Minimally Invasive Surgery and Its Role in Pediatric Trauma

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Objectives

- Participants will understand:
  - Basic concepts of minimally invasive surgery
  - Applications of minimally invasive surgery in the treatment of trauma patients
  - Limitations of minimally invasive surgery in trauma

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History

- Hippocrates
- 400 BC
- Used anoscope to evaluate hemorrhoids
- Speculum found in Pompeii ruins (AD 70)
- Abulkasim used reflected light for cervical exam (AD 1000)

http://www.manoneileen.com/wpcontent/uploads/2011/04/Hippocrates_185912t1.jpg
Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

History

http://transitionvoice.com/wp-content/uploads/2011/07/darkages.jpg
Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

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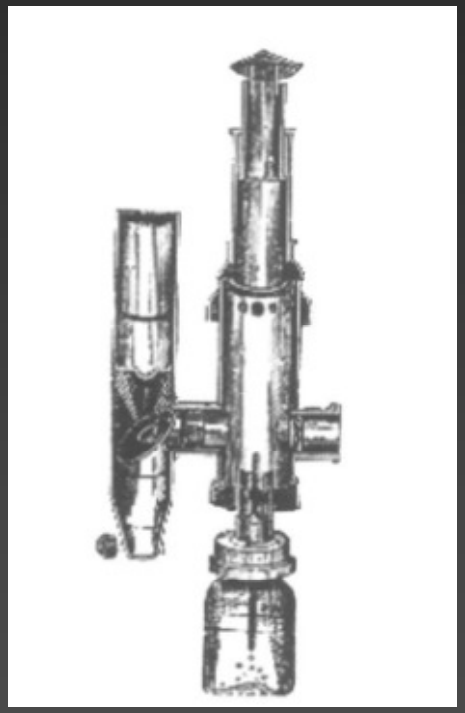
History

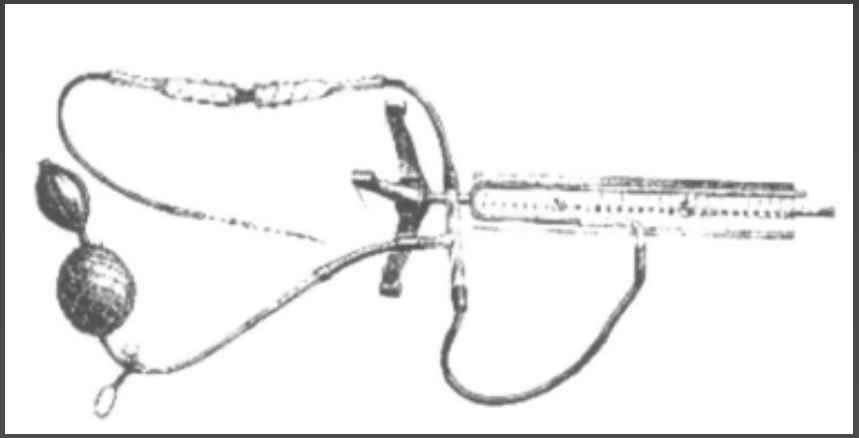


- Philip Bozzini (1806)
  - Endoscope with a light source
  - *Lichtleiter* (light conductor)
  - Mirrors and reflected candlelight
  - Cystoscopy and vaginoscopy
- Antoine Jean Desormeaux
  - Flame light source
  - Alcohol and turpentine
  - Urologic procedures

Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

History

- George Kelling (1901)
  - German surgeon
  - *Coelioskope*
  - Canine model
  - Insufflated with sterile air
  - Cystoscope in abdomen



Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

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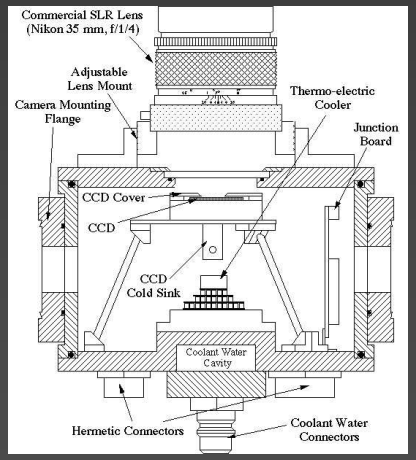
History

- Hans Christian Jacobaeus (1911)
  - Swedish internist
  - *Laparothorakoskopie*
  - Human subjects

Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

History

- Fiber optics (1950s)
- Flexible endoscopy (1960s)
- In-vitro fertilization (1970s)
- Charge-coupling device (CCD) camera (1982)



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Holcomb GW, Georgeson KE, Rothenberg SS (eds.) Atlas of Pediatric Laparoscopy and Thoracoscopy. Saunders/Elsevier, Philadelphia, PA, 2008.

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Why MIS?

- Less Pain (Less Narcotic Use)
- Less Wound Complications
- Shorter Hospital Stay
- Earlier Return To School
- Better Cosmesis

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Elective MIS

Laparoscopic Cholecystectomy

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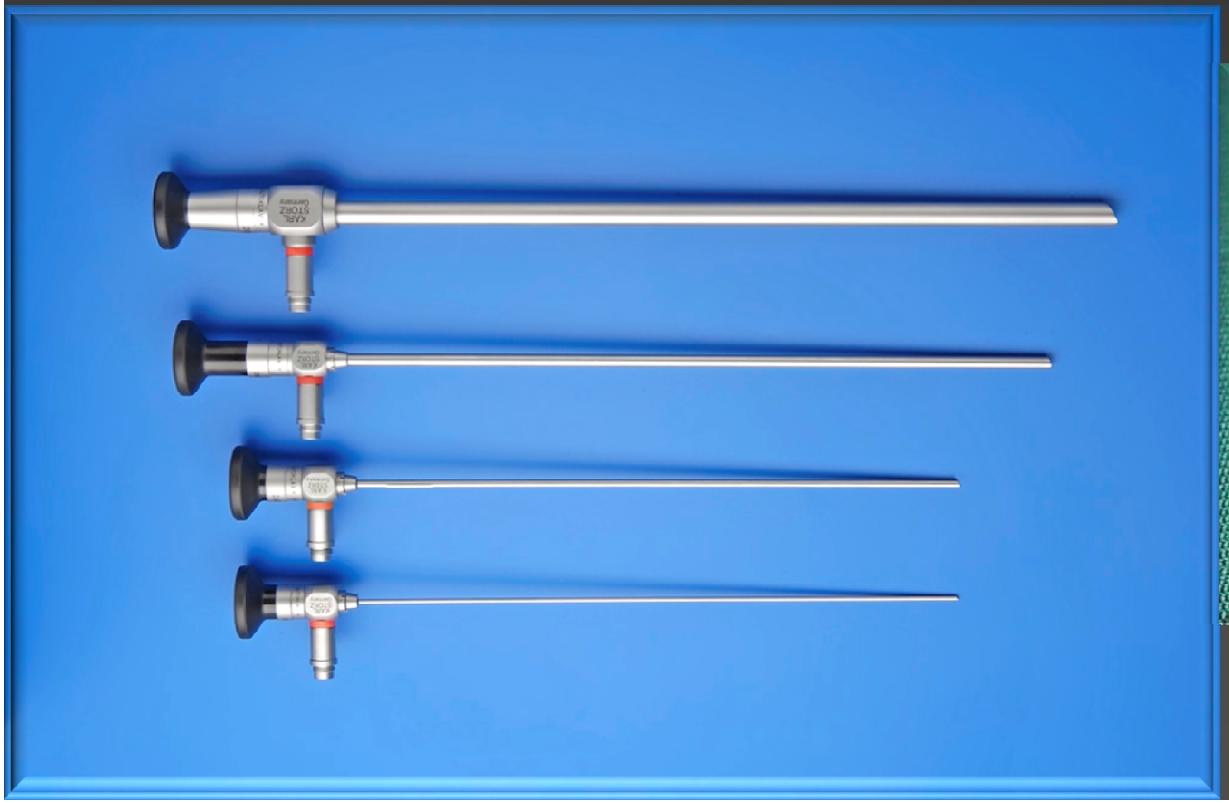
10mm to 3mm



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2-3 mm Instruments

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Urgent MIS?

- Lengthy set-up?
- Lengthy procedure?
- After-hours?
- Dangerous?

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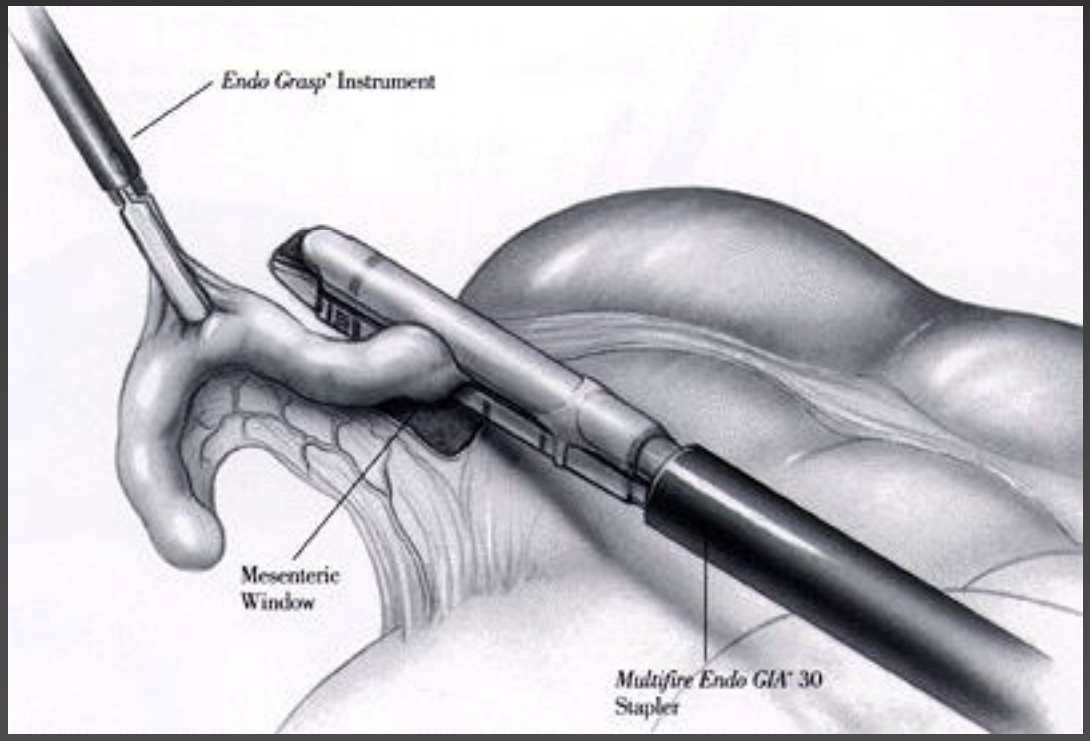
Laparoscopic Appendectomy

- Gained popularity in the late 1990's



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Clinical Case

- 14 year old male
- Acute onset of abdominal pain
- Peritonitis
- Thermodynamically stable
- 2 AM
- X-ray…

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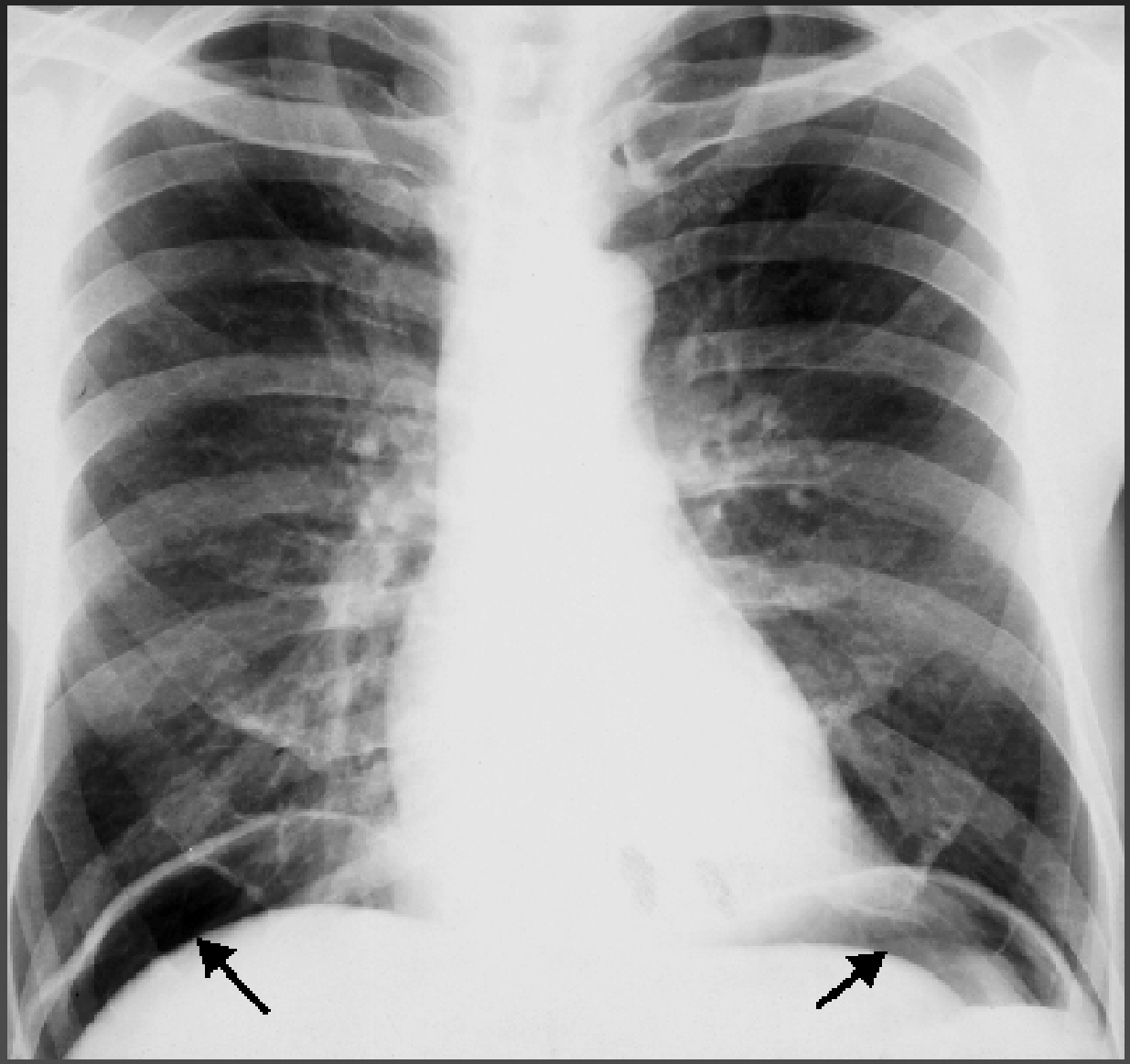

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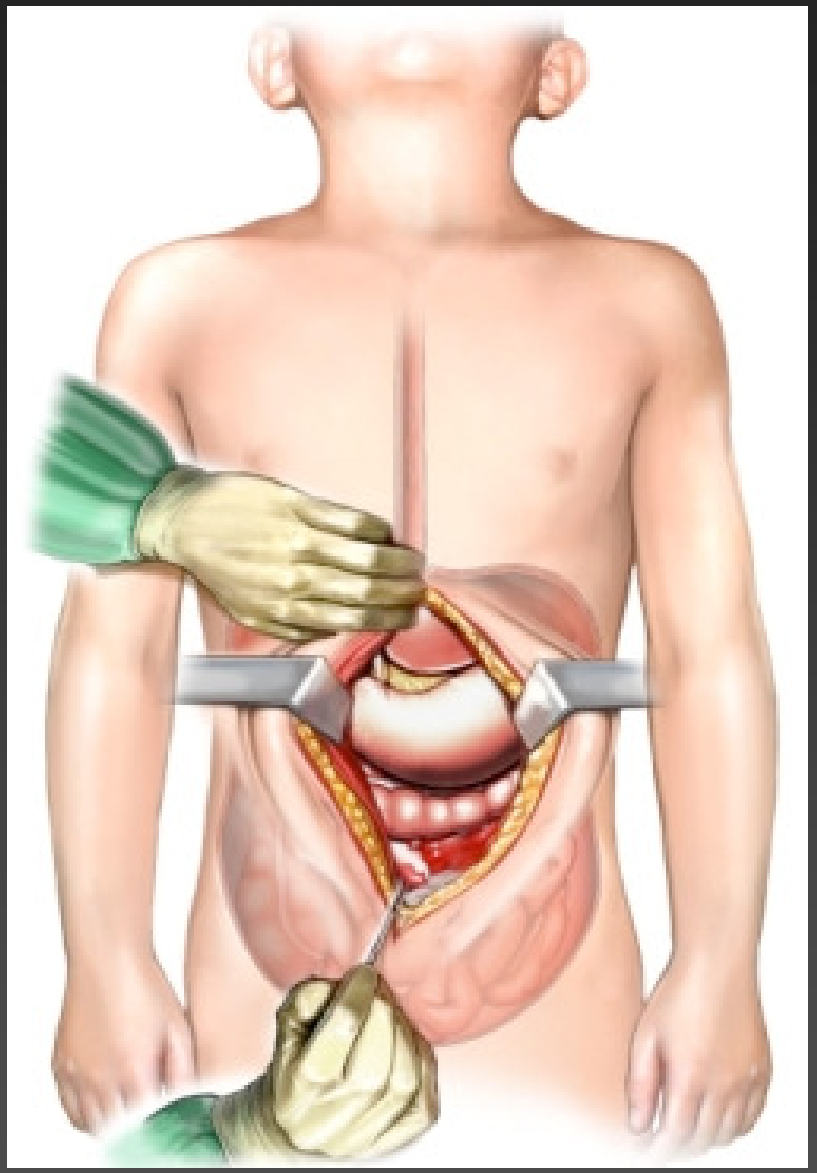

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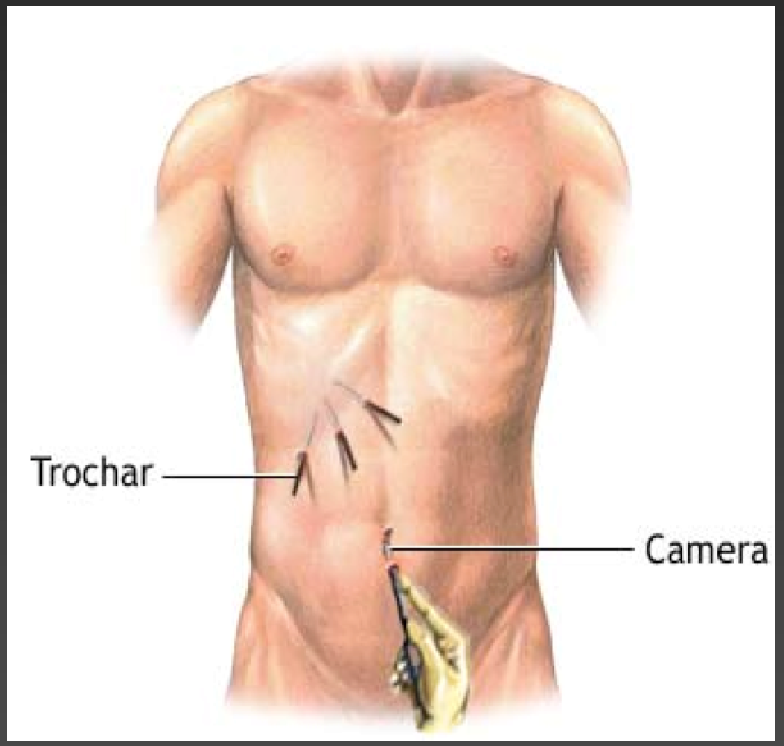

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http://www.advanced-surg.com/wp-content/uploads/2010/02/laparoscopy.jpg

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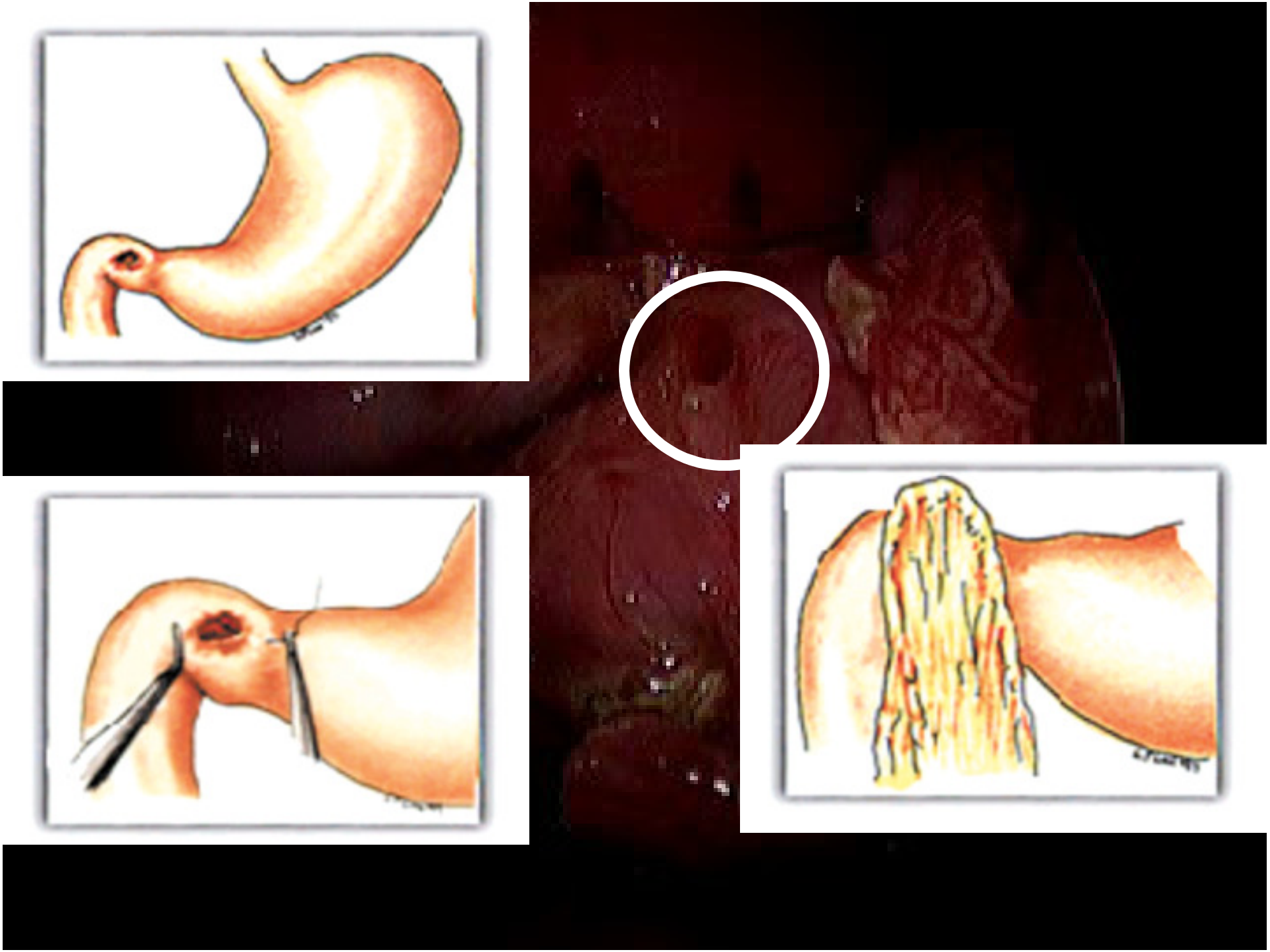

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Clinical Case

- 6 year old
- 2 days
  - Nausea
  - Vomiting
  - Abdominal pain
  - No stool
  - No flatus

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Clinical Case

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MIS?

MIS is NOT POSSIBLE because . . .

- Bowel too distended?
- No visibility?
- Risk of bowel injury?

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MIS?

MIS is POSSIBLE because . . .

- Bowel becomes less distended with insufflation
- Single adhesive band?

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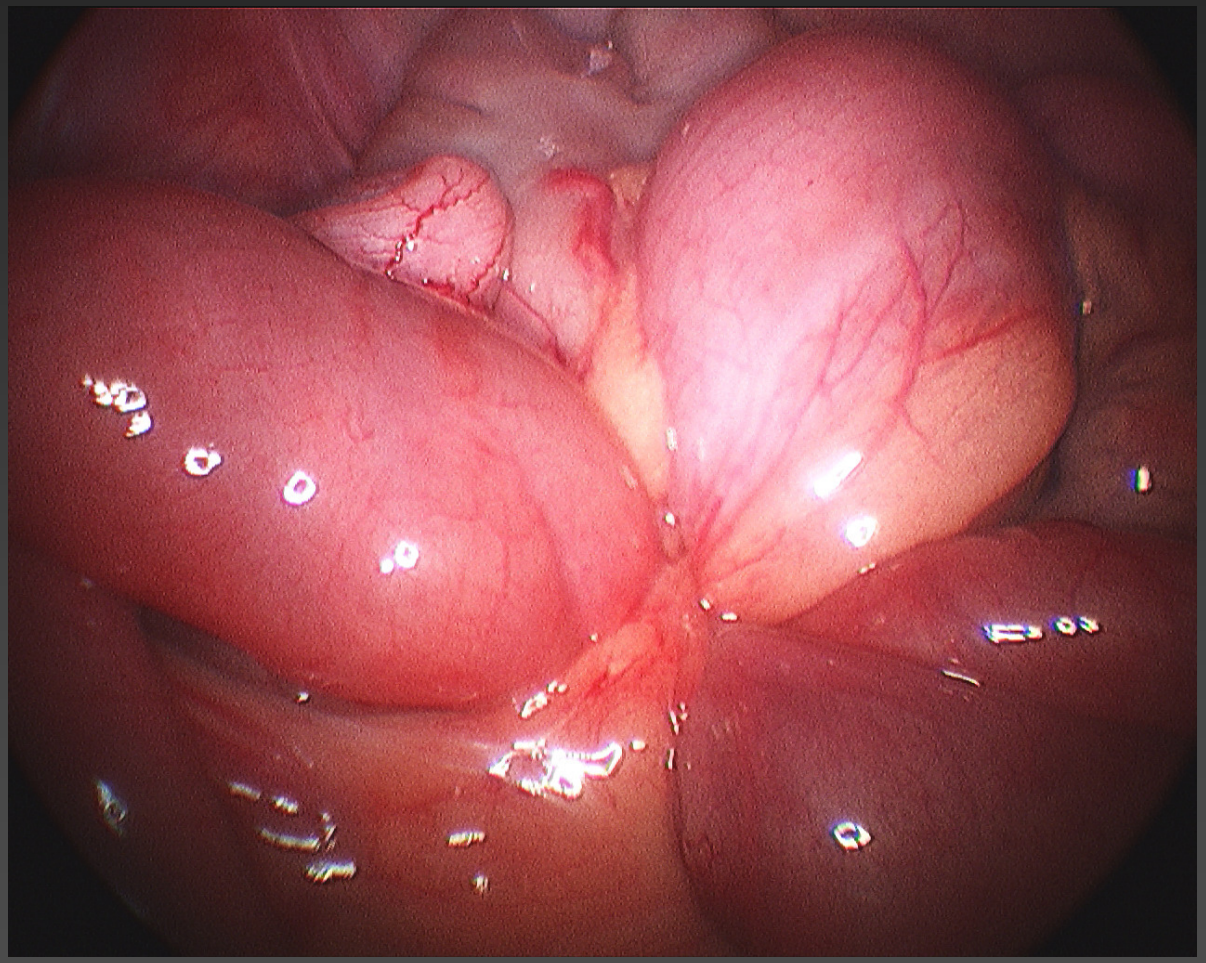
Small Bowel Obstruction



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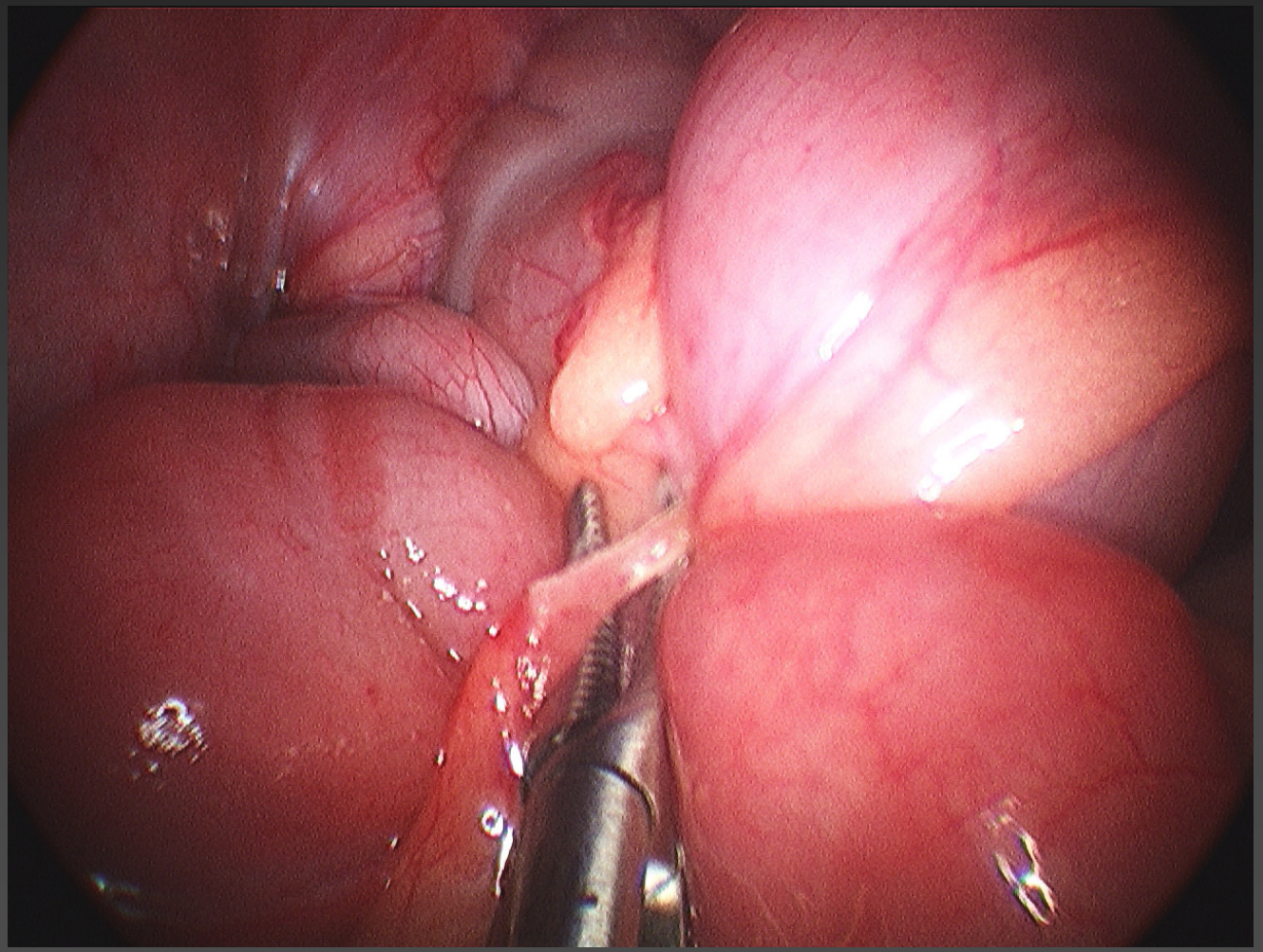
Small Bowel Obstruction



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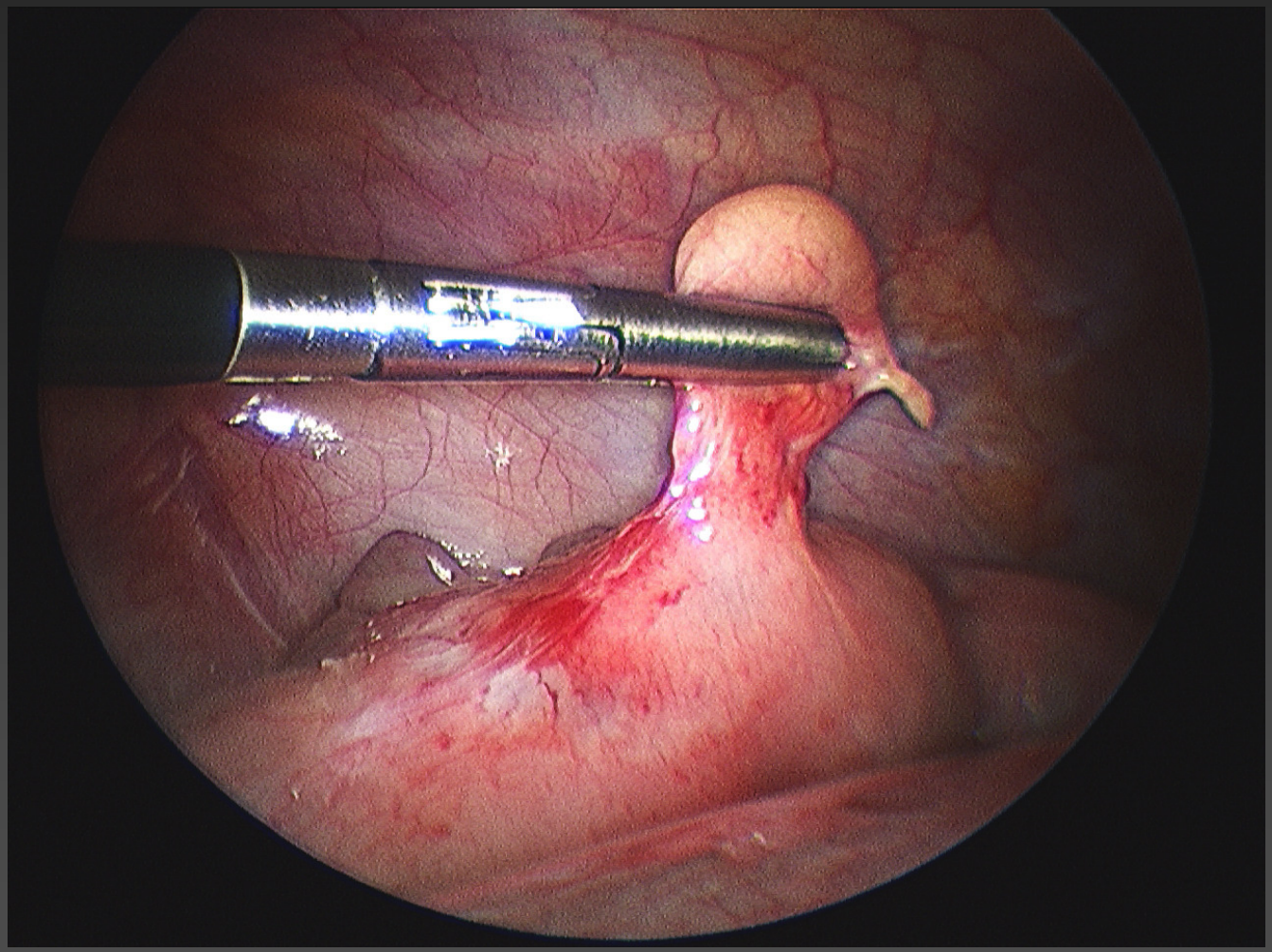
Omphalomesenteric Band



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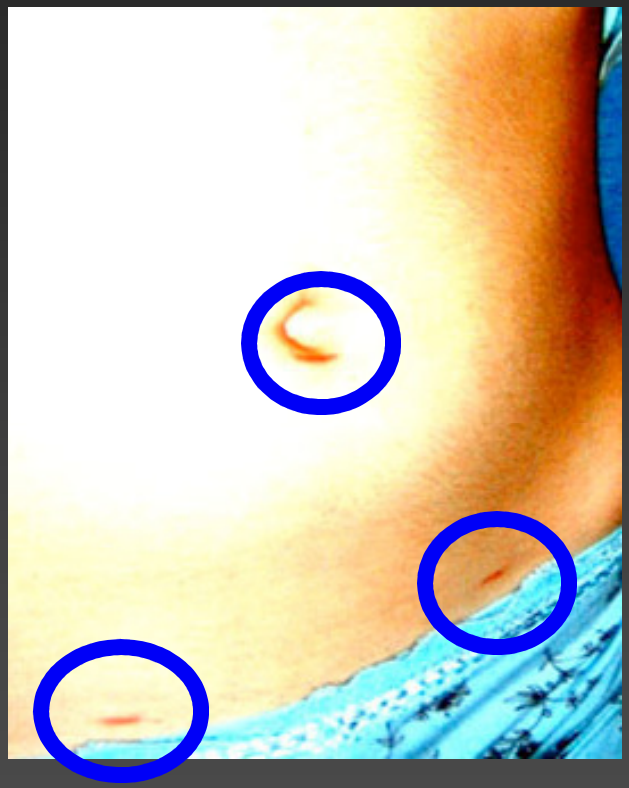

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MISsion Possible!

- Intussusception
- Incarcerated inguinal hernia
- Ovarian cyst
- Ovarian torsion
- Pyloric stenosis
- Ladd's procedure
- Congenital diaphragmatic hernia
- Esophageal atresia
- Tracheoesophageal fistula

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But What About Trauma?

- Elective MIS √
- Urgent MIS √
- EMERGERNT MIS ?

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Maybe the injury is not as serious as expected…

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Or maybe it's more serious…

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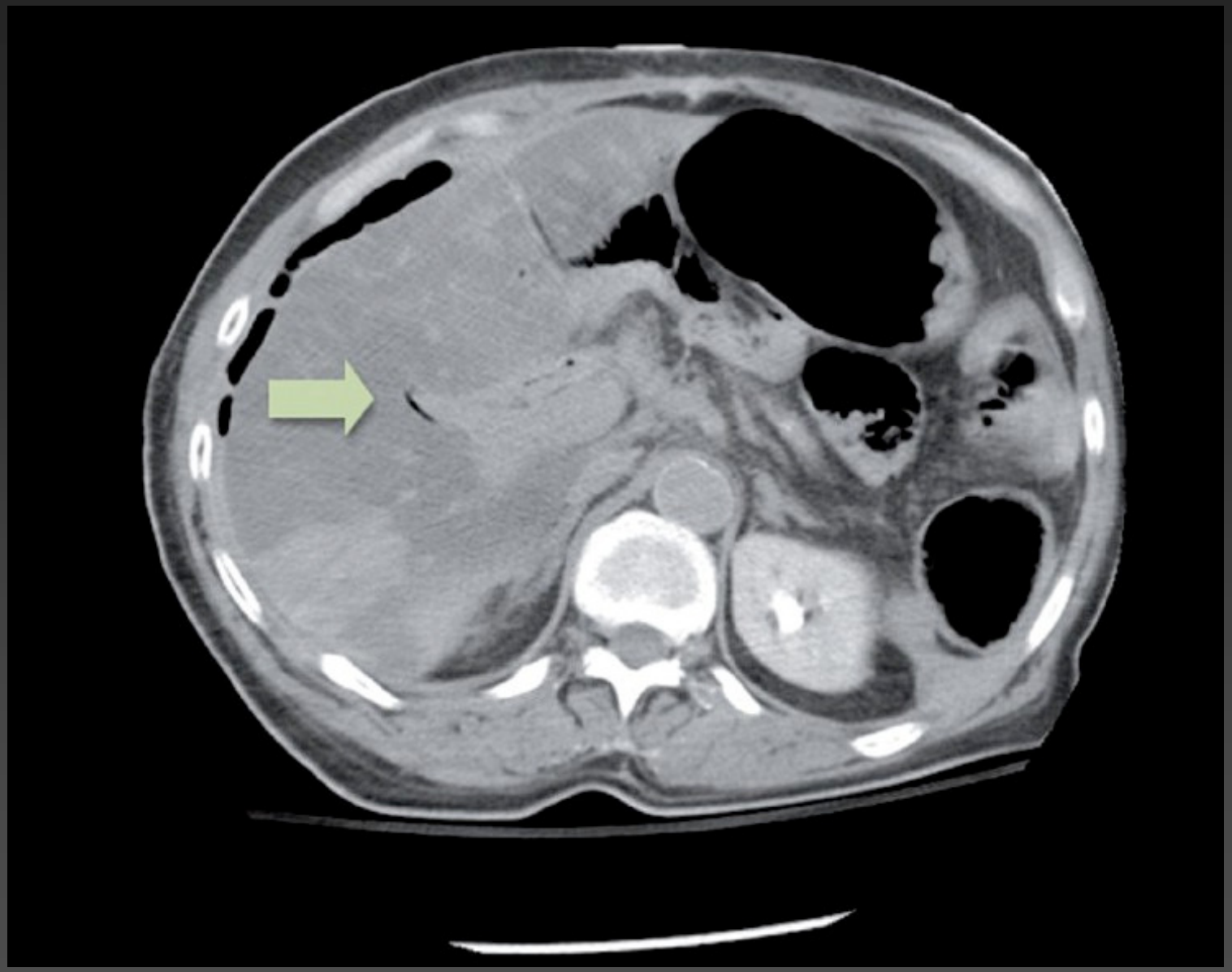

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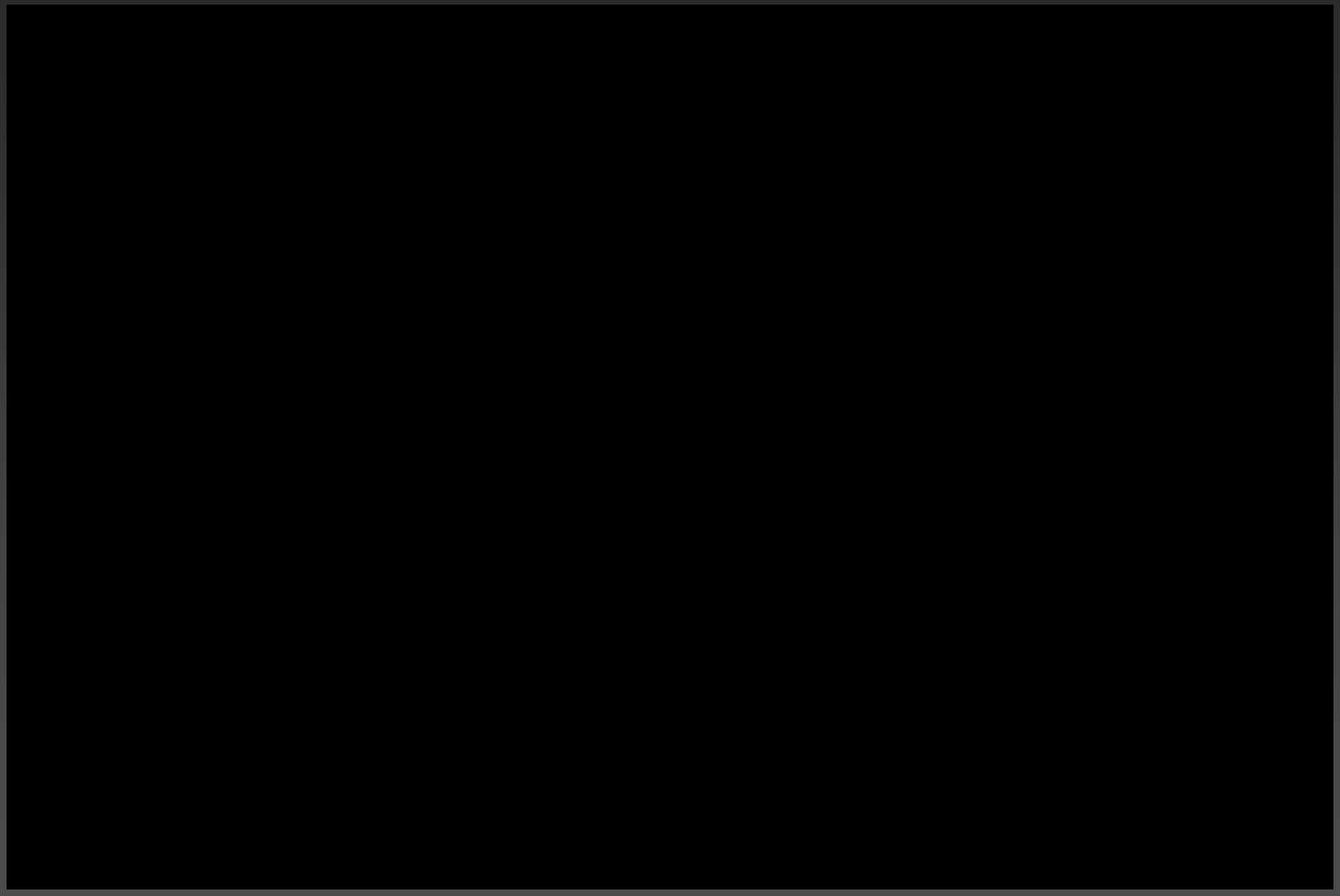
Laparoscopy for Blunt Injury?



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Pancreatic Injury

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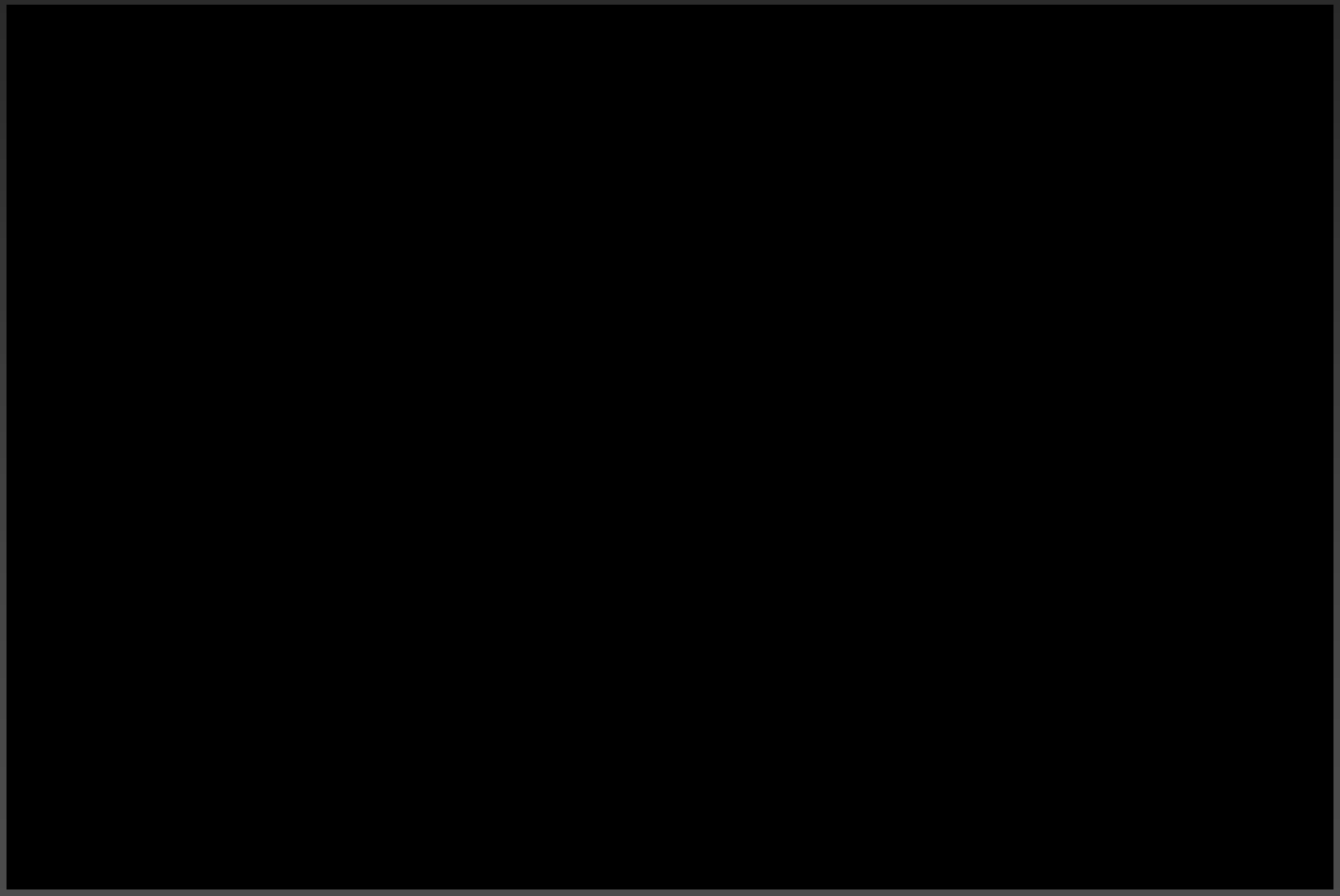
Pancreatic Injury



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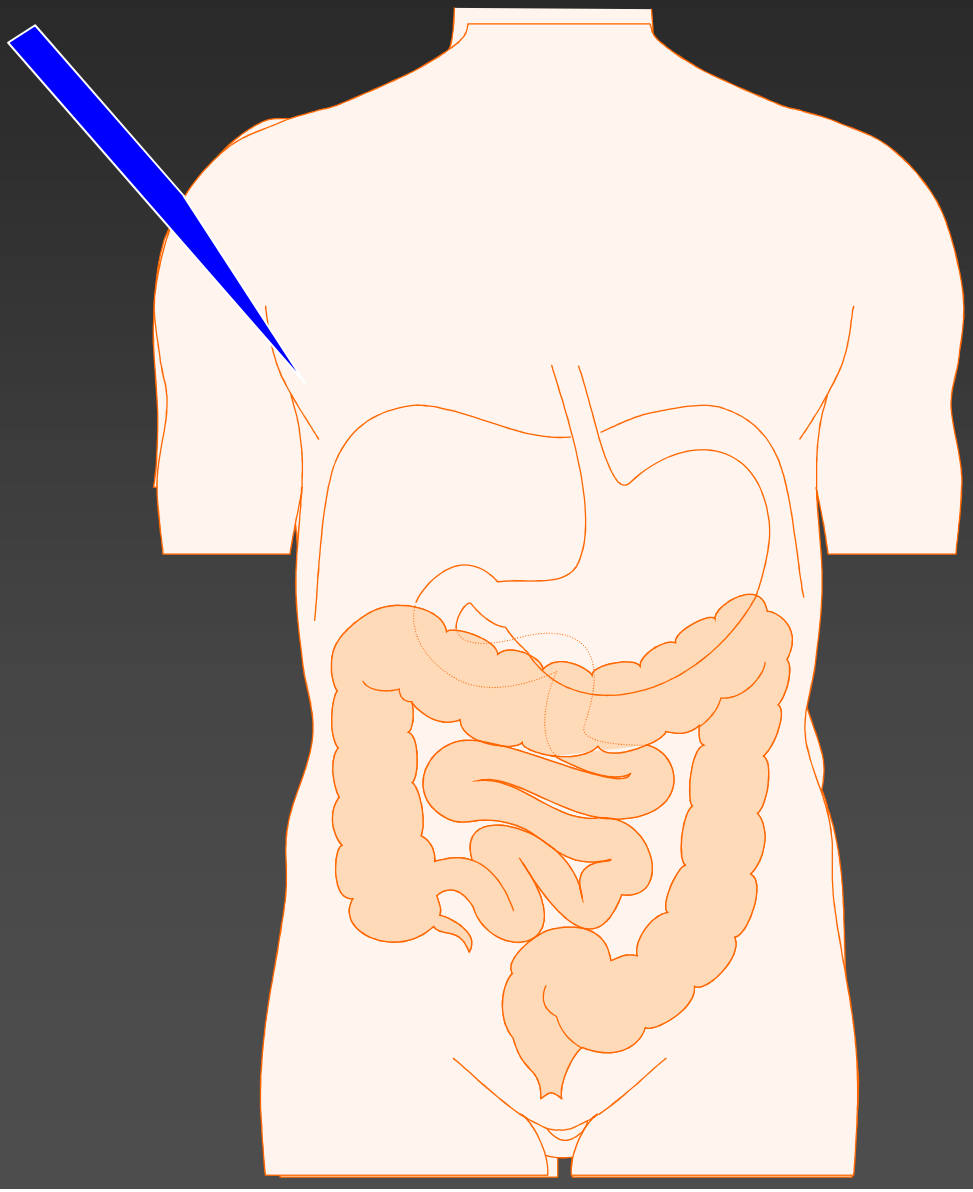
Penetrating Injury



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Dr. Mark Wulkan, Emory Univ, Atlanta, GA

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Where's the Data?

There are no randomized controlled studies.

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Where's the Data?

- Berci, et. al. (1991)
  - Adult study
  - 25% incidence of positive findings laparoscopically
  - Successfully managed without intervention
  - Would have resulted in non-therapeutic laparotomies

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Berci G, Sackier JM, Paz-Partlow M: Emergency laparoscopy. *Am J Surg 161: 332*-335, 1991.

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Where's the Data?

- Marwan A, et. al. (2010)
  - Retrospective review 1997-2009 (4836 admissions)
  - Level I pediatric trauma center
  - Looked at all trauma laparotomies and laparoscopies
  - Laparoscopies grouped diagnostic or therapeutic
  - Diagnostic success
    - attaining the correct diagnosis
  - Therapeutic success
    - ability to repair the lesion by laparoscopy
  - Avoidance of laparotomy
    - correct diagnosis was obtained
    - problem corrected by laparoscopy without conversion to open

Where's the Data?

- Marwan A, et. al. (2010)
  - 92 patients were explored surgically
  - Laparotomy 71 (77%)
  - Laparoscopic 21 (23%)
  - Blunt 47 (51%)
  - Penetrating 35 (38%)

Where's the Data?

- Marwan A, et. al. (2010)
  - 21 diagnostic laparoscopies
    - 19 acute – all successful
    - 2 delayed – conversion to open to reach diagnosis
  - ISS
    - Diagnostic and therapeutic laparoscopy ISS = 8.58 ± 2.53
    - Laparotomy ISS = 21.54 ±1.56 (*p 0.002*)
  - Length of stay (days)
    - Laparoscopic 3.41 ± 0.96
    - Laparotomy 14.74 ± 2.18 (*p 0.001*)
  - Deaths
    - Laparoscopy 0/21
    - Laparotomy 6/71 (8.5%) (*p 0.33*)

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Marwan et al. JTrauma, 69(4), October 2010, 761-764

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TABLE 1. Abdominal Trauma Patients Managed by Laparoscopy

Mechanism	Age	Diagnostic Success	Therapeutic Success	ISS	Reason to Convert	Outcome
GSW	9.0	+	+	4	—	Retrieval of pellet
Stab wound	2.8	+	+	13		Reduction of omentum, repair of abdominal wall
MVC, rollover	7.8	+		27		Grade I liver laceration, colon hematoma, no injury
MVC	8.2	+		24		Grade I liver laceration, contusion of mid jejunum
MVC, seat-belt sign	5.2	+		10	Duodenojejunal perforation	Exploratory laparotomy—resection of third and fourth portion duodenum
GSW to abdomen	5.2	+	+	9		Repair of 2 enterotomies, 1 colostomy
MVC, seat-belt injury 3 wk before admission	8.9	-		9	Dense adhesions in RLQ	Exploratory laparotomy—resection proximal ileum and reanastomosis
Bicycle, stab wound to abdomen	9.5	+		4		Omental injury—retrieval of nail
Bicycle injury 2 wk before admission	9.3	-		9	Dense adhesions	Exploratory laparotomy, missed small bowel injury, repair
Lawnmower injury/fall	3.0	+		18	Matted small bowel with perforation	Exploratory laparotomy, repair of 5 small bowel enterotomies
MVC seat-belt injury	12.2	+	+	1		Single jejunal perforation—repair
Fall/penetrating wound of abdomen	6.1	+		4		No peritoneal violation
GSW right scrotum groin	13.4	+		5		No peritoneal violation
MVC	13.0	+		17	Left colon degloving injury	Exploratory laparotomy, jejunal laceration repair, anastomosis
GSW LLQ	15.9	+		1		No peritoneal violation
ATV penetrating injury handlebar	14.4	+		10		No peritoneal violation
Stab-wound RUQ ice pick	15.4	+		1		No peritoneal violation
Abdominal kick, CT no free fluid, worsening pain	7.7	+		10	Jejunal perforation with major contamination	Exploratory laparotomy, repair of jejunal laceration, anastomosis
MVC passenger	5.0	+		19	Bilio sanguinous fluid	Exploratory laparotomy, repair of transected duodenum
MVC passenger	11.4	+		10	Mesenteric disruption, active bleeding	Exploratory laparotomy—repair of mesenteric laceration
GSW to RUQ	10.2	+	+	4		Retrieval of pellet, cholecystectomy

GSW, gunshot wound; MVC, motor vehicle crash; ATV, all terrain vehicle; RU(L)Q, right upper (lower) quadrant; CT, computed tomography.

Marwan et al. JTrauma, 69(4), October 2010, 761-764

Where's the Data?

- Marwan A, et. al. (2010)
  - Conclusions
    - Laparotomy was avoided in 62% of patients
    - No missed injuries
    - Helpful in excluding peritoneal violation in stable patients with penetrating trauma

Where's the Data?

- Largest published series to date (Feliz A, et. al.)
  - 5-year retrospective review, 7127 admissions
  - Level 1 pediatric trauma center database
  - 113 children (blunt and penetrating mechanisms)
  - 32 patients underwent initial diagnostic laparoscopy
  - 9 (28%) had no injury observed
  - 3 had an injury that required no further therapy
  - 6/32 patients had their injury repaired laparoscopically
  - Laparotomy was therefore avoided in 17 (56%)
  - No missed injuries

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Feliz A. et. al. Journal of Pediatric Surgery (2006) 41, 72–77

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Table 1 Demographic information of children undergoing initial laparoscopic exploration or laparatomy

Demographics	Laparotomy	Laparoscopy
n	81	32
Male (%)	58 (72)	22 (69)
Female (%)	23 (28)	10 (31)
Age (y)	9.2 ± 4.1	8.7 ± 3.3
ISS	19.3 ± 12.2	11.3 ± 8.3**
TRISS	0.831 ± 0.305	0.941 ± 0.168*
Mechanism		
Blunt (%)	74 (91)	26 (81)
Penetrating (%)	7 (9)	6 (19)
Glasgow Coma Score	12 ± 5	14 ± 3*
Length of ICU stay (d)	3.7 ± 7.1	0.6 ± 1.6**
Length of hospital stay (d)	12.5 ± 11.4	7.4 ± 5.6**

* $P = .02$.

** $P < .003$.

Table 2 Type of laparoscopic operations and injuries identified during laparoscopic explorations

Laparoscopic operations	n (%)	Injuries
Diagnostic laparoscopy		
Negative	9 (28)	None
Nontherapeutic	3 (9)	3 Mesenteric or retroperitoneal hematomas
Positive laparoscopic repair	6 (19)	3 Perforated viscera 2 Mesenteric defect 1 Foreign body
Positive conventional repair	14 (44)	10 Perforated viscera 3 Diaphragmatic rupture 1 Distal pancreatic injury

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Feliz A. et. al. Journal of Pediatric Surgery (2006) 41, 72–77

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Where's the Data?

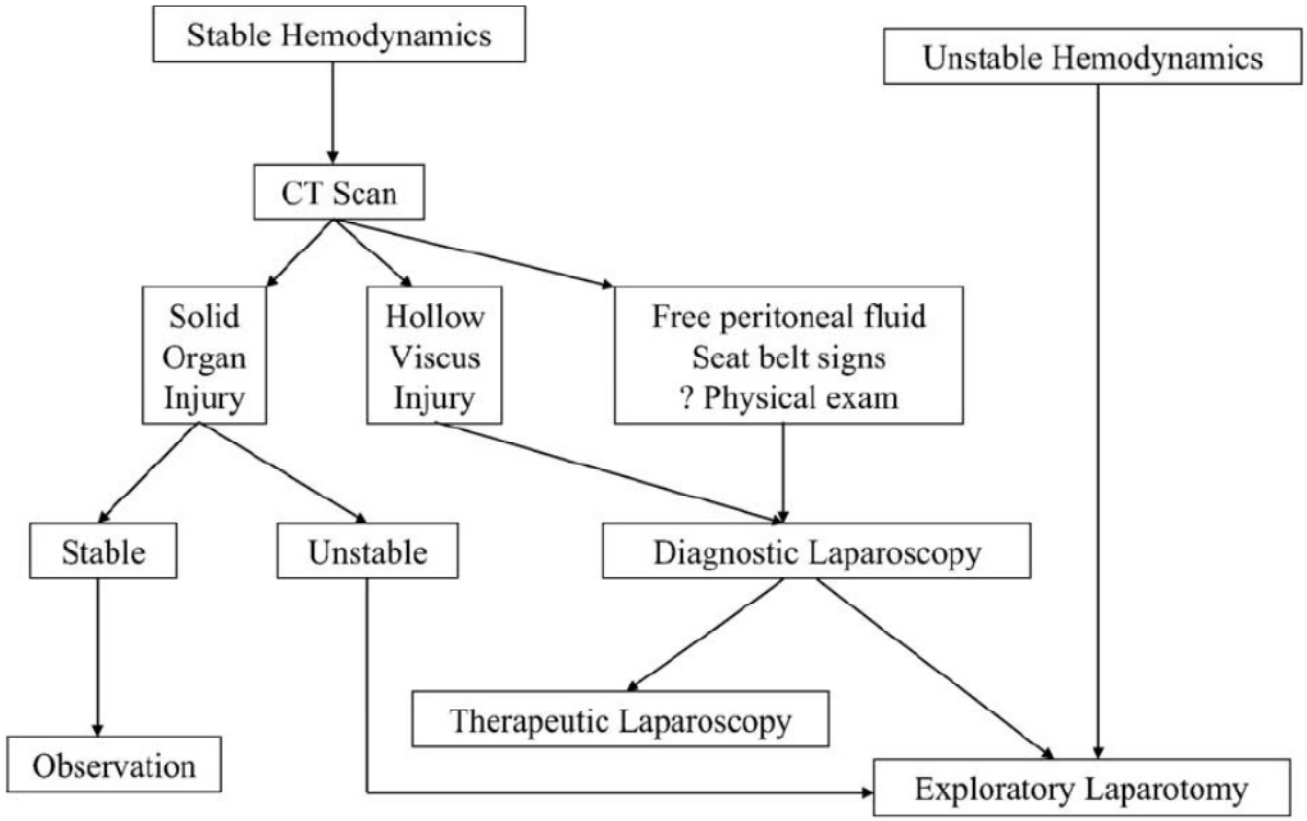

Fig. 1 Algorithm for laparoscopy in blunt abdominal trauma.

Feliz A. et. al. Journal of Pediatric Surgery (2006) 41, 72–77

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Where's the Data?

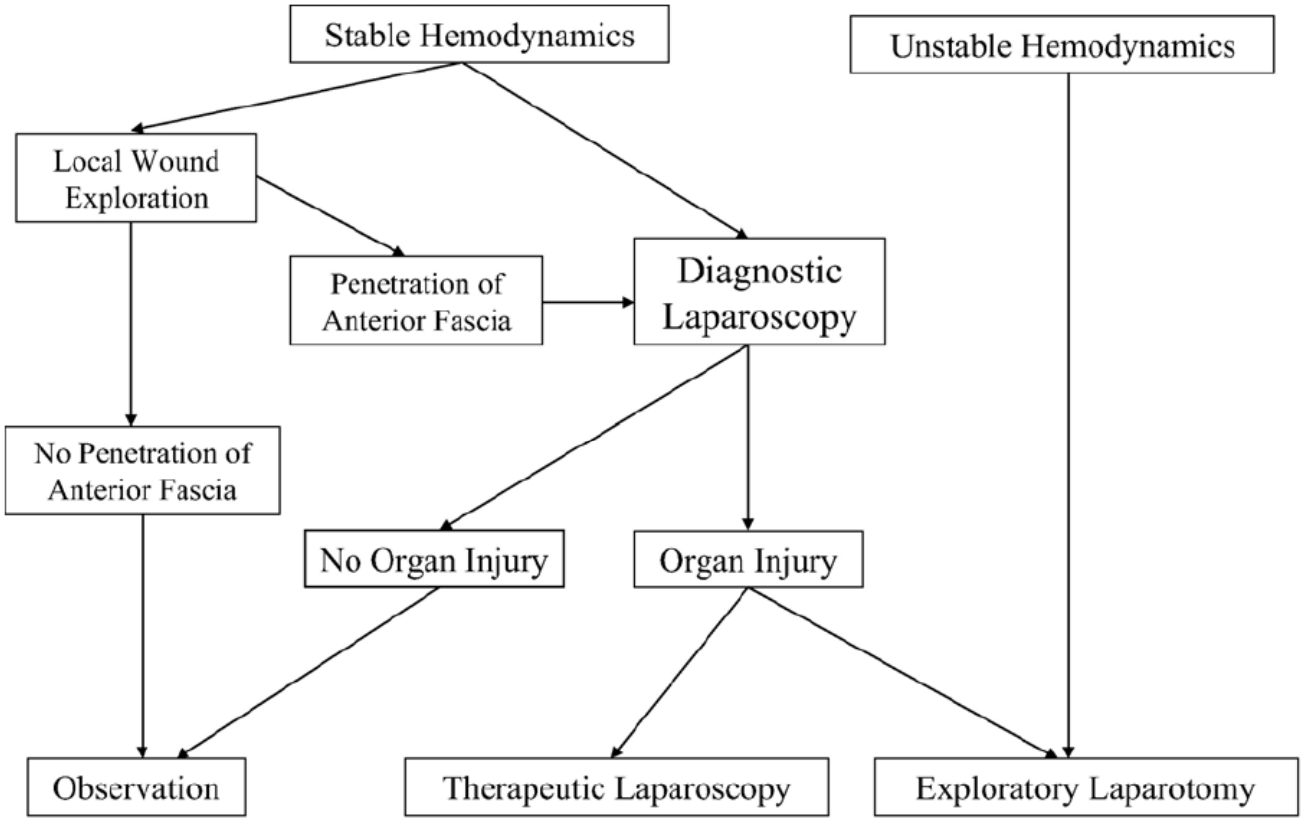

Fig. 2 Algorithm for laparoscopy in penetrating abdominal trauma (abdominal stab or tangential GSWs).

Feliz A. et. al. Journal of Pediatric Surgery (2006) 41, 72–77

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General Guidelines

- Management of identified injuries is dependent upon the minimally invasive skills and judgment of the surgeon.
- Hemodynamically unstable patients should be explored using a conventional laparotomy.
- Typical indications for laparoscopy:
  - To explain free fluid
    (free fluid alone should not mandate exploration)
  - Pain out of proportion to expectations
  - Lap belt sign

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Gaines BA and Rutkoski JD. Seminars in Pediatric Surgery (2010) 19, 300-303

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Technical Aspects

- General anesthetic
- Maintain c-spine precautions
- Type and cross
- Orogastric tube and Foley catheter
- Preparation for conversion to open

Gaines BA and Rutkoski JD. Seminars in Pediatric Surgery (2010) 19, 300-303
http://web.mac.com/kieran.mcmanus/Chapters/General/Developing_a_thoracoscopy_program_files/IMG_2715.jpg
http://myweb.facstaff.wwu.edu/knecht/current%20research_files/prbc.gif

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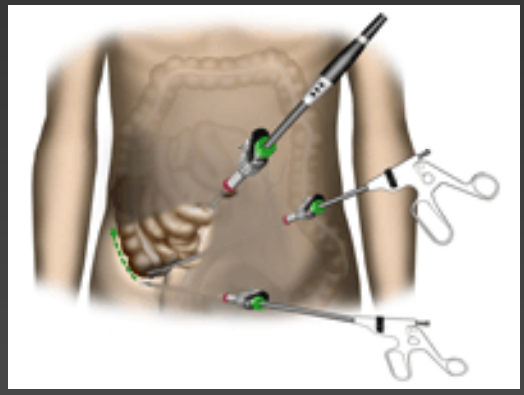
Technical Aspects

- Start with 3 trocars
  - 5mm umbilical
  - 2 additional 3-5mm ports (SP and LLQ)
- Systematic exploration
  - Liver
  - Spleen
  - Diaphragm surfaces
  - Peritoneal surfaces
  - SB from ICV to LOT with mesentery
  - Colon, duodenum, stomach
  - Pancreas and lesser sac (may require additional port) (use of pre-op CT)



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Gaines BA and Rutkoski JD. Seminars in Pediatric Surgery (2010) 19, 300-303
http://images.med.cornell.edu/body/cornellsurgery/colonrectal/abd_lap.gif

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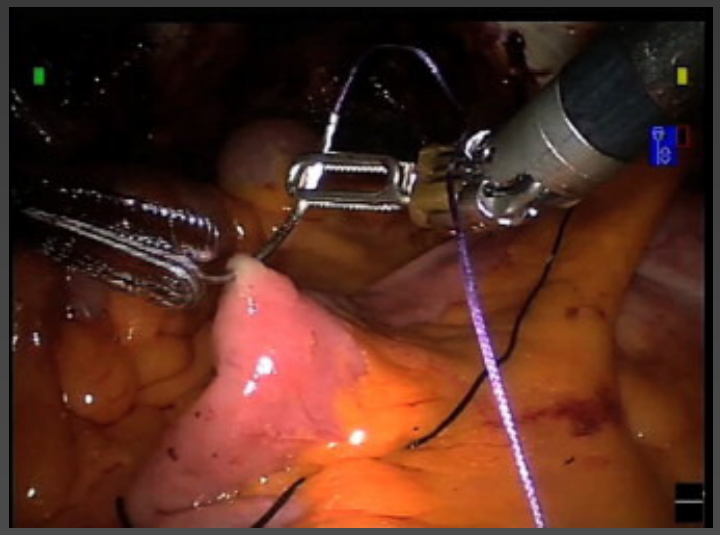
Technical Aspects

- If injury is identified
  - Laparoscopy
    - Repair simple bowel perforation
    - Evaluate rectal injuries
    - Assist with creation of stoma
    - Minor solid organ injuries
      - Topical hemostatic agents
      - Vicryl splenorrhaphy bag
    - Distal pancreatectomy



Gaines BA and Rutkoski JD. Seminars in Pediatric Surgery (2010) 19, 300-303
http://www.europeanurology.com/uploads/eur_articles/S0302-2838(09)01324-4/assets/gr2.jpg

Technical Aspects

- If injury is identified
  - Thoracoscopy
    - Removal of foreign bodies
    - Evaluation and repair of the diaphragm
    - Release of lung trapped in fibrinous exudate

Gaines BA and Rutkoski JD. Seminars in Pediatric Surgery (2010) 19, 300-303
http://www.worldofstock.com/slides/PHE4076.jpg

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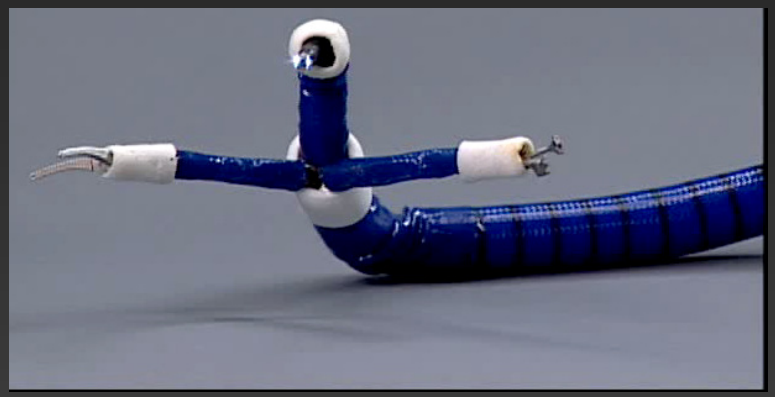
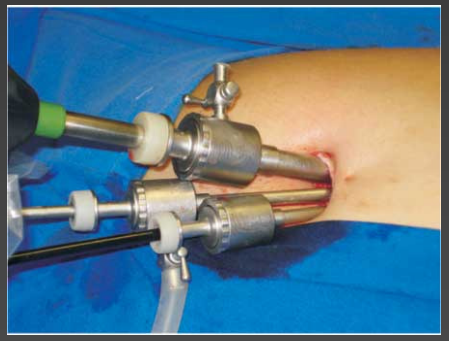
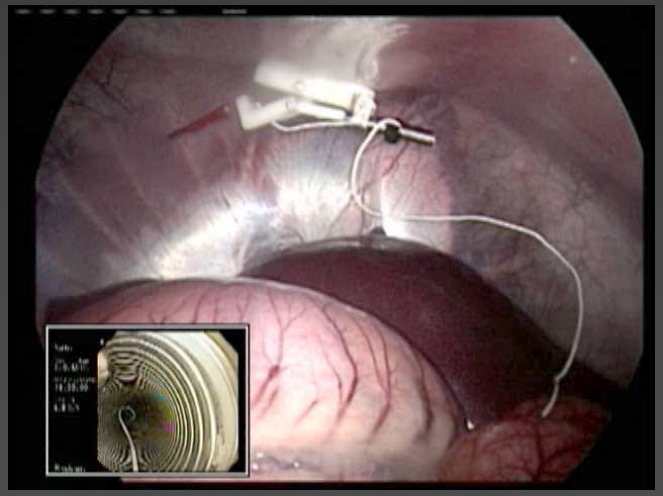
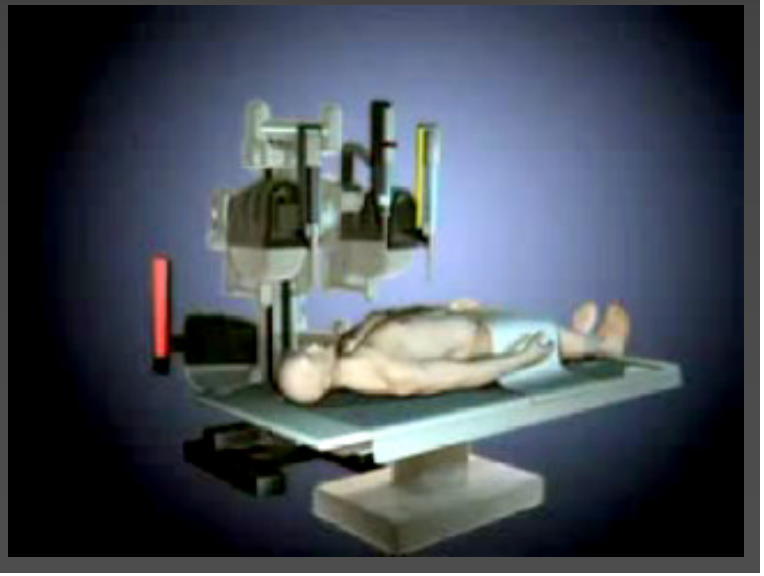
The Future Is Now!









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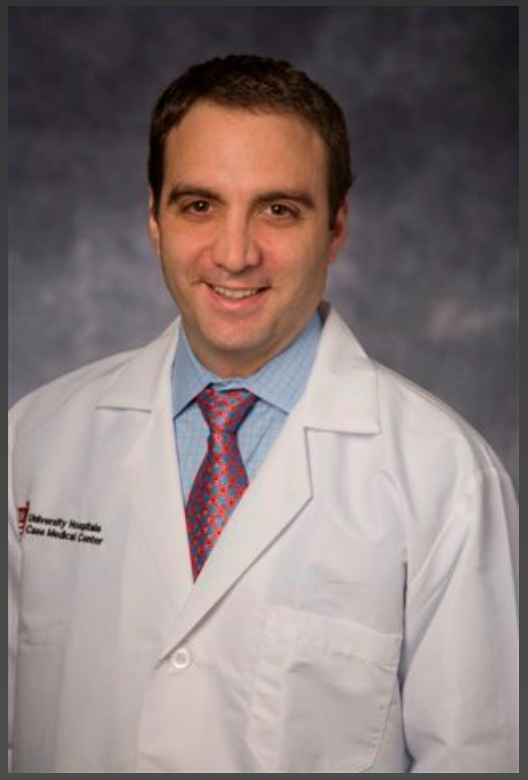
Special Acknowledgment

Todd Ponsky, MD



CASE Surgery

Rainbow Babies & Children's Hospital