Robotic approaches to surgical resection in esophageal cancer

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Gastric and esophageal tumors

11 million tumors diagnosed worldwide

Gastric and Esophageal: 1.39 million cases

- **Exceeds lung (1.35 million) or breast cancer (1.15 million)**

Estimate half of patients would benefit from surgery and have resectable disease (700,000)

Incidence of esophageal carcinoma

- In Asia, most common esophageal cancer is squamous cell carcinoma in the mid and proximal esophagus
- In most Western countries it is adenocarcinoma in the distal esophagus and at the GE junction
- **In USA: About 21,560 new esophageal cancer cases diagnosed (17,030 in men and 4,530 in women)**

Historical perspective of results of esophageal resection for tumors

"Mortality associated with esophageal resection is unacceptably high", Gut 1994

1975-1988: 316 patients presented with esophageal tumors

-Surgical Exploration	134	42%
-Tumor Resection	106	79%
-**Operative Mortality**		**27%**
-Median Survival Following Surgical Resection		292 Days
-5-year survival		7%

Hospital volume and surgical mortality in the United States

	Low Volume	High Volume	Diff
Colectomy	6.9%	5.4%	1.5
Gastrectomy	12.7%	8.7%	4.0
Esophagectomy	18.9%	8.1%	10.8
Pancreatectomy	15.4%	3.8%	12.6
Nephrectomy	3.2%	2.6%	.6
Cystectomy	6.3%	2.9%	3.4
Pulmonary Lobectomy	5.9%	4.2%	1.7
Pneumonectomy	15.4%	10.6%	4.8

Birkmeyer et al. NEJM 2002;346:1128-37

Minimally invasive versus open esophagectomy
Randomized controlled trial

		Open(N=56)	MIE (N=59)	p value
Primary outcomes				
Pulmonary infection within 2 weeks		16 (29%)	5 (9%)	**0·005**
Pulmonary infection in-hospital		19 (34%)	7 (12%)	**0·005**
Secondary outcomes				
Hospital stay (days)		14 (1–120)	11 (7–80)	**0·044**
Short-term quality of life: 3 scales			⇧	**0.01**
Total lymph nodes retrieved		21 (7–47)	20 (3–44)	0·852
RO Resection		47 (84%)	54 (92%)	0·080
Mortality[‖]				0·590
	30-day mortality	0 (0%)	1 (2%)	
	In-hospital mortality	1 (2%)	2 (3%)	

Biere SS, et al. Lancet. 2012 May 19;379(9829):1887-92.

Modern results of esophagectomy

		Operation	N	Mortality
Portale	2006	Open	263	4.5%
Orringer	2007	Open	2007	3.0%
Low	2007	Open	340	0.3%
Smithers	2007	Open	114	2.6%
Van Heijl	2010	Open	940	3.3%
Palanivelu	2006	MIE	130	1.5%
Luketich	2012	MIE	1011	1.8%
Hochwald	2022	MIE	600	1.1%

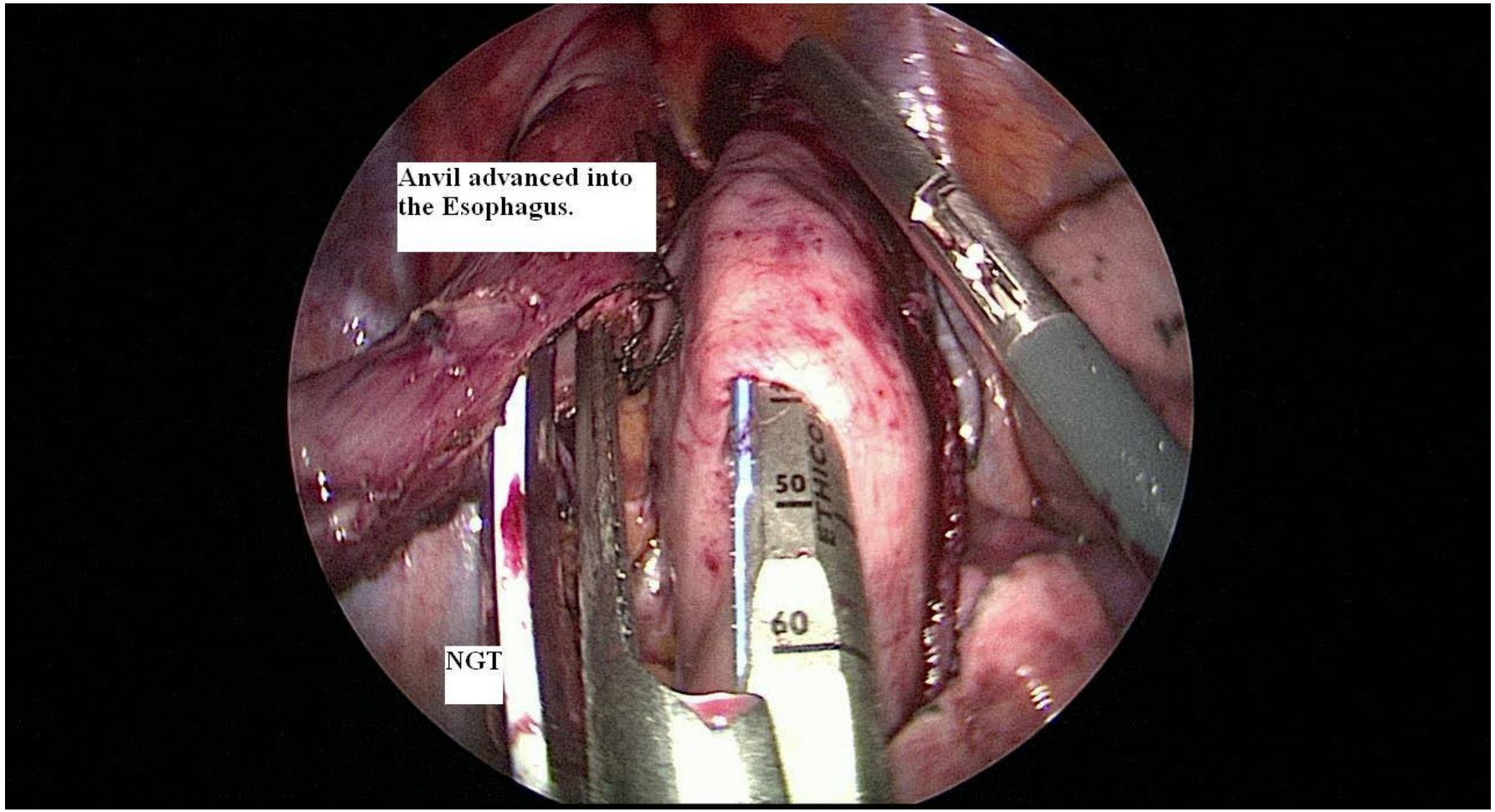
We have learned that esophagectomy should not be done in all medical centers and not by all surgeons. Mortality rates can be routinely in the 3% range and certainly should be <5%.

ESOPHAGECTOMY
Controversial Topics

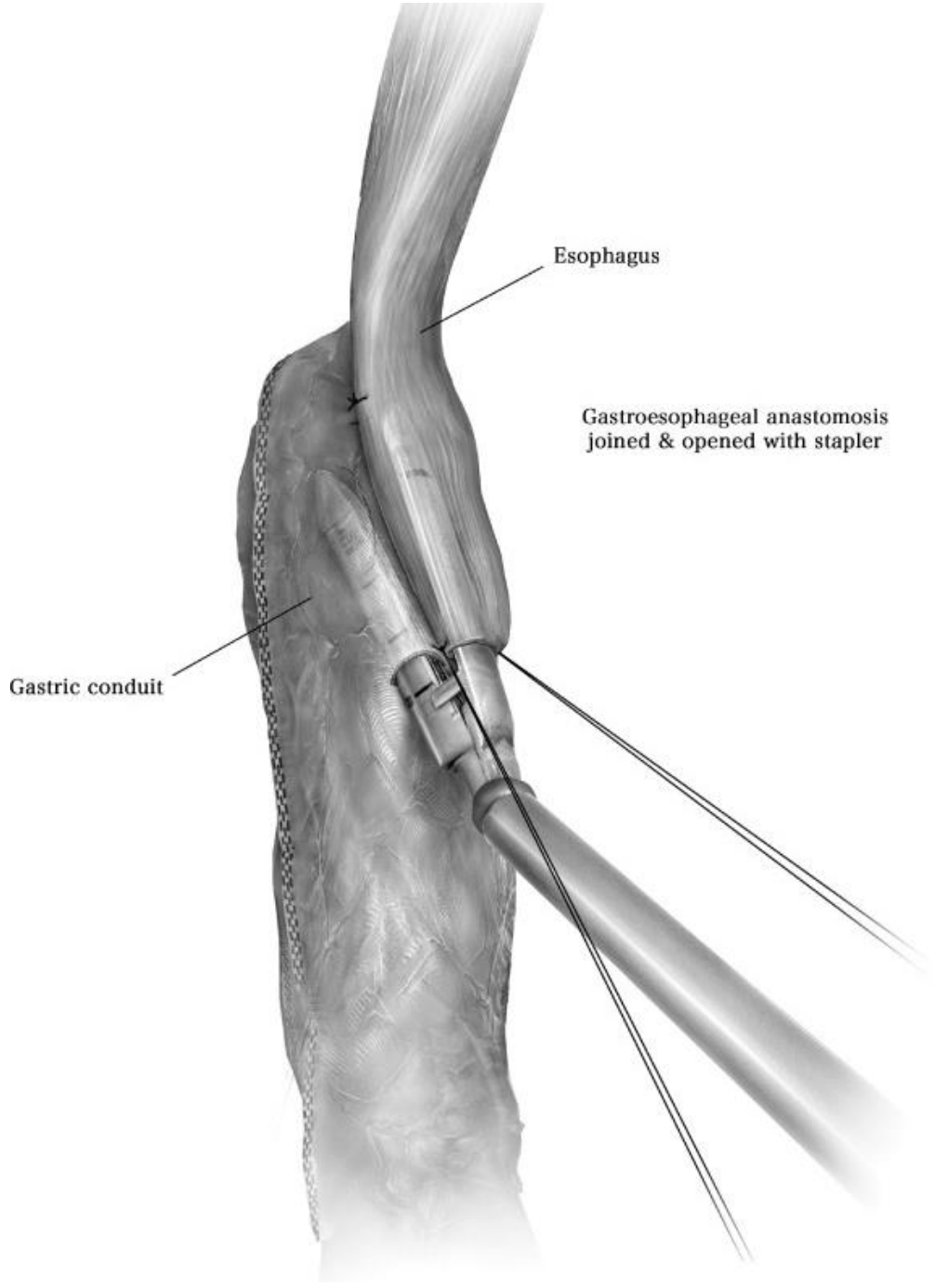
- Ideal approach:
  --Laparascopic/Thoracoscopic vs Robotic Ivor Lewis

- Ideal anastomotic technique:
  - circular
  - side to side stapled
  - handsewn

Intrathoracic side to side anastomosis



Technique of minimally invasive IVOR-LEWIS esophagogastrectomy with intrathoracic stapled side to side anastomosis. Ben-David K and Hochwald S. Journal of Gastroint Surg. (2010): 14; 1613-8.


Esophagus
Gastroesophageal anastomosis
joined & opened with stapler
Gastric conduit

Postoperative outcomes for patients with MIE (Ivor Lewis) with Intrathoracic side-to-side anastomosis (n=114)

Any postoperative complication	58 (50.9%)
Respiratory	
Failure requiring intubation	7 (6.1%)
Failure not requiring intubation	5 (4.4%)
Aspiration	14 (12.3%)
Pneumonia	**11 (9.6%)**
Arrhythmia	13 (11.4%)
Anastomotic leak	**6 (5.3%)**
RLN paresis	3 (2.6%)
Chyle leak	2 (1.8%)
Reoperation	7 (6.1%)

Kukar M and Hochwald S, J Gastroint Surg, 2019

Postoperative outcomes for patients with MIE (Ivor Lewis) with Intrathoracic side-to-side anastomosis (n=114)

Length of stay (days)	8 [7,11]
Disposition to home	90.3%
30 day readmission	14 (12.3%)
Mortality	
30 day	**1 (0.9%)**
90 day	**2 (1.8%)**
Stricture	**6 (5.1%)**

Kukar M and Hochwald S, J Gastroint Surg, 2019

Why use robotics for esophagectomy?

- Training Surgical Residents and Fellows for the future
- Minimizing learning curve
- Some struggle even past the learning curve, specifically precise suturing
- Attending surgeon fatigue and frustration

Robot assisted minimally invasive esophagectomy (RAMIE) vs open esophagectomy
A randomized controlled trial
Dutch multicenter trial

Endpoint	RAMIE (n=54)	Open (n=55)	p
Overall complications	32 (59%)	44 (80%)	0.02
Pulmonary	17 (32%)	32 (58%)	0.005
Cardiac	12 (22%)	26 (47%)	0.006
Wound	2 (4%)	8 (14%)	0.09
Anastomotic leak	13 (24%)	11 (20%)	0.42
Functional recovery	38 (70%)	28 (51%)	0.04
Health related quality of life	57.9	44.6	0.02

Van Der Sluis PC, Ann Surg 2019, 269: 621-30.

Robotic Assisted MIE vs Laparoscopic/Thoracoscopic

- 2016 to June 2021
- 72 Laparoscopic/Thoracoscopic cases matched to 67 Complete Robotic Ivor Lewis
- 0%: 30 day mortality
- 1%: 90 day mortality

Chouliaris K et al. Dis Esophagus. 2022 Dec 31;36

Patient Demographics
Lap/Thoraco vs RAMIE

		Lap/Thoraco	Robotic	p value
N		72	67	
Age (median)		66	64	0.06
BMI (median)		28.5	29.7	0.19
COPD		11 (15.3%)	11 (16.7%)	1.0
Neoadjuvant Tx		64 (88.9%)	54 (80.6%)	0.24
Path: Adenocarcinoma		67 (93.1%)	60 (89.6%)	0.55
Clinical stage	I	5 (6.9%)	13 (10.4%)	0.03
	IIA	1 (1.4%)	1 (1.5%)	
	IIB	6 (8.3%)	9 (13.4%)	
	III	53 (73.6%)	43 (64.2%)	
	IV	7 (9.7%)	1 (1.5%)	

Chouliaris K et al. Dis Esophagus. 2022 Dec 31;36

Patient Demographics
Lap/Thoraco (n=72) vs RAMIE (n=67)

		Lap/Thoraco	Robotic	p value
Location:	Type 1	29 (40.3%)	32 (47.8%)	0.31
	Type 2	30 (41.7%)	30 (44.8%)	
	Type 3	2 (2.8%)	1 (1.5%)	
	Esophageal	11 (15.3%)	4 (6%)	
Pathological Stage:	0	15 (20.8%)	18 (26.9%)	0.33
	1	23 (31.9%)	23 (34.3%)	
	2	14 (19.4%)	5 (7.5%)	
	3	18 (25%)	18 (26.9%)	
	4	2 (2.8%)	3 (4.5%)	
Nodal yield, med (range)		19 (9-39)	20 (0-49)	0.82

Chouliaris K et al. Dis Esophagus. 2022 Dec 31;36

Patient Complications
Lap/Thoraco (n=72) vs RAMIE (n=67)

	Lap/Thoraco	Robotic	p value
Grade 2 complication	43 (59.7%)	28 (41.8%)	0.04
Grade 3 complication	27 (37.5%)	17 (25.4%)	0.15
Anastomotic leak	9 (12.5%)	2 (3%)	0.06
Length of Stay (median)	8 days	7 days	0.02

Worldwide Techniques and Outcomes in Robot-Assisted Minimally Invasive Esophagectomy (RAMIE): Results from the Multicenter International Registry

- 20 centers from Europe, Asia, North and South America, UGIRA
- 2012 patients were included

Anastomotic technique Ivor Lewis	2016-2018 n=368	2019-2020 n=563	2021-2023 n=1081
Circular Stapled	44%	66%	64%
Hand Sewn	47%	14%	12%
Linear Stapled	9%	20%	24%

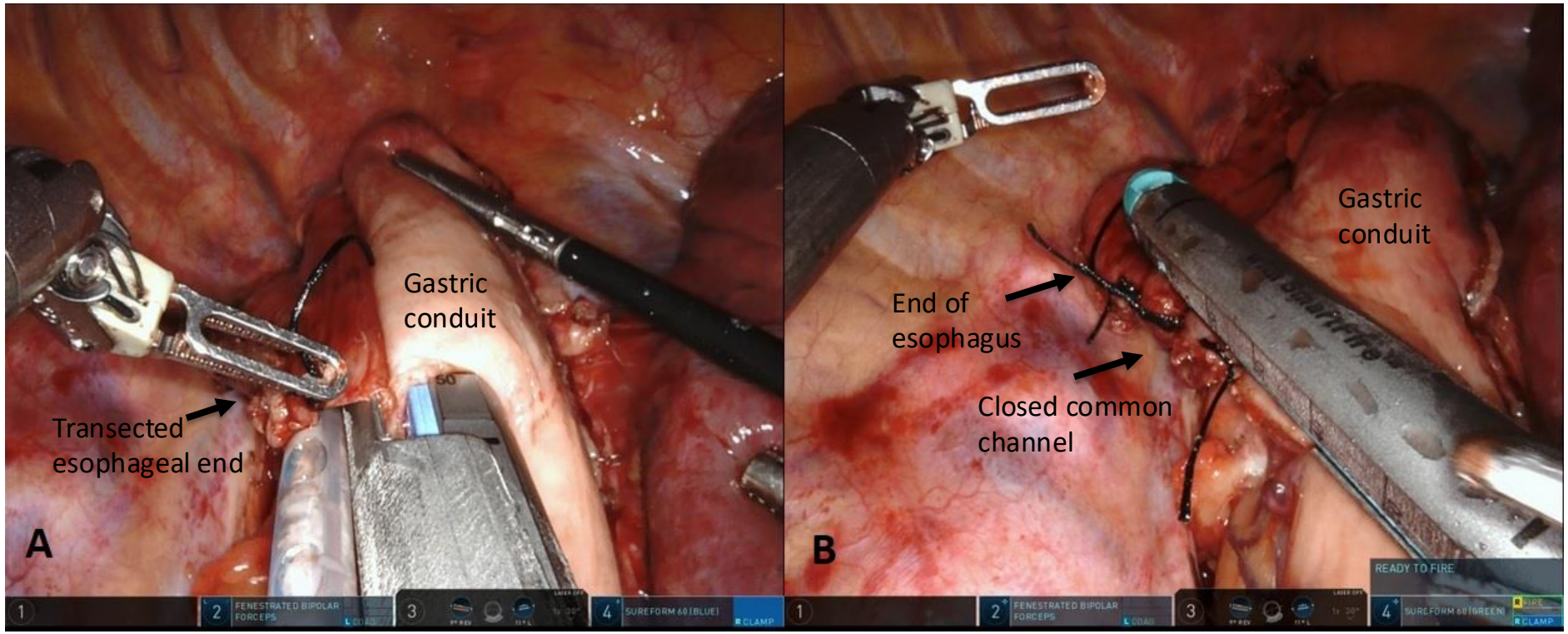
Ann Surg Oncol 2025; 32: 823.

Worldwide Techniques and Outcomes in Robot-Assisted Minimally Invasive Esophagectomy (RAMIE): Results from the Multicenter International Registry

	2016-2018 n=368	2019-2020 n=563	2021-2023 n=1081
Anastomotic leak rate	22%	22%	16%
Textbook outcome	39%	48%	49%

Ann Surg Oncol 2025; 32: 823.

Stapled side to side intrathoracic anastomosis



Peng JS, Hochwald SN. Surg Oncol Clin N Am. 2019 Apr;28(2):177-200

Achieving Textbook Outcomes with Robotic Assisted Ivor Lewis Esophagectomy: A Single Center Experience with 150 consecutive patients

Patient demographics 2020-2024

Age (median, range)		64 (33-83)
Sex	Male	128 (85%)
	Female	22 (15%)
Race	White	141 (94%)
	Black	7 (7%)
	Hispanic	2 (2%)
ECOG	0	110 (74%)
	1	38 (26%)
ASA	2	50 (33%)
	3	99 (66%)
	4	1 (1%)

Kukar M and Hochwald S, J Gastrointest Surgery, in press, 2025

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Smoking and BMI

Smoking Status	Never	45 (30%)
	Quit>6 months	59 (40%)
	Quit<6 months	16 (11%)
	Active	**19 (13%)**
BMI (median, range)		27.9 (19.7-45.8)

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Stage, location and histology

Clinical Stage	I	18 (13%)
	II	26 (19%)
	III	89 (64%)
	IV	7 (5%)
Clincal Nodal Status	Negative	94 (63%)
	Positive	56 (37%)
Neoadjuvant Tx	None	22 (15%)
	Chemotherapy	20 (13%)
	Chemoradiation	98 (65%)
	Chemo followed by CRT	10 (7%)
Siewert Type	Type 1	52 (35%)
	Type 2	71 (47%)
	Type 3	9 (6%)
Histology	Adeno	138 (92%)
	Squamous	11 (7%)
	Other	1 (1%)

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Operative Details

Operative Time (median, range)	410 (294-665)
EBL (median, range)	80 (5-500)
Lymph nodes harvested (median, range)	21 (13-49)
Chest conversion	0
Abdomen conversion	0

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Pathology

Pathology stage	0	35 (23%)
	1	49 (33%)
	2	18 (12%)
	3	44 (29%)
	4A	4 (3%)
Pathology Margins	Negative	144 (96%)
	Positive	6 (4%)
Pathologic CR		35 (27%)

Kukar M and Hochwald S, J Gastrointest Surgery, in press, 2025

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Complications

Length of Stay (median days, range)	7 (5-25)
Anastomotic leak	2 (1%)
Reoperation (30 days)	2 (1%)
Reoperation (31-90 days)	0
Chyle leak	3 (2%)
Pneumonia	11 (7%)
Septic shock	1 (1%)
Stricture (90 days)	3 (3%)

Kukar M and Hochwald S, J Gastrointest Surgery, in press, 2025

Achieving Textbook Outcomes with Robotic Assisted Ivor Lewis Esophagectomy:
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Complications

Readmission (30 days)	5 (3%)
30 day mortality	1 (1%)
90 day mortality	2 (1%)
Textbook outcome	135 (90%)

Kukar M and Hochwald S, J Gastrointest Surgery, in press, 2025

Esophagectomy Pathway
Mount Sinai Medical Center

POD#1: Intermediate care unit

POD#2 : Transfer to regular floor

POD#3 : D/C NG tube

POD#4 : Clear liquid test

POD#5 : Remove drains/tubes, full liquids

POD#6 : D/C home with tube feeds

The volume equation: Is it just about the numbers of resections?

- Diversity of services
  - Thoracic anesthesiology
  - Dedicated ORs and ICU's
  - Interventional GI
  - Interventional radiology
- Established pathways and databases
- Improved communications: Oncologic nurse coordinators
- Committed to long term functional follow-up
- Dedicated tumor boards
- Published results

Conclusions

Robotic Ivor Lewis is the procedure of choice for adenocarcinoma of the esophagus

Side to side anastomoses associated with excellent results

Low leak and stricture rates

Procedure can be adopted by trainees with reasonable learning curve

Less attending surgeon fatigue

Thank you!

Questions?

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