



Abdominal vascular trauma

What every emergency surgeon should know

Alberto García, MD, MSc
Cali, Colombia

Disclosure

Alberto F García

I do not have any relevant financial relationship(s) with any commercial interest that pertains to the content of my presentation.

Abdominal vascular trauma

- Diagnosis
- Surgical indication
- Aortic occlusion
- Operative decisions
 - Transient control
 - Damage control
 - Specific approach
 - Definitive management



Initial Information

Community Hospital

- Male, 23 years old
- M – Multiple GSW wounds, 1 hour ago
- I – GSW wounds: Neck, right zone III, left shoulder, left thoracoabdominal region
- S – Abdominal pain
- T – Started IV fluids and analgesics. Transference

Initial Information

Trauma Bay

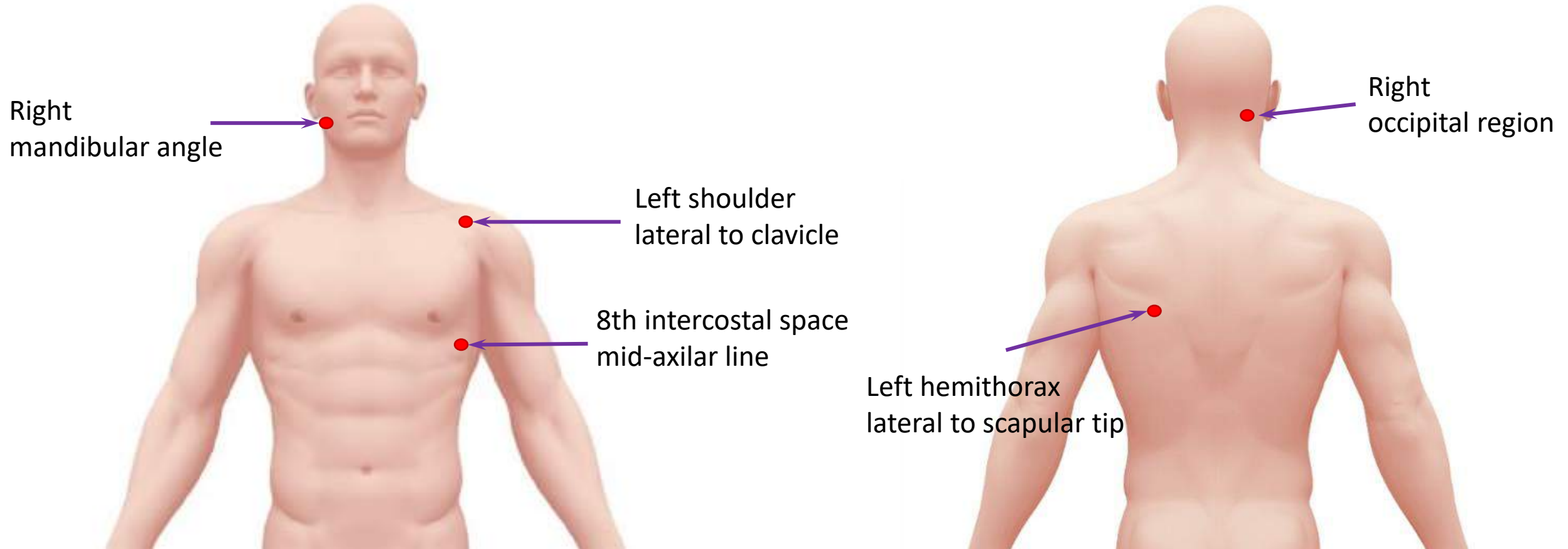
Primary Survey

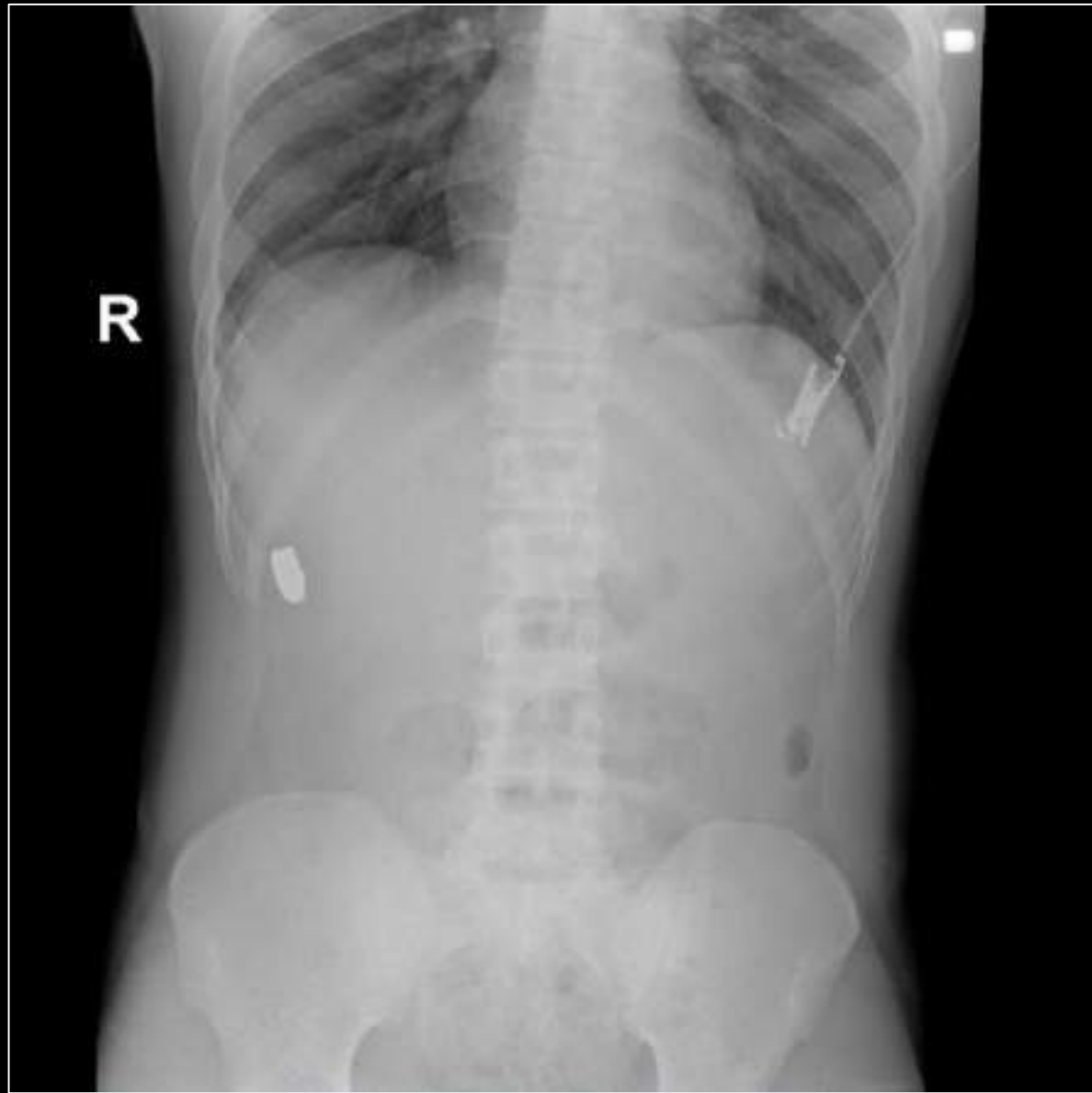
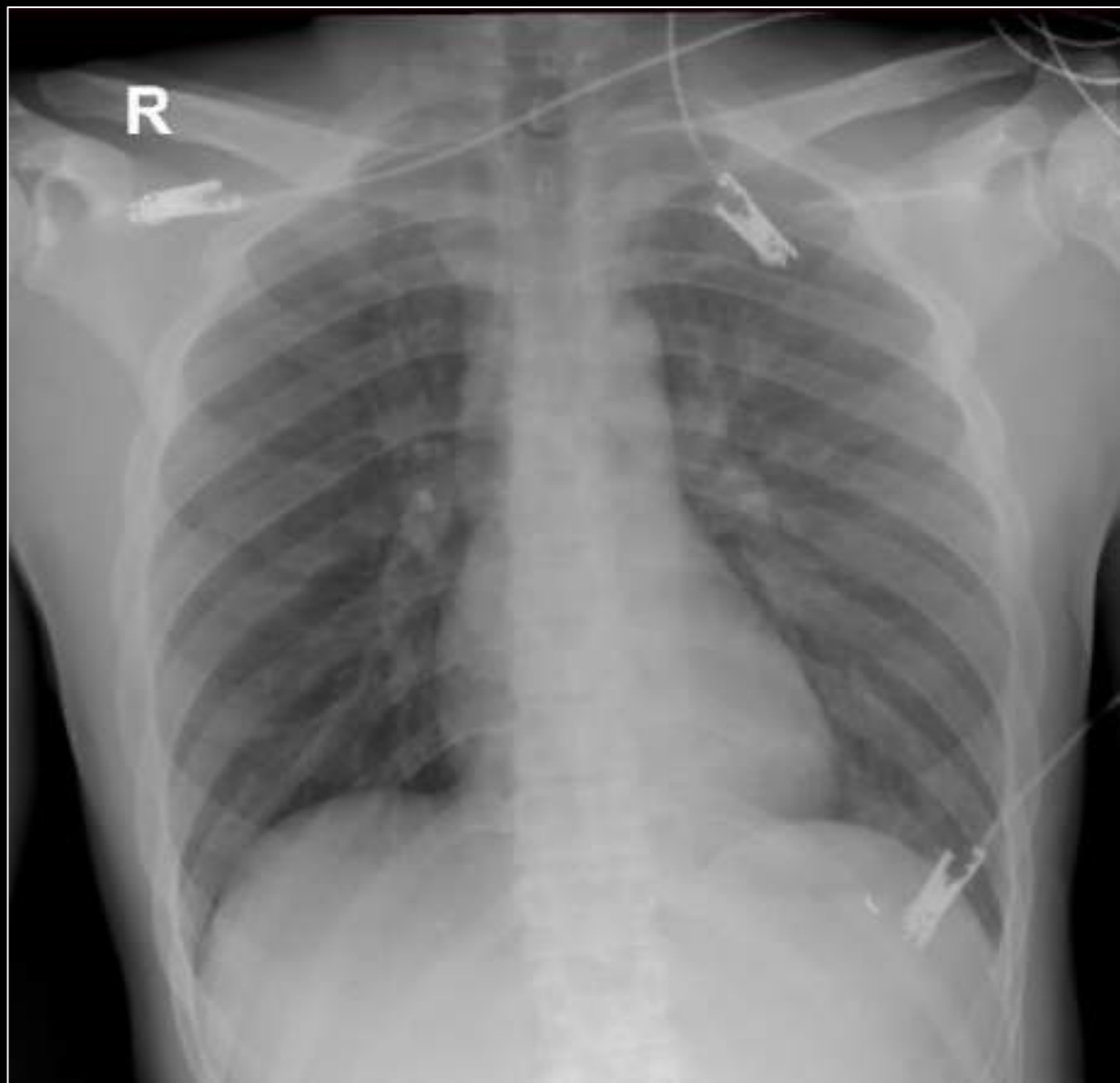
- A, Clear
- B, Whitout alterations. RR 18
- C- HR: 97 BP: 101/76 . FASTE (+) left hemithorax and abdomen
- D – Glasgow 15
- E – Gunshot wounds Neck, right zone III, left shoulder, left thoracoabdominal region

Secondary Survey

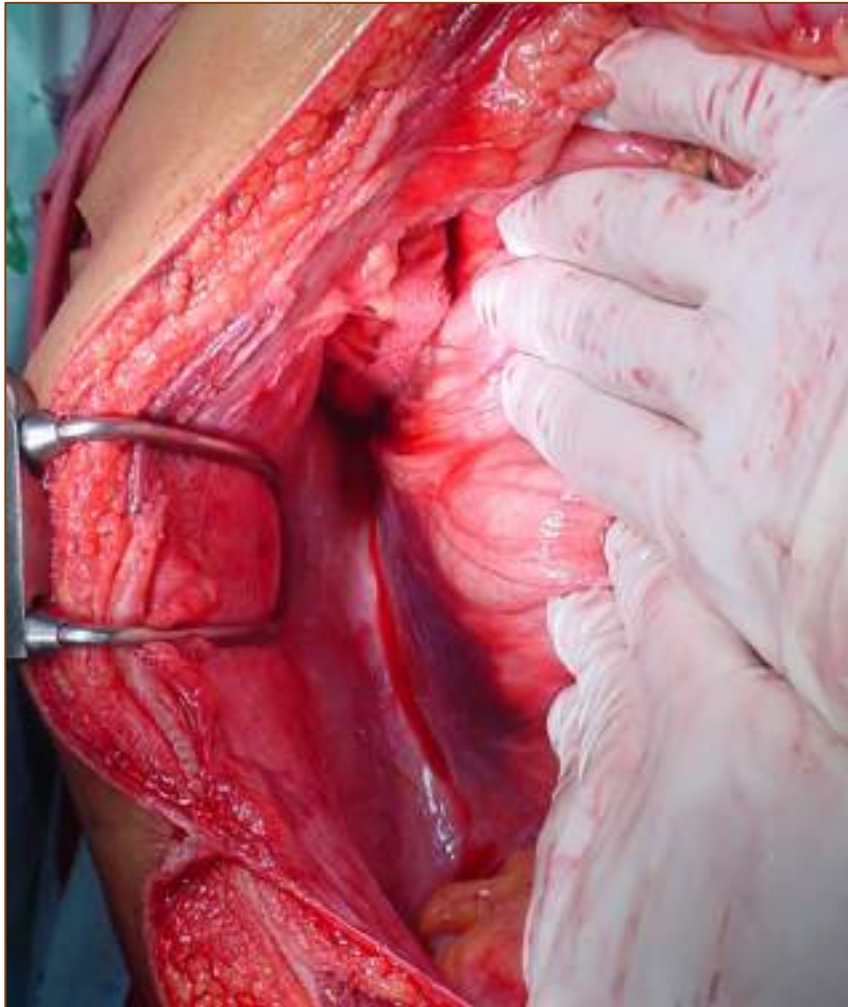
- Gunshot wounds (graphic)
- No neck or neurologic findings
- Acute abdomen

Wounds location





Operative findings

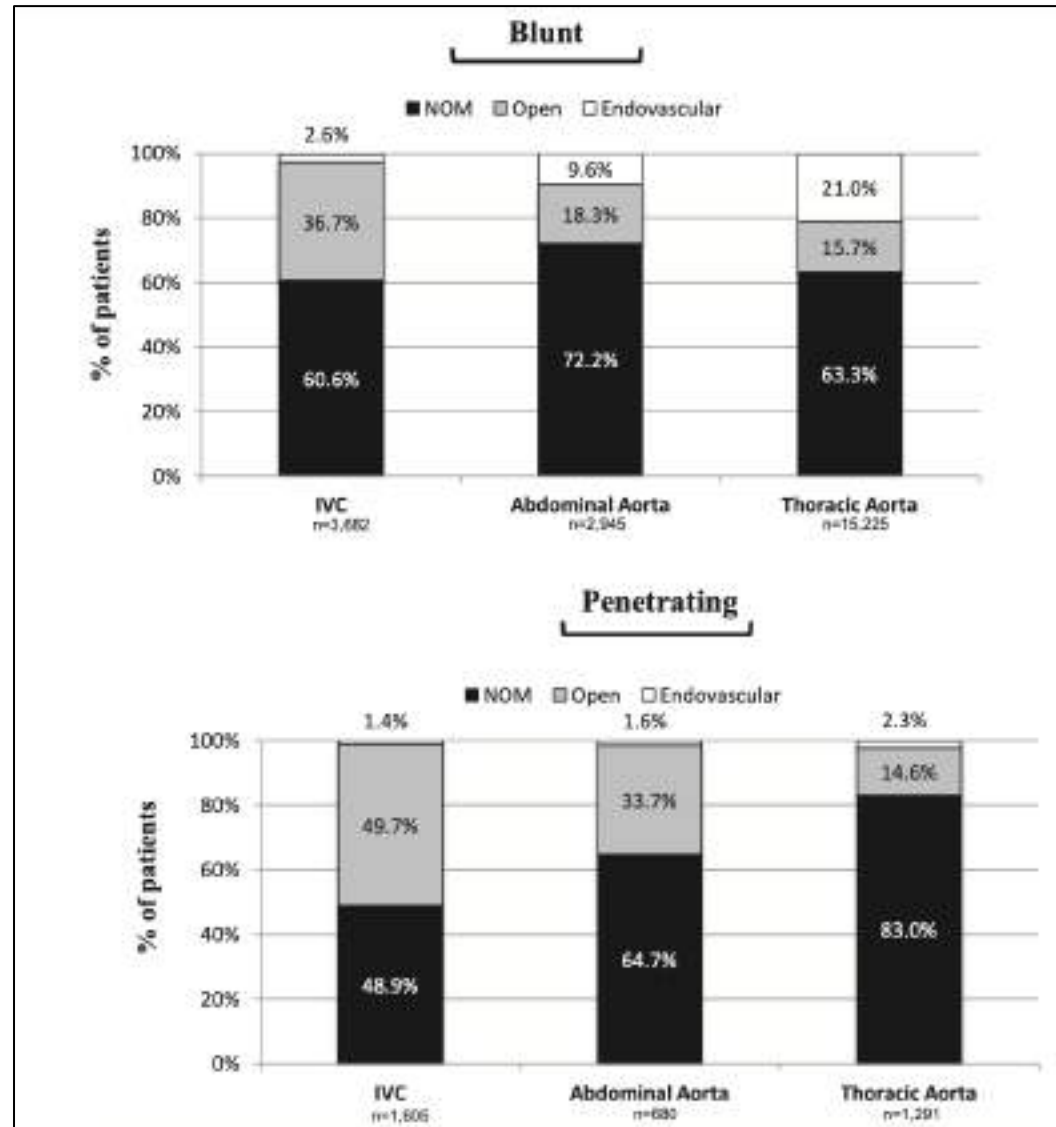


- Hemoperitoneum 1 L
- Retroperitoneal hematoma
 - Level 1 and 2
 - Not expanding
 - Not active bleeding
- Gallbladder perforation
- Nonbleeding liver wound (IV segment)

Diagnosis

Survival trends after inferior vena cava and aortic injuries in the United States

Bernardino C. Branco, MD,^a Tashinga Musonza, MD,^b Michael A. Long, MD,^b Jayer Chung, MD,^a Samuel R. Todd, MD,^c Matthew J. Wall Jr, MD,^c Joseph L. Mills Sr, MD,^a and Ramyar Gilani, MD,^a Houston, Tex.



Diagnosis

- Exsanguination 15% – 30%
- Shock 60% – 70%
- Acute abdomen 30% – 40%
- Multiple penetrating injuries
- High energy trauma



Surgical technique

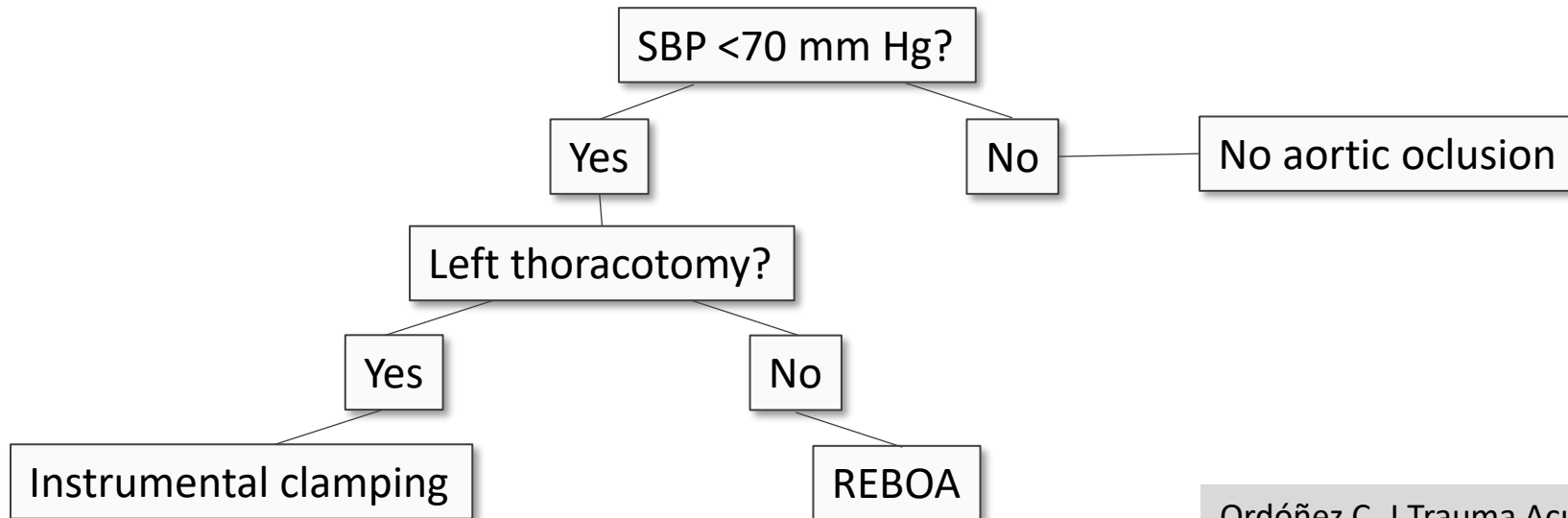
- Surgical approach
- Temporary control
- Proximal and distal control
- Repair

Step 0 Surgical Decision

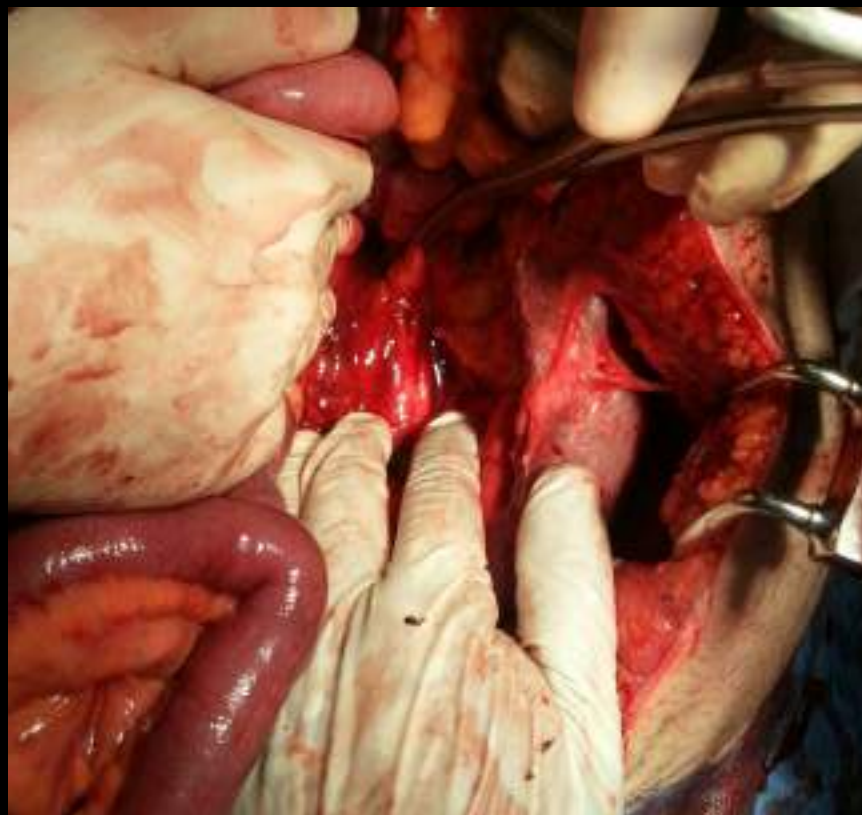
Massive Transfusion Package Activation

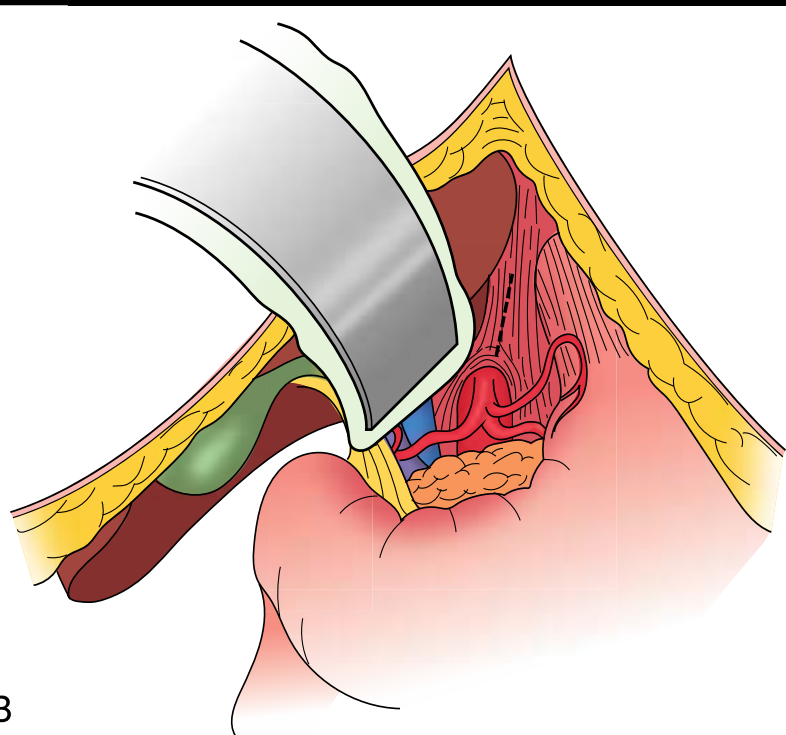
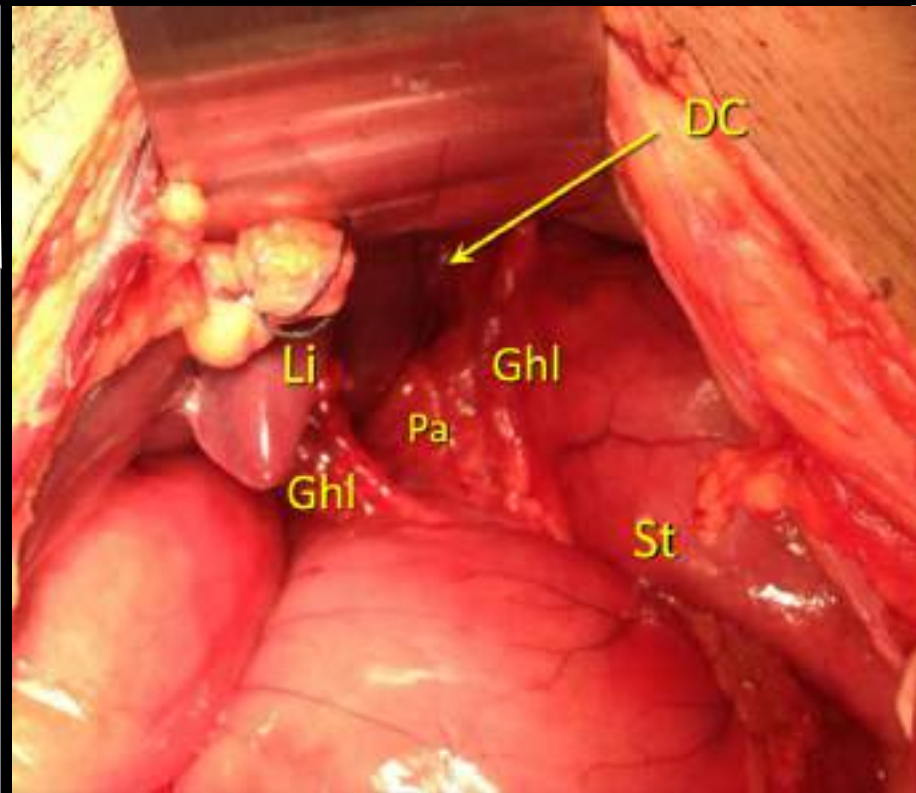
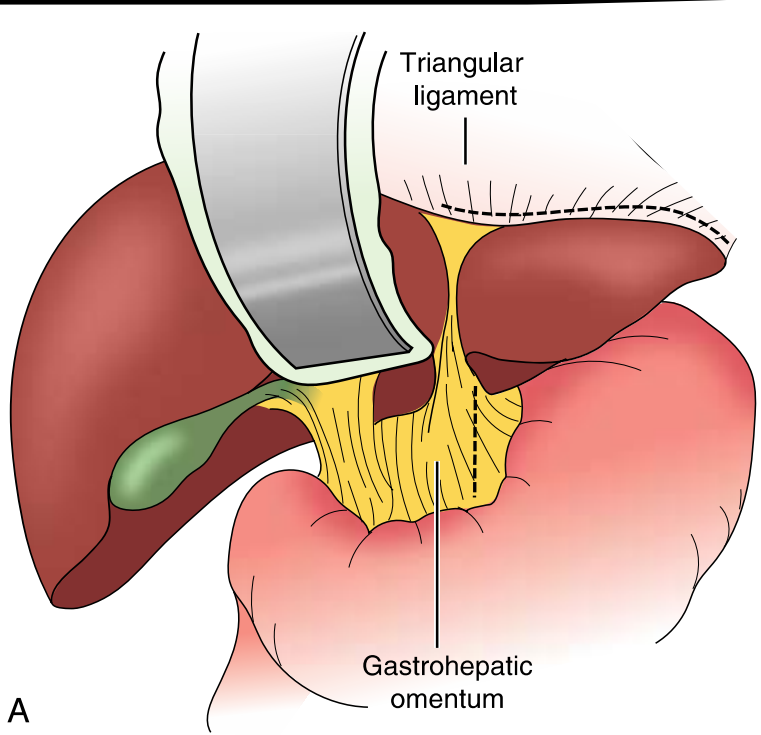
Tranexamic acid administration

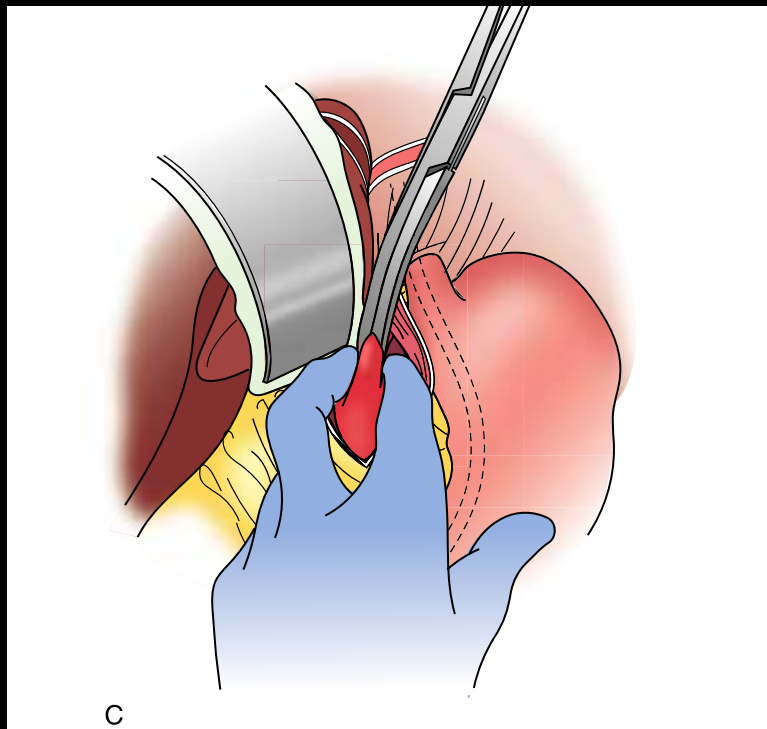
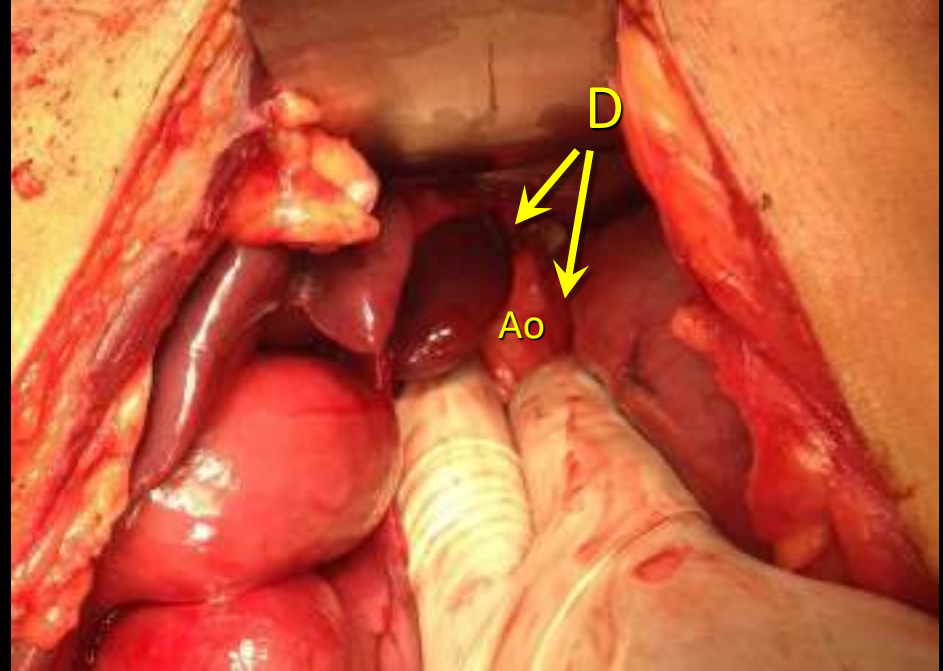
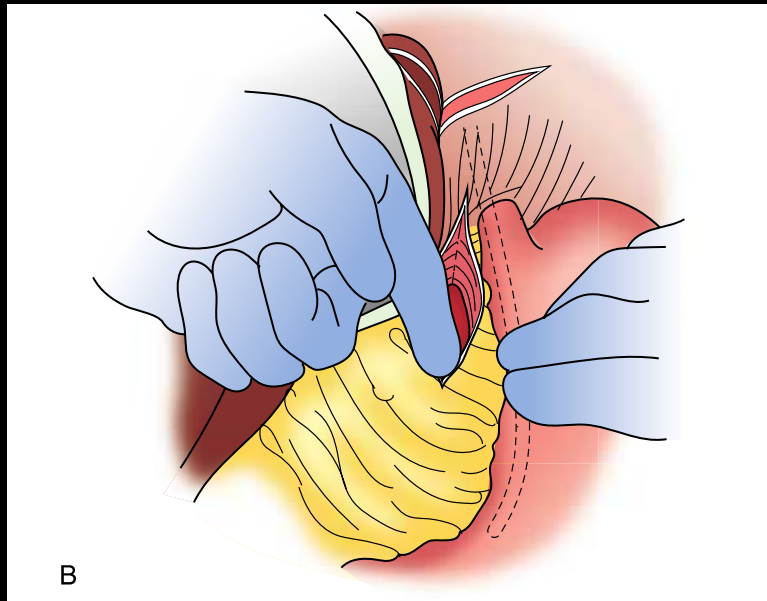
Aortic Occlusion Indication?



Aortic occlusion



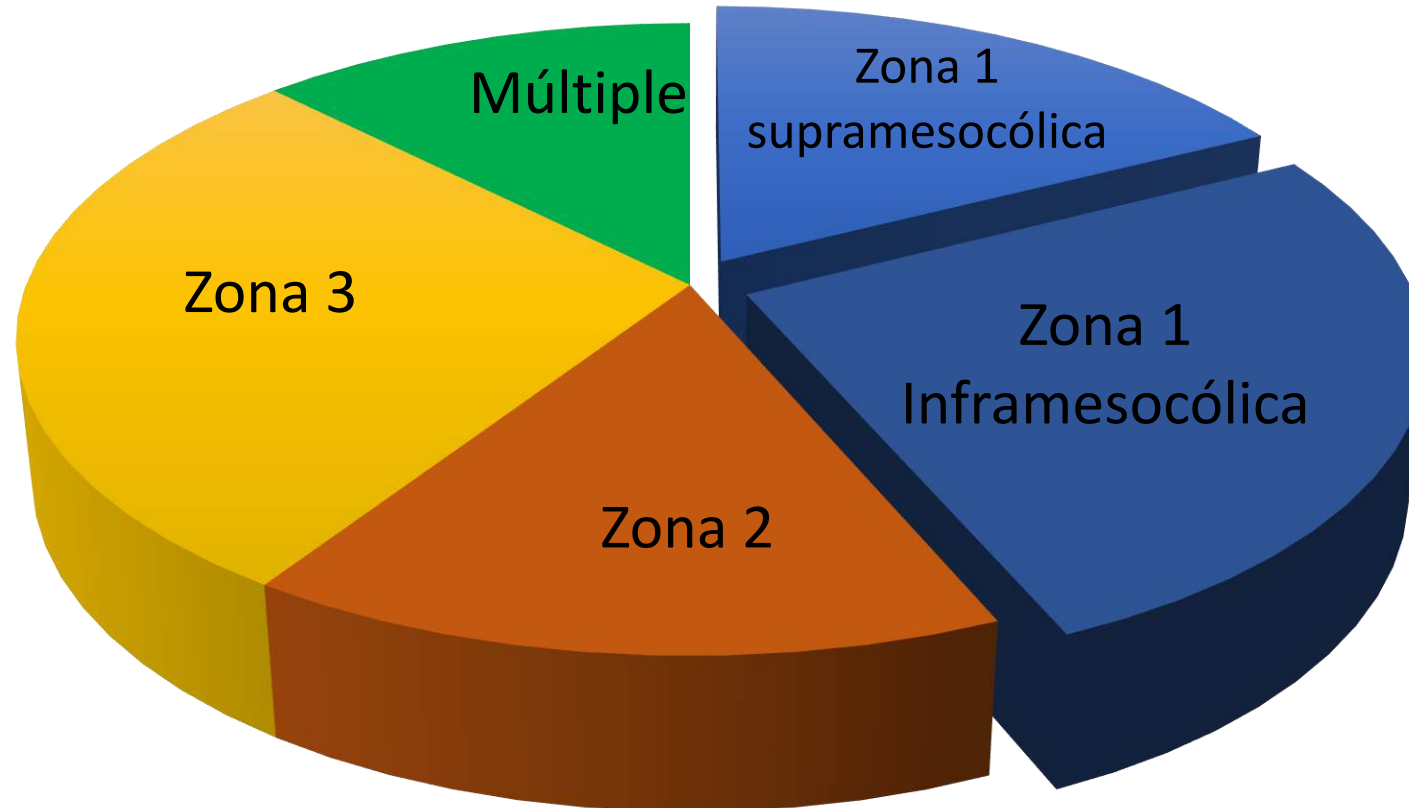




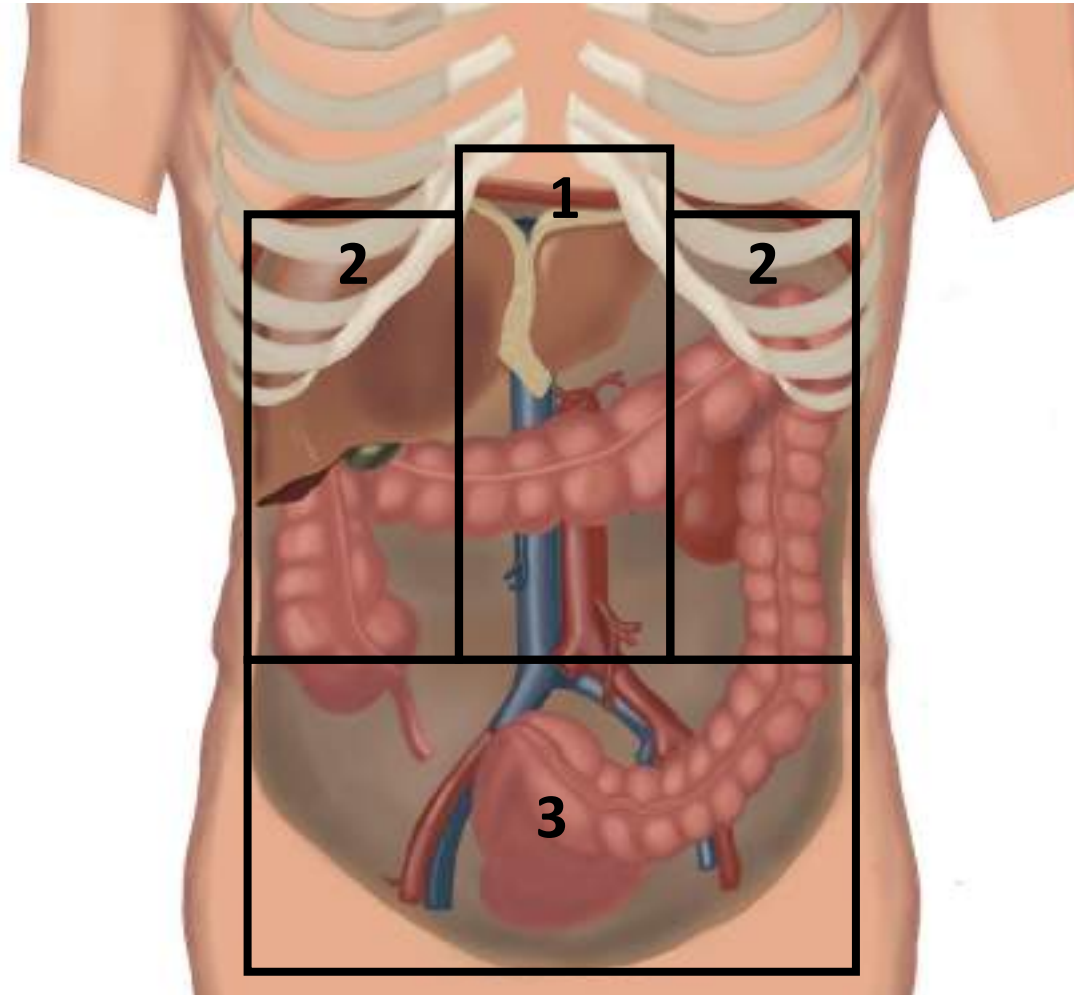
Operative Management and Outcome of 302 Abdominal Vascular Injuries

Juan A. Asensio, MD, Santiago Chahwan, MD, David Hanpeter, MD, Demetrios Demetriades, MD, PhD, Walter Forno, MD, Esteban Gambaro, MD, James Murray, MD, George Velmahos, MD, PhD, Jason Marengo, BS, William C. Shoemaker, MD, Thomas V. Berne, MD, *Los Angeles, California*

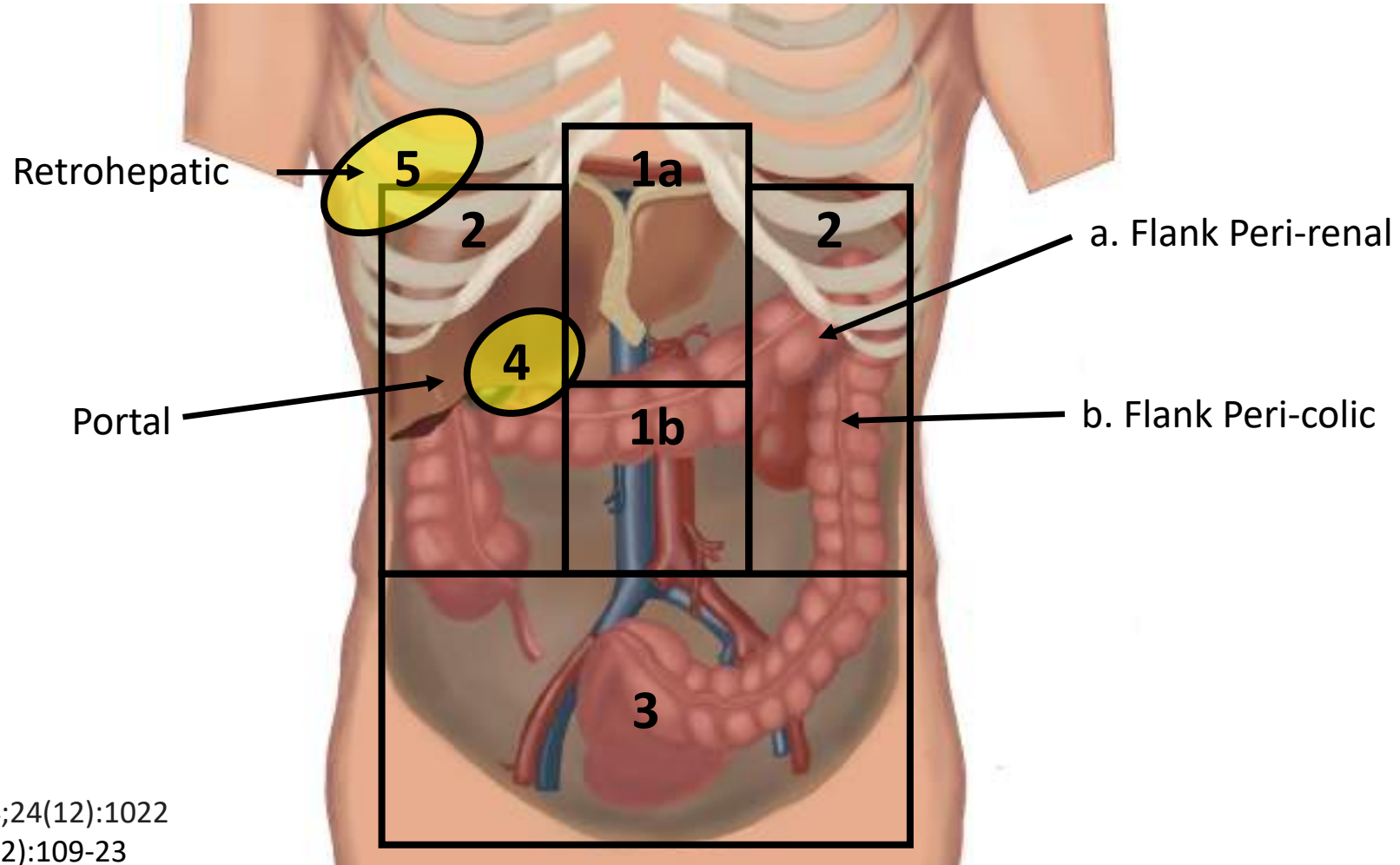
275/302



Retroperitoneal hematoma Classification



Retroperitoneal hematoma Classification



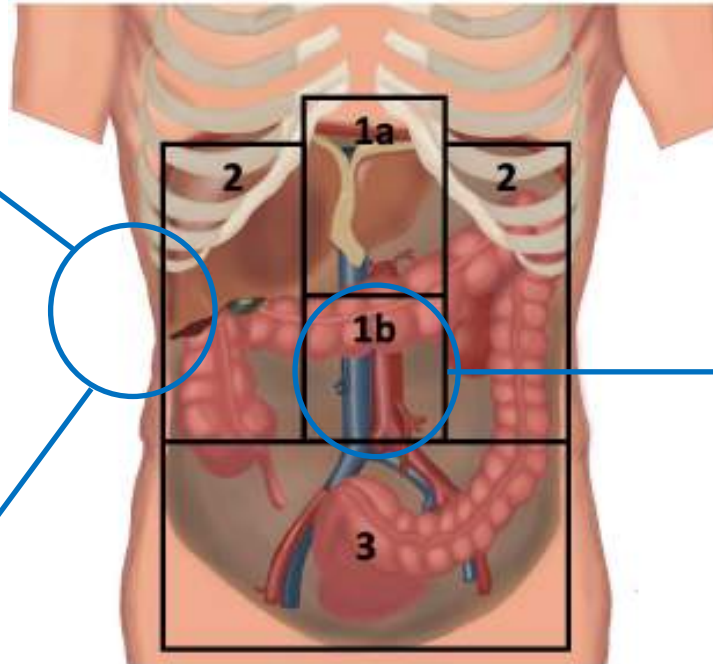
Intraoperative diagnosis

Zone 2a Flank, peri-renal

Kidney
Supra-renal Gl.
Distal renal vessels

Zone 2b Flank, peri-colic

Infra-hepatic vena cava
Yuxta-renal vena cava
Infra-renal vena cava

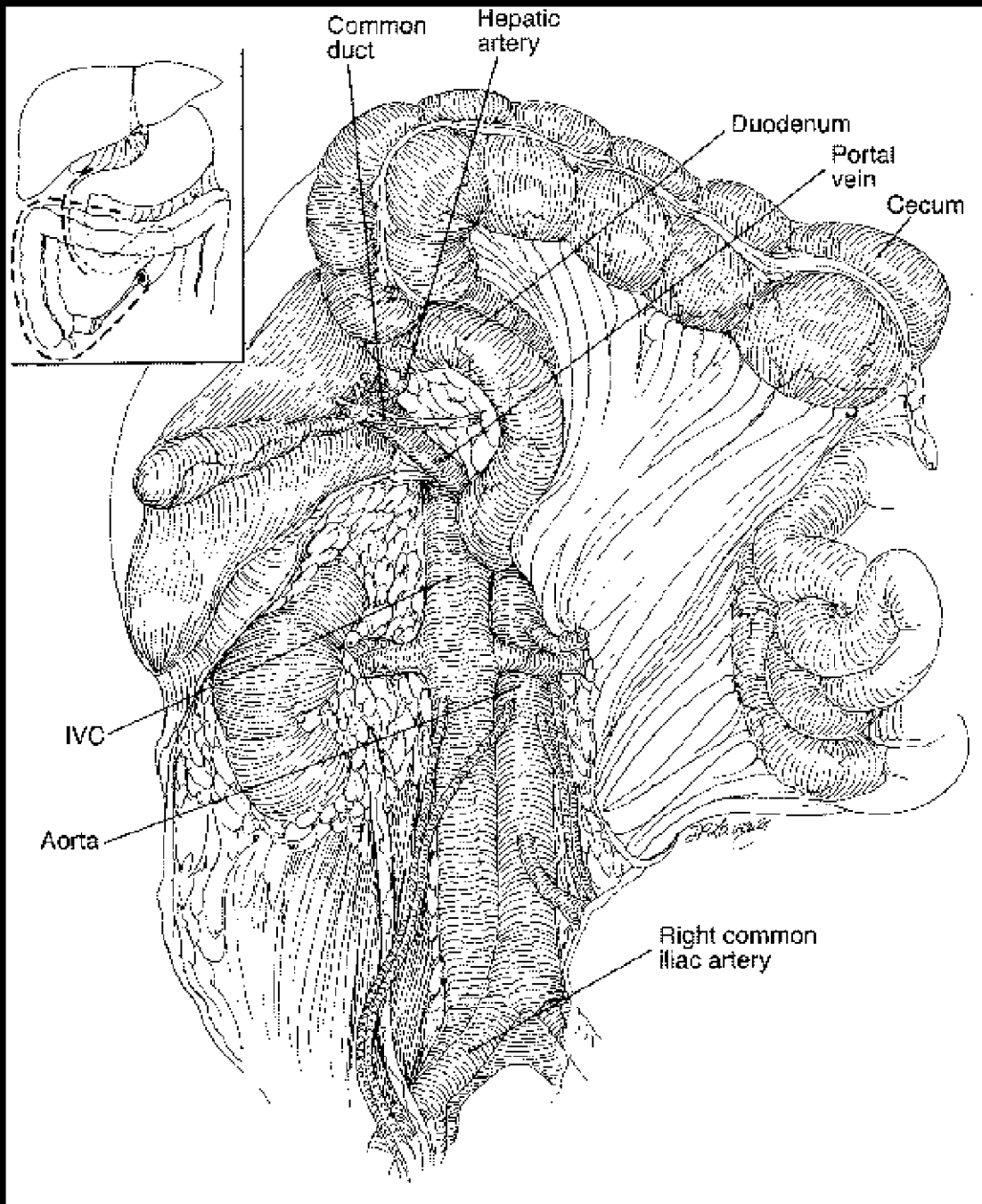


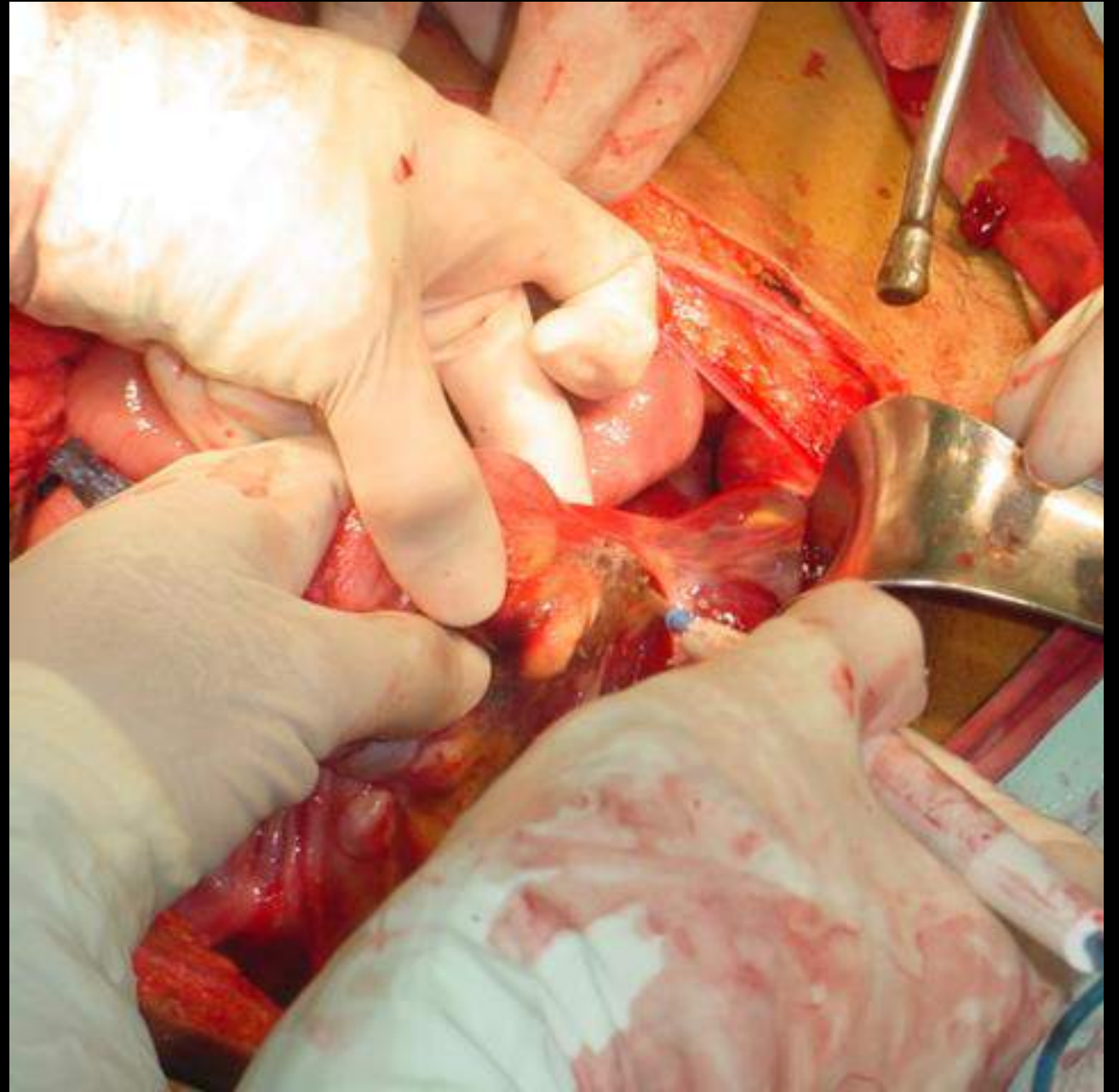
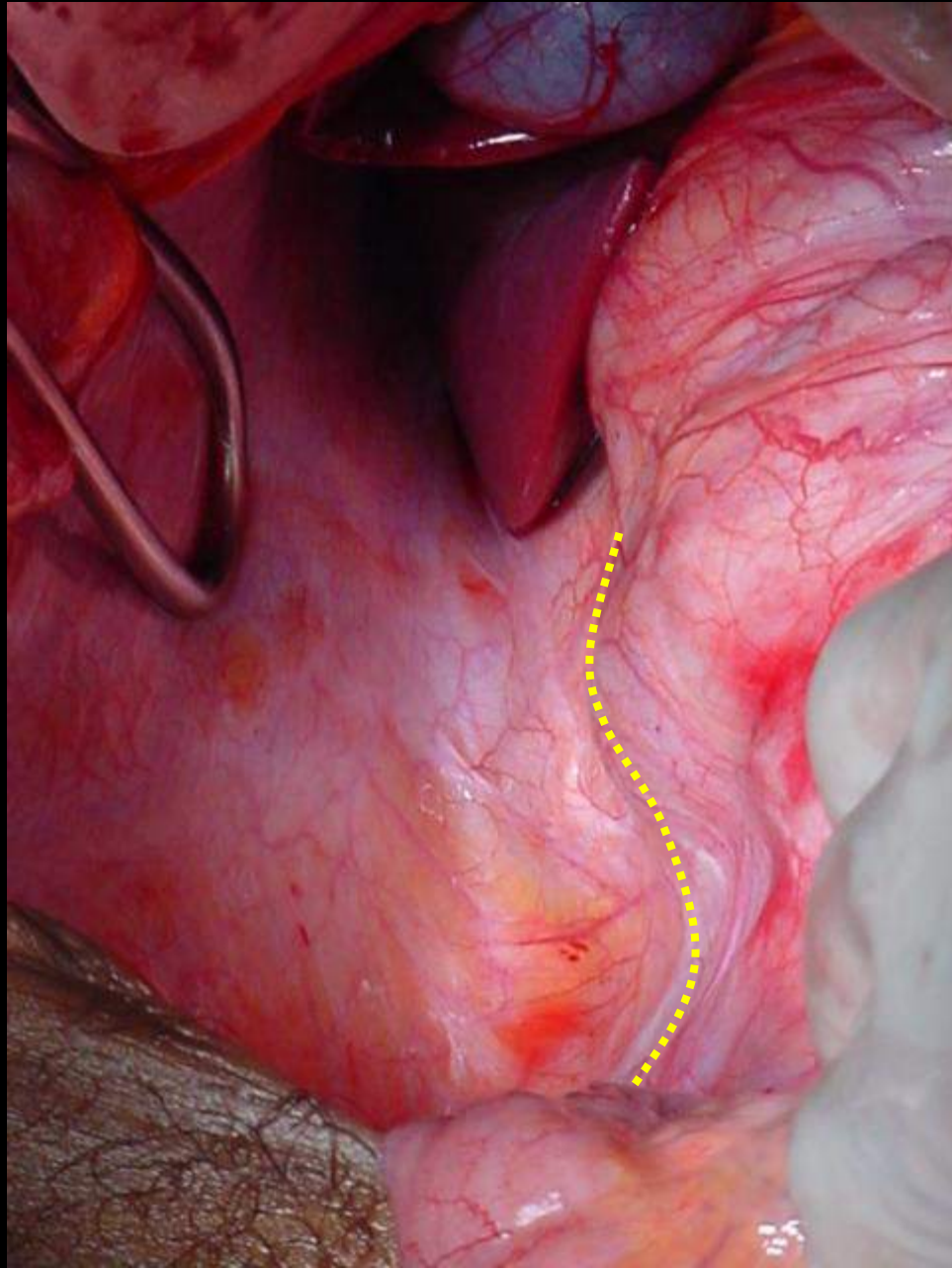
Zone 1 Inframesocolic

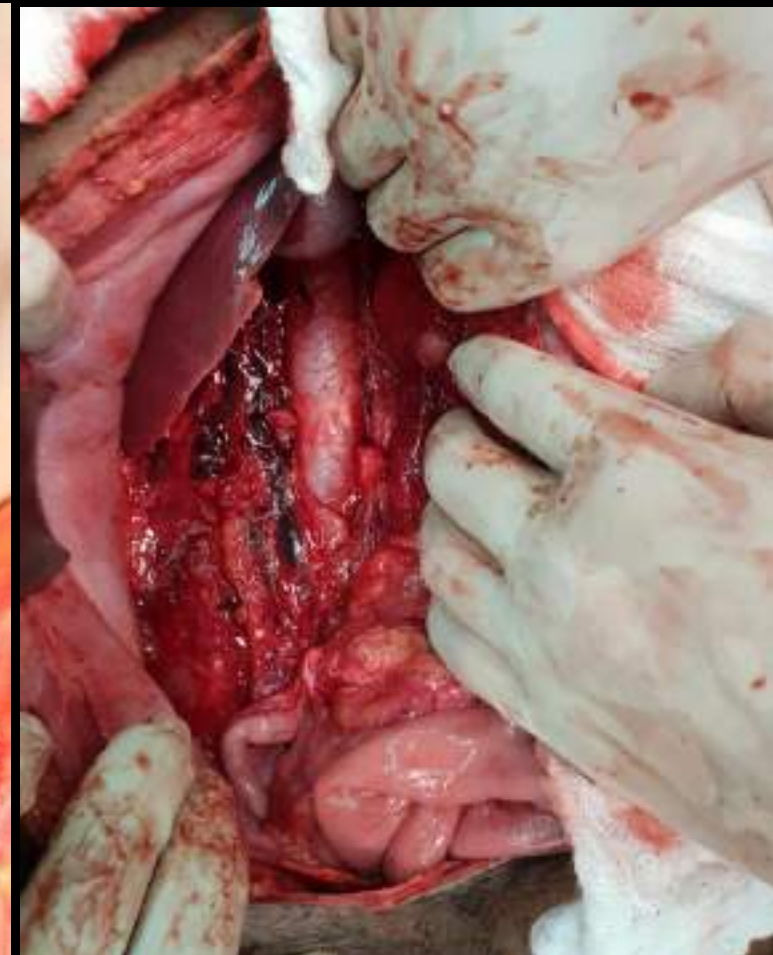
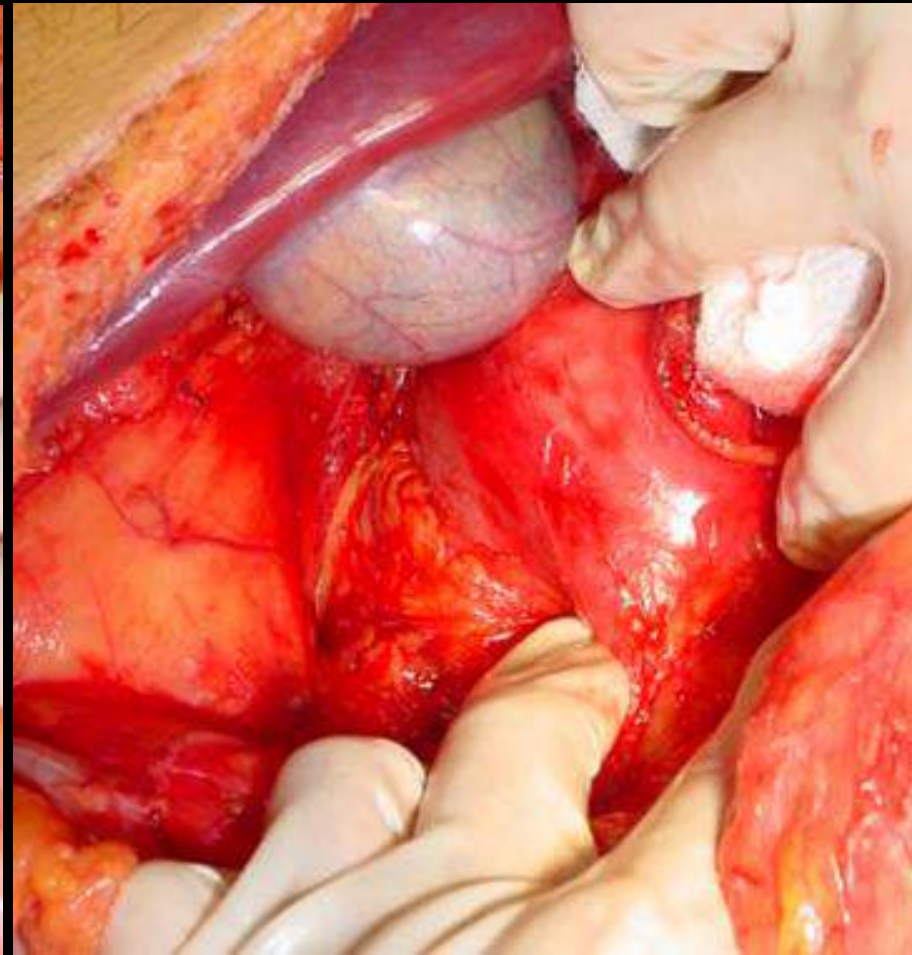
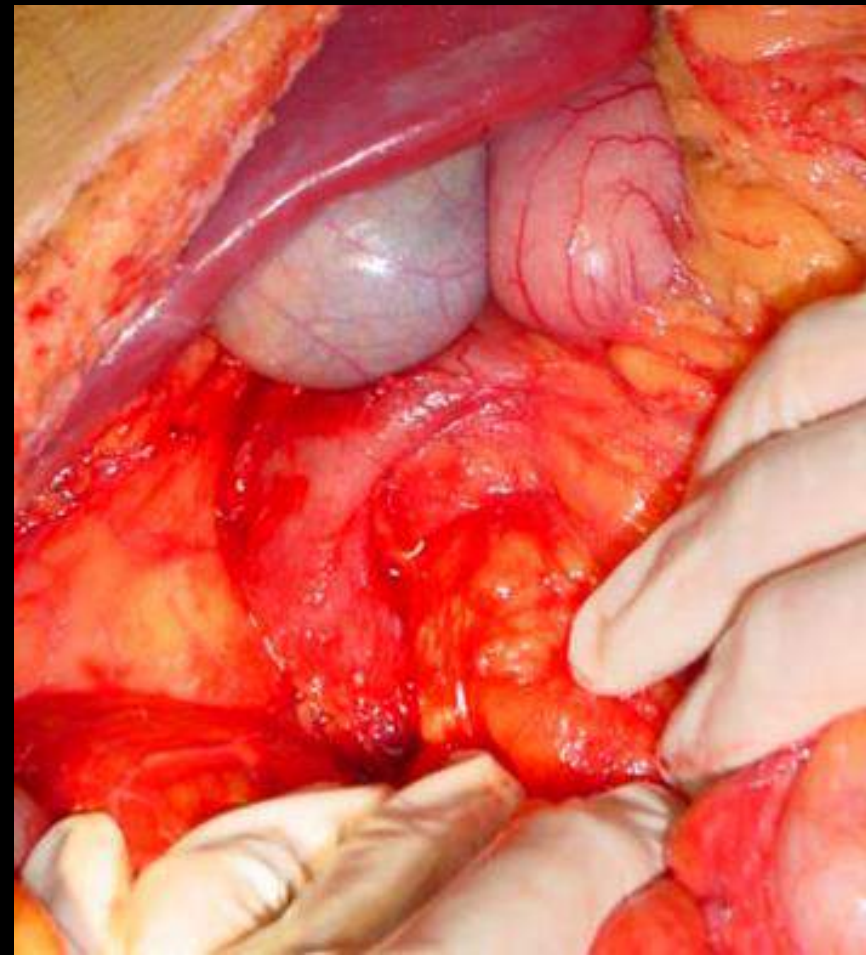
Infrarenal Vena Cava
Infrarenal Aorta Artery

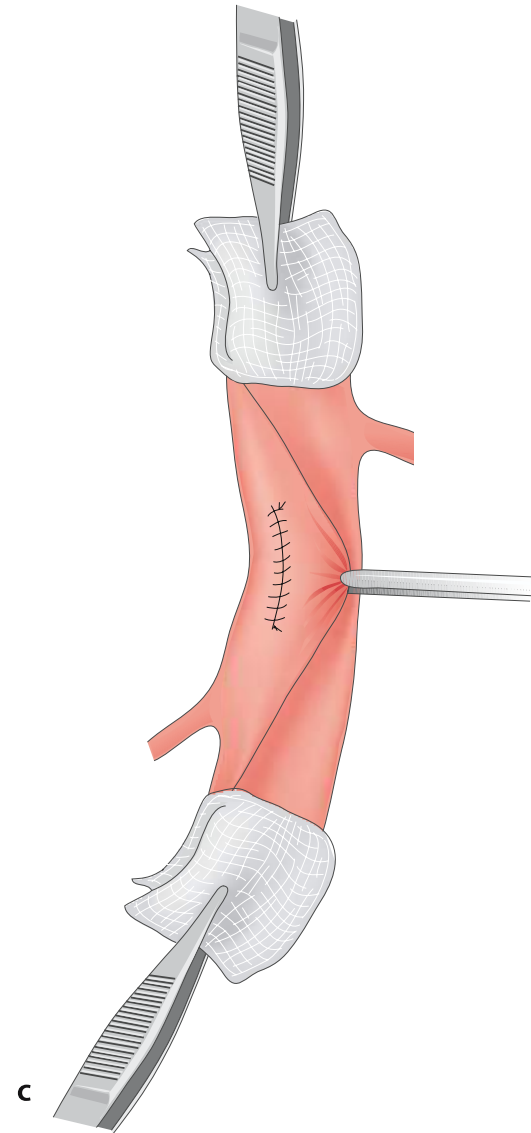
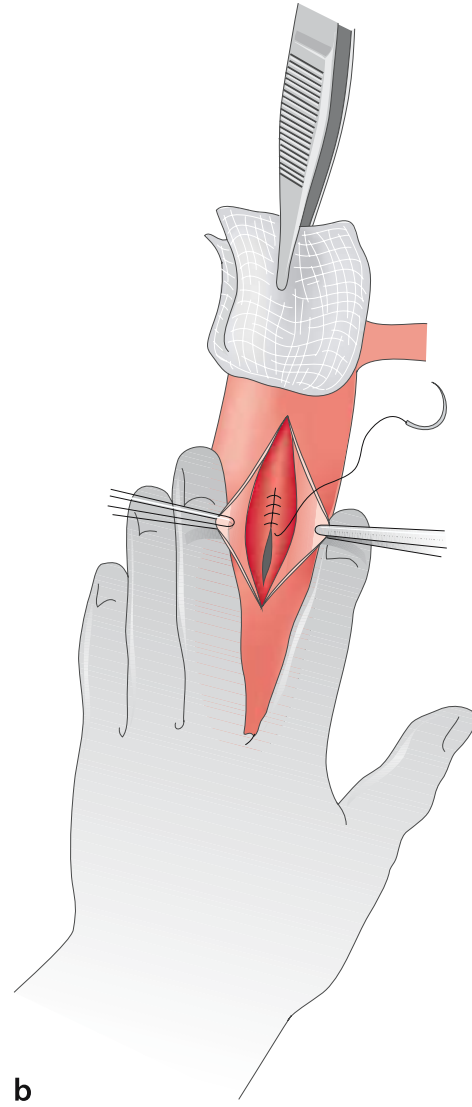
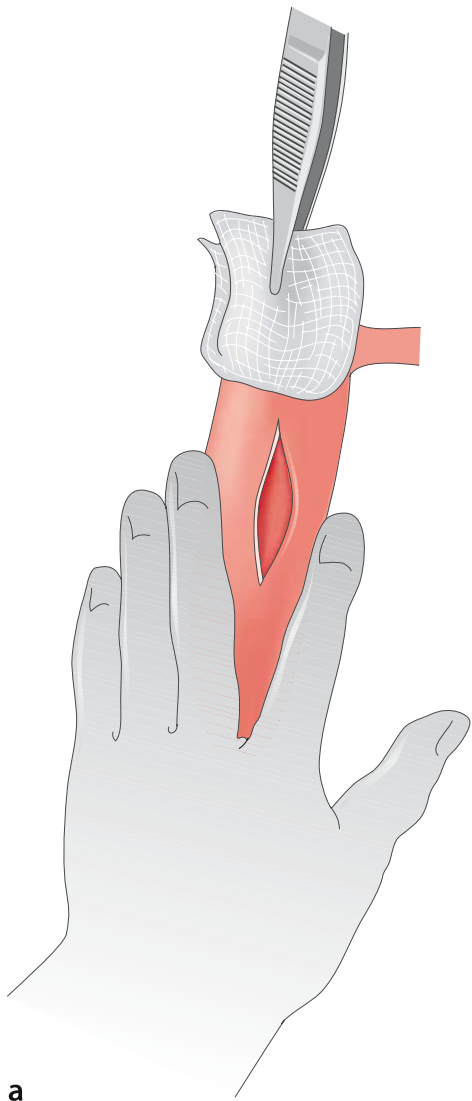
Location of the hematoma	Injured structure	Approach
1A. Central supra-mesocolic	Suprarenal abdominal aorta Celiac trunk and branches Superior mesenteric artery Superior mesenteric vein Proximal renal vessels	Medial mobilization of the viscera on the left side (Mattox maneuver)
1B. Central infra-mesocolic	Infrarenal aorta Infrarenal cava Proximal iliac vessels	Midline approach Mobilization of the viscera on the right side (Cattell-Braasch maneuver) Mobilization of the left colon and the right colon
2A. Peri-renal, flank	Kidney Distal renal vessels Supra-renal gland	Cattell-Braasch maneuver Mobilization of the left colon and the right colon
2B. Flank, pericolic	Infra-hepatic Cava Juxta-renal Cava Infra-renal Cava	Cattell-Braasch maneuver Mobilization of the left colon and the right colon
3. Pelvic	Iliac vessels	Mobilization of the left colon and the right colon
4. Portal	Portal Vein Common hepatic artery	Examination of the hepatic hilum Cattell-Braasch maneuver
5. Retro-hepatic	Retro-hepatic Vena Cava Hepatic veins	Formal liver isolation Intra-aortic (REBOA) and intracaval (REBOC) balloon catheters

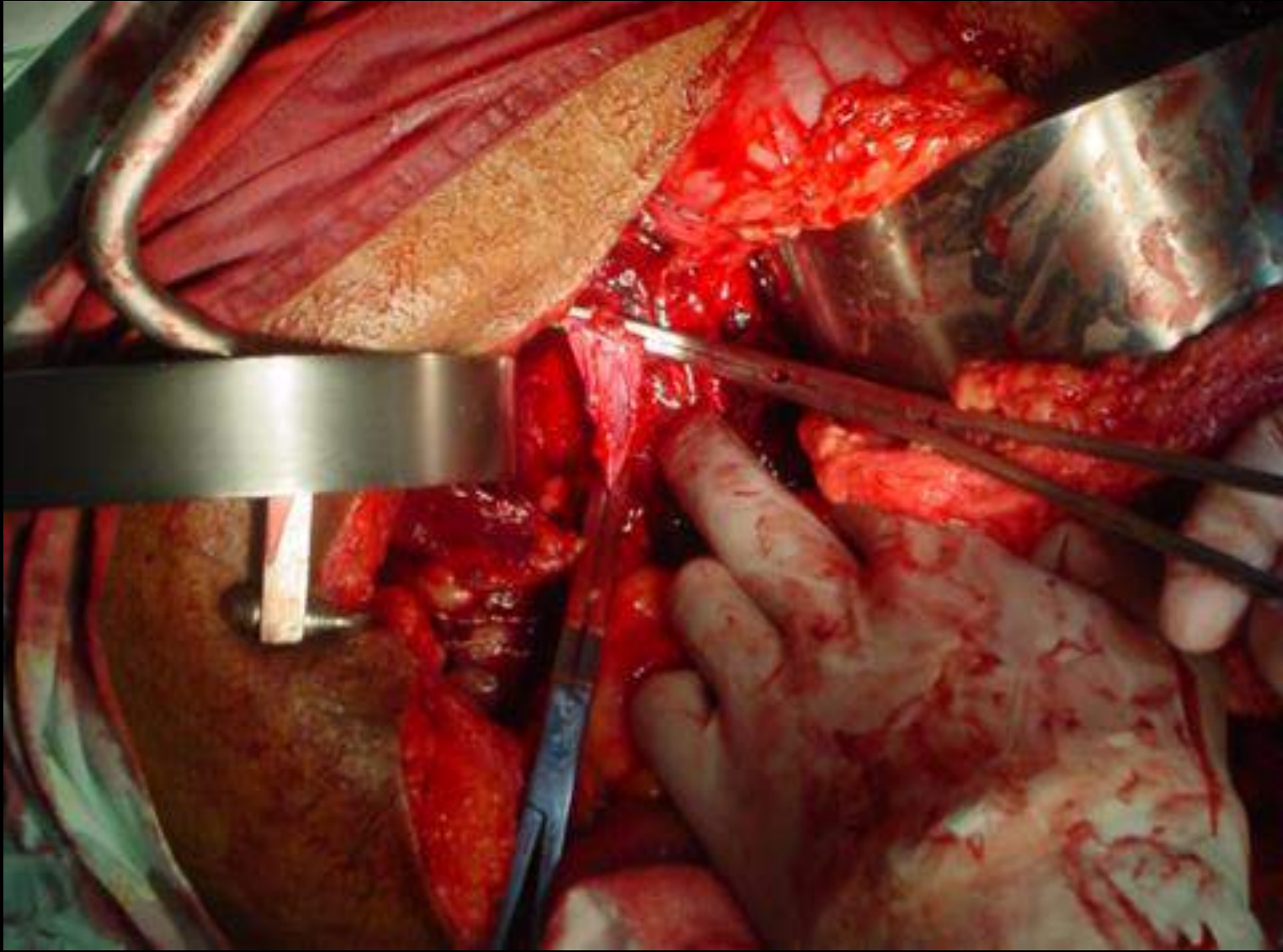
Table 3. Classification of retroperitoneal hematomas, probable associated vascular structures, and recommended approaches









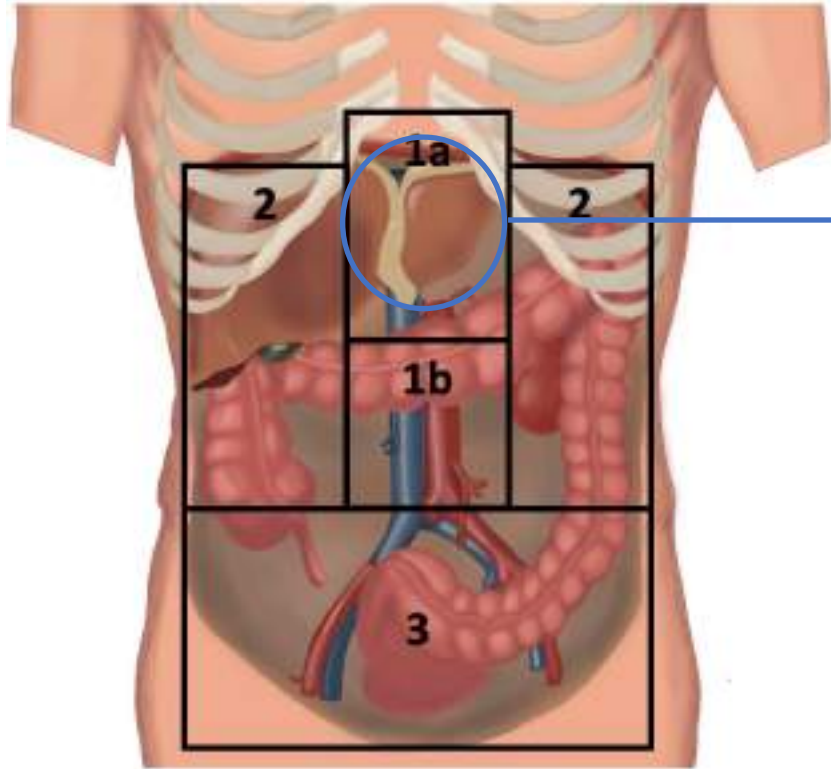






Surgical technique

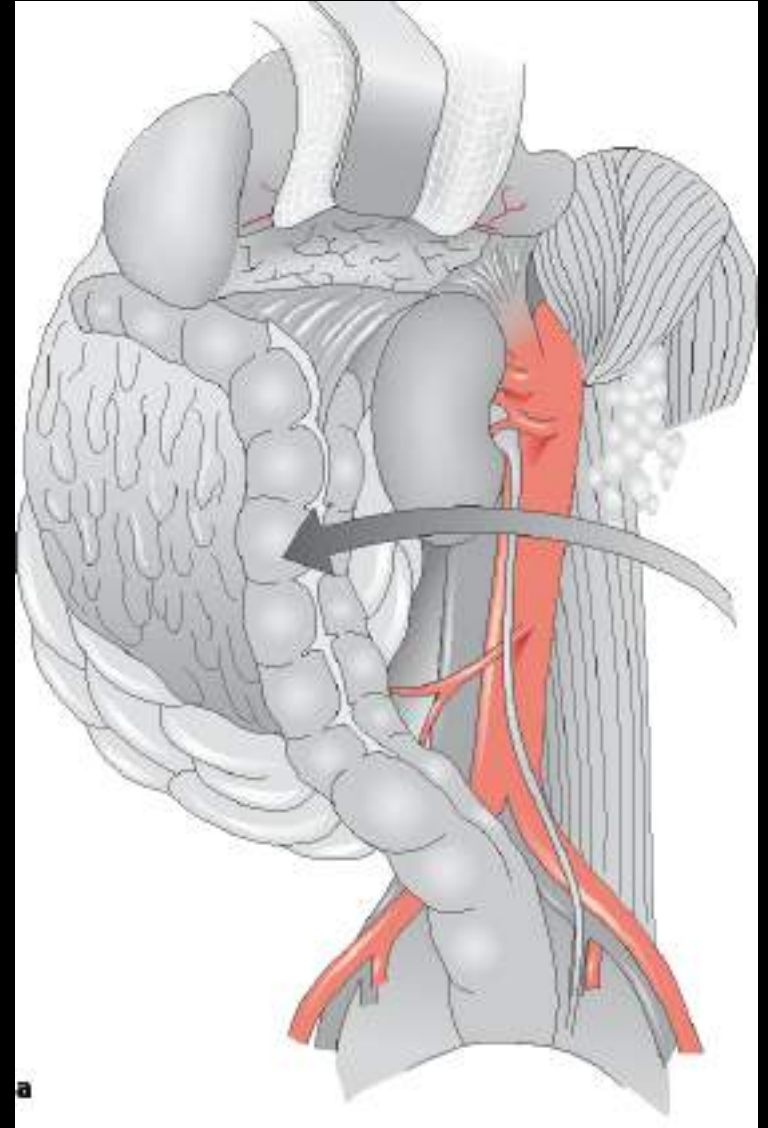
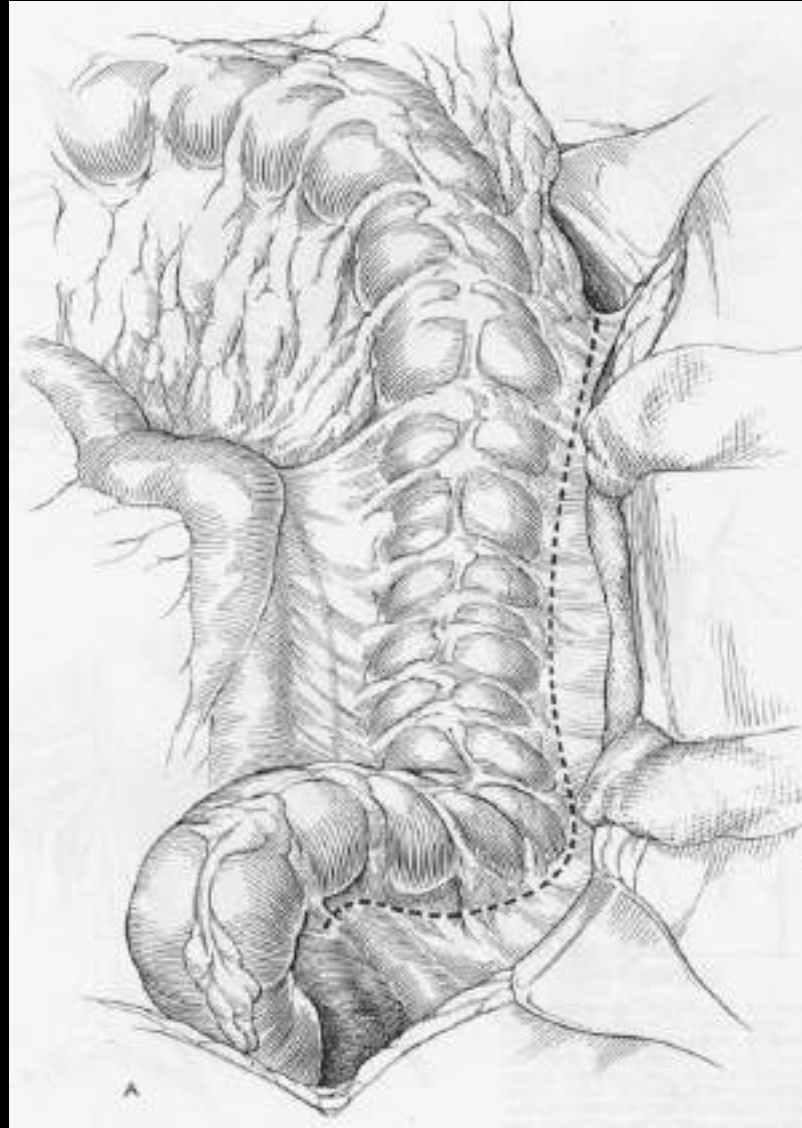
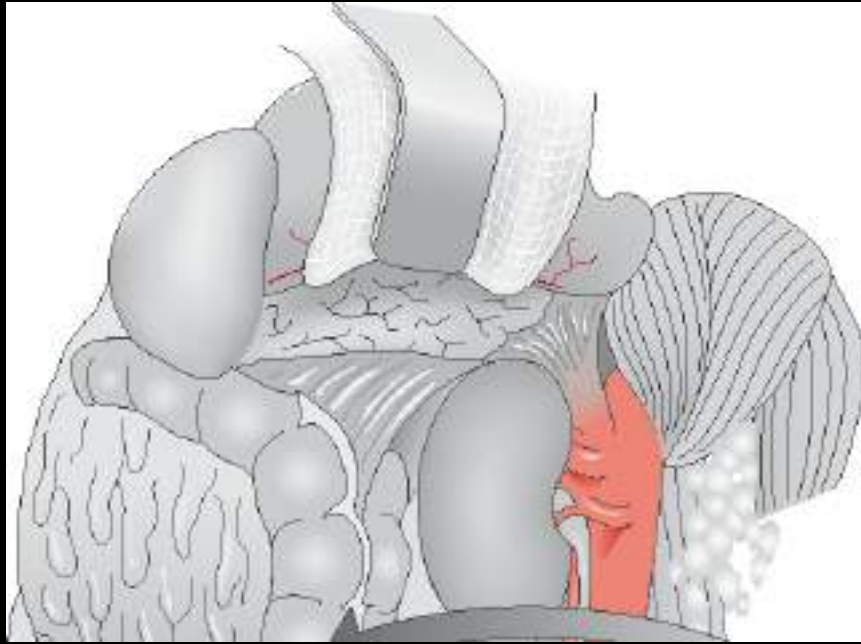
- Surgical approach
- Temporary control
- Proximal and distal control
- Repair

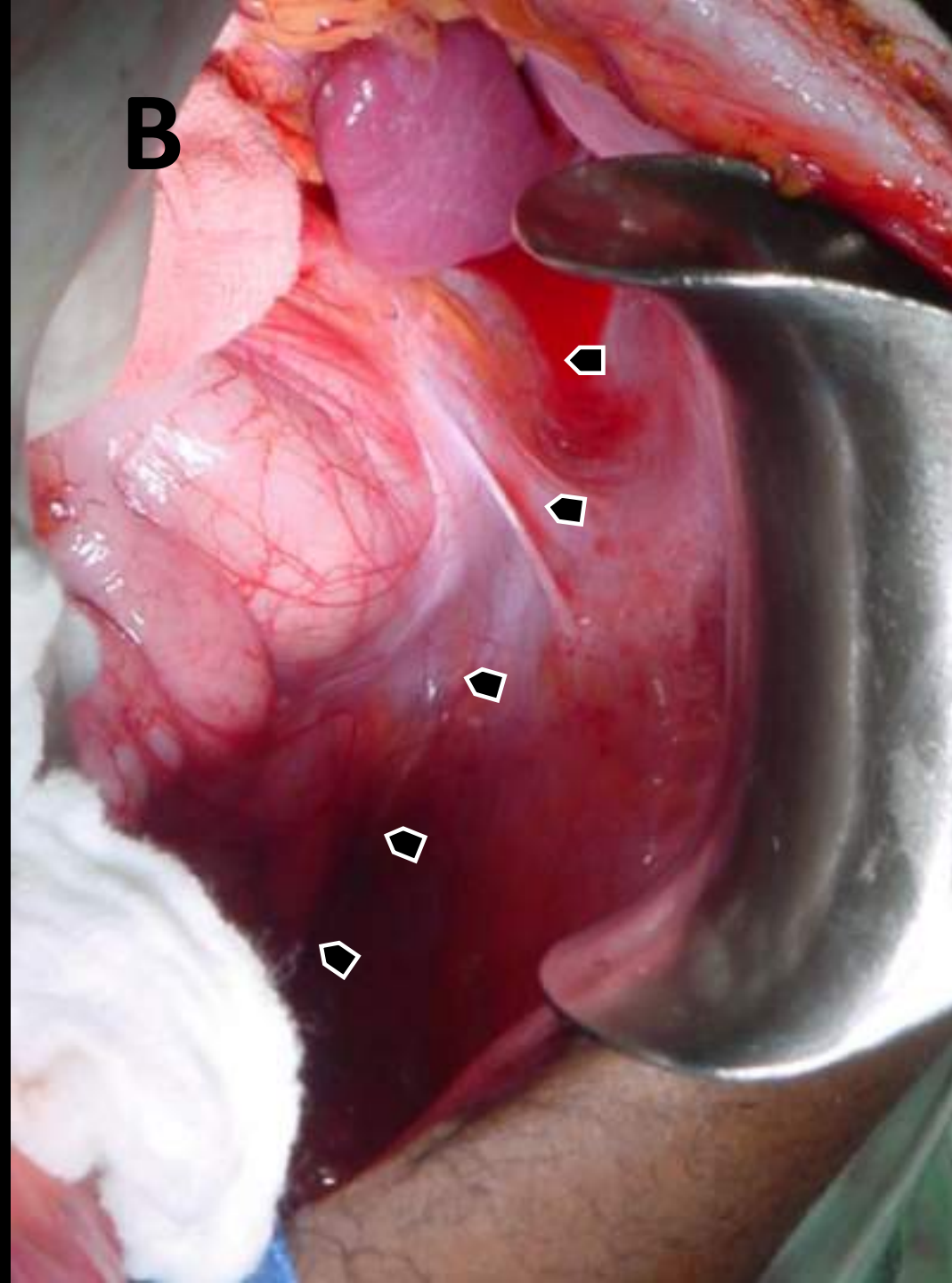
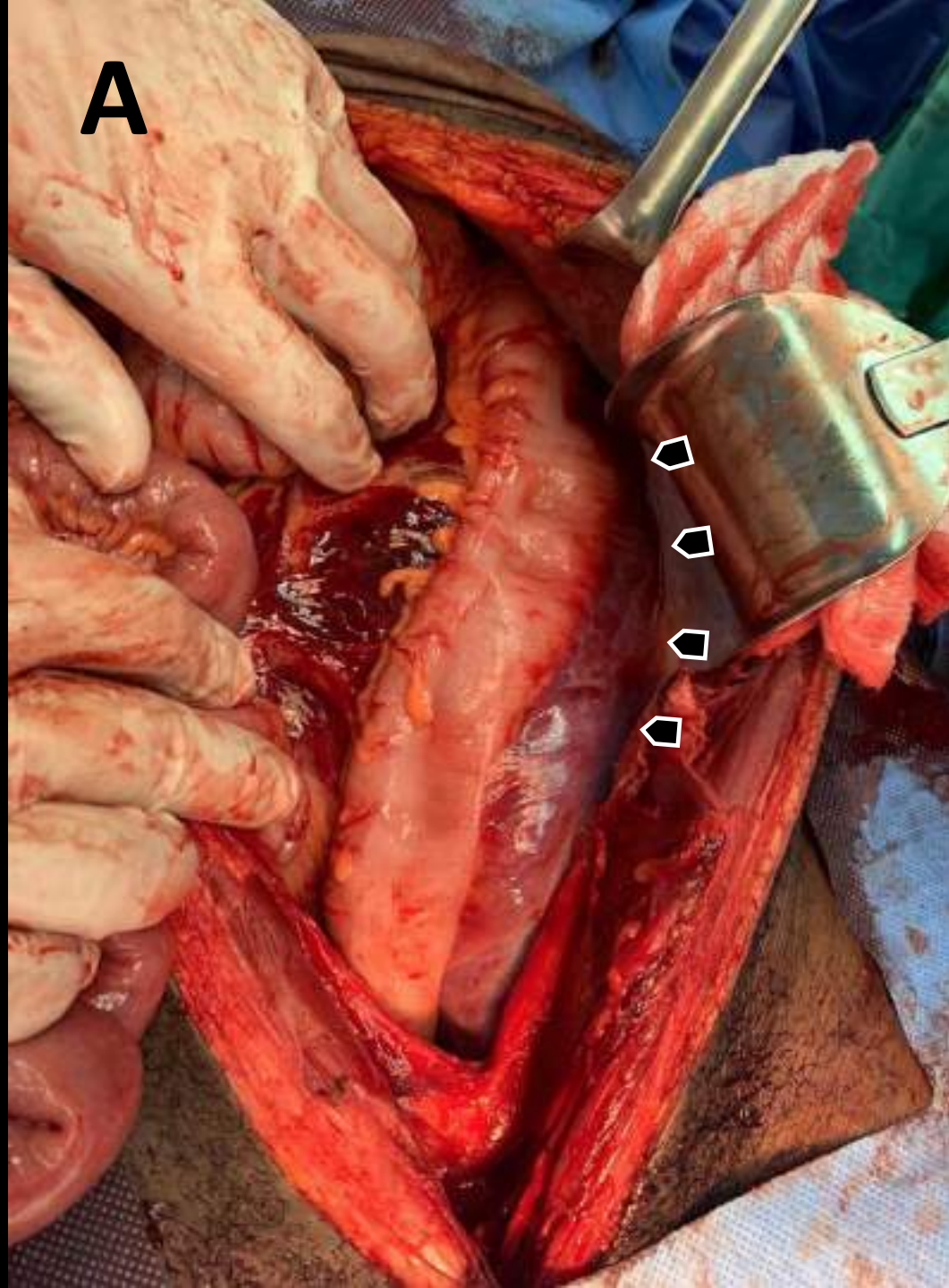


Supramesocolic Zone 1

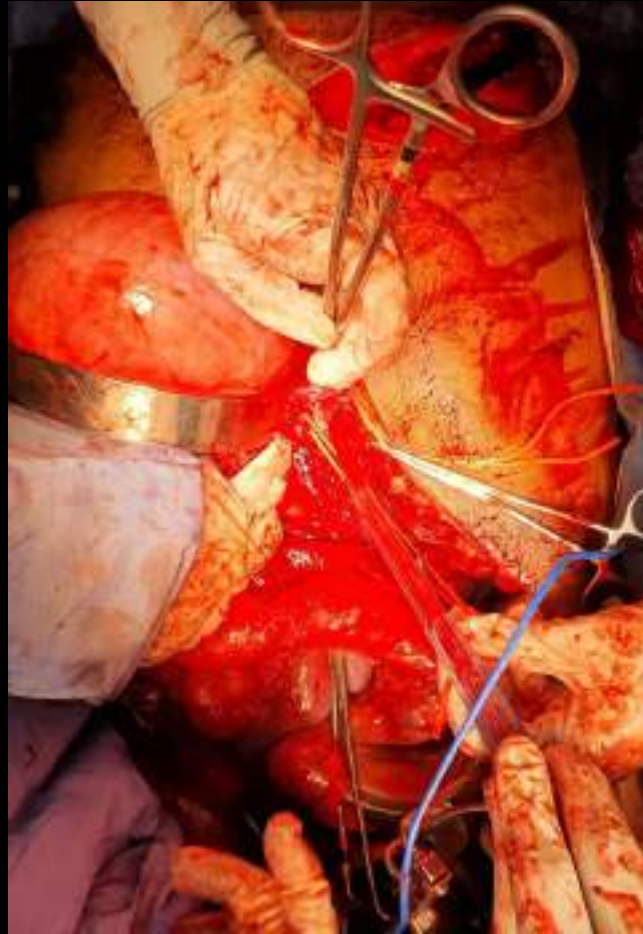
Supra-renal Aorta
Celiac axis & branches
Superior Mesenteric Artery
Proximal Renal vessels

Mattox Manouver

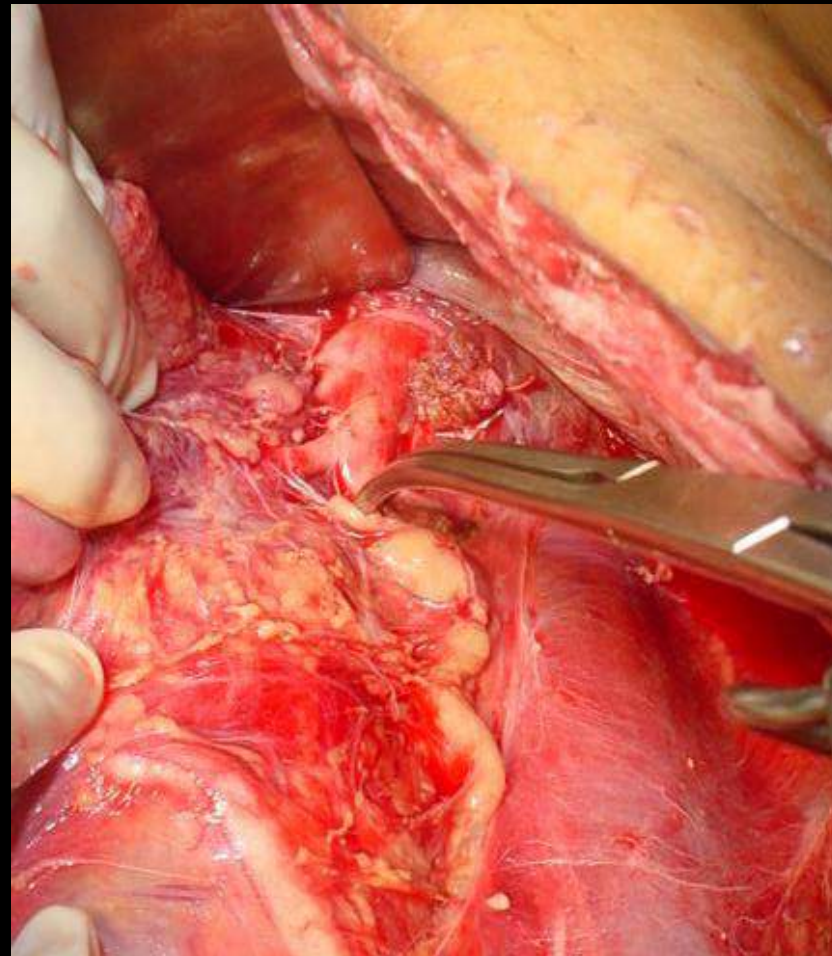
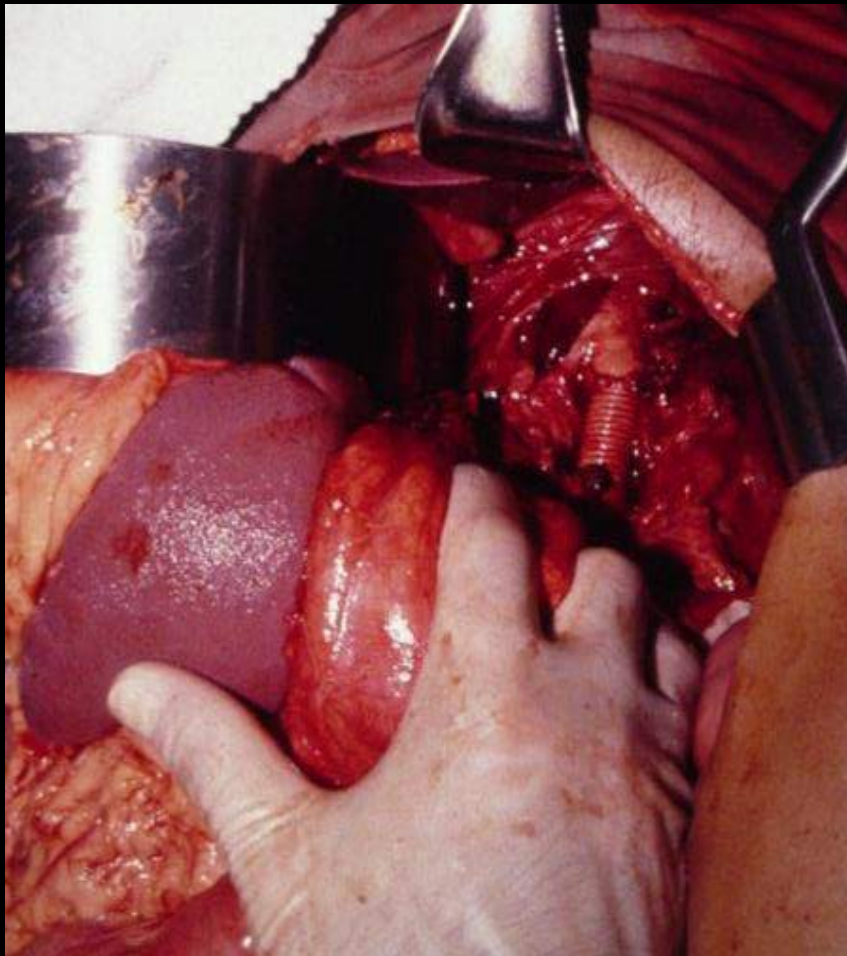




Temporary bleeding control



Definitive management



Associated injuries

Small bowel	31% - 51%
Colon	18% - 35%
Duodenum	14% - 15%
Liver	35% - 37%
Spleen	12% - 14%
Kidney	6% - 15%



J Trauma 1981; 81: 1040 – 44

South Med J 1985; 78: 1152 – 60

J Trauma. 2001; 50:1020-1026

Surgical technique

- Surgical approach
- Temporary control
- Proximal and distal control
- Repair



Damage control in abdominal vascular trauma

Alberto F. García, M.D, MSc

Cali, Colombia

Abdominal Vascular Trauma. Death by Exsanguination

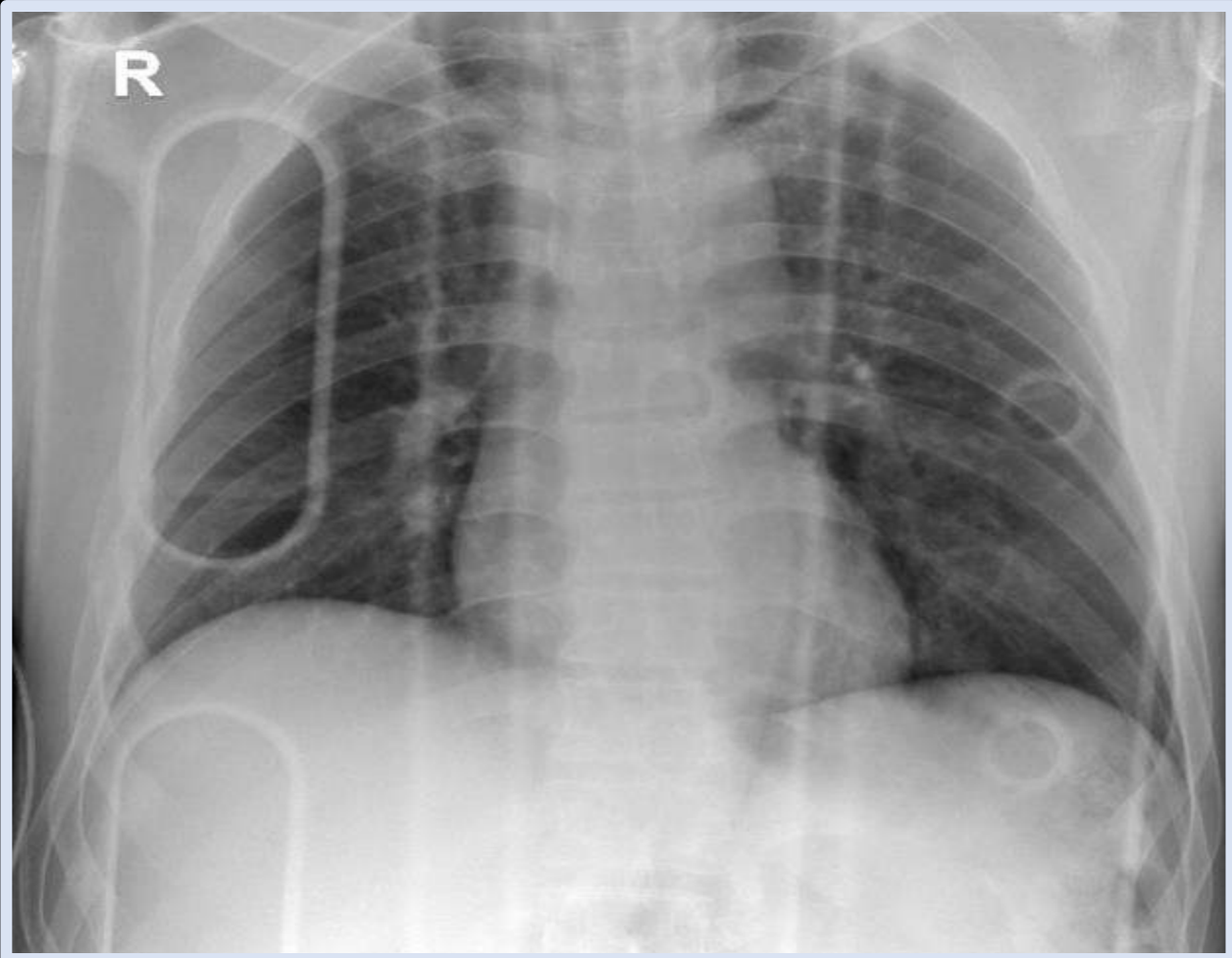
Year	Scenario	City	Cases	Mort	Exsang
1971	V. Cava	Houston	82	40%	79%
1981	Vascular Abdominal	Milwaukee	81	36%	70%
1982	Vascular Abdominal	Denver	123	37%	89%
1983	V. Cava	Denver	219	38%	95%
1985	Vascular Abdominal	Nashville	58	29%	85%
1986	Vascular Abdominal	Detroit	105	54%	88%
1990	Vasos Iliacos	Houston	233	28%	85%
1996	V. Cava	Johanesburg	74	39%	100%
1997	V. Cava	N. Y.	81	44%	100%
2000	Vascular Abdominal	L. A.	302	54%	84%
2001	A. Mesentérica sup	L. A.	250	39%	71%
2005	V. Cava	Cape Town	48	31%	80%
2010	Vascular Abdominal	Mineapolis	167	32%	89%
2012	Vascular Abdominal	Denver	64	33%	62%
2019	Vascular Abdominal	Bangkok	55	40%	73%



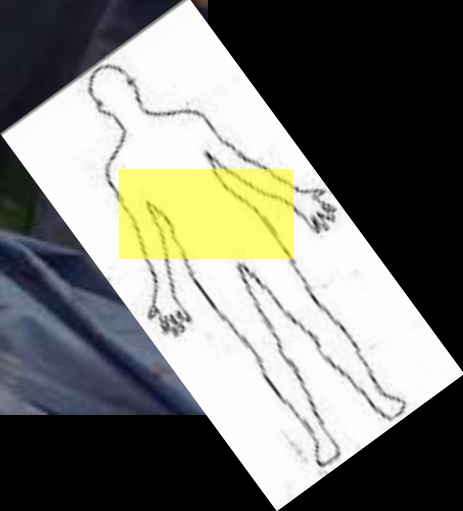
Case #2

- Male, 26 year old
- Blunt abdominal trauma
- 2 Lt. prehospital cristalloids
- B.P. 70/30 H.R. 120 R.R. 32 Glasgow 11
- Ecchymosis in abdominal wall
- Abdominal distension
- FAST (+)
- Resto del EF (-)

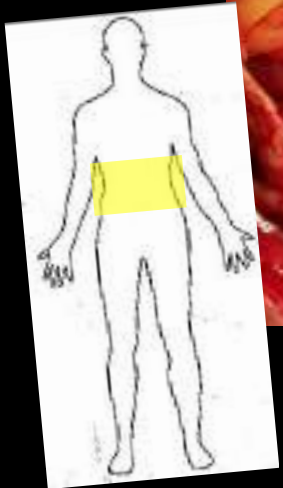
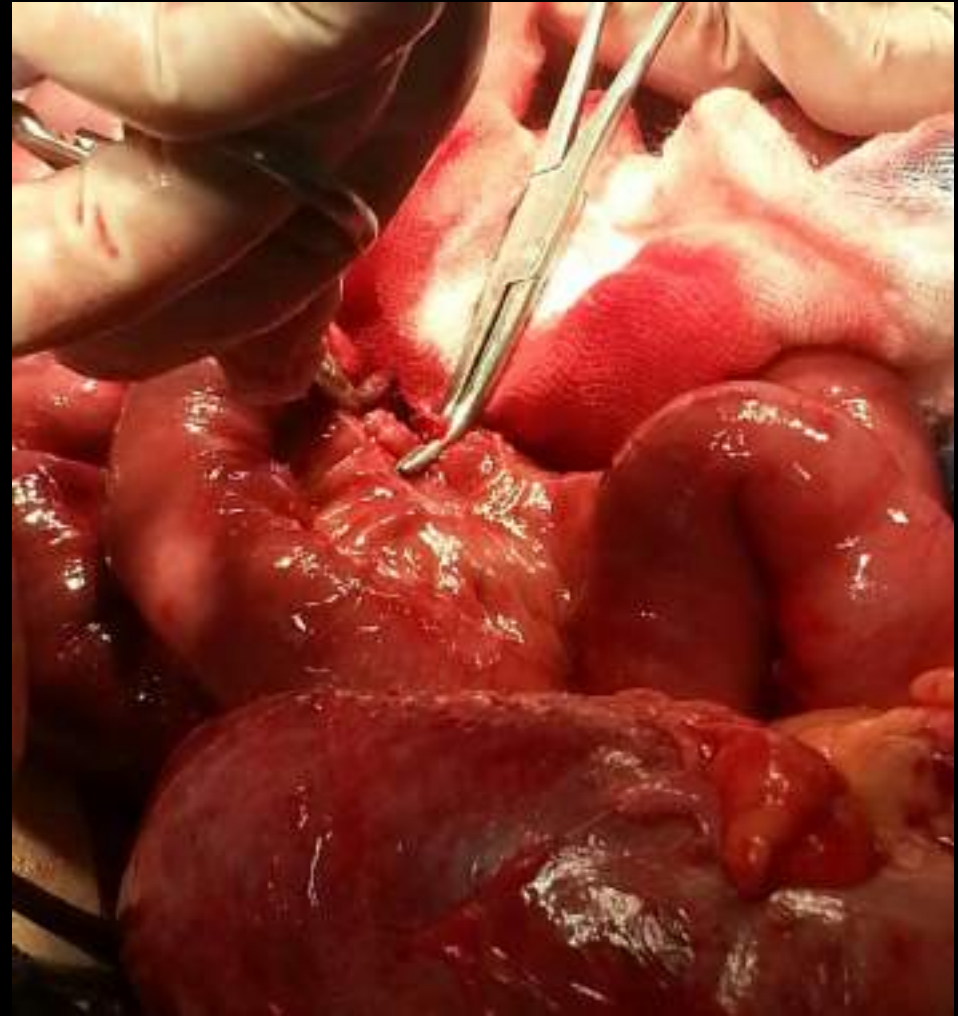
Damage control in abdominal vascular trauma



Damage control in abdominal vascular trauma



Damage control in abdominal vascular trauma



Case #2

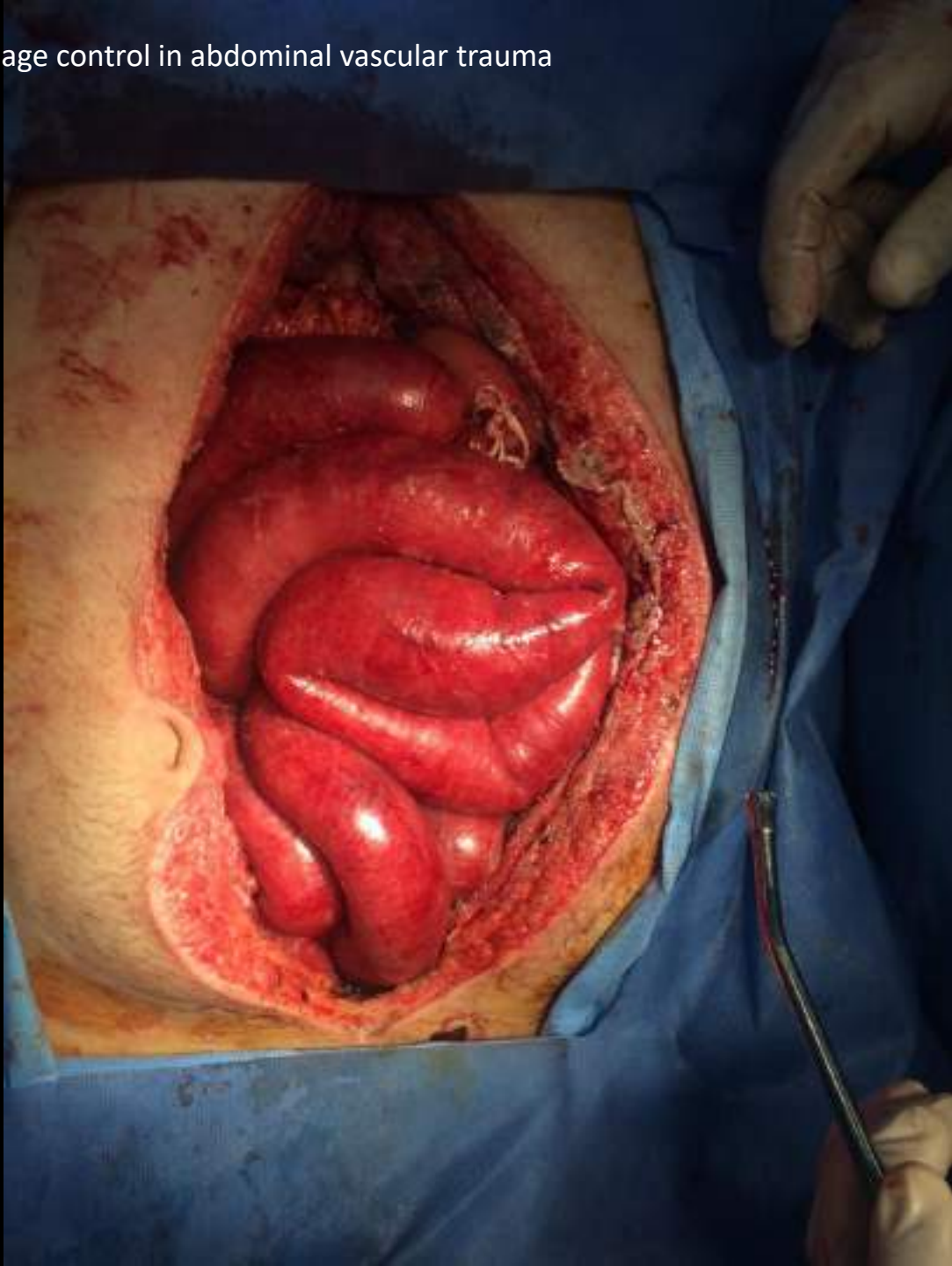
Reoperations

- 1st Reoperation (4 hours)
 - Mesenteric Hemostasis
 - Proximal ileum resection (30 cm) – ligation
 - Right hemicolectomy – ligation
- 2nd Reoperation (16 hours)
 - Distal ileum resection (150 cm) – ligation
 - Transverse and left colectomy. Rectal stump closure (Hartmann's)
- 3rd Reoperation (44 hours)
 - 3 intestinal resections – ligation
- 4th Reoperation (90 hours)
 - Intestinal congestion

1st day Transfusions

PRBC	23u
FFP	20u
Plt	3x6 apheresis
Cryo	63u

Damage control in abdominal vascular trauma



Case #2

Evolution

- 6th Reoperation (Day 6)
 - Jeyuno - jeyunal anastomosis (manual)
 - Jeyuno - jeyunal anastomosis (manual)
 - Ileorectal anastomosis (mechanical)
- 8th Reoperation (Day 14)
 - Filtration entero – enteric anastomosis
- 11th Reoperation (day 21)
 - Persistent enteric fistula. Rectal stump filtration
- 21th Reoperation (día 59)
 - Rectal stump fistula: spontaneous closure
 - Persistent enteric fistula

Case #2

Evolution

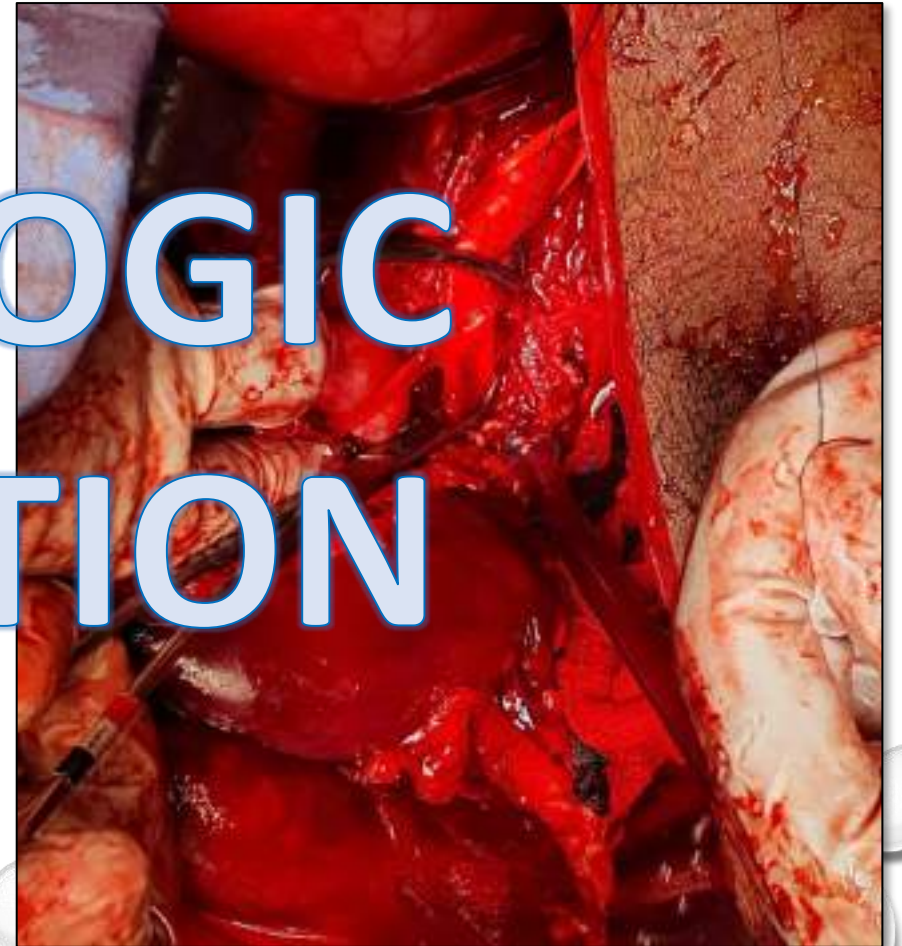
- Hospital discharge (Day 158)
 - Persistent oriented enteric fistula
 - Ambulatory parenteral nutrition
 - Enterostomal therapy
 - Physycal rehabilitation
- Surgical fistula closure (Day 243)
- Eventrorrhaphy with anterior components separation (day 248)

Damage control in abdominal vascular trauma

DEFINITION

- Abbreviated surgery
 - Hemorrhage control
 - Restoring vascular permeability
 - Contamination control
 - Abbreviated abdominal closure
- Reanimation
- Scheduled Reoperation (s)/ Reconstruction

PHYSIOLOGIC
EXHAUSTION



Damage control decision

Indications
Physiological parameter
Glasgow <14
Temperature < 35°C at the beginning of surgery
Arterial pH <7.2
Base deficit >8 mmol/L
Lactate >5 mmol/L
Clinical pattern - surgical finding
Requirement of resuscitative thoracotomy
Hemoperitoneum >1.5L
NISS >35
Retrohepatic cava lesion
Suprarenal abdominal aortic injury
Portal vein injury
Injury of two or more vessels
Clinical coagulopathy



J Trauma Acute Care Surg 2012, 73: 1074
J Am Coll Surg 2016, 223 4s2: 197
Ann Surg 2016, 263 (5):1018

Damage control procedures

- Vascular Trauma
 - Ligation
 - Shunts
 - Packing
 - Retained clamp
- Non-vascular injuries
 - Intestinal ligation
 - Deliberate missing of injuries
 - Not conventional abdominal closure

Ligation permitted

Low risk of complications

Veins

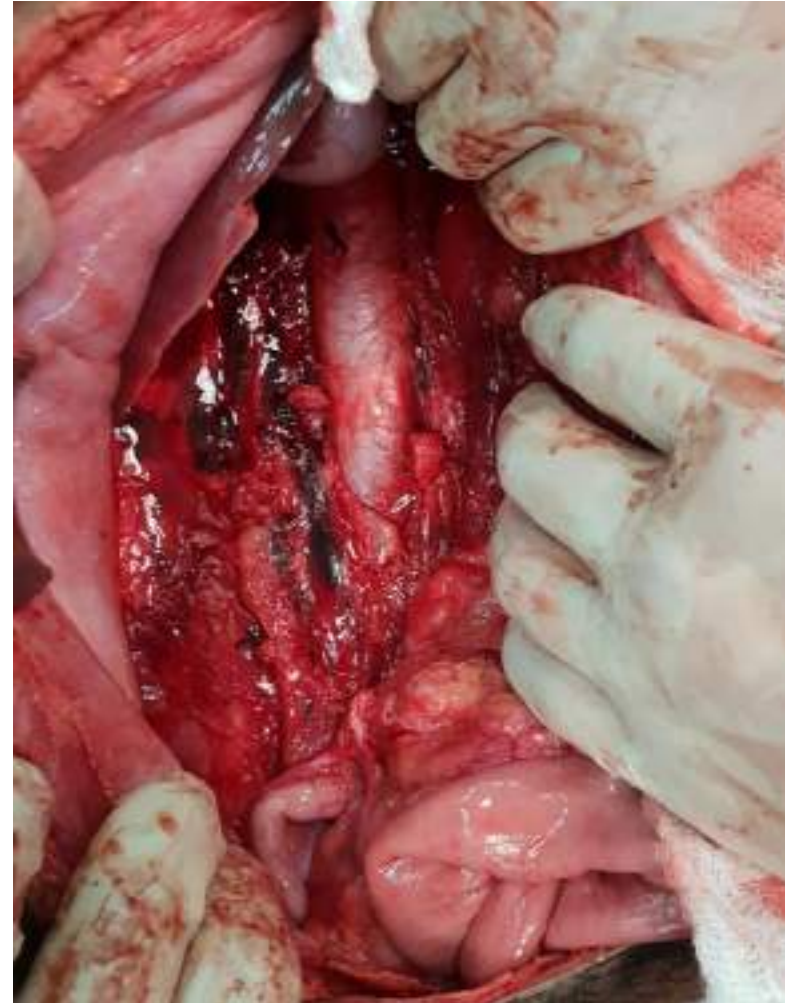
- Infra-renal cava
- Iliacs
- Left renal
- Inferior mesenteric
- Splenic

Arteries

- Celiac trunk
- Hepatic
- Inferior mesenteric
- Internal Iliac

In special circumstances

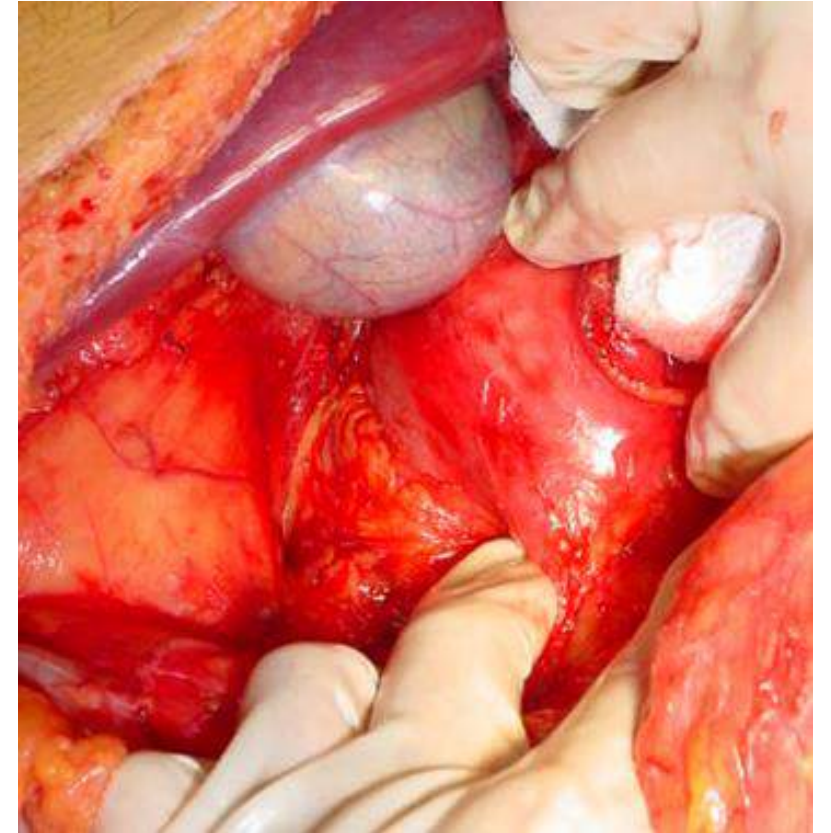
- Portal Vein
 - Infra-hepatic cava vein
 - Superior mesenteric artery
 - Superior mesenteric vein
-



Portal vein trauma

Bleeding control & approach

- Supraduodenal
 - Pringle's maneuver
- Retropancreatic
 - Kocher's maneuver
 - Pancreatic section



Portal vein trauma

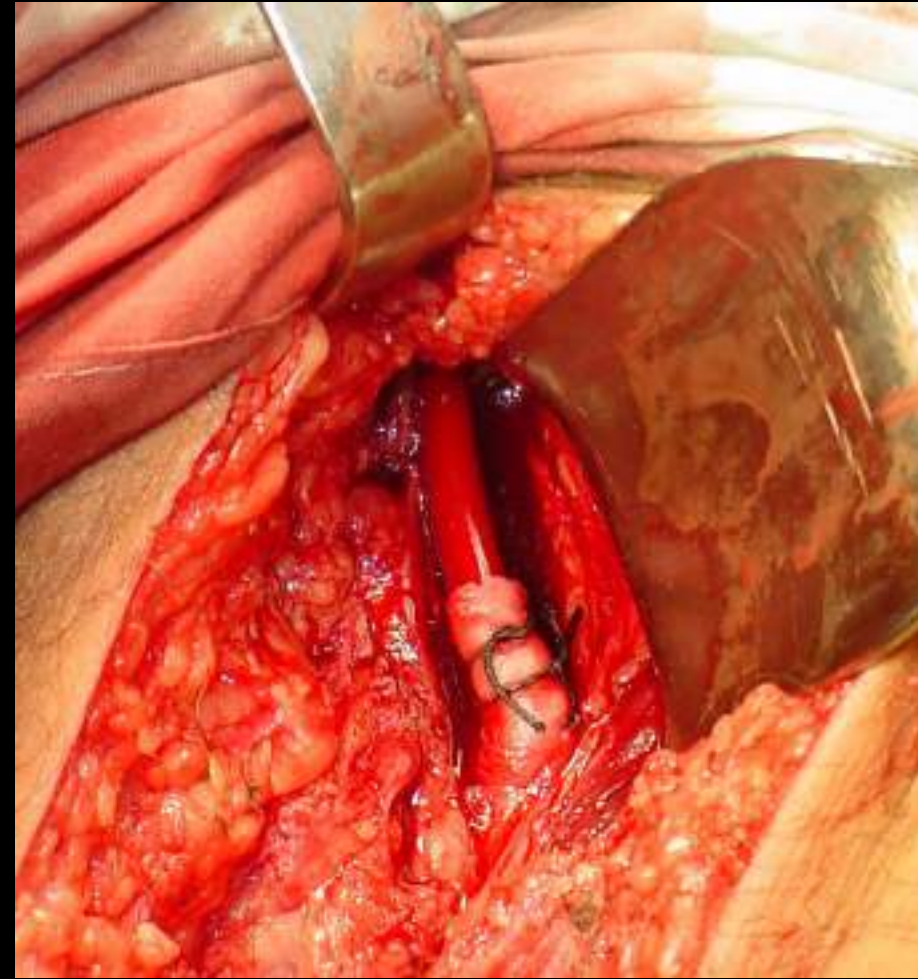
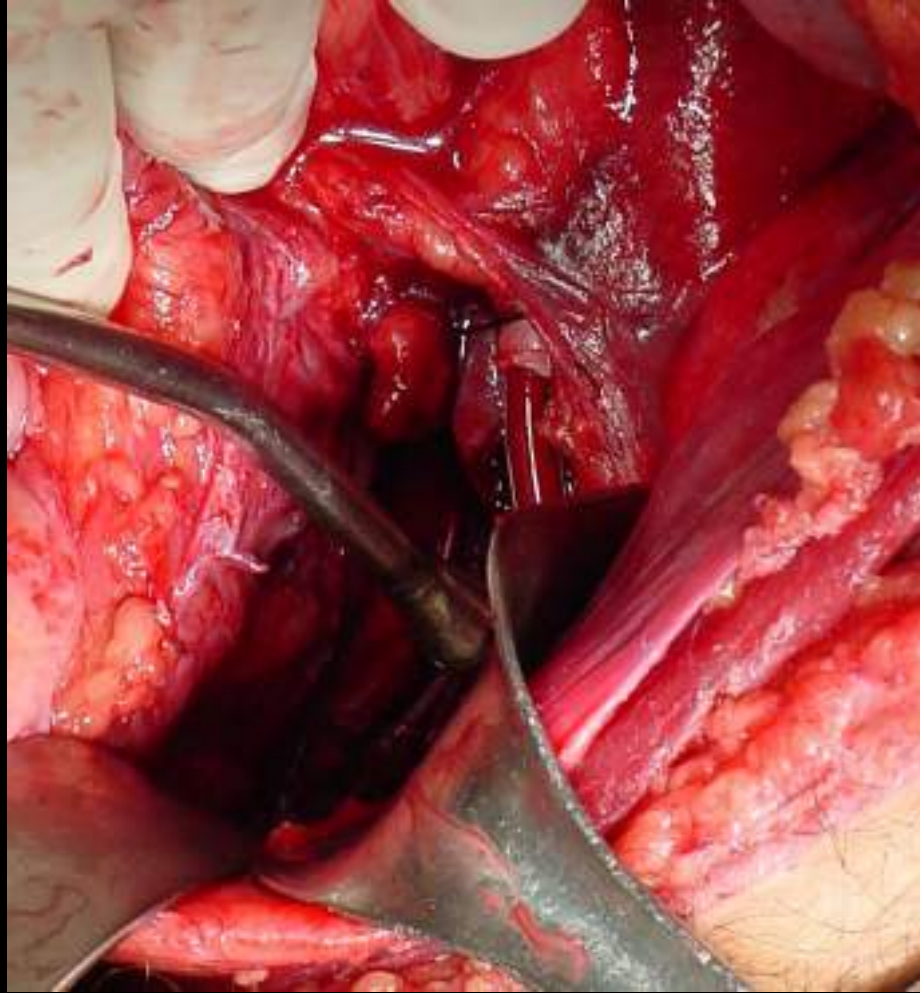
Surgical treatment

- Favorable anatomy & physiology
 - Consider repair
- Unfavorable anatomy & physiology
 - Consider ligation
- Ligation effect
 - Similar mortality
 - Low risk of portal hypertension
 - Low risk of ischemic complications

Damage control in abdominal vascular trauma



Damage control in abdominal vascular trauma



Damage control in abdominal vascular trauma



Multicenter evaluation of temporary intravascular shunt use in vascular trauma

Kenji Inaba, MD, Hande Aksoy, MD, Mark J. Seamon, MD, Joshua A. Marks, MD, Juan Duchesne, MD, Rebecca Schroll, MD, Charles J. Fox, MD, Fredric M. Pieracci, MD, MPH, Ernest E. Moore, MD, Bellal Joseph, MD, Ansab A. Haider, MD, John A. Harvin, MD, Ryan A. Lawless, MD, Jeremy Cannon, MD, SM, Seth R. Holland, DSc, Demetrios Demetriades, MD, PhD, and the Multicenter Shunt Study Group, Los Angeles, California

TABLE 2. Shunted Vessels

	n	Argyle	Feeding/ Nasogastric Tube	Chest Tube	Pruitt- Inahara
Extremity					
Axillary artery	9	8	0	0	1
Brachial artery	28	26	0	0	2
Brachial vein	1	1	0	0	0
Radial artery	3	2	1	0	0
Ulnar artery	1	1	0	0	0
Common femoral artery	21	20	0	1	0
Femoral vein	3	1	0	0	2
Superficial femoral artery	51	46	0	1	4
Popliteal artery	40	28	2	0	10
Popliteal vein	3	2	0	0	1
	160	135	3	2	20
Trunk					
Aorta	11	0	0	11	0
Inferior vena cava	1	0	0	1	0
Carotid artery	8	8	0	0	0
Subclavian artery	3	3	0	0	0
Portal vein	1	1	0	0	0
Superior mesenteric artery	3	3	0	0	0
Superior mesenteric vein	1	1	0	0	0
Iliac artery	24	22	1	1	0
Iliac vein	1	0	0	1	0
	53	38	1	14	0

Multicenter evaluation of temporary intravascular shunt use in vascular trauma

Kenji Inaba, MD, Hande Aksoy, MD, Mark J. Seamon, MD, Joshua A. Marks, MD, Juan Duchesne, MD, Rebecca Schroll, MD, Charles J. Fox, MD, Fredric M. Pieracci, MD, MPH, Ernest E. Moore, MD, Bellal Joseph, MD, Ansab A. Haider, MD, John A. Harvin, MD, Ryan A. Lawless, MD, Jeremy Cannon, MD, SM, Seth R. Holland, DSc, Demetrios Demetriades, MD, PhD, and the Multicenter Shunt Study Group, Los Angeles, California

TABLE 4. Final Conduit

	n	Death Before Removal	RSVG	PTFE/Dacron	Primary Repair/Ligation
Extremity					
Axillary artery	9	2	7	0	0
Brachial artery	28	2	26	0	0
Brachial vein	1	0	0	0	1
Radial artery	3	0	2	0	1
Ulnar artery	1	1	0	0	0
Common femoral artery	21	2	13	6	0
Femoral vein	3	1	1	1	0
Superficial femoral artery	51	6	33	10	2
Popliteal artery	40	1	38	0	1
Popliteal vein	3	0	3	0	0
	160	15	123	17	5
Trunk					
Aorta	11	10	1	0	0
Inferior vena cava	1	1	0	0	0
Carotid artery	8	0	2	5	1
Subclavian artery	3	2	1	0	0
Portal vein	1	0	0	1	0
Superior mesenteric artery	3	0	3	0	0
Superior mesenteric vein	1	0	1	0	0
Iliac artery	24	13	3	7	1
Iliac vein	1	0	0	0	1
	53	26	11	13	3

RSVG, reverse saphenous vein graft.

- 1st Surgery in other hospital
- Male, 26 Years
- Gunshot wound in right hemithorax
- Tamponade
- Right thoracotomy-cardiorrhaphy
- Persistent shock -> transferece

- On admission: pale, cold, undetectable blood pressure
- Thoracostomy: no bleeding



Massive transfusion protocol
Resuscitation in the
operating room.

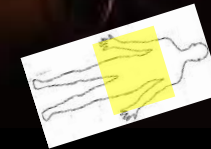
REBOA (open)

LAPAROTOMY

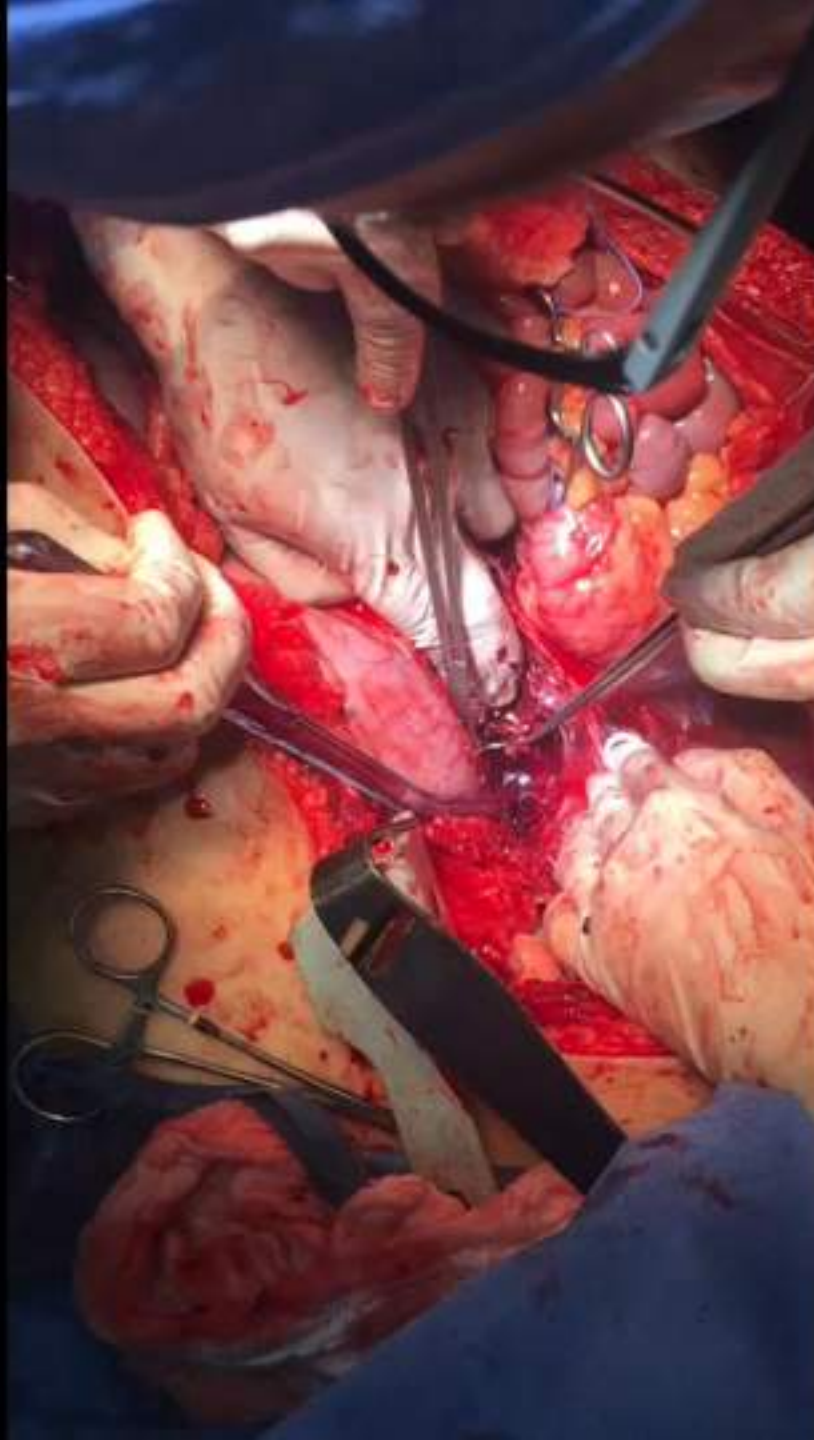
- Retrohepatic dark bleeding
- Compression
- **REBOC (Open)**
- Hepatic mobilization

THORACOTOMY

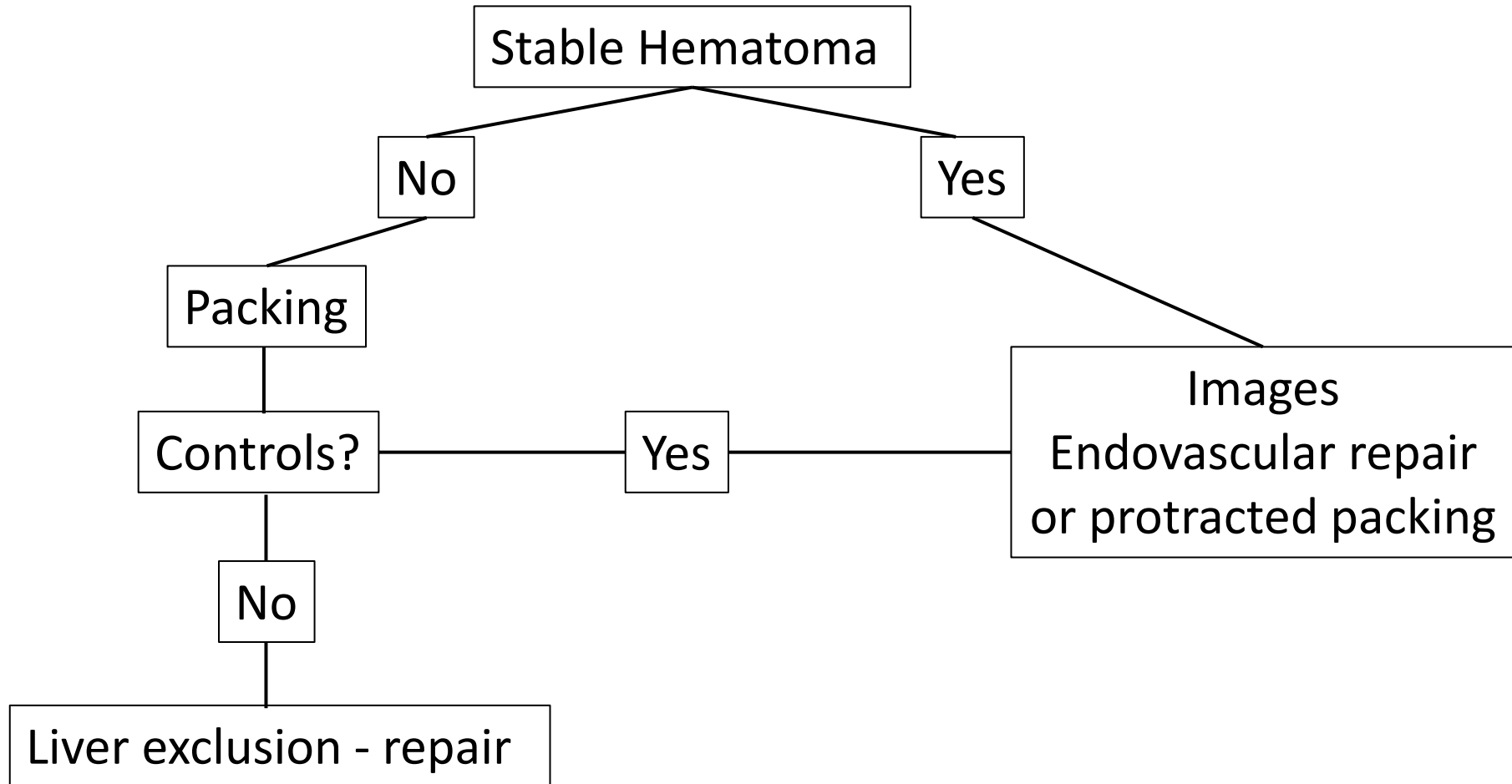
- Frenotomy
- Intrapericardic cava repair
- Hepatic exclusion



Damage control in abdominal vascular trauma



Approach to suprahepatic hematoma/bleeding



Temporary abdominal closure

What is the effectiveness of the negative pressure wound therapy (NPWT) in patients treated with open abdomen technique?
A systematic review and meta-analysis

Roberto Cirocchi, MD, PhD, Arianna Birindelli, MD, Walter L. Biffl, MD, Ventsislav Mutafchiyski, DSci,
Georgi Popivanov, PhD, Osvaldo Chiara, MD, Gregorio Tugnoli, MD, PhD,
and Salomone Di Saverio, MD, *Bologna, Italy*

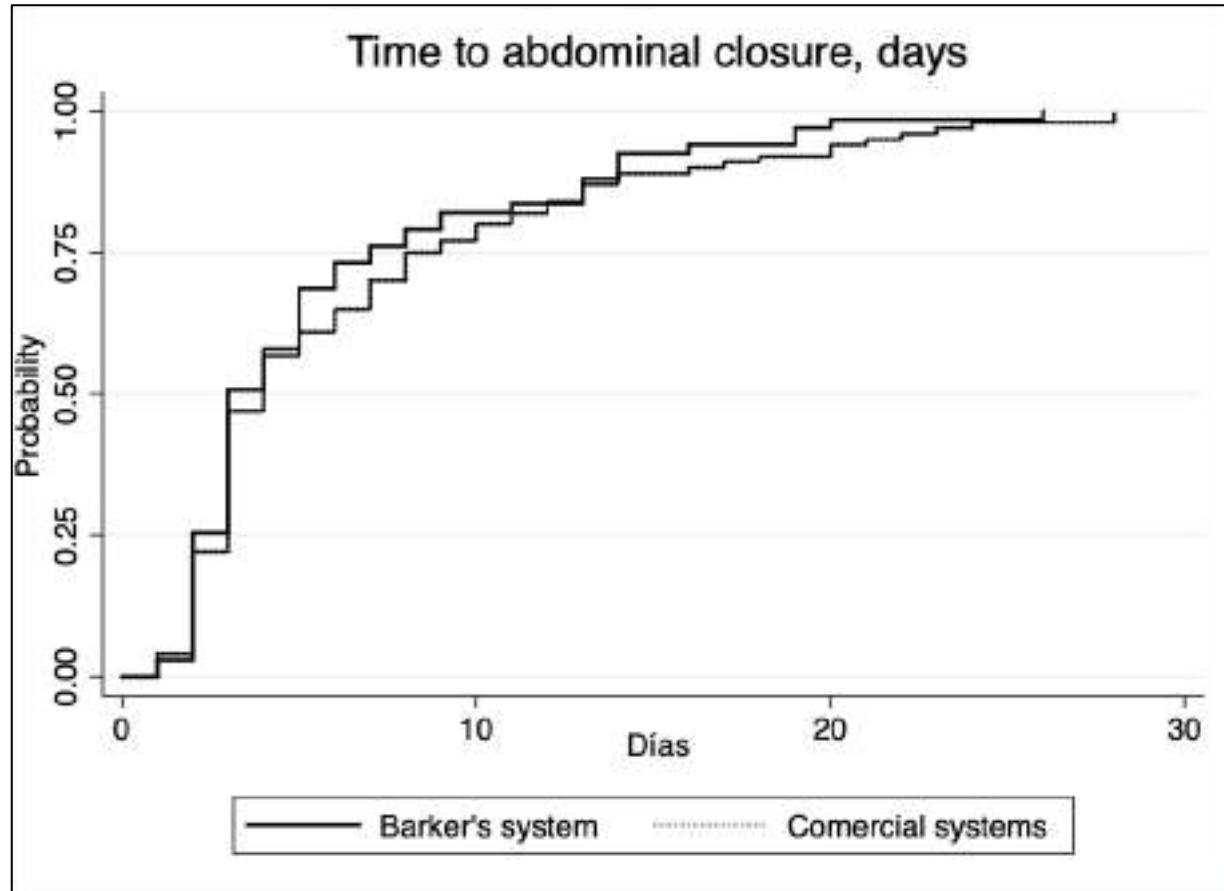
- Low quality evidence
- Better outcomes?
- Similar results
 - Reoperations (bleeding)
 - Closure probability
 - Fistula
 - ICU & hospital stay



Comparison of Barker's and Comercial Systems In Damage Control Laparotomy in Trauma

Fundación Valle del Lili 2012 - 2021

75 vs 109



Abdominal vascular trauma

- Early recognition
- Surgical approach
- Temporary control
- Proximal and distal control
- Repair
- Early consideration of damage control



Reoperations and reconstruction

- Emergency
 - Hemorrhage
 - Abdominal compartment syndrome
 - Sepsis
- Scheduled
 - Physiologic optimization
 - Need to revascularize
 - Intestinal viability evaluation



Summary

