

Selective Conservative Management of Penetrating Abdominal Wounds

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ONE OF THE MOST perplexing problems facing the surgeon is that of the wound suspected of penetrating the abdominal cavity: should laparotomy be performed in all cases, or should operation be limited to the group demonstrating signs mandating exploration? Shaftan^{8,9} cited cogent arguments for the expectant treatment of abdominal wounds when certain signs are absent, and his views are supported by others^{2,7} who believe that negative or unnecessary exploration carries a greater risk than expectant treatment. Other investigators^{1,3-5,10} favor laparotomy in all cases of suspected peritoneal penetration. This report is a retrospective evaluation of patients seen at a center handling large numbers of trauma cases, and was undertaken to ascertain the incidence of penetration in such cases, the frequency of significant visceral damage, the risk of empiric laparotomy, and the risk of expectant management.

Methods

This study includes records of all instances of wounds penetrating or suspected of penetrating the peritoneal cavity seen at The Greenpoint Hospital from May 1957 through April 1966, and at The Jewish Hospital of Brooklyn from July 1959 through March 1966. All cases suspected of penetration by physicians caring for the patients are included, as well as those which, on re-

view, should have been placed in the same category. All stab wounds below the sixth rib are included, as are missile wounds, regardless of the point of entry, if peritoneal penetration was possible. Excluded are grazing wounds of the parietes, caused by either sharp instruments or missiles, which were lacerations of varying length limited to skin and subcutaneous tissue. No patient in the latter group proved to have significant intraperitoneal injury.

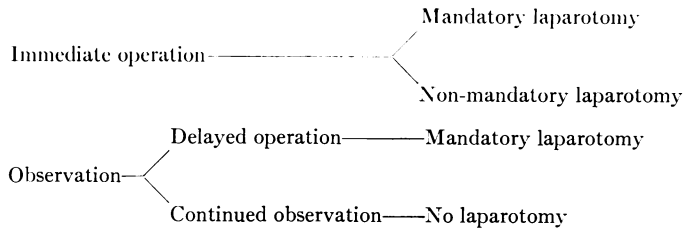
During the period of the study, neither hospital had set policies governing the treatment of these wounds. Rather, the management of each case was dictated by the judgment and experience of the responsible surgeon. A substantial number of cases is available in each category of management: immediate laparotomy in all instances, and laparotomy only when indicated by certain signs. The different plans of management are outlined in Table 1.

Patients brought to operation as soon as possible after admission constitute the *Immediate Laparotomy Group*. Those in whom nonoperative management was elected are designated the *Observed Group*. Among the latter, cases in which a delayed decision was made to operate are the *Delayed Laparotomy Group*. All cases in which laparotomy was performed were evaluated and classified according to two sets of criteria: 1) On the basis of the physical findings and the reasons for performing the operation, as stated by the senior surgeon, the indication for under-

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TABLE 1. *Plans of Management*



taking each laparotomy was classified as either mandatory or non-mandatory. The criteria for this classification are given in Table 2). On the basis of the surgeon's description of the findings at operation and the patient's postoperative course, each laparotomy was classified as either *Retrospectively Necessary* or *Retrospectively Unnecessary*. Both of these groups are subdivided, as shown in Table 3, to indicate the presence or absence of peritoneal penetration, and the degree, if any, of visceral injury.

Abdominal paracentesis was employed in less than 7% of cases; when positive, the results were an aid in management. In no case, however, was the decision for operation based solely upon the findings of paracentesis.

Local exploration of the wound was performed too infrequently (nine instances) to be statistically significant. It was of value, however, in excluding the need for laparotomy when it could be determined that the trajectory of a bullet was tangential to the peritoneal cavity.

Abdominal films seldom disclosed free air in the peritoneal cavity. This was the sole finding, however, in a patient with a stab wound of the colon. In two others, paradoxically, air entered the abdomen from perforated lung through a hole in the diaphragm, and contributed to the indications for what proved to be unnecessary operations.

The cases are further subdivided and analyzed according to the wounding instrument. Complication and mortality rates are derived for the various groups.

TABLE 2. *Classification of Indications for Laparotomy*

Mandatory Laparotomy: one or more of the following

1. Peritoneal signs
 - A. Absent bowel sounds
 - B. Rebound tenderness
 - C. Abdominal rigidity
2. Shock or systolic B.P. below 90 mm. Hg
3. Gastrointestinal bleeding
4. Urinary tract bleeding
5. Free intraperitoneal air
6. Evisceration of bowel
7. Uncontrolled bleeding from the wound

Non-Mandatory Laparotomy: either of the following

1. Herniation of greater omentum through the wound, without any of the above signs
2. No signs (empiric laparotomy)

TABLE 3. *Criteria for Retrospective Evaluation of Necessity for Laparotomy*

Retrospectively Unnecessary Laparotomy:

- Grade 1. Peritoneum intact.
- Grade 2. Peritoneum penetrated, but peritoneal contents uninjured.
- Grade 3. Peritoneum penetrated, with minor visceral injury not requiring repair and/or minor hemoperitoneum not requiring evacuation.*

Retrospectively Necessary Laparotomy:

- Grade 1. Peritoneum penetrated, with either
 - A. Hemoperitoneum large enough to require evacuation caused by visceral injury not requiring repair.**
 - or B. Hemoperitoneum large enough to require evacuation caused by bleeding from parietes.
- Grade 2. Peritoneum penetrated, with either
 - A. Major visceral injury requiring repair (including diaphragm, mesentery, and omenta).
 - and/or B. Retroperitoneal hemorrhage requiring operative control of bleeding.
 - and/or C. Preoperative evisceration of bowel through the wound.

* Less than 250 cc. blood.

** Example: Small stab wound of liver, not bleeding at time of operation, with over 250 cc. blood in peritoneal cavity.

Material

There were 267 patients, of whom 235 (88%) were men, and 32 (12%) were women. Ages ranged from 6 to 75 years (average 28.5 years; median 26 years).

The wounding instrument in 224 cases (84%) was a knife, ice pick, stiletto, letter opener, or scissors. Missile injuries accounted for 37 wounds (14%), of which 33 were bullet wounds, and four were shotgun blast injuries. Four cases resulted from impalement upon fence posts, and two from automobile injuries.

Three patients were subjected to thoracotomy shortly after admission, at which time the abdominal cavity was inspected either through the opened diaphragm or through a separate incision. None had significant intraperitoneal injury. These cases have been excluded from the retrospective analysis because abdominal exploration was performed under convenient circumstances (patient anesthetized for concurrent thoracotomy) which vitiate consideration of either postoperative complications or, more important, the question of whether laparotomy would have been elected had the thoracotomy not been performed.

With the exclusion of two patients who died before laparotomy could be started, 262 cases are available for analysis.

Location of Wounds. There were 276 wounds in the 224 patients injured by knives, etc. (excluding additional wounds beyond the anatomic area considered in this report); 191 were located on the abdominal wall, flanks, and lumbar regions, 84 between the sixth rib and the costal margin, and one in the groin. In the 37 patients with missile injuries, there were 42 wounds in the area under consideration. In 25, the point of entry was the abdomen, in 15 the chest, and in one each the shoulder and buttock. No patient had combined missile and stab wounds, although several had associated blunt injuries of other parts of the body. (In two cases, wounds of other parts of the body accounted for death.) If

TABLE 4. Frequency of Organ Injury*

Organ	Times Injured
Small bowel	27
Liver	24
Stomach	18
Large bowel	15
Diaphragm	10
Spleen	6
Mesentery	6
Kidney	4
Pancreas	4
Omentum	3
Major vessel	3
Gall bladder	1

* Multiple wounds of same organ counted as single injury.

all wounds are considered, 24% of patients had multiple wounds.

Frequency of Organ Injury. Multiple wounds of the same organ were counted as a single wound. The figures are given in Table 4.

Management of Cases. Of the 262 cases analyzed, 122* were operated upon immediately (*Immediate Laparotomy Group*). One hundred-forty patients were initially managed non-operatively (*Observed Group*). Eight of these were subsequently brought to operation (*Delayed Laparotomy Group*, seven after developing signs mandating operation, and one for empiric reasons. In these eight, the period of observation ranged from 4 to 37 hours.

Among the patients with missile injuries, initial observation was elected less frequently (37%) than in the group with stab wounds (56%). The management of cases is summarized in Table 5.

Analysis of Indications for Laparotomy. Among the 122 patients in the *Immediate Laparotomy Group*, 66 (54%) were derived from those with mandatory indications, and 56 (46%) from those with non-mandatory indications for laparotomy. Of the eight patients in the *Delayed Laparotomy Group*, the indication for operation was mandatory in seven and non-manda-

* Includes one case cancelled after complications of induction of anesthesia.

TABLE 5. Management of Cases

	Immediate Laparotomy Group		Observed Group				Total No.
			No Operation		Delayed Operation		
	No.	%	No.	%	No.	%	
Knives, etc.	100	44	122	54	5	2	227
Missiles	22	63	10	32	3	5	35
Total	122	47	132	50	8	3	262

tory in one. In total, then, of 130 * patients undergoing laparotomy, 73 (56%) were operated upon for mandatory indications, and 57 (44%) for non-mandatory indications. For missile wounds, 84% of operations were done for mandatory indications; for stab wounds, 50%.

Retrospective Analysis of Necessity for Operation. Of the 73 operations performed for mandatory indications, 12 (16%) ultimately proved unnecessary. (Of the seven delayed operations with mandatory indications, included in the foregoing, five were unnecessary.) Of the 57 operations performed for non-mandatory indications, in contrast, 45 (79%) were found unnecessary. The difference between the mandatory and non-mandatory indications groups in the necessity for operation is significant at the 0.01 level ($p < 0.001$). The data are summarized in Table 6.

Incidence of Penetration and Degree of Visceral Damage. In Table 7, comparison is made between the mandatory and non-mandatory indications groups in regard to the presence or absence of peritoneal penetration and the degree, if any, of visceral injury. In six of the 73 cases (8%) operated

upon for mandatory indications, there was no intraperitoneal damage, while in the group with non-mandatory indications, 32 of 57 patients (56%) had no damage. Incurring insignificant intraperitoneal injury were an additional six cases (8%) from the mandatory indication group and 13 cases (24%) from the non-mandatory indication group. Considered from another viewpoint, of the 57 cases comprising the *Retrospectively Unnecessary Laparotomy Group*, 45 (79%) were derived from those patients who were operated upon for non-mandatory indications.

Because bullet wounds constitute a category distinct from stab wounds (see Discussion), these cases are also considered separately. In 33 patients with bullet wounds, the wound was tangential to the peritoneal cavity in four. In another, the bullet, apparently spent, lodged just beneath the skin at the point of entry; these cases were managed nonoperatively. Of the remaining 28, two underwent immediate thoracotomy and have been discarded from consideration. Twenty patients were subjected to immediate laparotomy (three on empiric grounds), of whom only two, in retrospect, did not require it. An additional six patients were observed, three of whom underwent delayed laparotomy. None of the

* Includes two cases cancelled after complications of induction of anesthesia.

TABLE 6. Retrospective Evaluation of Laparotomies by Wounding Agent and Indication for Laparotomy

Indication for Laparotomy	Knives, etc.		Missiles		All Wounds	
	Necessary	Unnecessary	Necessary	Unnecessary	Necessary	Unnecessary
Mandatory	43	9	18	3	61 (84%)	12 (16%)
Non-mandatory	10	43	2	2	12 (21%)	45 (79%)
Total	53	52	20	5	73 (56%)	57 (44%)

TABLE 7. *Incidence of Peritoneal Penetration and Degree of Visceral Damage in Relation to Indication for Laparotomy*

Retrospective Evaluation of Laparotomy	Indication for Laparotomy		Total
	Mandatory	Non-mandatory	
Unnecessary			
Grade 1	4	21	25
Grade 2	2	11	13
Grade 3	6	13	19
Total	12	45	57
Necessary			
Grade 1	3	0	3
Grade 2	58	12	70
Total	61	12	73
Total	73	57	130

three treated by delayed operation proved to have injuries requiring repair.

Incidence of Complications. Among the 57 patients in the *Retrospectively Unnecessary Laparotomy Group*, there were 19 (33%) who developed complications, six of major degree. When considered in relation to indication for operation, complications developed in 18 (40%) of the 45 patients who underwent unnecessary operation on empiric grounds or solely because of protrusion of the omentum through the wound. In contrast, for those unnecessary operations done for mandatory indications, the complication rate was 8% (one of 12). Considering the small number of patients in the mandatory indication group (12), Fisher's Exact Probability method was used to compare the incidence of complications in this group with that of the non-mandatory indication group. It was found that the probability of obtaining such a distribution (40% vs. 8%) or a more divergent one by chance alone is 0.038. Based on these incidence figures, one could roughly predict that the likelihood of incurring complications in more than three of these 12 patients is less than 5% (S.D. = 7.9%). The data are summarized in Table 8.

Among the patients treated without operation, whether with stab wounds or mis-

TABLE 8. *Occurrence of Complications in the Unnecessary Laparotomies Among the Mandatory and Non-mandatory Indication Groups*

Indication	Complications	No Complications	Total
Mandatory	1	11	12
Non-mandatory	18	27	45
Total	19	38	57

sile injuries, no complications could be attributed to failure to operate. Indeed, in one case when the patient refused to consent to operation despite the presence of peritoneal signs, the signs subsided spontaneously and the patient recovered uneventfully.

Of the seven patients operated upon in the *Delayed Laparotomy Group*, minor complications occurred in three which could not be attributed to the delay before operation.

Mortality. Six patients (2.2%) died. Two died before planned laparotomy could be started (one from pneumohemopericardium, and one from an associated brain injury). One died during an operation in which bleeding from lacerated iliac vessels could not be controlled. Two died after operation (one from sepsis, and one of unknown cause). One died during observation, 9 days after injury, of complications ensuing from transection of the cervical spinal cord by a second bullet wound. In no case was death attributable to delayed or unnecessary operation.

Hospital Stay. Excluding deaths, the average hospital stay for patients undergoing laparotomy was 11.1 days; for patients treated nonoperatively, it was 4.9 days. Although most patients with uncomplicated wounds treated nonoperatively were discharged within 48 hours, the average stay is more than twice that time because of the care necessary for associated wounds in many patients.

Discussion

If the mandatory indications for laparotomy are accepted as listed in Table 2,

the proportion of unnecessary operations (16%) in cases meeting these criteria must be regarded as a relatively fixed minimum, since it is impossible to sort out beforehand those in which the injuries responsible for the production of the signs are not life-threatening. For example, several patients were operated upon because of abdominal rigidity and absent bowel sounds; they were found to have a small amount of blood leaking into the peritoneal cavity from a lacerated lung through a torn diaphragm or from a laceration of the parietes which was no longer bleeding, or were found to have a non-expanding retroperitoneal hematoma caused by a bullet which grazed, but did not enter, the peritoneum. Therefore, if a reduction is to be effected in the number of unnecessary operations, and the attendant risk of complications (one in three), it must be made in that group of patients who do not manifest the mandatory signs. The results of treatment by observation in these patients are gratifying, as this management program incurred no deaths or complications. It is of little significance that, of eight patients brought to delayed laparotomy, six did not require operation. They must be regarded as part of the irreducible minimum who will develop significant abdominal signs after an inconsequential injury.

In this study, the complication rate was significantly higher after unnecessary laparotomy in those who did not manifest the mandatory signs compared to those who did. Although no logical explanation can be found for this discrepancy, it is certain that any complication occurring after an unnecessary operation is potentially avoidable.

Of the 44 patients who underwent laparotomy for purely empiric reasons, only eight, in retrospect, required operation. Based upon the operative findings, eight more of the 44 could conceivably have developed mandatory signs if operation were withheld. If these 44 are placed with the *Observed Group* (total 184), including

those who underwent delayed laparotomy, 21 (12%) could reasonably be expected to have developed mandatory signs if operation were withheld in all. Of these 21, only eight (4.3% of the 184 patients) would actually, in retrospect, have required operation. Considering the size of the sample studied, one is justified in concluding, with 95% confidence, that among similar patients, a purely empiric laparotomy for a suspected penetrating wound will disclose an injury which requires repair in only 1.3% to 7.3% of cases (S.D. = 1.5%). If these figures were revised to include the 13 patients explored solely because of protrusion of the omentum through the wound, only 12 (6.1%) of the 197 patients would have required operation, and the 95% confidence range would be 2.7% to 9.5% (S.D. = 1.7%), since four of the 13 had significant intraperitoneal damage. The findings in these four were such that it can safely be assumed that mandatory signs would soon have developed if laparotomy were delayed, thus allowing exclusion of the remaining nine cases. (The four had lacerations of liver, diaphragm, small bowel, and omentum.) We, therefore, agree with Shaf-tan's^{8,9} conclusion that it is safe to amputate the protruding omentum and close the wound while awaiting the development of signs to indicate the need for laparotomy. Obviously, as he points out, expectant treatment, to be trusted, must involve frequent examination of the patient by the same personnel.

It would appear, on speculation, that the likelihood of intraperitoneal damage rises with the number of wounds. On the contrary, this was not the case in this series, since the percentages are identical for patients with single and multiple wounds. This conclusion is supported by the report of Rothschild and Treiman.⁷

We observed that, in stabbings involving the lower chest and upper abdomen, the majority of wounds are directed caudally. Therefore, in stab wounds about the costal margin, when hemothorax or pneumotho-

rax is present, the likelihood of intraperitoneal damage is decreased, since these findings indicate a more cranial direction of the wound. Among the *Observed Group*, 29 patients (21%) manifested hemo- or pneumothorax. Six of the 130 patients operated upon had such intrapleural pathology caused by the wound necessitating the laparotomy; one had significant injury (lacerated diaphragm). The limited data do not permit conclusions to be drawn, but suggest that the presence of hemothorax or pneumothorax in cases with wounds about the costal margin lessens the likelihood of intraperitoneal injury.

It has been stated that, "There is no reason to expect that a sharp knife inflicts less damage than a dull, low-velocity bullet."⁸ On the contrary, we believe that once the peritoneum has been penetrated, a knife is less likely than a missile to cause damage to the viscera. Requarth⁶ observed that all structures in the path of a bullet are usually damaged. If the velocity of a knife at the moment of stabbing is estimated at 30 miles per hour (the actual figure may be lower), that value is 18 times smaller than the muzzle velocity of a 25-calibre pistol bullet used in commercially available guns, and approximately 10-15 times smaller than that of a 22-calibre bullet issuing from a home-made "zip" gun. Although other factors, such as muzzle energy and (in close-range wounds) gas injury must be taken into account, it hardly seems likely that the rapidity of penetration of a bullet permits bowel, for example, to slip aside as it does in a significant proportion of stab wounds.

The foregoing discussion, implying as it does the greater likelihood of significant damage by missiles, still does not indicate that all patients with missile wounds of the abdomen should be explored. Rather, the results of this study support the conclusion that it is just as safe to treat missile wounds by observation as stab wounds when the aforementioned criteria are adhered to.

One must simply expect that a far greater proportion of bullet wounds inflict serious damage than do stab wounds.

Summary

An analysis of 267 cases of penetrating and suspected penetrating wounds of the peritoneal cavity by various weapons is reported. There were six deaths (2.2%).

In cases treated expectantly, there was neither morbidity nor mortality attributable to nonoperative management.

In cases operated upon for certain indications regarded as mandatory, there was a 16% incidence of what is viewed retrospectively as unnecessary laparotomy. In patients operated upon for other than mandatory indications, including those for empiric reasons only, the incidence of unnecessary laparotomy was 79%.

It is concluded that, whatever the wounding instrument, the best plan of treatment is one which defers laparotomy unless the mandatory signs are present.

References

1. Klickstein, G. D., Edmunds, R. T. and Allen, P. D.: Immediate Laparotomy in Penetrating Wounds of the Abdomen. *N. Y. State J. Med.*, **62**:3923, 1962.
2. Mason, J. H.: The Expectant Management of Abdominal Stab Wounds. *J. Trauma*, **4**:210, 1964.
3. McComb, A. R., Pridgen, J. E., Hills, W. J., Smith, R., Gregory, E. E., Sammis, W., Wright, R. R. and Herff, A.: Penetrating Wounds of the Abdomen. *Amer. Surg.*, **24**:123, 1958.
4. Moore, R. M. and Singleton, A. O.: Penetrating Wounds of the Abdomen. *Gastroenterology*, **32**:485, 1959.
5. Moss, L. K., Schmidt, F. E. and Creech, O.: Analysis of 550 Stab Wounds of the Abdomen. *Amer. Surg.*, **28**:483, 1962.
6. Requarth, W.: Indications for Operation for Abdominal Trauma. *Surgery*, **46**:461, 1961.
7. Rothschild, P. D. and Treiman, R. L.: Selective Management of Abdominal Stab Wounds. *Amer. J. Surg.*, **111**:382, 1966.
8. Ryzoff, R. I. and Shaftan, G. W.: Selective Conservatism in Penetrating Abdominal Trauma. *Surgery*, **59**:650, 1966.
9. Shaftan, G. W.: Indications for Operation in Abdominal Trauma. *Amer. J. Surg.*, **99**:657, 1960.
10. Wilson, H. and Sherman, R.: Civilian Penetrating Wounds of the Abdomen. *Ann. Surg.*, **153**:639, 1961.