International Journal of Surgery 21 (2015) 51–56

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Utilizing quantitative measures of visceral adiposity in evaluating trauma patient outcomes

Salvatore Docimo Jr. *, Brooke Lamparello, Melissa Fay Cohen, Anthony Kopatsis, Fausto Vinces

NYU Lutheran Medical Center, Department of Surgery, 150 55th Street, Brooklyn, NY 11220, USA

HIGHLIGHTS

- Quantitative radiologic measures of visceral adiposity is the gold standard to assess obesity.
- This is the first attempt to associate V/S ratios with trauma outcome measurements.
- Clinical association of an increased V/S ratio and complications in trauma patients noted.
- Further prospective studies are required for further analysis.

ARTICLE INFO

Article history:
Received 9 March 2015
Received in revised form
11 May 2015
Accepted 20 June 2015
Available online 9 July 2015

Keywords:
Visceral adiposity
Quantitative measures
Adiposity
Trauma outcomes

ABSTRACT

Introduction: Body mass index (BMI) has commonly been used as a parameter to assess obesity in trauma patients. However, the variability of height and weight data in trauma patients limits the use of BMI as an accurate assessment tool in the trauma population. Quantitative radiologic measurements of visceral adiposity is an accurate method for assessing obesity in patients but requires further analysis before it can be accepted as a measurement tool for trauma patients.

Methods: A retrospective review of trauma cases with pre-operative CT scan from 2008 to 2015 produced 57 patients for evaluation. Preoperative BMI was calculated using measured height (m2) and weight (kg). Radiologic measurements of adiposity were obtained from preoperative CT scans using OsiriX DICOM viewer software. Visceral fat areas (VFA) and subcutaneous fat areas (SFA) were measured from a single axial slice at the level of L4-L5 intervertebral space.

Results: No statistically significant results were found relating visceral fat:subcutaneous fat ratios to length of stay or post-operative complications. Initial clinical observations noting an increased incidence of complications among patients with a V/S $\geq$ 0.4 demonstrates a possible link between obesity and poor outcomes in trauma patients. A statistically significant correlation was noted between length of stay, peri-nephric fat and injury severity score.

Discussion and Conclusion: Our pilot study should be viewed as the foundation for a larger prospective study, utilizing quantitative measurements of visceral adiposity to assess outcomes in trauma patients.

1. Introduction

Obesity in the United States has become a significant health problem. In a 2014 JAMA publication, the prevalence of obesity in the United States was estimated to be 34.9% in 2011–2012 [1]. To date, the association between obesity and patient outcomes in the setting of trauma is still under investigation. Previous studies have demonstrated higher rates of in-hospital complications and increased mortality in obese patients suffering blunt traumatic injury [2–4]. Glance et al. [5] performed a retrospective review of nearly 150,000 patients, which after adjusting for injury severity and other factors, found severely obese trauma patients were at least 30% more likely to die and twice as likely to have major complications compared with non-obese patients.

Body mass index (BMI) has commonly been used in the literature as a parameter to assess obesity in trauma patients [3–5]. The

* Corresponding author. Present address: Penn State Milton S. Hershey Medical Center, Department of Minimally Invasive & Bariatric Surgery, 500 University Dr, Hershey, PA 17033, USA.
E-mail address: sdocimo@gmail.com (S. Docimo).

http://dx.doi.org/10.1016/j.ijsu.2015.06.069
1743-9191/

previously published literature demonstrating obesity as an independent risk factor of mortality in trauma patients utilized only BMI as their standard for comparison. However, variability in the definition of obesity in previously published studies presents a difficult problem in standardizing the assessment of obesity and its affect on patient outcomes. The National Institutes of Health [7] define obesity as a BMI $\geq$ 30 kg/m2. Previous studies have applied their own definitions and interpretations of obesity, which can lead to findings that may not be easily extrapolated to other trauma populations. Smith-Choban et al. [8] classified patients as normal (BMI < 27 kg/m2), over-weight (BMI 27–31 kg/m^2), and obese (BMI > 31 kg/m^2). Byrnes et al. [9] chose to define obesity for their patients as a BMI $\geq$ 35 kg/m^2. Such variability in obesity definitions can create a barrier to consistent extrapolation of data.

However, quantitative radiologic analysis of visceral adiposity using standard CT scans have been described as being the gold-standard method for assessing visceral adiposity [10,11]. Quantitative analysis of visceral adiposity using CT-based measurements has been evaluated as a more effective means of assessing obesity in patients [10,11]. In some disease processes, such as rectal cancer, visceral adiposity has shown to have stronger associations with cancer recurrence than BMI [12]. Malietzis et al. [13] also utilized CT-based measurements of body composition to demonstrate a link between visceral obesity, reduced skeletal muscle, and poorer short-term recovery, poorer oncological outcomes, and poorer survival.

To our knowledge, this study is the first to apply quantitative radiologic analysis of visceral adiposity to trauma patients undergoing surgical exploration to evaluate complication rates, such as anastomotic leaks and pulmonary embolism, and outcomes, such as length of stay. The objective of this pilot study is to introduce quantitative measures of visceral adiposity as a tool to measure the effect of obesity on the post-operative morbidity and mortality of trauma patients undergoing surgical intervention for abdominal trauma.

2. Methods

A retrospective review of trauma cases from 2008 to 2015 was performed with institutional review board approval. All trauma patients over the age of 18 years of age with abdominal trauma who underwent surgical repair were examined. Those patients who had a computed tomography scan performed after arriving in the trauma bay was included in the study. Data was collected on patient demographics, medical co-morbidities, preoperative vital signs, operative findings, complications and length of stay.

2.1. Systematic data retrieval

Preoperative BMI was calculated using measured height (m^2) and weight (kg). Radiologic measurements of adiposity were obtained from preoperative CT scans using OsiriX DICOM viewer software. Visceral fat areas (VFA) and subcutaneous fat areas (SFA) were measured from a single axial slice at the level of L4-L5 intervertebral space. The CT attenuation level to delineate the regions of adipose tissue was set using Hounsfield units of −190 to −30 [12]. The VFA and the SFA were then delineated and measured. Fig. 1 provides an example of the quantitative visceral adiposity measurements taken during the study. The visceral fat area to subcutaneous fat area ratio (V/S) was calculated using the VFA and SFA measurements. Elevated V/S ratio indicates a larger amount of visceral fat compared to subcutaneous fat with a defined obesity threshold of V/S $\geq$ 0.4 [12,14]. Linear perinephric fat (PNF) thickness was measured at the level of the renal veins. Perinephric fat thickness was defined as the shortest distance (in mm) between the kidney and abdominal wall at the level of the renal vein [12,15].

2.2. Statistical analysis

Adiposity variables (PNF, SFA, VFA) were measured as continuous variables. Linear correlations were calculated using SPSS between various adiposity variables and endpoints (LOS, complications, intra-operative pressors, etc). The chi-square, Fisher's exact tests, and student T-tests were utilized to evaluate the differences in adiposity variables and endpoints. We attempted to eliminate bias in the study by having one individual, who was the not the primary investigator, to gather the visceral and subcutaneous measurements. Furthermore, the individuals who were enrolled in the study were randomly generated from our trauma registry and not specifically chosen by any of the investigators.

3. Results

3.1. Demographics and clinical features

The study population consisted of 57 patients, who underwent surgical intervention for abdominal trauma, which was confirmed on preoperative abdominal CT scans. There were more men (n = 49) than women (n = 8) with the mean age of 36.77 ± 16.83 years. The frequency of comorbidities such as diabetes, hypertension, and hypercholesterolemia among this population was 10.5%, 19.3% and 3.5%. Thirty-seven (65%) patients underwent exploratory laparotomy and 20 (35%) underwent laparoscopic surgical repair. Four (9%) patients presented with hypotension in the trauma bay. Eleven (19.3%) patients experienced hypotension in the operating room with seven (12.2%) and 10 (17.5%) patients requiring pressor support and colloids. Table 1 summarizes the demographic and co-morbidity findings.

3.2. Adiposity measurements

The patients demonstrated a mean BMI of 30.0 kg/m^2, a mean perinephric fat thickness of 1.34 cm, a mean subcutaneous fat area of 142.64, a mean visceral fat area of 91.25, and a mean V/S ratio of 0.89. Mean PNF was higher in females than in males (1.56 vs 1.31; p = 0.63), higher in patients without hypertension (1.37 vs 1.26; p = 0.80) and higher in patients without DM (1.37 vs 1.17; p = 0.73). A BMI >30 kg/m^2 was noted only in male patients with an average BMI of 37.23 kg/m^2 A V/S ratio $\geq$0.4 (indicating obesity) was more common in males (n = 35) vs. females (n = 7) who had an average V/S ratio of 0.91 compared to a V/S ratio of 0.75 in females (p = 0.66). There was no statistical significance regarding a V/S > 0.4 and patients having HTN or no HTN (0.87 vs 1.17; p = 0.46) or DMand no DM (1.10 vs 1.22; p = 0.85). Table 2 summarizes the obesity measurement findings for the 57 patients.

3.3. Overall analysis

The mean injury severity score (ISS) 28.4 ± 12.2 and was not correlated with PNF (p = 0.55), V/S ratio (p = 0.86) or BMI (p = 0.60), indicating injuries were well randomized. The mean LOS was 9.2 ± 10.4 days. The LOS did demonstrate a correlation to PNF (p = 0.031) and ISS (p = 0.01). The LOS did not correlate with subcutaneous fat thickness (p = 0.79), visceral fat (p = 0.87), BMI (p = 0.73), and V/S ratio (p = 0.86). The incidence of complications was not correlated with PNF (p = 0.27), subcutaneous fat area (p = 0.10), visceral fat area (p = 0.11), or V/S ratio (p = 0.34).

The likelihood of a correlation between V/S ratio and intra-operative hypotension was not statistically significant (p = 0.93). The likelihood of a correlation between V/S ratio and postoperative