Open abdomen in trauma

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Frequency and causes of open abdomen

- in 23% (344/1531) after trauma laparotomies
  - damage control 66%, ACS 33%

<table>
<thead>
<tr>
<th></th>
<th>Trauma</th>
<th>Vascular</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage control</td>
<td>40%</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>Planned re-explor.</td>
<td>23%</td>
<td>32%</td>
<td>65%</td>
</tr>
<tr>
<td>Inability to close</td>
<td>19%</td>
<td>46%</td>
<td>13%</td>
</tr>
<tr>
<td>IAP increase</td>
<td>16%</td>
<td>14%</td>
<td>7%</td>
</tr>
<tr>
<td>Multifactorial</td>
<td>3%</td>
<td>0</td>
<td>8%</td>
</tr>
</tbody>
</table>

Miller 2005

Barker 2007
### Outcome in open abdomen

<table>
<thead>
<tr>
<th></th>
<th>Trauma</th>
<th>GI</th>
<th>Pancreatitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>25</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>Fascial closure</td>
<td>52%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Operations/patient</td>
<td>3.7</td>
<td>4.8</td>
<td>6.1</td>
</tr>
<tr>
<td>Mortality</td>
<td>20%</td>
<td>36%</td>
<td>43%</td>
</tr>
<tr>
<td>EC fistula</td>
<td>12%</td>
<td>16%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Tsuei et al. 2004
Outcome after open abdomen in trauma

- n = 344, 68 (20%) died before wound closure
- complications after wound closure (69/276 = 25%)
  - wound infection 16%, abscess 11%, fistula 12%
  - 34 (12%) died after wound closure
    - 7 (3%) from wound complication
  
  Miller 2005

- n = 116, 10 (9%) died before wound closure
- 106 survived to wound closure (DFC 63%, SSG 37%)
  - abscess 5, fistula 4, evisceration 1, ACS 1, ileus 1

Barker 2007
Amended classification of open abdomen

1A Clean, no fixation
1B Contaminated, no fixation
1C Enteric leak, no fixation
2A Clean, developing fixation
2B Contaminated, developing fixation
2C Enteric leak, developing fixation
3A Frozen abdomen, clean
3B Frozen abdomen, contaminated
4 Established enteroathmospheric fistula

Temporary closure of the open abdomen - what is the best method?
In the early days...
Evolution of temporary abdominal closure techniques

- first generation: abdominal coverage
  - running skin suture, towel clip
  - synthetic cover (plastic, mesh etc.)

- second generation: fluid control
  - vacuum pack

- third generation: negative pressure therapy
  - V.A.C.™
  - ABThera™

De Waele and Leppäniemi 2011
Bolsa de Borraez (Bogota bag)
Wittmann patch
Home-made negative pressure dressing
Vacuum assisted closure
## Systematic review (3169 patients)

<table>
<thead>
<tr>
<th>Method</th>
<th>Mort.</th>
<th>DFC</th>
<th>Fist.</th>
<th>Absc. [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAC</td>
<td>15</td>
<td>60</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Vacuum pack</td>
<td>27</td>
<td>52</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Wittmann patch</td>
<td>17</td>
<td>90</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mesh or sheet</td>
<td>26</td>
<td>23</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Dynamic retention sutur.</td>
<td>23</td>
<td>85</td>
<td>nr</td>
<td>nr</td>
</tr>
<tr>
<td>Bogota bag (silo)</td>
<td>41</td>
<td>29</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Loose packing</td>
<td>39</td>
<td>11</td>
<td>28</td>
<td>nr</td>
</tr>
<tr>
<td>Skin only</td>
<td>39</td>
<td>43</td>
<td>nr</td>
<td>nr</td>
</tr>
<tr>
<td>Zipper mesh/sheet</td>
<td>33</td>
<td>39</td>
<td>14</td>
<td>6</td>
</tr>
</tbody>
</table>

van Hensbroek et al. WJS 2009;33:199
Comparative studies I

- pre-patch (n=56) before 2004 (Bogota bag, vac pack, VAC, mesh) vs. patch (n=103) (Wittmann) 2004 onwards
  - early fascial closure 59% vs. 65% (p=ns)

- remaining:

<table>
<thead>
<tr>
<th></th>
<th>pre-patch</th>
<th>Patch</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed fascial closure</td>
<td>30%</td>
<td>78%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Planned hernia</td>
<td>29%</td>
<td>8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Abdominal morbidity</td>
<td>9%</td>
<td>11%</td>
<td>ns</td>
</tr>
</tbody>
</table>

Weinberg et al. 2008
Comparative studies II

- prospective randomized study, polyglactin mesh vs. VACx3+mesh (90% trauma, n=51-3 early deaths)

<table>
<thead>
<tr>
<th></th>
<th>VAC</th>
<th>Mesh</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed fascial closure</td>
<td>31%</td>
<td>26%</td>
<td>ns</td>
</tr>
<tr>
<td>Abscess</td>
<td>44%</td>
<td>47%</td>
<td>ns</td>
</tr>
<tr>
<td>Fistula</td>
<td>21%*</td>
<td>5%**</td>
<td>ns</td>
</tr>
</tbody>
</table>

*all VAC fistulas related to feeding tubes and suture lines
  - avoid feeding jejunostomy, prefer nasojejunal tube

**mesh fistula followed colon leak remote from the mesh

Bee et al. 2008
2nd vs. 3rd generation

- Prospective randomized study, Barker’s vacuum pack vs. AbThera
- n = 45 (22+23), 52% abdominal sepsis (rest: trauma)
- Primary endpoint: difference in plasma concentration of IL-6 24 and 48 hours after temporary abdominal closure
- No difference in primary endpoint or other inflammatory markers
- No difference in fascial closure rates at 90 days
- Higher mortality at 90 days with Barker’s vacuum pack (78% vs. 50%, p=0.04)

Kirkpatrick et al. 2015
4th generation: mesh-mediated vacuum-assisted gradual closure
Delayed primary fascial closure

Proportion of patients with closed fascia (%)

Days from laparostomy

Group 1

Group 2

log rank p=0.007
What is the best TAC method?

- systematic review of different temporary abdominal closure methods in peritonitis
- more than 70 studies, >4000 patients
- about 10 different techniques included

→ better results with negative pressure wound therapy with continuous fascial traction
- fascial closure rate >70% (highest)
- fistula rate <6% (lowest)

Atema et al. WJS2015;39:912
One year later…

111 patients undergoing mesh-mediated vac-closure 2006-2009 surviving patients underwent clinical and CT evaluation at 1 year
among 64 survivors who had delayed primary closure 23 (36%) had a clinically detectable hernia another 19 (30%) had a hernia only detected with CT the median hernia widths were 7.3 cm and 4.8 cm, respectively

Conclusion: Incisional hernia rate is high but most of them are small and asymptomatic

Bjarnason et al. World J Surg 2013
Delayed primary fascial closure

- Ability to close fascia depends on underlying etiology of the open abdomen and physiology
- Early fascial closure is better than delayed fascial closure
- Delayed fascial closure vs. planned hernia
- How late is late closure?
- When to accept the hernia?
Complications after damage control open abdomen for trauma: effect of fascial closure

Miller et al. 2005
Intestinal anastomosis leak rate increases when fascial closure is delayed

Cothren Burlew et al. 2011
Mesh-mediated vacuum-assisted closure technique or the “Vacuum-assisted wound closure and mesh-mediated fascial traction” (VAWCM)

1st step: leaving the abdomen open and using the VAWCM

1. Insert the inner plastic layer covering the viscera as far laterally as possible
2. Sew a polypropylene mesh to the fascial edges with continuous suture
3. Cover the mesh and the wound with the sponge
4. Cover the sponge with air-tight plastic sheet
5. Apply negative pressure
WARNING: Don’t put the mesh directly over the bowel
At 1st reoperation

1. Remove the plastic cover and sponge
2. Divide the mesh vertically in the midline (leave 1-2 cm at the ends intact)
3. Remove the plastic covering the viscera
4. Mobilize the abdominal cocoon from lateral adhesions (bacterial sample)
5. Insert new plastic sheet over the viscera
6. Tighten and close the mesh in the midline with continuous suture
7. Apply sponge, plastic cover and negative pressure as before
Repeat and tighten with new negative pressure dressing every 2-3 days
Aim: Delayed fascial and skin closure
Sometimes you need little help...
Component separation to help closure

augmenting delayed fascial closure with minimally invasive component separation (CS) (n = 16)
during TAC treatment in 7 patients

DFC achieved in 3/7

at the fascial closure in 9 patients

DFC achieved in 9/9, no dehiscence

CS at the time of delayed fascial closure results in high closure rate

When to accept the hernia

- re-explorations are no longer needed
- conditions favoring planned hernia strategy
  - inability to reapproximate the retracted abdominal wall edges
- sizeable tissue loss
- risk of tertiary ACS, if primary closure attempted
- inadequate infection source control
- anterior enteric fistula
- poor nutritional status

Leppäniemi 2008
“Skin only” closure
Planned hernia with early skin-grafting
Summary

- aim for early fascial closure after open abdomen
  - trauma patients have higher closure rates than patients with peritonitis or pancreatitis
- early fascial closure (within 8 days) reduces complications (avoid fistulas!)
- late fascial closure (>8 days) is possible up to 2-3 weeks and is safe as planned hernia strategy
- when unable to close, think planned hernia at 3 weeks
Thank you !