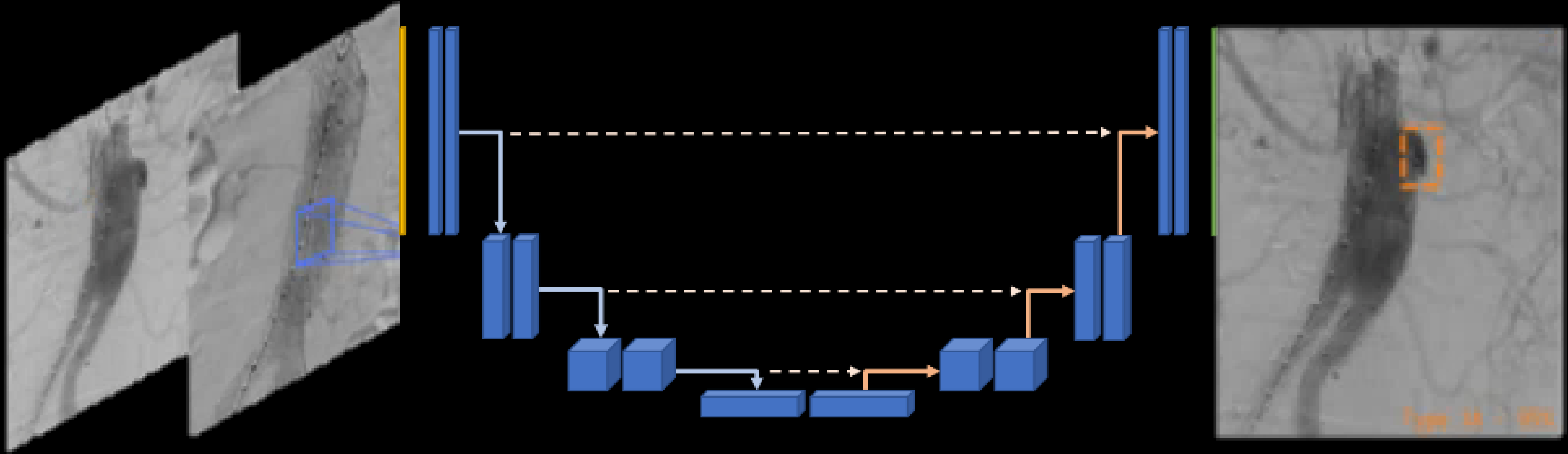
Artificial intelligence-based intraoperative **endoleak visualization** with completion digital subtraction angiography images during **EVAR**

Stefan P.M. Smorenburg MSc, Kaj O. Kappe MSc, Arjan W.J. Hoksbergen, MD,PhD
Jelmer M. Wolterink, PhD, Kak Khee Yeung, MD,PhD,FEBVS



Disclosures

Speaker name:

Stefan Smorenburg

I have the following potential conflicts of interest to report:

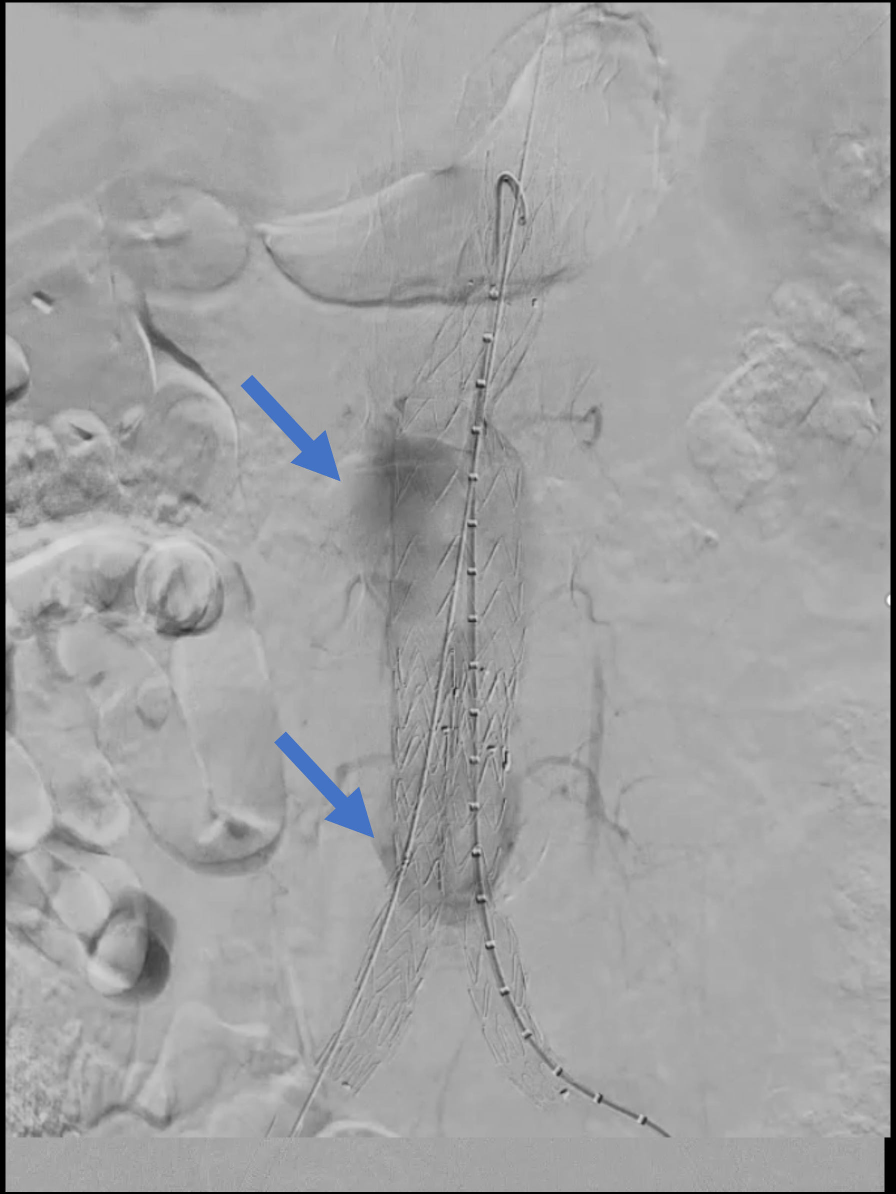
- ☐ Consulting
- ☐ Employment in industry
- ☐ Stockholder of a healthcare company
- ☐ Owner of a healthcare company
- X Other(s)

  partly funded research by Philips

- ☐ I do not have any potential conflict of interest

Completion angiography

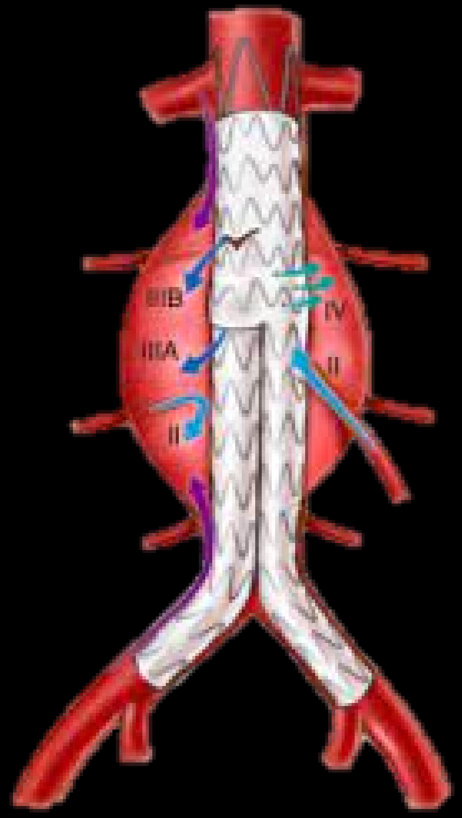
- Performed at the end of every EVAR procedure
- Digital subtraction angiography (DSA)
- Inspection of:
  - Stent graft position
  - Patency of renal/visceral/iliac arteries
  - Endoleaks



Intraoperative endoleaks

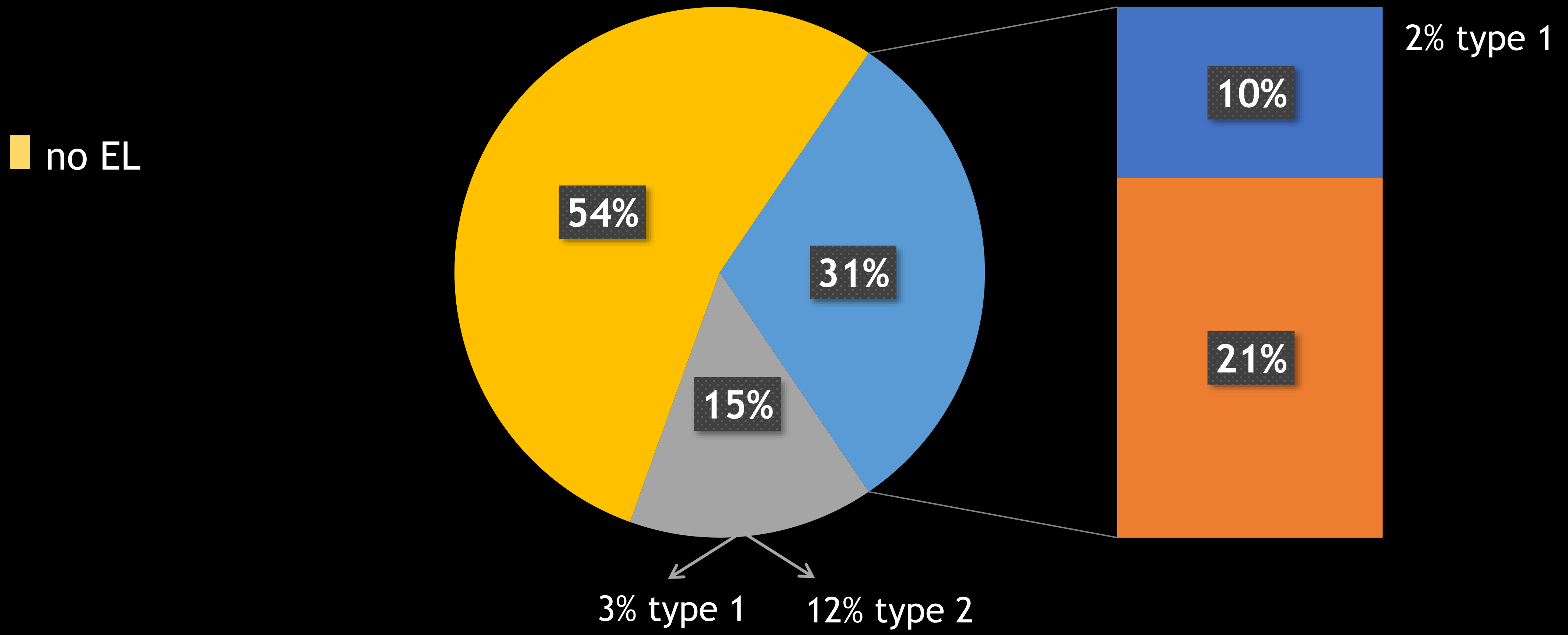
- Types 1 and 3 endoleaks can be treated within thesame procedure:
  - proximal/distal ballooning (1a/1b)
  - cuff extension (1a)
  - endoanchors (1a)
  - distal leg extension (1b)
  - relining (3)

- Current endoleak assessment is performed by ‘visual inspection’
  - subjective
  - limited by human interpretation
  - physician experience



Do we detect all endoleaks intraoperatively? If not → possible reintervention

Intraoperative endoleaks versus 30-day CTA
detection by surgical team



Study aim

To perform **automatic analysis** of **completion angiography** imaging obtained during EVAR procedures with **artificial intelligence**-based **deep learning**

Methods
patient cohort

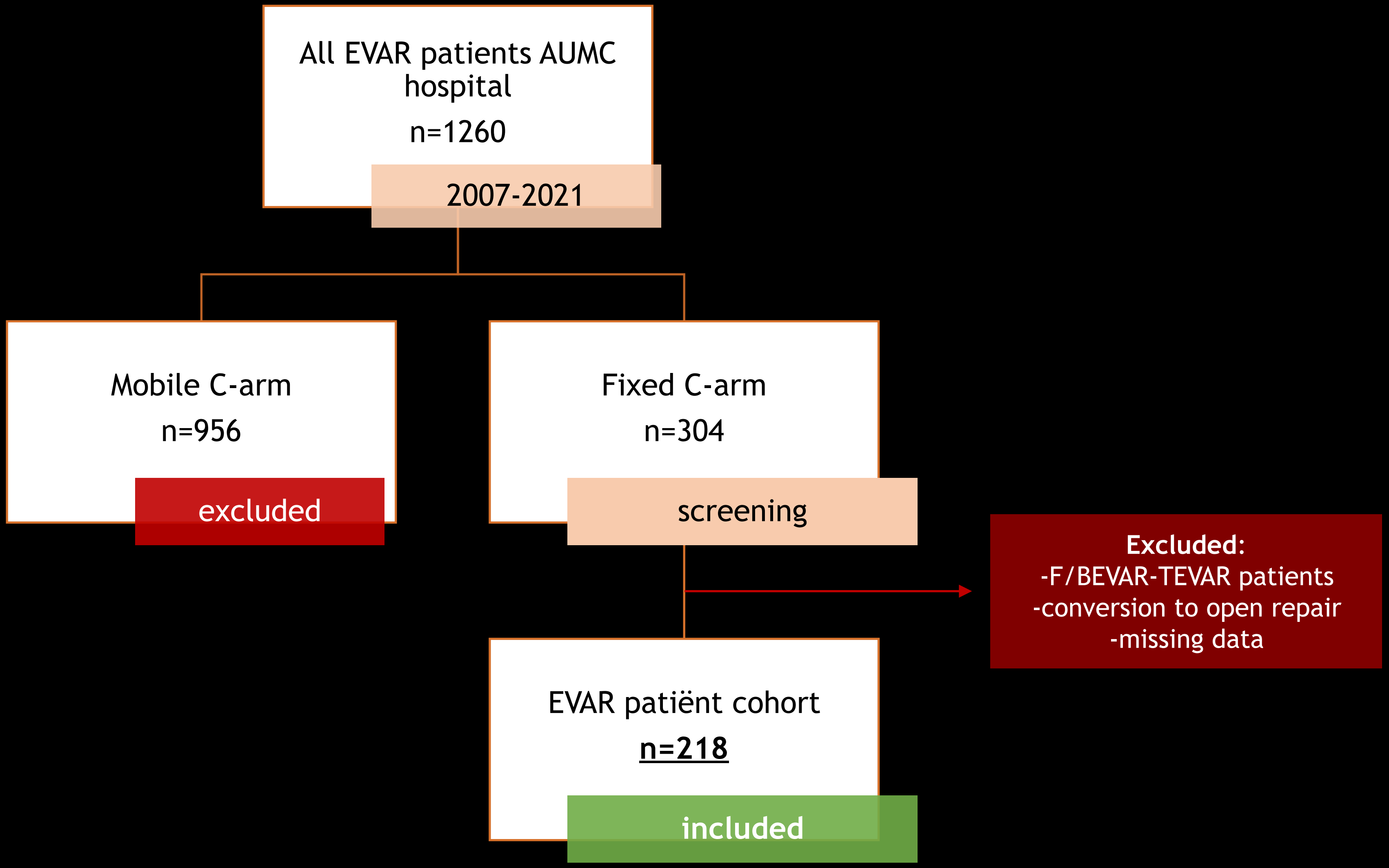
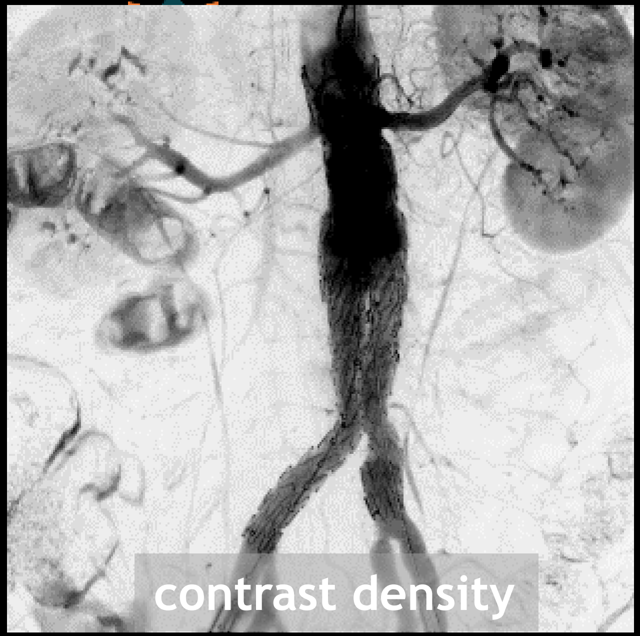
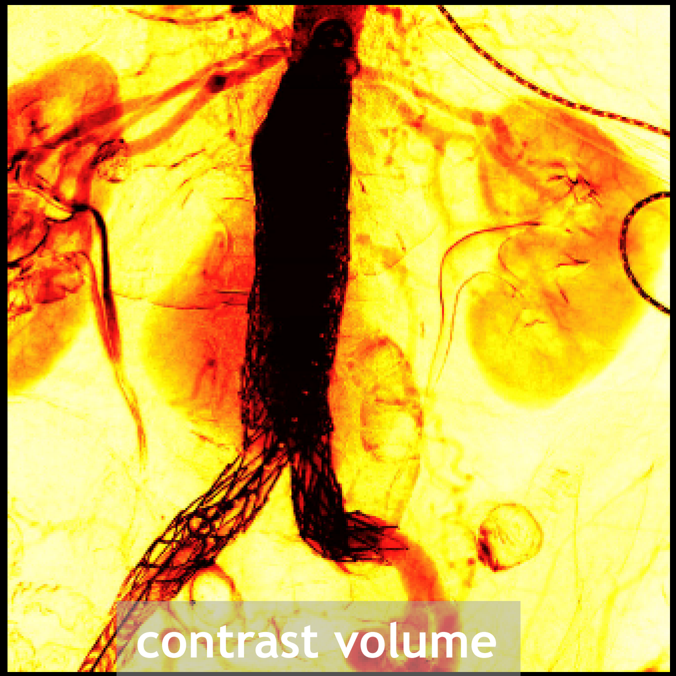


Image preprocessing
perfusion parameters

DSA movie was converted





Manual labeling
for model input

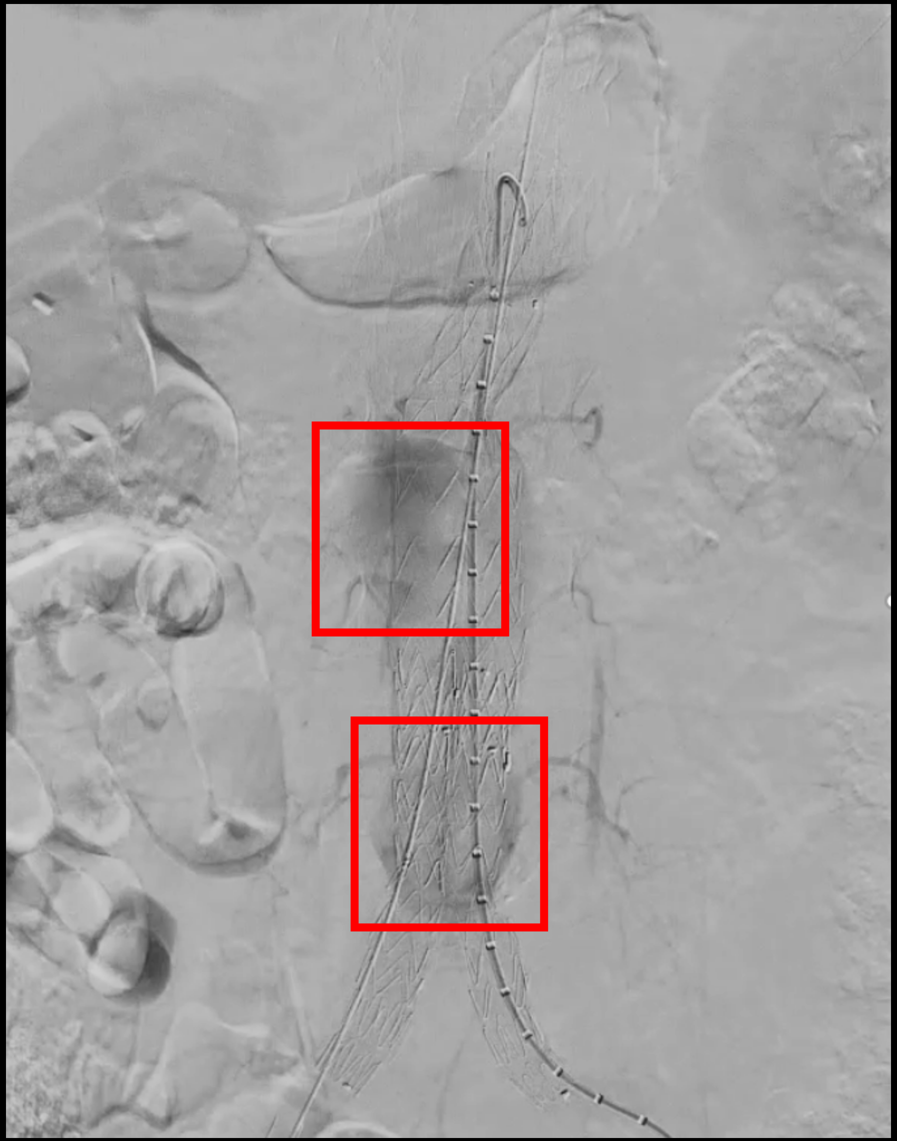
2 vascular surgeons

2 interventional radiologists

1 operating team

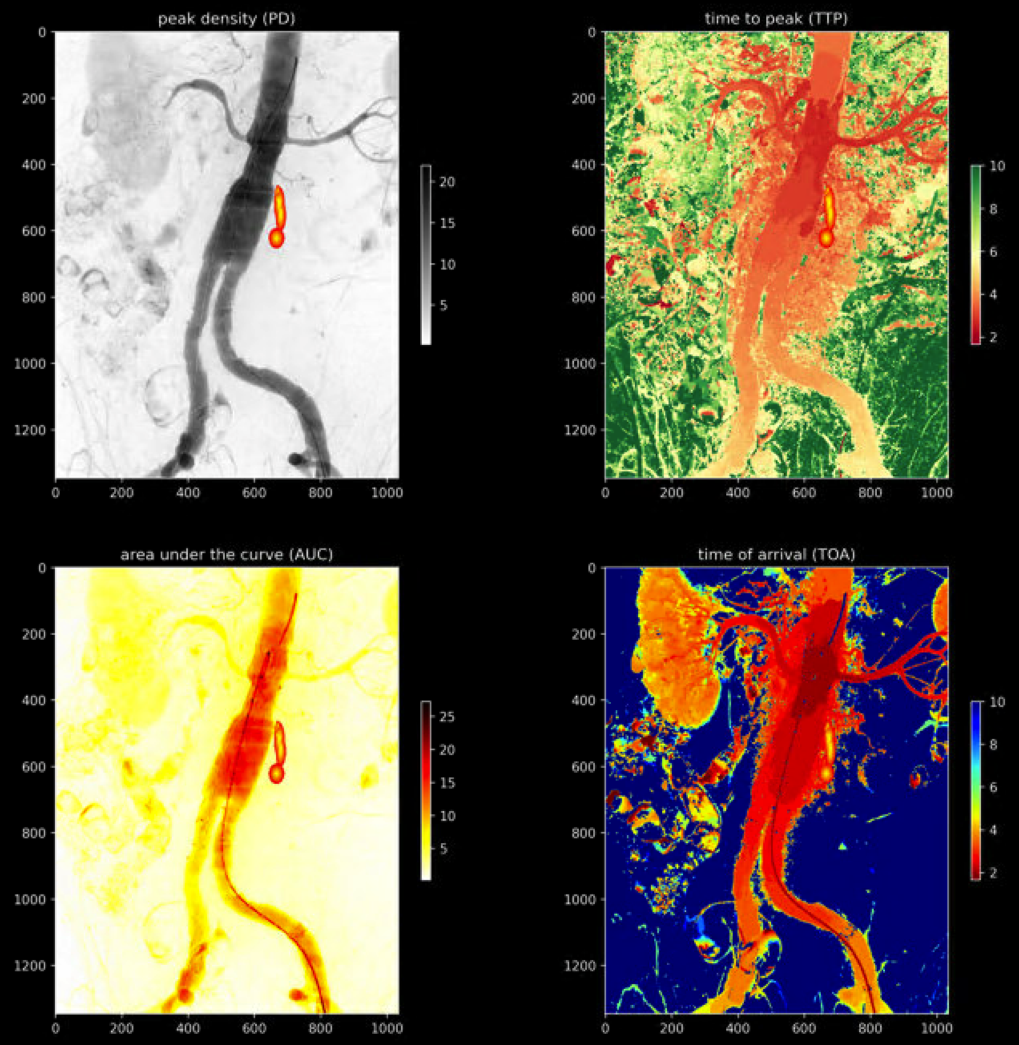
Scored the completion angiographies on:

- Endoleak yes/no
  - Type
  - Location



Deep learning model

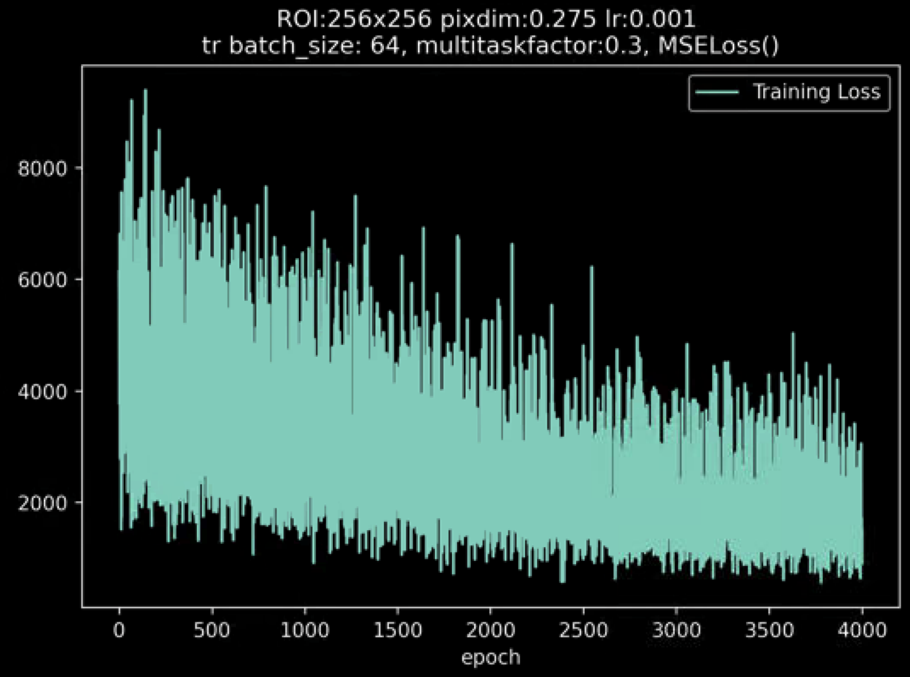
inputs:



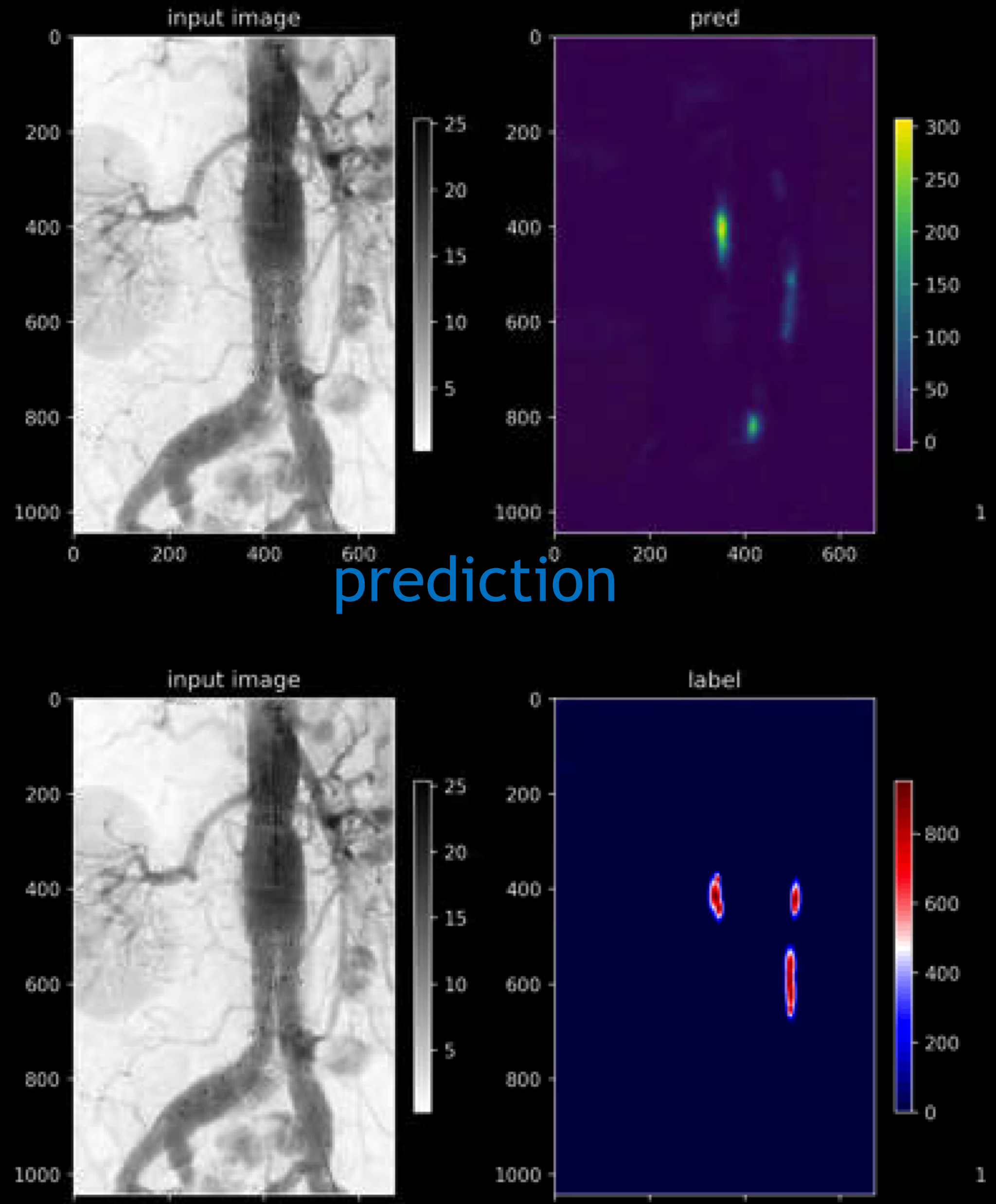
- U-Net architecture
- Data:
  - 220 completion angiograms
    - Half with endoleak
  - Split in train (70%), validation (10%) and test set (20%)

- Data augmentation:
  - Vertical flipping
  - Z-axis rotation (15 degrees)
- MSE-loss, Adam optimizer
- Pytorch and Medical Open Network for AI (MONAI)

Results
Deep learning model



Training loss declining

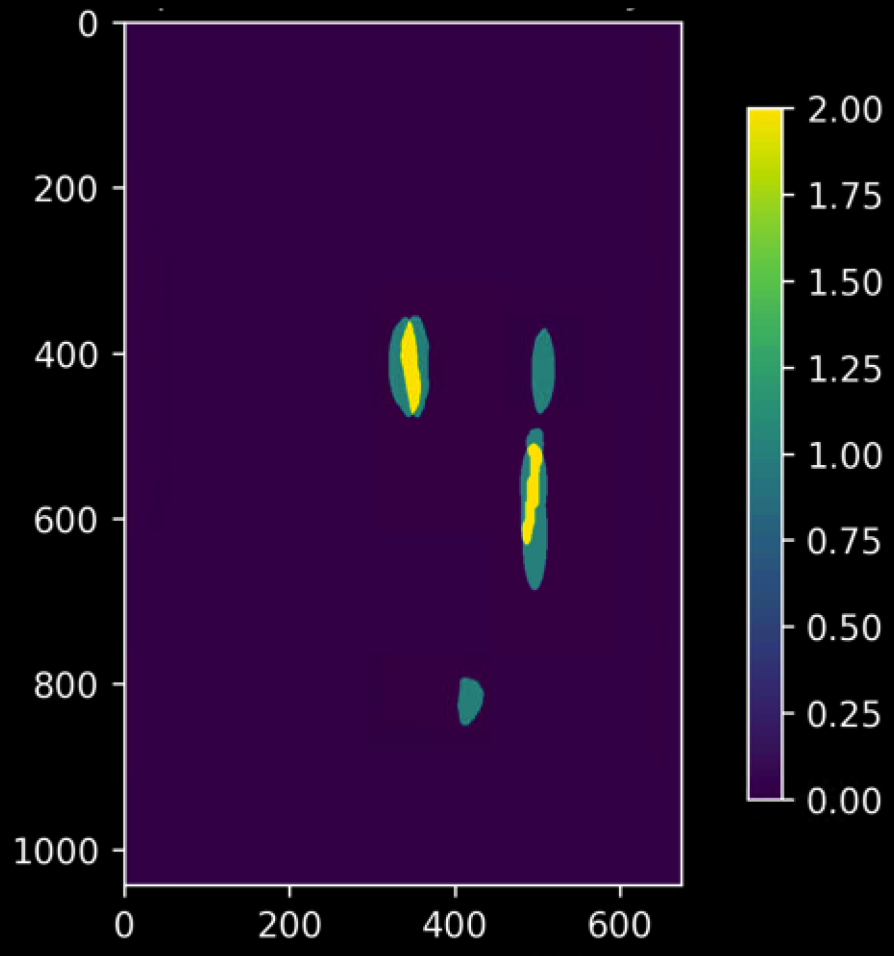


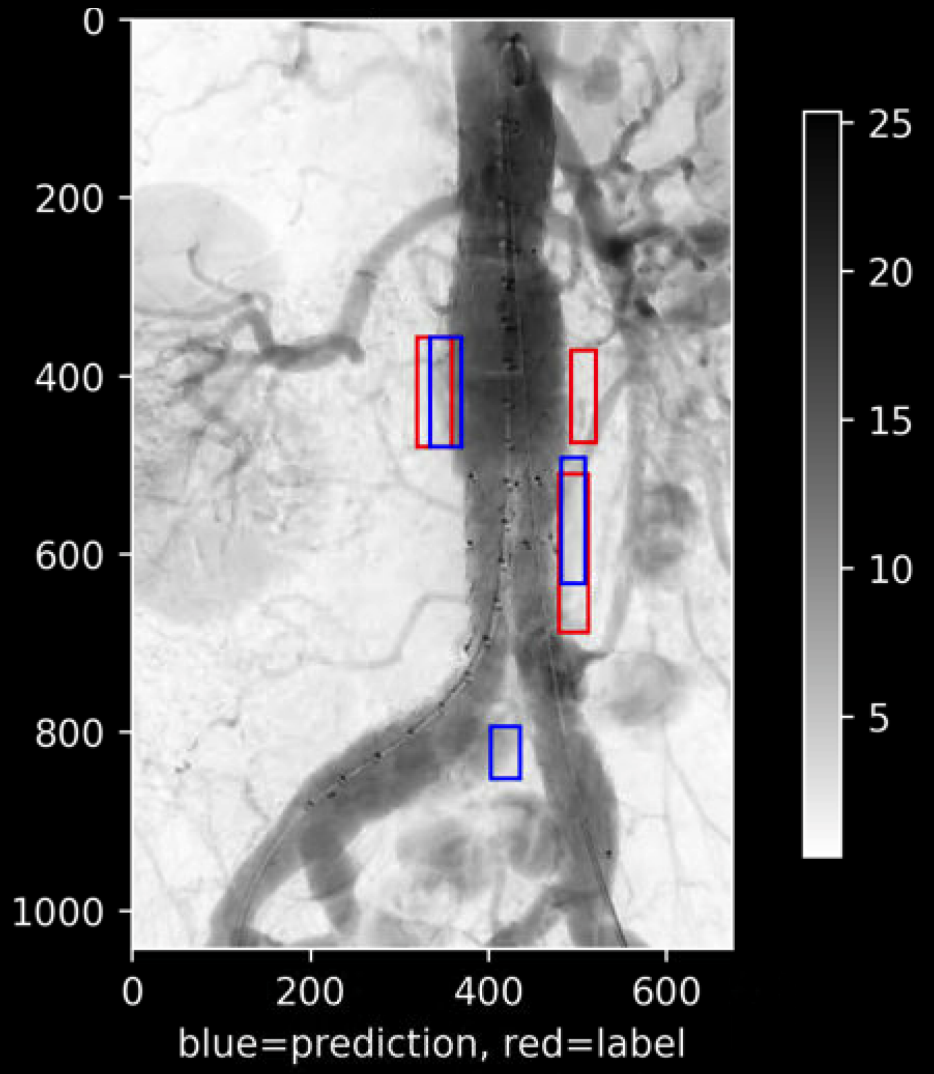
prediction

label

Results

Deep learning intraoperative endoleak visualization

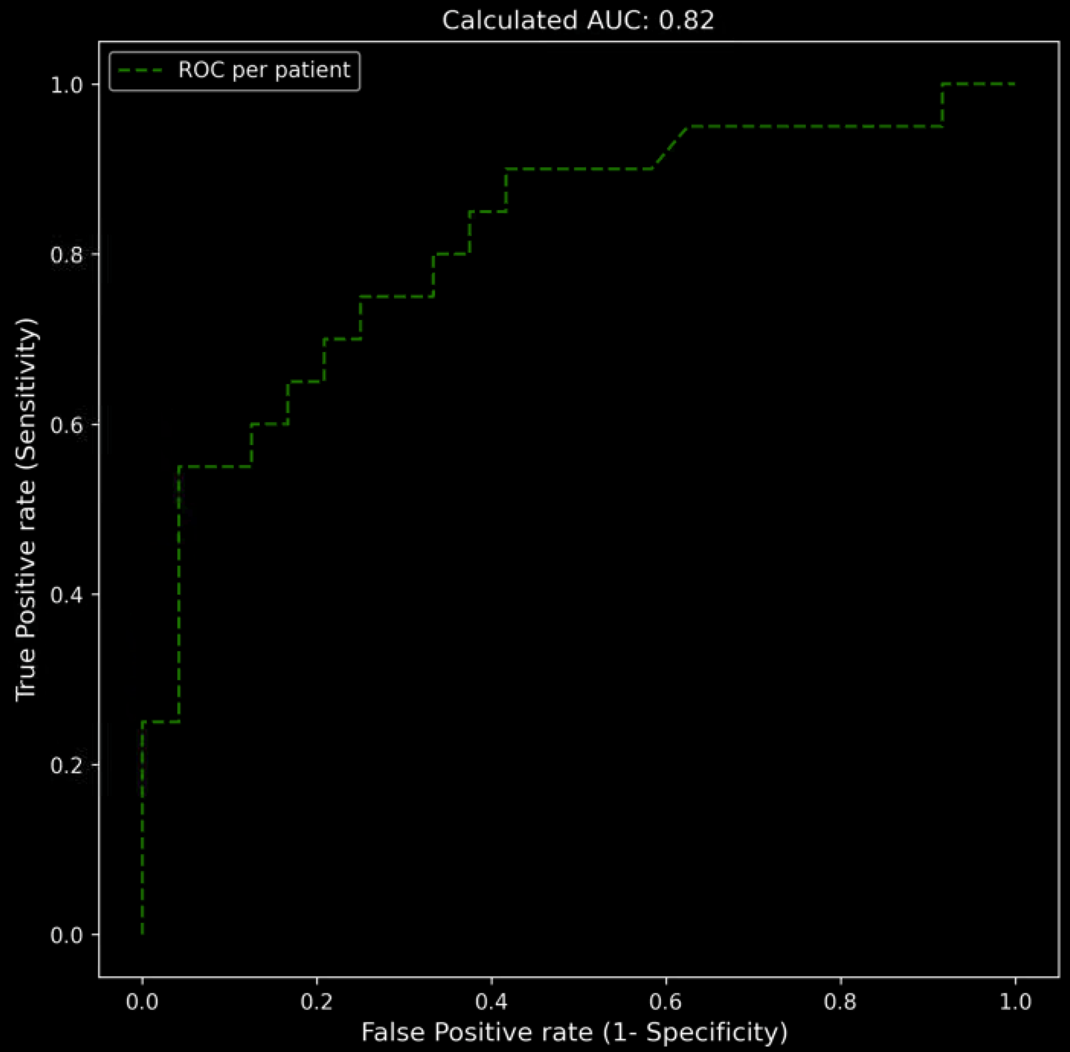




2 TP
1 FP
1 FN

Results

Receiver operating curve (ROC) with area under the curve (AUC)



AUC of 0.82

Conclusion

We developed a fully automated endoleak visualization method, based on the completion digital subtraction aniography during EVAR.

The extraction of detailed imaging knowledge, can aid in intraoperative clinical decision making.

Future development will focus on better endoleak classification.

AI-team at Amsterdam UMC

Kakkhee Yeung – vascular surgeon
Jelmer Wolterink – assistant professor

Dieuwertje Alblas – mathematician
Kaj Kappe – technical physician

s.smorenburg@amsterdamumc.nl