Abdominal Wall Closure
David Radvinsky, PGY-4
Richmond University Medical Center
March 26, 2015
First, a Case!

- 61 year old male
  - 5 day history of diffuse abdominal pain
  - Worsened the morning of presentation
  - Nausea and nonbiliary/nonbloody vomiting
  - Denies fevers
  - No obstructive symptoms
  - Similar to prior episodes
Presentation

- **PMHx:** none
- **PSHx:** 4 prior instances of small bowel perforation s/p ex-lap (2003, 2007, 2009, 2012)
  - Ventral hernia repair with mesh during 2007 operation
- **SH:** *smokes 1 ppd x 43 yrs*
- **Allergies:** NKDA
- **Meds:** omeprazole

- Prior workup included CT scans, upper and lower endoscopy, and capsule endoscopy.

- **Working Diagnosis:** *Small bowel vasculitis secondary to smoking*
Exam

- Afebrile, HR 90’s, BP 120’s/70’s, SpO2 >95%
- Moderate distress
- Abdomen distended, peritoneal
- Previous midline laparotomy scar noted with reducible ventral hernias

\[
\begin{align*}
17 & \quad 16.4 & \quad 382 & \quad 1.1 \\
50.9 & & & 12.1 & 24.0 \\
3.3 & 92 & 11 & 98 & 1.1 \\
26 & 0.6 & & &
\end{align*}
\]
OR – after resuscitation of course

- Exploratory Laparotomy
- Extensive lysis of adhesions
- Primary repair of jejunal perforation
  2 layers
- Pathology: none
Abdominal Wall Closure

- Alternating interrupted figure of eight and simple #1 prolene sutures
- Fascia supported with #2 nylon retention sutures
POD#1

- Sedation weaned
- Evisceration of small bowel

To OR:
- Re-exploration
- Abdominal washout
- Strattice Mesh
- Sutures broke / pulled through fascia
Post-Op Course

- Extubated POD#2
- Wound VAC
- Complicated by post-op ileus, AKI
  - Metabolic alkalosis
  - Short term TPN
- POD#11 - Return of bowel function
- POD# 14 - Restarted diet
  - Downgraded to the floor
- Nutrition – Prealbumin 5.9 -> 29
- PT and Wound Care
- POD#21 Discharged
Questions?
Laparotomy Closure

- **Anatomy**

- **Primary closure**
  - Basics of elective closure
  - Dehiscence
  - Retention sutures

- **Relaparotomy**
  - Temporary abdominal closure
  - Planned ventral hernia
  - Abdominal wall reconstruction
Anatomy

ABOVE ACUTE LINE

7 10 11
8 9 6 5

BELOW ACUTE LINE

8 9 7 5
Abdominal Wall Closure

- What is the optimal technique for primary abdominal wall closure to prevent incisional hernia, dehiscence, and evisceration?

- Incisional hernia incidence – 9-20%
- Dehiscence – 0.5-3.5%
Case:

- 50 yo male with hx of recurrent diverticulitis.
- Exploratory laparotomy, sigmoidectomy with primary anastomosis.
- About to close abdomen....
What do you do?

- Mass closure vs. layered?
- Type of suture?
  - Absorbable vs. non-absorbable?
  - Monofilament vs. Braided?
- Running vs. Interrupted closure?
- Close the peritoneal layer?
- Size of the bites?
- Suture to wound length ratio?

European Hernia Society guidelines on the closure of abdominal wall incisions
Mass closure vs. Layered technique

- Layered technique
  - Anterior and Posterior aponeurotic sheaths separately
- Mass closure technique
  - Single-layer closure of all musculofascial layers
  - +/- peritoneum
  - No skin
- No advantage of layered technique over mass closure

Statement: For closure of midline abdominal wall incisions in elective surgery, a single layer aponeurotic closure is suggested. (weak)
Continuous vs. Interrupted

- Distribution of tension across the suture
- Adjust to strains of wound post-op
- Faster
- Single thread holding fascia together
### 6.1 Elective procedures: Continuous versus interrupted

<table>
<thead>
<tr>
<th>Study name</th>
<th>Cumulative statistics</th>
<th>Cumulative odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Point Lower limit Upper limit p-value</td>
<td>Continuous Interrupted</td>
</tr>
<tr>
<td>Trimbos 1992</td>
<td>0.72 0.22 2.32 0.586</td>
<td>5 / 168 7 / 172</td>
</tr>
<tr>
<td>Brolin 1996</td>
<td>0.52 0.27 1.00 0.050</td>
<td>16 / 288 27 / 281</td>
</tr>
<tr>
<td>Colombo 1997</td>
<td>0.58 0.39 0.87 0.008</td>
<td>43 / 596 68 / 587</td>
</tr>
<tr>
<td>Seiler 2009</td>
<td>0.59 0.43 0.82 0.001</td>
<td>80 / 950 96 / 763</td>
</tr>
<tr>
<td></td>
<td>0.59 0.43 0.82 0.001</td>
<td></td>
</tr>
</tbody>
</table>

**Statement**

Continuous suturing for closure of midline abdominal wall incisions in elective surgery is recommended.
Elective vs. Emergency

### Table A: Elective procedures

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Continuous Events</th>
<th>Total Events</th>
<th>Interrupted Events</th>
<th>Total Weight</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimbos 1992</td>
<td>5</td>
<td>168</td>
<td>7</td>
<td>172</td>
<td>0.72 [0.22, 2.32]</td>
</tr>
<tr>
<td>Brolin 1996</td>
<td>11</td>
<td>120</td>
<td>20</td>
<td>109</td>
<td>0.45 [0.20, 0.99]</td>
</tr>
<tr>
<td>Colombo 1997</td>
<td>27</td>
<td>308</td>
<td>41</td>
<td>306</td>
<td>0.62 [0.37, 1.04]</td>
</tr>
<tr>
<td>Seiler 2009</td>
<td>37</td>
<td>354</td>
<td>28</td>
<td>176</td>
<td>0.62 [0.36, 1.05]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td></td>
<td>950</td>
<td>763</td>
<td>100.0%</td>
<td>0.59 [0.43, 0.82]</td>
</tr>
<tr>
<td>Total events</td>
<td>80</td>
<td></td>
<td>96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2 = 0.00; \chi^2 = 0.64, df = 3 (P = 0.89); I^2 = 0$

Test for overall effect: $Z = 3.18 (P = 0.001)$

### Table B: Elective and emergency procedures

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Continuous Events</th>
<th>Total Events</th>
<th>Interrupted Events</th>
<th>Total Weight</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richards 1983</td>
<td>4</td>
<td>244</td>
<td>1</td>
<td>229</td>
<td>3.80 [0.42, 34.25]</td>
</tr>
<tr>
<td>Wissing 1987</td>
<td>128</td>
<td>870</td>
<td>48</td>
<td>286</td>
<td>0.86 [0.60, 1.23]</td>
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<tr>
<td>Lewis 1989</td>
<td>2</td>
<td>93</td>
<td>1</td>
<td>103</td>
<td>2.24 [0.20, 25.14]</td>
</tr>
<tr>
<td>Sahlin 1993</td>
<td>20</td>
<td>148</td>
<td>11</td>
<td>155</td>
<td>2.05 [0.94, 4.43]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td></td>
<td>1355</td>
<td>773</td>
<td>100.0%</td>
<td>1.40 [0.70, 2.81]</td>
</tr>
<tr>
<td>Total events</td>
<td>154</td>
<td></td>
<td>61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2 = 0.22; \chi^2 = 5.79, df = 3 (P = 0.12); I^2 = 48$

Test for overall effect: $Z = 0.95 (P = 0.34)$
Absorbable vs. Non-absorbable

- Decreased rates of scar pain and suture sinus/fistula
- Intrinsic loss of tensile strength
- Increased rates of hernia

- Synthetic absorbable suture with delayed degradation
Slowly absorbable vs. Non-absorbable

- Incisional hernia and dehiscence rates equivalent
- Lower rates of suture sinus formation and scar pain

**Statement**
Using slowly-absorbable suture material instead of non-absorbable sutures for continuous closure of midline abdominal wall incisions in elective surgery is suggested.

Strength: weak
### Slowly vs. Rapidly absorbable

#### 6.2 Elective procedures: Slowly-absorbable versus rapidly-absorbable

<table>
<thead>
<tr>
<th>Study name</th>
<th>Cumulative statistics</th>
<th>Cumulative odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Point</td>
<td>Lower limit</td>
</tr>
<tr>
<td>Trimbos 1992</td>
<td>0.72</td>
<td>0.22</td>
</tr>
<tr>
<td>Bresler 1995</td>
<td>0.84</td>
<td>0.40</td>
</tr>
<tr>
<td>Colombo 1997</td>
<td>0.69</td>
<td>0.45</td>
</tr>
<tr>
<td>Hsiao 2000</td>
<td>0.66</td>
<td>0.44</td>
</tr>
<tr>
<td>Seiler 2009</td>
<td>0.65</td>
<td>0.47</td>
</tr>
</tbody>
</table>

**Statement**

The use of rapidly absorbable suture material for closure of midline abdominal wall incisions in elective surgery is **NOT** recommended.

[Rating: 💩🪤🪤🪤🪤] **Strong**
Monofilament vs. Braided

- Lower rates of wound infection
- Lower rates of incisional hernia and dehiscence

Statement: We suggest using monofilament suture material for continuous closure of midline abdominal wall incisions in elective surgery.  

-4 weak
<table>
<thead>
<tr>
<th>Producer</th>
<th>Material</th>
<th>Absorbable</th>
<th>Absorption time</th>
<th>Mono/multifilament</th>
<th>Antibiotics impregnated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolene</td>
<td>Ethicon Polypropylene</td>
<td>Non</td>
<td></td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Surgipro</td>
<td>Covidien Polypropylene</td>
<td>Non</td>
<td></td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Ethilon</td>
<td>Ethicon Nylon</td>
<td>Non</td>
<td></td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Monosof</td>
<td>Covidien Nylon</td>
<td>Non</td>
<td></td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Ethibond</td>
<td>Ethicon Polyethylene</td>
<td>Non</td>
<td></td>
<td>Multifilament</td>
<td>No</td>
</tr>
<tr>
<td>Mersilene</td>
<td>Ethicon Polyester</td>
<td>Non</td>
<td></td>
<td>Multifilament</td>
<td>No</td>
</tr>
<tr>
<td>Surgilon</td>
<td>Covidien Nylon</td>
<td>Non</td>
<td></td>
<td>Multifilament</td>
<td>No</td>
</tr>
<tr>
<td>Maxon</td>
<td>Covidien Polyglyconate</td>
<td>Slowly</td>
<td>180 days</td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>PDS</td>
<td>Ethicon Polydioxanone</td>
<td>Slowly</td>
<td>183–238 days</td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>PDS plus</td>
<td>Ethicon Polydioxanone + triclosan</td>
<td>Slowly</td>
<td>183–238 days</td>
<td>Monofilament</td>
<td>Yes</td>
</tr>
<tr>
<td>Monoplus</td>
<td>B Braun Polydioxanone</td>
<td>Slowly</td>
<td>180–201 days</td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Monomax</td>
<td>B Braun Poly-4-hydroxybutyrate</td>
<td>Slowly</td>
<td>390–1080 days</td>
<td>Monofilament</td>
<td>No</td>
</tr>
<tr>
<td>Vicryl</td>
<td>Ethicon Polyglactin</td>
<td>Rapidly</td>
<td>56–70 days</td>
<td>Multifilament</td>
<td>No</td>
</tr>
<tr>
<td>Vicryl plus</td>
<td>Ethicon Polyglactin + triclosan</td>
<td>Rapidly</td>
<td>56–70 days</td>
<td>Multifilament</td>
<td>Yes</td>
</tr>
<tr>
<td>Polysorb</td>
<td>Covidien Polyglycolic acid</td>
<td>Rapidly</td>
<td>60–90 days</td>
<td>Multifilament</td>
<td>No</td>
</tr>
<tr>
<td>Dexon</td>
<td>Covidien Polyglycolic acid</td>
<td>Rapidly</td>
<td>60–90 days</td>
<td>Multifilament</td>
<td>No</td>
</tr>
</tbody>
</table>
Closure of the Peritoneum


Does the peritoneum need to be closed at laparotomy?

HAROLD ELLIS AND ROBERT HEDDLE*

- Closure vs. non-closure of peritoneum
- Dehiscence 2.5% vs. 3%
- Hernia – 4.3% vs. 4.3%

* Statement: Closure of the peritoneum as a separate layer during closure of laparotomy incisions is NOT recommended. (weak)
Suture length to wound length

- Reduction of incidence of incisional hernia
- Ratio > 4:1

<table>
<thead>
<tr>
<th>Statement</th>
<th>A suture to wound length ratio (SL/WL) of at least 4/1 for continuous closure of midline abdominal wall incisions in elective surgery is suggested.</th>
</tr>
</thead>
</table>
Small vs. Large bites

Effect of Stitch Length on Wound Complications After Closure of Midline Incisions

A Randomized Controlled Trial

Daniel Millbourn, MD; Yucel Cengiz, MD, PhD; Leif A. Israelsson, MD, PhD

- 5-8 mm bites every 5 mm
- 10 mm bites every 10 mm

Table 2. Wound Complications Related to Stitch Length

<table>
<thead>
<tr>
<th>Complication</th>
<th>Long</th>
<th>Short</th>
<th>( P ) Value(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound dehiscence, No. (%) of patients</td>
<td>1/381 (0.3)</td>
<td>0/356</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Surgical site infection, No. (%)</td>
<td>35/343 (10.2)</td>
<td>17/326 (5.2)</td>
<td>.02</td>
</tr>
<tr>
<td>Incisional hernia, No. (%)</td>
<td>49/272 (18.0)</td>
<td>14/250 (5.6)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

\(^a\) Fisher exact test.
Primary elective closure

- Running technique
- Slowly absorbable, monofilament suture
- Small bites, 5-8 mm every 5 mm
- Mass closure
- Suture length: wound length
  - 4:1 or greater
Technique


Continuous double loop closure: a new technique for repair of laparotomy wounds.

Niggebrugge AH, Trimbos JB, Hermans J, Knippenberg B, van de Velde CJ.

- Start at the apices
- Looped suture
- Not too tight
Dehiscence

• Approximate wound edges
• Don’t strangulate!
• Ischemic tissue becomes necrotic
• Avoid tension
• Retention sutures
Retention sutures?

- Fascial evisceration - 15-20% mortality
- High-risk patients
- No difference:
  - Wound infection
  - Incisional hernia
- Decreased incidence of dehiscence and evisceration

Prophylactic retention sutures in midline laparotomy in high-risk patients for wound dehiscence: A randomized controlled trial

Zhamak Khorgami, MD, a,b,* Saeed Shoar, MD, a Bardia Laghaie, MD, a Ali Aminian, MD, c Negin Hosseini Araghi, MD, a and Ahmadreza Soroush, MD a,b

a Department of Surgery, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran
b Research Center for Improvement of Surgical Outcomes and Procedures, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran
c Department of Surgery, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran
High risk for dehiscence

- Poor nutritional status
- Intra-abdominal infection
- Malignancy
- Corticosteroids > 3 mo.
- COPD
- Jaundice
- DM
- Uremia
- Age > 60
Technique

- Large non-absorbable
- Placed every 2-5 cm along the incision
- 3-5 cm bites
- Exclude peritoneum
- Bridge
Now What?

- Back to the OR for relaparotomy

- Etiology?
  - Dehiscence or Evisceration
    - Technical vs. patient-related
  - Secondary peritonitis
  - Trauma
  - Hemorrhage
Relaparotomy Closure

• Tension free repair
• Primary Facial closure?
• Open abdomen
  ◦ Mortality rates of >30%
  ◦ Temporary abdominal closure
  ◦ Closure within 8 days
    • 12% vs. 52%
    • Fistula formation
    • Abscess formation
    • Wound infection
Temporary abdominal closure

- Protection of bowel
- Minimization of fascial injury
- Protection against abdominal compartment syndrome
- Minimization of loss of domain
Temporary abdominal closure

- **VAC closure**
  - Tension on fascial edges
  - Collects excessive abdominal fluid
  - Resolves edema

- **Whittmann patch**
  - Velcro sheets
  - Stepwise re-approximation of fascia

- **Bogota bag**
  - Sutured to fascial edges
  - Reduced in size to reapproximate fascial edges

- **Skin approximation**
  - Towel clips
  - Running suture
Planned Ventral Hernia

- Open abdomen for > 8 days
- Abdominal visceral coverage
  - Skin Graft
  - Acute component separation
  - Bridge closure
    - Biologic
    - Absorbable
Abdominal Wall Reconstruction

- Delayed 6-12 months for nutritional optimization
- Component separation
- Complex abdominal wall closure
  - Free tensor fasciae latae (TFL) flap utilizing a saphenous vein arteriovenous loop
References