Selective Nonoperative Management of Penetrating Abdominal Trauma

Kings County Hospital Center
Verena Liu, MD
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Case Presentation

28M admitted on 8/27/2011 s/p GSW to right upper quadrant and left back

PMH/PSH- none

Meds- none

SH- denies tobacco, drug use, alcohol occasionally

NKDA

Case Presentation

Exam:

VS- temp 99.0 BP 130/80 HR 100

HEENT- EOMI, PERRLA

Chest- CTA b/l

Abd/back- 1 GSW RUQ right anterior axillary line at T10, 1 GSW back left paravertebral L3-L4, abdomen soft, no guarding, no rigidity, tender at GSWs

Ext- warm, pp+

Case Presentation

Labs:

VBG- 7.30/49/51/80%/21/-2

CBC- 9/14/43/249

BMP- 142/3.2/103/22/18/1.15/92

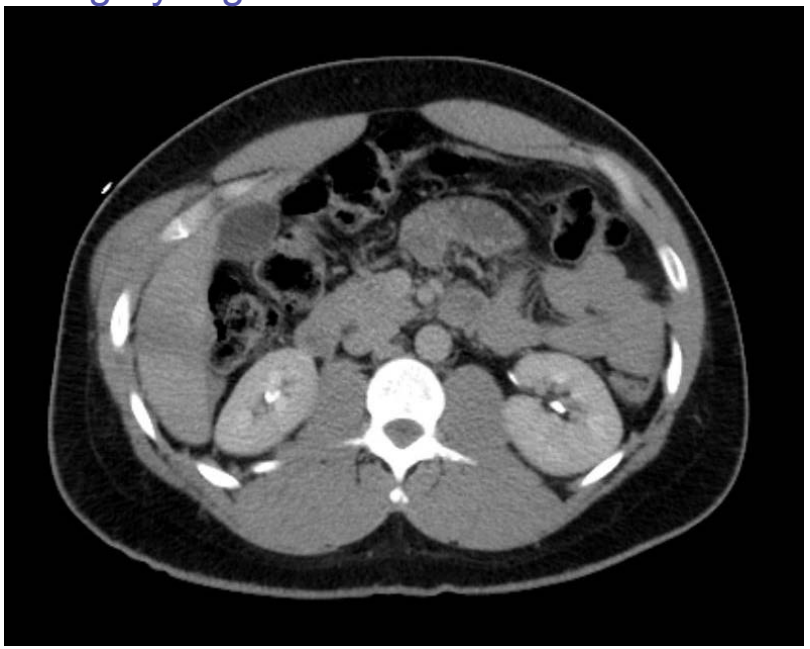
LFTs- 6.9/4.4/44/44/51/0.3

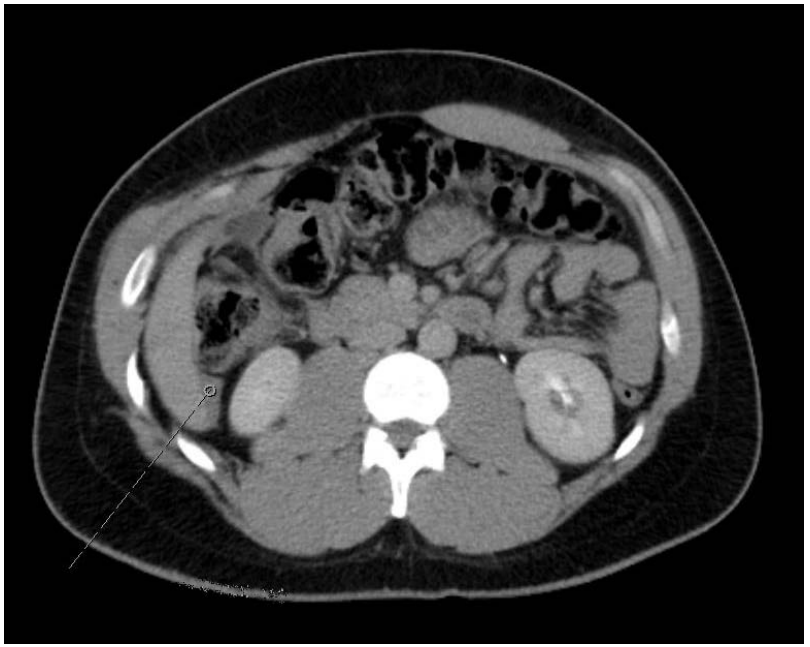
Amylase/lipase- 30/71

Lactate- 8.1

CT abdomen/pelvis

GSW at the right lateral thoracic wall tracking through the abdomen with exit wound in the back.
Liver hematoma with perihepatic fluid.
Perisplenic hematoma.
Hemoperitoneum surrounding loops of bowel at the hepatic flexure.
Pneumoperitoneum.
Bullet tract extends through liver but trajectory does not appear to align with bowel.





Hospital Course

8/28/2011- admitted to SICU for observation, serial abdominal exams and serial cbc

8/29/2011- in SICU, NPO

VS- 102.8 BP 120-140/70-80 HR 60-70

cbc 13/13/40/190 and cbc 14/13/41/186

abdomen soft, non-tender

8/30/2011- regular diet, transferred to floor

cbc 11/12/38/174

abdomen soft, non-tender

8/31/2011- tolerating diet, + BM

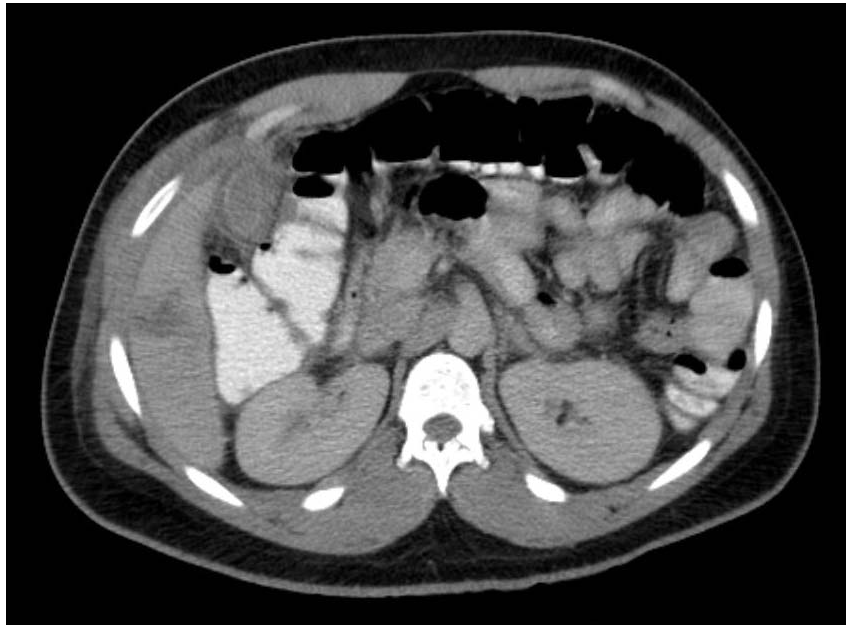
VS- 102.2 BP 133/79 HR 111

cbc 9/12/36/170

abdomen soft, non-tender

CT abdomen/pelvis

Thickening and inflammation involving the ascending colon with evidence of active extravasation of contrast from the medial wall of the colon with foci of free air. Stable grade 2 hepatic laceration.



Operation

- Exploratory laparotomy
- Walled-off collection of stool in the right upper quadrant at the hepatic flexure, large hole 3-4 cm in the right colon, necrotic edges
- Right hemicolectomy with primary anastomosis in the right lower quadrant, irrigation of abdominal cavity, fascial closure, skin stapled intermittendly, packing in between staples

Postoperative Course

POD#1-3 – NPO, NGT removed POD#2, on mefoxin

POD#4- regular diet, return of bowel function, mefoxin discontinued

POD#5- febrile to 102.8, WBC 15

POD#6- CT abdomen/pelvis – no evidence of anastomotic leak, peritoneal fluid collections 4.1 x 3.4 cm at distal ileum, 9.6 x 2.5 cm fluid collection anterior to transverse colon

POD#7- febrile to 101.7, WBC 19, started on zosyn

POD#8- afebrile, WBC 20, wound completely opened for foul-smelling drainage, wound cx- enterobacter cloacae, sensitive to zosyn

Postoperative Course

POD#11- afebrile, WBC 14

POD#12- afebrile, WBC 17, abdominal CT- s/p right hemicolectomy, anastomosis intact. Interval decrease in fluid collections, RLQ collection now 0.9 x 1.2 cm, collection anterior to transverse colon now 4.2 x 1.6 cm

POD#15- completed 1 week course of zosyn, switched to cipro PO

POD#16- WBC 11, discharged home on PO cipro

Selective nonoperative management of penetrating abdominal trauma: historical perspective

Until end 19th century: expectant management with rest, wound dressings, blood letting and opium[1]

Beginning 20th century: operative management standard of care

1960s: observant and expectant treatment for penetrating abdominal injury, mainly SW, advocated by Shaftan[2] and Nance and Cohn[3], but mandatory or routine laparotomy remained standard of care at many institutions

1: Loria et al: Historical aspects of penetrating wounds of the abdomen. Int Abstracts Surg. 1948:87:521-549
2: Shaftan GW: Indications for operation in abdominal trauma. Am J Surg. 1960;99:657-664
3: Nance et al: Surgical management in the management of stab wounds of the abdomen: a retrospective and prospective analysis based on a study of 600 stabbed patients. Ann Surg. 1969;170:569-580

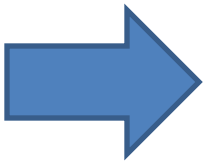
Arguments for and against selective nonoperative treatment of penetrating abdominal trauma

Pro:

- High incidence of nontherapeutic laparotomy from civilian, low velocity wounding: 23-53% for SW, 5.3-27% for GSW
- Complication rate 2.5- 41% for nontherapeutic laparotomies[1]

Contra:

- High incidence (>90%) of significant intraabdominal injuries after GSWs
- nontherapeutic laparotomy is harmless procedure
- delay in diagnosis is a/w high morbidity and mortality
- abdominal exam is unreliable[2]



Selective nonoperative management is standard of care for patients with abdominal stab wounds who are stable without signs of peritonitis, but controversy remains in the application of these same principles to GSW victims.

1: Como et al: Practice Management Guidelines for Selective Nonoperative Management of Penetrating Abdominal Trauma. J Trauma 2010;68:721-733

2: Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

Recommendations for SNOM based on literature search including articles published from 1960-2007 by Como et al:

- Patients who are hemodynamically unstable or who have diffuse abdominal tenderness should be taken for emergent laparotomy.
- Patients who are hemodynamically stabel with an unreliable clinical examination (i.e. brain injury, intoxication, need for sedation/anesthesia) need further diagnostic evaluation or should undergo exploratory laparotomy.
- Routine laparotomy is not indicated in hemodynamically stable patients with abdominal SW without peritonitis or diffuse tenderness.
- Routine laparotomy is not indicated in hemodynamically stable patients with abdominal GSW without peritonitis if wounds are tangential or isolated to the right upper quadrant.
- Serial physical exam is reliable in detecting significant injuries after penetrating trauma to the abdomen.
- In patients selected for NOM, abdominopelvic CT should be strongly considered.
- The majority of patients with penetrating abdominal trauma managed nonoperatively can be discharged after 24h observation.
- Diagnostic laparoscopy may be considered as a tool to evaluate diaphragmatic lacerations and peritoneal penetration.

Como et al: Practice Management Guidelines for Selective Nonoperative Management of Penetrating Abdominal Trauma. J Trauma 2010;68:721-733

Nonoperative management of Abdominal GSWs to the Right Upper Quadrant

- Prospective series of 13 stable patients with GSW to the right thoracoabdominal area admitted from 1990-1993 without peritoneal signs
- All patients had right chest tube placed
- CT confirmed intraabdominal injuries to solid organs (liver, kidney)
- Patients were managed without laparotomy, follow-up CT scan was performed 3-14 days later, which showed partial or complete resolution of liver injuries

Renz et al: Gunshot wounds to the right thoracoabdomen: A prospective study of nonoperative management. J Trauma. 1994;37:737-744

Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries

- Prospective study including 152 patients with penetrating abdominal trauma admitted to level 1 trauma center over 20 months period were evaluated for SNOM (GSW 70%, SW 30%)
- 91 patients (60%) underwent immediate laparotomy, 61 (40%) underwent CT scan evaluation
- 43 patients had no CT findings of hollow viscus injury and were selected for observation
- 2 patients with left thoracoabdominal injuries underwent laparoscopy to rule out diaphragmatic injury

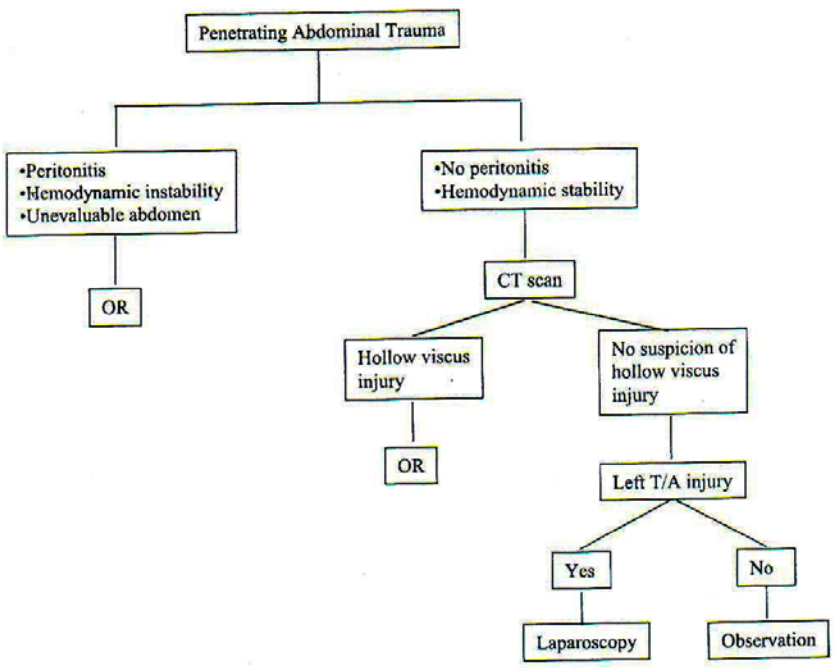


FIGURE 1. Algorithm for the management of penetrating abdominal trauma.

Demetriades et al: Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries. Ann Surg. 2006;244:620-628

Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries

CT scan evaluation- findings diagnostic or highly suspicious for significant injuries requiring laparotomy:

- Free intraperitoneal or retroperitoneal air
- Free intraperitoneal fluid in the absence of solid organ injury
- Localized bowel wall thickening
- Bullet tract close to a hollow viscus with surrounding hematoma
- Contrast blush in the presence of hemodynamic instability

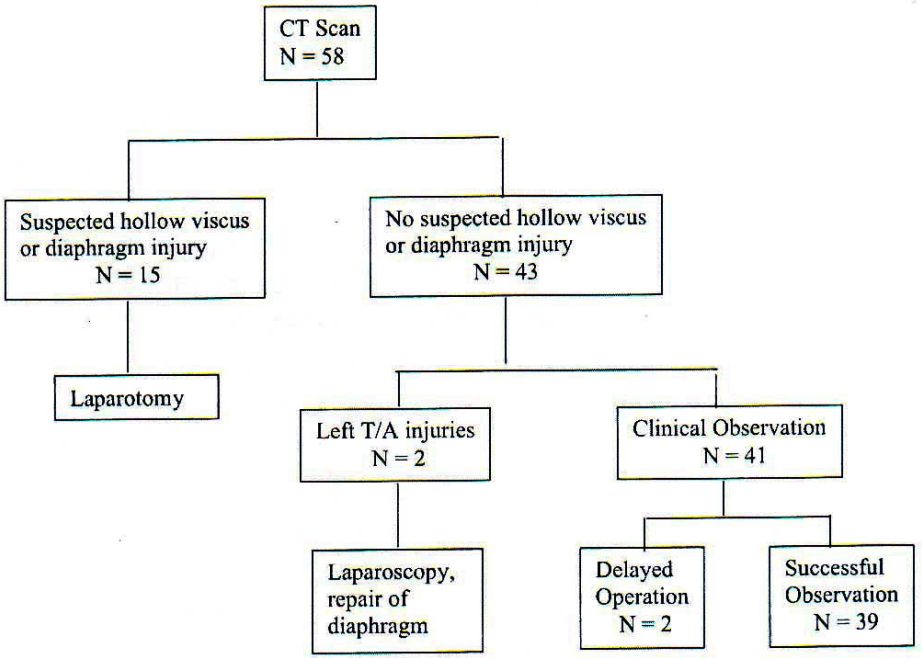


FIGURE 2. CT scan evaluation of penetrating solid organ injuries.

Demetriades et al: Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries. Ann Surg. 2006;244:620-628

Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries: Severity of solid organ injuries selected for nonoperative management

TABLE 5. Patients and Severity of Solid Organ Injuries Selected for Nonoperative Management (n = 43)

	All Patients (n = 152) (n)	Selected for Nonoperative Management (n = 43) [n (%)]	Successful Nonoperative Management (n = 41)† [n (%)]
Liver injuries			
I, II	58	21	19 (32.8)
Grade III–V	51	15	12 (23.5)
All grades	109	36	31 (28.4)
Spleen injuries			
Grade I, II	12	3	1 (8.3)
Grade III–V	16	0	0
All grades	28	3	1 (3.5)
Kidney			
Grade I, II	19	5	5 (26.3)
Grade III–V	28	3	2 (7.1)
All grades	47	8	7 (14.9)
All patients	152*	43 (28.9)	41 (27.0)

*A total of 32 patients had more than one solid organ injury.
†Including 2 patients with laparoscopic repair of the diaphragm.

Demetriades et al: Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries. Ann Surg. 2006;244:620-628

Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries: Results

TABLE 7. Management of 185 Penetrating Solid Organ Injuries

Organ	No. of Patients	Nonoperative Management [n (%)]	Operative Management [N (%)]			
			Simple Surgical Techniques	Damage Control	Organ Removal	No Treatment
Liver	111	32 (28.8)	27 (24.3)	25 (22.5)	0	26 (23.4)
Spleen	28	1 (3.6)	9 (32.1)	0	19 (67.9)	0
Kidney	46	8 (17.4)	19 (41.3)	0	10 (21.7)	11 (23.9)
All organs	185	41 (22.2)	55 (29.7)	25 (13.5)	29 (15.7)	37 (20.0)

Demetriades et al: Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries. Ann Surg. 2006;244:620-628

Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries: Conclusions

- 40% of liver injuries, 30% of renal injuries and 10% of splenic injuries do not have any associated significant intra-abdominal injuries
- Especially liver injuries can be managed nonoperatively, even if high-grade
- Angiographic embolization by interventional radiology may play a critical role in the successful management of these patients
- Renal and splenic injuries can be managed nonoperatively, but this might need further evaluation
- CT scan aids in the selection of patient with isolated solid organ injuries

Demetriades et al: Selective Nonoperative Management of Penetrating Abdominal Solid Organ Injuries. Ann Surg. 2006;244:620-628

Selective Nonoperative management for Patients with abdominal GSWs

- Retrospective study including 1,856 patients with abdominal GSWs admitted at a level 1 trauma center over 8 years period (1993-2000) who were evaluated for SNOM
- 792 patients (42%) were selected for nonoperative management (followed by serial abdominal exam and CT scan after 1998)

***Failure of SNOM**:*

- *new abdominal tenderness*
- *progression of localized to generalized tenderness or tenderness away from the wound*
- *drop in hct*
- *drop in BP*
- *increase in WBC, fever*

Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

Selective Nonoperative management for Patients with abdominal GSWs: Results

Table 1. EXPERIENCE WITH 1,856 PATIENTS WITH ABDOMINAL GUNSHOT GUNSHOT (AGSW)

	All AGSW (n = 1,856)	Anterior AGSW (n = 1,405)	Posterior AGSW (n = 451)	*P* Value Between Anterior and Posterior AGSW
mmediate laparotomy	1,064 (57%)	921 (66%)	143 (32%)	<.0001
nitially not operated	792 (42%)	484 (34%)	308 (68%)	<.0001
Delayed laparotomy	80 (4%)	65 (5%)	15 (3%)	.24
Finally operated	1,144 (62%)	986 (70%)	158 (35%)	<.0001
Finally not operated	712 (38%)	419 (30%)	293 (65%)	<.0001
Negative laparotomy among operated patients*	163 (14%)	124 (13%)	39 (25%)	<.0001
Negative laparotomy after immediate exploration†	140 (13%)	107 (12%)	33 (23%)	.0002
Negative laparotomy after delayed exploration‡	23 (29%)	17 (26%)	6 (40%)	.35

Percentages calculated on 1,144 patients who received a laparotomy (986 anterior AGSW and 158 posterior AGSW).
Percentages calculated on 1,064 patients who received immediate laparotomy (921 anterior AGSW and 143 posterior AGSW).
Percentages calculated on 80 patients who received delayed laparotomy (65 anterior AGSW and 15 posterior AGSW).

Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

Selective Nonoperative management for Patients with abdominal GSWs: Results

Table 2. IMMEDIATE OPERATION VS. NONOPERATIVE MANAGEMENT

	Immediate Operation (n = 1,064)	Nonoperative Management (n = 792)	*P* Value
Age (yr)	26 ± 10	25 ± 10	.59
Age ≥ 55 years	17 (2%)	8 (1%)	.31
Male gender	988 (93%)	722 (91%)	.18
ISS	15 ± 13	3 ± 5	<.0001
ISS ≥ 16	493 (46%)	45 (6%)	<.0001
Systolic BP (mm Hg)	114 ± 44	140 ± 23	<.0001
Systolic BP < 100 mm Hg	287 (27%)	120 (14%)	<.0001
Heart rate (beats/min)	93 ± 32	84 ± 34	<.0001
Heart rate ≥ 100 beats/min	385 (37%)	241 (32%)	.03
Emergent intubation	82 (8%)	2 (0.25%)	<.0001
Anterior AGSW	921 (87%)	484 (61%)	<.0001
Extraabdominal injury	368 (35%)	215 (27%)	.0006
Hospital days	14 ± 13	4 ± 4	<.0001
Charges	$50,169 ± 78,569	$10,637 ± 14,360	<.0001
Death	183 (17%)	1 (0.13%)	<.0001

ISS, Injury Severity Score; BP, blood pressure on admission; AGSW, abdominal gunshot wound.

Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

Selective Nonoperative management for Patients with abdominal GSWs: Results

Table 3. PATIENTS WITH THERAPEUTIC DELAYED LAPAROTOMIES AND COMPLICATIONS POTENTIALLY ASSOCIATED WITH THE DELAY

Pt. No.	ISS	GSW Site	Time From Admission to OR (hr)	Intraabdominal Injuries	Extraabdominal Injuries	Surgical Procedure	Complications	Days in Hospital
1	10	Anterior	3	Colon	None	Primary repair	Psoas abscess	18
2	14	Anterior	6	Colon	Lung	Primary colon repair	Intraabdominal abscess/ pneumonia	24
3	10	Anterior	6.5	Small bowel/ ureter	None	Primary repair	Intraabdominal abscess/ pneumonia	29
4	16	Posterior	8	Iliac artery and vein	None	Repair of artery/vein	Postoperative ileus	12
5	14	Anterior	48	Liver, right kidney	Lung	Hepatorrhaphy, nephrectomy	ARDS/sepsis	39

ISS, Injury Severity Score; GSW, gunshot wound; OR, operating room; ARDS, acute respiratory distress syndrome.

Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

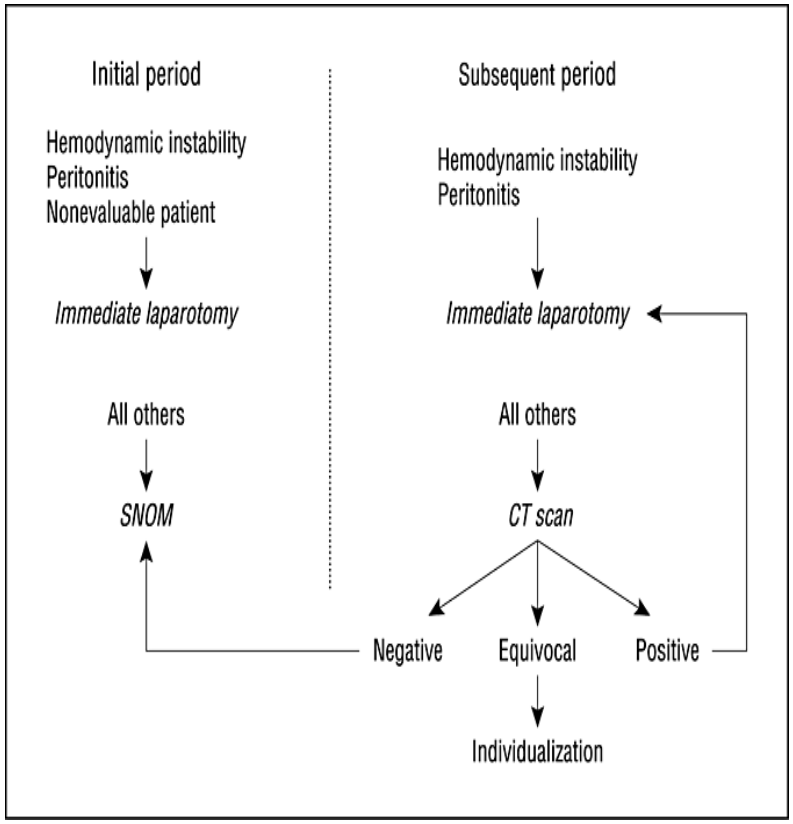
Selective Nonoperative management for Patients with abdominal GSWs: Conclusions

- Compared with patients with nontherapeutic laparotomy, patient managed without surgery had shorter hospital stay and lower hospital charges
- Of 1,856 patients with abdominal GSWs, 38% did not require an operation. The rate of unnecessary laparotomies was 14% with SNOM and would have been 47% with routine laparotomy
- SNOM is a safe method for large level 1 trauma centers with in-house trauma team

Velmahos et al: Selective nonoperative Management in 1,856 Patients with Abdominal GSW: Should Routine Laparotomy still be the standard of care? Ann Surg. 2001;234:395-403

Selective Nonoperative Management of Abdominal GSW in low volume centers

- Retrospective study including 125 patients with abdominal GSW at low volume level 1 trauma center form 1999 to 2009 who were evaluated for SNOM
- 87 patients (70%) had immediate laparotomy for hemodynamic instability, peritonitis or inability to evaluate clinically
- 38 patients (30%) were managed nonoperatively, 7 had delayed laparotomy for worsening abdominal exam, often with suspicious CT findings



Fikry et al: Successful Selective Nonoperative Management of Abdominal Gunshot Wounds Despite Low Penetrating Trauma Volumes. Arch Surg. 2011;146(5):528-532

Selective Nonoperative Management of Abdominal GSW in low volume centers

- 10 patients (8%) had nontherapeutic laparotomy (all immediate laparotomy patients)
- 30 patients were discharged without operation
- Patients without operation had fewer complications and shorter hospital stay
- SNOM is safe and effective for the management of abdominal GSWs in low volume centers

Table 3. Comparison of Patients Who Received an Operation During Their Hospital Stay With Those Who Were Successfully Managed Nonoperatively[a]

Characteristic	Operated On (n = 95)	Successfully Managed Nonoperatively (n = 30)	*P* Value
Age, y	25 (7)	25 (8)	.66
Male sex, No. (%)	92 (97)	29 (97)	.96
Anterior AGSW, No. (% of category) (n = 99)	79 (83)	20 (67)	.05
Posterior AGSW, No. (% of category) (n = 26)	16 (17)	10 (33)	
Abbreviated Injury Score abdomen	3 (1)	1 (1)	<.01
Injury Severity Score	28 (11)	11 (10)	<.01
Blood pressure on admission, mm Hg	132 (27)	143 (27)	.05
Heart rate on admission, beats/min	97 (22)	104 (23)	.18
Hematocrit	38 (5)	38 (7)	.32
Length of stay, d	11 (11)	6 (7)	<.01
Complications, No. (%)	29 (31)	3 (10)	.03
Mortality, No. (%)	4 (4)	0	.25

[a]Abbreviation: AGSW, abdominal gunshot wound. Data are given as mean (SD) unless otherwise indicated.

Fikry et al: Successful Selective Nonoperative Management of Abdominal Gunshot Wounds Despite Low Penetrating Trauma Volumes. Arch Surg. 2011;146(5):528-532

Role of CT

- Prospective study including 104 hemodynamically stable patients without peritonitis with penetrating injuries to the torso form nipple line to upper third of the thigh over 17 months period at high volume level 1 trauma center
- 50 patients with SW, 54 patients with GSW
- Triple-contrast CT scans of the chest and abdomen/pelvis were performed on all patients

Shanmuganathan et al: Triple Contrast Helical CT in Penetrating Torso Trauma: A Prospective Study to Determine Peritoneal Violation and the Need for Laparotomy. AJR. 2001;177:1247-1256

Role of CT

- Positive findings on CT for peritoneal penetration:
  - Wound tract entering peritoneal cavity
  - Intraperitoneal free air, bullet fragments
  - Intraperitoneal organ, mesenteric or vascular injury (active bleeding, pseudoaneurysm)
- Positive findings on CT for diaphragmatic injury:
  - Wound tract adjacent to the diaphragm
  - Thickening of the diaphragm
  - Defect in the continuity of the normal diaphragm
- Positive findings on CT for bowel or mesenteric injuries:
  - Extravasation of oral or rectal contrast
  - Defect in bowel wall
  - Bowel wall thickening
  - Mesenteric bleeding, mesenteric hematoma
  - Wound tract extending up to the wall of hollow viscus
  - Free air or fluid was not considered a sign of hollow viscus injury

Shanmuganathan et al: Triple Contrast Helical CT in Penetrating Torso Trauma: A Prospective Study to Determine Peritoneal Violation and the Need for Laparotomy. AJR. 2001;177:1247-1256

Role of CT: Results

- 35 patients (34%) had positive findings on CT, 21 patients out of 35 underwent laparotomy, as well as 1 patient with negative CT.
- Laparotomy was therapeutic in 86%, nontherapeutic in 9% and negative in 5% (total 3 patients, all SW).
- Patient with negative CT had hematoma on sigmoidoscopy, no injury was identified on laparotomy.
- 69 patients (66%) had negative CT, 97% of those were treated nonoperatively without late complications from missed injuries.
- Sensitivity 100%, specificity 96%, negative predicting value 100%, positive predicting value 86% for the need for laparotomy in this study

Shanmuganathan et al: Triple Contrast Helical CT in Penetrating Torso Trauma: A Prospective Study to Determine Peritoneal Violation and the Need for Laparotomy. AJR. 2001;177:1247-1256

Role of CT: Comparison with other adjuncts to nonoperative management

TABLE 2 Selective Treatment of Penetrating Injuries

Study	Mechanism	Method	Unnecessary Laparotomy	Missed Injury
Demetriades et al. [4]	Gunshot wound	Clinical examination	9% (9/106)	5% (5/106)
Demetriades and Rabinowitz [10]	Stab wound	Clinical examination	5% (15/306)	3.6% (11/306)
Feliciano et al. [12]	Stab wound	Diagnostic peritoneal lavage, local wound exploration	2% (10/500)	1.4% (7/500)
Ivatury et al. [14]	Gunshot wound	Laparoscopy	Not mentioned	7% (7/100)
Keleman et al. [35]	Gunshot wound	Diagnostic peritoneal lavage	18% (8/44)	9% (4/44)
This study	Gunshot wound, stab wound	CT	3% (3/105)	0

Shanmuganathan et al: Triple Contrast Helical CT in Penetrating Torso Trauma: A Prospective Study to Determine Peritoneal Violation and the Need for Laparotomy. AJR. 2001;177:1247-1256

Role of CT: Conclusion

- Triple contrast CT is accurate in excluding peritoneal violation in hemodynamically stable patient with penetrating torso trauma
- Among patients with peritoneal violation, CT was accurate in verifying isolated liver injury and permitting nonoperative treatment for patients with penetrating trauma to the right upper quadrant
- Accuracy of diaphragmatic or bowel injuries should be determined with further studies

Shanmuganathan et al: Triple Contrast Helical CT in Penetrating Torso Trauma: A Prospective Study to Determine Peritoneal Violation and the Need for Laparotomy. AJR. 2001;177:1247-1256

Role of CT

- Prospective study inlcuding 103 patients with nontangential abdominal GSWs selected for NOM admitted during 2 year period (2002 -2004) to level 1 trauma center who underwent single contrast (IV only) CT scan
- 26 patients underwent laparotomy, which was nontherapeutic in 5 (19%)
- 74 patients did not undergo laparotomy, 11 of those patients had isolated solid organ injuries that were managed nonoperatively
- 2 CT scans were false- negative (missed hollow viscus injury), 3 CT scans were false-positive (suspicion of colon injury based on bullet trajectory, no injury on laparotomy)
- Overall, sensitivity was 90.5% and specificity 96%
- CT scan was found to be a useful tool in conjunction with serial abdominal exams to follow patients selected for nonoperative management of abdominal gunshot wounds

Velmahos et al: Abdominal computer tomographic scan for patients with gunshot wounds to the abdomen selected for non-operative management. J Trauma. 2005;59:1155-1160

Role of DPL

- DPL for penetrating trauma was described starting in the 1960s, with thresholds for positive lavage ranging from 1000 to 100 000 RBC/mm^3
- With the concept of SNOM, noninvasive tools like CT and FAST became more popular adjuncts for hemodynamically stable patients
- DPL now is more often reserved for unstable patients requiring rapid diagnosis

Como et al: Practice Management Guidelines for Selective Nonoperative Management of Penetrating Abdominal Trauma. J Trauma 2010;68:721-733

Role of laparoscopy: Evaluation of the diaphragm

- Prospective case series of 34 hemodynamically stable patients with thoracoabdominal penetrating trauma
- All patients underwent laparoscopy and subsequent laparotomy (30) or thoracoscopy (4)
- 1 patient had false- negative laparoscopy due to hemoperitoneum and splenic injury obscuring the diaphragm
- Sensitivity 87%, specificity 100% for laparoscopy to identify diaphragmatic injuries

Table 5 Outcomes Table

	Diaphragm Injury		Total
	Present	Absent	
Laparoscopy			
Positive	7	0	7
Negative	1	30	31
Total	8	30	38

Friese et al: Laparoscopy is sufficient to exclude occult diaphragmatic injury after penetrating abdominal trauma. J Trauma. 2005;58:789-792

Summary

- Selective nonoperative management is well established for abdominal SWs in stable patients without peritoneal signs and is practiced in some high volume trauma centers for abdominal GSWs
- Nonoperative management of GSW to the right upper quadrant resulting in isolated liver injuries is more widespread and practiced safely at many institutions
- With mandatory laparotomy, the rate of nontherapeutic laparotomy is 25-42% for SWs and 5-27% for GSWs, with SNOM and use of CT its is 14% for GSWs
- The complication rate for nontherapeutic laparotomies is 2.5 % (only major complications) to 42% (including minor complications), LOS 4-5 days
- The complication rate for delayed laparotomy is low
- Abdominal CT scan is a useful adjunct for SNOM, with sensitivity >90% and specificity >95% for peritoneal violation and need for laparotomy
- Diagnostic laparoscopy should be strongly considered in patients with penetrating trauma to the left thoracoabdominal area to rule out and to potentially repair diaphragmatic injuries

References

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