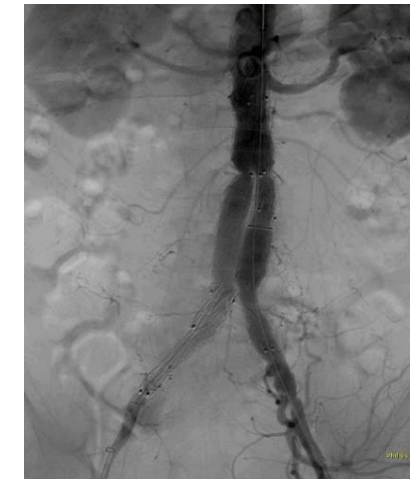
Motivation – 3D stent graft guidance

Idea: 3D stent graft guidance without the use of X-ray and contrast agent

Fiber optic shape sensing (FOSS)

✓ Shape

X Location

Khan et al. 2019,

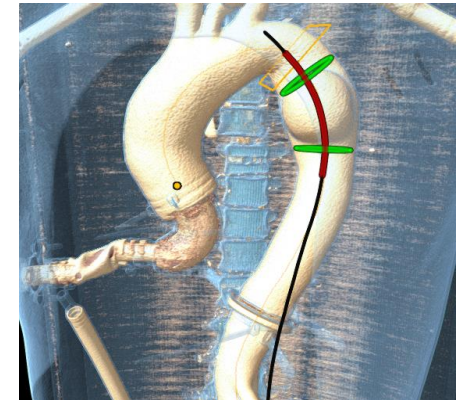Roesthuis et al. 2014

+

Electromagnetic Tracking

X Shape

✓ Location

Condino et al. 2012,

Lambert et al. 2012

=

3D stent graft guidance

✓ Shape

✓ Location

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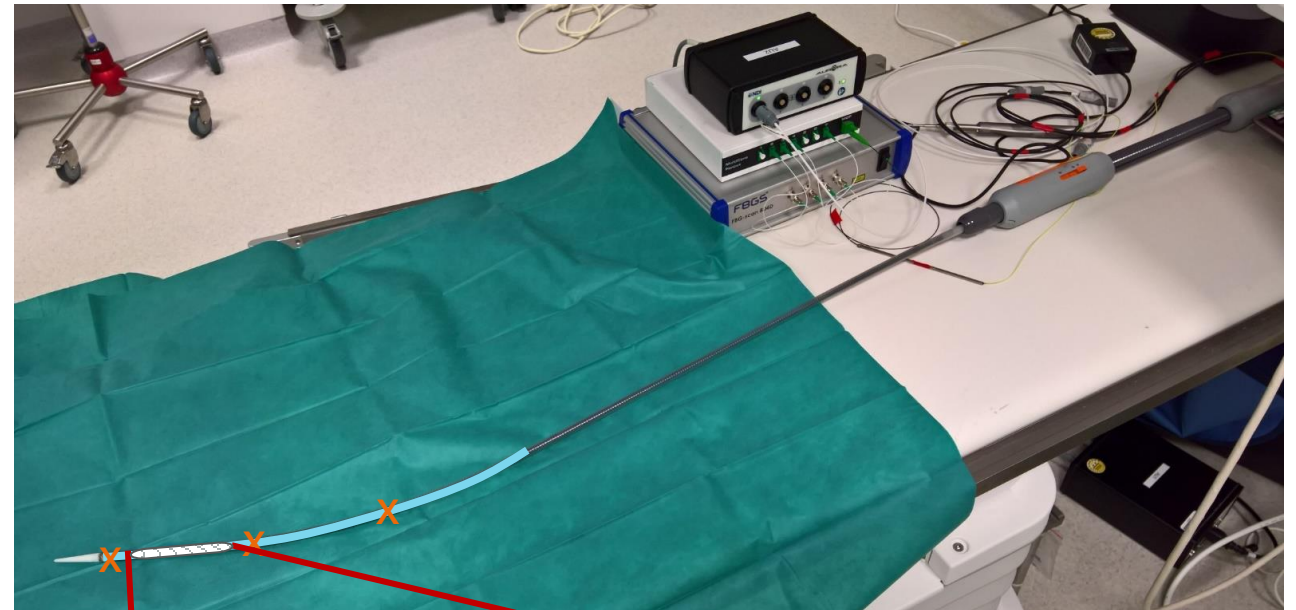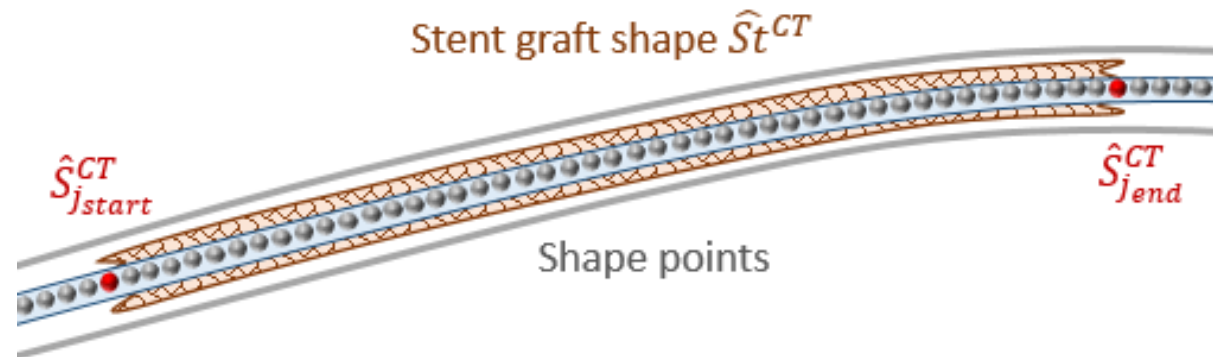
Stent Graft System

- Stent graft system:

  - Multicore fiber with 38 cm shape sensing length

  - 3 EM sensors at the first 25 cm

- Stent graft is placed at the first ~15 cm

  → Accurate tracking of the stent graft

Stent grafts guidance

- From the tracking based guidance (Jäckle et al. 2020, Jäckle et al. 2020)

  3D shape positions of the stent graft system's first 38 cm

- Stent graft shape is part of the tracked shape

- Calibration: The start and end positions have to be determined

Stent grafts guidance - visualization

- Everything is shown in the preoperative scan

- Before intervention:

  - **Insertion path** can be chosen

  - **Marker rings** for the landing zone of
    the stent graft can be set

- During intervention:

  - **Whole tracked shape** is shown

  - **Stent graft shape** is highlighted

→ Stent graft can be navigated such
that the stent graft shape is through
both marking rings

Evaluation – Experimental Setup

Conduction of a standard EVAR procedure on a torso phantom including the following steps:
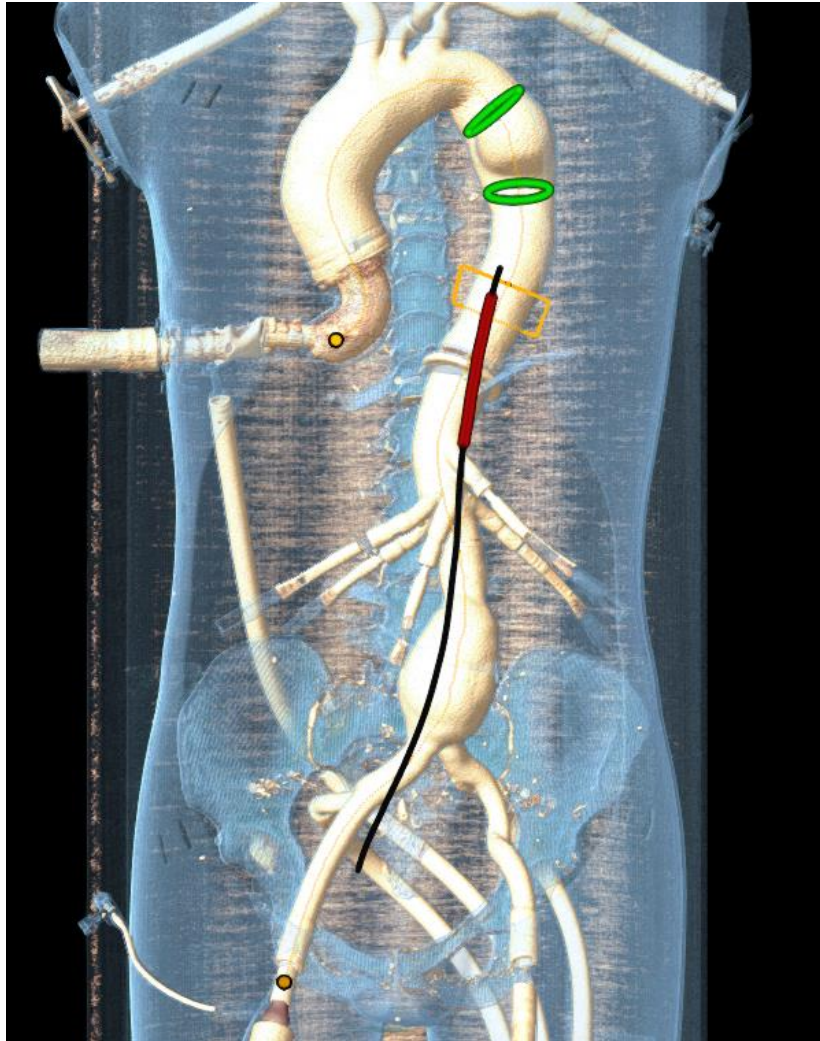
1. Insert and navigate a soft guide to the landing zone

2. Replace soft by a stiff guide wire

   Standard X-ray based guidance

3. Navigation of the stent graft system to the landing zone

4. Placement and implantation of the stent graft

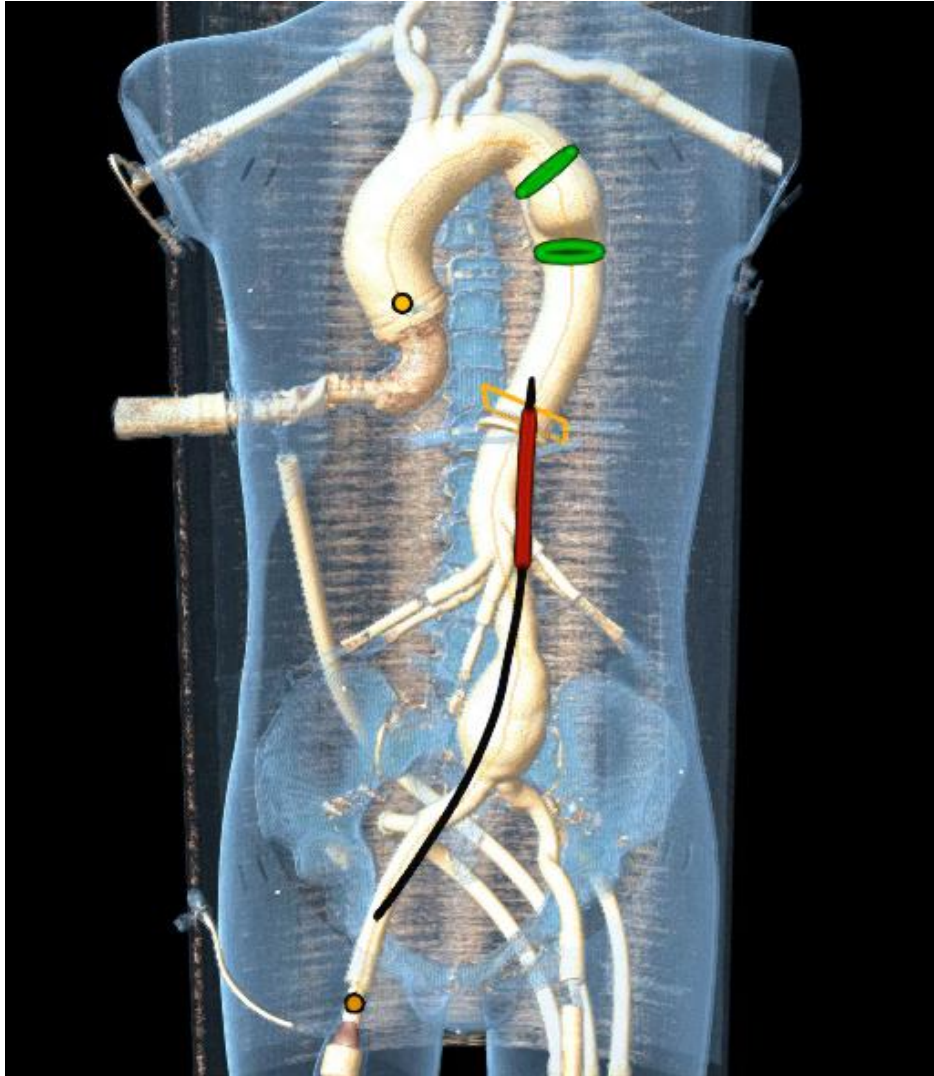   **Tracking based 3D stent graft guidance**

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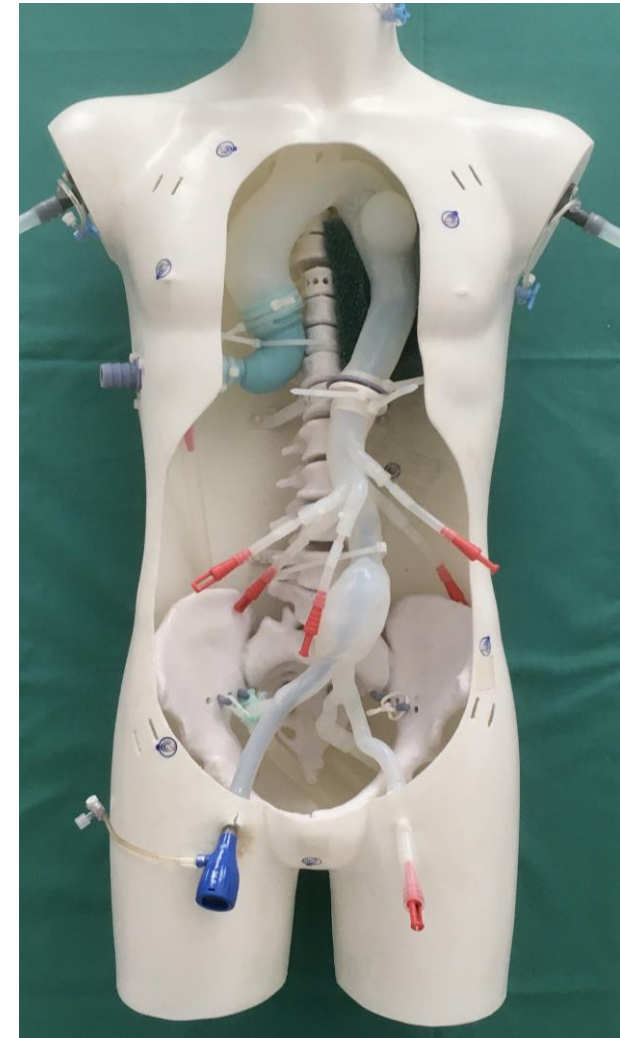
Results - 3D stent graft guidance vs. 2D fluoroscopy imaging

+ 3D guidance information

+ No health side effects

+ Clear visualization of the stent graft system & integrated stent graft

- Preoperative information of vessel anatomy
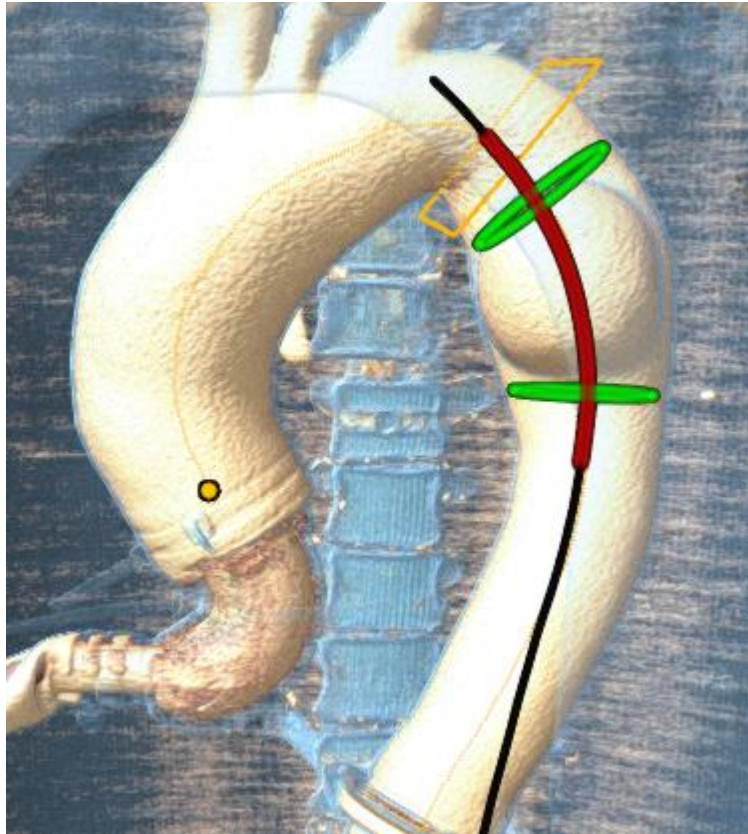
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Results - Navigation of the stent graft

- 3D guidance with 10 Hz frequency & no observed latencies

  → Real-time guidance

- Feedback from the physicians:

  Easy handling due to intuitive visualization

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Results - stentgraft placement

Before implantation

After implantation

→ **Successful stent graft implantation as intended by the clinicians**

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Conclusions

- 3D stent graft guidance based on tracking systems
  - → **No health side effects**
  - → **Intuitive visualization**

- Pre-clinical evaluation
  - → **Successful stent graft implantation**

- Next steps:
  - **Clinical evaluation**
  - **Updating anatomical structure of preoperative scan**

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