Esophageal Cancer

Christina Wu, MD
Assistant Professor of Internal Medicine
Department of Internal Medicine
Division of Medical Oncology
The Ohio State University Wexner Medical Center

Esophageal cancer

- In the US (2012):
  - 17,460 new cases, 15,070 deaths
- Worldwide (2008)
  - 482,300 new cases, 406,800 deaths
  - 6th leading cause of cancer deaths
- Median age of diagnosis: 67 years
- Male predominance

<table>
<thead>
<tr>
<th>Esophageal cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Histology</td>
</tr>
<tr>
<td>Anatomic location</td>
</tr>
<tr>
<td>Incidence</td>
</tr>
<tr>
<td>Risk factors</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Barrett’s esophagus

- Replacement of squamous epithelium with intestinal columnar epithelium
- Incidence:
  - 10-15% of endoscopies evaluating GERD
  - 40% patients with esophageal strictures
- 2% risk of adenocarcinoma over 10 yrs
- No therapy reverts (antacids, surgery, laser)
Barrett's esophagus

- Consider screening if with risk factors for esophageal cancer:
  - >50 years, Caucasian
  - chronic GERD
  - hiatal hernia
  - high body mass index

Wang et al. Am J Gastroenterol 2008;103:788

Chemoprevention for Barrett’s Esophagus Trial

- ↑COX-2 in Barrett’s esophagus
- U.S. trial with celecoxib
  - 100 pts with Barrett’s esophagus: low or high grade dysplasia
  - Placebo vs Celecoxib 200 mg BID
  - No change in EGD findings at 48 weeks
  - No change in COX 1/2 mRNA

Heath et al. JNCI 2007;99:545

Barrett’s esophagus

<table>
<thead>
<tr>
<th>Dysplasia</th>
<th>Repeat endoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No dysplasia</td>
<td>3 years</td>
</tr>
<tr>
<td>Low-grade</td>
<td>6-12 months</td>
</tr>
<tr>
<td>High-grade</td>
<td>Every 3 months or local therapy</td>
</tr>
</tbody>
</table>

Esophageal cancer

- Signs and symptoms:
  - Dysphagia and odynophagia (solids before liquid)
  - Weight loss
  - Abdominal pain
  - Cough and hoarseness
  - Supraclavicular adenopathy
### Diagnostic work-up

- CBC and chemistry
- Esophagogastroduodenoscopy
- CT chest/abdomen/pelvis with IV and PO contrast
- PET/CT
- Endoscopy with ultrasound
- Bronchoscopy (if above and at level of carina)

### Staging

#### Tumor
- Tis – High grade dysplasia
- T1 – Tumor invades lamina propria, muscularis mucosae or submucosa
- T2 – Tumor invades muscularis propria
- T3 – Tumor invades adventitia
- T4 – Tumor invades adjacent structures
  - T4a – Resectable tumor invading pleura, pericardium or diaphragm
  - T4b – Unresectable tumor invading other adjacent structures, such as aorta, vertebral body, trachea, etc

#### Node
- N0 – No regional LN involvement
- N1 – Metastasis in 1-2 regional nodes
- N2 – Metastasis in 3-6 regional nodes
- N3 – Metastasis in more than 7 regional nodes

#### Metastasis
- M0 – No distant metastasis
- M1 – Distant metastasis

### PET/CT

- Utilized for preoperative staging
  - Correlate with EUS and CT scans
  - Upstages tumor to avoid surgery
- Prognostic
  - PET/CT responders after induction chemotherapy have improved survival
### 5 Year Survival by Stage

<table>
<thead>
<tr>
<th>Stage</th>
<th>TNM</th>
<th>5-year Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>TisN0M0</td>
<td></td>
</tr>
<tr>
<td>Stage I</td>
<td>T1N0M0</td>
<td>80-90%</td>
</tr>
<tr>
<td>Stage IIA</td>
<td>T2-T3N0M0</td>
<td>50%</td>
</tr>
<tr>
<td>Stage IIB</td>
<td>T1-2N1M0</td>
<td>20%</td>
</tr>
<tr>
<td>Stage III</td>
<td>T3N1M0 T4N0-1M0</td>
<td>10-15%</td>
</tr>
<tr>
<td>Stage IVA</td>
<td>M1a</td>
<td>10%</td>
</tr>
<tr>
<td>Stage IVB</td>
<td>M1b</td>
<td>Anecdotal</td>
</tr>
</tbody>
</table>

### Treatment Options

**Resectable cancer**
- Tumor location
- Tumor stage (nodal involvement, metastasis)
- Patient medically fit for esophagectomy

**Metastatic cancer**
- Chemotherapy
- Radiation therapy
- Photodynamic Therapy
- Laser Ablation
- Stents
- Nutrition (PEG, TPN)

**Unresectable cancer**
- Radiation
- Chemotherapy

### Meta-analysis: Survival benefit from neoadjuvant chemoradiation vs. chemotherapy

<table>
<thead>
<tr>
<th></th>
<th>Neoadjuvant chemoradiation</th>
<th>Neoadjuvant chemotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>10 studies, total n = 1209</td>
<td>8 studies, total n = 1724</td>
</tr>
<tr>
<td>HR for all-cause mortality</td>
<td>0.81 (p=0.002)</td>
<td>0.90 (p=0.05)</td>
</tr>
<tr>
<td>Absolute survival difference at 2 years</td>
<td>13%</td>
<td>7%</td>
</tr>
<tr>
<td>Comments</td>
<td>Similar results for SCC and AC</td>
<td>Benefit only in AC, not SCC</td>
</tr>
</tbody>
</table>

Delski et al, Lancet Oncol 2007; 8:228-34.
CALGB 9871 trial

Trimodality vs surgery:
- Median OS: 4.5 vs 1.8 years
- 5-yr survival: 39% vs. 16%
- Median PFS: 3.5 vs. 1 yr

Tepper et al. J Clin Oncol 2008; 26:1086

CROSS trial

Patients with resectable esophageal or GE junction cancer
- N=188

Chemoradiation and surgery

Surgery
- N=180

Van Hagen et al, NEJM 2012;366:2074

CROSS trial results

<table>
<thead>
<tr>
<th></th>
<th>Surgery</th>
<th>Trimodality</th>
</tr>
</thead>
<tbody>
<tr>
<td>67%</td>
<td>R0 resection</td>
<td>92.3%</td>
</tr>
<tr>
<td>3.8%</td>
<td>In hospital mortality</td>
<td>3.4%</td>
</tr>
<tr>
<td>70%</td>
<td>1 year survival</td>
<td>82%</td>
</tr>
<tr>
<td>52%</td>
<td>2 year survival</td>
<td>67%</td>
</tr>
<tr>
<td>48%</td>
<td>3 year survival</td>
<td>(HR 0.67, p=0.011)</td>
</tr>
</tbody>
</table>

Van Hagen et al, NEJM 2012;366:2074

Unresectable tumor
Non-operative trial: RTOG 85-01

- Esophageal cancer
  - Radiation
  - Radiation And 5FU + cisplatin

Cooper et al. JAMA 1999;281:1623.

Definitive Chemoradiation or Radiation for Esophageal Cancer

<table>
<thead>
<tr>
<th></th>
<th>Chemoradiation</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median survival</td>
<td>12.5 months</td>
<td>8.9 months</td>
</tr>
<tr>
<td>1-year survival</td>
<td>52%</td>
<td>34%</td>
</tr>
<tr>
<td>2-year survival</td>
<td>36%</td>
<td>10%</td>
</tr>
<tr>
<td>5-year survival</td>
<td>26%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Cooper et al. JAMA 1999;281:1623.

Targeted therapy-HER2

- Human epidermal growth factor receptor-2
- HER2 is over-expressed in 20% gastro-esophageal and gastric cancers
- Antibody to HER2- trastuzumab

Wagner et al. JCO 2006;24:2903.

Metastatic esophageal cancer: Best Supportive Care vs Chemotherapy

<table>
<thead>
<tr>
<th>Study</th>
<th>No. Chemotherapy</th>
<th>EDC</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miettinen 1987</td>
<td>30</td>
<td>10</td>
<td>0.35 (0.17 to 0.69)</td>
</tr>
<tr>
<td>Kaipainen 1995</td>
<td>24</td>
<td>20</td>
<td>0.26 (0.13 to 0.63)</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>30</td>
<td>0.35 (0.28 to 0.43)</td>
</tr>
</tbody>
</table>

Test for heterogeneity: $Z^2 = 6.38, P = .039$
Primary end point: OS

<table>
<thead>
<tr>
<th>Event</th>
<th>Median</th>
<th>OS</th>
<th>HR</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC + T</td>
<td>167</td>
<td>13.8</td>
<td>0.74</td>
<td>0.60, 0.91</td>
<td>0.0046</td>
</tr>
<tr>
<td>FC</td>
<td>162</td>
<td>11.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Surgical Intervention for Esophageal Cancer

Edmund Kassis, MD
Assistant Professor of Surgery
Department of Surgery
Division of Thoracic Surgery
The Ohio State University Wexner Medical Center

In summary

- **Incidence**: Adenocarcinoma †, squamous cell ‡
- **Risk factors**:
  - Adenocarcinoma: tobacco, obesity, GERD, Barrett’s esophagus
  - Squamous cell carcinoma: tobacco, alcohol, HPV, corrosive ingestion
- **Signs and symptoms**:
  - Dysphagia/odynophagia, weight loss, pain, and cough
- **Work-up**: CBC + CMP, EGD, CT chest/abdomen/pelvis
- **Treatment**: Multi-modality- surgery, radiation, chemotherapy
- **Prognosis**:
  - Poor prognosis (1/3 patients have metastatic disease at diagnosis)
  - Improved prognosis if localized, resectable cancer

Overview

- **OSU approach to esophageal cancer**
- **Morbidity and mortality after esophagectomy**
- **Approaches to esophageal resection**

Using evidence-based medicine, has the ideal operative approach been determined?
Answer: No
Algorithm for Esophageal Cancer: OSU Approach

CT C/A/P, PET/CT, EUS

T4 or Metastases

T1N0 — Esophagectomy

T2-T3 — Chemo/XRT, esophagectomy

N1 — Chemo/XRT, esophagectomy

Photodynamic therapy

Esophageal stenting

Palliative CTX/XRT

Esophagectomy and Survival

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>N</th>
<th>Approach</th>
<th>1 year survival</th>
<th>5-year survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swanson (2001)</td>
<td>250</td>
<td>Three hole</td>
<td>44</td>
<td>NR</td>
</tr>
<tr>
<td>Bailey (2003)</td>
<td>1777</td>
<td>Varied</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Rizk (2004)</td>
<td>510</td>
<td>Varied</td>
<td>44</td>
<td>NR</td>
</tr>
<tr>
<td>Lerut (2005)</td>
<td>394</td>
<td>Varied</td>
<td>63</td>
<td>30</td>
</tr>
<tr>
<td>Portale (2006)</td>
<td>263</td>
<td>Varied</td>
<td>NR</td>
<td>46.5</td>
</tr>
<tr>
<td>Orringer (2007)</td>
<td>2007</td>
<td>THE</td>
<td>70</td>
<td>29</td>
</tr>
<tr>
<td>Mathisen (1998)</td>
<td>104</td>
<td>Varied</td>
<td>NR</td>
<td>15%</td>
</tr>
</tbody>
</table>

Survival by Stage

Esophagectomy and Mortality

- Open esophagectomy mortality rates range from 8% at high volume centers to 23% in low volume centers (NEJM 2002)

- Published series from experienced centers report a mortality rate of 5%
High Volume Centers for Esophagectomy: Number needed to achieve low post-operative mortality

ROL in last 10 years w/13 papers:
- Reduction in post-op mortality with increasing case volumes per year
- Post-op complication rates are lower in high-volume hospitals

Metzger, R. et al. Dis of the Esophagus, Vol17(4)310, Dec, 2004

High Volume Centers for Esophagectomy: What is the number needed to achieve low post-operative mortality

- Management of complications is more successful in high-volume hospitals
- Long-term prognosis is also correlated to case-volume
- With the experience of > 20 esophagectomies/yr mortality <5% can be achieved

Metzger, R. et al. Dis of the Esophagus, Vol17(4)310, Dec, 2004

<table>
<thead>
<tr>
<th>Hospital Volume and Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
</tr>
<tr>
<td>Dimick (2001)</td>
</tr>
<tr>
<td>Dimick (2003)</td>
</tr>
</tbody>
</table>

Fig: Correlation between number of esophagectomies and hospital mortality rate.
### Esophagectomy and Perioperative Mortality

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>N</th>
<th>Approach</th>
<th>LOS</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swanson (2001)</td>
<td>250</td>
<td>Three hole</td>
<td>13</td>
<td>3.6</td>
</tr>
<tr>
<td>Bailey (2003)</td>
<td>1777</td>
<td>Varied</td>
<td>NR</td>
<td>9.8</td>
</tr>
<tr>
<td>Rizk (2004)</td>
<td>510</td>
<td>Varied</td>
<td>11</td>
<td>6.1</td>
</tr>
<tr>
<td>Lerut (2005)</td>
<td>394</td>
<td>Varied</td>
<td>NR</td>
<td>2.1</td>
</tr>
<tr>
<td>Portale (2006)</td>
<td>263</td>
<td>Varied</td>
<td>NR</td>
<td>4.5</td>
</tr>
<tr>
<td>Mathisen (1998)</td>
<td>104</td>
<td>Varied</td>
<td>NR</td>
<td>2.9</td>
</tr>
</tbody>
</table>

### Lowering the Morbidity of Esophagectomy

- Limit rib spreading to 5 cm during transthoracic esophagectomy (Skinner 1967)
- Avoid thoracotomy and perform transhiatal approach (Orringer 1980)
- Perform only in high volume centers (Birkmeier 2002)
- Perform minimally invasive esophagectomy in high volume center (Luketich 1996)

### Esophagectomy Morbidity

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Michigan</th>
<th>VA</th>
<th>MSKCC</th>
<th>Duke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak</td>
<td>12%</td>
<td>NR</td>
<td>21%</td>
<td>14%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2%</td>
<td>21%</td>
<td>21%</td>
<td>16%</td>
</tr>
<tr>
<td>RLN Injury</td>
<td>4.5%</td>
<td>NR</td>
<td>4%</td>
<td>NR</td>
</tr>
<tr>
<td>Conduit Necrosis</td>
<td>2%</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Chylothorax</td>
<td>1%</td>
<td>0.02%</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>MI</td>
<td>NR</td>
<td>1.2%</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Tracheal Injury</td>
<td>0.4%</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Splenectomy</td>
<td>2%</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Diaphragm Hernia</td>
<td>NR</td>
<td>NR</td>
<td>1.2%</td>
<td>NR</td>
</tr>
</tbody>
</table>

### Surgical Options

#### Approach
- Transhiatal
- Transthoracic
- Three Field
- Minimally Invasive
- En Bloc

#### Conduit
- Stomach
- Colon
- Jejunum
- Skin Tube

#### Anastomosis
- Neck
- Chest
- Abdomen

#### Route
- Post. Mediast.
- Retrosternal
- Subcutaneous
Transhiatal Esophagectomy

- Experienced centers report <5% mortality
- Overall survival: 20-25%
- Stage I: 60-70%
- Stage III: 5%
- 40% rate of local recurrence
- Major complication rate of 30-40%

Perioperative Mortality After Intrathoracic Leak

- No difference in operative time, blood loss, morbidity or mortality
- Survival similar
- Anastomotic Leak rate
  - Cervical 11%
  - Thoracic 6%

En-Bloc Esophagectomy

- Overall Operative Mortality
- Leak Associated Mortality

Historical

- Overall Operative Mortality
  - 43%

- Leak Associated Mortality
  - 11%

Modern

- Overall Operative Mortality
  - 2.5%

- Leak Associated Mortality
  - 3.3%

Martin et al., Ann Surg, 2006

Putnam et al., Annal Thor Surg, 1994
### Extended Surgical Resection

<table>
<thead>
<tr>
<th>THE</th>
<th>TT “En Bloc”</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Pts.</td>
<td>106 pts</td>
</tr>
<tr>
<td>Pulm Cxns</td>
<td>29 (27%)</td>
</tr>
<tr>
<td>ICU Days</td>
<td>2 (0-38)</td>
</tr>
<tr>
<td>Op Mort</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Relapse</td>
<td>62 (58%)</td>
</tr>
<tr>
<td>5-yr Surv.</td>
<td>27%</td>
</tr>
</tbody>
</table>

Hulscher et al., NEJM, 2002

### Radical Three Field Esophagectomy

- Thoracic, abdominal and cervical incisions
- Three field lymphadenectomy
- Increased complications:
  - RLN Injury: 56 vs 30%
  - Tracheostomy: 53 vs 10%
  - Phrenic nerve injury: 13 vs 0%
  - No difference in 5-year survival
- Significant increase in morbidity with no improvement in survival

### MIE Techniques

- Thoracoscopic; laparotomy
- Laparoscopic; thoracotomy
- Laparoscopic; transhiatal
- Thoracoscopic; laparoscopic

### MIE vs Open

<table>
<thead>
<tr>
<th></th>
<th>MIE</th>
<th>Transthoracic</th>
<th>Transhiatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time</td>
<td>364</td>
<td>437</td>
<td>391</td>
</tr>
<tr>
<td>Blood Loss</td>
<td>297</td>
<td>1046</td>
<td>1142</td>
</tr>
<tr>
<td>Intraop Transfusion</td>
<td>0.3</td>
<td>1.8</td>
<td>2.9</td>
</tr>
<tr>
<td>ICU Stay</td>
<td>6.1</td>
<td>9.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Hospital Stay</td>
<td>11.3</td>
<td>23.0</td>
<td>22.3</td>
</tr>
<tr>
<td>No. LN’s Removed</td>
<td>10.8</td>
<td>6.3</td>
<td>6.9</td>
</tr>
</tbody>
</table>
**MIE**

- Luketich, 2003
- 222 patients
- High grade dysplasia 47 pts
- Esophageal cancer 175 pts
  - Neoadjuvant chemotherapy 78 pts
  - Neoadjuvant radiotherapy 36 pts

**MIE**

- ICU stay 1 day (1 – 30)
- Time to oral intake 4 days (1 – 40)
- Hospital stay 7 days (3 – 75)
- Median follow-up 9 months

**MIE**

- MIE completed in 206 (92.8%) pts
- Conversion to open
  - Thoracotomy 12 pts
  - Laparotomy 4 pts

<table>
<thead>
<tr>
<th>Complication</th>
<th>N (%)</th>
<th>Complication</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>3 (1.4)</td>
<td>Chylothorax</td>
<td>7 (3.2)</td>
</tr>
<tr>
<td>Leak</td>
<td>26 (11.7)</td>
<td>Gastric necrosis</td>
<td>7 (3.2)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>17 (7.7)</td>
<td>Delayed gastric</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>empying</td>
<td></td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>14 (6.3)</td>
<td>Tracheal injury</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>Recurrent nerve</td>
<td>8 (3.6)</td>
<td>ARDS</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>palsy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Two patients completed thus far
- Mean age 59 years
- Mean operative time 10 hours
- Mean blood loss <100 cc
- Mean LOS 7 days
- No anastomotic leak
Summary

- Debate continues as to optimal approach
  - Transhiatal
    - Pros: Avoid thoracotomy
      - Technically easier operation
    - Cons: Increase rate of anastomotic leak
      - Recurrent laryngeal nerve injury
        (aspiration)
      - Limited thoracic lymphadenectomy

- Transthoracic (Ivor Lewis)
  - Pros: Lower rate of leaks, More extensive lymphadenectomy, decreased stricture rate, no risk to recurrent laryngeal nerve
  - Cons: Increased pain (thoracotomy)

- Intrathoracic leak not associated with increased mortality

Summary

- Three field esophagectomy and ‘en-bloc’ esophagectomy increase morbidity without improving survival

- MIE
  - ? Decrease in peri-operative complications
  - Not proven to be superior to open approach
  - Long term outcomes similar to open approach

Esophagectomy

<table>
<thead>
<tr>
<th>Techniques</th>
<th>Transhiatal</th>
<th>Ivor Lewis</th>
<th>Three field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Shorter operation</td>
<td>↓ Neck morbidity</td>
<td>↓ Chest Leak</td>
</tr>
<tr>
<td></td>
<td>↓ Pulm Comp</td>
<td>↓ Lower leak rate</td>
<td>Increased lymph node yield</td>
</tr>
<tr>
<td></td>
<td>↓ Pain</td>
<td></td>
<td>? Increased complete resection</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>↓ Node dissection</td>
<td>Increased pulmonary comp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>↓ Double the leak rate</td>
<td>Improved pain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recurrent nerve injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Injury to thoracic structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neck morbidity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

- Overall survival still poor in patients with esophageal cancer
- Surgery remains mainstay of treatment
- In order for surgery to have an impact on survival peri-operative mortality and morbidity must be low

Jejunal Interposition

- 79 year old male with esophageal cancer in the setting of end stage achalasia
- History of multiple dilations and Botox injections
- History of subtotal gastrectomy
- New onset dysphagia and dyspnea

Summary

- There is no ideal approach to esophagectomy
- Outcomes are best when performed in high volume centers

CT Chest
Jejunal Interposition for Esophageal Replacement

• Advantages
  – Readily available
  – Limited physiologic impact
  – Sterile conduit
  – Generally free of intrinsic disease
  – Approximates diameter of esophagus
  – Maintains intrinsic peristalsis

Technique

Jejunal Interposition for Esophageal Replacement

• Disadvantages
  – Anatomic limitations of mesenteric arcades
• Limited to short segment interpositions
• Longer segment risks ischemia
<table>
<thead>
<tr>
<th>Technique</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
</tr>
<tr>
<td><strong>Ischemic</strong></td>
<td><strong>Proximal arcade vessels</strong></td>
</tr>
<tr>
<td><strong>Perfused</strong></td>
<td><strong>Divided mesentery</strong></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image 3" /></td>
<td><img src="image4.png" alt="Image 4" /></td>
</tr>
<tr>
<td><strong>Technique</strong></td>
<td><strong>Technique</strong></td>
</tr>
</tbody>
</table>

- **Ischemic**
- **Perfused**
- **Proximal arcade vessels**
- **Divided mesentery**
Technique

**Divided Redundant esophagus**

Technique

**Proximal anastomosis**

Bowel divided, mesentery intact

Technique

**Divided esophagus**

Redundant ischemic jejunum

Technique

Ischemic

Microvascular augmentation
### “Supercharging”

- Microvascular augmentation
- Internal thoracic or cervical vessels

### Technique

- Perfused monitor flap
- Perfused interposition
- Monitor flap