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Management and Outcome of Abdominal Shotgun Wounds

Trauma Score and the Role of Exploratory Laparotomy

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Objective
The management and outcome of 138 abdominal shotgun wounds were examined over a 5-year period.

Summary Background Data
It has been proposed that exploratory laparotomy may be unnecessary and even overused in a subset of patients with abdominal shotgun wounds.

Methods
Data on shotgun wound patients from October 1987 through March 1992 from a statewide trauma registry were examined. Patients with abdominal shotgun wounds were identified and compared with patients with nonabdominal shotgun wounds.

Results
Of 516 shotgun wound patients, 138 (26.7%) had abdominal wounds and 88 (63.8%) had exploratory laparotomies. Abdominal shotgun wounds resulted in significantly longer number of intensive care unit days (4.3 *vs.* 2.5, $p < 0.05$), a greater number of blood units transfused (7.8 *vs.* 2.4, $p < 0.05$), and a higher mortality (15.9% *vs.* 4.8%, $p < 0.05$) when compared with nonabdominal shotgun wounds. When stratified for trauma score, the mortality for abdominal shotgun wounds always was significantly greater than for nonabdominal shotgun wounds. All abdominal shotgun wound patients with trauma scores less than ten died. The negative laparotomy rate for abdominal shotgun wound patients with normal trauma scores was 9.4%. No patient with a negative laparotomy died.

Conclusion
Abdominal shotgun wounds are a particularly lethal subset of shotgun wounds. Although some abdominal shotgun wound patients can be managed without laparotomy, the morbidity and mortality for these injuries are substantial, even in patients with normal trauma score. Clinical judgment is an excellent predictor of the need for laparotomy.

The spectrum of injuries resulting from abdominal shotgun wounds is vast and represents a particularly difficult challenge for the trauma surgeon. This diversity of injury, primarily caused by the unique ballistics of shotgun blasts,[1,2] ranges from extensive, multi-organ, visceral destruction to superficial, widespread, soft-tissue damage with minimal associated intra-abdominal injury.

Although abdominal shotgun wound patients with massive intra-abdominal injury clearly require operative intervention, the majority of abdominal shotgun wound patients have less serious injuries and thus, may appear to have a less obvious need for exploratory surgery. Since 1901,[3] several investigators have suggested that mandatory exploratory laparotomy (EXP LAP) for intra-abdominal pellet wounds is unwarranted.[4–10] Investigators have examined a number of factors in an attempt to identify the subset of abdominal shotgun wound patients who do not require mandatory EXP LAP. These factors include the pattern of injury (distance from muzzle, pellet scatter, and abdominal penetration),[11,12] roentgenographic appearance (number and location of apparent intraperitoneal pellets),[9] and clinical status of the patient (absence of peritonitis and hemodynamic instability).[7,8,10] Although none of these factors, either alone or in combination, have been found to be reliable indicators for the need for EXP LAP, a recent review continues to support the proposal that certain, particularly hemodynamically stable, abdominal shotgun wound patients with intra-abdominal pellet injury can be treated successfully without EXP LAP.[13]

In this study, we analyzed data on 138 abdominal shotgun wounds in a series of 516 shotgun wounds from a statewide trauma registry to compare the presentation, course, and outcome of abdominal shotgun wounds to other shotgun wounds. We also examined the relationship between initial clinical presentation, the need for EXP LAP, and outcome, in an attempt to determine if EXP LAP is overused in abdominal shotgun wound patients.

METHODS

The North Carolina Trauma Registry collects data for all trauma patients (ICD-9-CM 800–959.99) in the eight designated trauma centers in North Carolina, as previously described.[14] In this study, data were obtained from the North Carolina Trauma Registry (>40,000 patients) for the 66-month period from October 1987 to March 1992. A shotgun wound patient was identified as any trauma patient with an ICD-9-CM E-code designating shotgun wound as the cause of injury (922.1, 955.1, 965.1, 985.1). The subset of abdominal shotgun wounds was identified and separated from other shotgun wounds if the patients had an ICD-9-CM diagnosis for abdominal injury (862–879, 902), an abdominal procedure (34, 38–54), or an abdominal Abbreviated Injury Score ≥ 1. Data were classified arbitrarily as demographic data (cause of injury, age, sex, mode of transport), initial clinical data (Glasgow Coma Scale, pulse, systolic blood pressure, emergency room [ER] trauma score [TS], hematocrit), and outcome data (intensive care unit days, hospital days, injury severity score [ISS], number of blood units transfused, hospital charges, and hospital disposition). Data among abdominal shotgun wounds and other shotgun wounds were compared using Student's t test and chi square analysis where appropriate. Abdominal shotgun wound patients were divided into those who had EXP LAP (any intra-abdominal procedure) and those who did not. Positive EXP LAP patients were those with abdominal shotgun wounds with any repair procedure for intra-abdominal visceral injury. Abdominal shotgun wounds were stratified by EXP LAP and no EXP LAP and by initial clinical status using ER TS (calculated from Glasgow Coma Scale, systolic blood pressure, respiratory rate and expansion, and capillary refill), and mortality for each group was determined.

RESULTS

For the 66 months from October 1987 to March 1992, 516 patients in the North Carolina Trauma Registry were identified as shotgun wound patients, of which 138 (26.7%) had abdominal shotgun wounds. A comparison between abdominal shotgun wound patients and other shotgun wound patients is shown in Table 1. None of the demographic data were significantly different between abdominal shotgun wounds and other shotgun wounds. In both groups, the average patient age was 30 years, and men outnumbered women nearly nine to one. In both groups, assaults were the major E-code cause of injury, followed by accidents and suicide attempts. Nearly ¾ of patients in both groups were transported to the hospital by ambulance, and less than 20% were transported by helicopter. Most initial clinical data were not significantly different between abdominal shotgun wounds and other shotgun wounds. The mean Glasgow Coma Scale (13.5 *vs.* 13.7, $p = 0.49$), mean initial systolic blood pressure (120 mm Hg *vs.* 125 mm Hg, $p = 0.20$), and mean ER TS (14.1 *vs.* 14.3, $p = 0.10$) were not different between abdominal shotgun wound patients and other shotgun wound patients. Although the majority of patients in both groups (>70%) had normal TS, fewer abdominal shotgun wound patients had TS between 15

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Table 1. SHOTGUN WOUND (SGW) CHARACTERISTICS

n	Abdominal SGW 138 (26.7%)	Other SGW 378 (73.3%)
E-code		
Assault	93 (67.4%)	225 (59.5%)
Accident	27 (19.6%)	100 (26.4%)
Suicide	14 (10.1%)	37 (9.8%)
Unknown	4 (2.9%)	16 (4.2%)
Age (yrs, mean ± SEM)	30.5 ± 1.4	30.1 ± 0.8
Male	123 (89.1%)	328 (86.8%)
Female	15 (10.9%)	50 (13.2%)
Transport		
Ambulance	98 (71.0%)	266 (70.3%)
Helicopter	25 (18.1%)	60 (15.9%)
Glasgow Coma Scale (mean ± SEM)	13.5 ± 0.3	13.7 ± 0.2
Systolic blood pressure (mmHg, mean ± SEM)	119.8 ± 3.4	124.6 ± 1.9
Initial Trauma score (TS, mean ± SEM)	14.1 ± 0.3	14.3 ± 0.2
TS 15–16	87 (72.5%)*	276 (83.4%)
TS 10–14	21 (17.5%)*	27 (8.2%)
TS < 10	12 (10.0%)	28 (8.4%)
Hematocrit (mean ± SEM)	35.6 ± 0.6†	38.0 ± 0.4
Blood units transfused (mean ± SEM)	7.8 ± 1.3†	2.4 ± 0.4
Injury severity score (mean ± SEM)	17.3 ± 0.9†	9.6 ± 0.5
Intensive care unit days (mean ± SEM)	4.3 ± 0.8†	2.5 ± 0.3
Ventilator days (mean ± SEM)	2.6 ± 0.8†	0.9 ± 0.2
Hospital days (mean ± SEM)	12.0 ± 1.1	11.4 ± 0.6
Hospital charges (mean ± SEM)	$23,274 ± 2,940†	$14,950 ± 985
Hospital disposition		
Home	104 (75.4%)	296 (78.3%)
Death	22 (15.9%)*	18 (4.8%)
Other (rehabilitation, etc.)	12 (8.7%)*	64 (16.9%)

* $p < 0.05$ by chi-square analysis.
† $p < 0.05$ by Student's t test.

and 16, and more had TS between 10 and 14 ($p < 0.05$) compared with other shotgun wound patients. Abdominal shotgun wound patients also had a lower mean initial hematocrit (35.6 *vs.* 38.0, $p < 0.05$). Mean length of hospital stay was not significantly different between abdominal shotgun wound patients and other shotgun wound patients; other outcome data, however, were substantially worse for abdominal shotgun wound patients than for other shotgun wound patients in nearly all categories. Abdominal shotgun wound patients required more blood unit transfusions (7.8 *vs.* 2.4, $p < 0.05$), had longer intensive care unit days (4.3 *vs.* 2.5, $p < 0.05$), had longer ventilator days (2.6 *vs.* 0.9, $p < 0.05$), incurred higher hospital charges ($23,300 *vs.* $14,900, $p < 0.05$), and had a mortality rate three times greater (15.9% *vs.* 4.8%, $p < 0.05$, $\chi^2 = 17.7$) than other shotgun wound. These data are summarized in Table 1.

When outcome was stratified for E-code cause of injury, abdominal shotgun wound patients fared worse than other shotgun wound patients, regardless of the cause of injury (Fig. 1). In addition, when outcome was stratified by ER TS, abdominal shotgun wound patients did worse than other shotgun wound patients at all TS. Most importantly, for patients with a relatively normal TS of 15 to 16, abdominal shotgun wound patients had

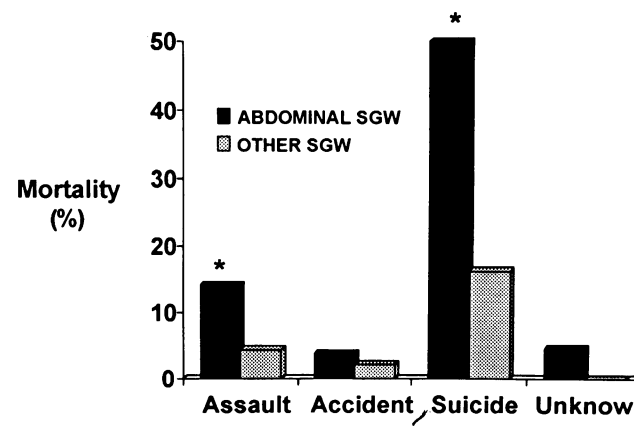

Figure 1. Mortality of abdominal shotgun wounds (SGWs) and other shotgun wounds for a given E-code cause of injury (*$p < 0.05$ for abdominal shotgun wounds compared with other shotgun wound by chi square analysis).

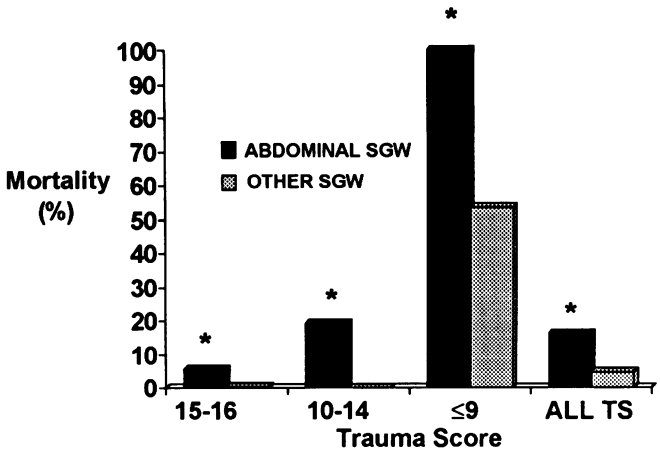

Figure 2. Mortality of abdominal shotgun wounds (SGWs) and other shotgun wounds by trauma score (TS) (*$p < 0.05$ for abdominal shotgun wounds compared with other shotgun wounds by chi square analysis).

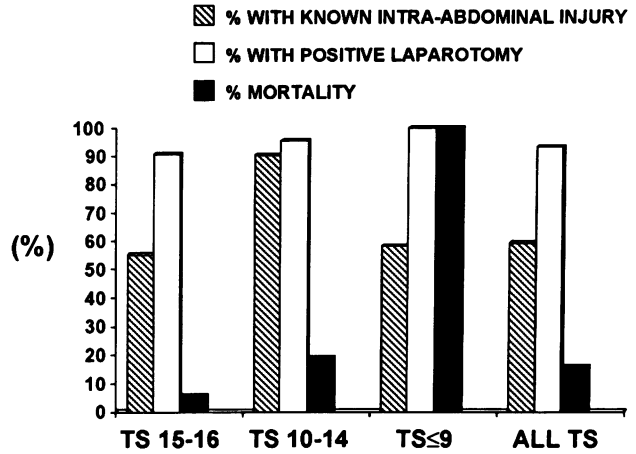

Figure 3. Relationship between known intra-abdominal injury, need for exploratory laparotomy (EXP LAP), and mortality for 138 abdominal shotgun wounds.

a mortality rate of 5.7%, 15 times greater than a mortality rate of 0.36% observed for other shotgun wound patients ($p < 0.05$, $\chi^2 = 11.8$, Fig. 2).

Of 138 abdominal shotgun wound patients, 63.8% (88/138) had EXP LAP and an overall negative EXP LAP rate of 6.8% (6/88), and 87.0% (120/138) had an ER TS, as shown in Table 2. When the need for EXP LAP was stratified by TS, 87 abdominal shotgun wound patients had TS between 15 and 16, 60.9% (53/87) of whom had EXP LAP, a negative EXP LAP rate of 9.4%, and a mortality rate of 5.7%. The only patient who died without an ER TS had a positive EXP LAP, and no patient with a normal TS and a negative EXP LAP died. With decreasing TS, there was a decrease in the negative EXP LAP rate and an increase in mortality. For abdominal shotgun wound patients with TS between 10 and 14, 95.2% (20/21) had EXP LAP, a negative EXP LAP rate of 5%, and a mortality rate of 19%. As in the case of patients with normal TS, no patient with a TS between 10 and 14 and a negative EXP LAP died. For abdominal shotgun wound patients with TS ≤ 9, the outcome was uniformly dismal—i.e., all patients with TS ≤ 9 died. Although only 58.3% (7/12) of patients with TS ≤ 9 had EXP LAP, all seven of these patients had positive findings at laparotomy. Of the five patients with TS ≤ 9 who did not undergo EXP LAP, all of these patients died either in the ER or within 24 hours of hospital admission of massive internal injuries. The relationship between TS, known intra-abdominal injury, and mortality is demonstrated in Figure 3.

Of the 88 abdominal shotgun wound patients who had EXP LAP, 42.1% (37/88) required operations predominantly for hollow viscus injuries, 18.2% (16/88) required operations for solid organ injuries, and 32.9% (29/88) required procedures for both. For all abdominal shotgun wound patients, there were a total of 224 abdominal procedures for 199 intra-abdominal injuries. The number and types of each injury and procedure are shown in Table 3 and Table 4, respectively.

DISCUSSION

In this study, we demonstrated that abdominal shotgun wounds are a particularly lethal subset of shotgun

Table 2. RELATIONSHIP BETWEEN EXPLORATORY LAPAROTOMY (EXP LAP), TRAUMA SCORE (TS), AND MORTALITY

	TS 15–16		TS 10–14		TS ≤ 9		All SGW	
	n	Death	n	Death	n	Death	n	Death
EXP LAP	53 (60.9%)	5 (9.6%)	20 (95.2%)	4 (20%)	7 (58.3%)	7 (100%)	88 (63.8%)	17 (19.3%)
Positive	48 (90.6%)	5 (10.4%)	19 (95.0%)	4 (21%)	7 (100%)	7 (100%)	82 (93.2%)	17 (20.7%)
Negative	5 (9.4%)	0%	1 (5%)	0%	0%	0%	6 (6.8%)	0%
No EXP LAP	34 (39.1%)	0%	1 (5%)	0%	5 (42.7%)	5 (100%)	50 (36.2%)	5 (10.0%)
Combined	87	5 (5.7%)	21	4 (19%)	12	100%	138	22 (15.9%)

Table 3. INJURIES IN 138 ABDOMINAL SGW PATIENTS

Injury	n
Total	199
Stomach	12
Small bowel	38
Large bowel	44
Spleen	15
Liver	36
Gallbladder	4
Pancreas	5
Vascular	21
Diaphragm	24

wounds, with a mortality rate three times greater than that of other shotgun wounds. We also demonstrated, that, unlike for other shotgun wounds, a stable "clinical" presentation, as defined by a normal TS, does not eliminate the substantial risk of morbidity and mortality after abdominal shotgun wounds. We confirmed that EXP LAP for abdominal shotgun wound is safe; no patient with a negative EXP LAP died. Finally, in this series of 138 abdominal shotgun wounds, we demonstrated that with a negative EXP LAP rate of 6.8%, clinical judgment—but not the presence of a normal TS—is an excellent predictor for the need for EXP LAP.

The need for mandatory EXP LAP in patients with abdominal shotgun wounds and suspected intra-abdominal injury is controversial. Unlike single missile wounds, where it is generally accepted that suspected intra-abdominal penetration requires exploration,[15] several investigators have proposed that some intra-abdominal injuries after abdominal shotgun wounds do not require surgical exploration and operative repair.[4-10] This proposal is based on the theory that some intra-abdominal injuries, in particular, hollow viscus injuries that occur as a result of long-range shotgun blasts, are self-limiting and benign. It has been suggested that pellets produce only small punctures of the bowel without mucosal eversion and minimal leakage—injuries that reportedly heal without exploration.

The defense of this proposal is based on the unique ballistics of shotgun wounds. Shotgun ammunition consist of numerous small pellets, available in a variety of shot sizes.[2] When a shotgun is discharged, the pellets inevitably spread and lose kinetic energy the further they travel from the muzzle. Thus, unlike the case for single-missile ammunition, distance from the muzzle to the target is a critical factor in determining the extent of injury after a shotgun discharge.[1] Therefore, in the case of abdominal shotgun wounds, if the weapon-to-victim range could be determined, it has been suggested that the severity of injury and even the subsequent need for operative repair could be predicted.

In 1963, Sherman and Parrish were the first to classify shotgun wounds into three types, based on distance from the target and level of tissue penetration.[11] Type I injuries are long-range shots (>7 yards), with penetration only to the deep fascia; Type II injuries are close range (3–7 yards), with perforation beyond the deep fascia; and Type III injuries are point-blank injuries, with massive destruction. Although this classification of shotgun wound injuries has been used in a variety of investigations on abdominal shotgun wounds, it is not always practical. The distance from weapon-to-victim only rarely is available and frequently is unreliable.[12] In addition, a number of other factors influence and potentially mask the extent of injury caused by shotguns, including the size of shot, muzzle choke, and barrel length. Sherman and Parrish were aware of the limitations of this approach. In 1963, they reported two cases of benign-appearing abdominal shotgun wounds based on distance and shot pattern, with tangential bowel injuries. One wound resulted in EXP LAP and an injury that clearly required repair, the other wound resulted in peritonitis due to a failure to explore a patient with a perforated jejunum.[11] Therefore, Sherman and Parrish recommended that EXP LAP be performed in all abdominal

Table 4. PROCEDURES IN 138 ABDOMINAL SGW PATIENTS

Procedure	n
Total	224
Exploratory laparotomy	44
Stomach	17
Repair	13
Resection	4
Small bowel	43
Repair	23
Resection	20
Large bowel	24
Repair	12
Resection	12
Ostomy	27
Spleen	7
Splenectomy	6
Splenorrhaphy	1
Liver	13
Repair	9
Resection	4
Gallbladder	4
Cholecystectomy	3
Cholecystostomy	1
Pancreas resection	2
Vascular repair	24
Diaphragm repair	14
Debride abdominal wall	5

shotgun wound patients where intra-abdominal penetration cannot be ruled out, regardless of the type of injury.

However, others have continued to suggest that normotensive abdominal shotgun wounds with a scatter pattern of pellets penetrating the peritoneum can be successfully observed expectantly, even in the advent of ongoing peritonitis.[7] Still others have reported a more selective approach in the management of hemodynamically stable intra-abdominal shotgun wounds.[10] Grimes et al. reported that all of the Type I and nearly one half of the hemodynamically stable Type II patients did not require laparotomies; they did report however, that one of the three Type II patients with "potential intra-abdominal injuries" who did not initially undergo operation, subsequently required exploration after developing abdominal wall fasciitis secondary to a small intestinal injury.[10] Investigators also have suggested that a combination of the roentgenographic appearance and clinical examination may be more likely to identify patients that require EXP LAP.[8,9] Although the presence of four or more intra-abdominal pellets has been suggested as an indicator for the need for EXP LAP, Flint et al. emphasized that the presence of peritonitis and clinical judgment were the most important indicators for surgery.[9]

In a more recent study, Glezer et al. redefined the Sherman classification of shotgun wounds to consider pellet scatter instead of distance.[12] This group also concluded that any patient with peritoneal irritation or clinical indication for surgery should undergo EXP LAP, regardless of the scatter pattern. They reported that all patients who underwent exploration using these criteria had substantial intra-abdominal pathology.

Although we were unable to examine the effect of these various factors on the need for EXP LAP in abdominal shotgun wounds in our study, we were able to demonstrate that the course and outcome of abdominal shotgun wounds were much worse, with a death rate three times greater than for other shotgun wounds, even though these two groups are similar in initial clinical presentation. We also found that abdominal shotgun wound patients may present with a normal TS and still have substantial intra-abdominal injuries that ultimately result in patient death. In addition, we confirmed the finding of others[9,11,12,16] that when EXP LAP is clinically indicated, a wide variety of substantial intra-abdominal injuries can be identified that require immediate attention, and is associated with a relatively low negative EXP LAP rate of 6.8%. Given the potential seriousness of abdominal shotgun wounds, this negative EXP LAP rate may be inappropriately low. Although none of the abdominal shotgun wound patients with TS $\geq$ 10 without EXP LAP died, it is conceivable that some of these patients suffered substantial morbidity from the lack of performing EXP LAP. Finally, although only 58.3% of abdominal shotgun wound patients with TS $\leq$ 9 in our series had EXP LAP, all of these patients had devastating and, ultimately, fatal injuries. It is evident that for these patients to have had a chance of surviving their injuries, all of them should have undergone immediate EXP LAP. We conclude that although some patients with abdominal shotgun wounds can be managed successfully without EXP LAP, the decision to observe these patients, particularly those with suspected intra-abdominal injury, must be balanced by the observations that the mortality for these injuries is high, that EXP LAP is relatively safe, and that clinical suspicion of injury rarely results in a negative EXP LAP.

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