

Abdominal Damage Control

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Objectives

- Definition of Damage Control
- Indications for and technique of abdominal damage control
- Complications associated with abdominal damage control and their management
- Outcomes with use of Damage Control for abdominal trauma



Priorities in Treatment

- Damage control / Abbreviated laparotomy
 1. Obtain hemorrhage control
 2. Obtain contamination control
 3. Obtain temporary coverage

NOT Bail-out surgery



Practical application of Damage Control



Wrapping and plugging of damaged propeller shaft



Damage Control Sequence

DC0 "Ground zero" - Recognition

- Rapid transport (EMS)
- Decision ----> OR
- Resuscitation (TB)
 - O2, Blood, Prevent heat loss
 - Massive transfusion protocol

Minutes

DC I – OR (warmed)

- Control hemorrhage
- Control contamination
- Intraabdominal packing
- TAC

< 2 hrs

DC II - ICU

- Rewarming
- Correct coagulopathy
- Maximize hemodynamics
- Ventilatory support
- Re-exam

~24-36 hrs

DC III - OR

- Pack removal
- Definitive repairs
- Closure ?

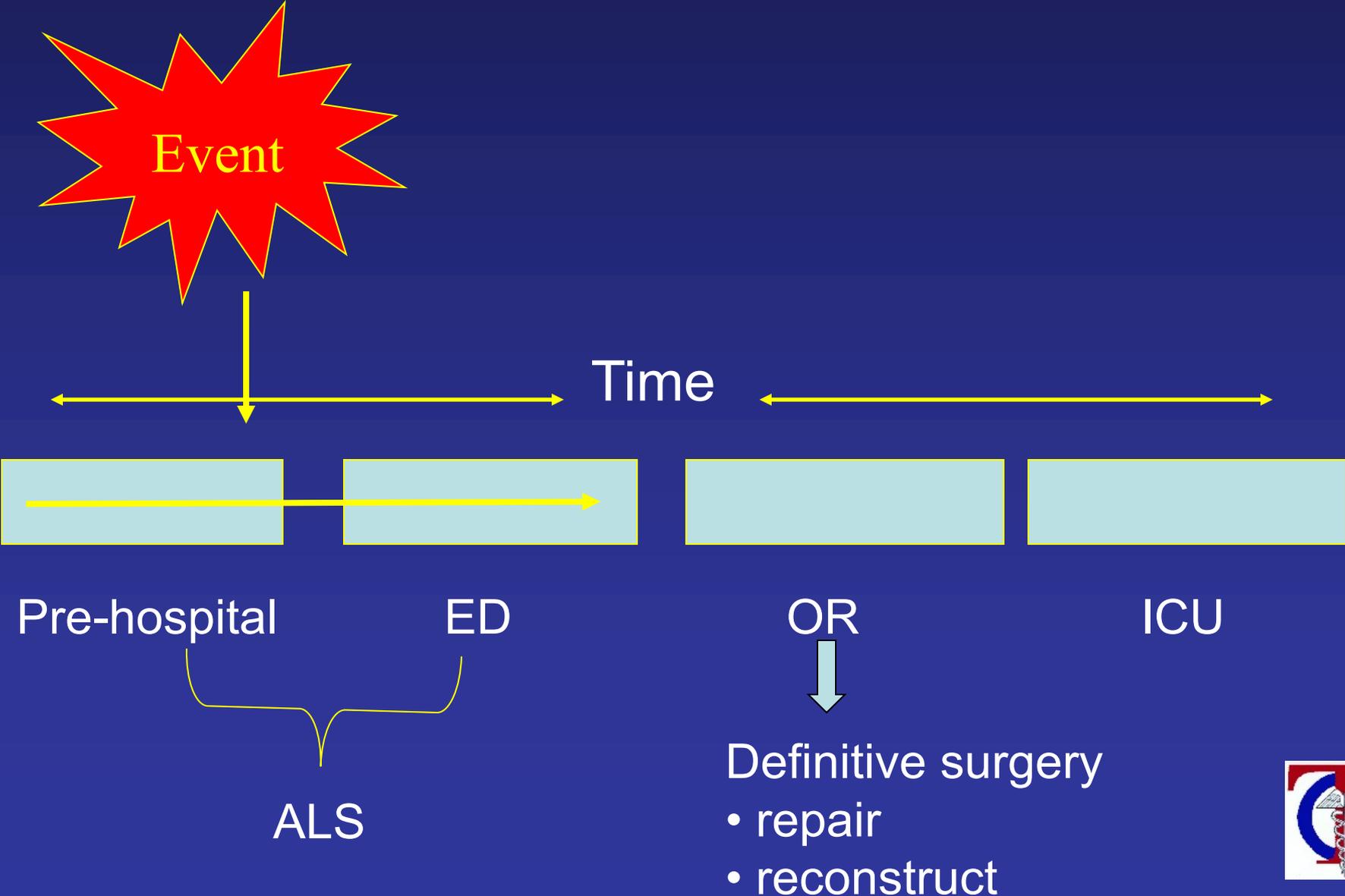
DC IV - OR

- Definitive Closure

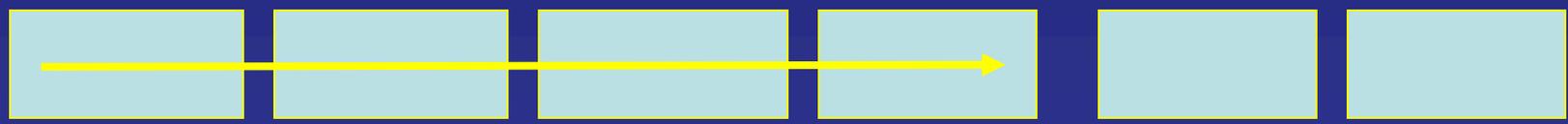
48hrs - 1yr



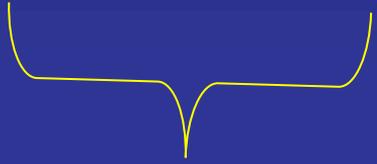
Conventional



Damage Control

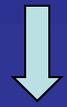


Prehospital ED OR ICU OR ICU



ALS

Control bleeding
• bleeding
• contamination
Pack



Planned reoperation
• reconstruction
• repair



Lethal Triad

- Acidosis
- Hypothermia (<35 C)
- Coagulopathy



Damage Control

Who?

- Shock
- Massive transfusion (> 10 Units PRBC)
- Clinical coagulopathy
- Hypothermia (< 95 F or 35 C)
- Multiple life threatening injury
- Inaccessible major injury (retro-hepatic IVC, pelvis) and demand for non-operative control
- Need for time consuming procedure(s)
- Indeterminate serious injury (pancreatic duct)
- Surgeon Judgment



“Getting Control”

Surgery (Damage control Part I)

The more injured the patient with more severe pathophysiology paradoxically requires less to be done at this initial stage.

MB Shapiro, J Trauma, November 2000



SOMATOM PLUS 4
VB40C
H-SP-CR

A

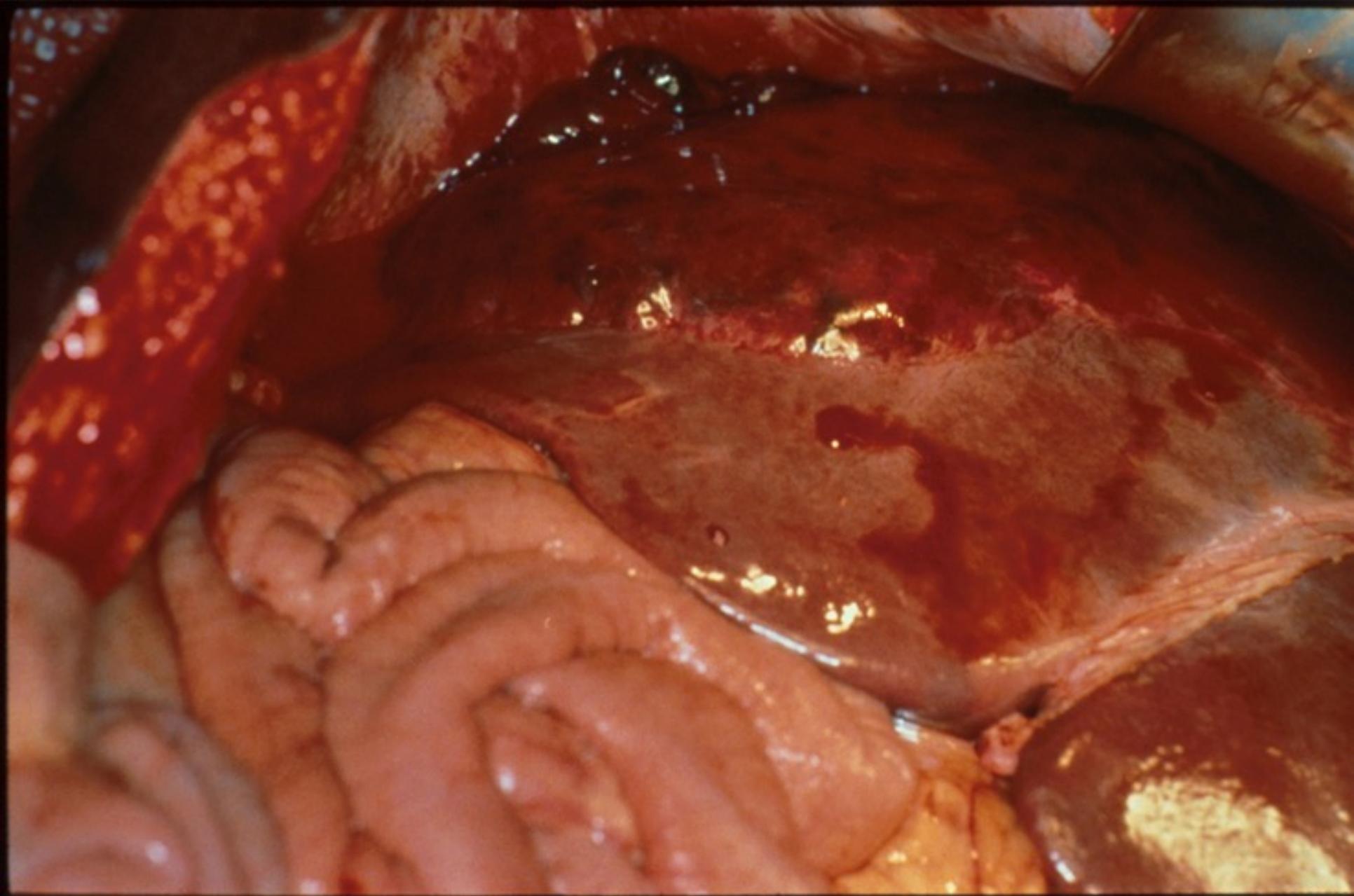
23:44:08.27
TP -423.5
IMA 78
SPI 35

R

kV 120
mA 240
TI 0.75
CT 0 0

10
C
M





Treatment

- Hemorrhage control
 - Pack, Press, Pringle, Plug
- Assess for intestinal injury – resect/close
- Assess for pancreatic injury – drain
- Assess for retroperitoneal injury – pack / plug



Perform angiographic control

- Liver
- Pelvis
- Retroperitoneum
- Deep muscle beds (gluteal, back thigh; no mesentery)
- Consider temporary balloon tamponade



GUT

- Suture
- Staple
- Tie off



Damage Control

- Initial operation: < 2 hours
 - Skin closure vs. open abdomen
 - Definitive control of hemorrhage
 - Control contamination
- Resuscitation in ICU: 24 – 36 hours
- Completion of surgical management of all injuries



Damage Control Part I

- Closure
 - Skin only: suture
 - Open abdomen: temporary abd closure
 - “vac-pack” most common

Leave the fascia alone...



TAC

- Towel clip closure
- Most rapid
- Low cost
- Maintains Abdominal domain
- ↓ heat/fluid loss
- loban over clips



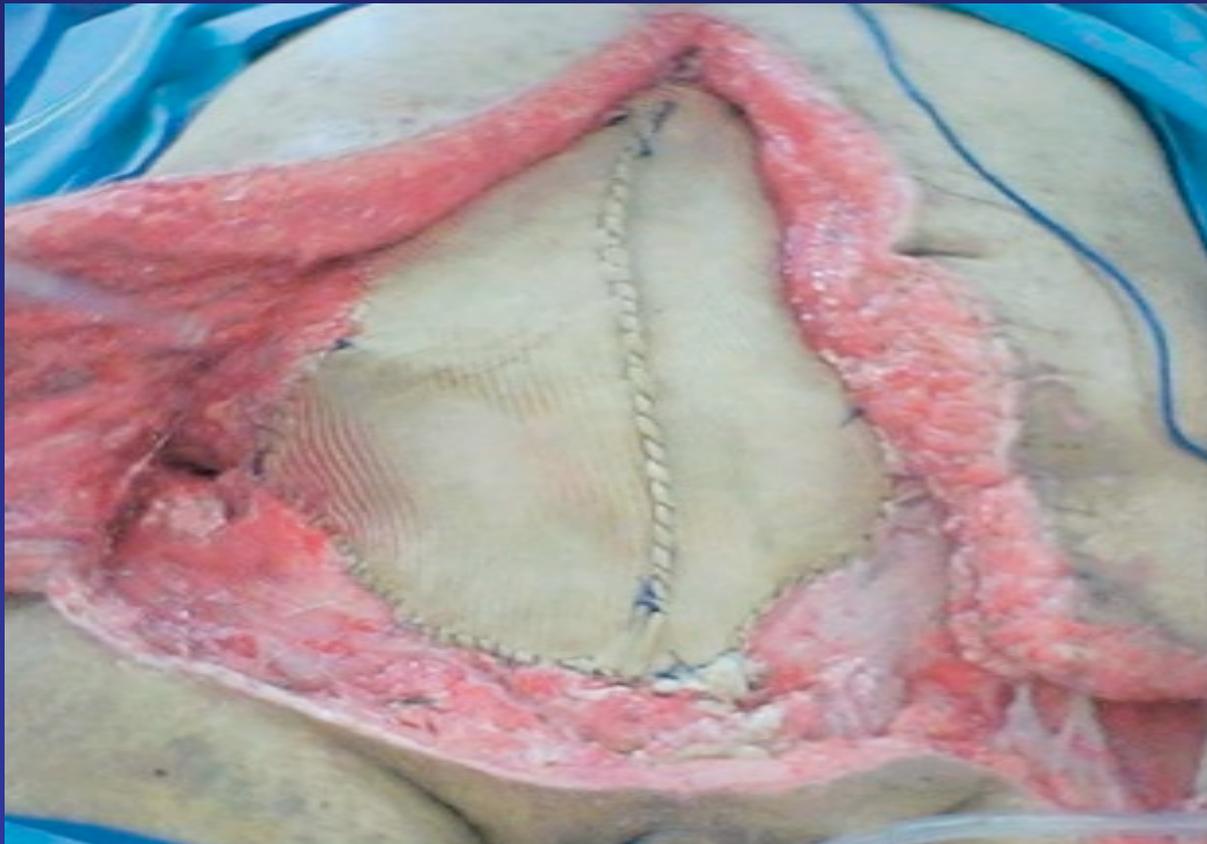
TAC

- Bogotá Bag
- Secure to skin
- Inexpensive
- Biologically inert
- Large capacitance
- Able to visualize bowel
- Easy to remove
- Partial control of fluid loss

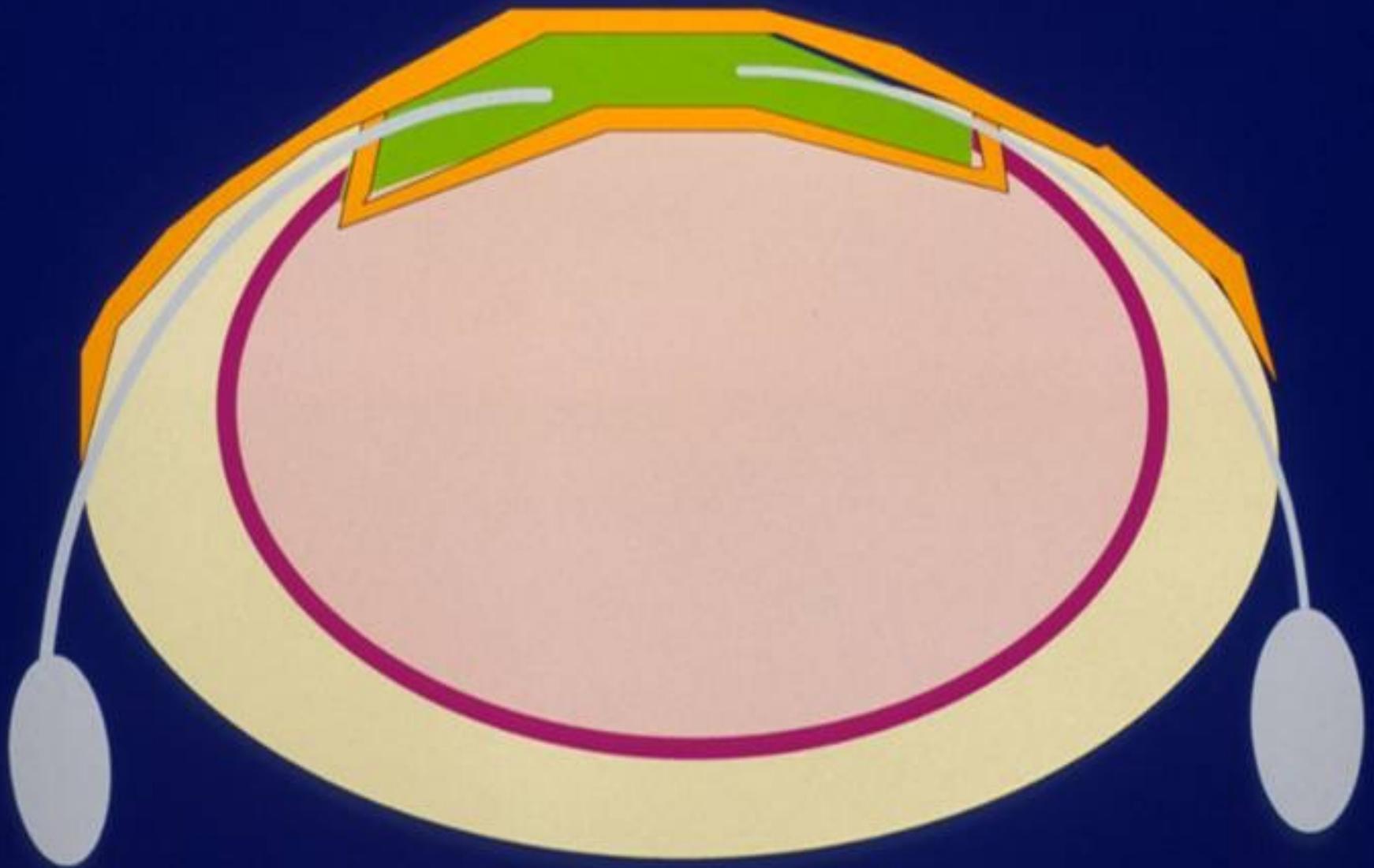


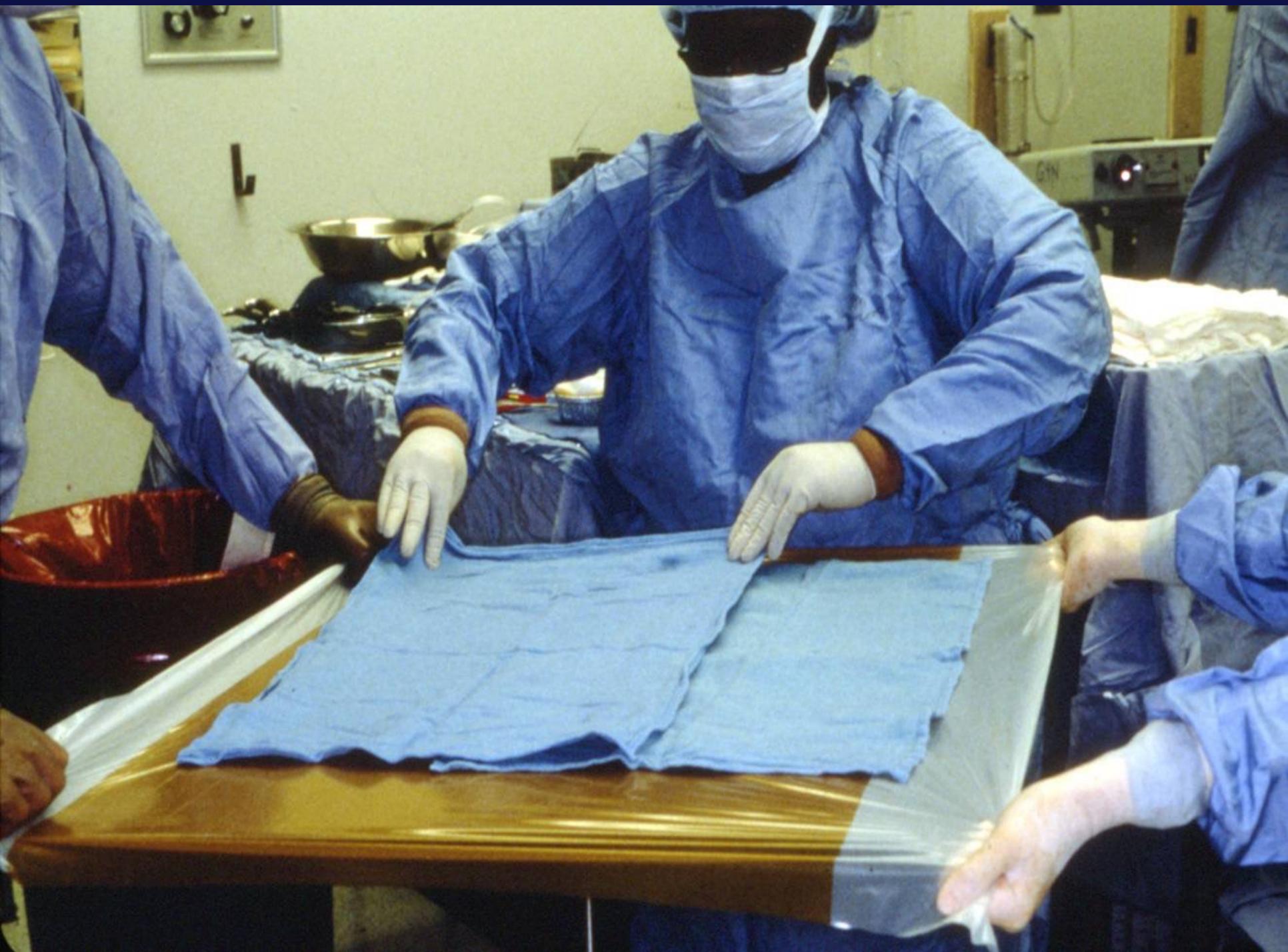
Early Definitive Abdominal Closure Using Serial Closure Technique on Injured Soldiers Returning from Afghanistan and Iraq *(JACS 2006)*

Amy Vertrees, MD, CPT, MC, USA, Dwight Kellicut, MD, MAJ, MC, USA, Shane Ottman, MD, MAJ, MC, USA,
George Peoples, MD, FACS, LTC(P), MC, USA, Craig Shriver, MD, FACS, COL, MC, USA



Layered Plastic Abdominal Dressing

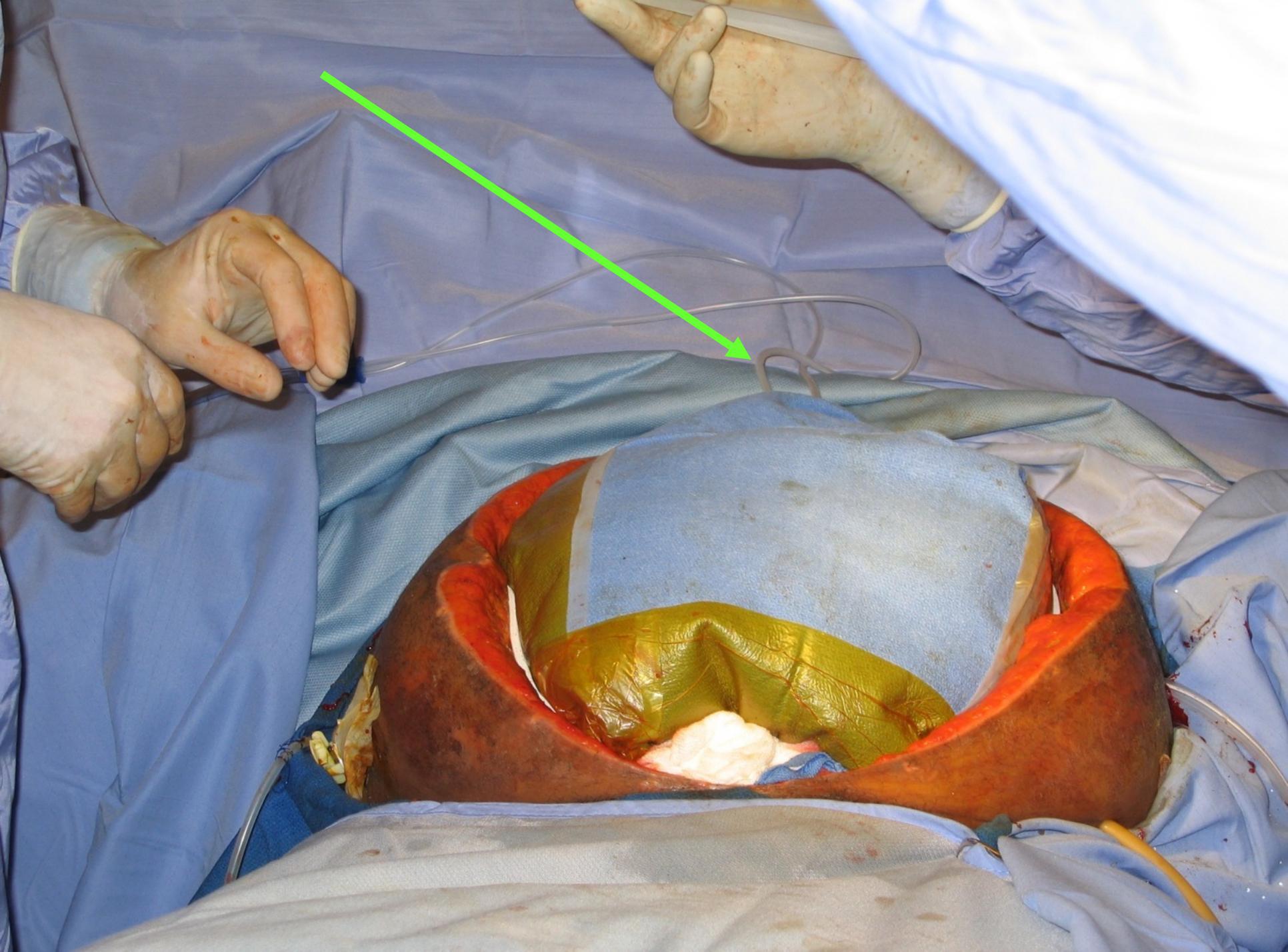


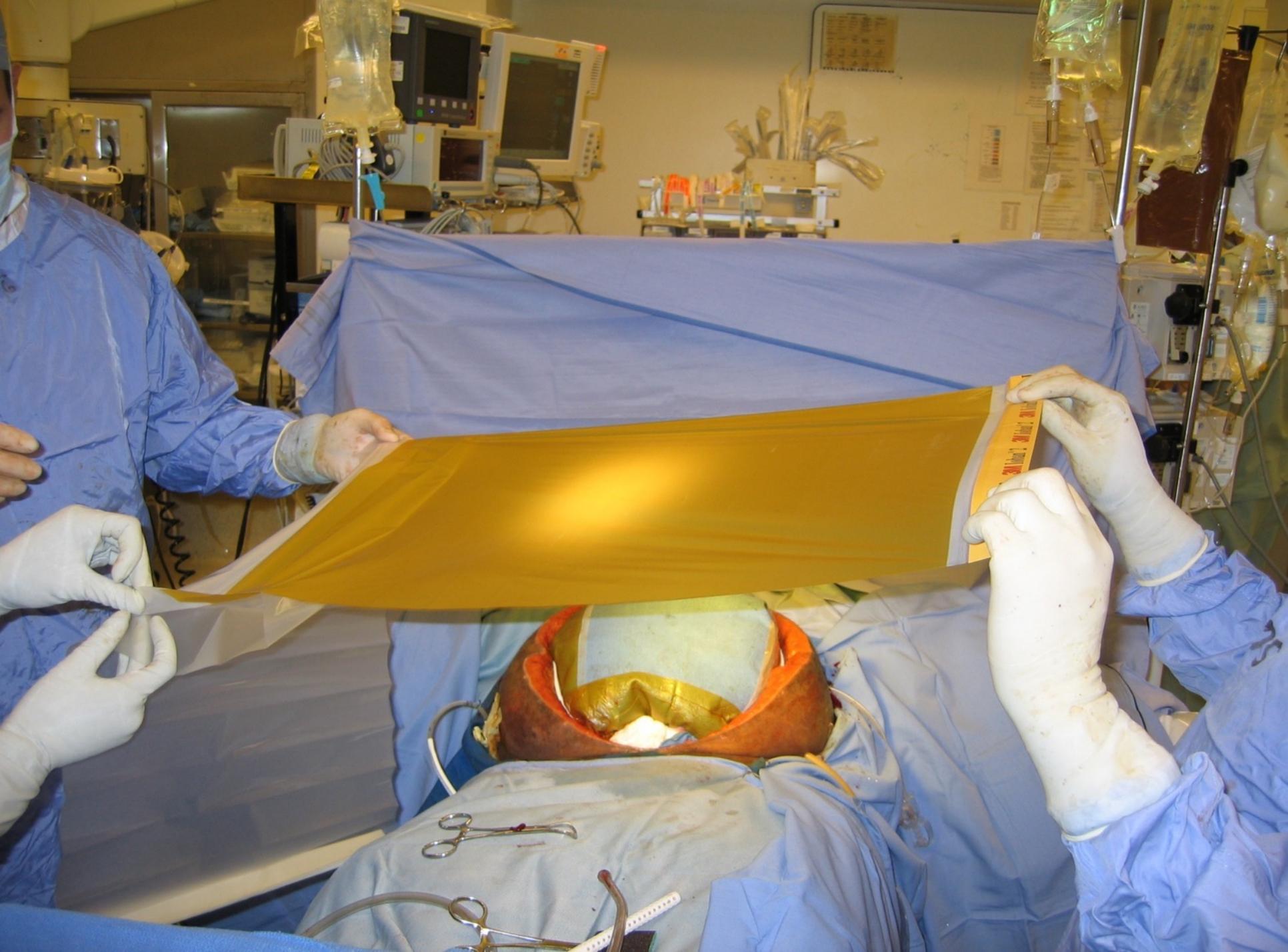










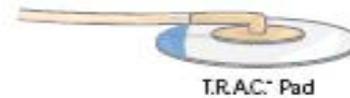




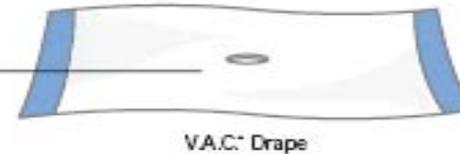
V.A.C.® ABDOMINAL DRESSING APPLICATION

Management of the Open Abdomen in Four Steps*

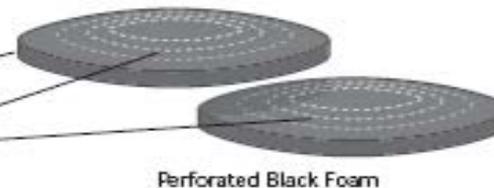
Step 4:
Apply the T.R.A.C. Pad® and initiate V.A.C.® Therapy.



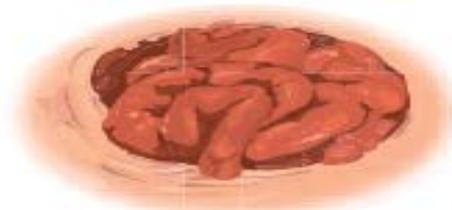
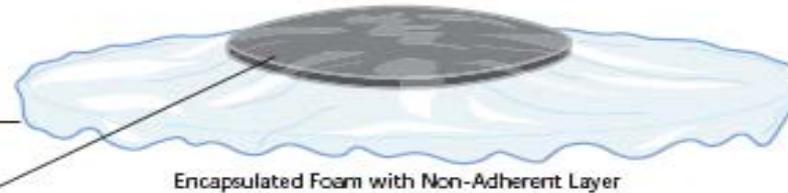
Step 3:
Apply semioclusive drape over the abdominal opening. Cut a two cm hole in drape. (Four pieces of drape included per dressing)



Step 2:
Secondary foam distributes negative pressure over the abdomen.
Perforations in the foam enable appropriate sizing of the foam to fit the wound size. One or two layers can be used as required.



Step 1:
Apply fenestrated non-adherent layer under the fascia and over the omentum or exposed internal organs.
The encapsulated foam helps minimize dressing shift within the abdomen and allows for easy dressing centering.



* Caution: Federal law restricts this device to use by or on order of a physician. Review all package inserts prior to applying V.A.C.® Abdominal Dressing.



ABThera™
Active Abdominal Therapy



ACS in the Open Abdomen

- Bulky abdominal packs
- Continued bleeding into the abdominal cavity
 - uncorrected coagulopathy
 - unrecognized mesenteric vascular injuries
- Bowel distension / Abdominal wall edema from extensive resuscitation (> 10 liters)
- High Mortality
- Decompress immediately

Gracias, Braslow, et al *Arch Surg* 2002





Damage Control

PART I - OR

- Control hemorrhage
- Control contamination
- Intraabdominal packing
- Temporary closure

PART III - OR

- Pack removal
- Definitive repairs

PART II - ICU

- Core rewarming
- Correct coagulopathy
- Maximize hemodynamics
- Ventilatory support



Damage Control

Part II - ICU

- Rewarm
- Support blood volume and coagulation
- Re-examination
- Abd Compartment Syndrome
- Recruit consultants
- Nutritional support



Damage Control Resuscitation: Directly Addressing the Early Coagulopathy of Trauma

John B. Holcomb, MD, FACS, Don Jenkins, MD, FACS, Peter Rhee, MD, FACS, Jay Johannigman, MD, FS, FACS, Peter Mahoney, FRCA, RAMC, Sumeru Mehta, MD, E. Darrin Cox, MD, FACS, Michael J. Gehrke, MD, Greg J. Beilman, MD, FACS, Martin Schreiber, MD, FACS, Stephen F. Flaherty, MD, FACS, Kurt W. Grathwohl, MD, Phillip C. Spinella, MD, Jeremy G. Perkins, MD, Alec C. Beekley, MD, FACS, Neil R. McMullin, MD, Myung S. Park, MD, FACS, Ernest A. Gonzalez, MD, FACS, Charles E. Wade, PhD, Michael A. Dubick, PhD, C. William Schwab, MD, FACS, Fred A. Moore, MD, FACS, Howard R. Champion, FRCS, David B. Hoyt, MD, FACS, and John R. Hess, MD, MPH, FACP

J Trauma. 2007;62:307-310.

“Prolongation of the PT is the sentinel event...and occurs early in the operation”

J Trauma 2003



Nitrogen Balance in Open Abdomen

- Estimate of 2g of nitrogen per liter of abdominal fluid output.
- $NB = N_{\text{intake}} - (UUN + 4 + (2 \times \text{Abd Fluid Output (Liters)}))$



Those who continue to **bleed!!**

- Chase normal #'s
- Continue to need RBC
- Don't warm
- Develop abd hypertension

Put fluid in and BP comes up, can't get the temp up to normal, ...where are they bleeding?

Damage control – Part II

Mean ICU time: 31.7 hours

| | Arrival | Departure |
|------------------|---------|-----------|
| pH | 7.37 | 7.42 |
| HCO ₃ | 20.6 | 24.2 |
| PT | 19.6 | 13.3 |
| PTT | 70.4 | 34.9 |
| Temp. | 33.2 | 37.7 |



Damage Control

PART I - OR

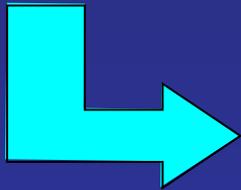
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Damage control

Part III – Back to the OR

- Peritoneal irrigation
- Definitive Arterial - venous repair
- Bowel resection and anastomosis
- Colostomy
- Liver debridement, resection or suture
- Feeding tubes
- Abdominal wall closure



Stoma Preparation in the Open Abdomen

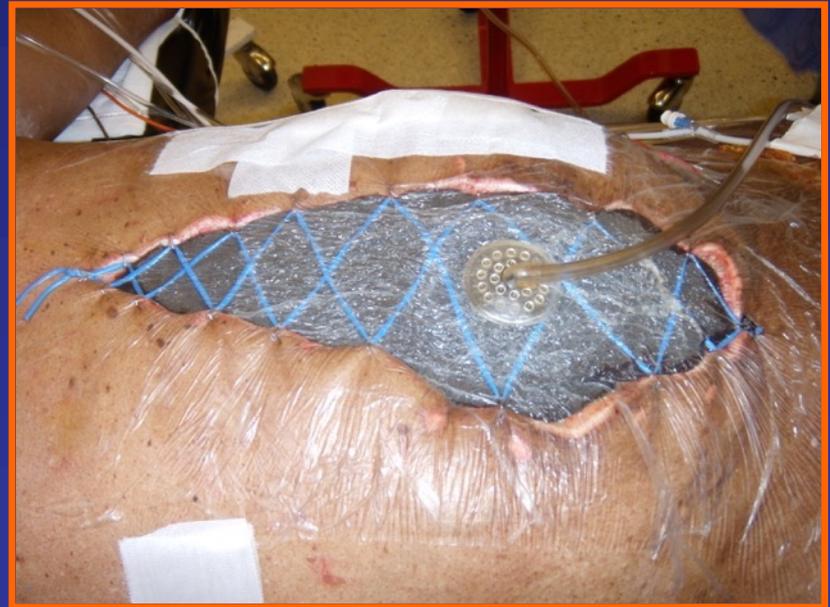


Feeding Tubes in the Open Abdomen



Primary Fascial Closure

- 50 – 65 %
- *Recent Penn 57 %
 - All within 8 days
- Vanderbilt 57%
- Wake* 88%
 - VAFC
 - Average 9 days
 - » 1-21days



Complications in the Open Abdomen

- Abdominal compartment syndrome
- Nitrogen Loss
- Fistula 2 – 20%
 - Enterocutaneous
 - Enteroatmospheric
- Abscess 12%
- Dehiscence
- Inability to obtain fascial closure



Risk Factors – Enteroatmospheric Fistula

- Delay in primary closure
 - > 8 days: complication rate ↑ from 12% to 52% ($p < 0.0001$)
- Anastomosis - technique
- Exposed suture lines
- ? Multiple washouts, multiple hands



Fistula Prevention

- Stapled vs sutured anastomosis:
 - Retrospective review of 5 Level 1 centers
 - 175 stapled vs 114 hand-sewn
 - Leak: 7/175 vs 0/114 ($p=0.04$)
 - Abscess: 19/175 vs 4/114 ($p=0.04$)
 - No difference in enterocutaneous fistula
 - Large bowel: 20% vs 4% complication rate
 - Small bowel: 7% vs 2% complication rate



When a fistula forms...

Historical Outcomes

- Most of enterocutaneous fistula close w/in 8 weeks
 - r/o traditional causes.
- Minimal closure of enteroatmospheric fistula
 - Protruding mucosa
 - Multiple



ECF Historical Outcomes

- “Standard Rx”:
 - * Treat infxn/drain
 - * Fluid electrolyte resuscitation
 - * Nutritional support
 - * Bowel rest +/-
- Wound management
 - Protect skin
 - VAC



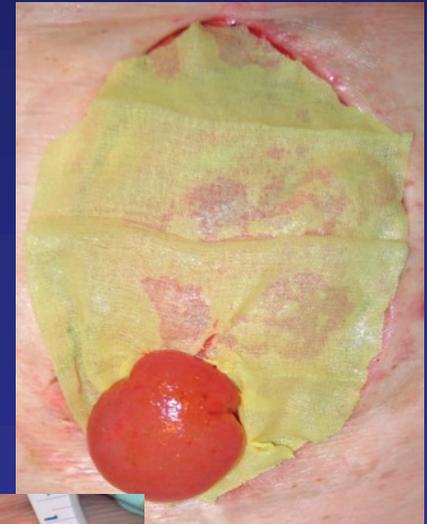
Attempt to Seal Leak: EAF

- Things NOT to do:
 - - place a well meaning stitch
 - - intubate the “floating” fistula orifice in an attempt to “control” leak
 - - acutely resect and start fresh
 - - give up hope!



Control Fistula

- The “Fistula VAC”
 - - protect granulation
 - - ostomy to gravity
 - - pre/post STSG
 - - thicken contents





The Open Abdomen

- Failed staged approximation of fascia
- Encourage granulation
 - Vicryl Mesh
 - VAC therapy alone
 - Requires 7-14 days









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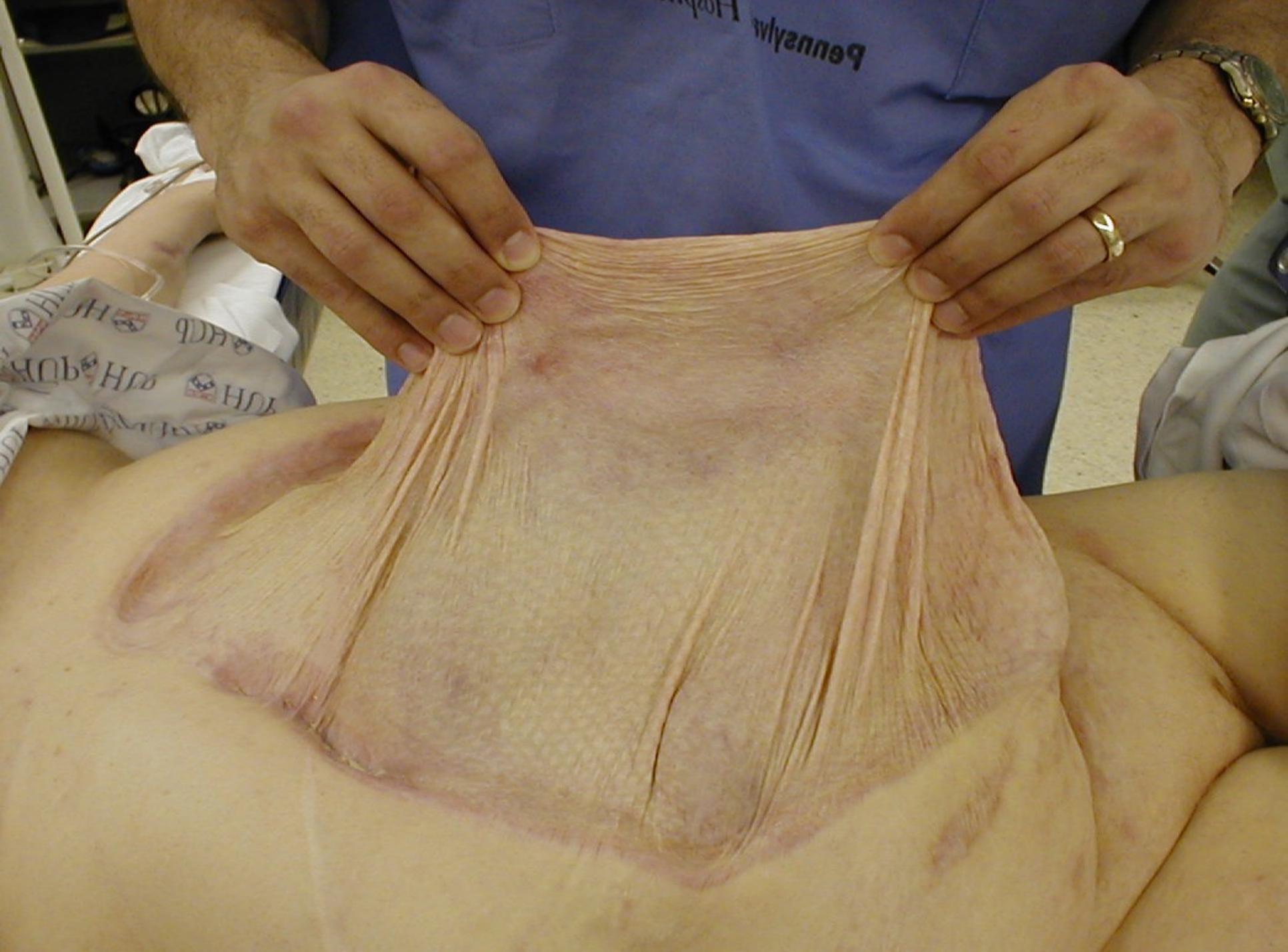
DC IV - OR

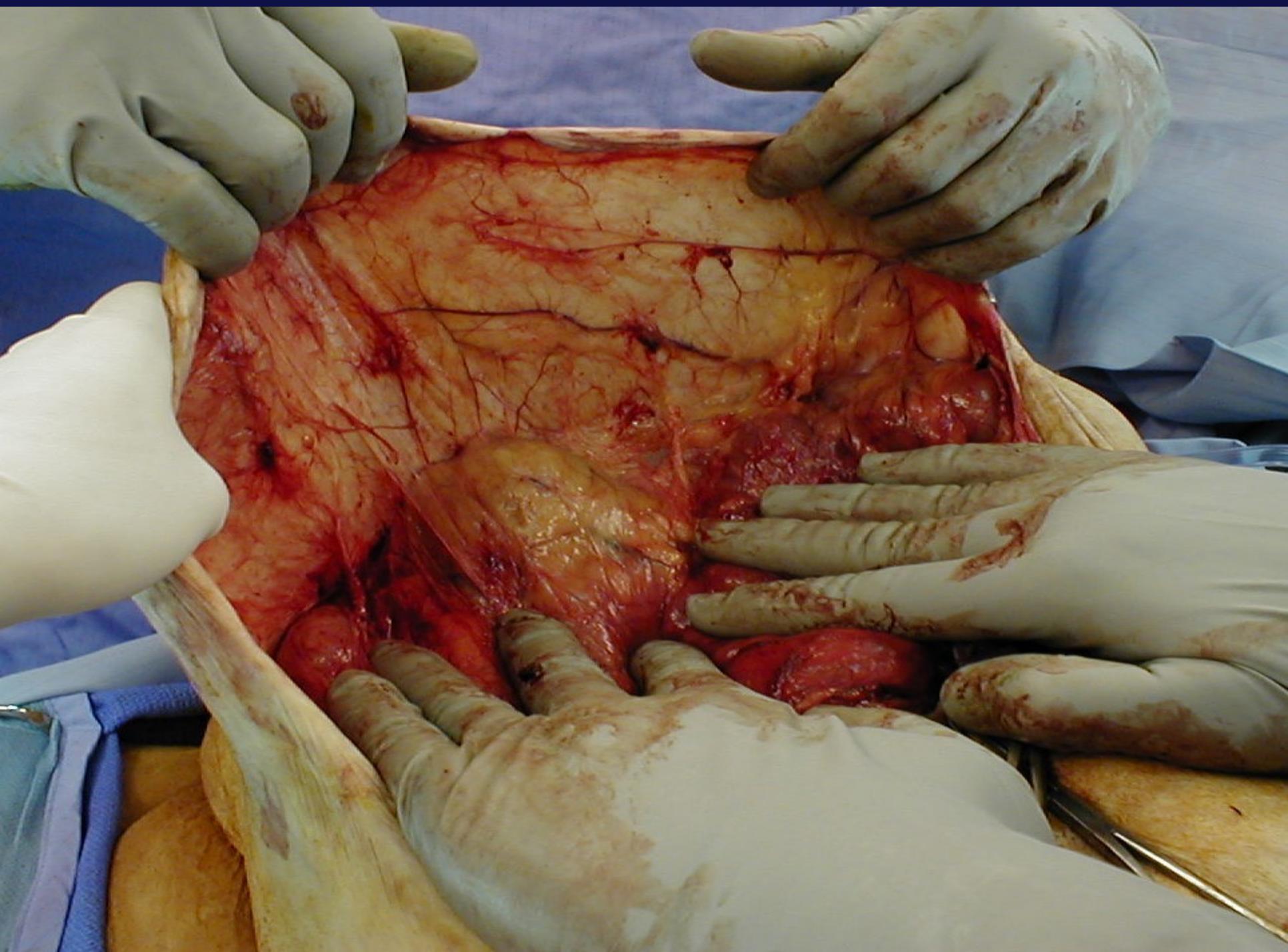
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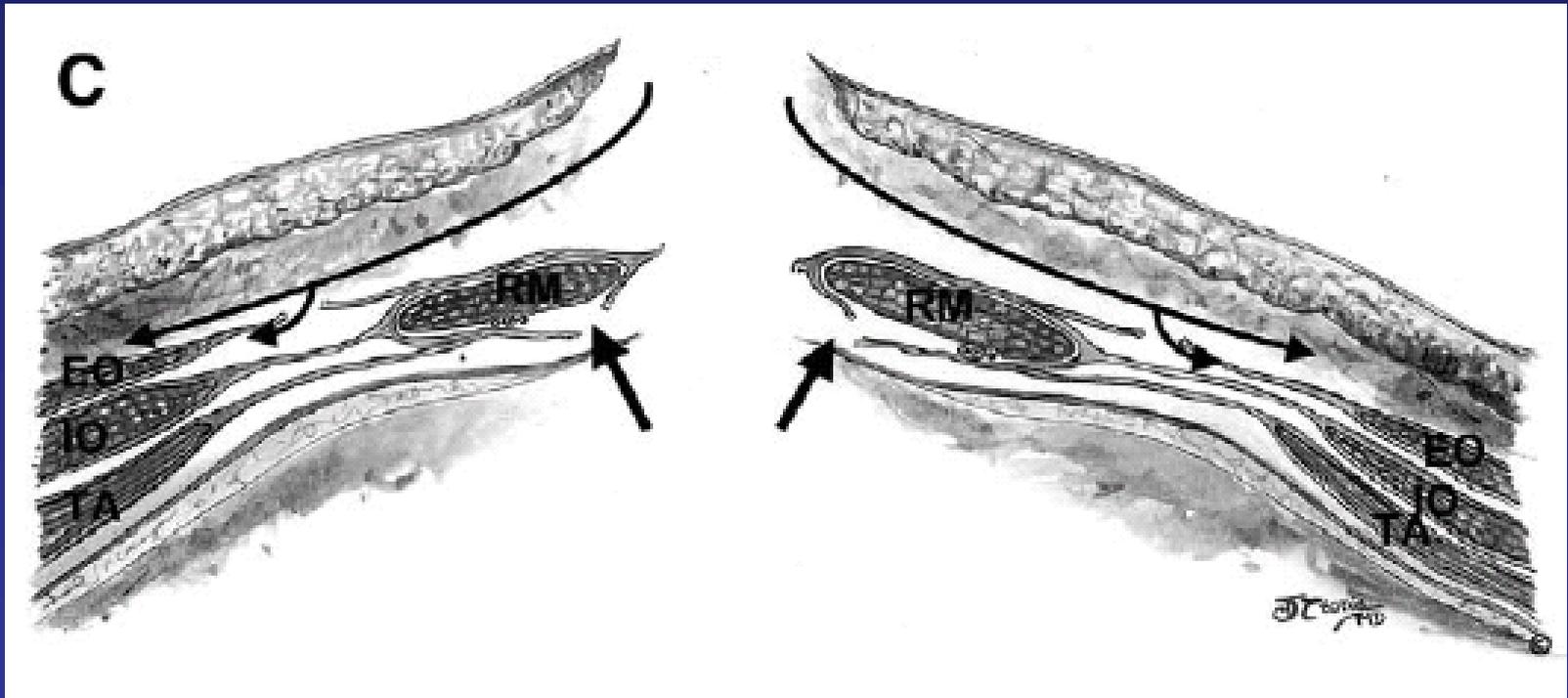
48hrs - 1yr

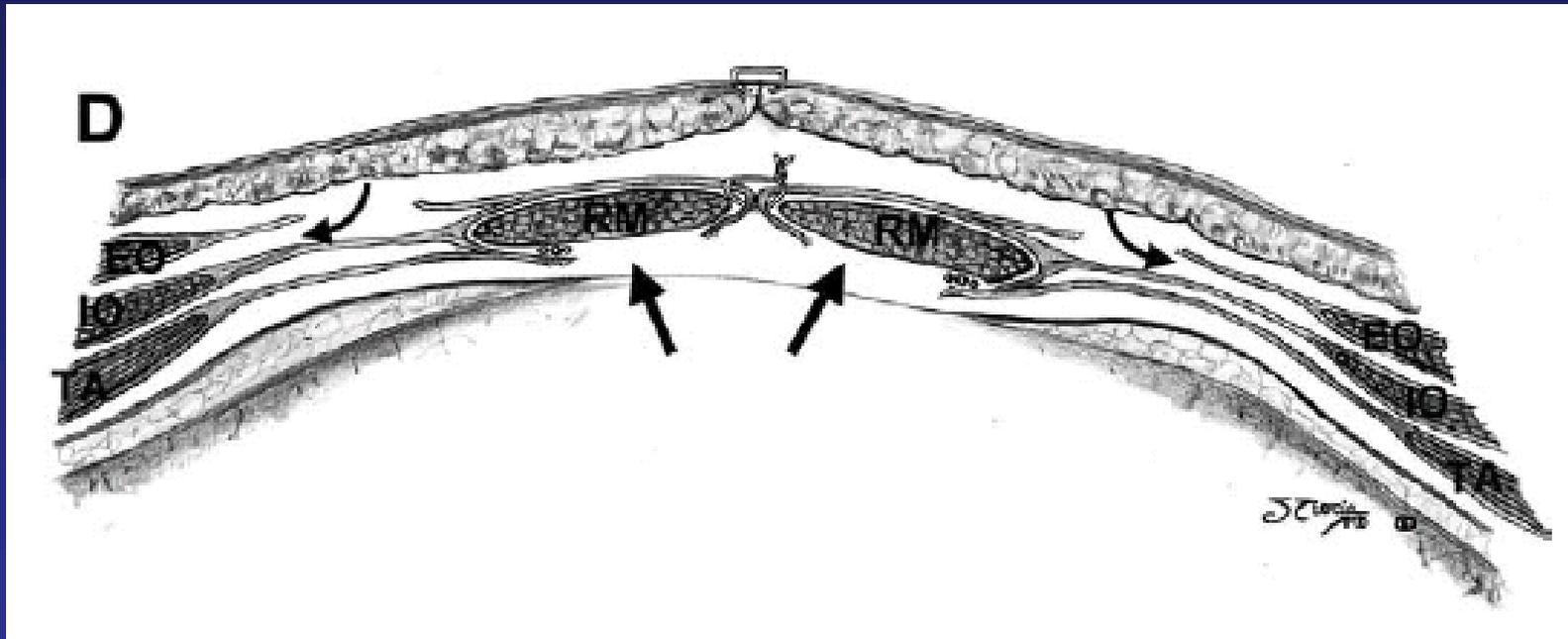






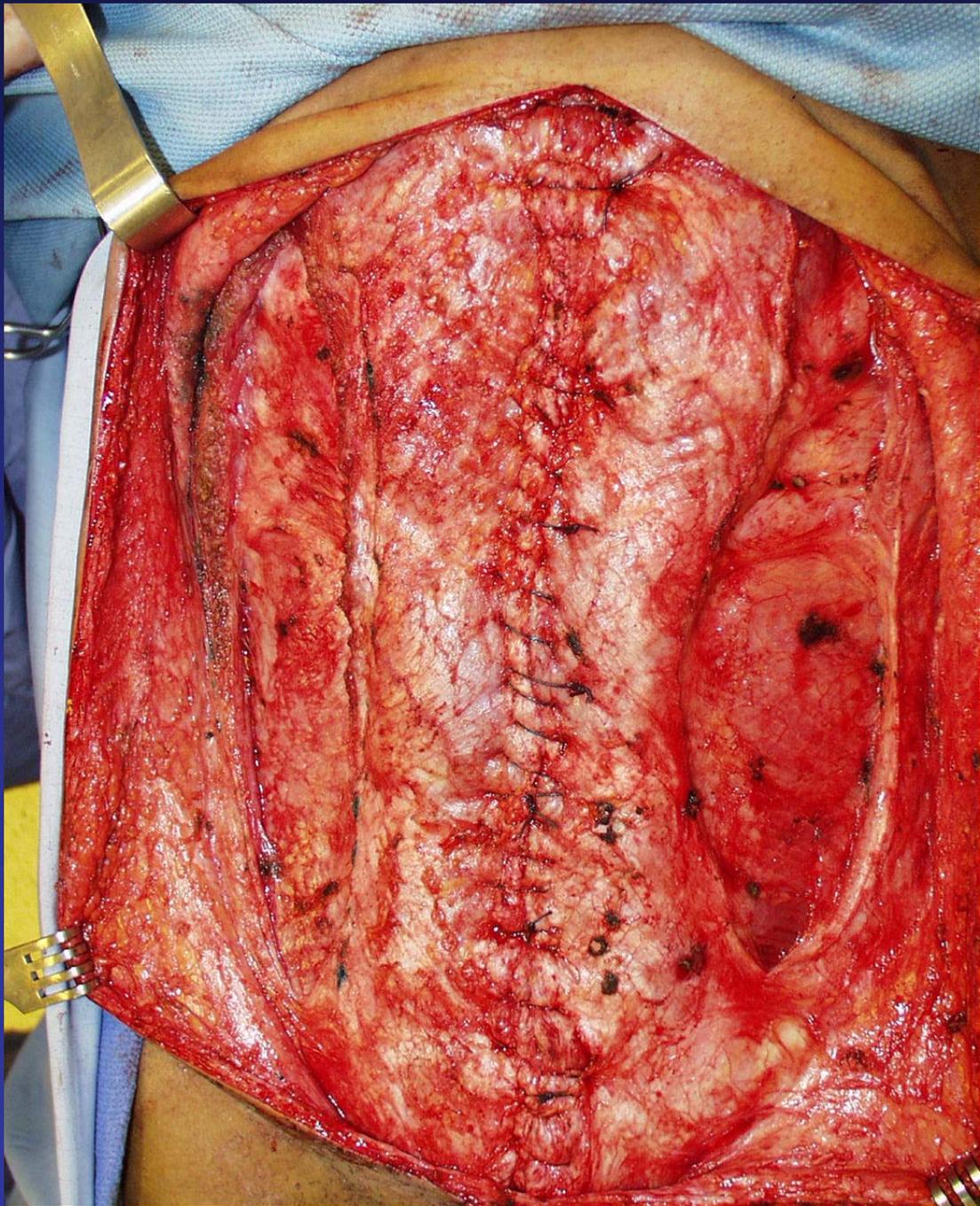






May use underlay mesh as buttress
Vicryl or Biologic





So Does it Work?

- No RCT
- Stone (1983)
 - 35% reduction in mortality following onset of coagulopathy
- Rotondo
 - 77% reduction in mortality with combined vascular/visceral injuries

Stone Ann Surg 197:532; 1983
Rotondo J Trauma 35:375; 1993



Evolution of Damage Control

- Vascular – temporary shunts
- Orthopedics – external fixation
- Neurosurgery – craniectomy, early decompression and posterior/external fixation
- Cardiac – Open Chest
- Resuscitation – minimize crystalloid, Plasma Based



Recommended Reading

- Injury 2004; volume 35
 - Dedicated to damage control



