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3D Stent Graft Guidance based on Tracking Systems

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MOTIVATION

- Medical use case: Endovascular aneurysm repair procedures.
- State-of-the-art guidance: 2D fluoroscopy and administration of contrast agent.
- Drawbacks:
  - Use of X-ray
  - Contrast agent burdening the kidneys
  - Missing depth information
- Novel approach: 3D guidance of the stent graft catheter as well as the stent graft based on tracking systems - without the need of X-rays and contrast agent.

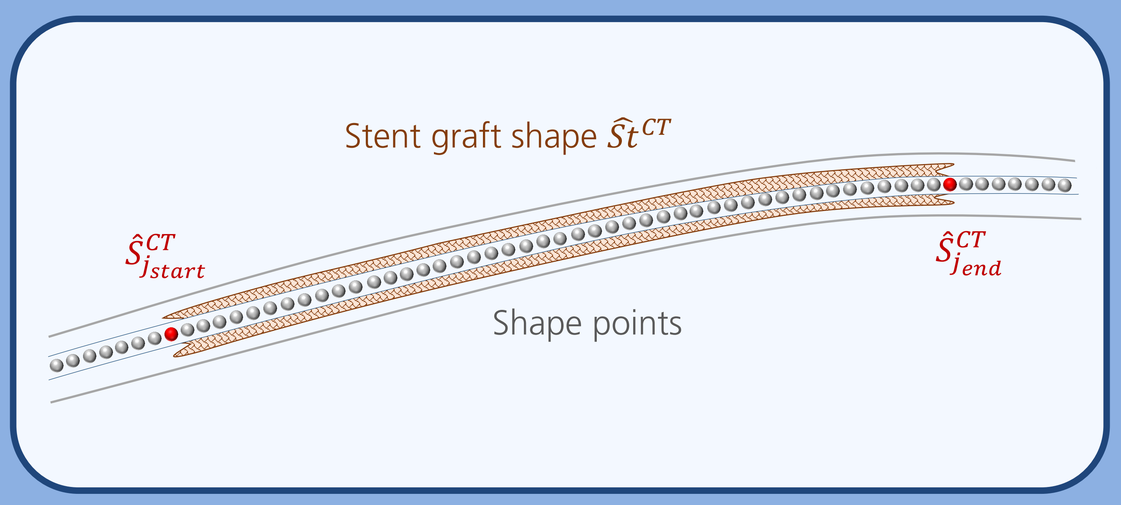
METHOD

- Given from the guidance based on tracking systems [1]:
  Shape positions of the stent graft catheter

$$\hat{S}^{CT} = \{\hat{S}_0^{CT}, \dots, \hat{S}_n^{CT}\}$$

- The stent graft shape $\widehat{St}^{CT}$ is a subset of the tracked shape $\hat{S}^{CT}$:

$$\widehat{St}^{CT} = \{\hat{S}_{j_{start}}^{CT}, \hat{S}_{j_{start}+1}^{CT}, \dots, \hat{S}_{j_{end}-1}^{CT}, \hat{S}_{j_{end}}^{CT}\} \subset \hat{S}^{CT}$$



- Calibration step:
  The indices j_{start}, j_{end} are determined by visiting the start and end of the stent graft with an EM equipped stylus. For more details, see our CURAC paper [2].
- Visualization:
  All tracked information is shown in the preoperative CT scan:

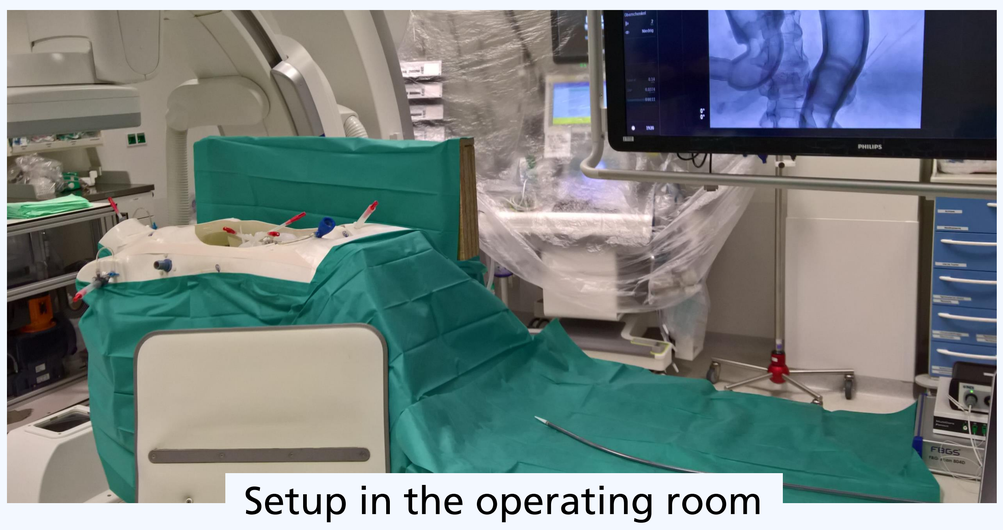
  Whole instrument → thin black curve

  Stent graft → thick red curve

  In addition, the start and end of the desired landing zone can be marked with two green rings.

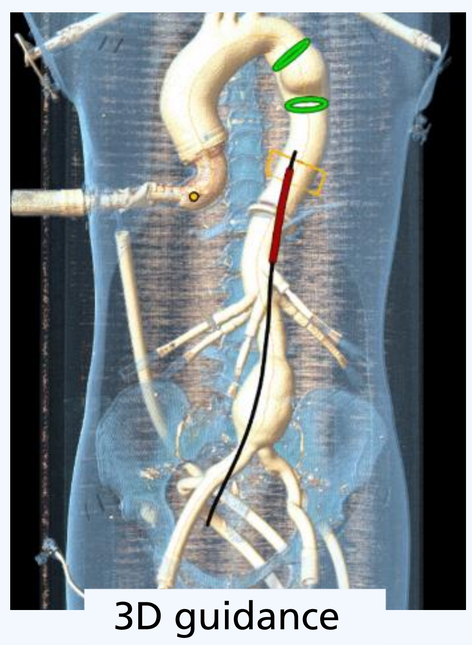
EVALUATION

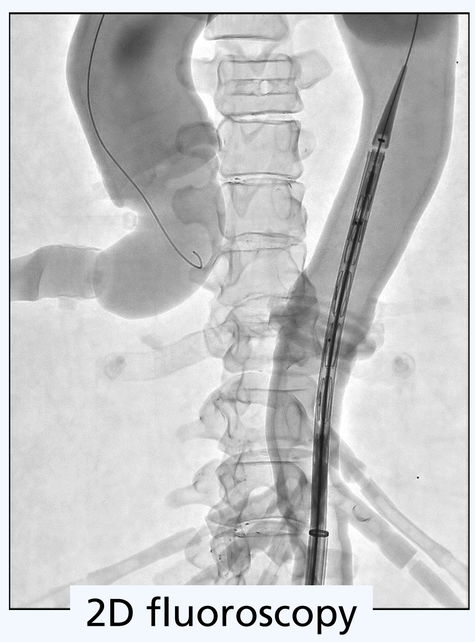
- Clinicians conducted an endovascular aneurysm repair procedure on a torso phantom using our tracked stent graft catheter.
- Setup in the operating room:


Setup in the operating room

RESULTS

- Comparison between tracking-based 3D stent graft guidance (left) and state-of-the-art 2D guidance (right):


3D guidance


2D fluoroscopy

- The clinicians successfully implanted the stent graft using our tracking-based guidance without acquiring 2D fluoroscopy images, see also our video.

Video:

CONCLUSION

- Application of the 3D tracking-based guidance for stent graft implantation.
- Promising results:
  → First successful usage of our guidance for stent graft implantation
- Future work:
  → More extensive, clinical validation

CURAC Paper:

REFERENCES

[1] Jäckle et al. Three-dimensional guidance including shape sensing of a stent graft system for endovascular aneurysm repair. IJCARS 2020.

[2] Jäckle et al. 3D Stent Graft Guidance based on Tracking Systems for Endovascular Aneurysm Repair, CURAC 2021.

CONTACT

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