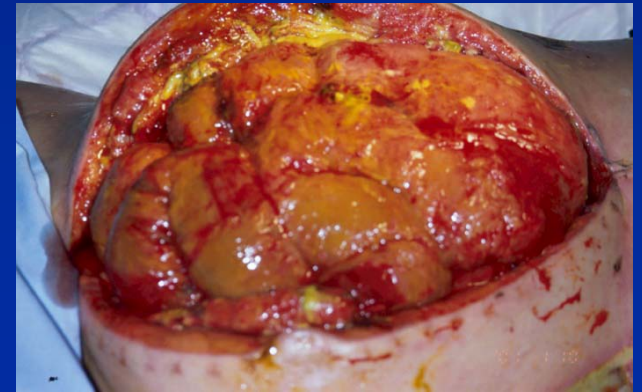


# The open abdomen in trauma: What you need to know

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# Frequency and causes of open abdomen

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

Miller 2005

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

Barker 2007

## Outcome in open abdomen

	Trauma	GI	Pancreatitis
No. of patients	25	25	21
Fascial closure	52%	17%	14%
Operations/patient	3.7	4.8	6.1
Mortality	20%	36%	43%
EC fistula	12%	16%	24%

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

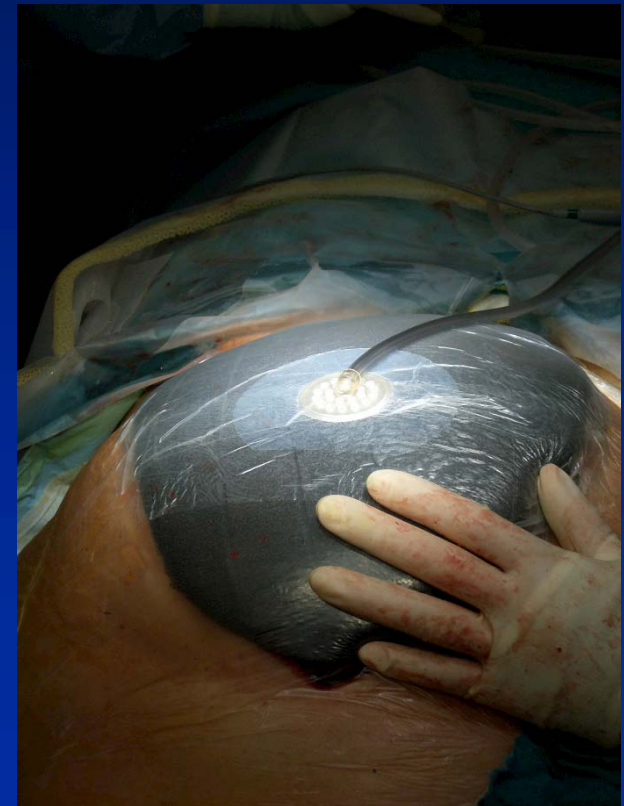
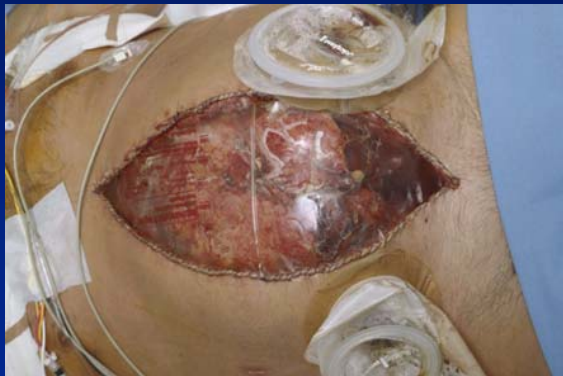
- **n = 116**, 10 (9%) **died** before wound closure
- 106 survived to wound closure (DFC 63%, SSG 37%)
  - **abscess 5, fistula 4, evisceration 1, ACS 1, ileus 1**

Barker 2007

## **Amended classification of open abdomen**

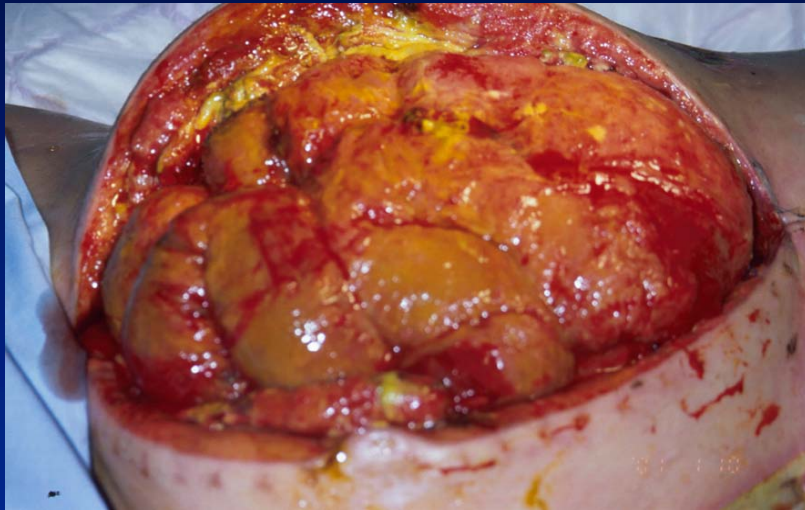
- 1A Clean, no fixation**
- 1B Contaminated, no fixation**
- 1C Enteric leak, no fixation**
- 2A Clean, developing fixation**
- 2B Contaminated, developing fixation**
- 2C Enteric leak, developing fixation**
- 3A Frozen abdomen, clean**
- 3B Frozen abdomen, contaminated**
- 4 Established enteroatmospheric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

# Temporary closure of the open abdomen - what is the best method ?



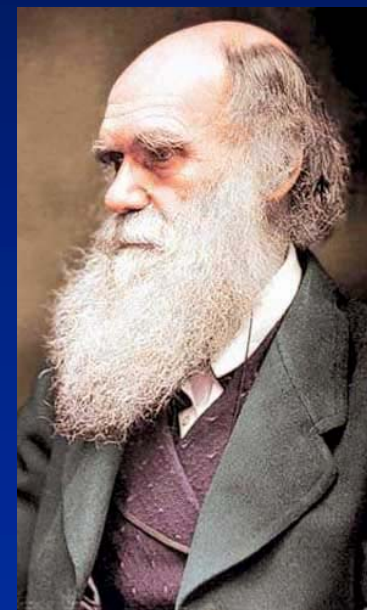


**In the early days...**



# 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 (Barker)
- third generation: **negative pressure therapy**
  - V.A.C.<sup>™</sup>
  - ABThera<sup>™</sup>

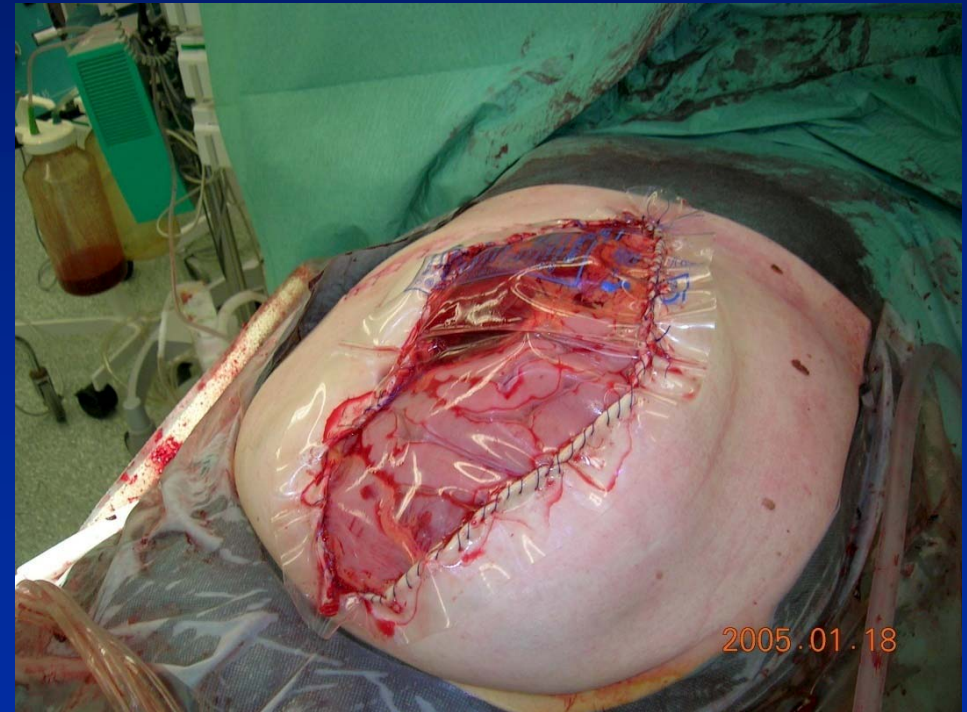


De Waele and Leppäniemi 2011





# Bolsa de Borraez (Bogota bag)

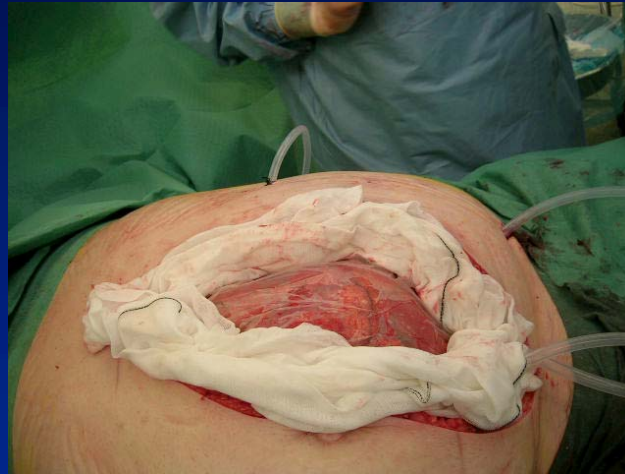
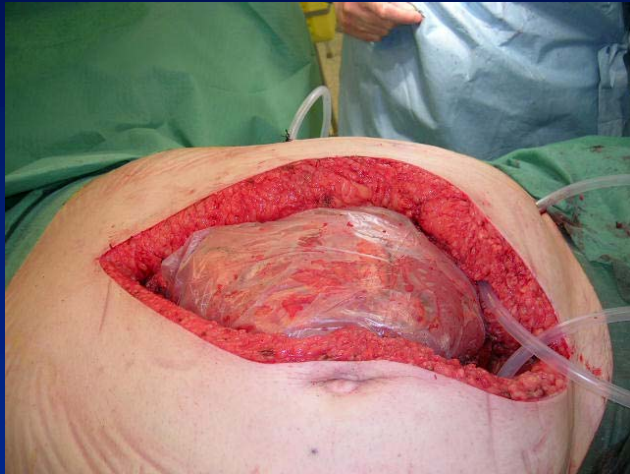


# Wittmann patch

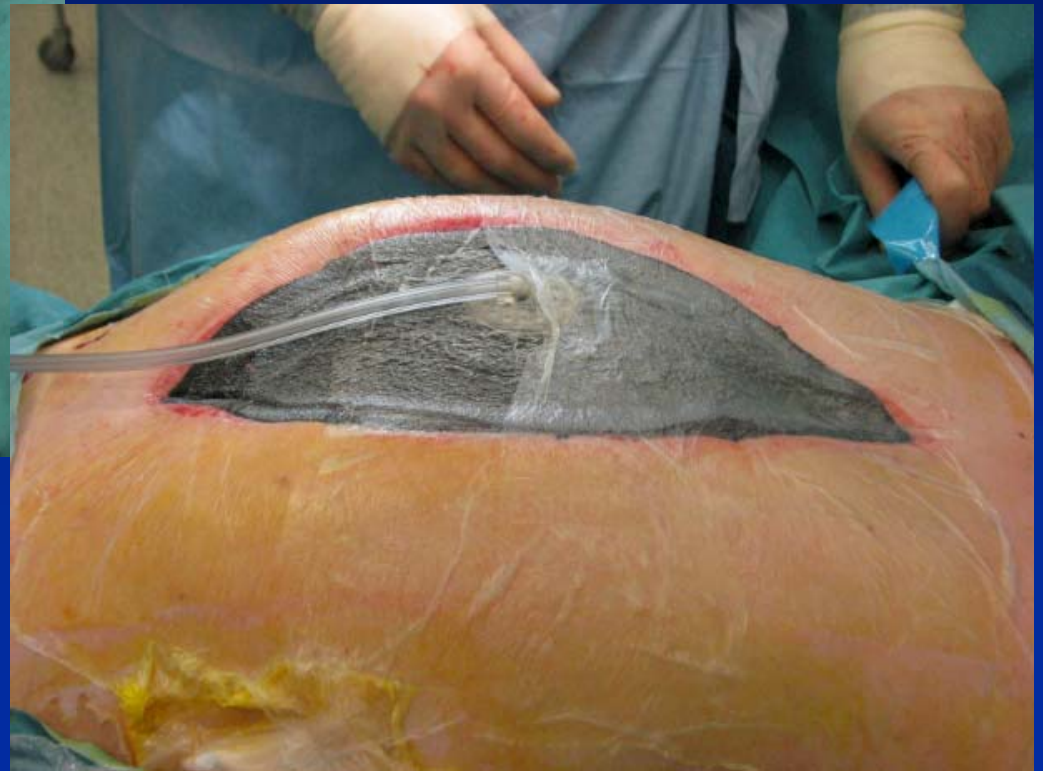




# Home-made negative pressure dressing



# Vacuum assisted closure



## Systematic review (3169 patients)

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

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:

	pre-patch	Patch	p
Delayed fascial closure	30%	78%	<0.001
Planned hernia	29%	8%	<0.001
Abdominal morbidity	9%	11%	ns

Weinberg et al. 2008

## Comparative studies II

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

	VAC	Mesh	p
Delayed fascial closure	31%	26%	ns
Abscess	44%	47%	ns
Fistula	21%*	5%**	ns

\*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

## 2<sup>nd</sup> vs. 3<sup>rd</sup> generation

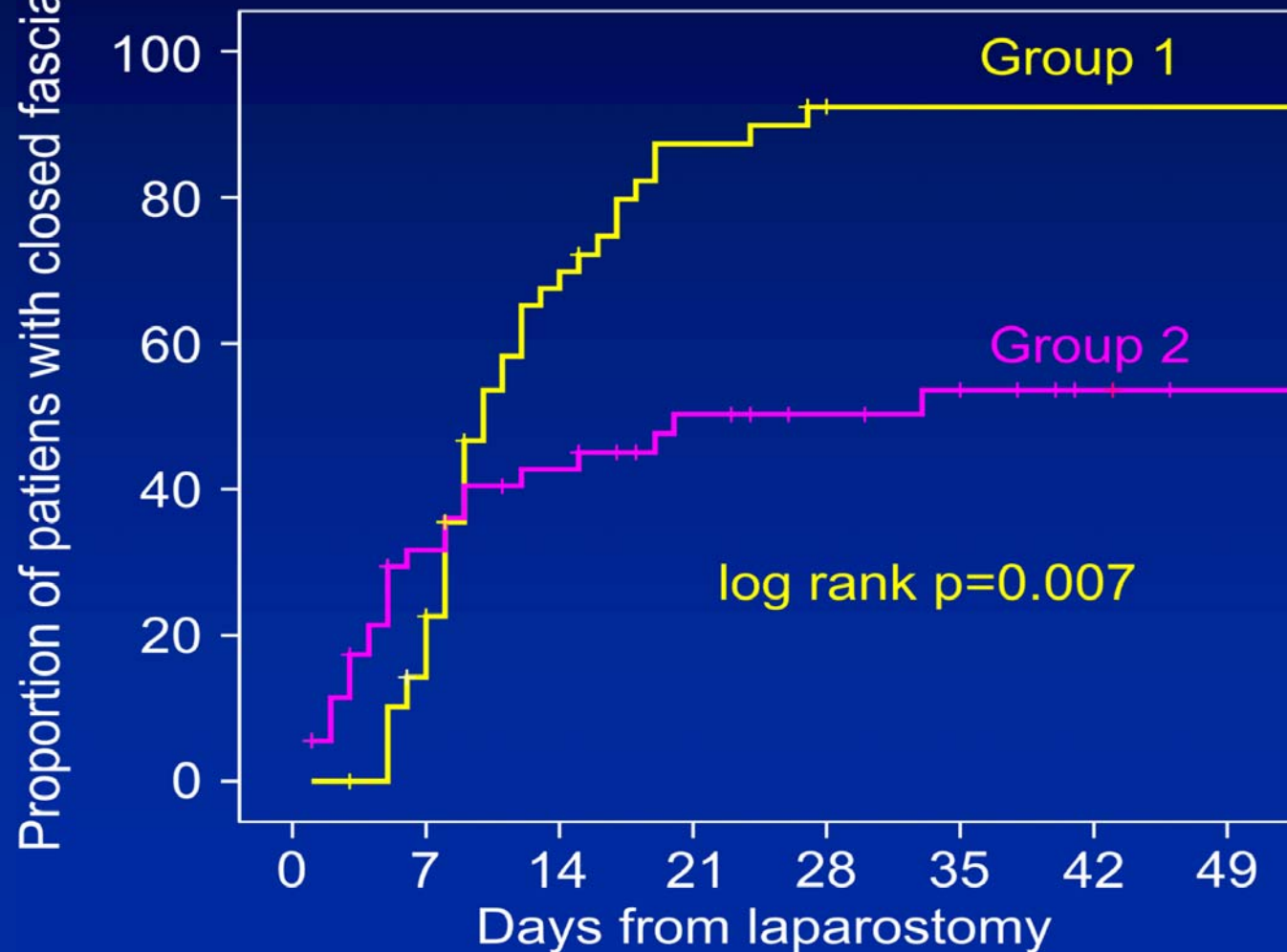
- prospective randomized study, Barker's vacuum pack vs. AbThera
- n = 45 (22+23), 52% abdominal sepsis (rest: trauma)
- primary endpoint: difference in plasma concentration of IL-6 24 and 48 hours after temporary abdominal closure
- no difference in primary endpoint or other inflammatory markers
- **no 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

## **4<sup>th</sup> generation: mesh-mediated vacuum-assisted gradual closure**



# Delayed primary fascial closure





# 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**

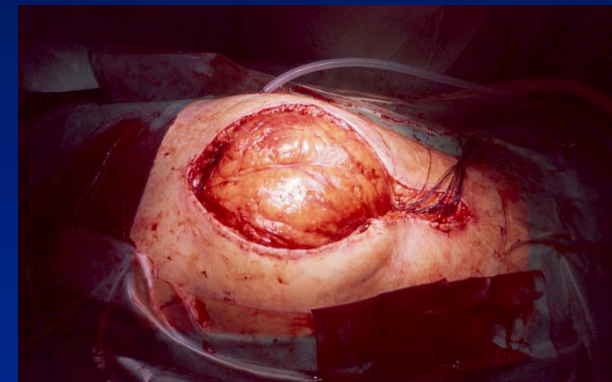
**the median hernia widths were 7.3 cm and 4.8 cm,  
respectively**

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

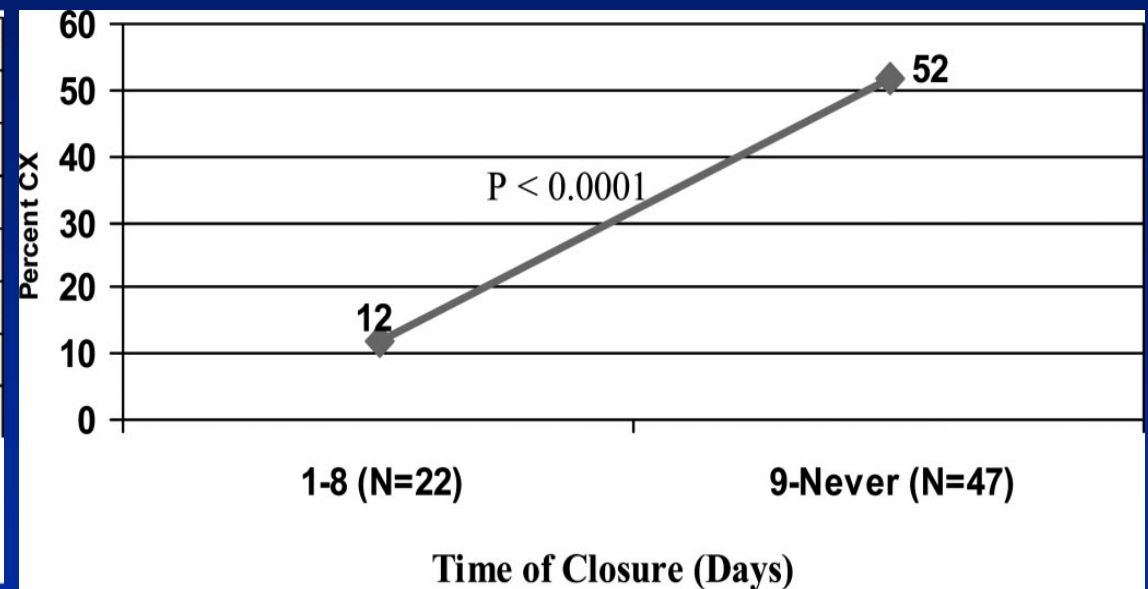
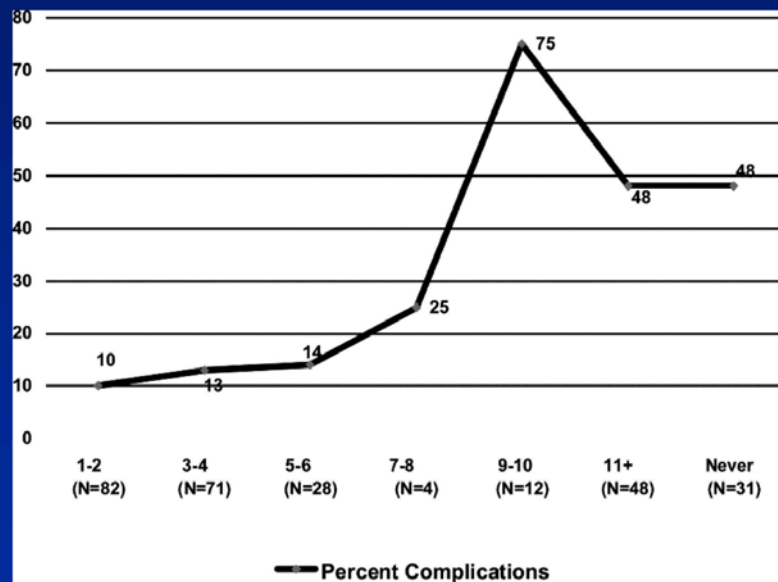
**Bjarnason et al. World J Surg 2013**

# 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?

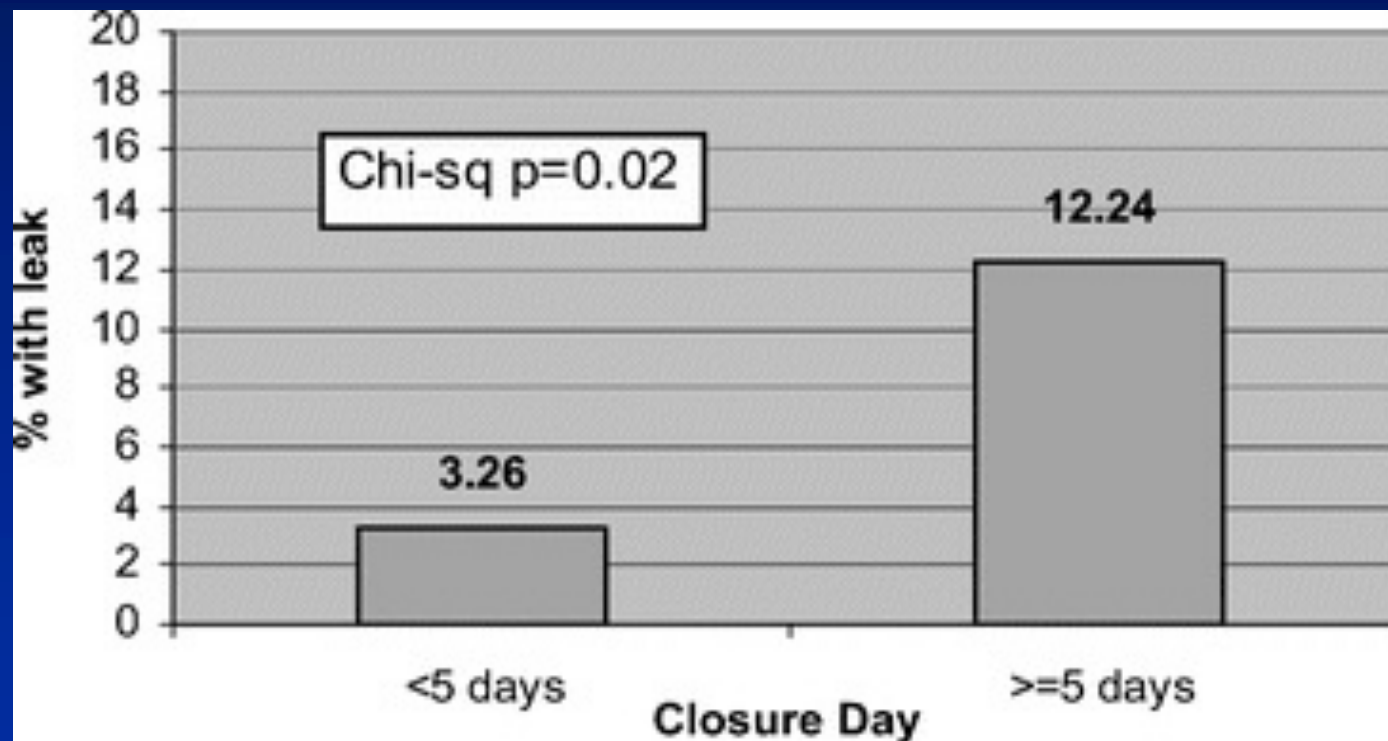


# Complications after damage control open abdomen for trauma: effect of fascial closure



Miller et al. 2005

## Intestinal anastomosis leak rate increases when fascial closure is delayed



Cothren Burlew et al. 2011

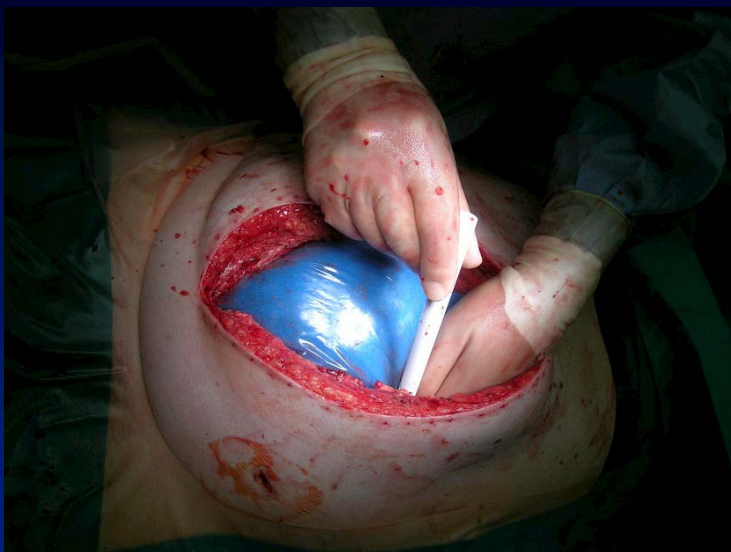


**Mesh-mediated vacuum-  
assisted closure technique  
or  
the “Vacuum-assisted wound  
closure and mesh-mediated  
fascial traction” (VAWCM)**

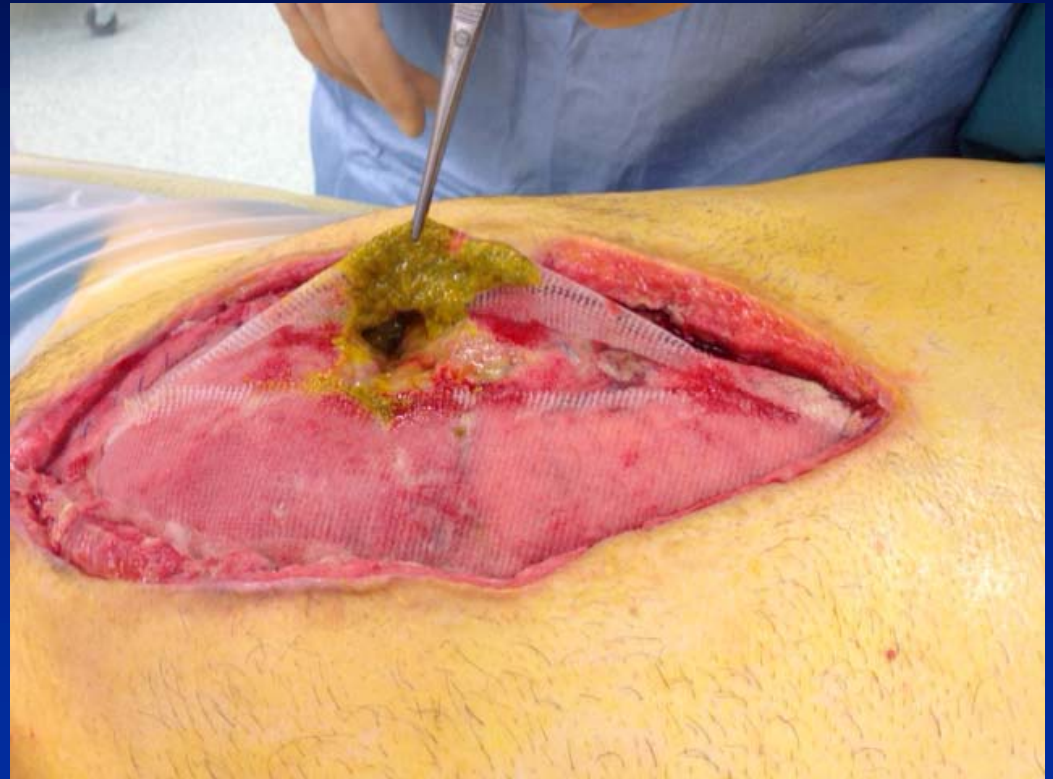
Petersson U, Acosta S, Björck M. Vacuum-assisted wound closure and mesh-mediated fascial traction – a novel technique for late closure of the open abdomen. World J Surg 2007;31:2133-2137.

## **1<sup>st</sup> 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**



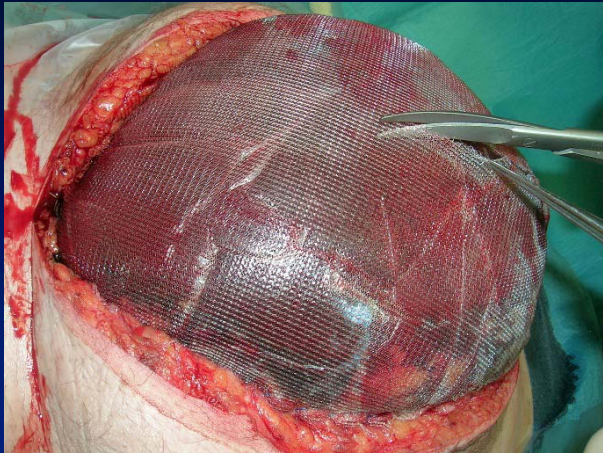
**WARNING:**  
Don't put the  
mesh directly  
over the  
bowel



## **At 1<sup>st</sup> 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**

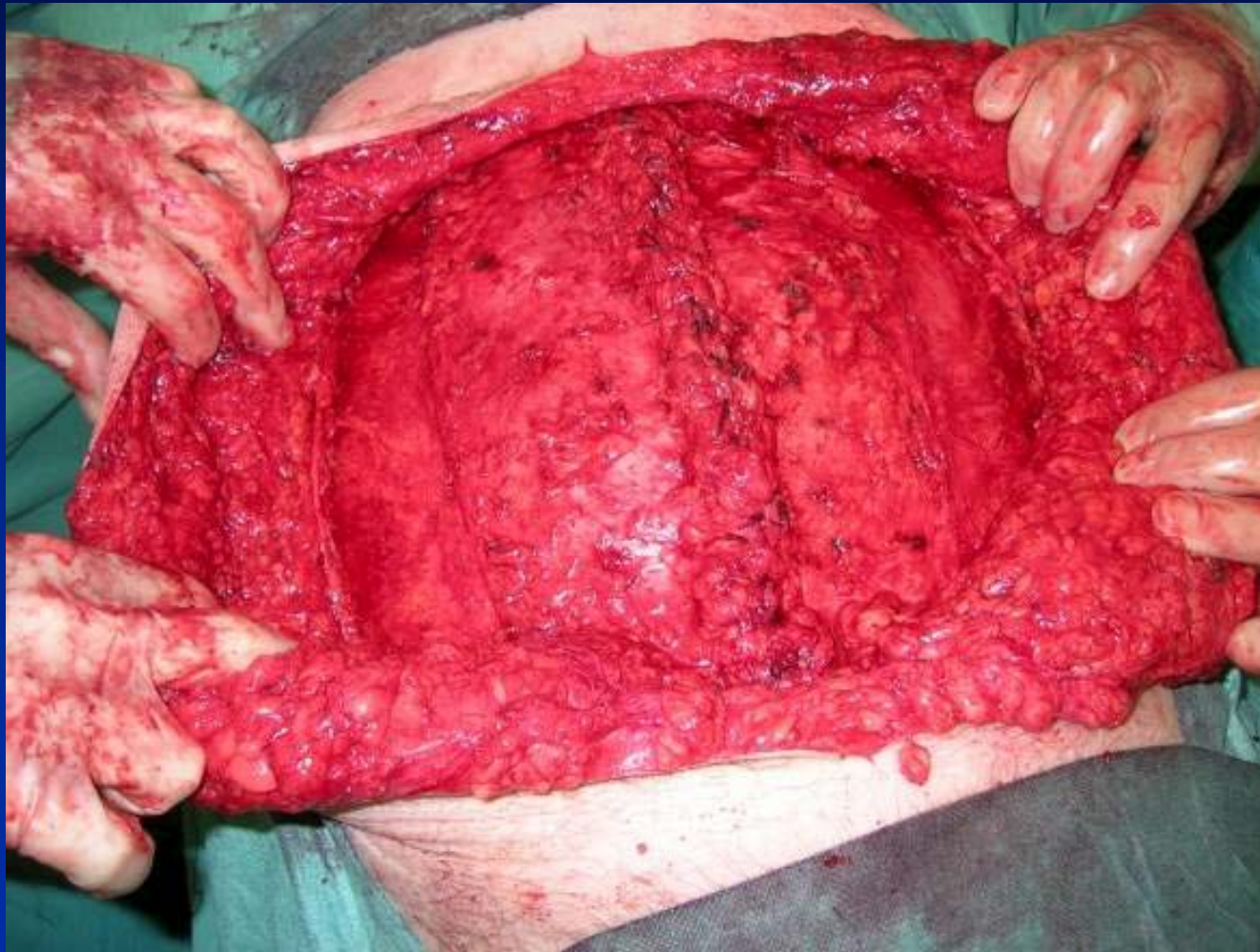




## **Aim: Delayed fascial and skin closure**



**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

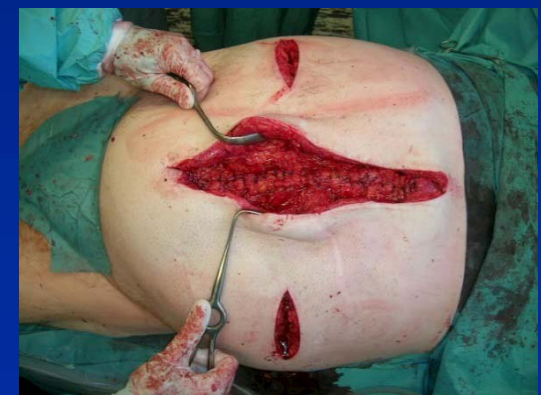
DFC achieved in 3/7

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

Rasilainen et al. Scand J Surg 2015



# **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 !**

