Complex hepatic trauma

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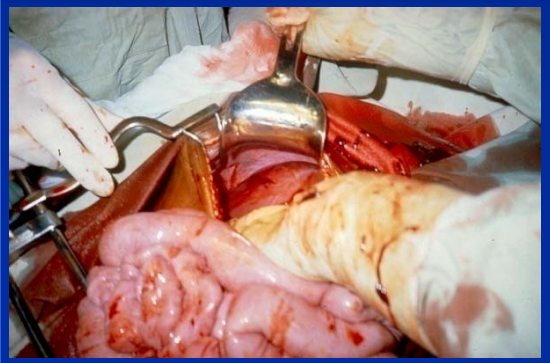
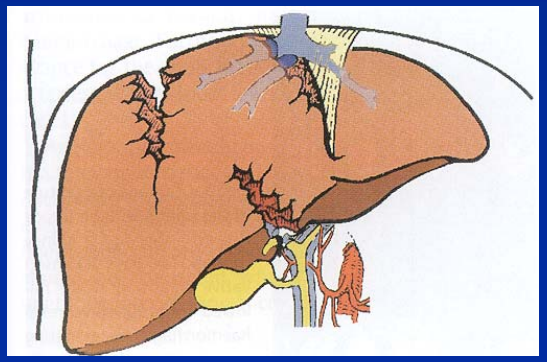




Liver Injury Scale

I - subcapsular (<10%) hematoma, <1cm laceration

II - subcapsular (10-50%), intraparenchymal (<10 cm) hematoma
- 1-3 cm deep laceration (<10 cm long)

III - subcapsular (>50% or exp.), intraparenchymal (>10 cm or exp.) or ruptured hematoma
- >3cm deep laceration

IV - parenchymal disruption (25-75% of lobe or 1-3 segments in one lobe)

V - parenchymal disruption (>75% of lobe, >3 segments)
- juxtahepatic venous injury, hepatic avulsion

Moore et al. 1995

Management strategy of liver injuries

- same principles apply to blunt and penetrating injuries
- unstable hemodynamics
  - urgent laparotomy → intraoperative assessment of all injuries → definitive repair or damage control
- stable hemodynamics
  - assessment of severity and other injuries (CT)

  → nonoperative management
    - adjuncts: angiography, endoscopy

  → operative management
    - “surgical” injuries, failed NOM

Severe hepatic trauma: Nonoperative management, definitive repair, or damage control surgery?

- n = 144 Grade III-V liver injuries (94% blunt)
- mean ISS 31, shock on admission 56 (39%)
- early laparotomy 50 (35%)
  - damage control 21 (42% of all operated injuries)
  - definitive repair 22 (44% of all operated injuries)
  - non-therapeutic 7
- nonoperative management 94 (65%)
  - failed 8 (9% of NOM patients)

Leppäniemi et al. WJS 2011;35:2643

Complex liver injuries (Helsinki)

Factors predicting early laparotomy for blunt trauma patients (univariate analysis)

	OR	95% CI
Shock on admission	30.72	11.00-85.8
Splenic injury grade 4-5	3.86	1.03-14.5
Head injury grade 4-5	3.54	1.46-8.59
Liver injury grade 5	3.5	0.83-10.82
Multiple injury	3	0.83-10.82
Liver injury grade 4-5	0.92	0.43-1.93
Renal injury grade 4-5	0.82	0.24-2.73

Leppäniemi et al. WJS 2011;35:2643

CT risk factors for operative treatment in initially stable patients with blunt liver trauma (n=214)

- more frequent findings in operated patients:
  - intraperitoneal contrast extravasation
  - hemoperitoneum in 6 compartments
  - maceration > 2 segments, high liver injury grade
  - deep laceration (>5 cm), porta hepatis involvement
- logistic regression:
  - extravasation = continuous bleeding (RR 12.5)
  - hemoperitoneum = massive bleeding (RR 22)

Fang et al. 2006

Complex liver injuries (Helsinki)

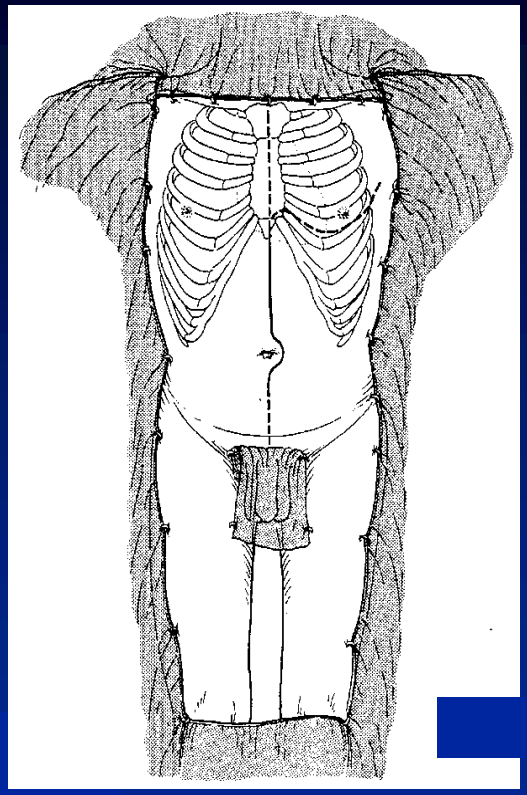
Factors predicting failure (9%) of NOM (univariate analysis)

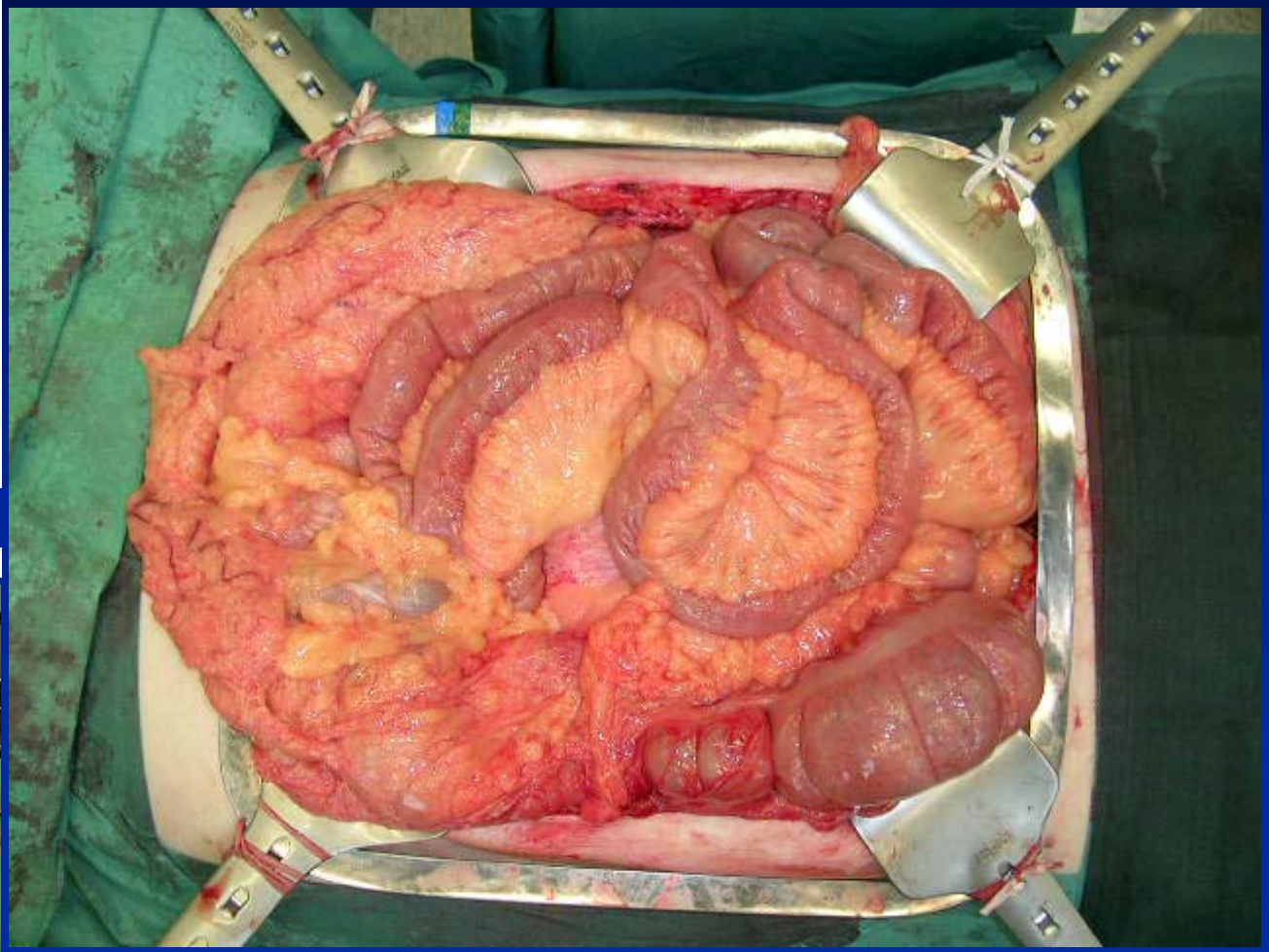
	OR	95% CI
Associated Grade 4-5 splenic injury	14.00	1.67-117.55
Shock on admission	6.82	1.49-31.29
Renal injury grade 4-5	2.85	0.5-16.3
Multiple injury	1.72	0.2-14.98
Head injury grade 4-5	0.97	0.11-8.69
Liver injury grade 4-5	0.62	0.15-2.66

Leppäniemi et al. WJS 2011;35:2643

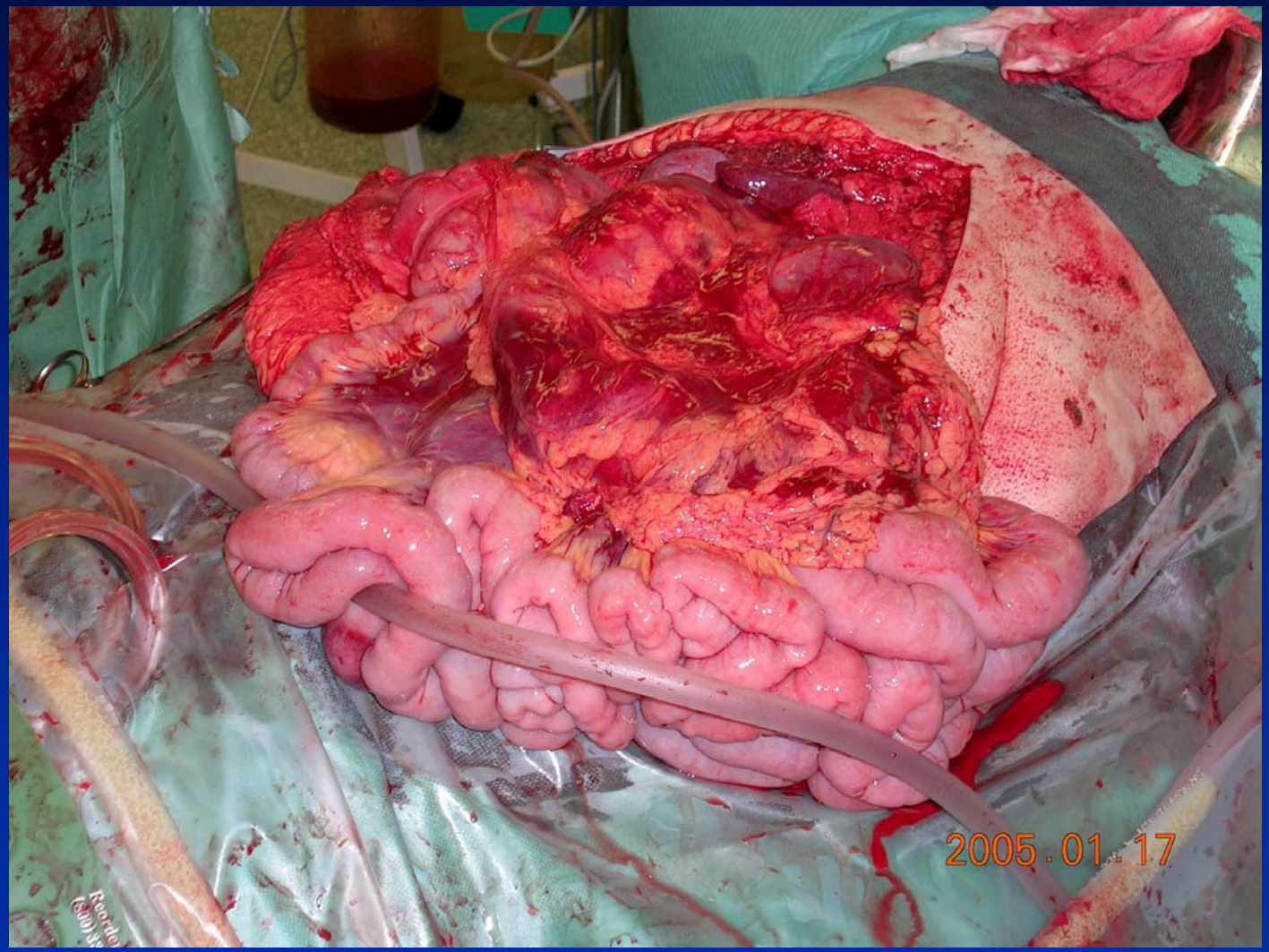
Key surgical techniques

Incision

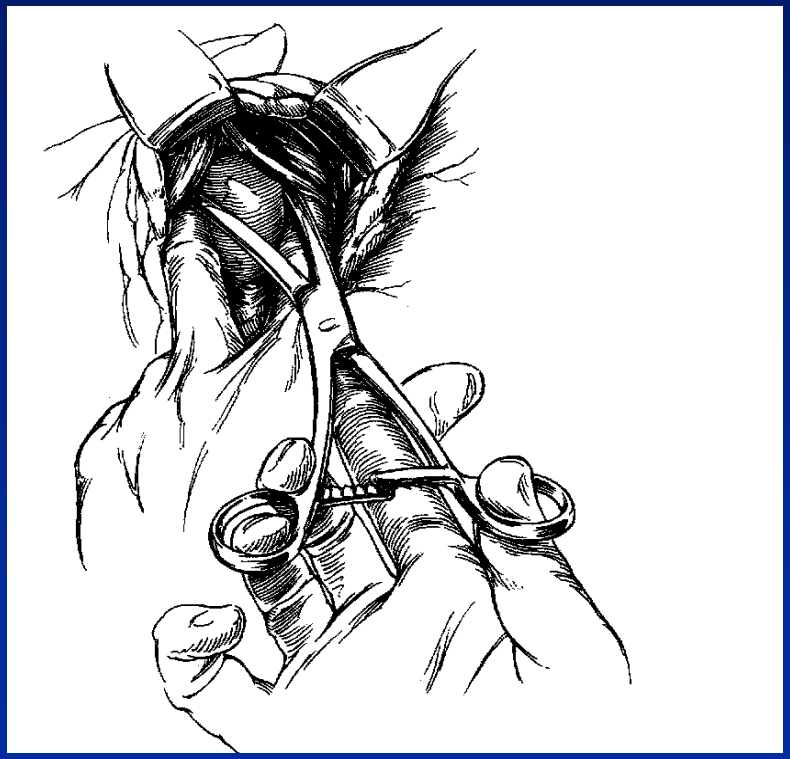


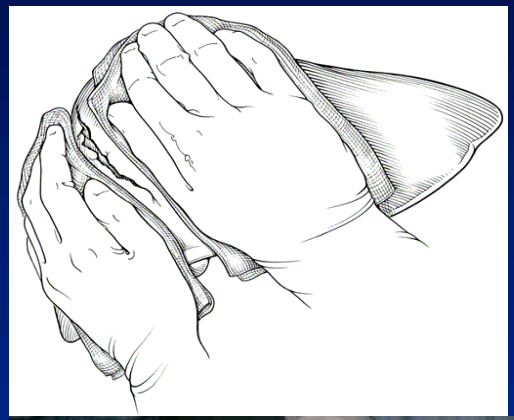


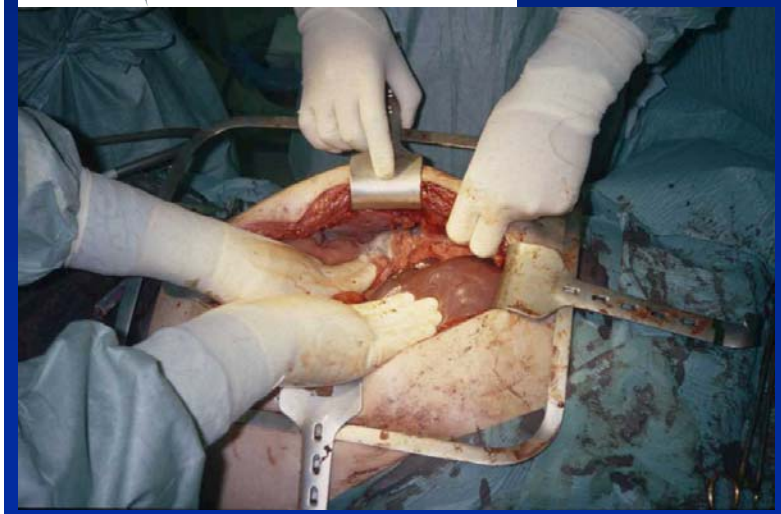
Massive bleeding



hemorrhage!





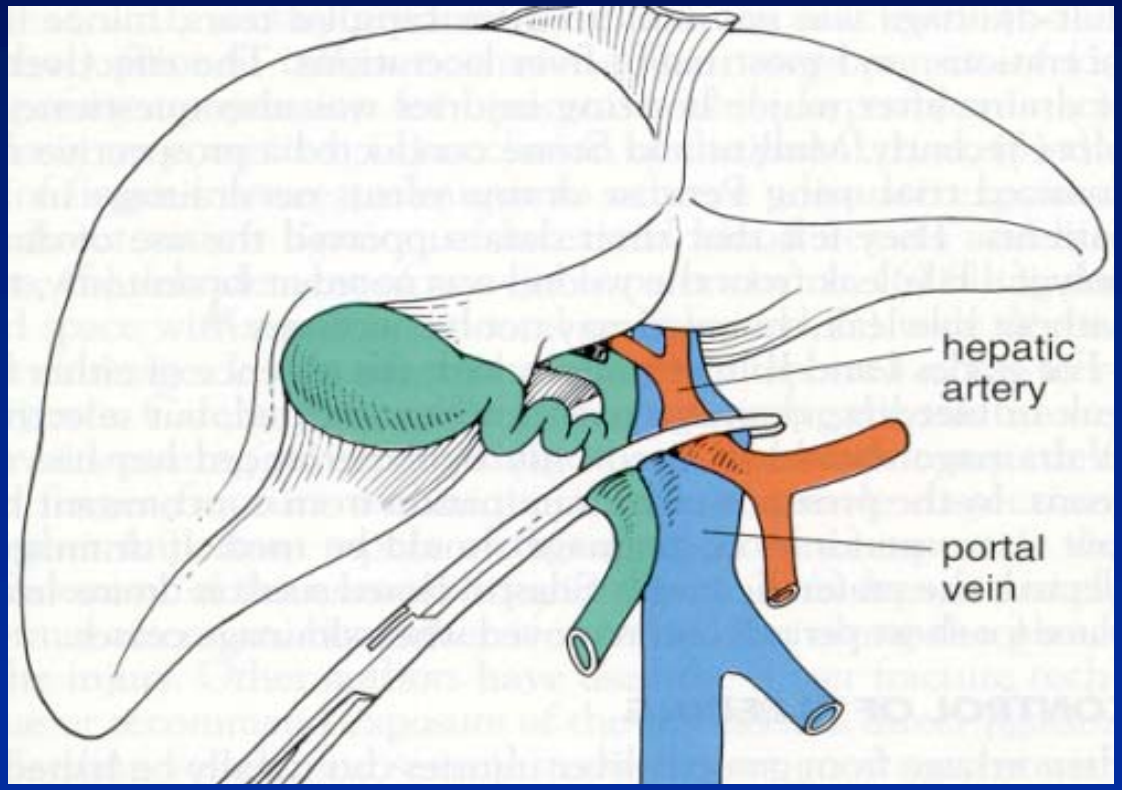


Techniques for temporary control

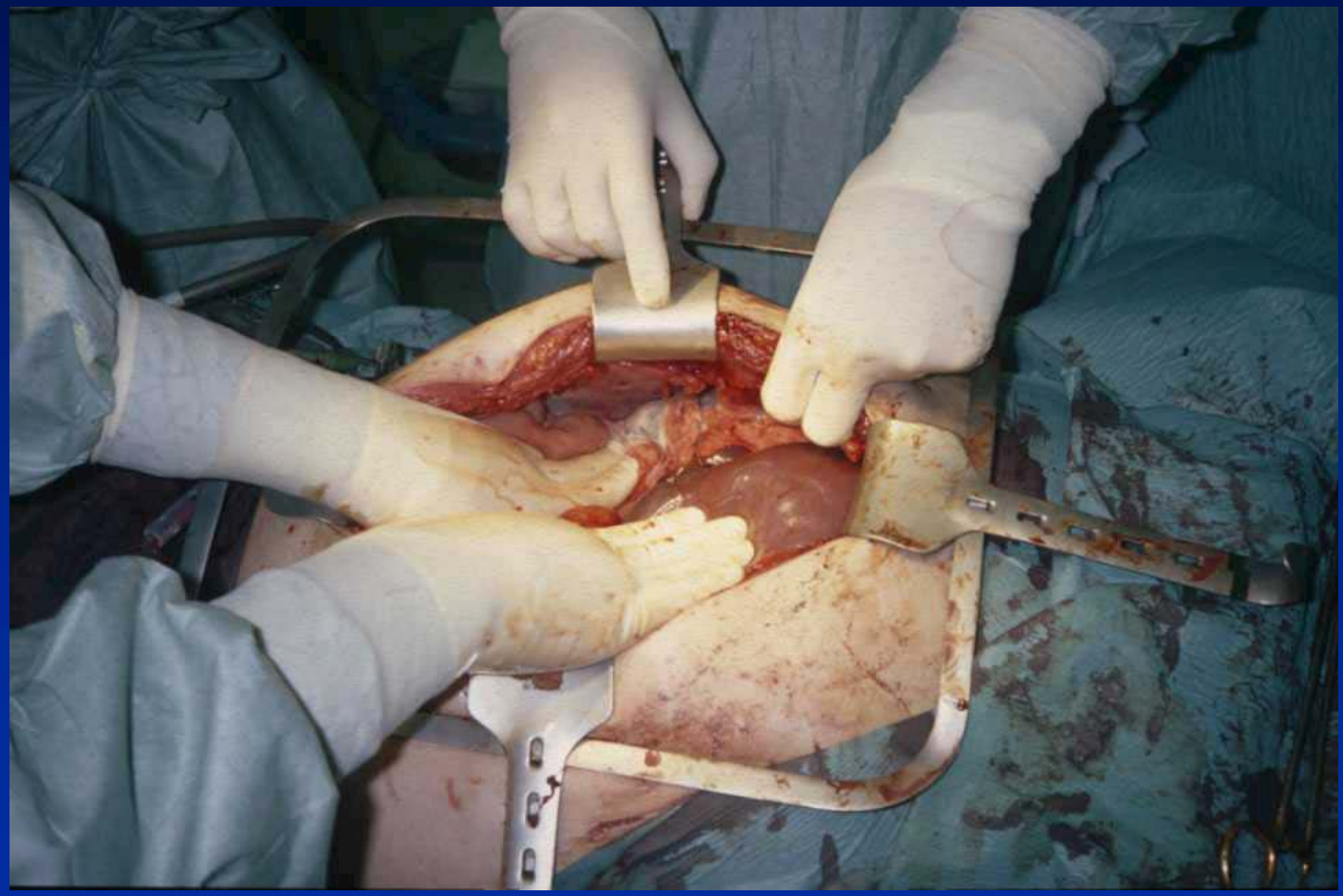
- Scoop out blood
  - 4 quadrant packing
  - determine source of bleeding
- Manual compression
- Pringle maneuver
- Perihepatic packing
- REBOA?

Pringle Maneuver

- finger dissection
- compression
- vascular clamp
- easier from patient's left
- 15 (60) minutes
- intermittent



Temporary packing

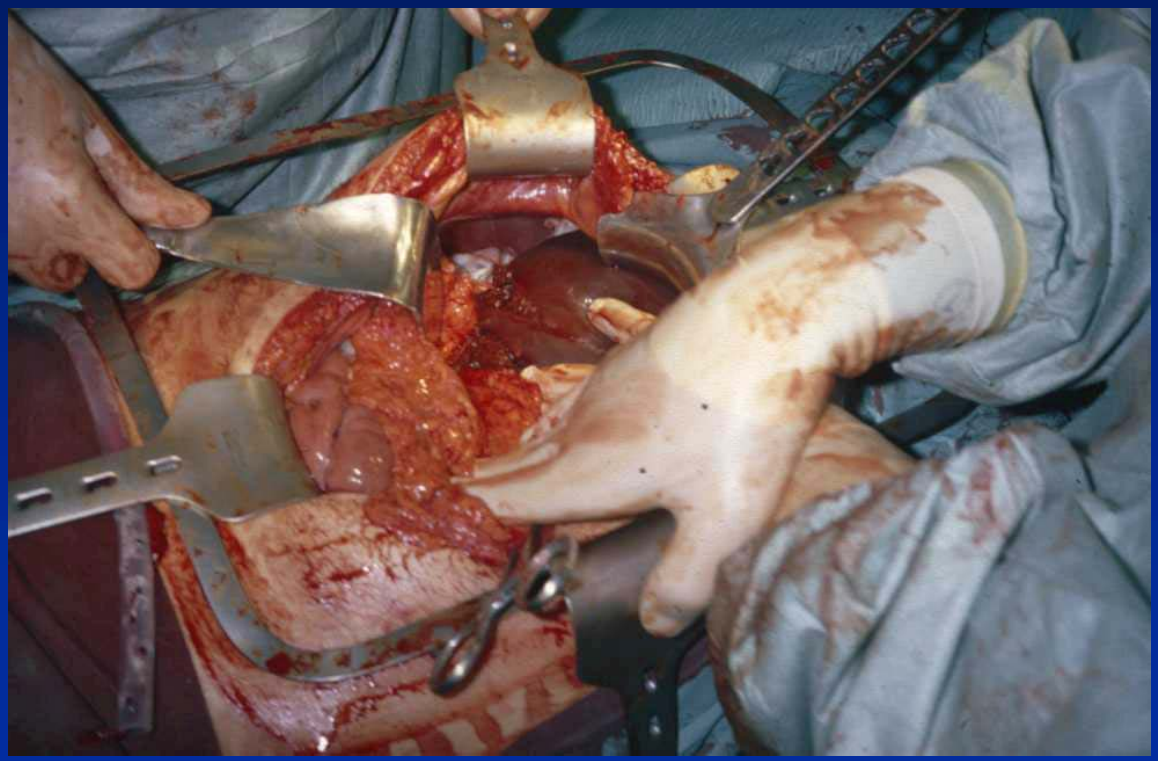


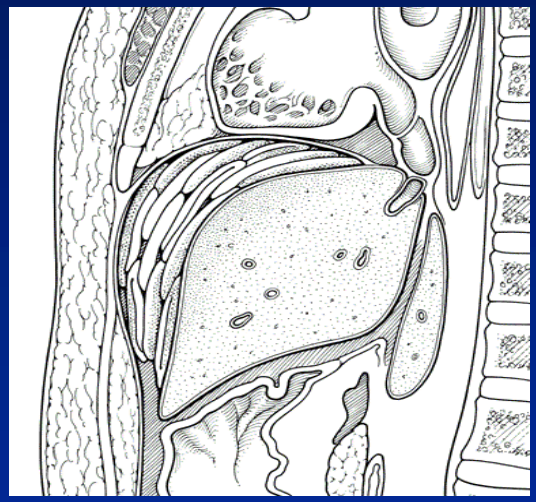
Stop
Think
Assess
Decide

Critical factors favoring damage control approach

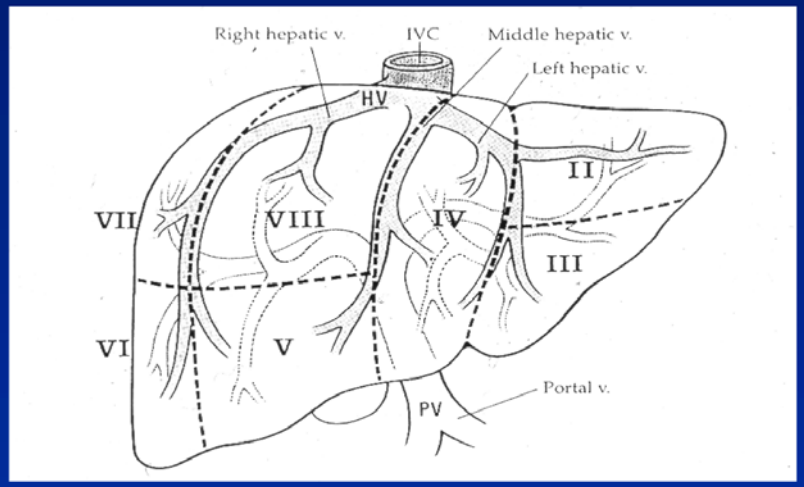
- Critical factors (the deadly triad)
  - Hypothermia : Tº < 34º
  - Severe metabolic acidosis
    - pH < 7.2
    - Lactate > 5 mmol/l
  - Coagulopathy
    - Massive transfusion
- Secondary factors
  - Severe injury
  - Operating time > 90 minutes

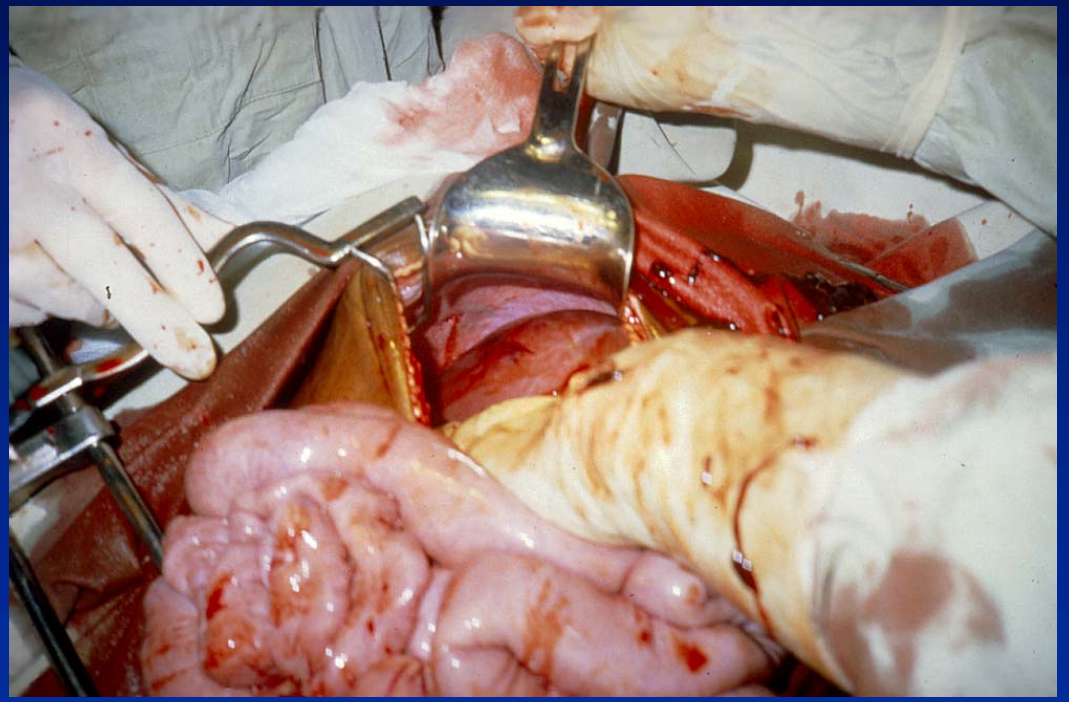
Definitive perihepatic packing





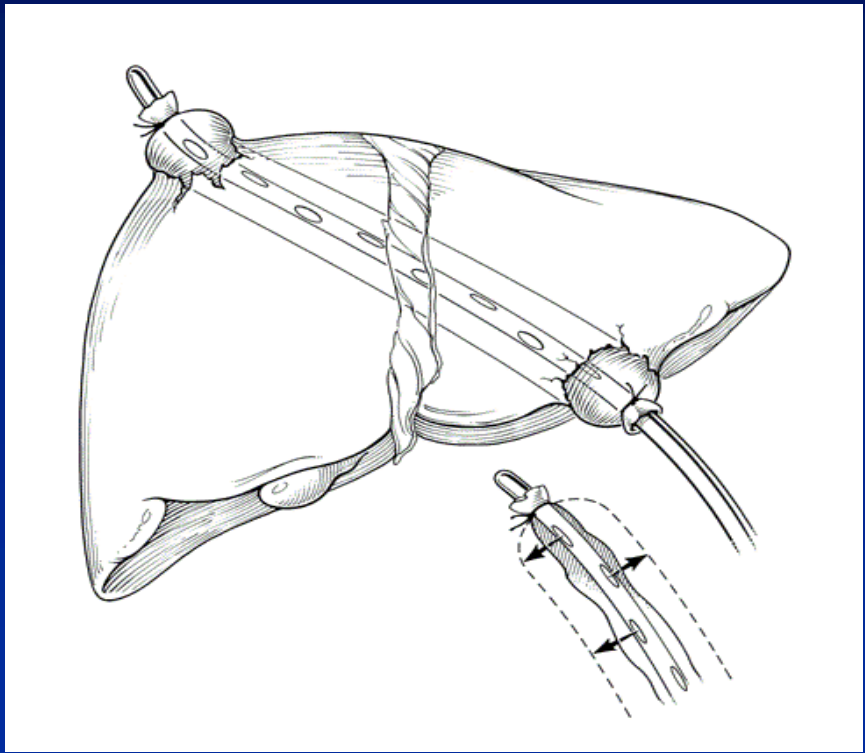
Through - and - thorough injury



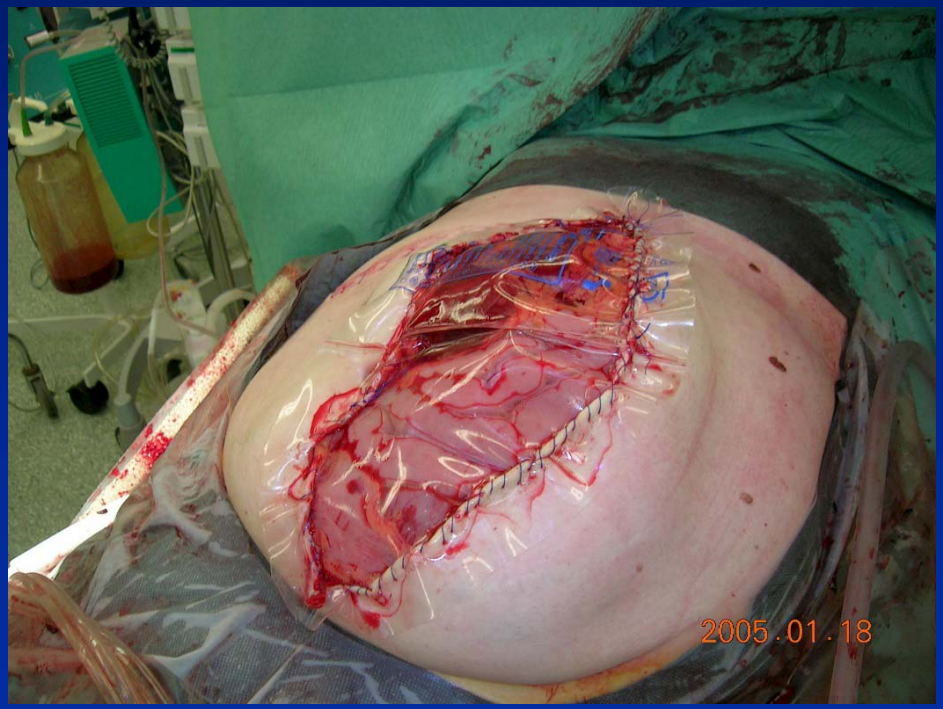


Internal tamponade

- balloon (Poggetti 1992)
- plastic bag pulled though the injury and filled with sponges (Ong 2007)
- appropriate size“cigar” constructed from absorbable material and pulled into the tract
  - does not require removal



Leave the abdomen open abdomen, temporary abdominal cover



Angiographic embolization of liver injuries

- 538 liver injuries, Gr III-VI (early angio as adjunct to oper.)
- 116 patients (22%) for angiography, 71 (13%) embolized
- liver-injury related death in 8/71 (11%)
- 43 (61%) patients liver-related complications
- hepatic necrosis (30), bile leak (14), abscess (12), gallbladder infarct (5), rebleeding (2), pseudoaneurysm, cholecystitis, biliary stricture (1 each)
- management of hepatic necrosis: lobectomy 16, operative debridement + percutaneous drainage 14

- Conclusion: AE useful adjunct to damage control surgery

Dabbs et al. 2009

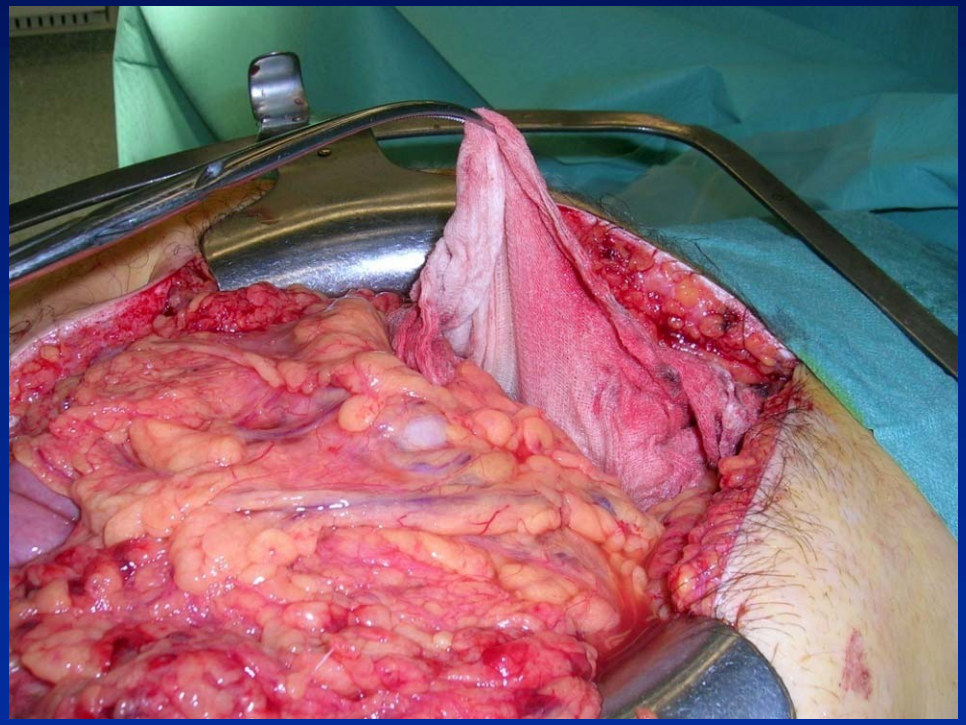
When to remove the packs ?

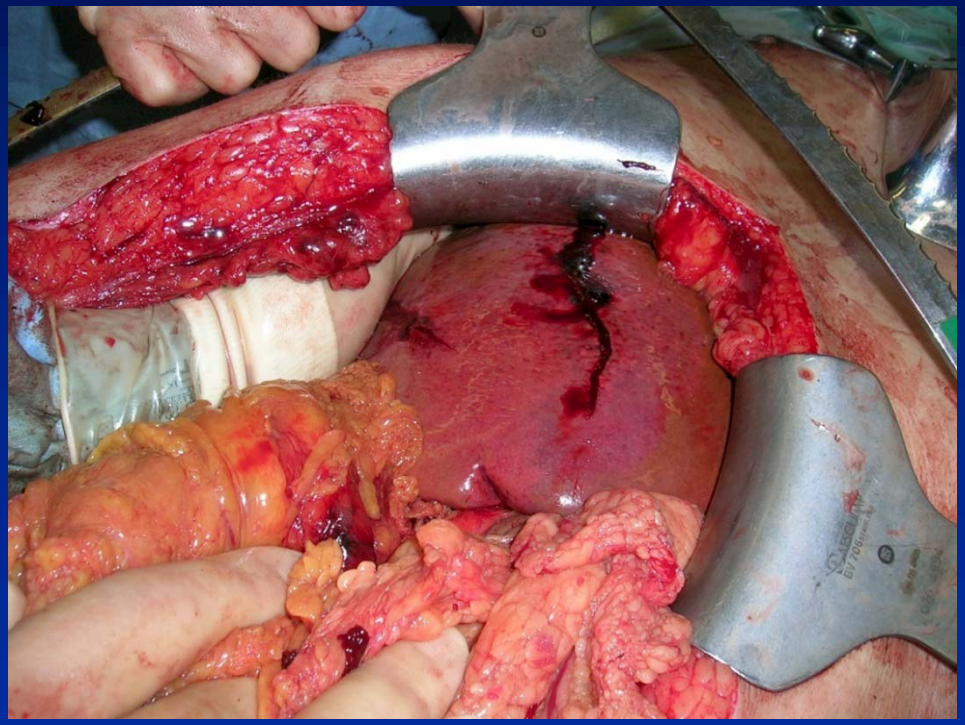
- too early → rebleeding, too late → infection
- 71 patients with damage control laparotomy
  - liver, pelvis, retroperitoneum, splenic bed

Packing (hr)	Infection	Re-bleeding
24	4.8%	42.9%
48	22.2%	14.8%
72	31.6%	10.5%
96	67%	0
120-144	100%	0

Ordonez et al. 2009

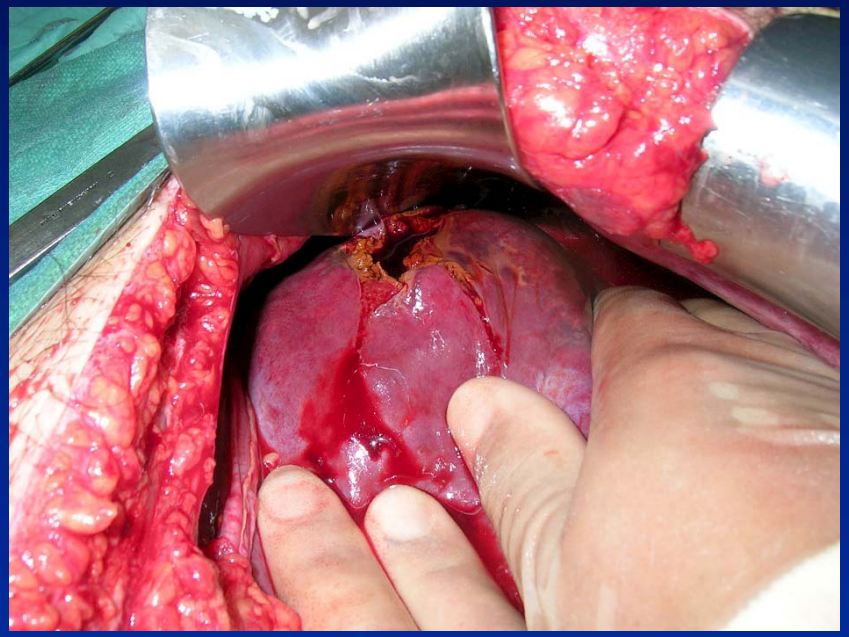
2-3 days later ...





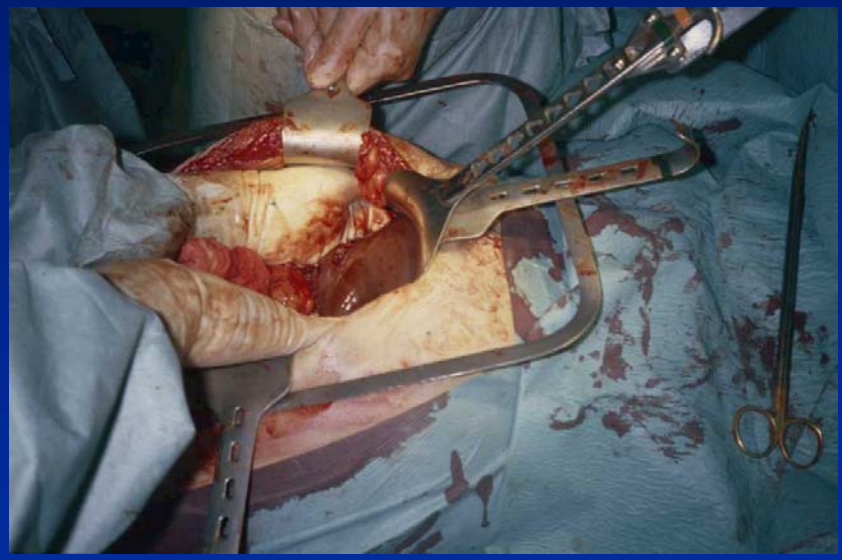
Definitive repair: surgical goals

- hemostasis
  - liver parenchyma
  - juxtahepatic veins
- preserving liver function
  - blood supply
  - amount of parenchyma
- infection control
  - removing devitalized tissue
  - controlling bile leaks

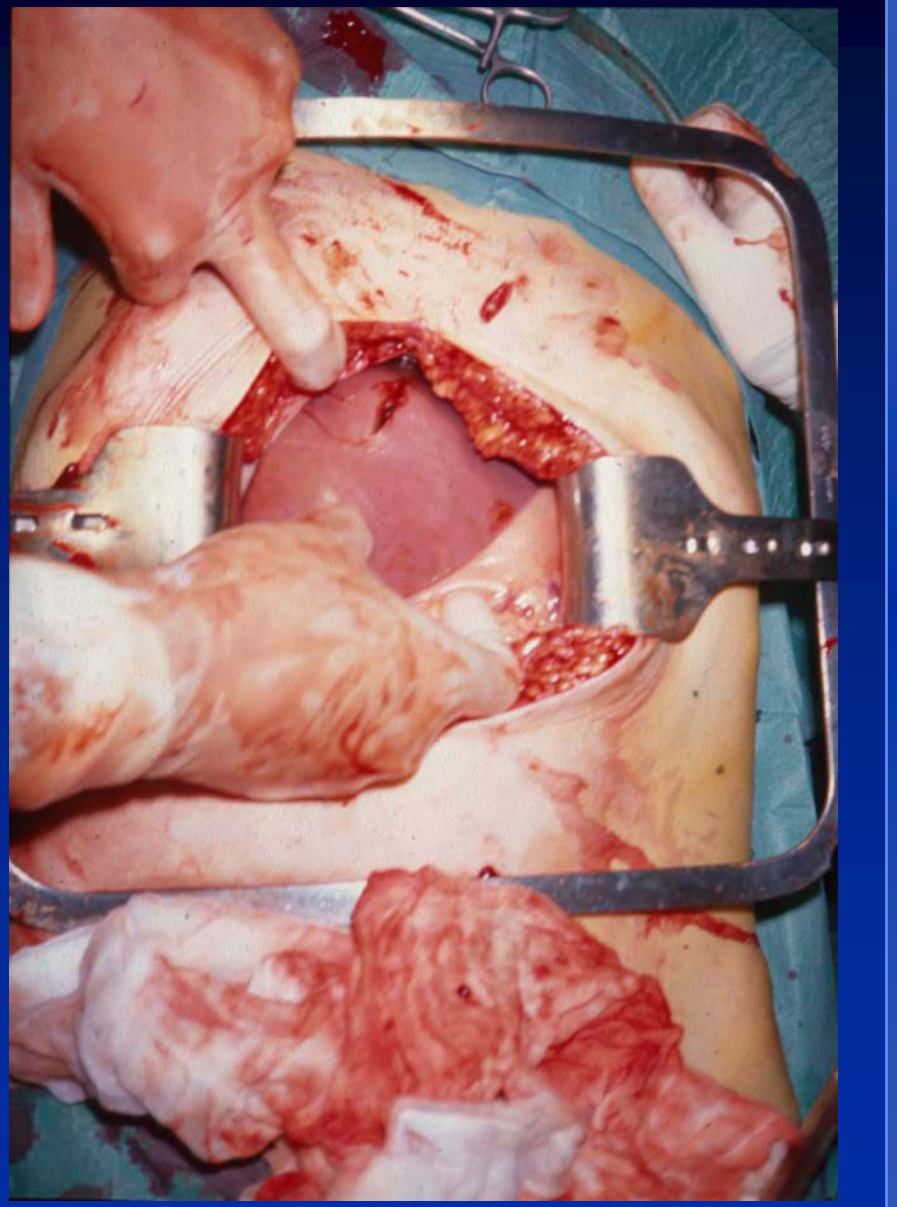


Liver injury → graded response

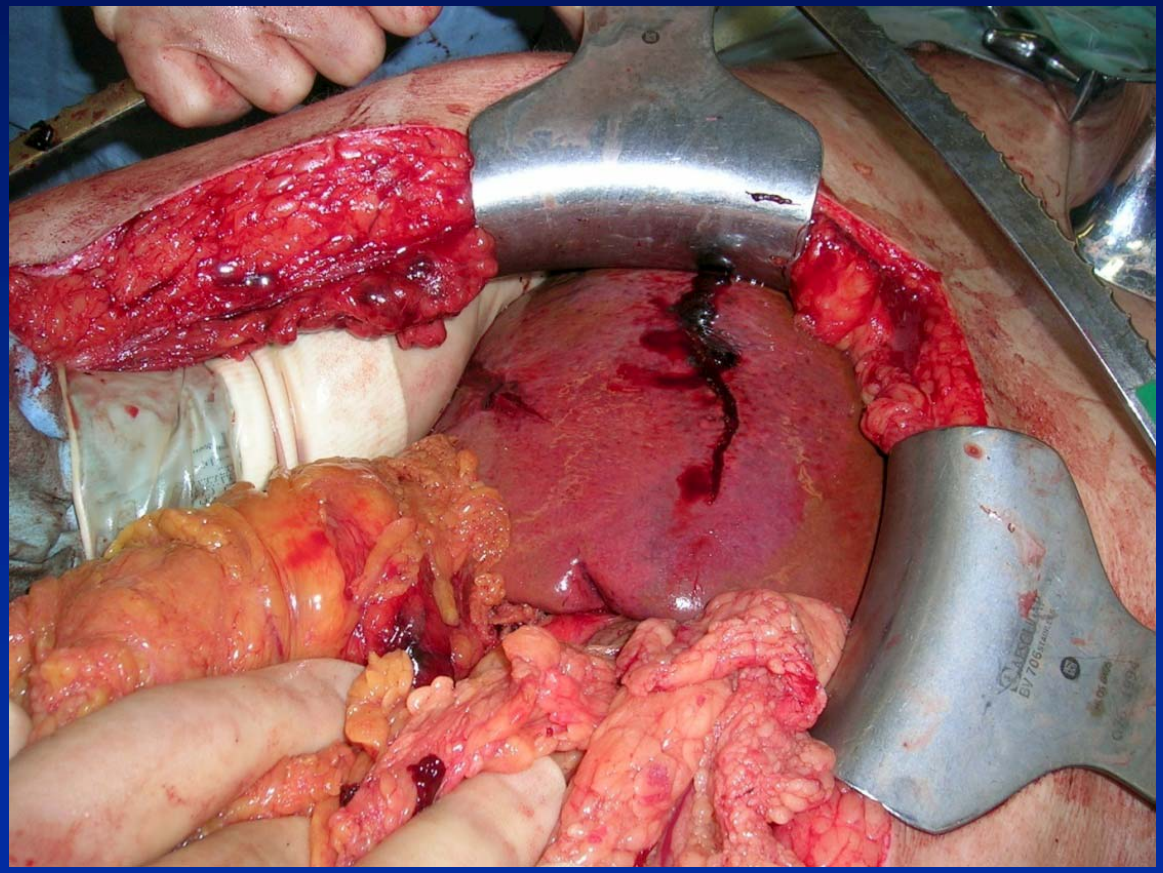
- start with the simplest hemostatic option
- if ineffective, be ready with an alternative hemostatic option



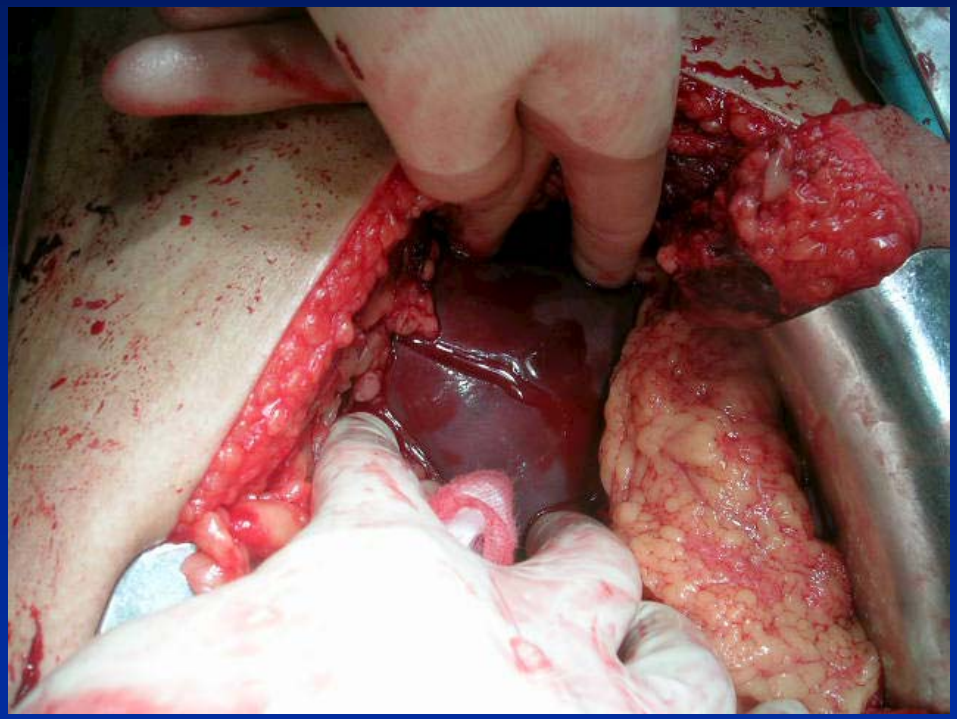
No bleeding, no bile leak → no action

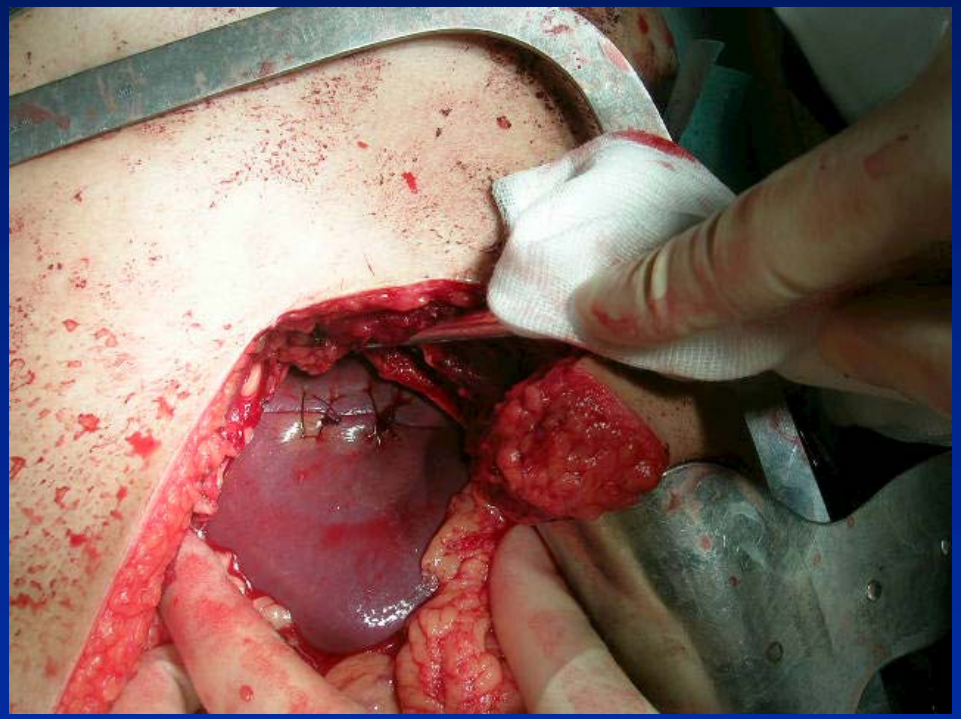


Superficial bleeding with capsular avulsion → local hemostatics

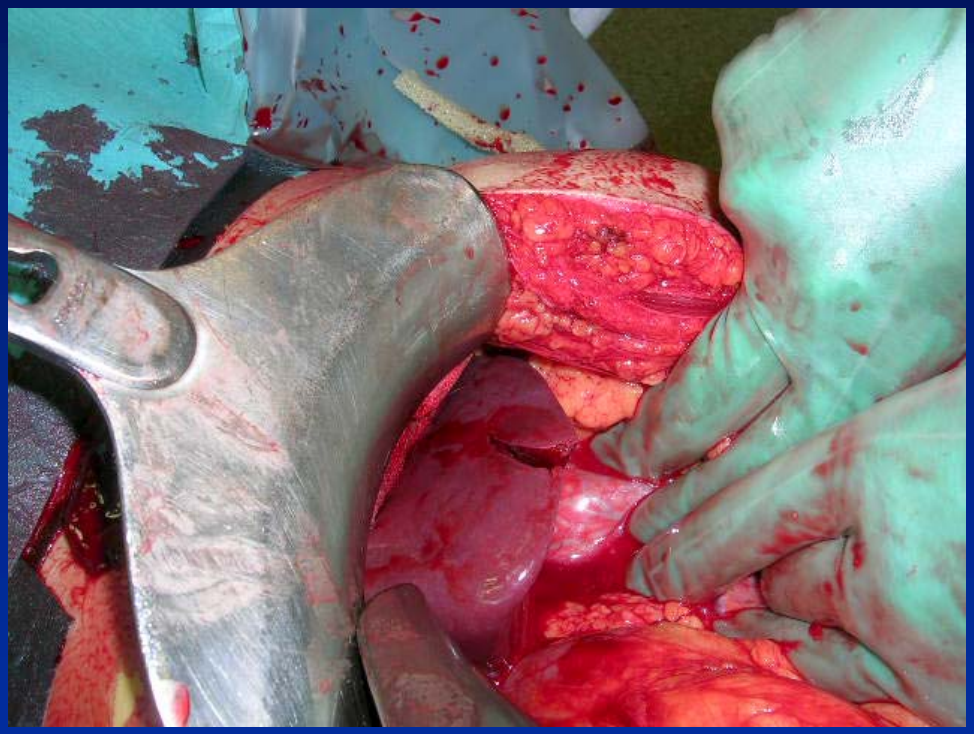


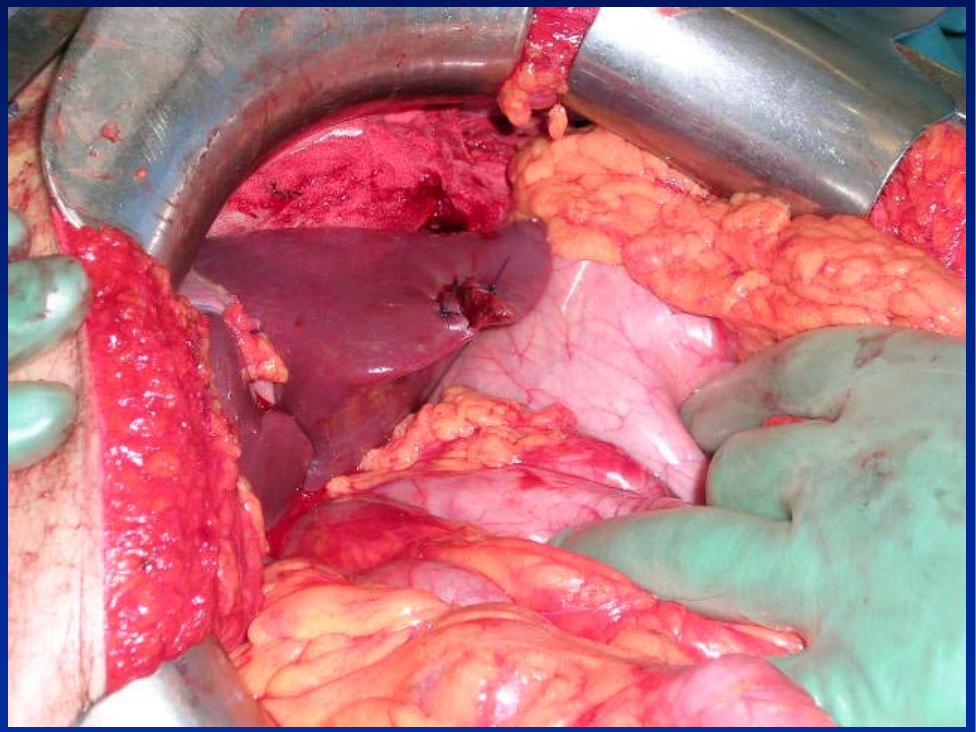
Capsular bleeding → suture



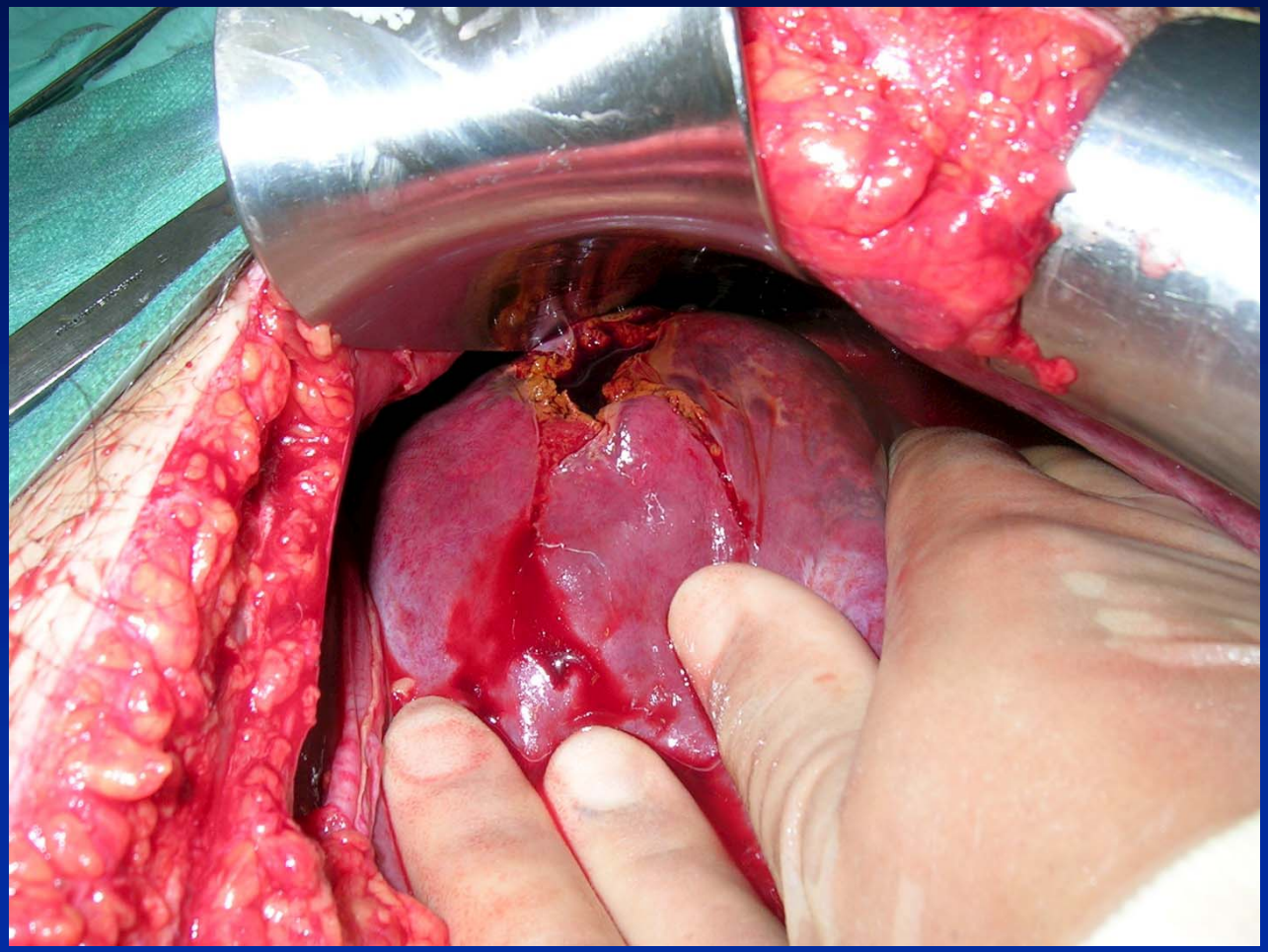


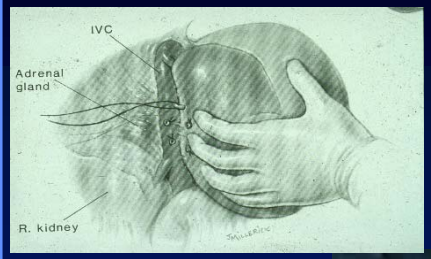
Peripheral injury → suture



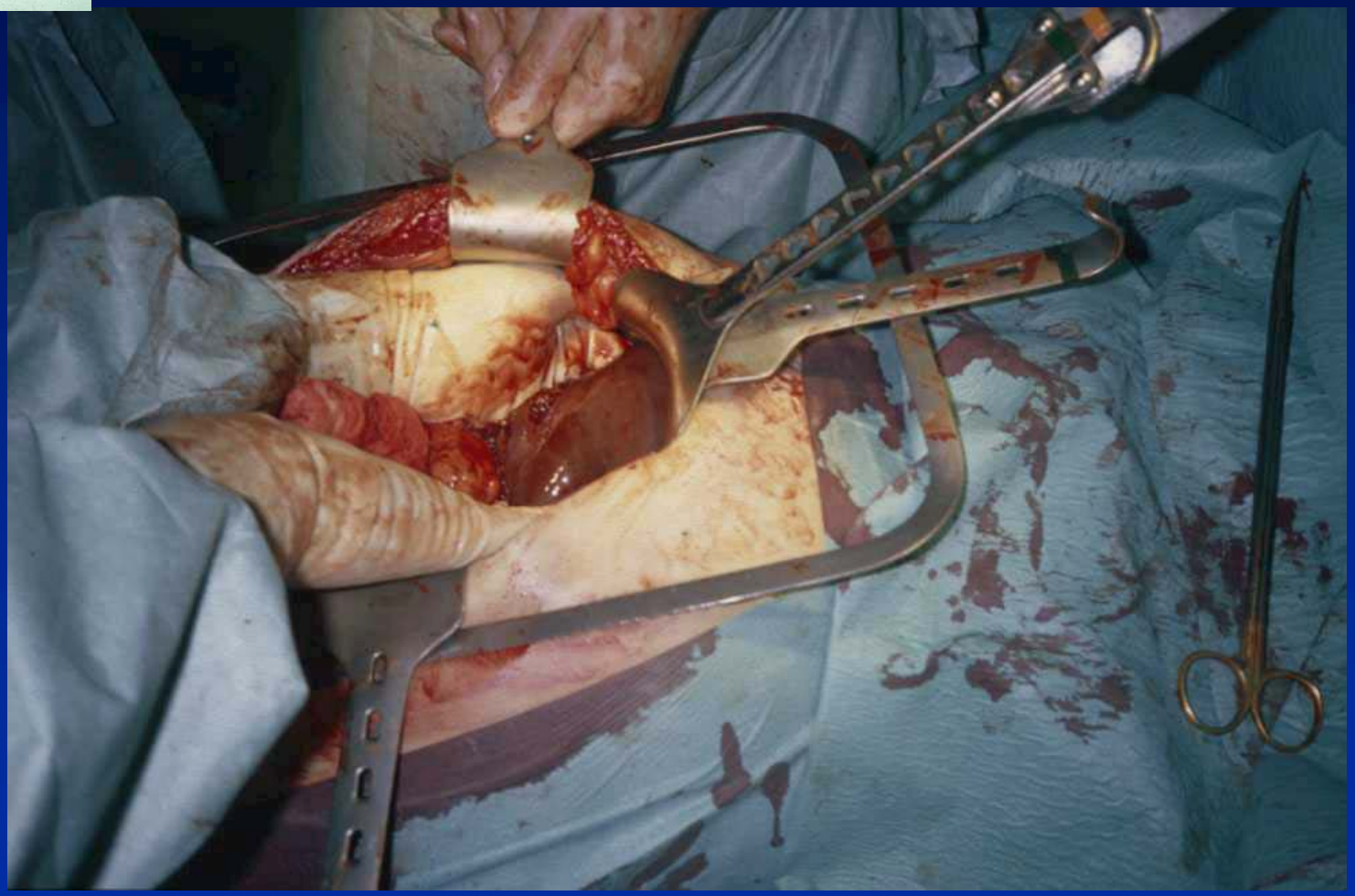


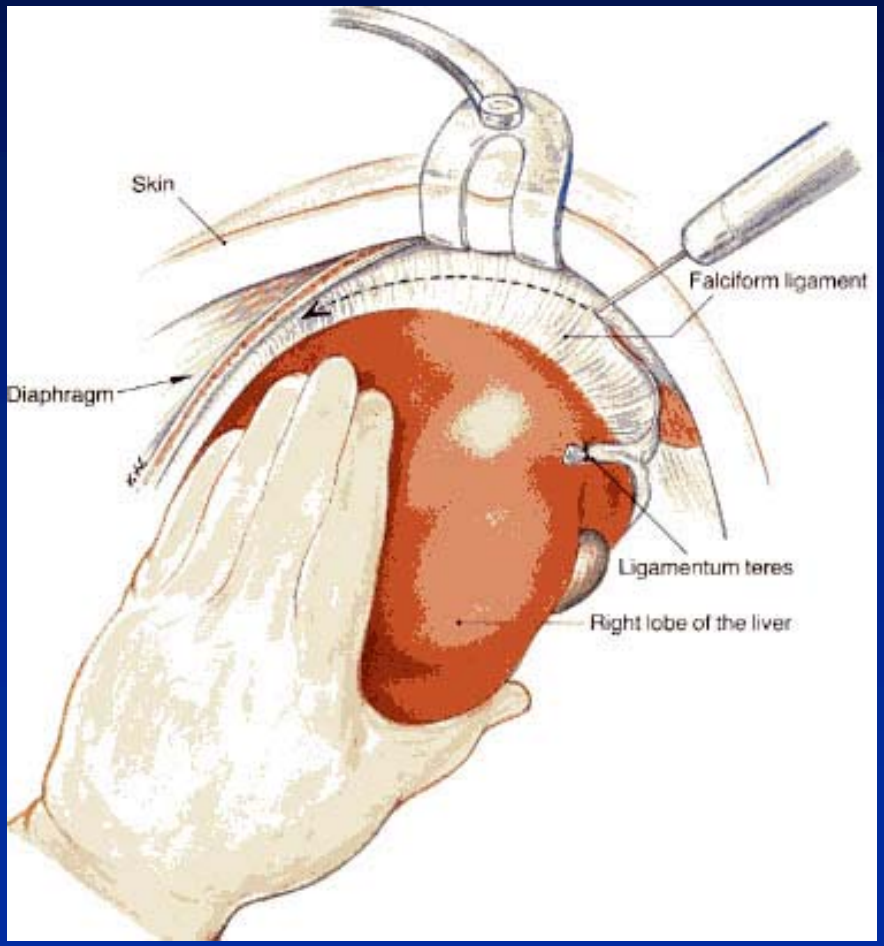
If bile leak → drain

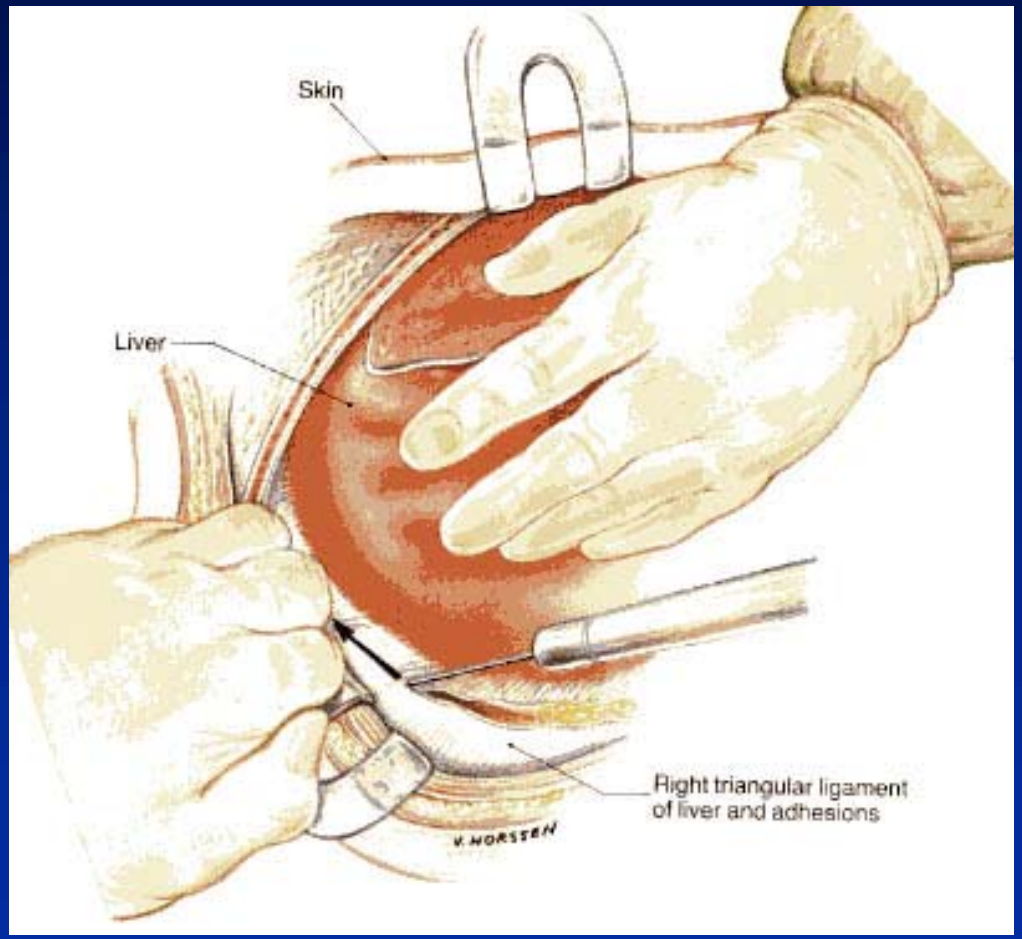


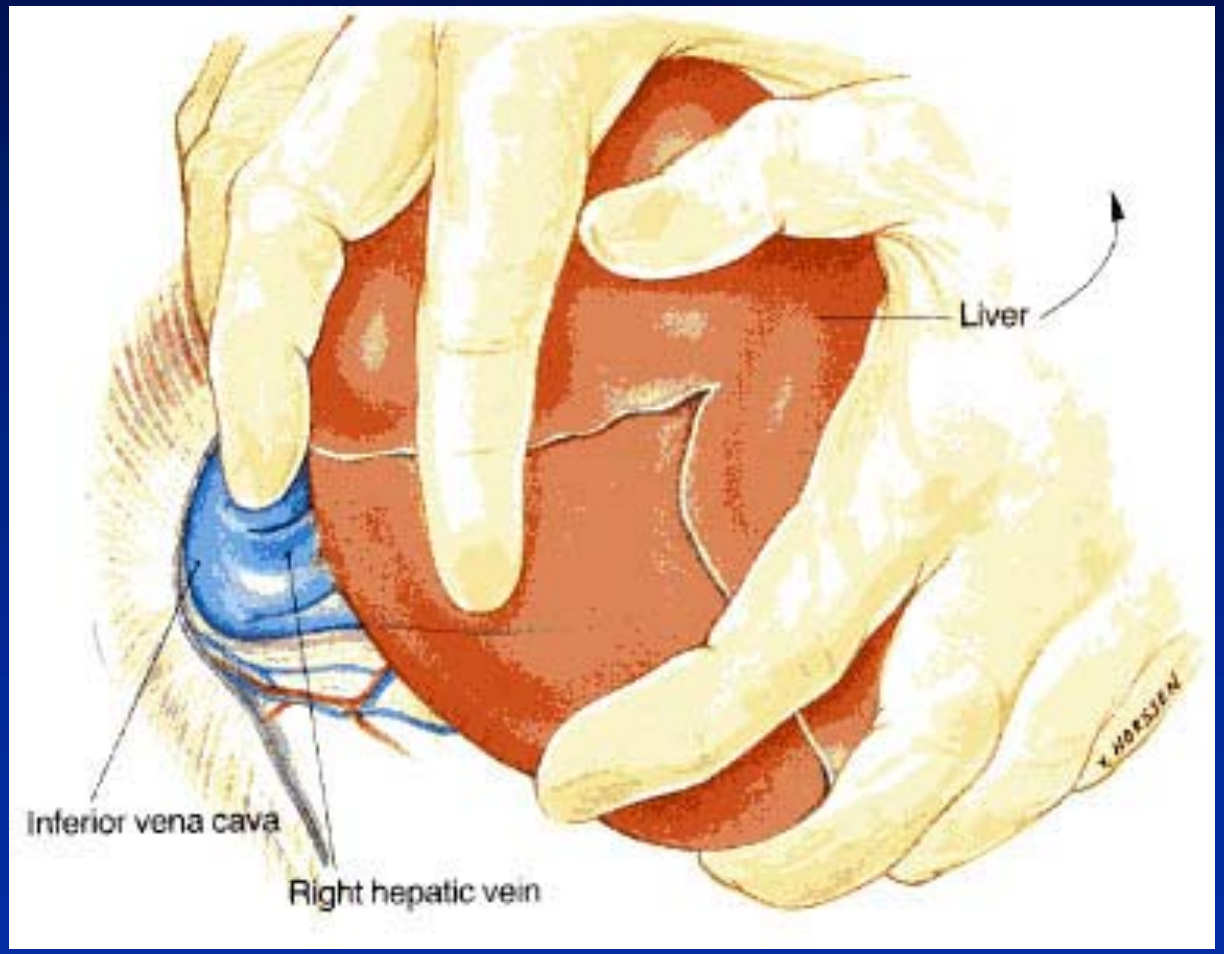


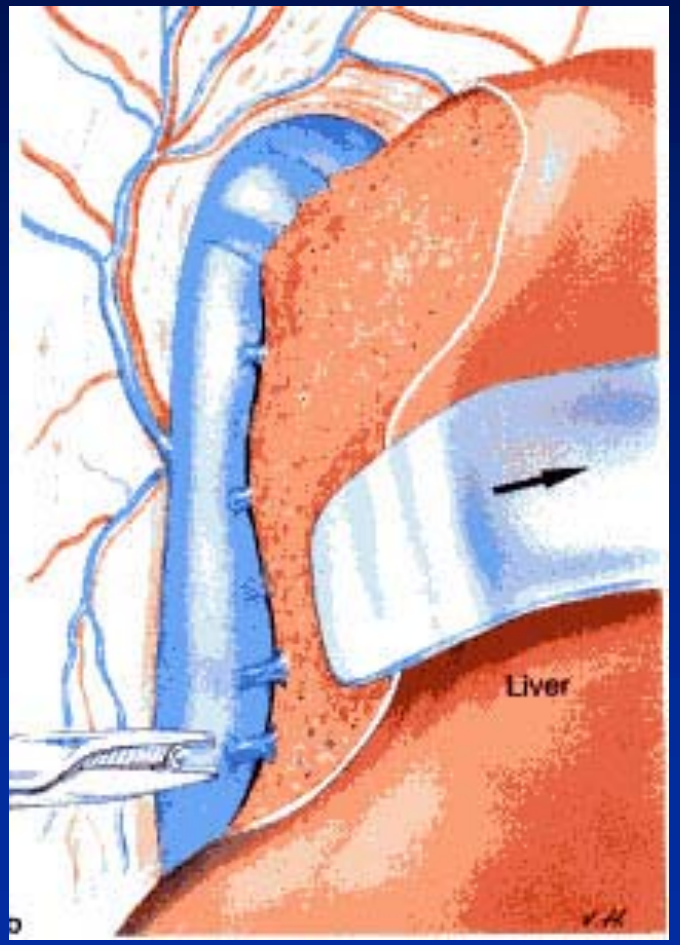
Mobilization ?

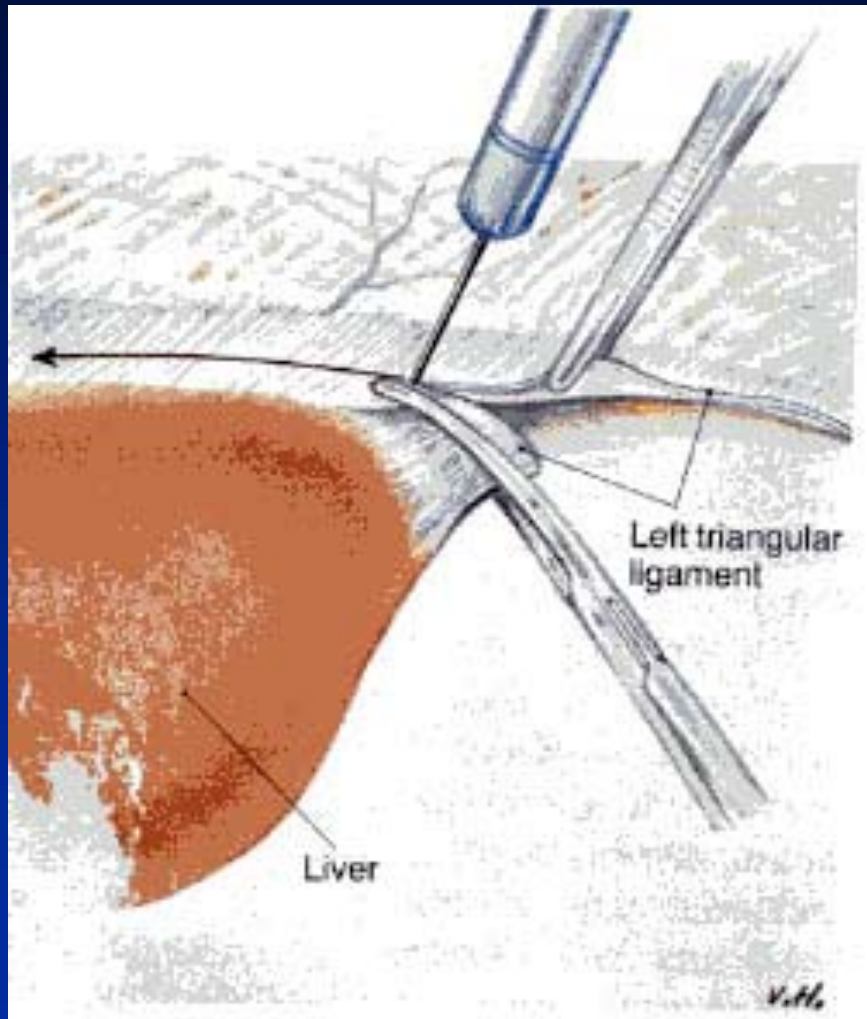


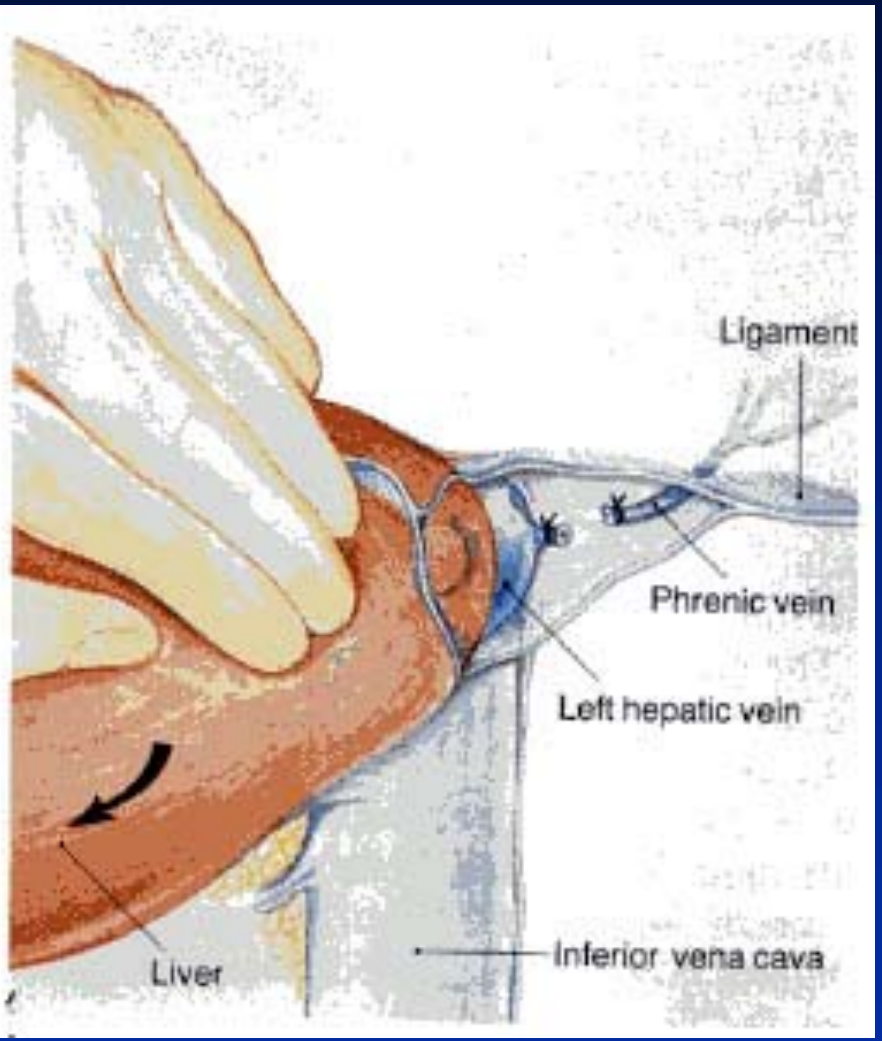

Skin
Falciform ligament
Diaphragm
Ligamentum teres
Right lobe of the liver


Skin
Liver
Right triangular ligament
of liver and adhesions
V. HORSTEN

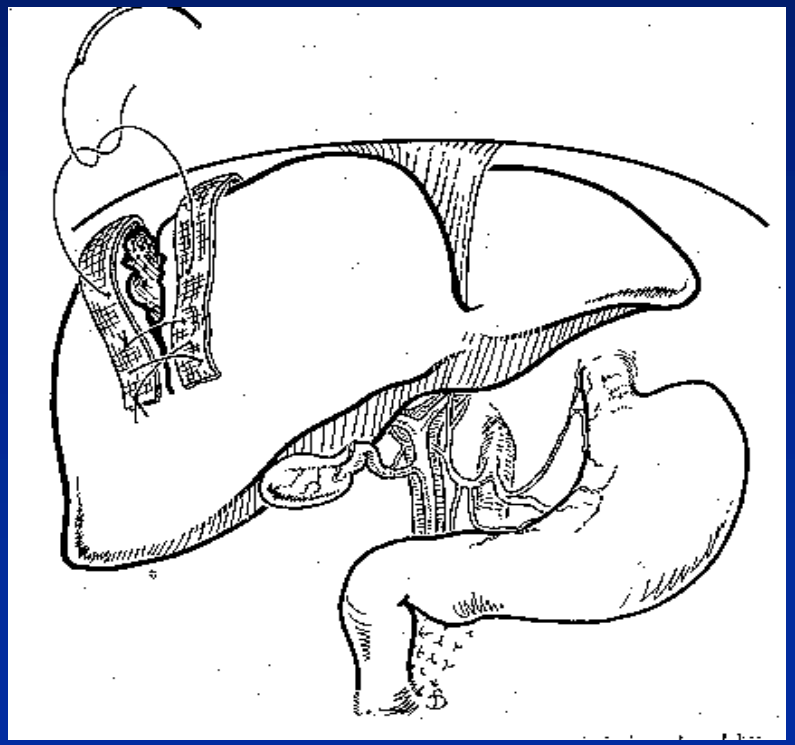

Liver
Inferior vena cava
Right hepatic vein

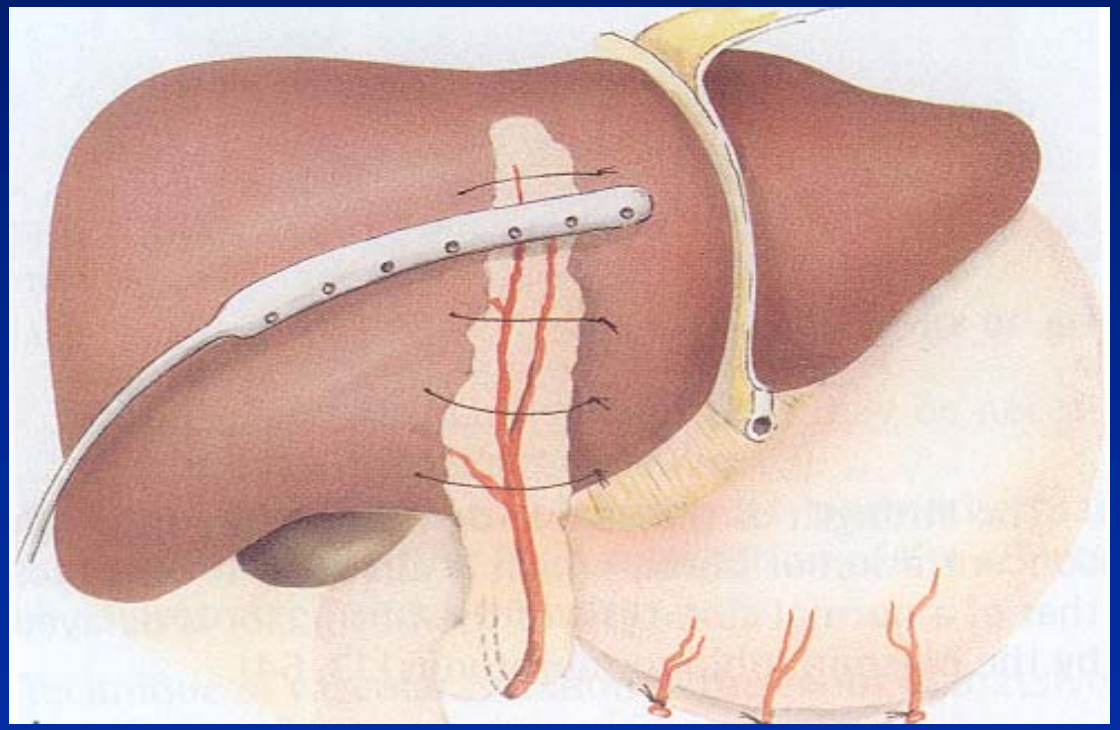

Liver


Left triangular ligament
Liver

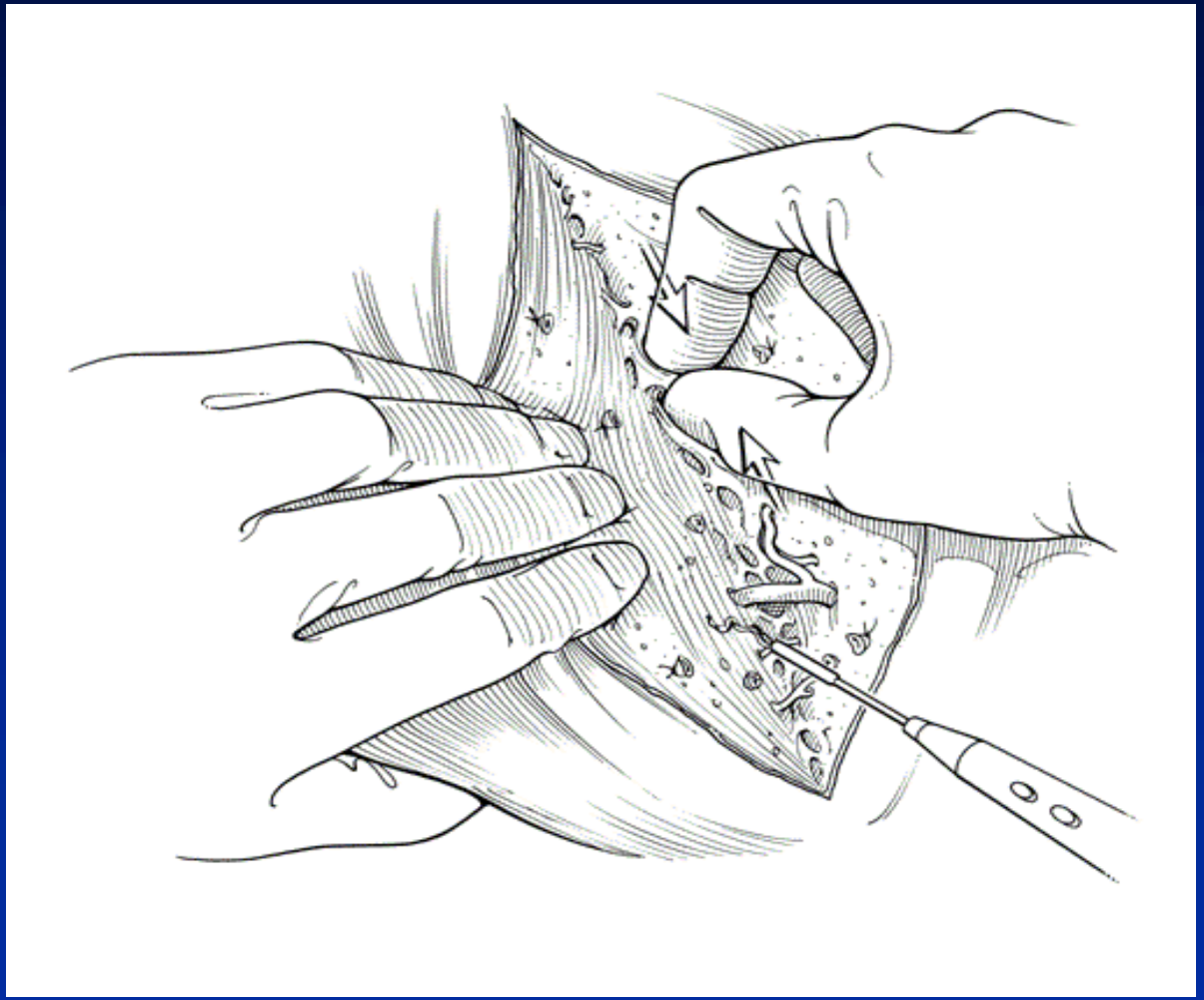

Ligament
Phrenic vein
Left hepatic vein
Liver
Inferior vena cava

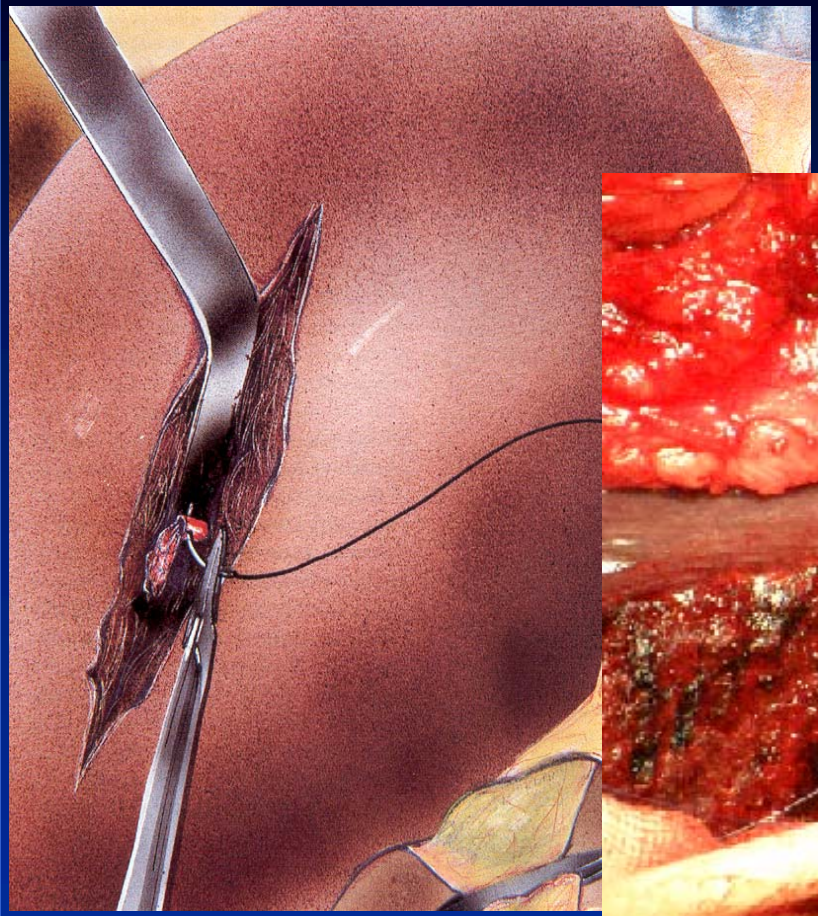
Major laceration → deep liver suture (pledgets or omentum if needed)

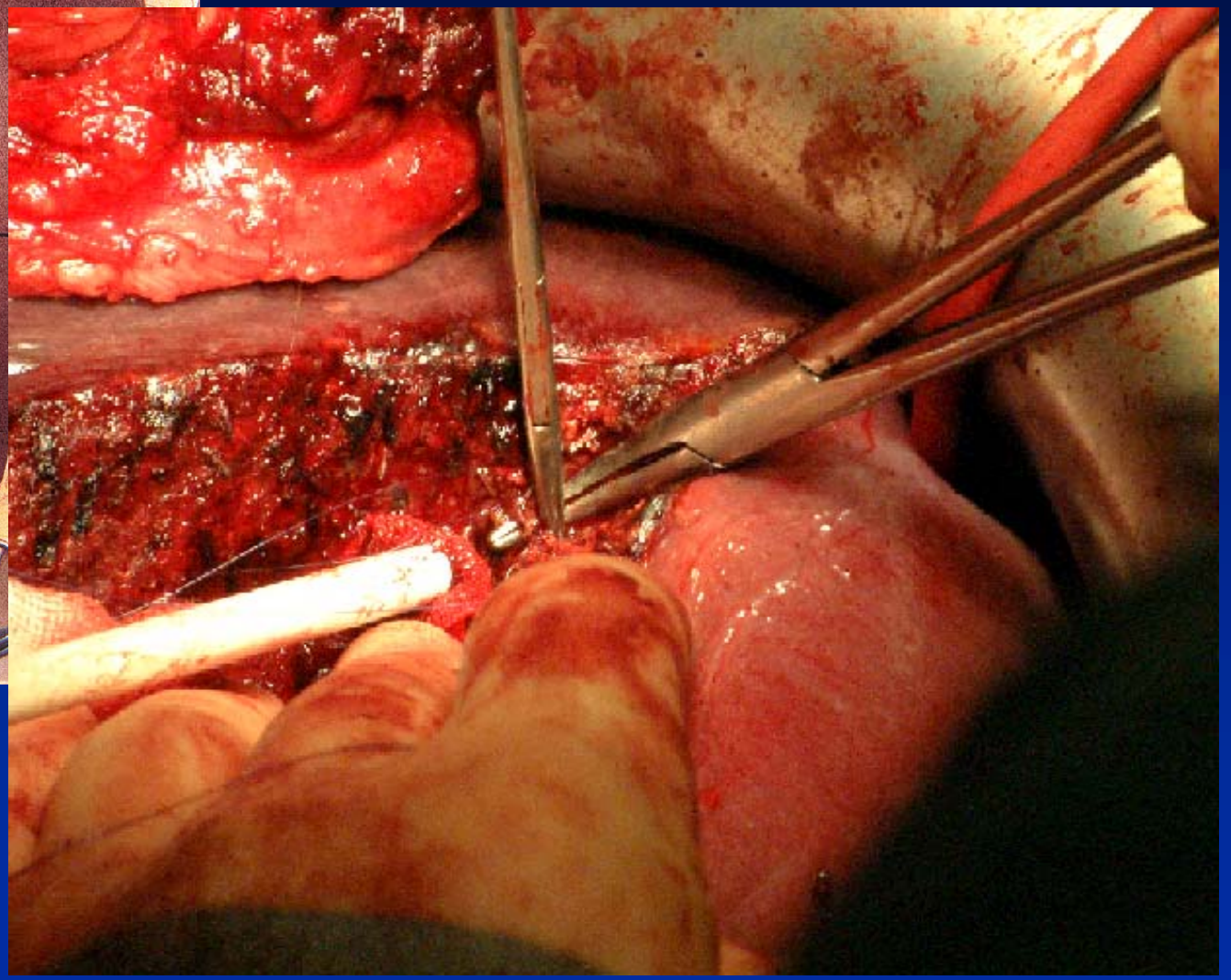




Finger fracture hepatotomy and vessel ligation

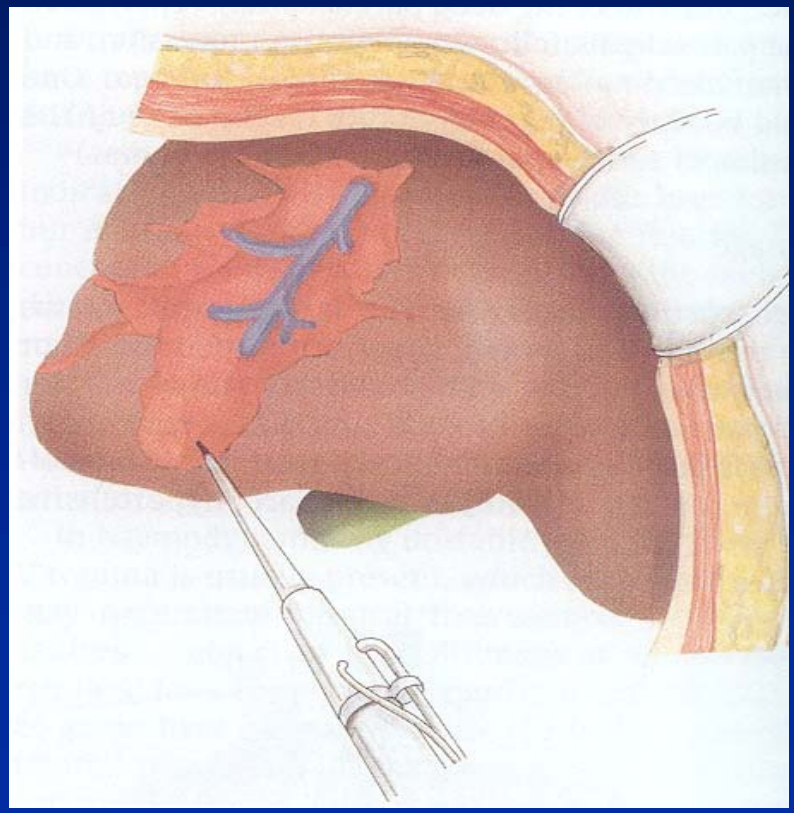






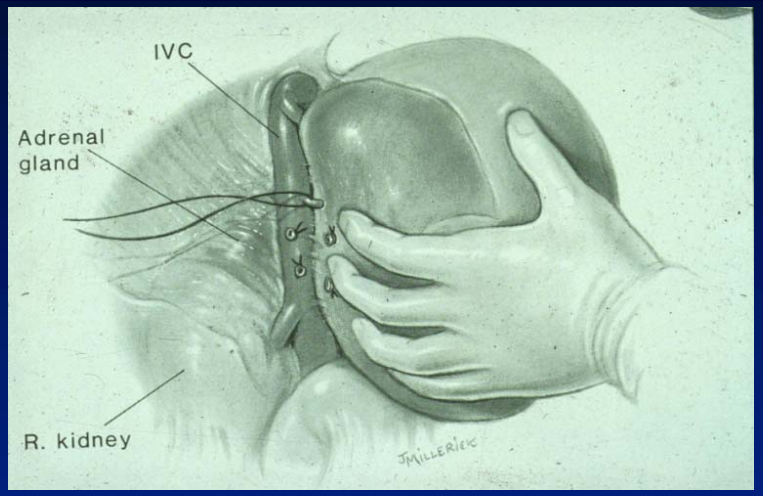
Nonanatomical resection

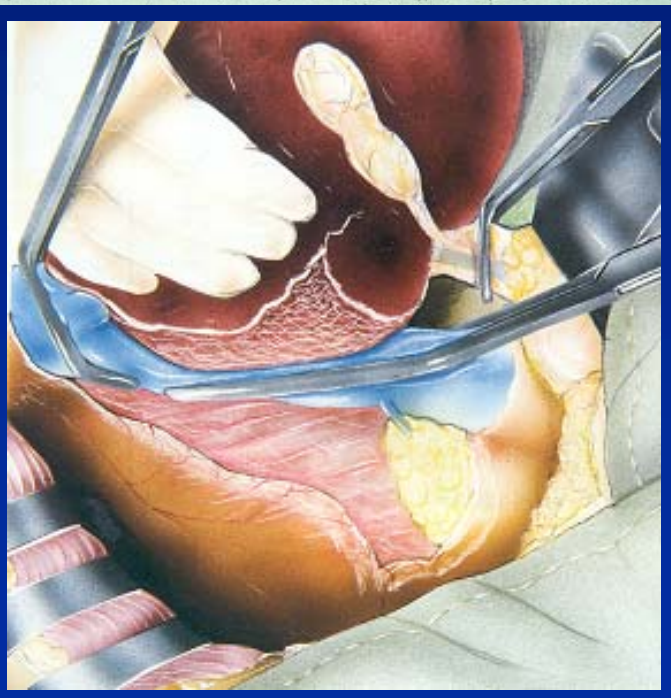
- resection along injury lines
- no hilar preparation
- ligation of vessels and bile ducts
- defect left open



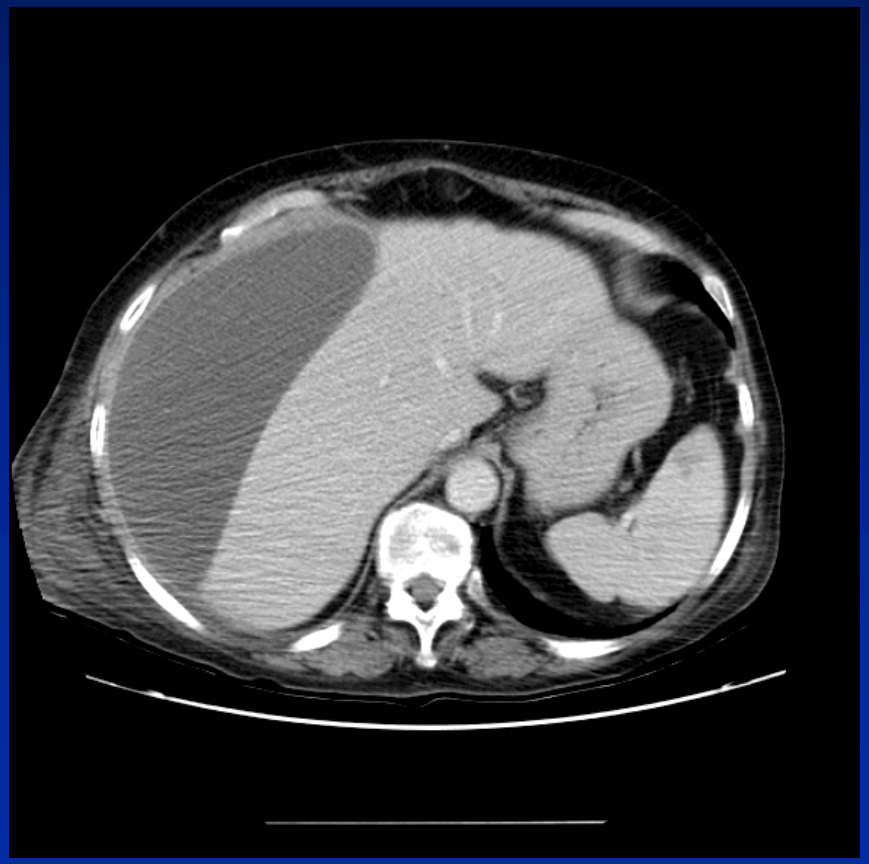
Juxtahepatic venous injury

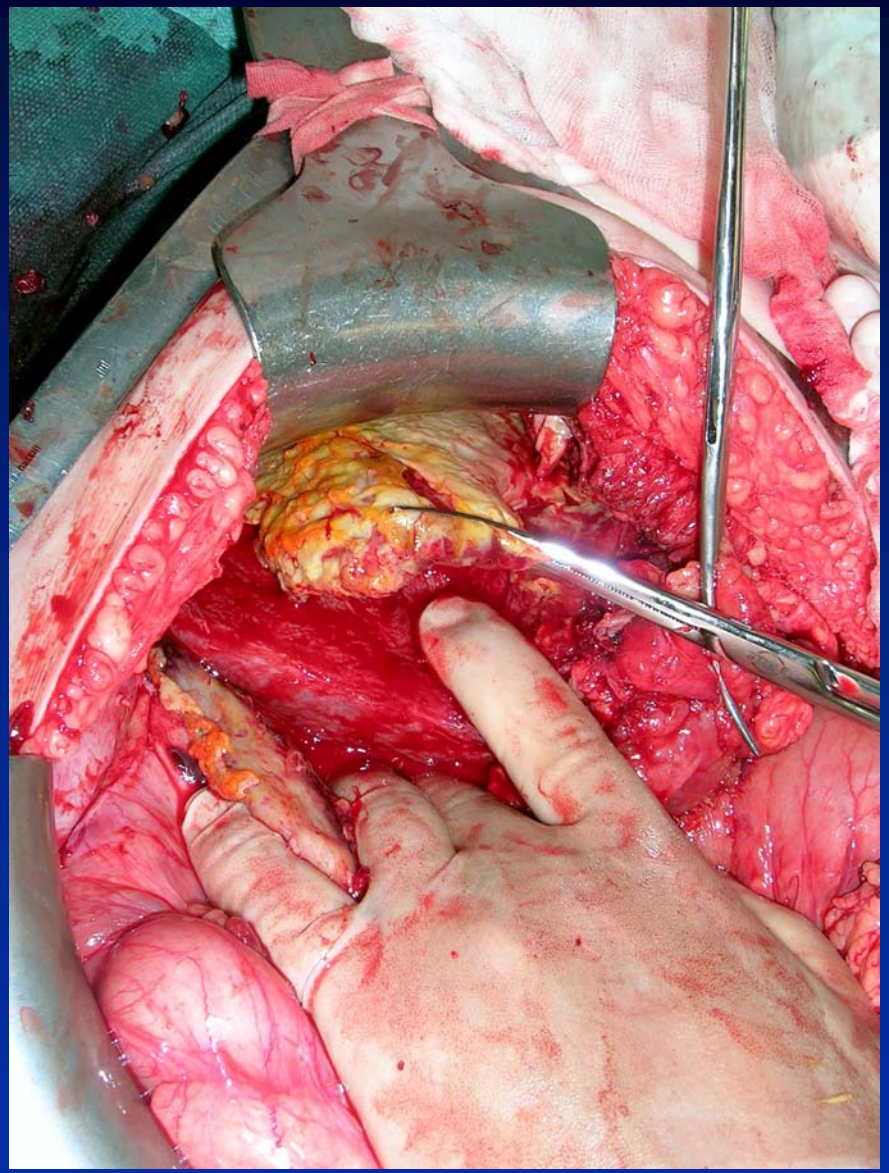
- suspect when Pringle does not help
- before mobilizing a retrohepatic hematoma: think !
  - perihepatic packing often safest
- suture repair after mobilization and initial vascular control
- shunts complicated, seldom used





Perihepatic drainage after major liver procedures





Complex liver injuries (Helsinki)

- overall mortality rate 21/144 (15%), 8 liver-related
- factors predicting death (univariate)

	OR	95% CI
Head injury (AIS 4-5)	13.75	4.8-39.36 *
Shock on admission	13.42	3.73-48.30 *
Compression injury	12.9	3.59-46.47
Laparotomy	8.50	2.69-26.90
Damage control laparotomy	6.35	2.25-17.92
Laparotomy <12 hours	6.29	2.26-17.51
Liver injury Grade IV-V	3.11	1.04-9.34

* significant in multivariate analysis

Leppäniemi et al. WJS 2011;35:2643

Summary

1. Which injuries should be managed operatively?

- hemodynamically unstable patients
- continuous or massive bleeding on CT
- associated high grade splenic injury
- failed nonoperative management

2. When to apply damage control surgery?

- physiological exhaustion of the patient and major liver trauma or multiple injuries

3. When to consider interventional radiology?

- angio: extravasation on CT (NOM), after damage control?
- percutaneous drainage of bile collections (± ERCP)