

# Nieuwe inzichten in de chirurgische behandeling van UGI

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# Moving target



# De opmars van laag-volume hoog-complexe robotchirurgie in Nederland

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# Achtergrond

- Aanzienlijke ontwikkeling robot-geassisteerde chirurgie (RAS) in afgelopen decennia<sup>1,2</sup>

Surgical Endoscopy

<https://doi.org/10.1007/s00464-024-10774-2>



## The death of laparoscopy

Davide Ferrari<sup>1,2</sup> · Tommaso Violante<sup>1,3</sup> · Marco Novelli<sup>4</sup> · Patrick P. Starlinger<sup>5</sup> · Rory L. Smoot<sup>5</sup> · Janani S. Reisenauer<sup>6</sup> · David W. Larson<sup>1</sup>

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1. Chapelle et Al., *Ned Tijd Geneesk.* 2013
2. Sheetz et Al., *JAMA Open* 2020
3. Intuitive Surgical 2024

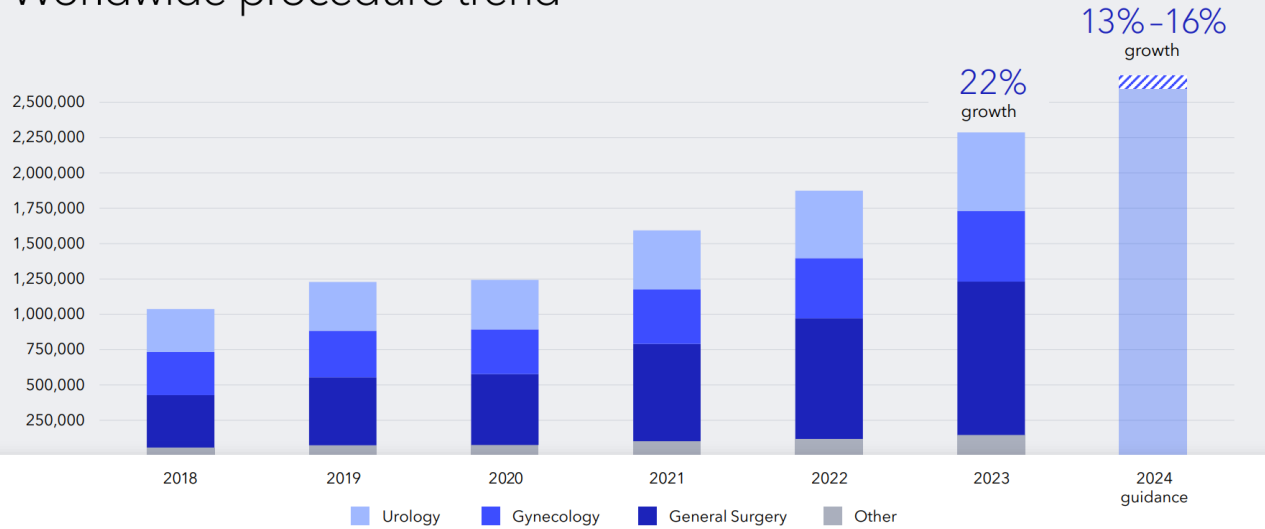
**DICA** Life  
saving  
data



32 ziekenhuizen - 47 systemen

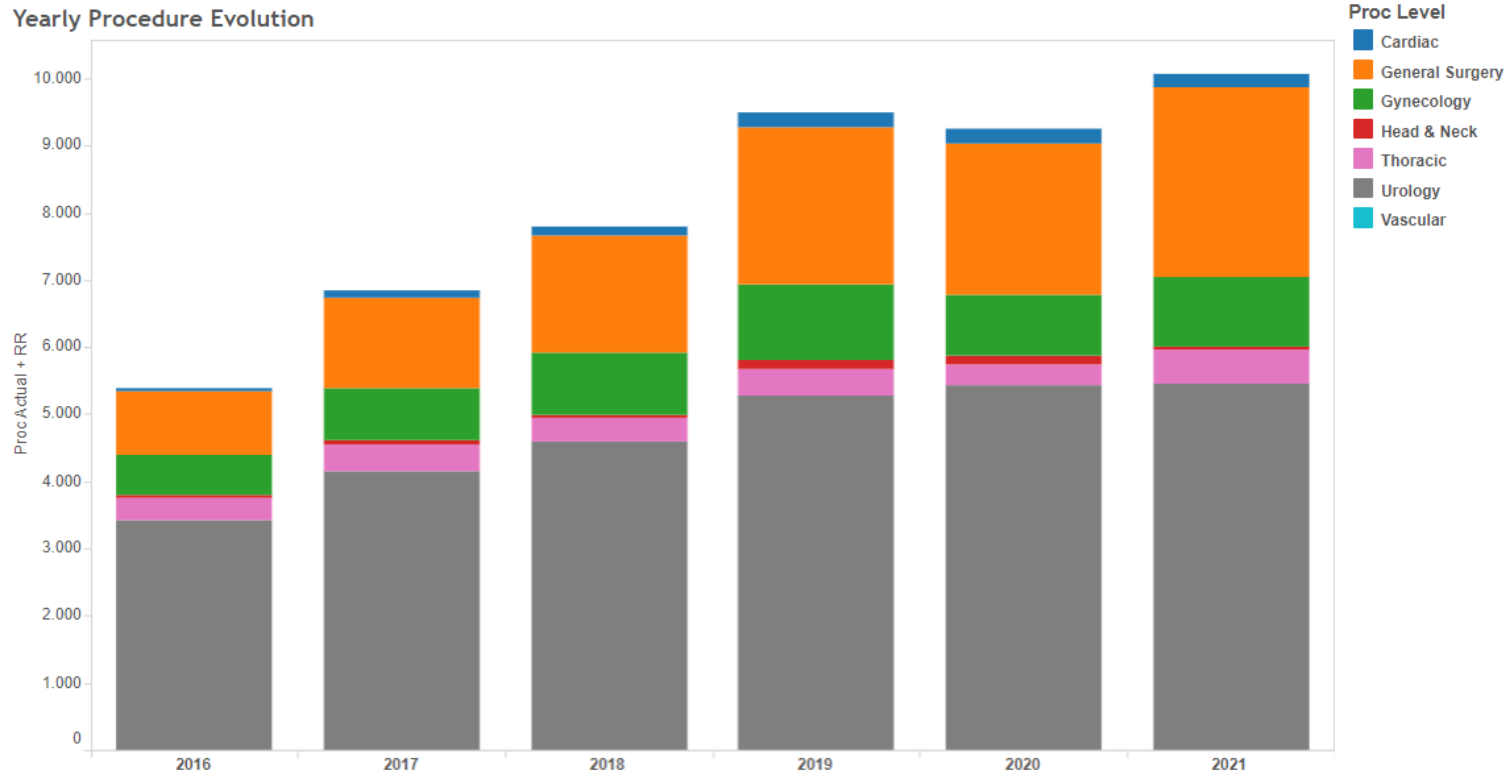


## Worldwide procedure trend



# da Vinci procedure evolution NL

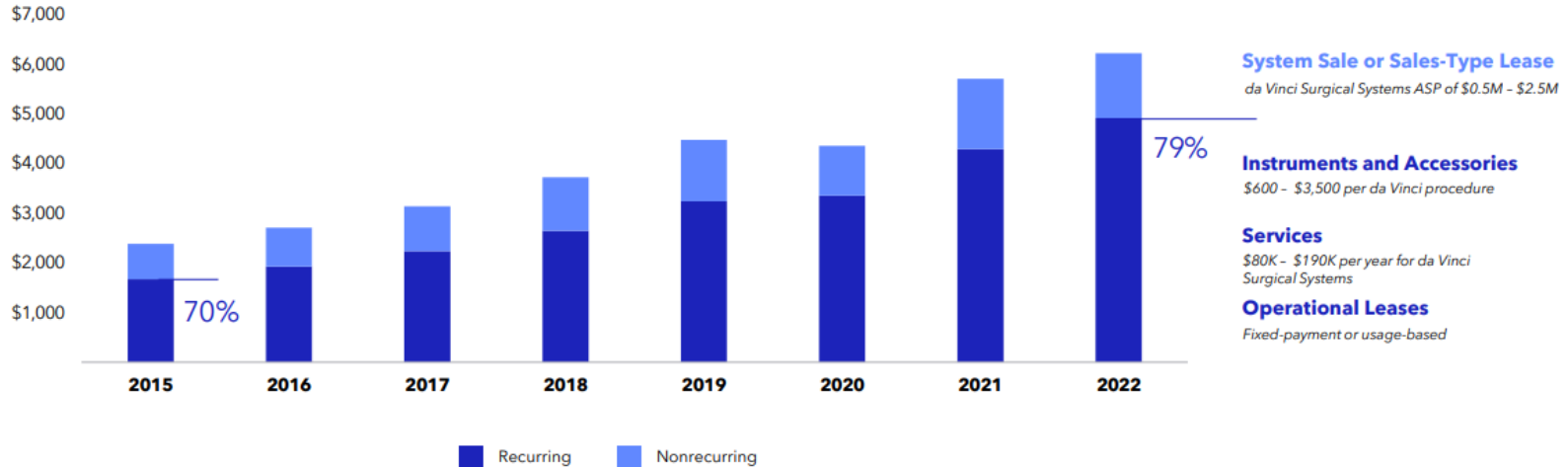
Yearly Procedure Evolution



# Recurring Revenue Model

## Revenue Trend

(USD, in millions)





# Achtergrond

- 47 robots in 32 ziekenhuizen in 2023<sup>3</sup>
- Gebruikt in o.a. urologische, gynaecologische en gastrointestinale chirurgie
- Bewijs voor superioriteit over conventionele (lap/open) chirurgie varieert<sup>4</sup>
- Grotere verschuiving richting RAS verwacht



- Doel: trends in implementatie en verschuivingen in indicaties voor RAS in Nederland

3. Intuitive Surgical 2024

4. Grossmann-Waniek et Al., *Surg Endosc* 2024

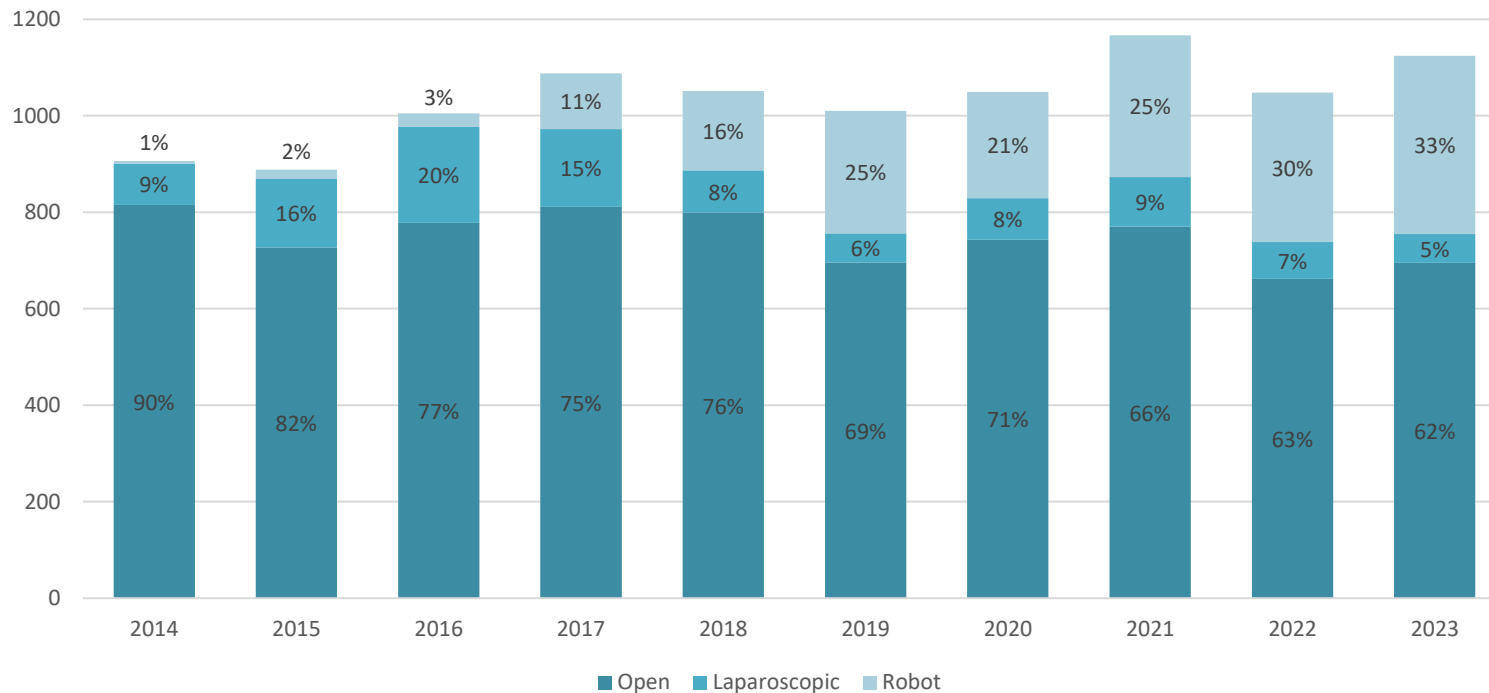
# Methode

- Nationaal retrospectief cohort onderzoek
- Alle chirurgisch behandelde patiënten
- Data van 4 DICA registraties:
  - DPCA (pancreas) 2014-2023
  - DHBA (lever) 2020-2023
  - DLCA-S (long) 2015-2023
  - DUCA (slokdarm & maag) 2022-2023
  - {DCRA (colon & rectum) 2015-2023}
- Bij start operatie robot-geassisteerd → classificatie RAS (intention-to-treat)

# Methode

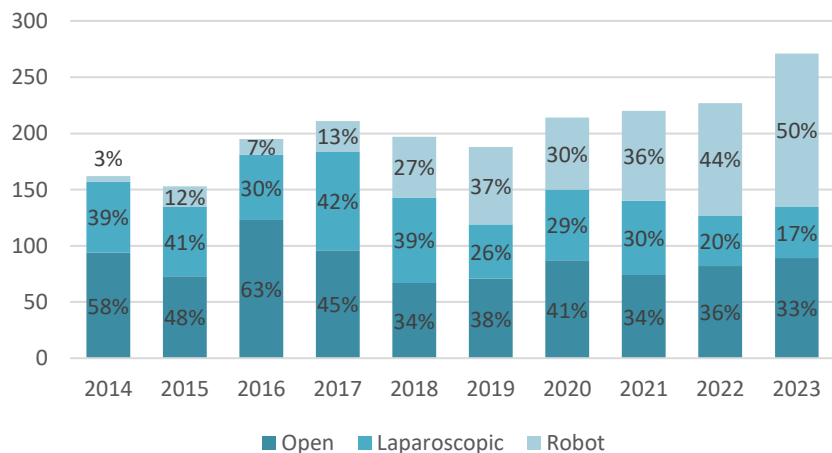
- Eindpunten:
  - Trend in aantal patiënten dat RAS ondergaat van totale operaties (open/laparoscopisch/RAS)
  - Aantal RAS centra & range RAS
  - Patiënt, tumor en behandelkarakteristieken van patiënten die RAS ondergaan over de tijd
    - » Patiënt risico: ASA-score en BMI
    - » Indicatie chirurgie: Tumor locatie; tumor type en chirurgische procedure

# Resultaten Pancreas

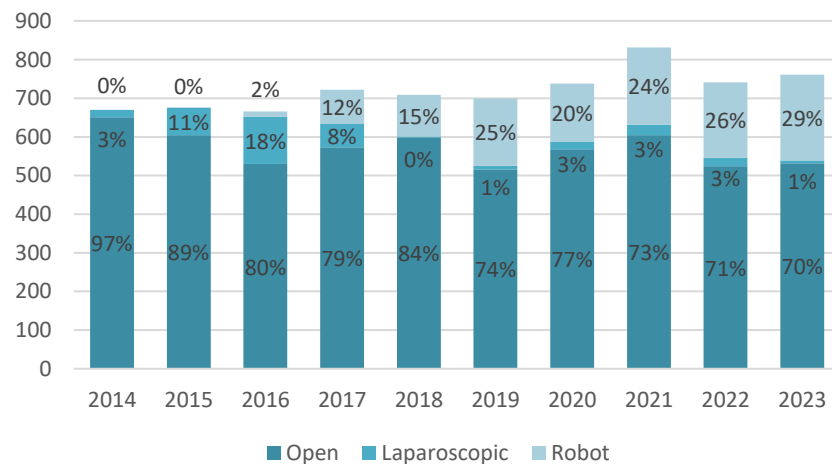


# Resultaten Pancreas

Pancreas corpus/staart chirurgie

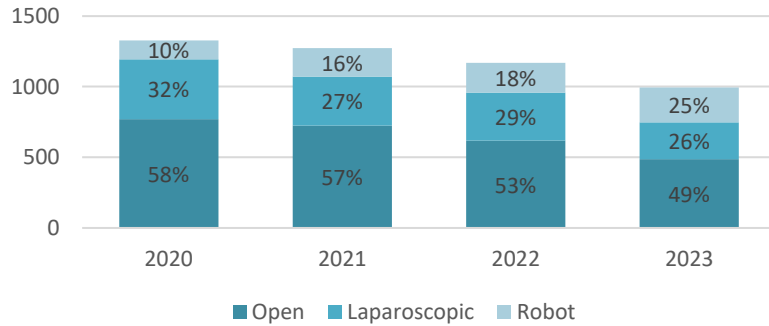


Whipple chirurgie

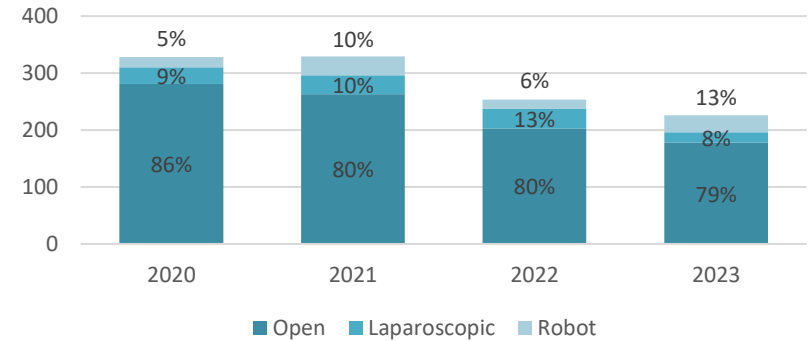


# Resultaten Lever

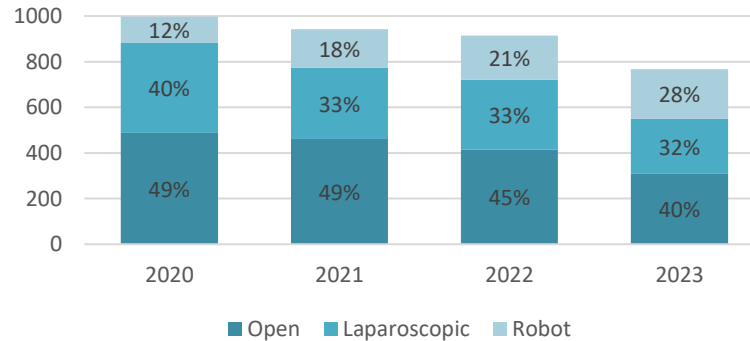
### A: Leverchirurgie



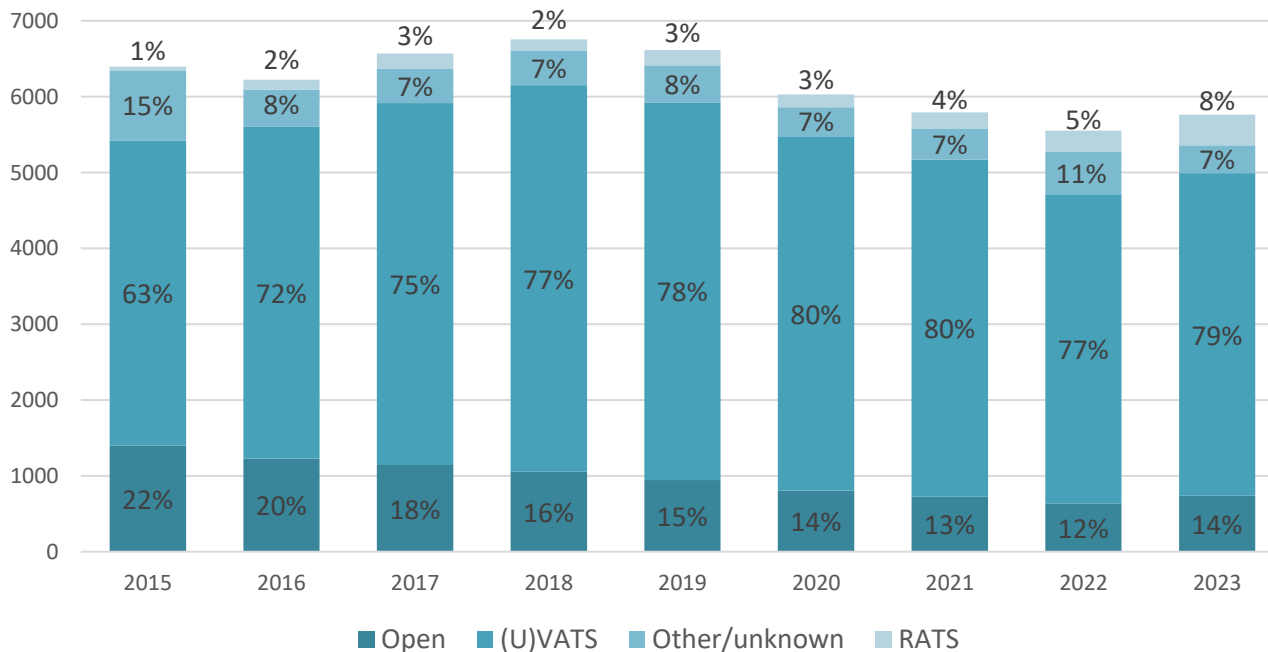
### B: Major resecties



### C: Minor resecties

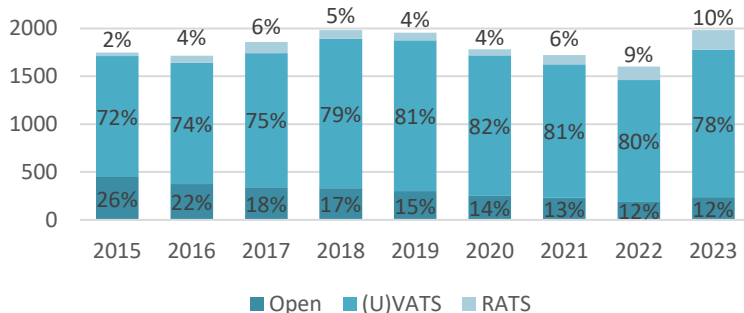


# Resultaten Long

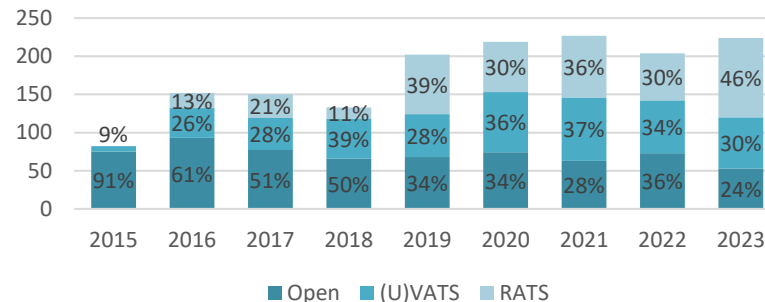


# Resultaten Long

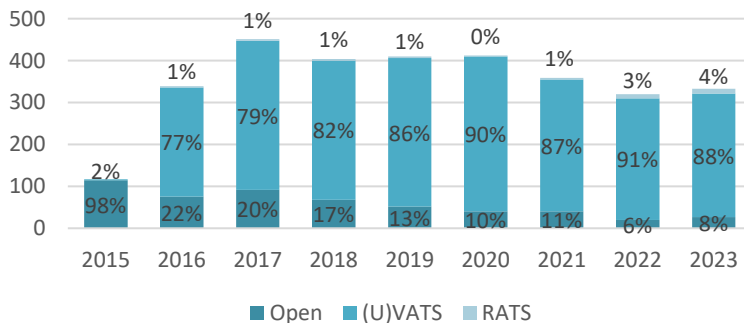
A: Lobectomie



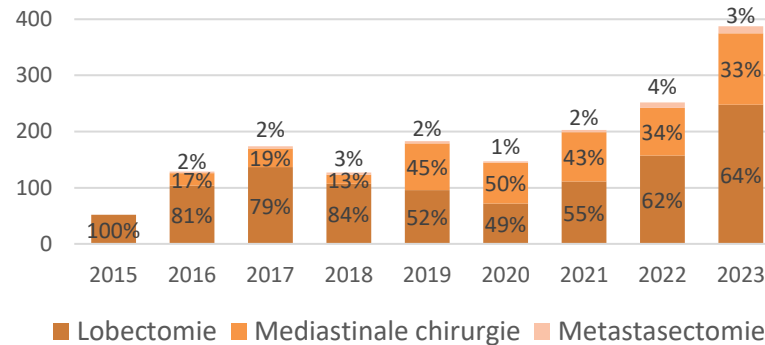
B: Mediastinale resecties



C: Metastasectomie

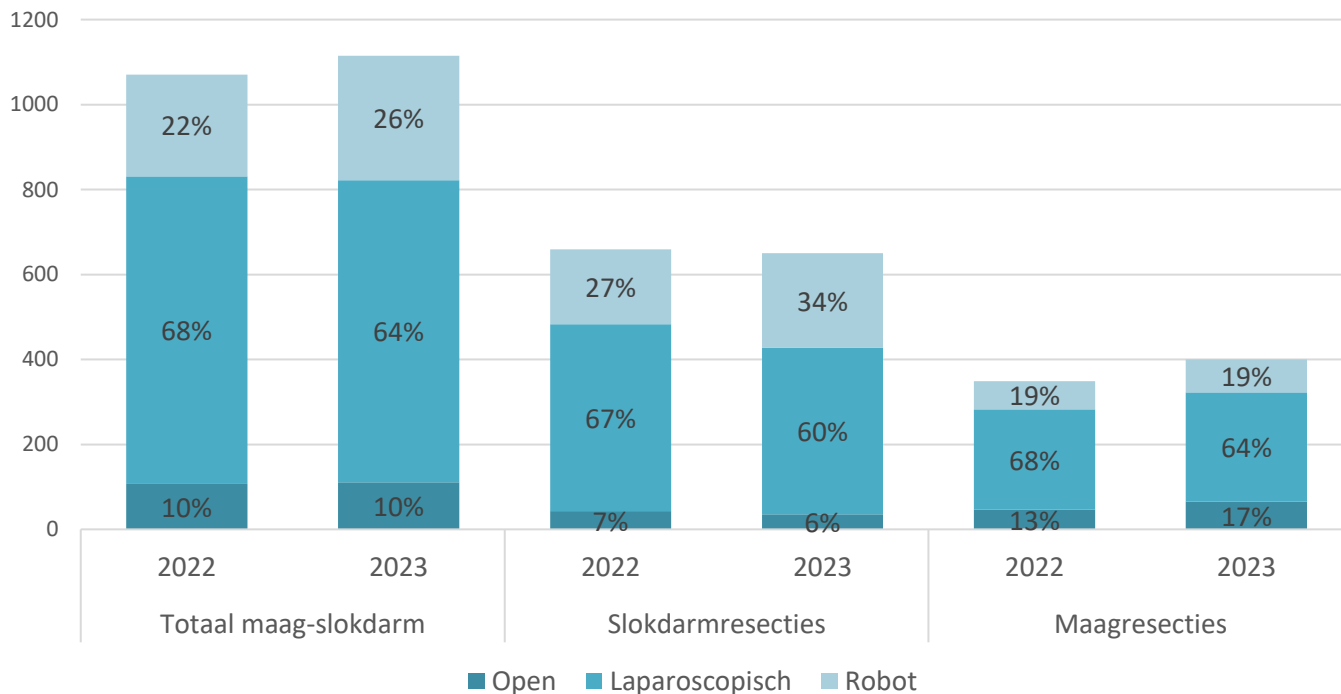


D: Type chirurgie in RATS



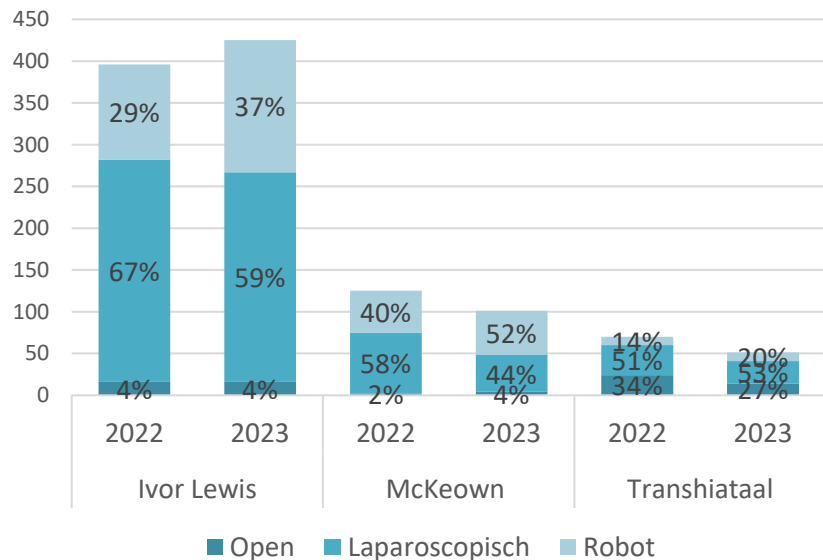


# Resultaten UpperGI

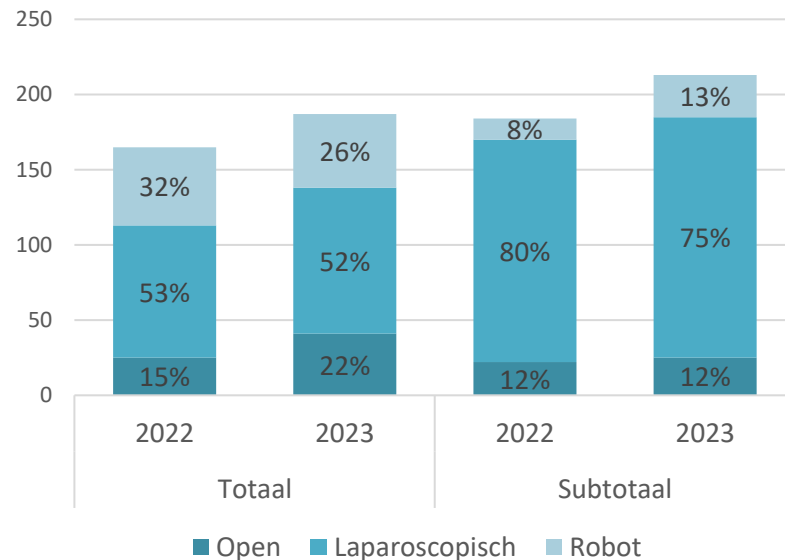


# Resultaten UpperGI

A: Slokdarmresecties

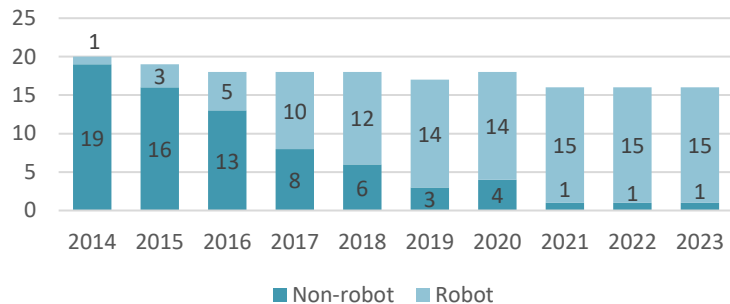


B: Maagresecties

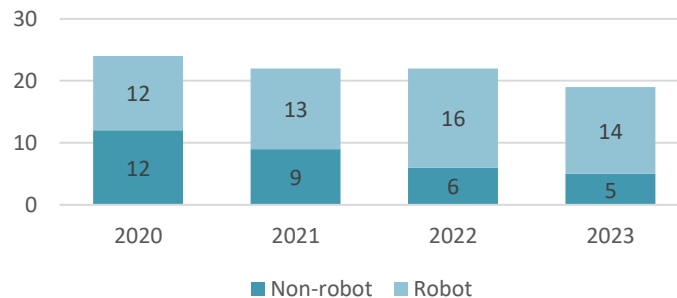


# Resultaten Centra

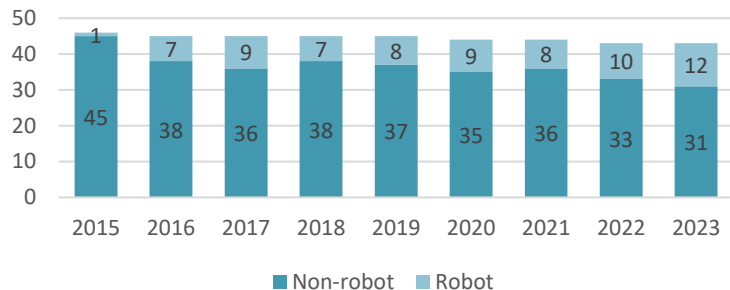
Pancreas



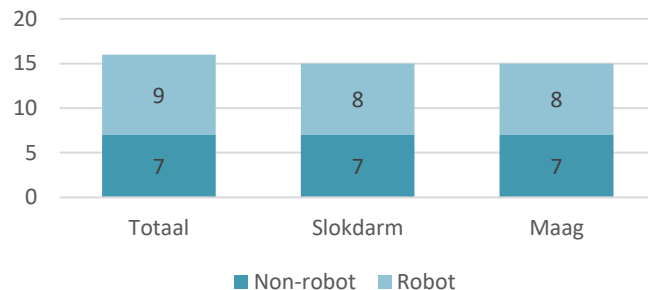
Lever



Long



UpperGI

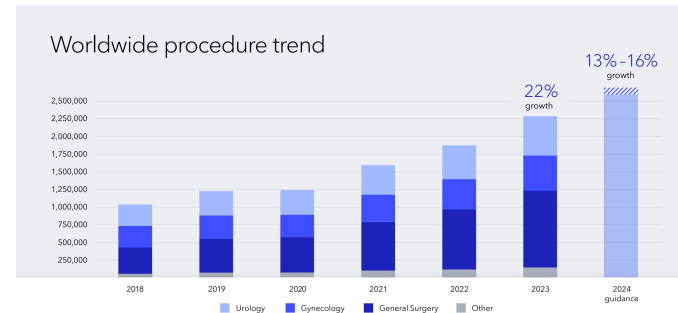


# Discussie

- Toenemend gebruik RAS in alle 4 chirurgische specialismen
- Toename ten koste van laparoscopie & open chirurgie
- Huidige adoptie van RAS het grootst in pancreas chirurgie, gevolgd door UpperGI, lever en long chirurgie
- RAS meer geschikt voor bepaalde typen operaties

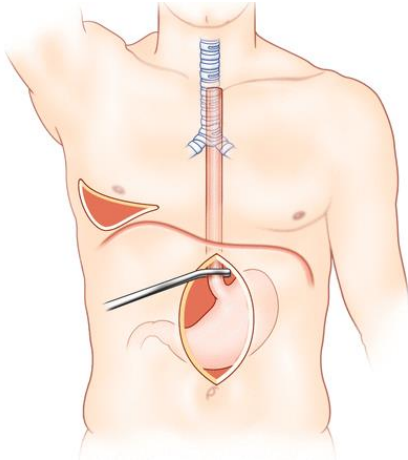
# Discussie

- Ondanks wisselend bewijs en hogere kosten sprake van toename  
→ Trials? Hype? Voorkeur chirurg?
- Niet in alle centra een robot & brede range in gebruik → ruimte voor verdere toename
- Gestage stijging gebruik RAS → steeds grotere rol in NL chirurgie



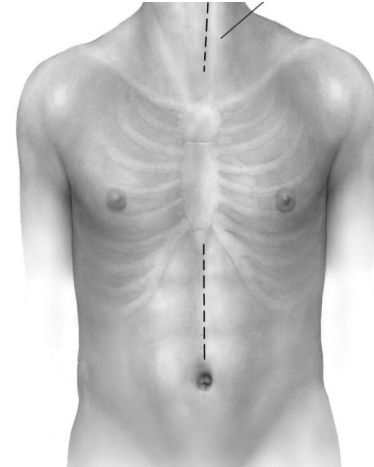
# Esophagectomie

## Transthoracaal



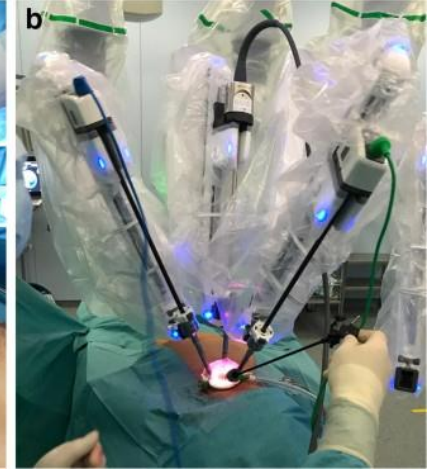
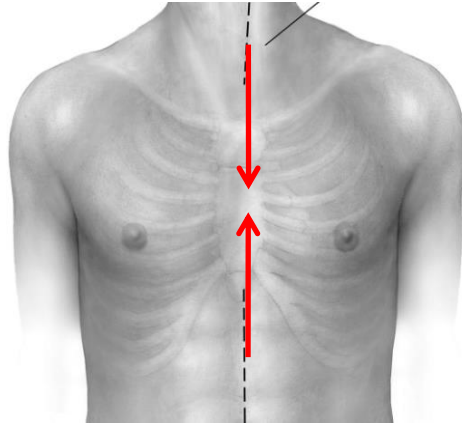
- + Lymfadenectomie mediastinum
- Single-lung ventilatie

## Transhiataal



- + Geen single-lung ventilatie
- Niet voor proximale/mid tumoren
- Geen mediastinale lymfadenectomie

# Robot-Assisted Cervical Esophagectomy



- + Geen single-lung ventilatie
- + Alle tumor levels
- + Mediastiale lymphadenectomy(?)



# Robot-Assisted Cervical Esophagectomy

- Enkele case series
  - 2018 (n=6)<sup>1</sup>
  - 2019 (n=4)<sup>2</sup>
- 1 prospectieve studie
  - 2024 (n=75)<sup>3</sup> (NB MICE)

1. Nakauchi et al. 2018  
2. Egberts et al. 2019  
3. Vercoulen et al. 2024

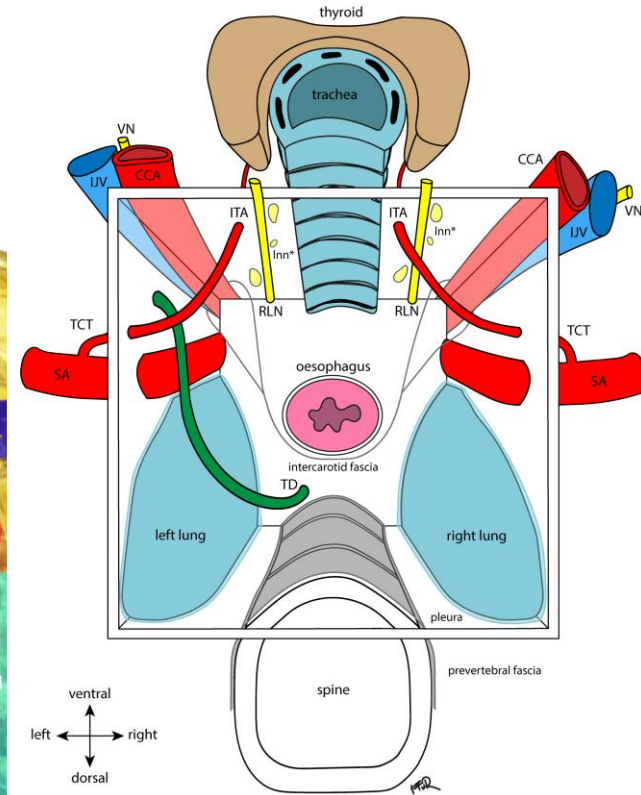
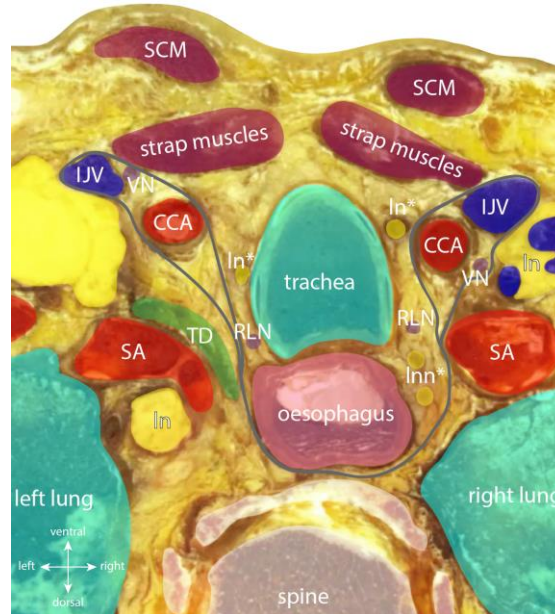
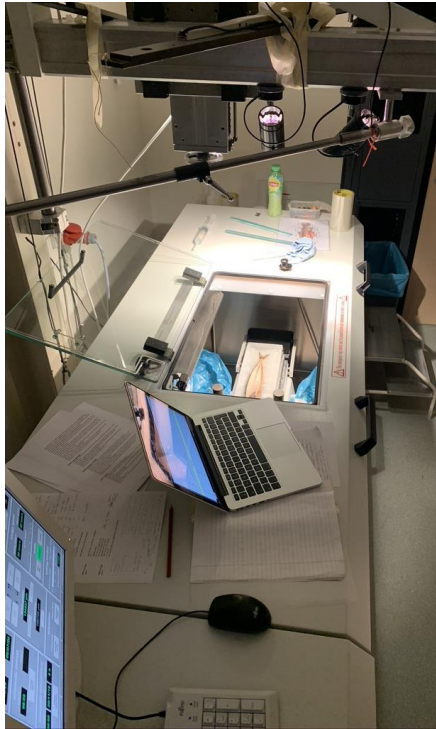




- **Robot-assisted cervical esophagectomy: first clinical experiences and review of the literature.** Chiu PW, de Groot EM, Yip HC, Egberts JH, Grimminger P, Seto Y, Uyama I, van der Sluis PC, Stein H, Sallum R, Ruurda JP, van Hillegersberg R. (2020)
- **Surgical anatomy of the upper esophagus related to robot-assisted cervical esophagectomy.** Wedel T, Heinze T, Möller T, van Hillegersberg R, Bleys RLAW, Weijs TJ, van der Sluis PC, Grimminger PP, Sallum RA, Becker T, Egberts JH. (2021)
- **Transcervical (SP) and Transhiatal DaVinci Robotic Esophagectomy: A Cadaveric Study.** van der Sluis P, Egberts JH, Stein H, Sallum R, van Hillegersberg R, Grimminger PP. (2021)
- **The surgical anatomy of a robot-assisted cervical esophagectomy.** ICLJ Filz von Reiterdank, MD 1, IL Defize, MD 2, EM de Groot, MD 2, T Wedel, MD, PhD3, PP Grimminger, MD, PhD4, JH Egberts, MD, PhD5, PC van der Sluis, MD, PhD6, H Stein, BME7, JP Ruurda, MD, PhD2, R van Hillegersberg, MD, PhD2 , RLAW Bleys, MD, PhD (2023)



**The surgical anatomy of a robot-assisted cervical esophagectomy.** ICLJ Filz von Reiterdank et al. Submitted.



# Inclusie criteria

- Histologisch bewezen adenocarcinoom (AC) of plaveiselcelcarcinoom (SCC) van de slokdarm of gastro-oesofageale overgang (GEJ)
- Niet in staat om een transthoracale benadering te ondergaan (MDO)
- ASA I-III
- Leeftijd > 17
- Informed consent





# INTRA SURGE & Runtime Verification

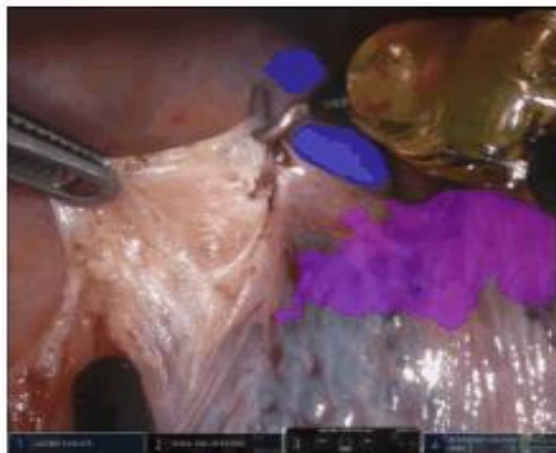
August 21st, 2024



## Computer-aided anatomy recognition in intrathoracic and -abdominal surgery: a systematic review

R. B. den Boer<sup>1</sup> · C. de Jongh<sup>1</sup> · W. T. E. Huijbers<sup>1</sup> · T. J. M. Jaspers<sup>2</sup> · J. P. W. Pluim<sup>2</sup> · R. van Hillegersberg<sup>1</sup> · M. Van Eijnatten<sup>2</sup> · J. P. Ruurda<sup>1</sup>

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Intelligent computer aided surgical guidance for robot-assisted surgery

## Research Goals

- 1 **Real-time anatomy & surgical phase recognition** on **multi-center** intraoperative videos
- 2 **Real-time registration of a 3D patient-specific anatomical model** to intraoperative videos
- 3 **Integration** of developed models with dedicated **surgical hardware**
- 4 **Runtime Verification** of surgical behaviours in order to develop a warning system

} Data-driven





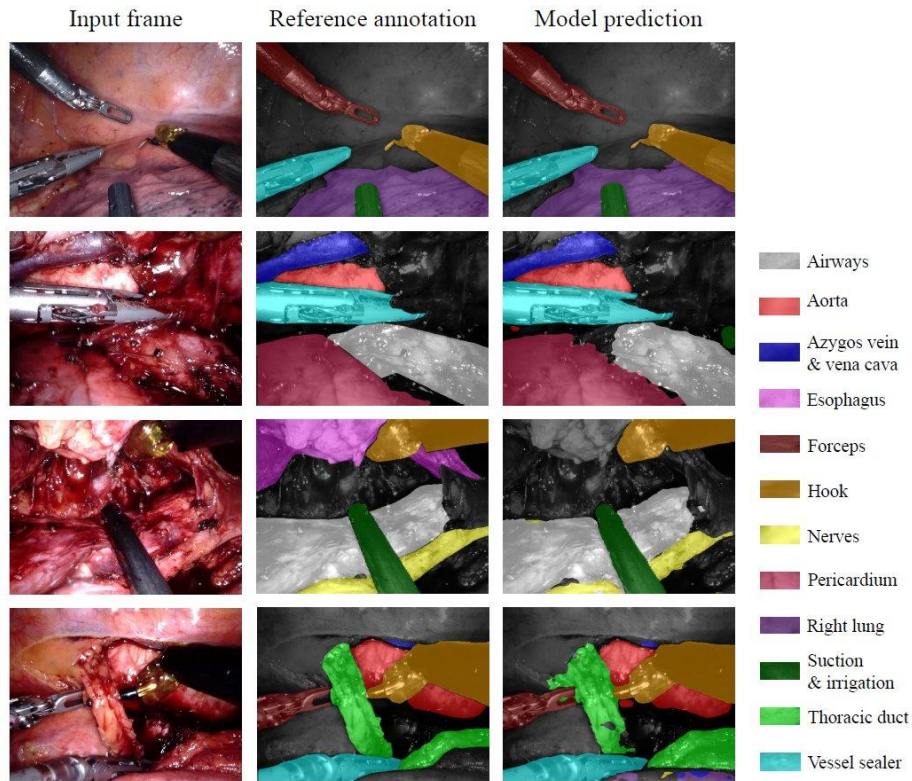
# Intelligent computer aided surgical guidance for robot-assisted surgery

## Anatomy recognition

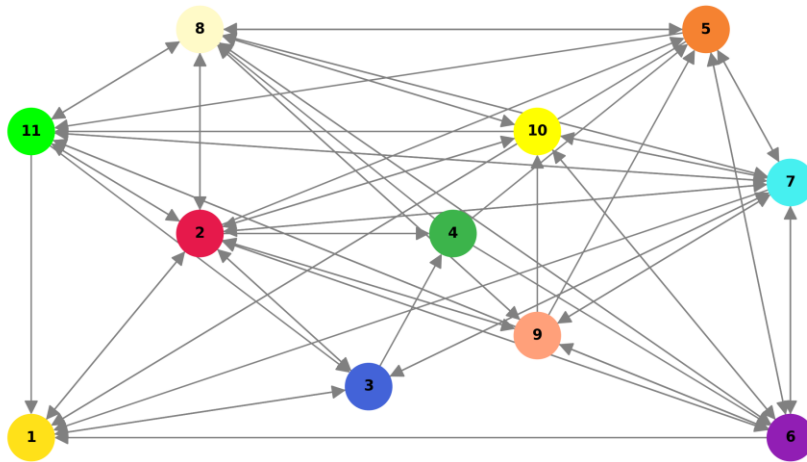
Good results on clearly dissected structures

Limitations:

- Nerves, thoracic duct
- Occluded views
- Limited data



# Surgical phase recognition



- 1 Mobilization of the inferior pulmonary ligament
- 2 Pericardial dissection
- 3 Right pleural dissection
- 4 Division of the arch of the azygous vein
- 5 Superior mediastinal pleural dissection
- 6 Right paratracheal dissection
- 7 Left recurrent laryngeal nerve dissection & tracheoesophageal dissection
- 8 Para-aortic and mesoesophageal dissection
- 9 Subcarinal lymph node dissection
- 10 AP lymph node dissection
- 11 Hiatal dissection
- 12 Non-standard
- 13 Camera out of body

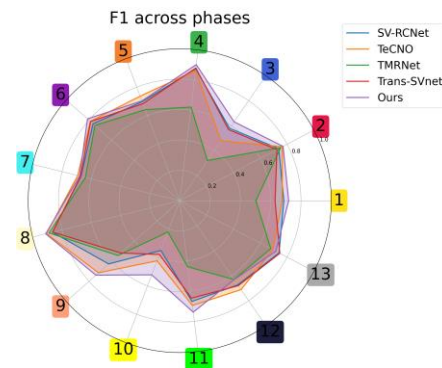
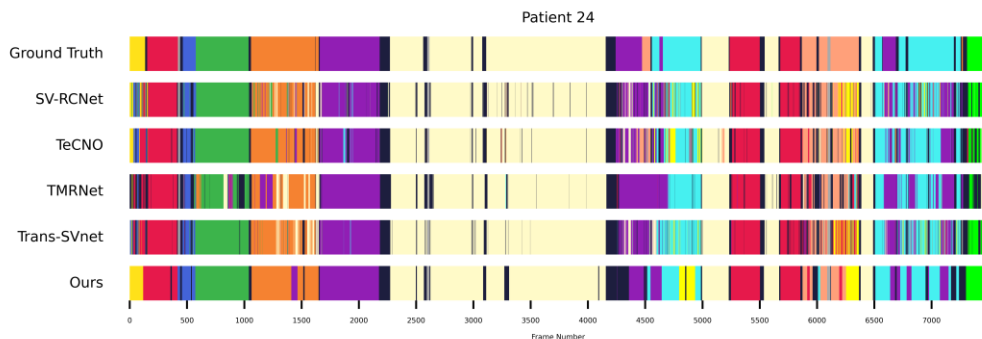


## Surgical phase recognition

Table 1: Experimental results (%) on RAMIE dataset

	Accuracy	Precision	Recall	Jaccard	Edit Score	F1@25	F1@50	F1@75
SV-RCNet	75.42 ± 3.88	75.54 ± 4.00	70.12 ± 5.02	56.56 ± 5.55	9.26 ± 1.39	11.94 ± 2.12	7.61 ± 1.43	4.04 ± 0.76
TeCNO	<b>78.46 ± 3.97</b>	73.87 ± 4.60	73.56 ± 5.10	58.34 ± 4.75	13.15 ± 1.83	17.79 ± 2.83	12.25 ± 2.86	6.52 ± 1.84
TMRNet	72.86 ± 4.82	76.56 ± 6.04	57.12 ± 5.85	46.87 ± 5.42	15.63 ± 1.96	19.34 ± 2.06	12.45 ± 1.27	5.55 ± 2.00
Trans-SVnet	75.15 ± 4.09	74.79 ± 6.62	68.43 ± 5.98	55.25 ± 6.23	6.85 ± 1.03	8.72 ± 1.32	5.63 ± 1.15	2.78 ± 0.75
Ours	78.28 ± 4.42	<b>77.28 ± 5.37</b>	<b>76.41 ± 6.01</b>	<b>61.94 ± 7.24</b>	<b>59.50 ± 6.34</b>	<b>58.42 ± 4.45</b>	<b>45.08 ± 5.94</b>	<b>27.19 ± 3.41</b>

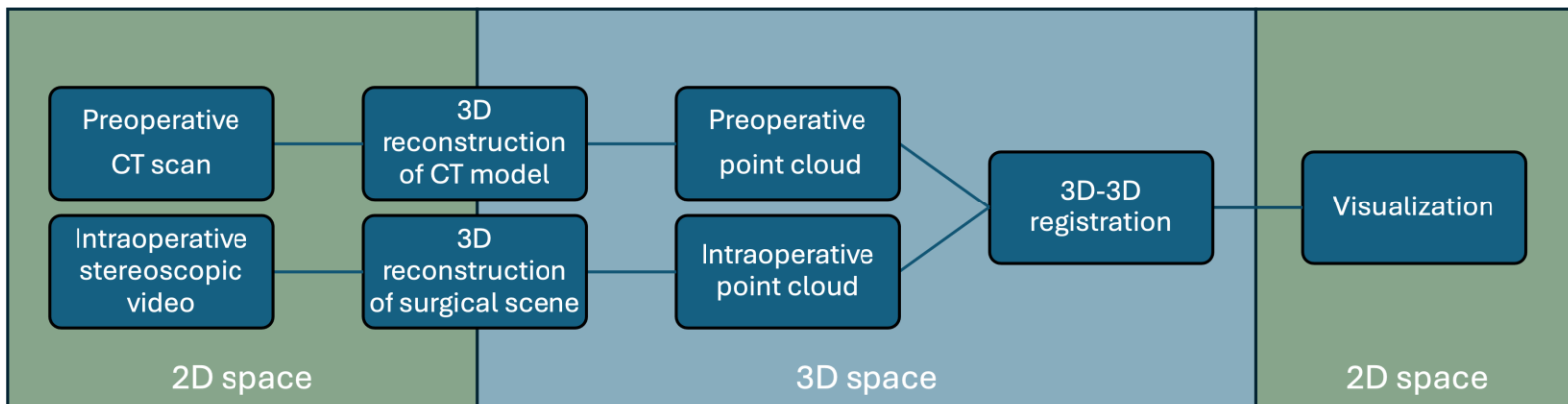
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Intelligent computer aided surgical guidance for robot-assisted surgery

## Image-to-patient registration





## Intelligent computer aided surgical guidance for robot-assisted surgery





## Intelligent computer aided surgical guidance for robot-assisted surgery



