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# Impact of body mass index on injury in abdominal stab wounds: implications for management

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## ABSTRACT

**Background:** Although it is assumed that obese patients are naturally protected against anterior abdominal stab wounds, the relationship has never been formally studied. We sought to examine the impact of body mass index (BMI) on severity of sustained injury, need for operation, and patient outcomes.

**Materials and methods:** We conducted a review of all patients presenting with abdominal stab wounds at an urban level I trauma center from January 2000–December 2012. Patients were divided into groups based on their BMI (<18.5, 18.5–29.9, 30–35, and >35). Data abstracted included baseline demographics, physiologic data, and characterization of whether the stab wound had violated the peritoneum, caused intra-abdominal injury, or required an operation that was therapeutic. The one-sided Cochran–Armitage trend test was used for significance testing of the protective effect.

**Results:** Of 281 patients with abdominal stab wounds, 249 had complete data for evaluation. Chest and abdomen abbreviated injury scale trends decreased with increasing BMI, as did overall injury severity score, the percent of patients severely injured (injury severity score  $\geq 25$ ), and length of intensive care unit stay. Rates of peritoneal violation (100%, 84%, 77%, and 74%;  $P = 0.077$ ), visceral injury (83%, 56%, 50%, and 30%;  $P = 0.022$ ), and injury requiring a therapeutic operation (67%, 45%, 40%, and 20%;  $P = 0.034$ ) all decreased with increasing BMI. Patients in the thinnest group required an operation three times more often than those in the most obese.

**Conclusions:** Increased BMI protects patients with abdominal stab wounds and is associated with lower incidence of severe injury and need for operation. Heavier patients may be more suitable to observation and serial examinations, whereas very thin patients are more likely to require an operation and be critically injured.

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## 1. Introduction

Obesity remains a national epidemic in the United States, with a prevalence of 35% of adults satisfying the body mass index (BMI)  $>30$  kg/m<sup>2</sup> definition [1]. In blunt trauma, prior studies have demonstrated an increased short-term rate of mortality

among obese patients when matched for injury severity compared with that of nonobese patients [2]. Obesity was found to be an independent risk factor for outcomes of intensive care unit (ICU) admission, infection, pneumonia, and mortality [3]. Multiple proinflammatory molecules and cytokines are released during blunt trauma, and obese

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patients demonstrate a marked depression of the early expression of the cytokine response [4]. Both this alteration to the “normal” host response, as well as preexisting medical comorbidities, are likely to be responsible for the worse outcomes.

Penetrating wounds other than of the central nervous system, however, have a much lesser metabolic effect on the victim. Further, the specific injury sustained from a stab wound is the result of direct contact between the knife blade and tissue, without the added effect of dispersal of kinetic and thermal energies. From an anatomic perspective, it would appear obvious that increased BMI should have a protective effect to limit organ damage in anterior abdominal stab wounds. To our knowledge, this has never been studied discretely.

Of historical interest, both written accounts and biochemical analysis of the remains of ancient Roman gladiators suggest that they purposefully engaged in high calorie diets designed to put on subcutaneous fat, believing that the extra layer would be protective against stab wounds [5]. In this study, we sought to investigate the effect of BMI on the severity and pattern of injury from abdominal stab wounds, as well as the need for surgical therapeutics and overall outcomes.

## 2. Materials and methods

We conducted a review of all nonpregnant patients aged  $\geq 15$  y presenting with anterior abdominal stab wounds at an urban adult level I trauma center from January 2000–December 2012. These subjects were divided into four groups based on their BMI:  $<18.5$  (underweight), BMI 18.5–29.9 (normal), BMI 30–35 (obese), and BMI  $>35$  (severely obese). Patient baseline demographics, physiologic data, abbreviated injury scale (AIS) scores, and injury severity score (ISS) were collected. The dictated reports of all operations were reviewed. Patients were managed with a combination of serial examinations, local wound exploration, laparoscopy, and laparotomy at the discretion of the trauma attending. Injuries were classified as to whether there had been violation the peritoneum, intra-abdominal injury, or injury that required therapeutic operation. A surgery was defined as therapeutic if there was damage to organs that could not have been successfully managed nonoperatively, including ongoing bleeding of a discrete vessel with  $>500$ -cc blood found in the abdomen, or intra-abdominal injuries  $\geq$  grade III, as defined by the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma. Diaphragm injuries that were repaired were considered therapeutic. Abdominal organ injuries not necessitating operative repair, such as minor bleeding laceration of the liver, spleen, or mesentery, were considered visceral, but not serious, injury.

Patients who were safely observed without an operation were considered as having no severe intra-abdominal injuries but were excluded from the peritoneal violation analysis if a local wound exploration did not occur. Numerical variables were compared across the BMI levels by the Kruskal–Wallis test. Because we hypothesized a decreasing (protective) trend for rates of penetration and severe injury (ISS  $\geq 25$ ) across the increasingly ordered BMI levels, a one-sided Cochran–Armitage

test was used. For all other binary variables, a two-sided Cochran–Armitage test was performed to assess trends.

## 3. Results

During the 12 year study period, 281 patients presented with abdominal stab wounds, and 249 patients had complete data for evaluation. Baseline patient characteristics (Table 1) were similar between groups with respect to age, Glasgow coma scale (GCS) score, and systolic blood pressure (SBP). Male patients comprised 86% (214 of 249) of the overall data set, but the percentage of female patients increased with increasing BMI in our series.

Indices of injury severity were similar for head and extremity injuries, but chest AIS (2.0, 1.0, 0.7, 0.6;  $P = 0.19$ ) and abdomen AIS scores (2.5, 2.1, 1.8, 1.7;  $P = 0.26$ ) trended downward with increasing BMI. ISS measures of overall injury severity trended downward as well (13.8, 11.3, 10.1, 8.6;  $P = 0.48$ ), and the percent of patients who were severely injured (ISS  $\geq 25$ ) significantly decreased with increasing BMI (17%, 8%, 3%, 0%;  $P = 0.045$ ).

The incidence of computed tomography (CT) scans performed in total was 35%. This rate was similar across BMI groups. Seventy-nine percent of patients were taken to the operating room for exploration. This resulted in a nontherapeutic operation rate of 44%, which increased significantly with BMI (33%, 42%, 52%, 75%;  $P = 0.043$ ).

The length of stay in the ICU in days varied as a function of patient's BMI (3.3, 1.3, 1.4, 0.4;  $P = 0.032$ ) but overall length of hospital stay did not. We had one death in our study group, which was not the direct result of the sustained injury but the result of perioperative complications from what was a nontherapeutic laparotomy.

A definitive determination as to whether a patient had experienced peritoneal violation had been performed procedurally in 197 of the 249 patients (79%). All 6 patients with BMI  $<18.5$  had peritoneal violation, (Figure), and 67% of these patients required a therapeutic operation. Rates of peritoneal violation decreased as patient BMI increased (100% [6 of 6], 84% [128 of 152], 77% [24 of 31], 75% [6 of 8];  $P = 0.077$ ). As BMI increased, the rates of visceral injury (83% [5 of 6], 56% [110 of 195], 50% [19 of 38], 30% [3 of 10];  $P = 0.022$ ) and serious injury requiring a therapeutic operation (67% [4 of 6], 45% [88 of 195], 40% [15 of 38], 20% [2 of 10];  $P = 0.034$ ) dropped significantly. For all patients, those in the thinnest group required an operation 3.4 times more frequently than those in the most obese (67% versus 20%). Furthermore, among patients with known peritoneal violation, the thinnest patients also required surgery two times more often (67% versus 33%).

The distribution of organs requiring operative repair is listed in Table 2. Small bowel was the most commonly injured viscus. Its incidence of injury rose with increasing BMI (0%, 27%, 33%, and 100%). Several patients had more than one organ injured.

## 4. Discussion

In this study, we demonstrate that the morbidity of an anterior abdominal stab wound is a function of the patients' body

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