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RESEARCH ARTICLE

BMI in Penetrating Abdominal Injury: Correlation with Morbidity

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Abstract

Aim: Penetrating abdominal injuries (PAI) are associated with significant morbidity in adults. No data exist on the relationship of BMI to the type or severity of injuries in patients with PAI.

Methods: Patients with PAI were identified through the registry of our Level I trauma center from 1/2003 through 7/2009. Data included injury mechanism, wound site, patient demographics, medical history, operative reports, and postoperative course. BMI was calculated using the formula wt(kg)/ht(M^2).

Results: 451 patients had PAI and were grouped by BMI of ≥ 30 (OBESE) or < 30 (NON-OBESE). 381 patients with abdominal obesity were included. 79 (21%) were OBESE and 302 (79%) were NON-OBESE. 68% of the OBESE underwent laparotomy vs. 57% of the NON-OBESE ($p = 0.06$). Of the OBESE undergoing surgery, 48% were therapeutic laparotomies. Of the NON-OBESE, 65% had therapeutic laparotomies ($p = 0.041$). 9% of the OBESE had liver injuries vs. 30% of the NON-OBESE. ($p = 0.003$) 21% of the OBESE had vascular injuries vs. 5% for the NON-OBESE ($p = 0.007$). There were no significant differences in rates of diaphragmatic, gastric, spleen, renal, small bowel, or colon injuries. There was a total of one death on arrival for patient with BMI below 30.

Conclusion: This study is the first to examine the correlation between PAI and BMI for results of laparotomy. OBESE patients have a higher rate of laparotomy and undergo more non-therapeutic operations. NON-OBESE patients are three times more likely to suffer liver injuries, while OBESE patients are four times more likely to suffer vascular injuries.

Abbreviations

PAI: Penetrating Abdominal Injury; FAST: Focused Abdominal Sonography in Trauma; CT: Computed Tomography; BMI: Body Mass Index

Introduction

In 1960, Shaftan, et al. recognized that mandatory laparotomy for penetrating abdominal injury (PAI) resulted in negative findings in approximately one-third of patients, with significant associated morbidity and mortality [1]. This was underlined by a 37 percent negative laparotomy rate after mandatory laparotomy for truncal stab wounds. Superior critical care facilities, advances in interventional radiology and the increased availability of abdominal ultrasonography, focused abdominal sonography in trauma (FAST), computed tomography (CT) and laparoscopy may have enabled more selective non-operative management of PAI. However, there are no studies correlating BMI with severity of PAI. Zarzaur, et al., in a retrospective study correlated the BMI with severity of injury in patients involved in motor vehicle accidents and found combination of BMI above 30 and seat belt use increases the odds of abdominal injury by 2.5-fold, there was no correlation between BMI above 30 with seat belts and increased intra-abdominal injury [2]. Bansal, et al., studied the role of BMI in predicting pelvic fracture in motor vehicle accidents. Occupants with BMI below 25 were twice more likely to sustain pelvic fractures compared with those who were obese, however the obese occupants who sustained pelvic fractures suffered more severe injuries [3]. The aim of this study is to determine whether differences in BMI, specifically BMI of 30 or above when compared to BMI of less than 30, affects the peri-operative morbidity with penetrating abdominal injuries. As the rates of obesity

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continue to increase in the United States, assessing the impact of increasing BMI on penetrating abdominal injury is of important clinical significance.

Patients and Methods

The study was approved by institutional review board of Lincoln Medical and Mental Health Center, a level one trauma center. The trauma registry prospectively enters all penetrating injury cases diagnosed and treated at the center into a prospective database and reports it to the National Trauma Database. These data have been queried by residents involved with the Lincoln Medical surgical program. For this retrospective study, we identified all patients from January of 2003 through July 2009 for international Classification of Diseases, Ninth Revision (ICD-9) procedure codes representing penetrating injuries. Patients were identified with data extracted using a standard pro forma. Original medical notes, paramedical notes and observation charts, and operative notes were reviewed by two senior surgical residents along with involved senior surgical staff. Data obtained on patients included mechanism of injury, site and number of wounds, patient demographics, past medical history, operative reports, postoperative course and complications. Exclusion criteria included patients with chest wounds above the forth intercostals space, below the inguinal ligament, flank and back as well as patients with BMI > 30 without abdominal obesity. Patients with a BMI ≥ 30.0 kg/m^2 were considered obese and patients with below BMI 30.0 kg/m^2 were considered non-obese. Patients demographics were well matched between obese and non-obese groups (Table 1). Data on non-therapeutic laparotomies, therapeutic laparotomies, and organs involved or repaired during the laparotomies was collected.

Results

A total of 756 patients were admitted to emergency room with penetrating wounds from January of 2003 to July of 2009, of which 381 (50%) were abdominal wounds. 21% (79) of total PAI were obese and 79% (302) were non-obese. 68% of the obese patients were explored in the operating room, while 57% of non-obese patients were explored. Of the obese patients, 52% had non-therapeutic laparotomies. Of the non-obese patients explored, 35% had non-therapeutic laparotomies. Obese patients had increased rate of non-therapeutic laparotomies (p = 0.041) compared to non-obese patients (Table 2).

There was no statistical difference in obese patients when compared to non-obese patients with respect to lower intra-abdominal injuries. There was also no statistically significant difference between the two groups in mortality. Some of the patients had multiple injuries hence the total number of injuries are in excess of the total therapeutic laparotomies. Of the patients with BMI 30 or above, the incidence of diaphragmatic injury was 11%, gastric 4%, liver 9%, spleen 11%, renal 10%, small bowel 24%, colon 10%, vascular 21%. Of the patients with BMI below 30, the incidence of diaphragmatic injury was 13%, gastric 12%, liver 30%, spleen 5%, renal 11%, small bowel 11%, colon 13%, vascular 5% (Table 3).

Patients with a BMI above 30 had 9% rate of liver injuries and the rate of liver injuries for those with a BMI below 30 was 30%. BMI above 30 had lower rate of liver injuries (p = 0.003) using the Fisher exact test. BMI of above 30 had a 21% rate of vascular injuries and the rate of vascular injuries for BMI below 30 was 5%. BMI above 30 had higher rate of vascular injuries (p = 0.007) using the Fisher exact test. There was no statistical difference when comparing, diaphragmatic, gastric, spleen, renal, small bowel or colon injuries in the two groups.

Discussion

As surgeons err on the side of vigilance, the non-therapeutic laparotomy rate is unlikely to ever reach zero, even with modern imaging. It is difficult however, to reconcile the decrease in laparotomy rate with the static proportion of non-therapeutic procedures. This

Table 1: Demographic data and clinical characteristics of patients with and without abdominal obesity. Categorical variables are presented as %. Continuous variables are presented as mean ± standard deviation.

	Obese Patients (n = 79)	Non-obese Patients (n = 302)	*P*-value
Age	33 (4.2)	36 (5.1)	0.198
Male	60	215	0.521
Caucasian	24	28	0.576
Hispanic	34	37	0.698
African American	42	35	0.379

Table 2: Penetrating abdominal injury, number of patients (%).

	BMI > 30	BMI ≤ 30	*P*-value
Non-Operative Intervention	25 (32)	131 (43)	0.211
Operative Intervention	54 (68)	171 (57)	0.06
Non-therapeutic Laparotomies[†]	28 (52)	60 (35)	0.041
Therapeutic Laparotomies[†]	26 (48)	111 (65)	0.189
Negative Intra-abdominal Injury[*]	44 (56)	167 (55)	0.592
Positive Intra-abdominal Injury[*]	35 (44)	135 (45)	0.662

[†]Data derived from patients in the operative column; [*]Intra-abdominal injury found in both operative and non-operative patients.

Table 3: Breakdown of injured organs, number of patients (%).

	BMI > 30	BMI ≤ 30	*P*-value
Diaphragm	4 (11)	20 (13)	0.443
Gastric	1 (4)	18 (12)	0.093
Liver	3 (9)	47 (30)	0.003
Spleen	4 (11)	7 (5)	0.178
Renal	4 (10)	17 (11)	0.639
Small Bowel	9 (24)	17 (11)	0.112
Colon	3 (10)	20 (13)	0.323
Vascular	8 (21)	7 (5)	0.007

may reflect a change in the patient population, either in those presenting to the emergency department or in those admitted to the surgical service. The mechanism of injury observed in this follow-up study has changed only slightly since the original description by McIntyre and colleagues [4].

The presence of hemodynamic instability continues to have a high specificity and positive predictive value for visceral damage [3-5]. The importance of serial clinical examination is undisputed; with the indication for laparotomy commonly being tenderness away from the wound or peritonitis [3].

Research on the best management of patients with isolated evisceration is limited [4,6,7]. The present study suggests that, in the absence of clinical signs, such patients should be considered for wound toilet and closure under local anesthetic, with admission for further observation and imaging. In the largest prospective study of omental evisceration, 91% of 116 patients with omental evisceration but no clinical signs mandating laparotomy had successful treatment without surgery or non-therapeutic laparotomy [6].

The role of imaging in determining the management of patients who do not require immediate laparotomy has been studied widely. CT has a high specificity and sensitivity for detecting peritoneal violation (97% and 98% respectively), through detection of pneumoperitoneum, intraperitoneal free fluid or active bleeding [8]. There is more variation in the reported accuracy of CT in identifying bowel injuries and one prospective study described a 13% non-therapeutic laparotomy rate in patients undergoing laparotomy solely on the basis of CT findings [8].

The benefit of ultrasonography or FAST in penetrating abdominal trauma is less clear. Although it has a high specificity (94-100%) for detection of intraperitoneal free fluid, sensitivity is limited, and was as low as 18% in one stab injury series [9-11].

As in other studies, there were major complications in all patient groups in the present study, a reminder of the burden on the patient undergoing a negative laparotomy [5]. Although many advocate the use of laparoscopy in the management of PAI, it was surprising that laparoscopy was not more commonly used [12]. It is difficult to place laparoscopy in the algorithm for the management of penetrating trauma, although it is likely to have a greater use in future. Laparoscopy is highly specific, but it has a low sensitivity, particularly in excluding hollow viscus injuries [13,14]. It has also been suggested that patients with left thoracoabdominal injuries should undergo emergency laparoscopy to rule out diaphragmatic injuries [15].

Previous studies that evaluated trauma morbidity and mortality in obese patients have shown that patients with BMI > 30 are more likely to die than their non-obese counterparts however this is the first study that specifically evaluates the rates of laparotomies in these patients [16].

Over the past 20 years there has been a reduction in the non-therapeutic laparotomy rate, from 27% of all trauma admissions to 6.7% in the present series [5]. Present studies and the weight of published literature support hemodynamic instability and peritonitis as definitive indications for laparotomy. Isolated evisceration and retained foreign bodies are only relative indications; a more selective management policy in the absence of other indications would probably benefit these patients. Although advances in imaging technology and availability have improved the non-operative management of penetrating injury, it is important to recognize that the relative experience of a centre in managing such injuries will limit the extent to which non-operative management is pursued.

Conclusion

This study is one of the first to examine the potential correlation between PAI and varying BMI. We have found patients with abdominal obesity are prone to a higher rate of exploration and of non-therapeutic laparotomies when compared to non-obese individuals. We have identified a group of patients in whom the evaluation of a stab wound of the abdomen is difficult, resulting in higher rate of non-therapeutic exploration. Non-obese patients are three times more likely to suffer liver injuries with PAI when compared to obese patients. This is unlikely to be related to anatomical variation but rather a protective effect of truncal obesity on injuries to the liver. Obese patients are four time more likely to suffer vascular injuries with PAI when compared to their non-obese counterparts. There was no statistically significant difference between the two groups in mortality.

Conflict of Interest

RC: No conflict of interest

HB: No conflict of interest

JP: No conflict of interest

MC: No conflict of interest

SK: No conflict of interest

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