"How do you feel when you hear the term ‘Robot'?"

Robotic Surgry: Past, Present, and Future...

-Robotic Surgery in Thoracic Field-

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Bong Soo Son M.D.

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The History of Innovation: Transitioning from Open Surgery to Minimally Invasive Surgery

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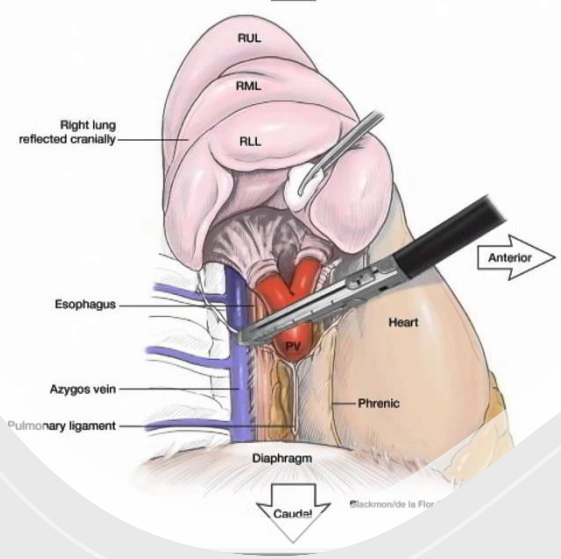
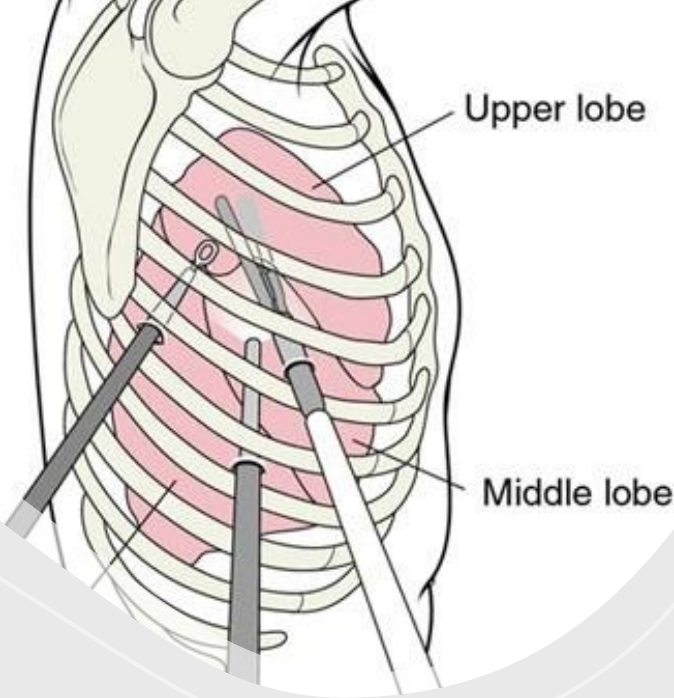
Pusan National University Yangsan Hospital





First VATS Lobectomy in 1991

Prof. Giancarlo Roviaro

University of Milan, Italy

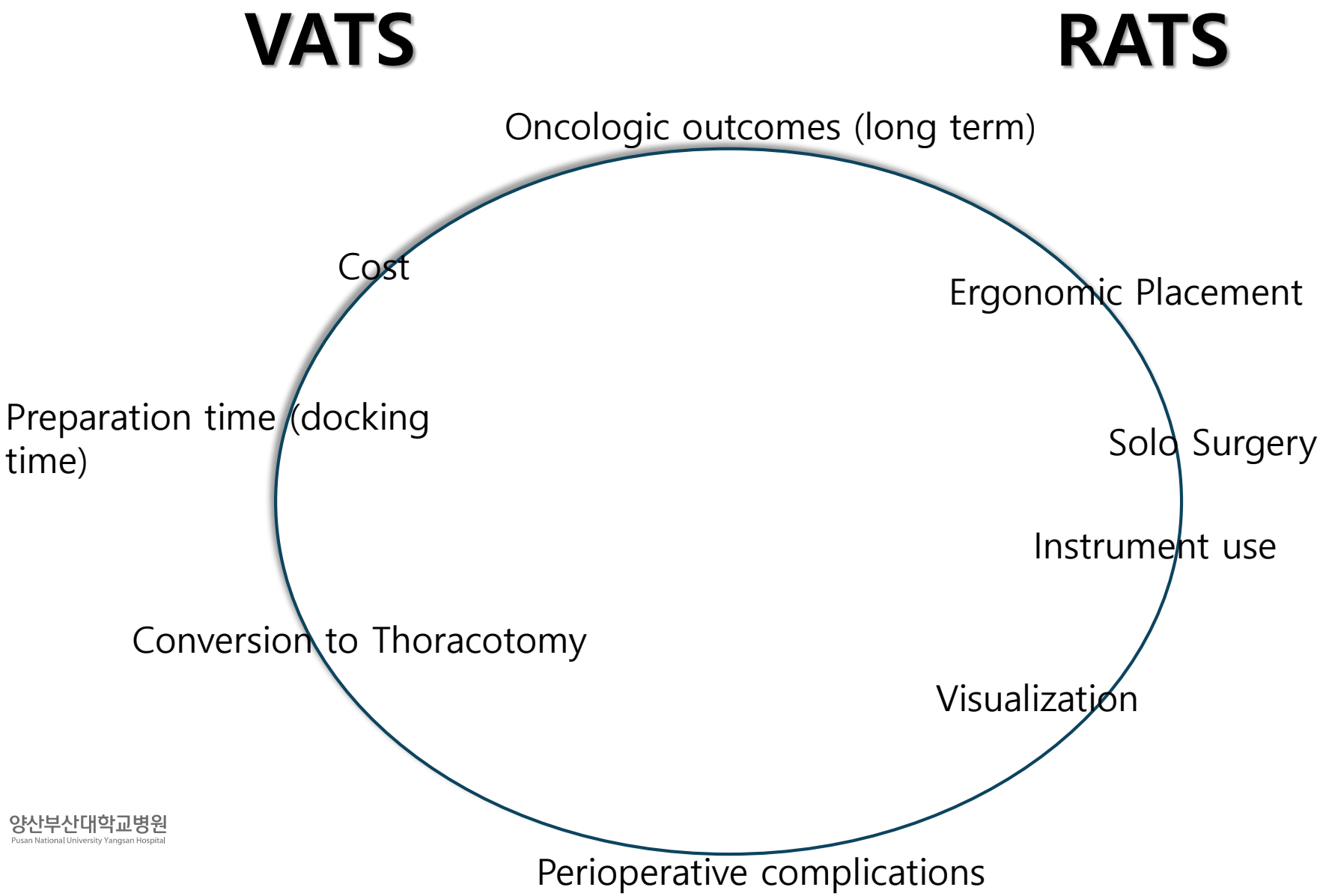
PNU 양산부산대학교병원
Pusan National University Yangsan Hospital

" VATS는 너무 위험해... 왜 쓸데없는 위험을 감수하는 거야?"

"폐암 수술에서 임파선 절제를 완벽하게 할 수 있을까?

"사용할 수 있는 도구와 접근 방향이 제한적인 VATS는 open thoracotomy를 대체할 수 없어!"

VATS Pulmonary Resection VS. RATS Pulmonary Resection



INTUITIVE

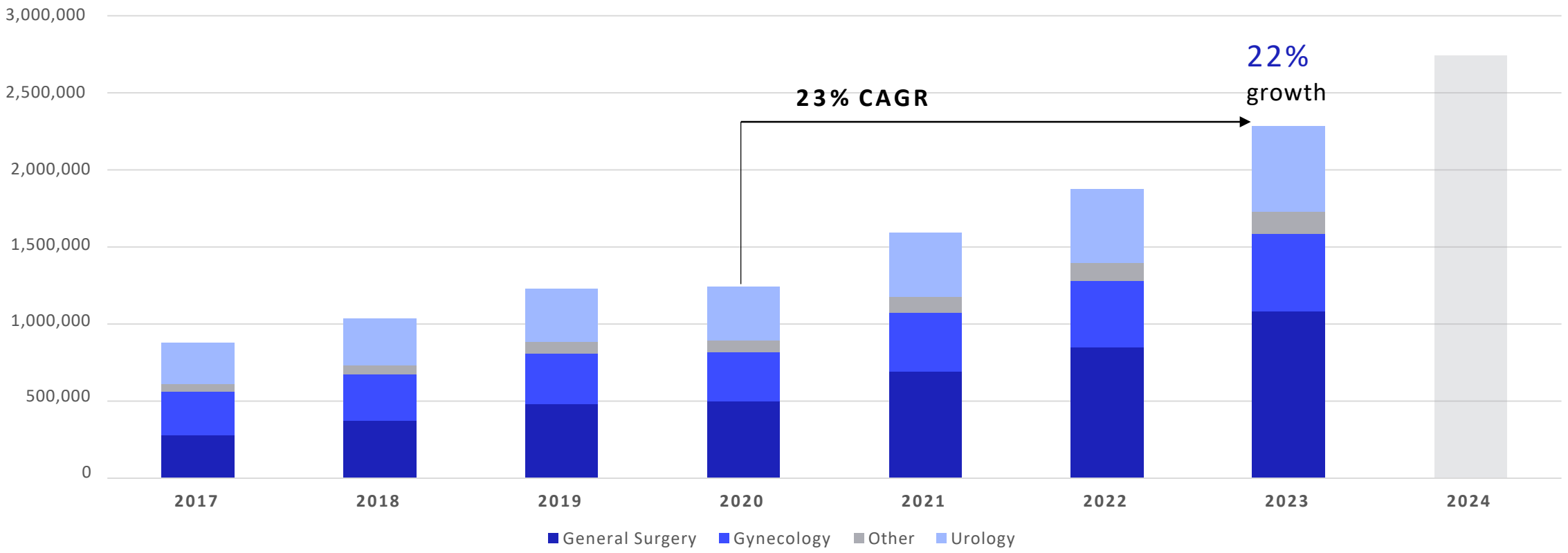
Robotic-assisted Surgery Procedure Trend

Global / Korea / Each Specialty

2000, FDA approvement.

Worldwide

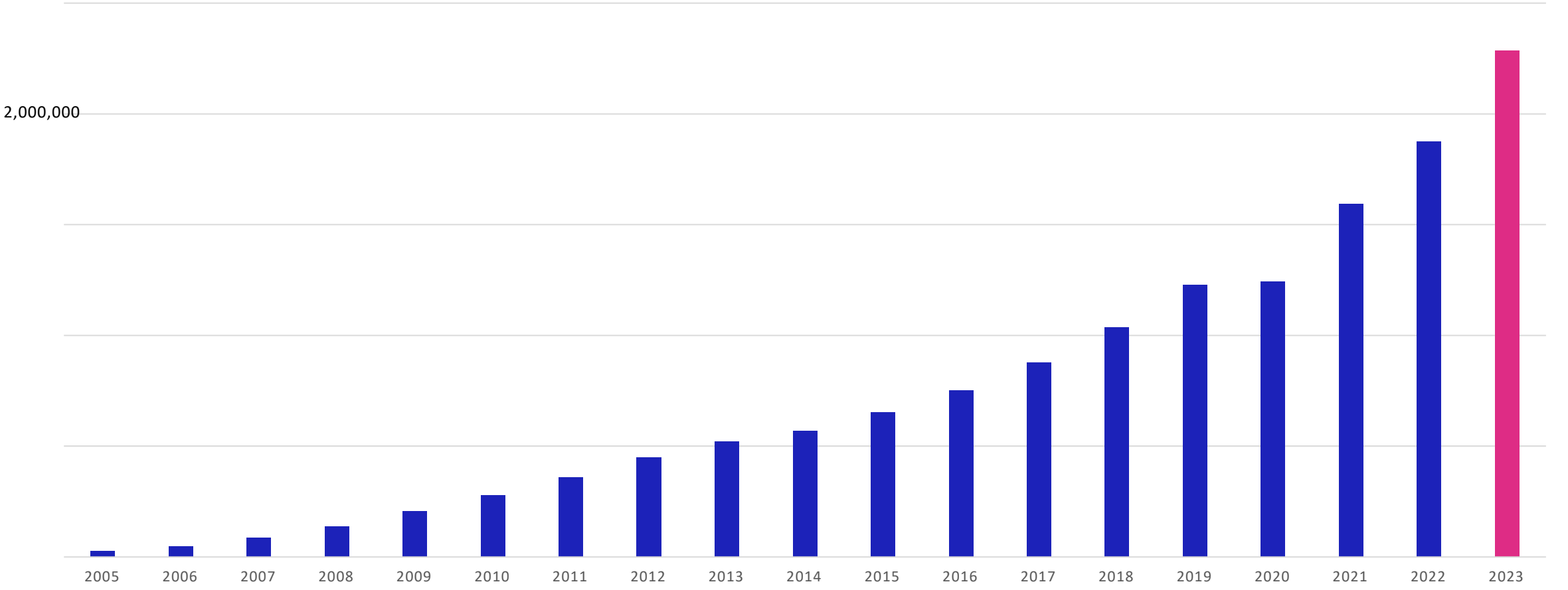
Worldwide procedure trend



Source: 2023 Proxy Statement

Robotic surgery with da Vinci in worldwide

Total Procedure Trend



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Korea General

Installed Base

OS3 Da Vinci Si®

March 2012

OS4 Da Vinci Xi®

December 2014

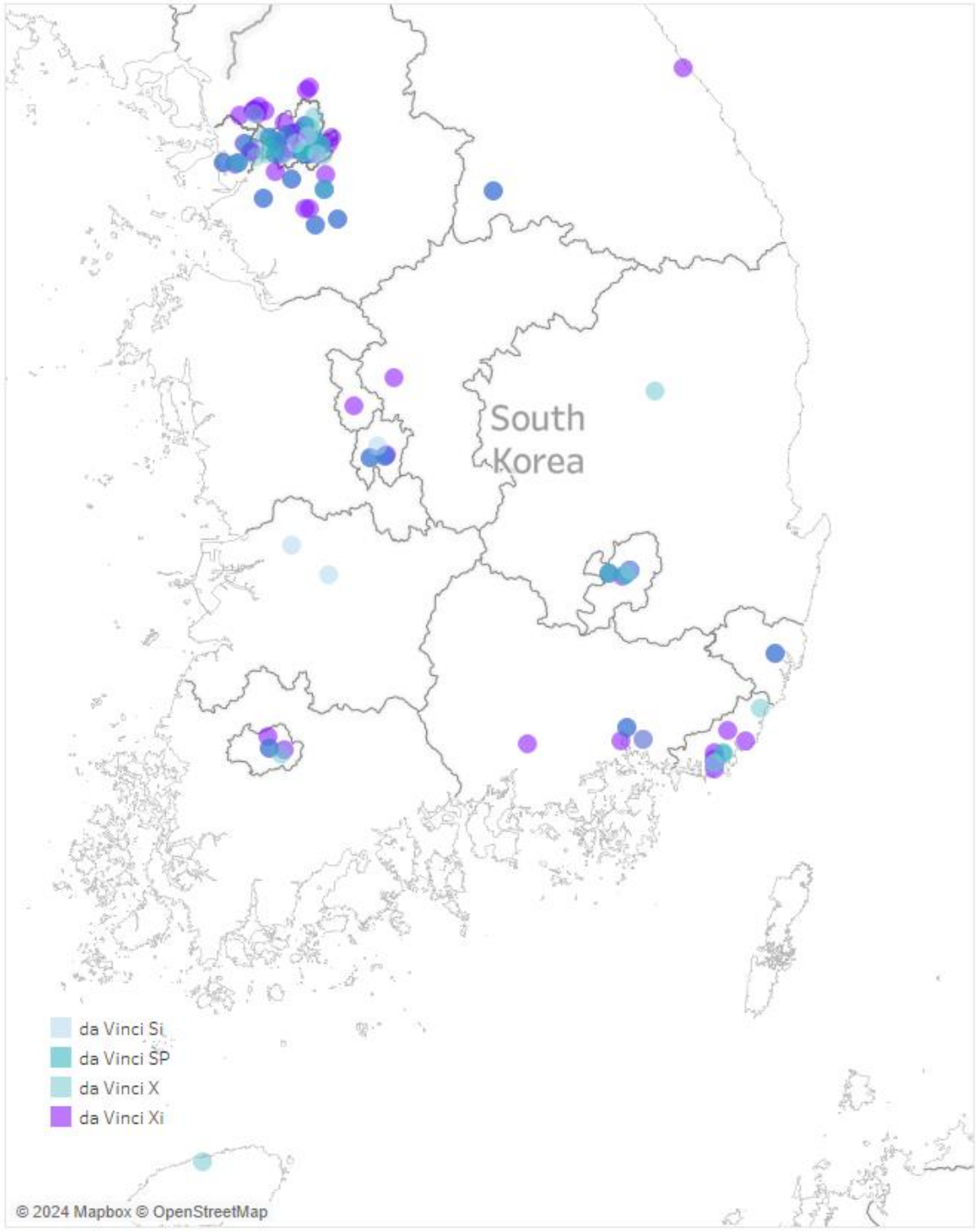
OS4 Da Vinci X®

December 2017

OS4 Da Vinci SP®*

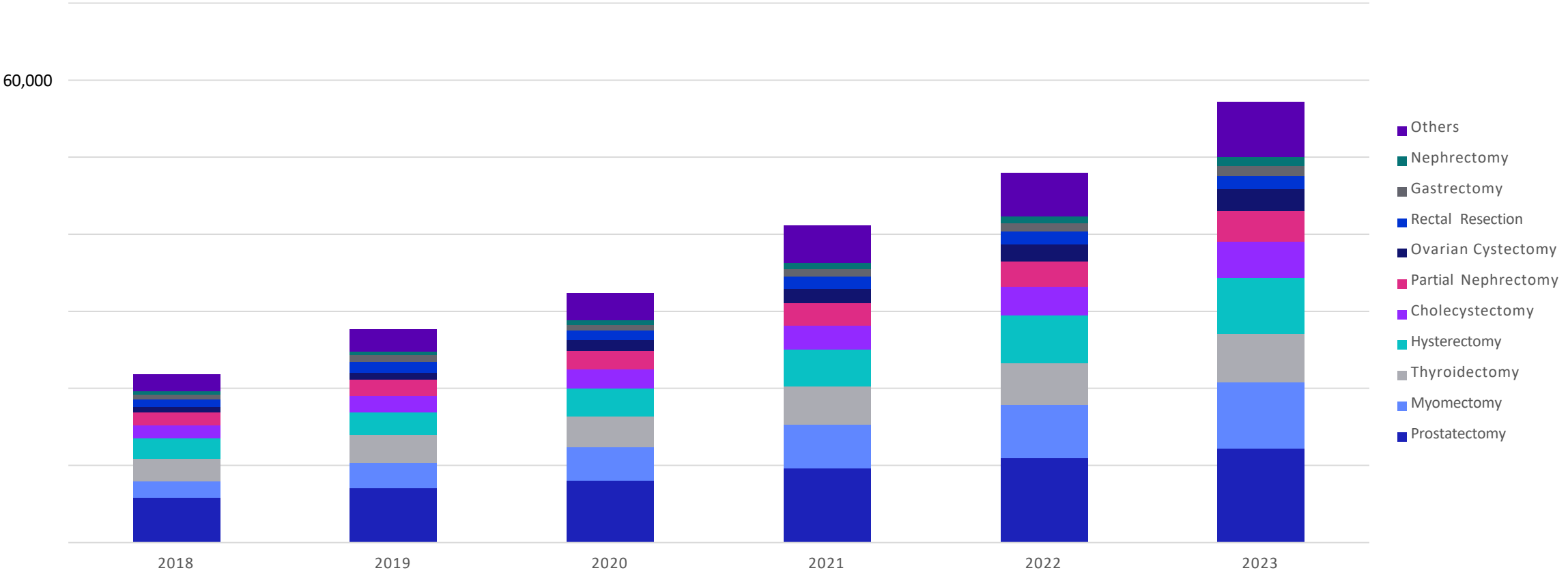
December 2018

	2024-Jan
da Vinci Si	8
da Vinci Xi	106
da Vinci X	25
da Vinci SP	30
Total	**169**



Korea procedure trend

Most often performed procedures



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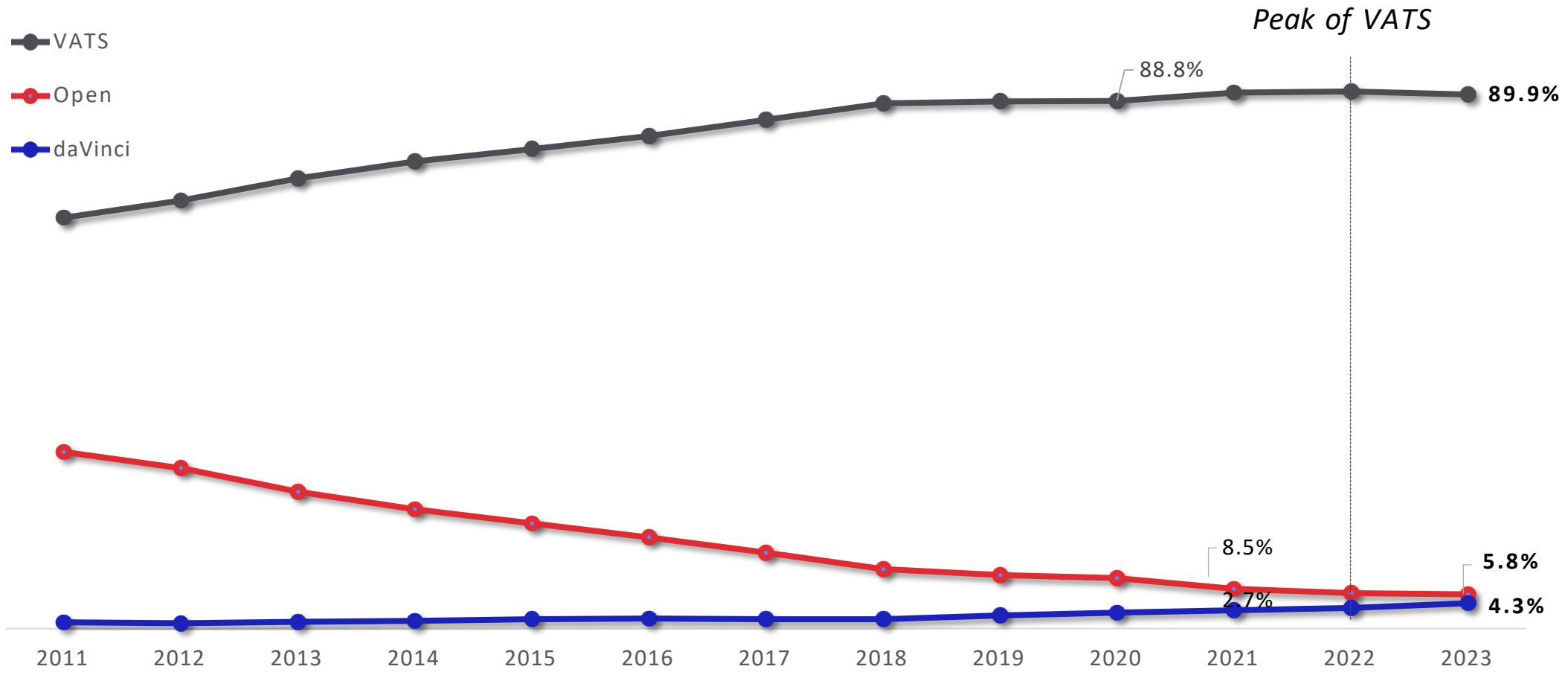
Thoracic

Da Vinci surgery adoption in Korean thoracic



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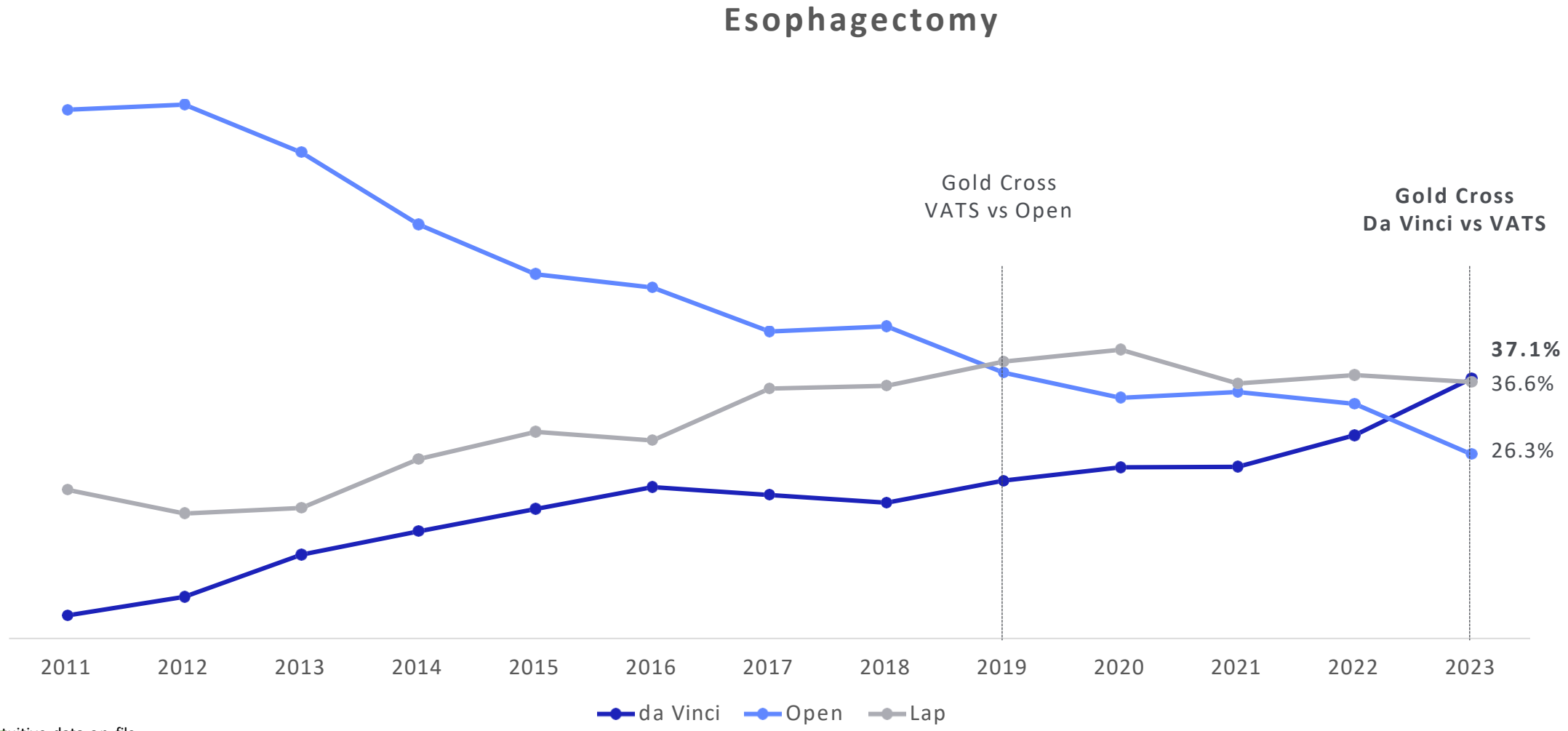
Da Vinci surgery adoption in Esophagectomy



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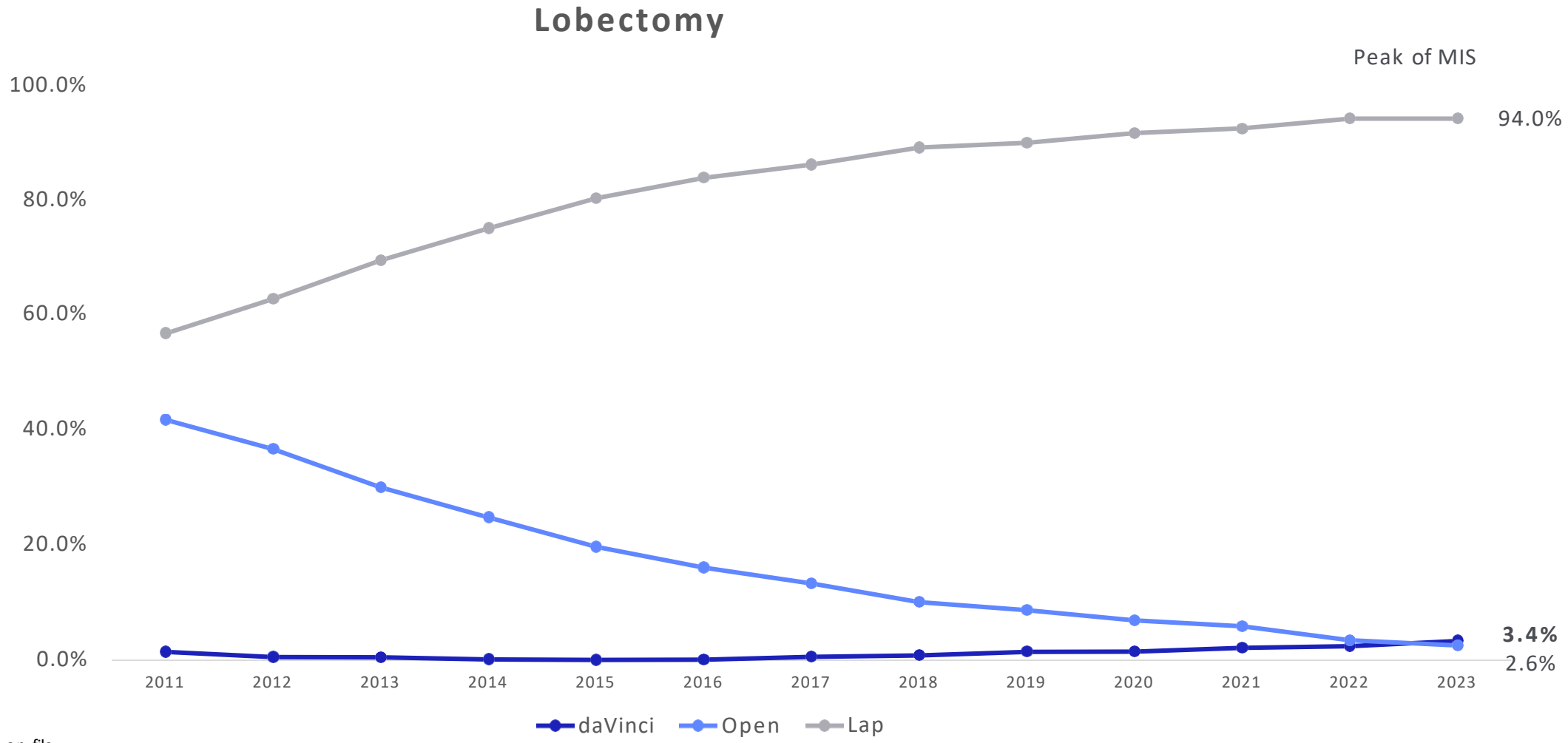
Da Vinci surgery adoption in Mediastinal & Lobectomy



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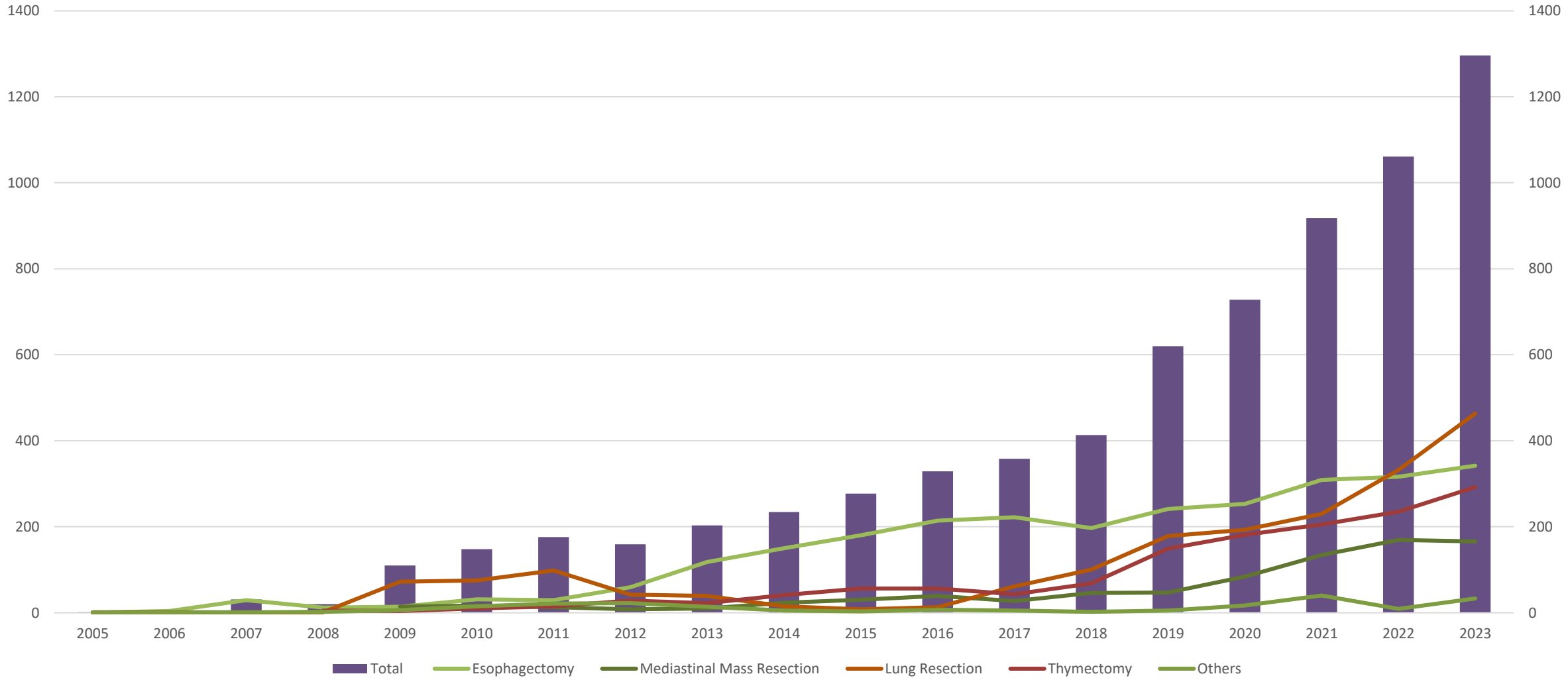
국내 흉부외과 로봇수술 변화



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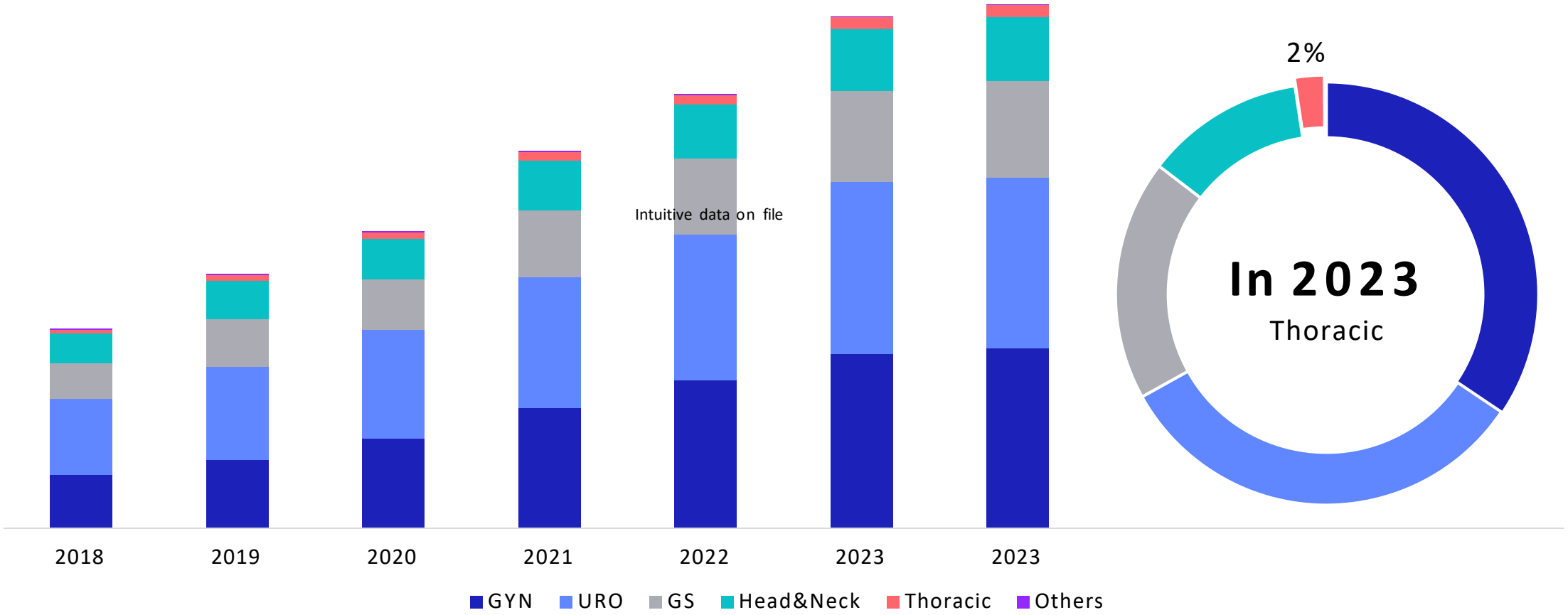
2023 Procedure overview in thoracic market

Da Vinci Procedure



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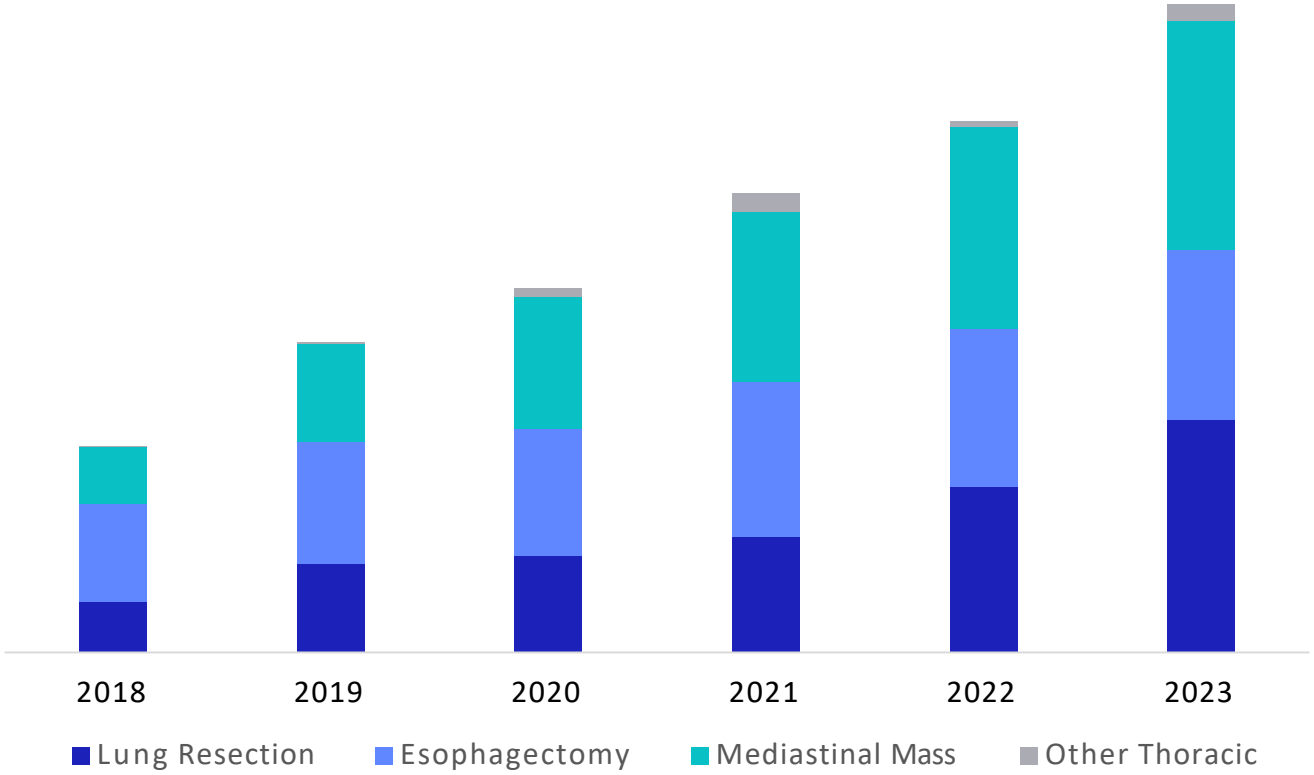
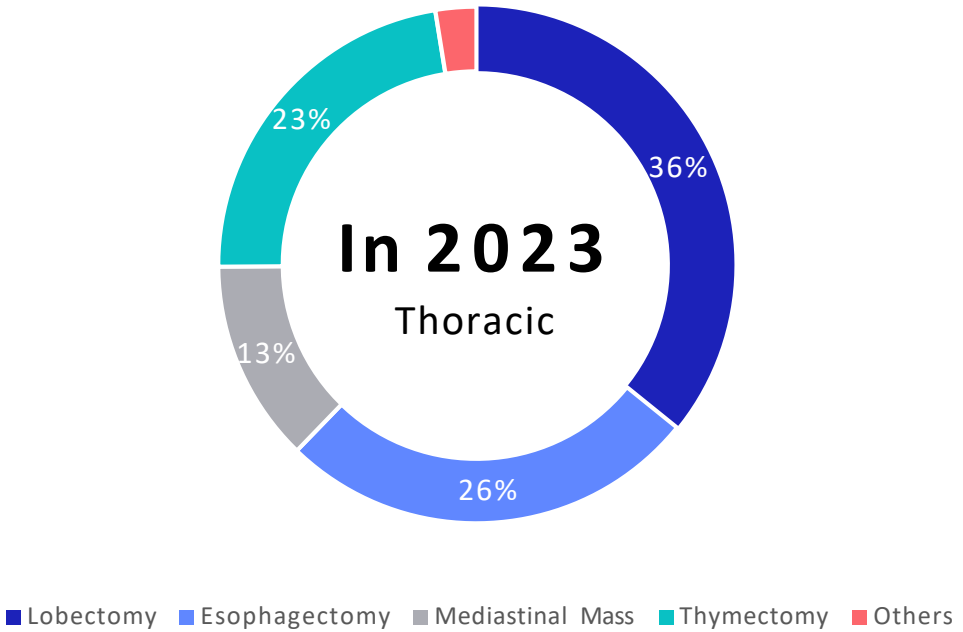
2023 Procedure overview in thoracic market

Thoracic procedure trend





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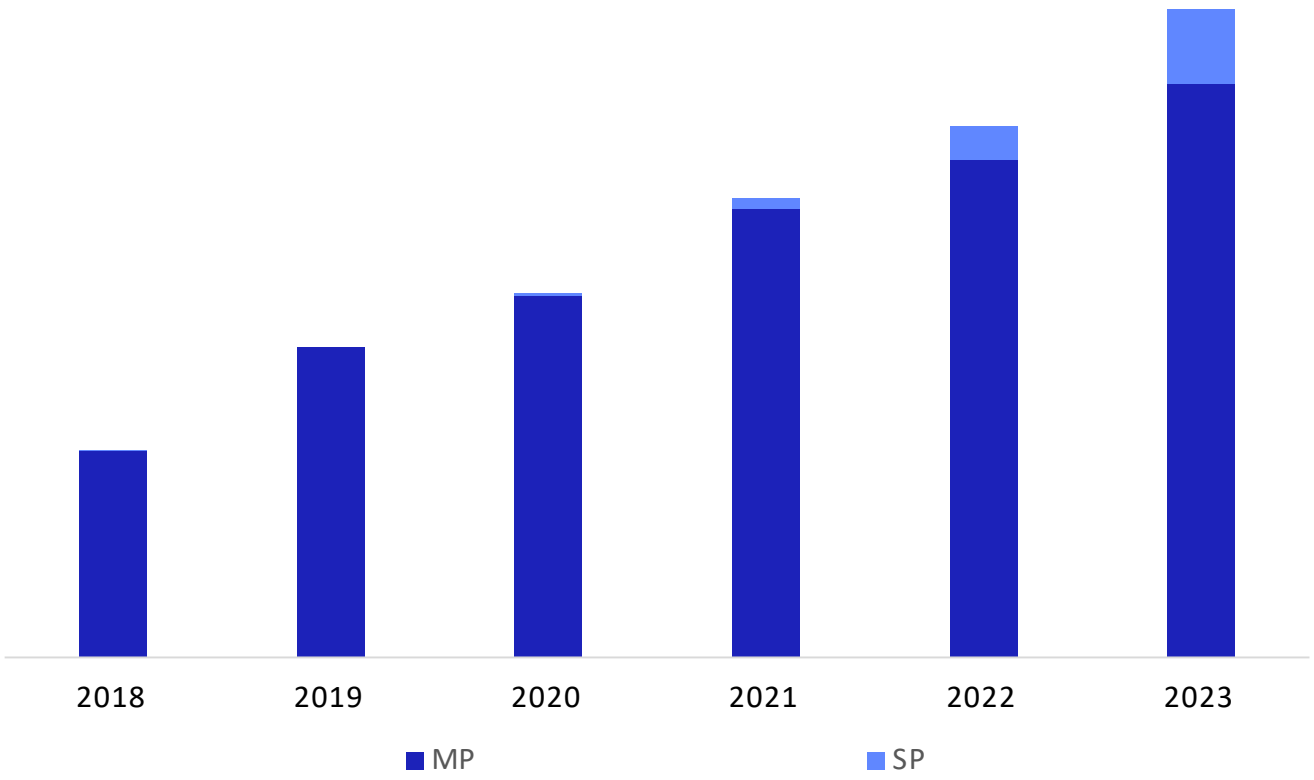
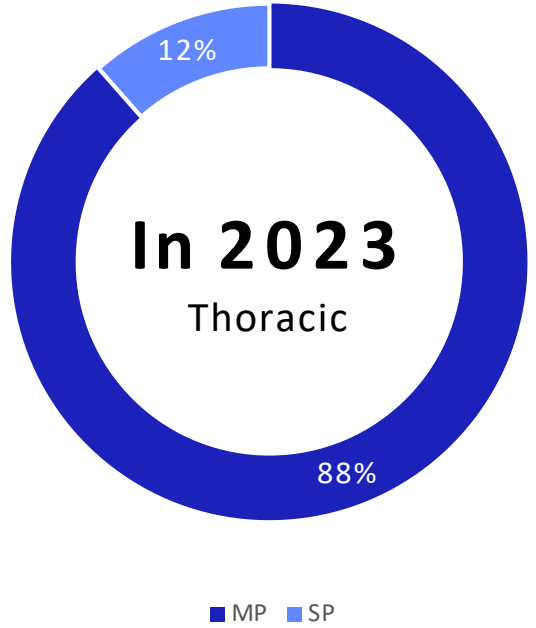
Pusan National University Yangsan Hospital

2023 Procedure overview in thoracic market

Thoracic procedure trend





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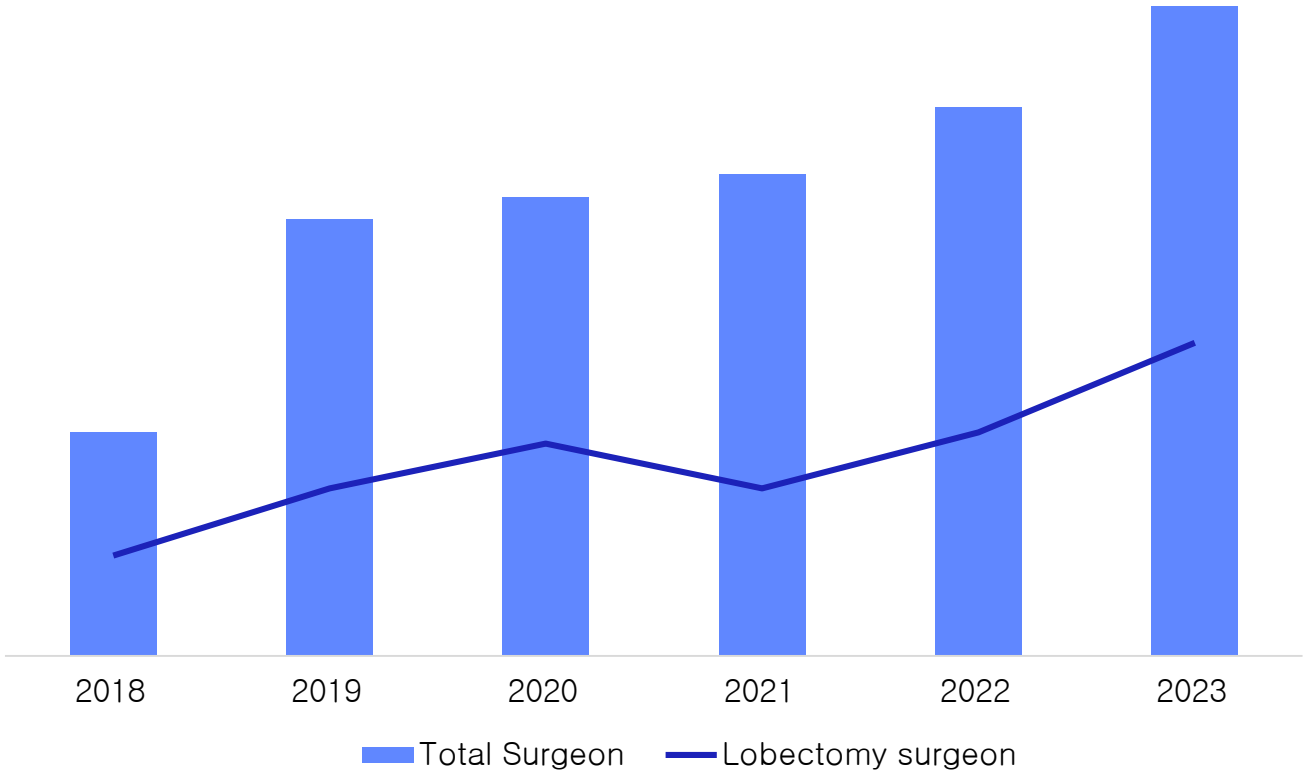
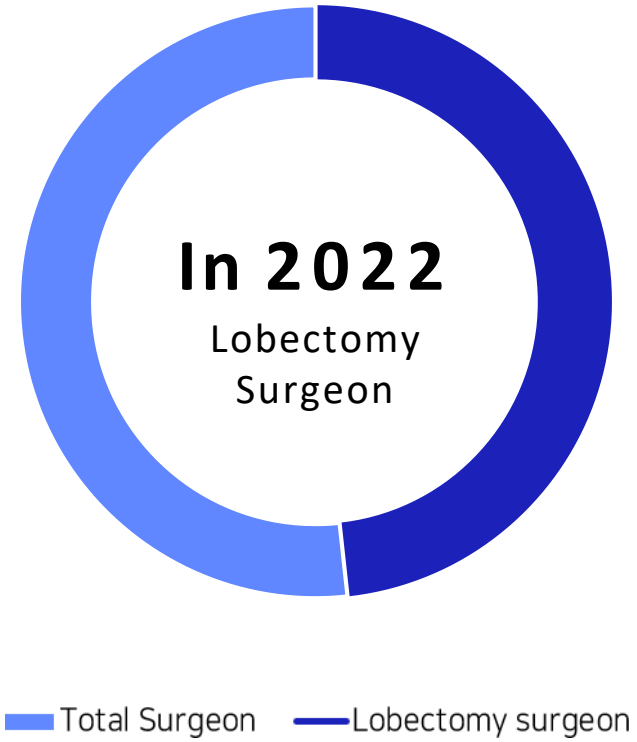
2023 Thoracic surgeon population

Surgeon population trend





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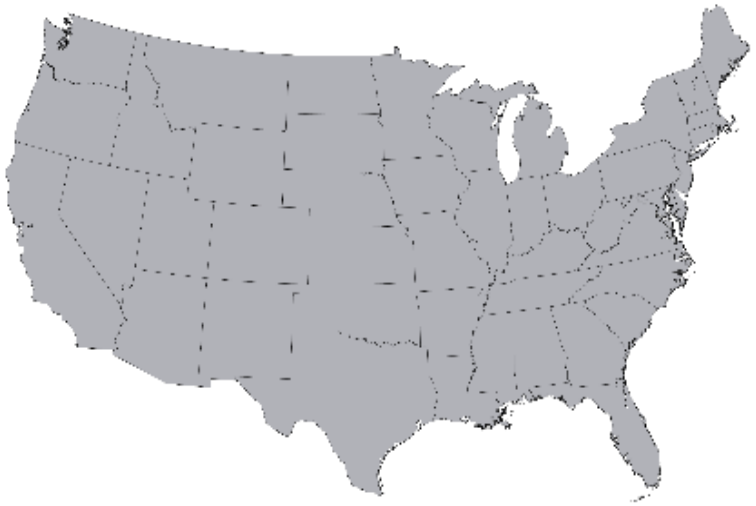
SP System Trend

Global / Korea / Each Specialty

No. of Da Vinci SP Systems Installed Worldwide

177 systems worldwide as of Dec 31, 2023

USA: 140



Korea: 30

China: 1

Japan: 6

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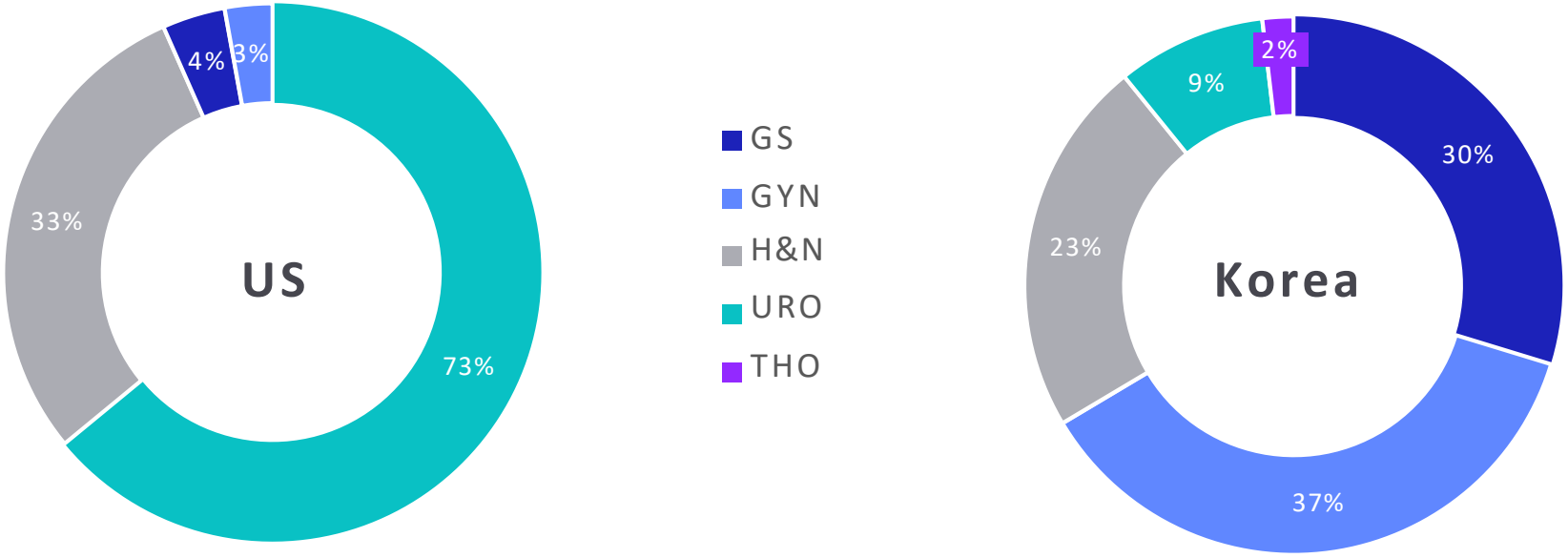
SP procedure trend

US vs Korea



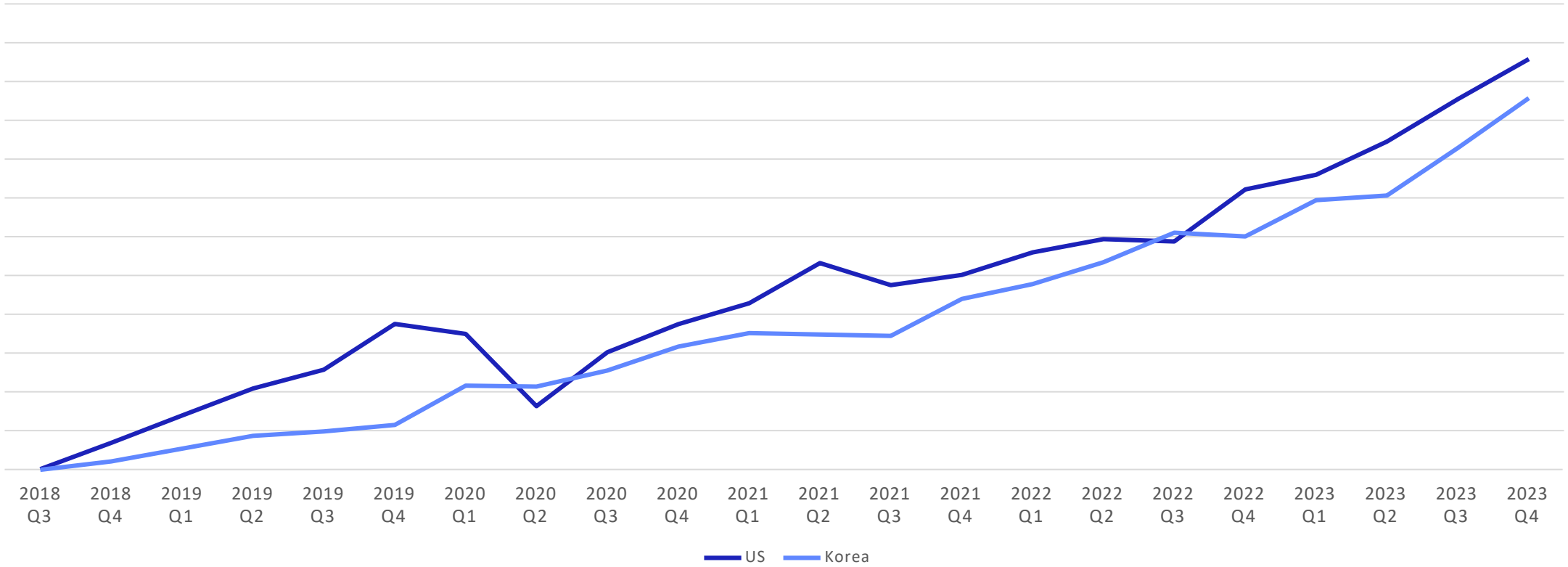
US SP cases
Around 9,000 cases in 2023

Korea SP cases
Around 7,900 cases in 2023

Intuitive data on file

SP procedure trend

US vs Korea



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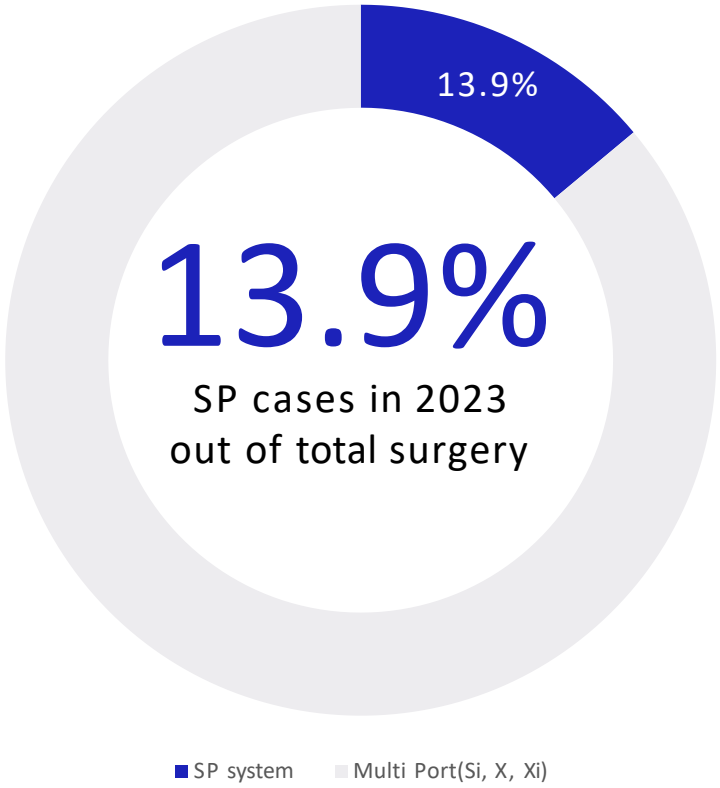
SP system in Korea

30 SP systems installed since 2018



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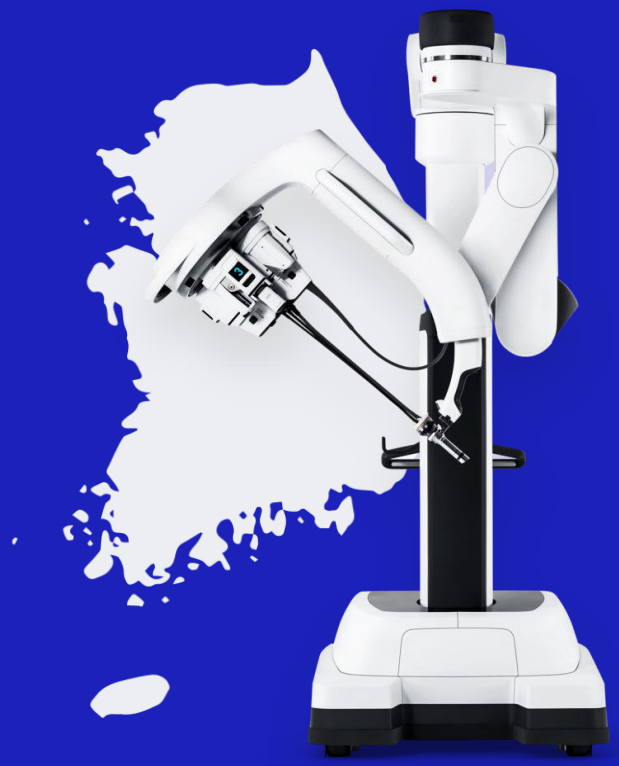

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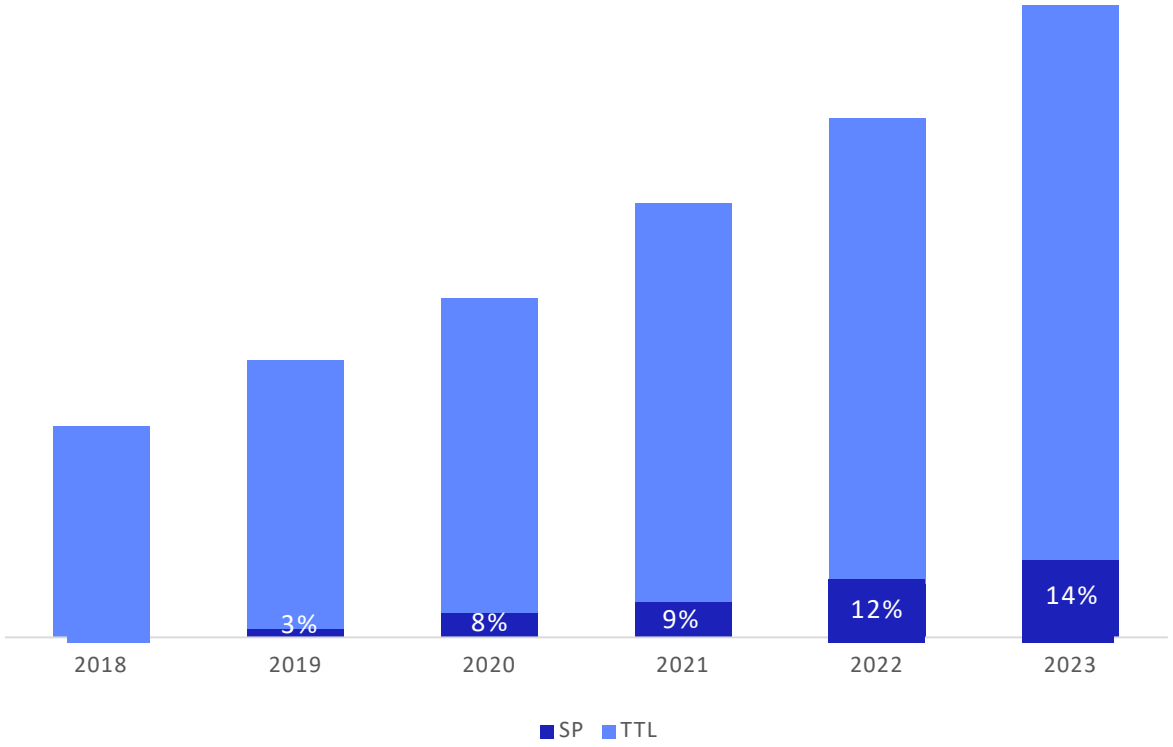
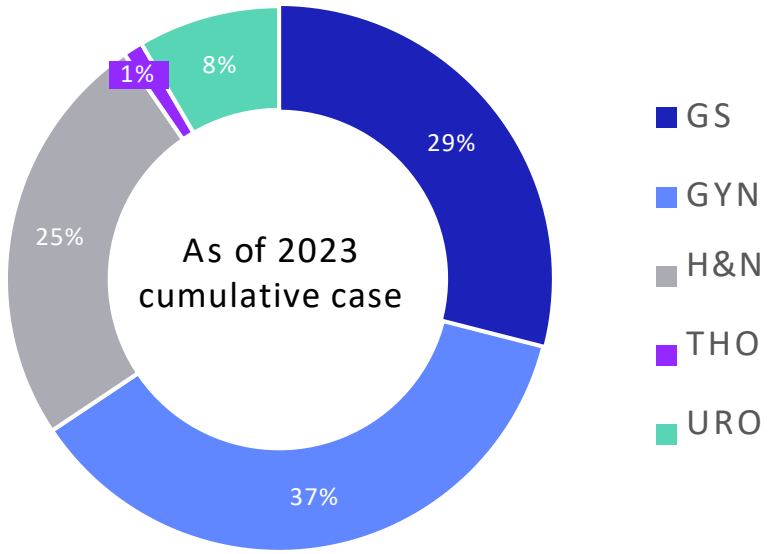
SP procedure trend in Korea

Year over Year





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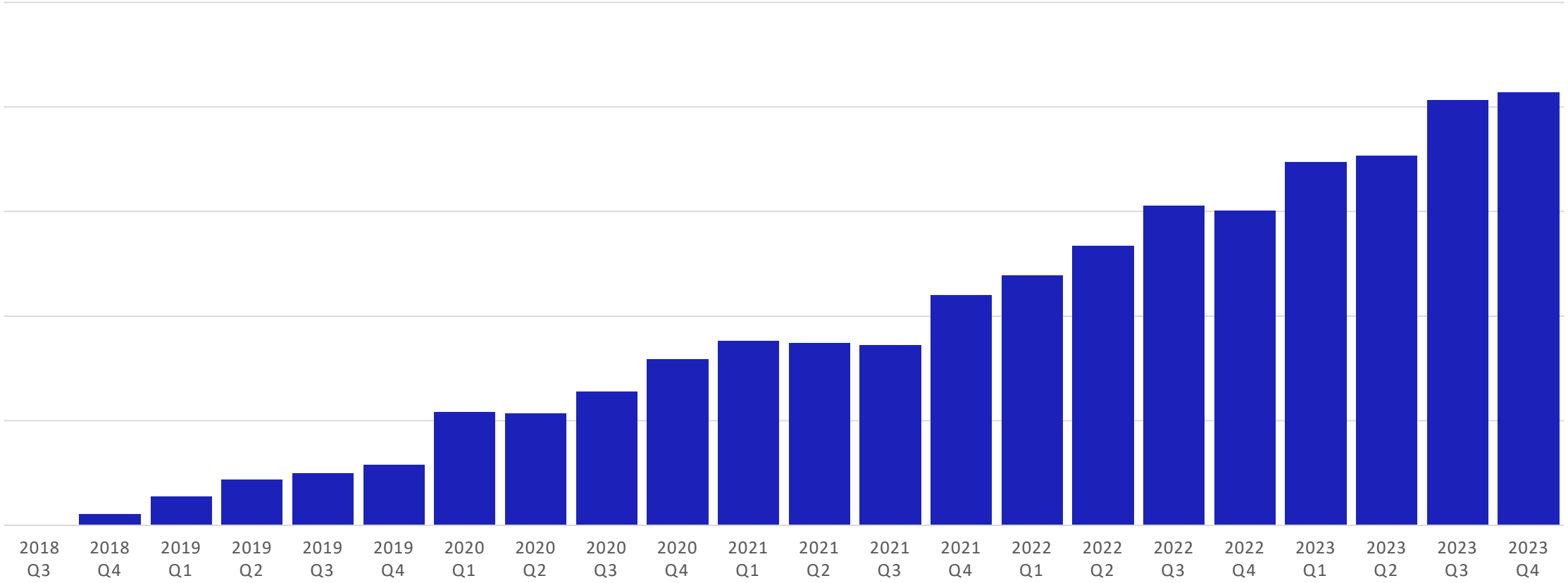
SP procedure trend in Korea

Per quarter



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Why Robotic Surgery??

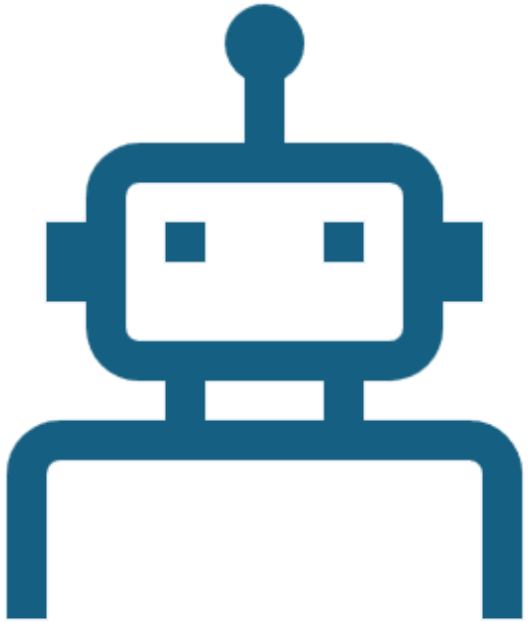
- **High-definition and Three-dimensional Vision**

Offer a stable camera platform, enhancing precise anatomical dissection.

Unlike VATS (Video-Assisted Thoracic Surgery), which requires constant eye adjustments due to screen and table distance, robotic platforms provide stereoscopic vision with optimal depth perception.

Surgeons can control the camera position for better eye-hand-target alignment, enabling operations in narrow spaces like the mediastinum.

Why Robotic Surgery??



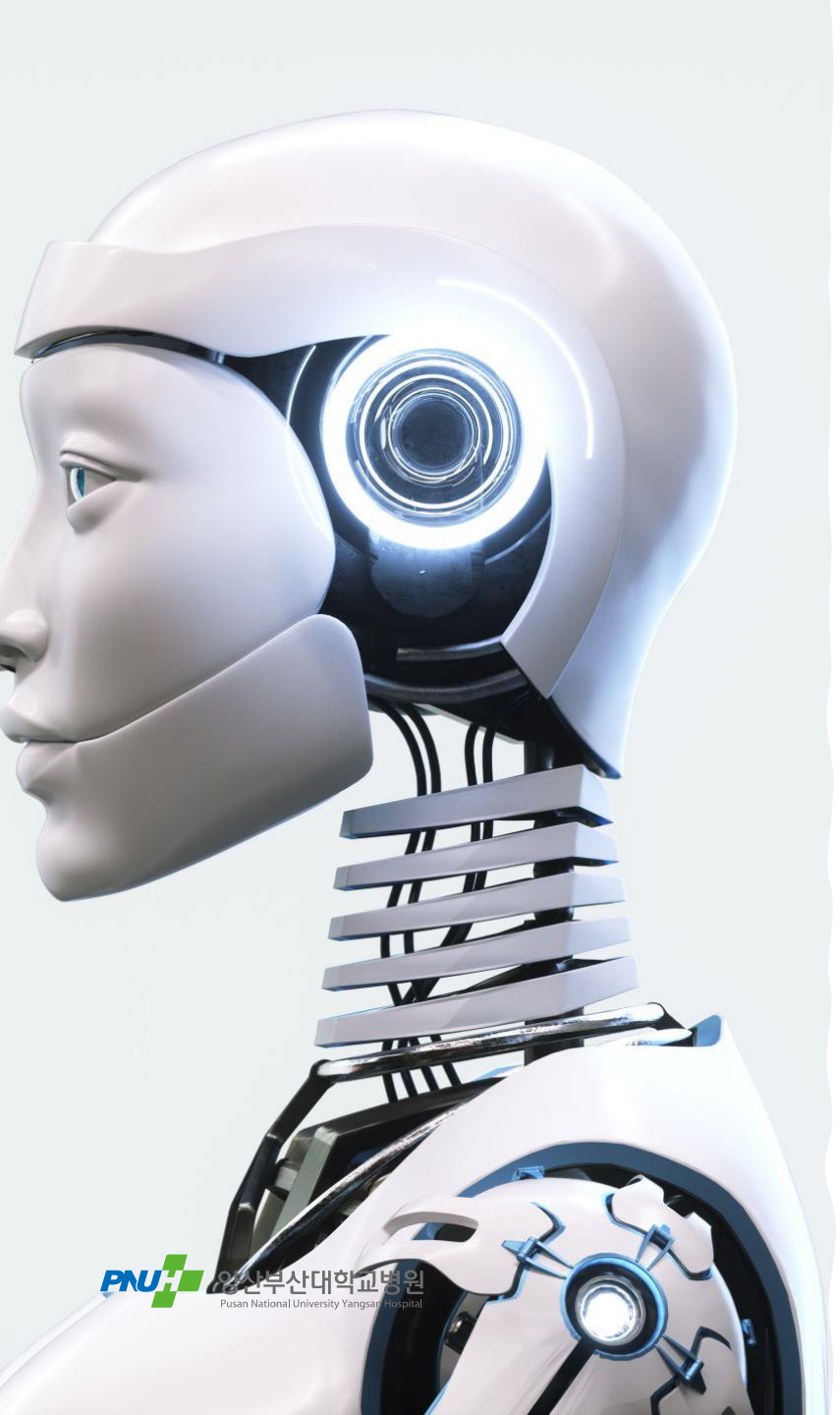
- **Ergonomics**

Robotic surgery reduces fatigue and musculoskeletal strain associated with prolonged standing. Surgeons can operate from a seated, relaxed position, conserving energy for complex operations. This is particularly beneficial for female surgeons, as the tools do not require significant muscular strength.

Why Robotic Surgery??

- **"EndoWrist" System**

Robotic instruments mimic human wrist movements with seven degrees of freedom and 360-degree rotation, allowing access to hidden chest spaces and enabling complex movements like suturing and precise dissections that preserve delicate anatomical structures.



Why Robotic Surgery??

- **"Fulcrum-effect"**

Robotic arms rotate around a fulcrum at the trocar level, reducing pressure on ribs and torque on the chest wall, thereby minimizing intercostal nerve and tissue damage, which results in less pain and reduced need for analgesics.

Why Robotic Surgery??

- **Motion Scaling and Tremor Filtering**

The robotic console translates large surgeon movements into smaller, precise ones while neutralizing physiological tremors. This is in contrast to VATS instruments, which tend to amplify small involuntary hand movements, making robotic tools more suitable for finer dissections with reduced blood loss.

Why Robotic Surgery??

- **Lymph-node Dissection and Upstaging**

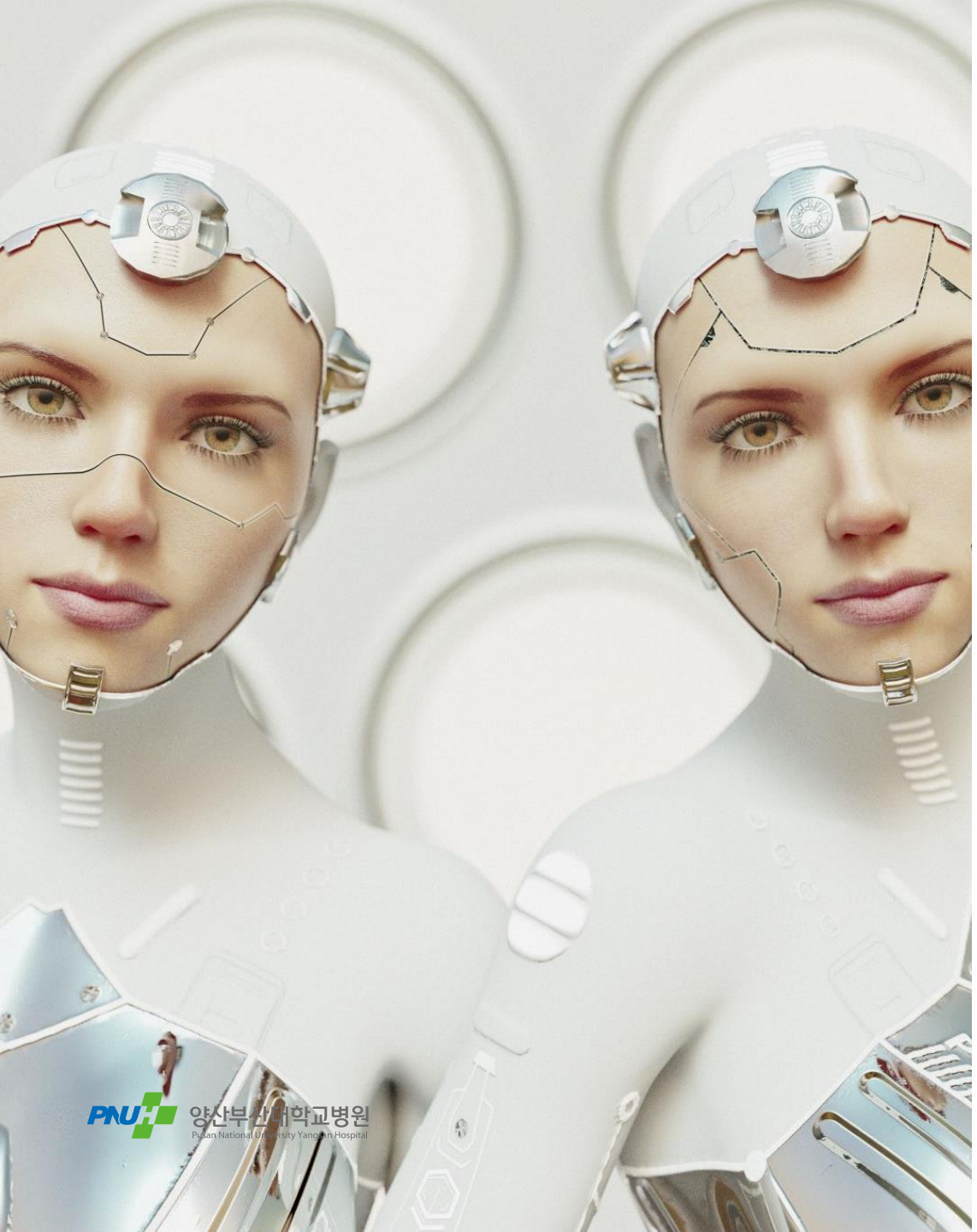
Robotic-assisted thoracic surgeries offer easier and more effective lymph node dissections compared to VATS or open surgery, even in cases with large lymph nodes and adhesions.

Studies indicate that robotic surgery results in a higher number of dissected lymph nodes, potentially leading to better staging and personalized oncologic treatments.

Why Robotic Surgery??

- **Learning Curve**

Robotic surgery appears to be easier to learn than conventional thoracoscopy, with approximately 20 robotic lobectomies needed to achieve competence, compared to 30–60 for VATS lobectomies.



Why Robotic Surgery??

- **Extended Indications**

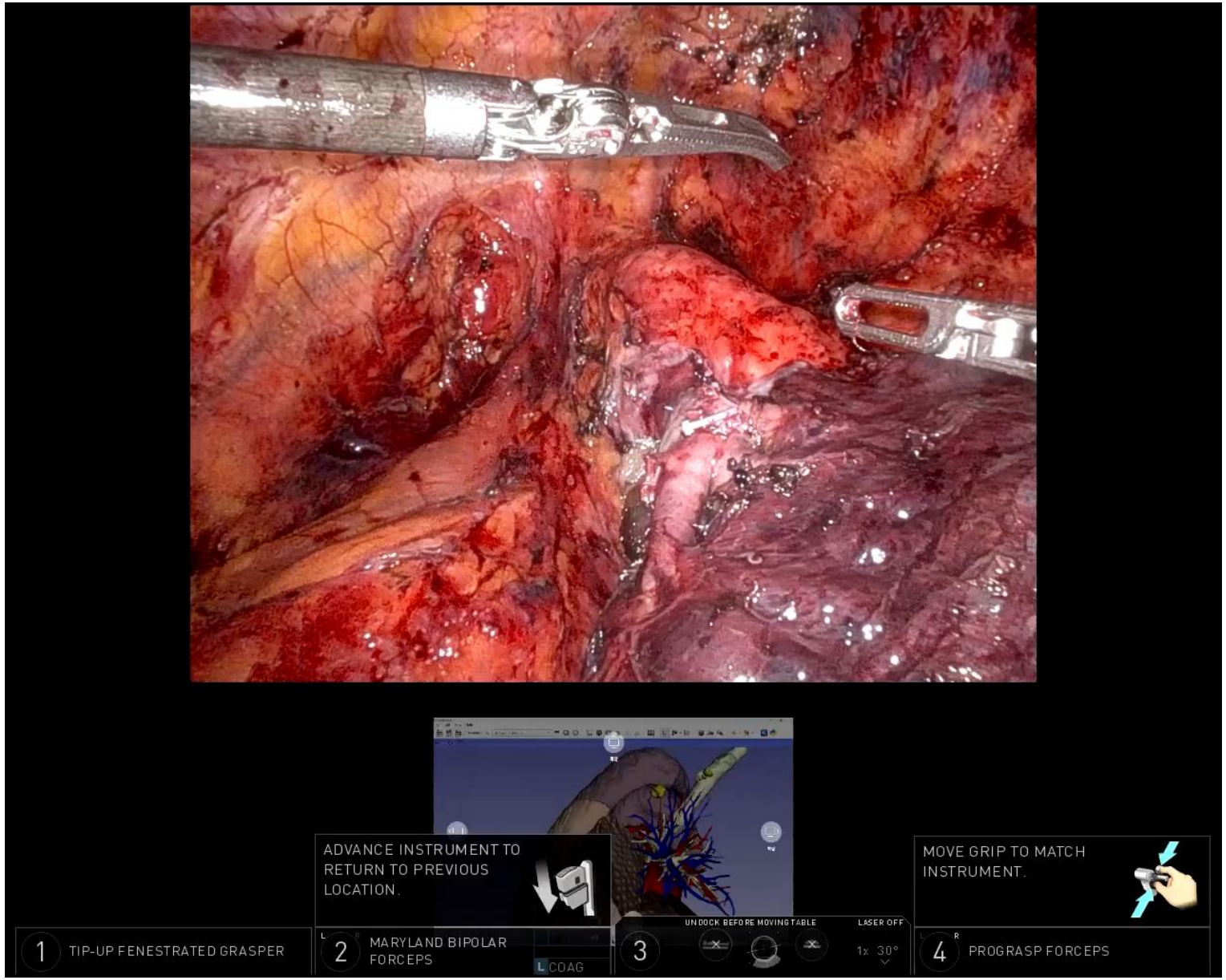
Robotic surgery can handle more complex operations than VATS, including sleeve resections and anatomical segmentectomies, expanding the indications for minimally invasive surgery.

- **Data Integration and Connectivity**

Modern robotic systems offer integrated digital platforms, allowing surgeons to access multiple imaging modes and patient data in real-time, enhancing decision-making and surgical independence.

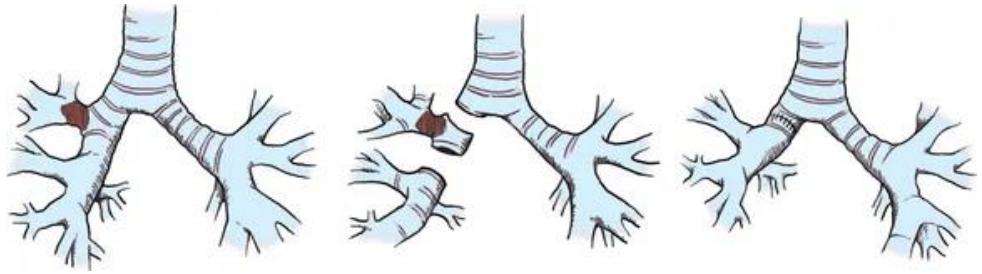
Case Presentation…….

Computer assisted Robotic Surgery (CAS)



Complicated Robotic Lung Resection

Sleeve Lobectomy for Advanced Lung Cancer



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Pusan National University Yangsan Hospital

Huge ant. Mediastinal Mass -Thymectomy-

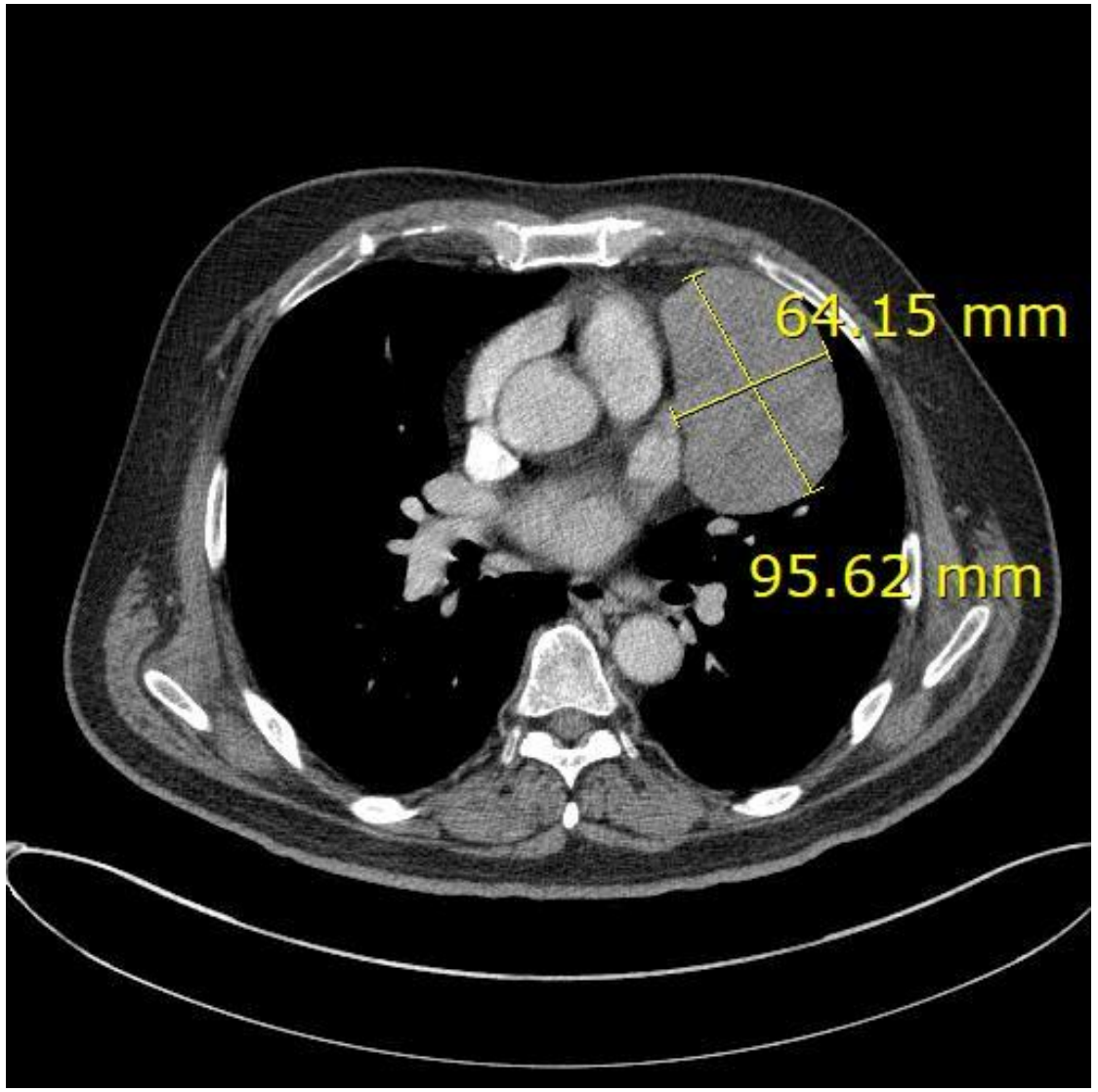
- **M / 58yr**
  - Evaluation d/t anemia (HOC)

<<Bone marrow Bx>>

- pure red cell aplasia

<< Chest CT >>

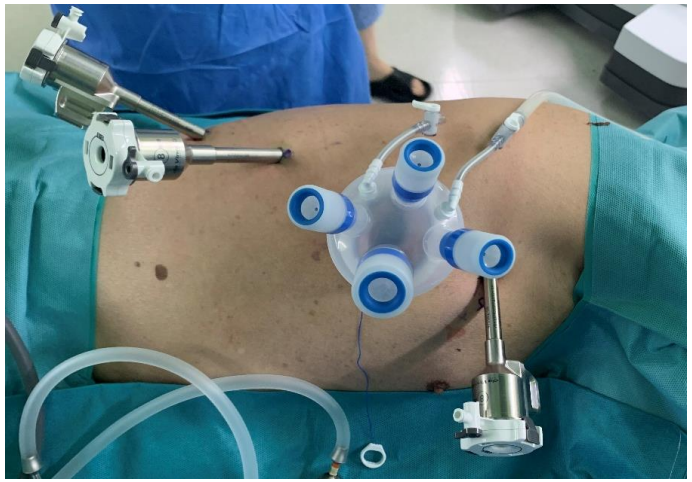
- **9.6cm** enhancing mass
  at left anterior mediastinum



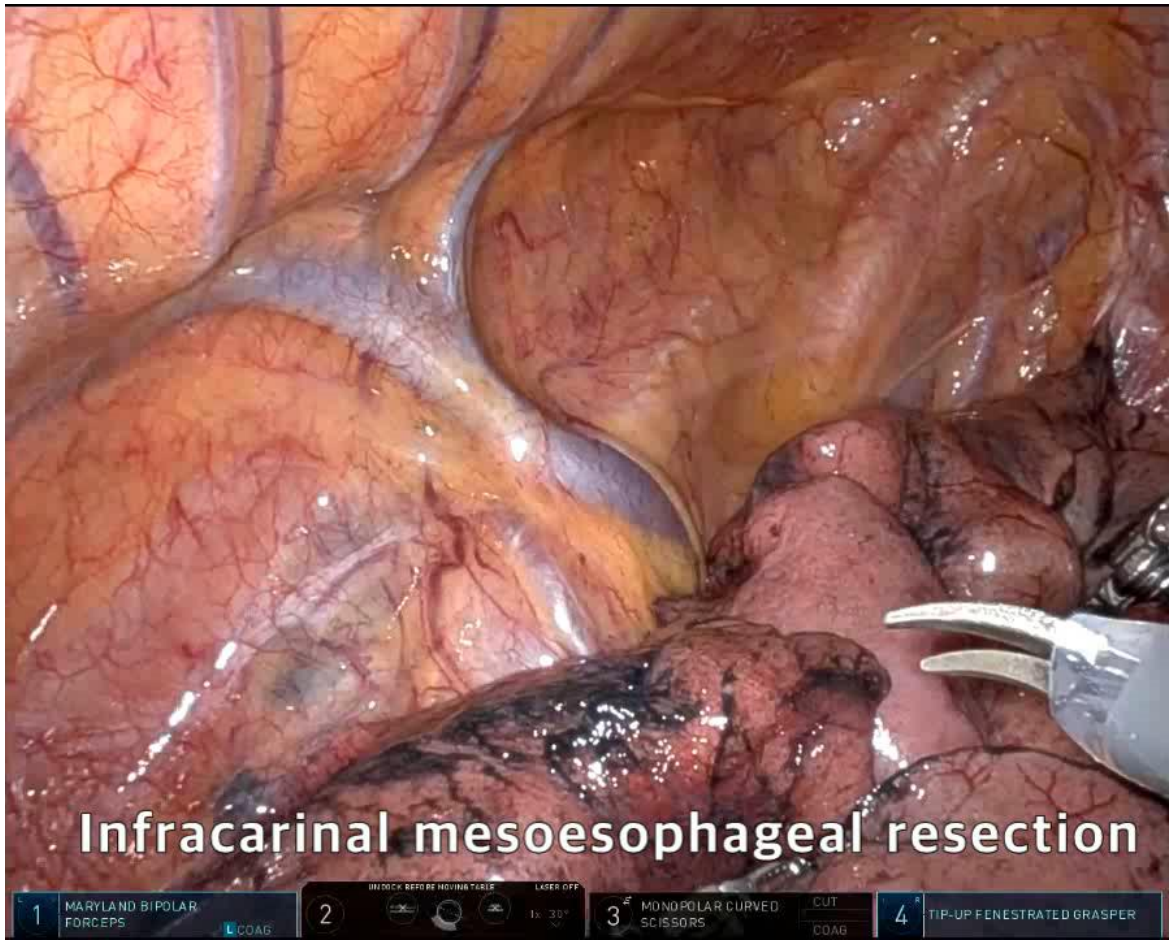
Robotic Thymectomy
Sub-xyphoid Approach

Esophageal ca. Surgery

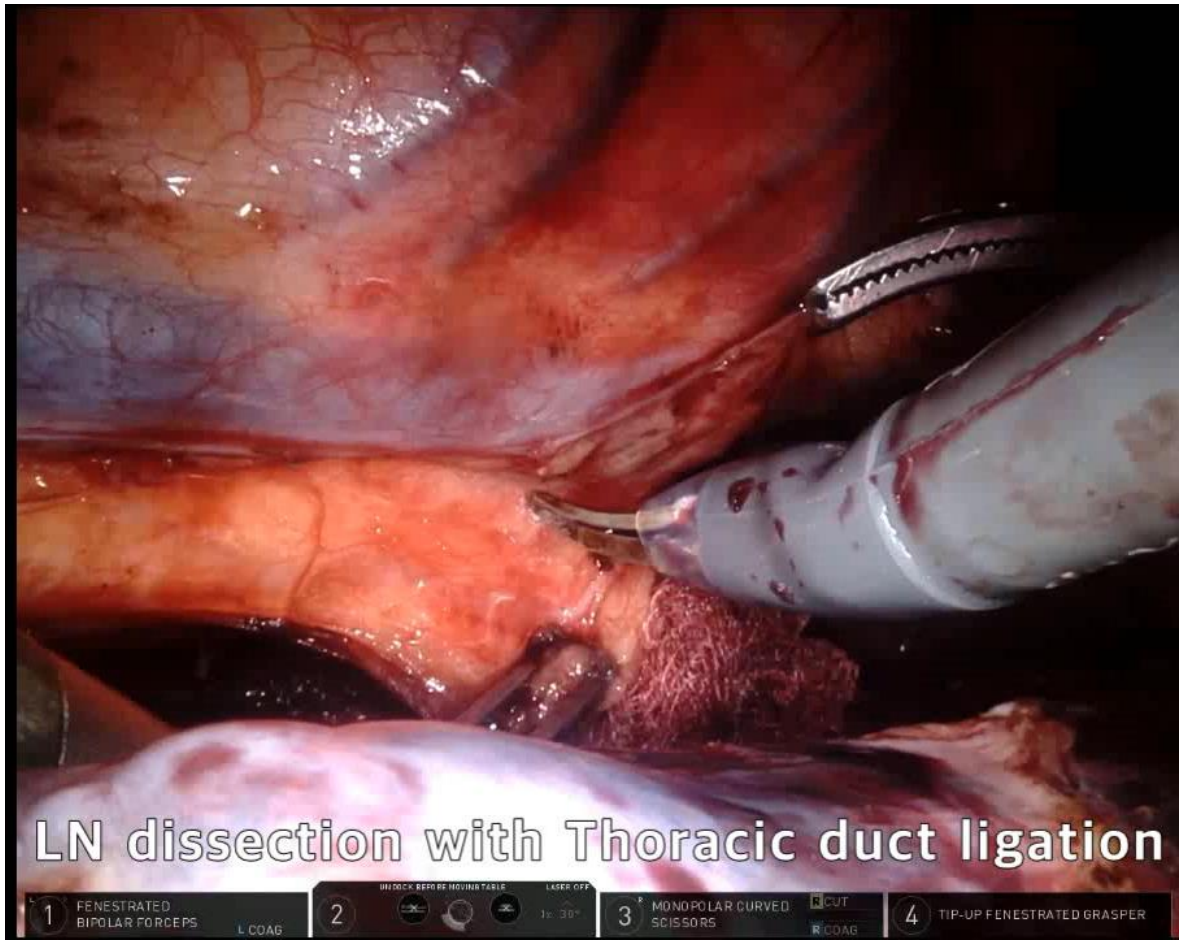
Robotic port application



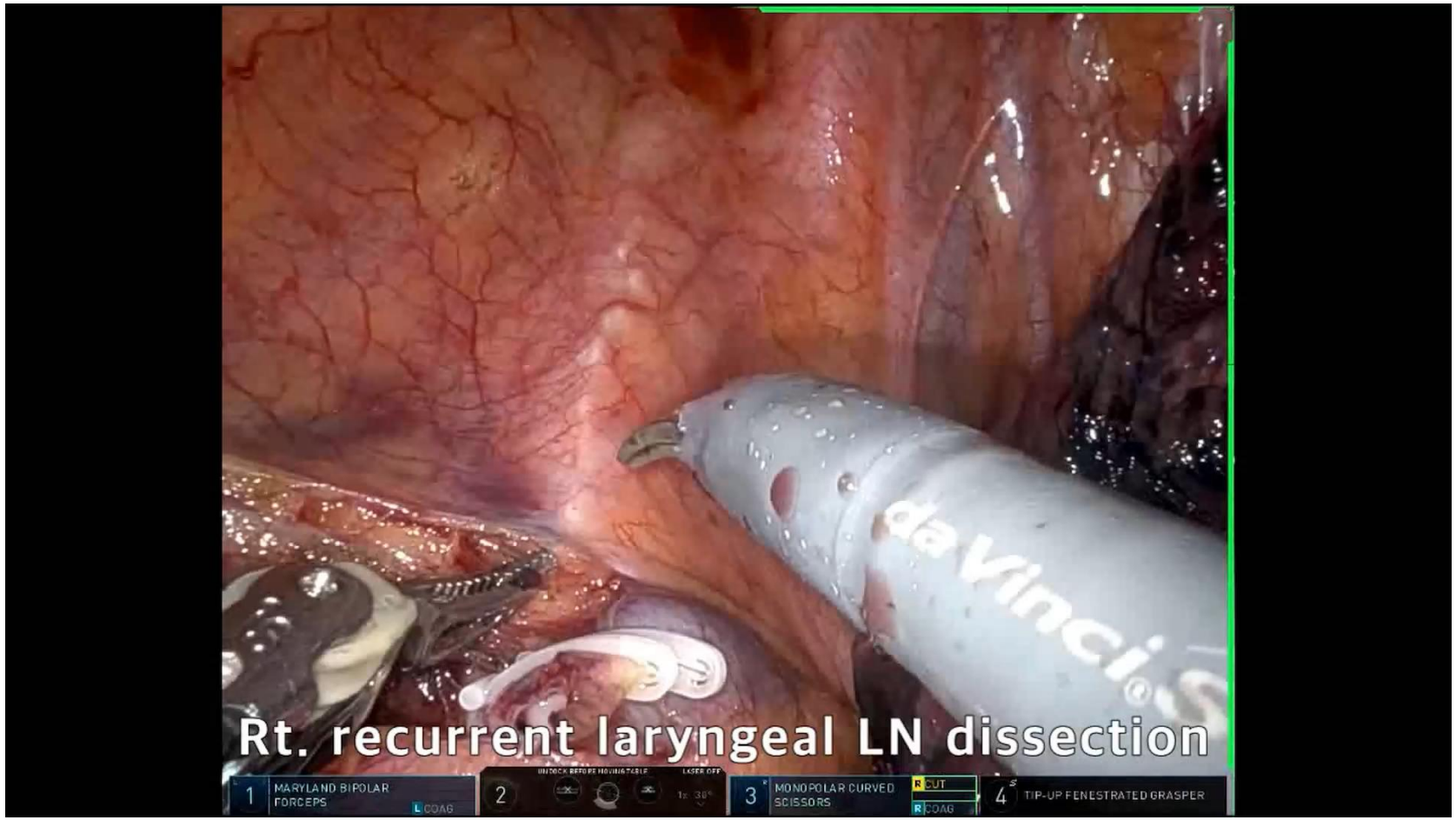
Infracarinal dissection of mesoesophagus



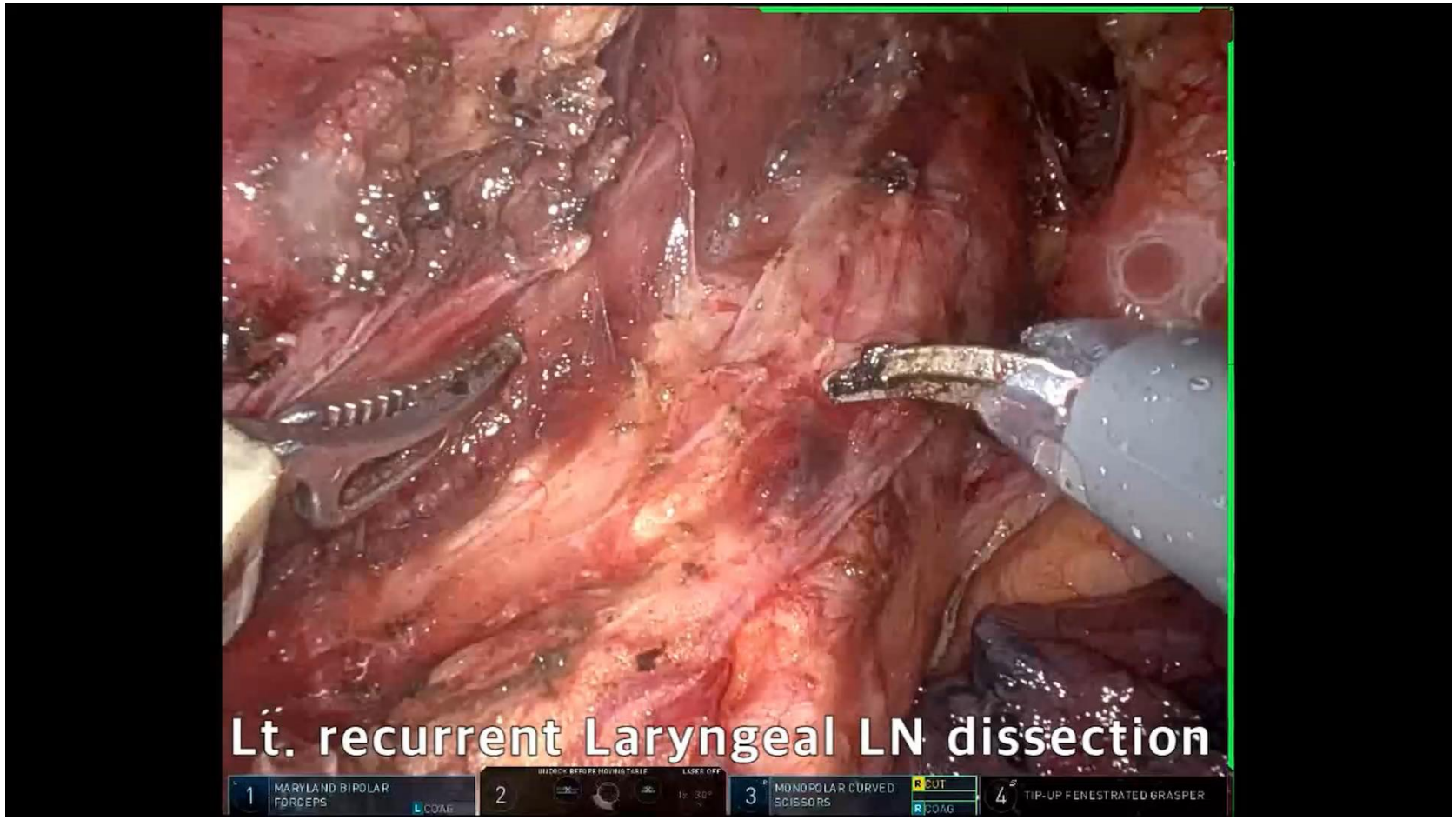
Lymphnode dissection with Thoracic duct



Rt. Recurrent laryngeal LN dissection

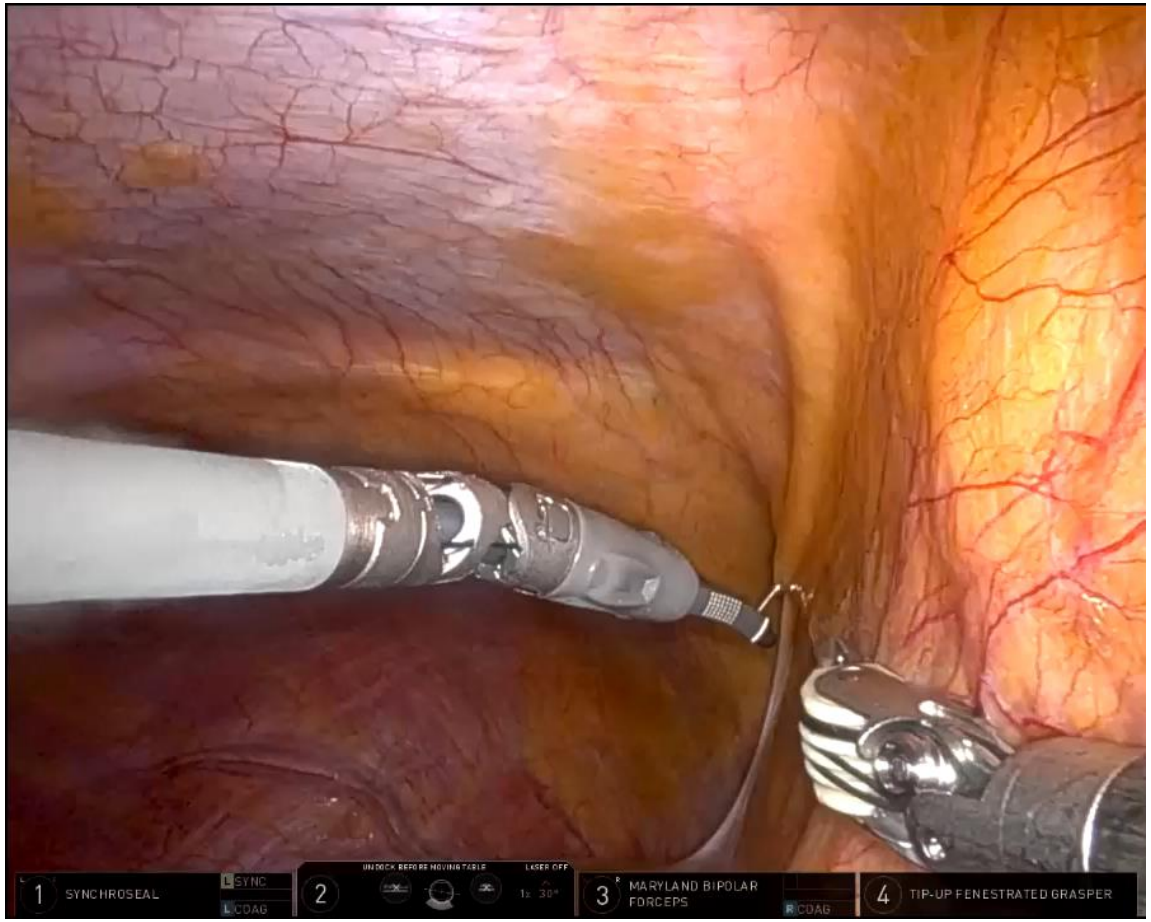


Lt. recurrent laryngeal dissection



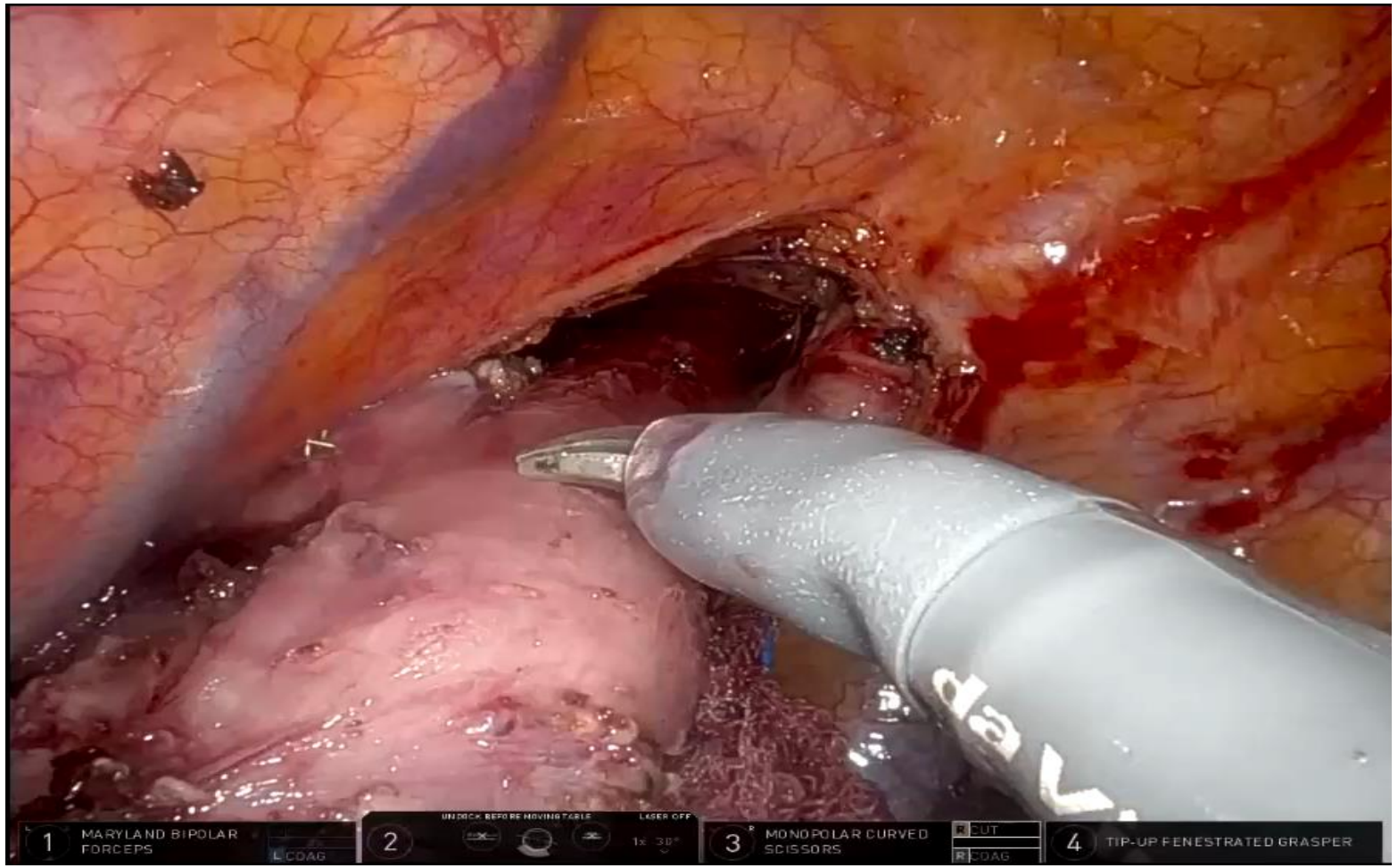
First Experience of Totally RAMIE

- Starting Robot assisted gastric mobilization

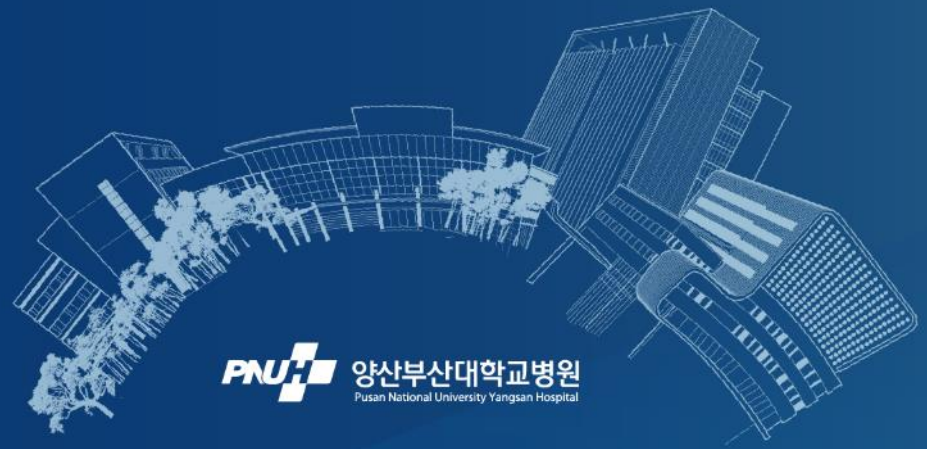


Recent Anastomosis Technique (Robotic assisted esophago-gastrostomy)

- Intra-thoracic Triangular anastomosis using linear stapler 60mm -> 40mm



Surgical treatment of recurrent esophageal ca. after definitive CCRT in a pneumonectomy state patient: Experience with robot assisted trans-hiatal esophagectomy.



Case presentation (patient's history)

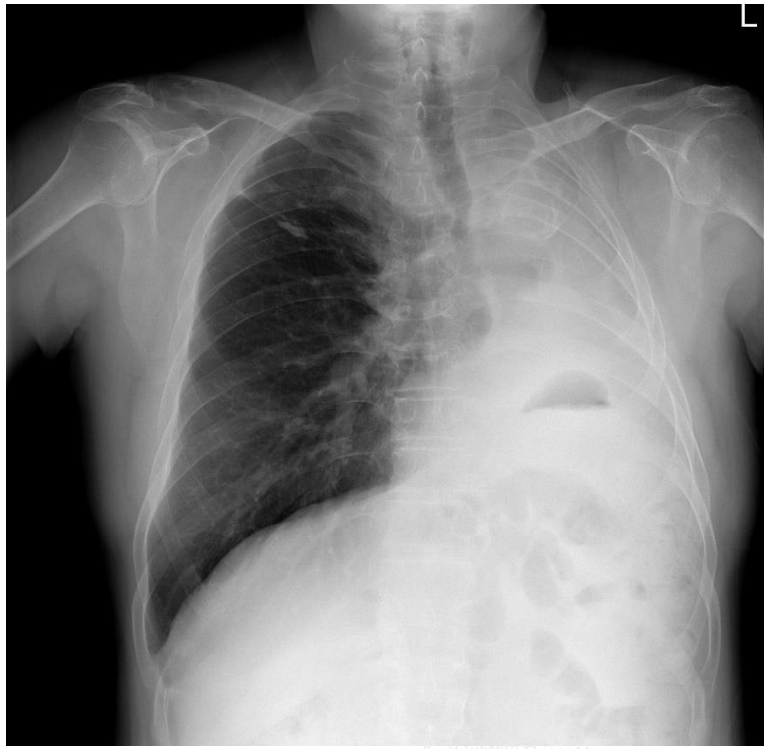
#M/67

HTN, DM, CAOD (angina pectoris) med.

Lt. pneumonectomy state due to pulmonary fibrosis 20 years age

Lt. vocal cord palsy

#CKD (Cr. 1.2~2.0)



Case presentation

- Recurrence within 7 moths despite 2 rounds of definite CCRTx !

  Esophageal ca, SqCC, IT 27cm, T1aN0M0

  Rec. Op. without alternative Tx.

- Recurrence but Complete Response….

  Esophageal ca, SqCC, IT 25cm, uT1b -> Op. refused

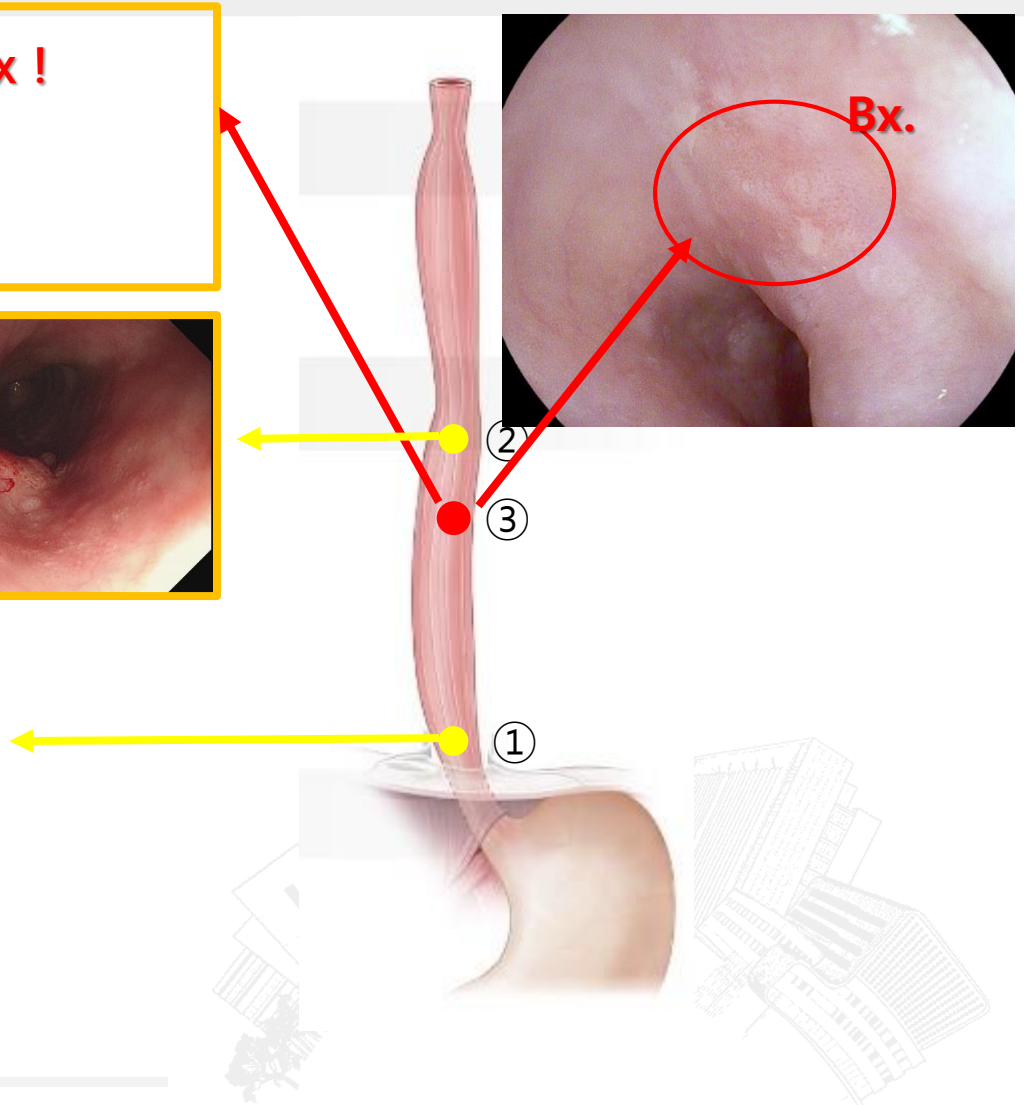
  Definite CCRT 50 Gy/25fx (22.07.27~22.08.31) c FP #2

- Complete response….

  Lower esophageal ca, SqCC

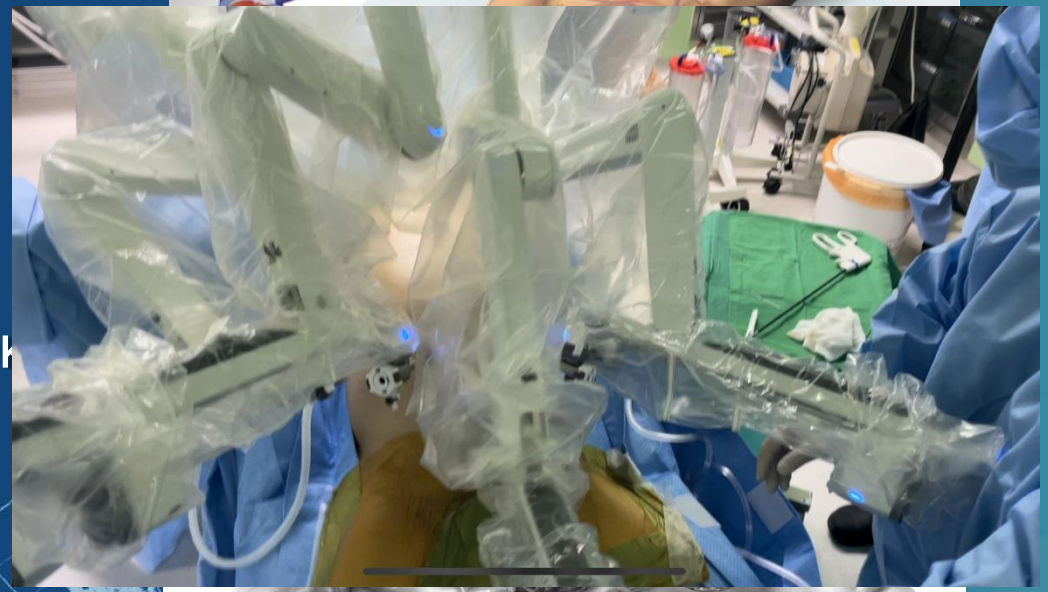
  s/p CCRT to Esophagus, 54 Gy/30fx

  (2012.04.17~2012.06.05)



Surgical plan : How to deal with it ?

- Trans-thoracic approach with intraoperative ECMO setting
- Robot-assisted transhiatal esophagectomy
  - Mediastinal LNs dissection
  - Massive beeding
    - Lower bleeding risk compared to using ECMO
  - Major pulomonary complication
- Conventional Trans-hiatal esophagectomy
  - Minimal invasive method including abdominal phase
  - Recurred esophageal ca. but relatively early cancer. Is it Ok
    - Visualization of paraesophageal connective tissue
  - Paraesophageal adhesion or fibrosis
  - Risk of blunt dissection – large vessel injury



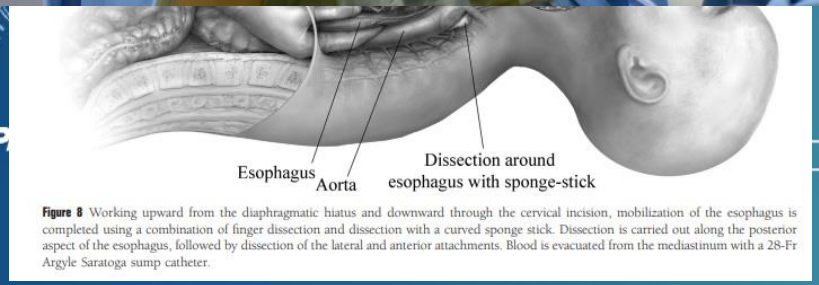


Figure 8 Working upward from the diaphragmatic hiatus and downward through the cervical incision, mobilization of the esophagus is completed using a combination of finger dissection and dissection with a curved sponge stick. Dissection is carried out along the posterior aspect of the esophagus, followed by dissection of the lateral and anterior attachments. Blood is evacuated from the mediastinum with a 28-Fr Argyle Saratoga sump catheter.

Robot-assisted Transhiatal esophagectomy, Gastric mobilization and pull-up,

Progression (1)

POD 1 jejunal feeding start

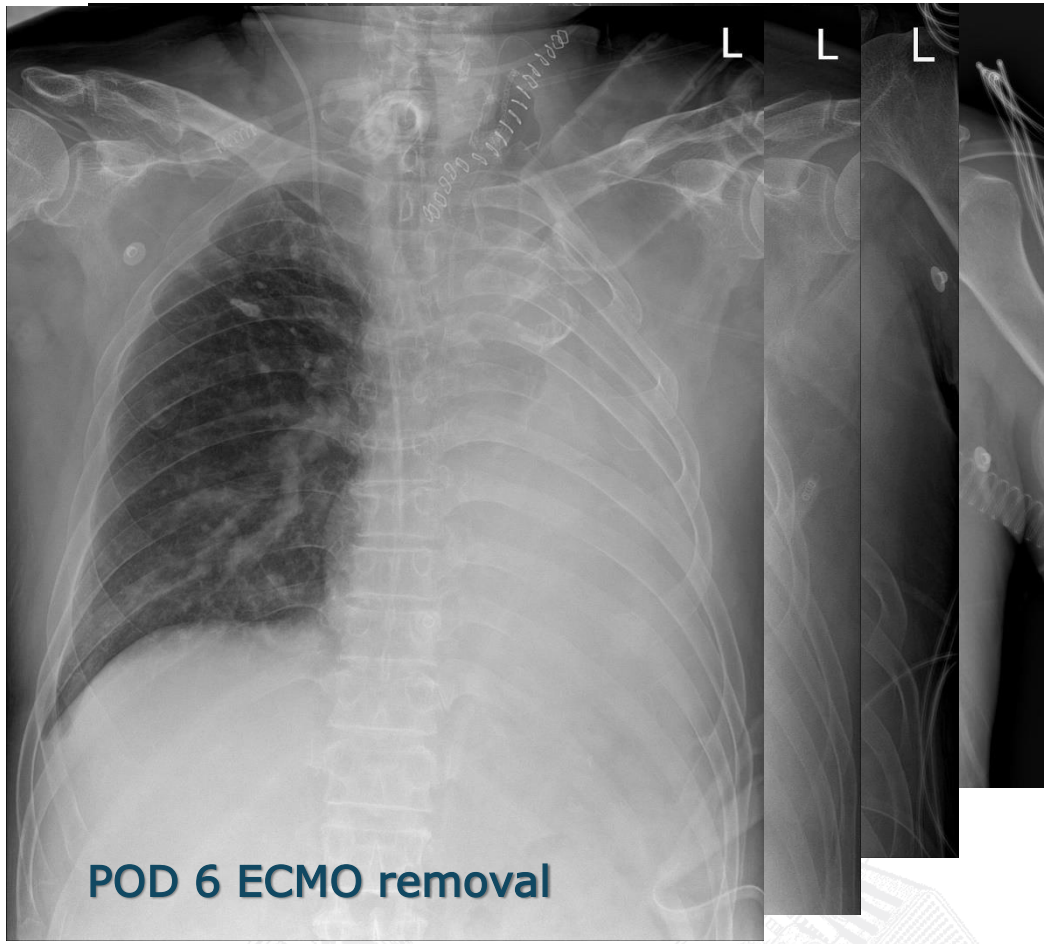
POD 2 increased O2 demand, R/O ARDS

POD 3 intubation and ECMO application

POD 5 early tracheostomy

POD 6 ECMO removal

POD 12 Refer to general ward

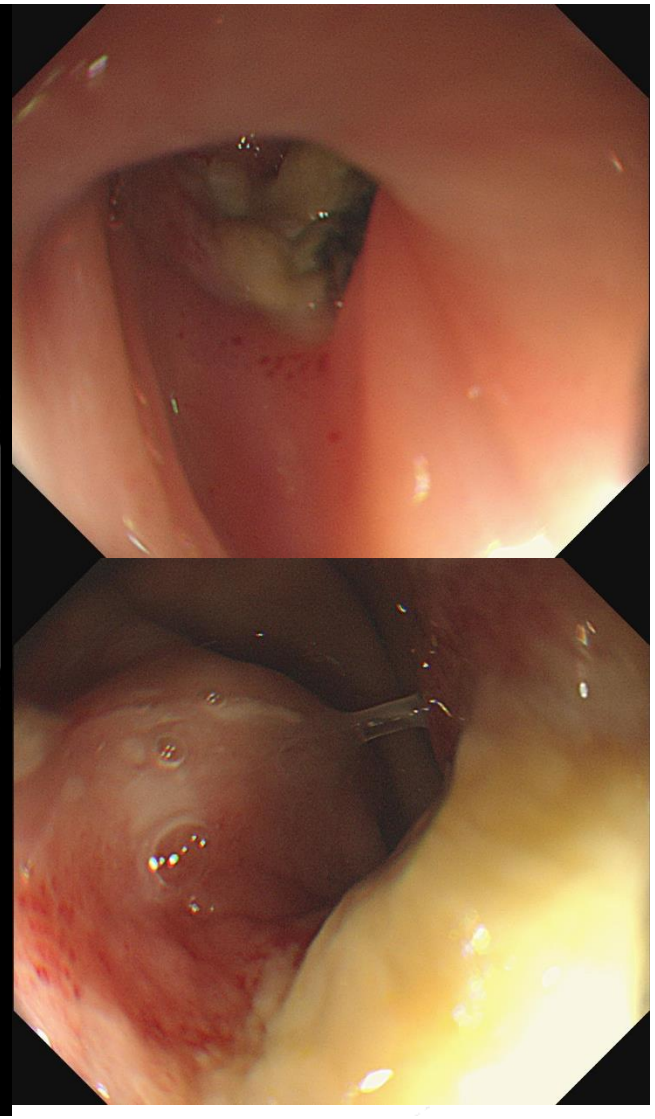


Progression (2)

POD 13 EGD check.

POD 18 esophagography

POD 33 discharge

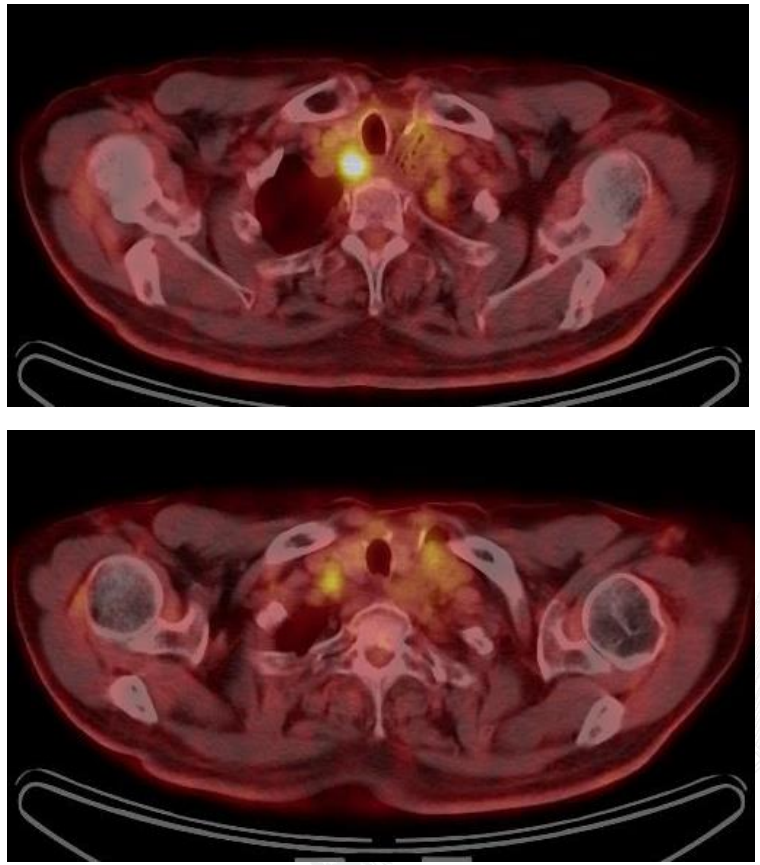


Progression (3)

Right. Supraclavicular LNs recur 4 months after surgery

Rt. SCLNs dissection was done (metastatic SqCC)

Planning Palliative chemotherapy



Conclusion

- Robot assisted trans-hiatal esophagectomy may be an **alternative surgical option.**

- It can be especially useful in patients with **poor pulmonary function**, such as pneun ectomy patients.

- In patients with paraesophageal adhesion or fibrosis in the preoperative Neoajudva nt setting, safe surgery is possible by **securing visibility without blind blunt dissecti on**.

Telehealth or Telemedicine?
And….. TeleSurgery !

Innovations

Collapse of Local Health Care System?

2000명의 증원이 과연 필요한가?

Future of Robotic Surgery

1. Integration of AI and Machine Learning
2. Miniaturization and Micro Robots
3. Integration of Virtual Reality (VR) and Augmented Reality (AR)
4. Telesurgery
5. Cost Reduction and Improved Accessibility
6. Soft Robotics and New Materials

경청해 주셔서 감사합니다.

Thank you for your attention