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# Repeat computed tomography is highly sensitive in determining need for delayed exploration in blunt abdominal trauma



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### ARTICLE INFO

#### Article history:

Received 9 February 2017

Received in revised form

10 May 2017

Accepted 25 May 2017

Available online xxx

#### Keywords:

Blunt trauma

Abdominal trauma

Abdomen

CT scan

Repeat

Delayed exploration

### ABSTRACT

**Background:** Computed tomography (CT) imaging has an established role in the initial evaluation of blunt abdominal trauma. What is less clear is the role of CT in guiding delayed exploration in patients initially managed nonoperatively after blunt trauma. We hypothesized that a repeat CT would accurately identify the need for an exploratory laparotomy in this patient population.

**Materials and methods:** From 2005 to 2014, we reviewed all blunt abdominal trauma patients at our institution who received an admission CT scan. We identified patients who underwent repeat CT of the abdomen within 72 h for the documented purpose of reevaluating potential intra-abdominal injuries. CT findings were categorized as either having a CT indication for exploration or not, allowing a sensitivity analysis.

**Results:** Of the 50 patients who met our inclusion criteria, 9 underwent surgical exploration of the abdomen and 41 did not. Admission clinical indicators such as Glasgow Coma Scale, Injury Severity Score, and vitals were similar between the operative and nonoperative groups ( $P > 0.05$ ). When compared with initial CT scan, repeat scan was found to increase the sensitivity from 67% to 100%, while also improving the specificity to 86%, positive predictive value to 50%, and negative predictive value to 100%.

**Conclusions:** Repeat CT scan of the abdomen may be useful in evaluating blunt trauma patients initially managed nonoperatively. The second CT scan increases the sensitivity of CT evaluation to 100% while also improving the specificity, positive predictive value, and negative predictive value.

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## Introduction

Computed tomography (CT) imaging has a clear and well-established role in the initial evaluation of patients after blunt abdominal trauma.<sup>1</sup> The sensitivity of emergency CT scan in this clinical situation has been thoroughly

demonstrated in the literature, with reports ranging from 92% to 98%.<sup>1–3</sup> Negative predictive values as high as 99% have been reported and used to support immediate discharge of patients with negative admission scans.<sup>4</sup> Furthermore, the utility of CT for detecting injuries which are otherwise unsuspected has been routinely confirmed.<sup>5,6</sup> What is far less clear is the role of

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<http://dx.doi.org/10.1016/j.jss.2017.05.107>

a repeat CT scan obtained to reevaluate patients lacking initial clinical or CT signs mandating operative exploration at the time of admission. There is little literature to guide trauma surgeons in the reevaluation of patients who are initially admitted for a trial of observation or nonoperative management and then undergo a clinical deterioration or fail to progress. The weakness of CT in diagnosing in particular mesenteric and hollow viscous injury is well known, with some studies showing a 10%-15% rate of false-negative CT with regard to bowel injury.<sup>7</sup> Furthermore, the trauma literature demonstrates an increase in morbidity and mortality inherent in delayed identification of blunt abdominal injury in the absence of prompt operative management, making an understanding of efficient and effective diagnosis paramount in caring for this patient population.<sup>8-10</sup>

Our goal with this study was to assess the utility of repeat CT scan in evaluating blunt abdominal trauma in patients who were initially managed nonoperatively. This investigation was intended to assist trauma surgeons in their management of this patient population and potentially aid in the decision of whether these patients are best served by using valuable time and resources on repeat CT versus proceeding directly to the operating room for surgical exploration and exposing the patient to the risks of a possibly unnecessary exploratory procedure. We hypothesized that repeat CT scan would provide useful clinical information to guide management in this clinical scenario, specifically that repeat CT would accurately identify the need for operative exploration.

## Materials and methods

After receiving institutional review board approval, all blunt abdominal trauma patients cared for at our urban-based, university-affiliated trauma center were collected from our institutional trauma registry for a 10-y period from 2005 to 2014. These were cross-referenced with our radiology database to identify patients who received an abdominal CT scan at the time of admission and a repeat CT scan of the abdomen within 72 h of the initial scan and before any surgical intervention. We only included patients aged over 16 y who received a repeat CT scan for the sole purpose of reevaluating for potential intra-abdominal injuries, as determined by the physician-completed indication field in the CT order. We therefore excluded patients who underwent repeat CT scan for purposes other than reevaluating abdominal trauma and those with missing or insufficient documentation. This narrowed our study cohort to patients who did not receive immediate abdominal exploration at time of presentation, were initially managed nonoperatively with respect to the abdominal trauma, and later underwent a repeat abdominal CT scan to reevaluate for intra-abdominal injuries.

A chart review was then undertaken for this cohort of patients and the following variables were collected: age, gender, Glasgow Coma Scale, Injury Severity Score, arrival heart rate, arrival systolic blood pressure, length of stay, intensive care length of stay, ventilator days, mortality, CT scan findings, abdominal operative findings, and information on the clinical course in the hospital. Only abdominal explorations were considered in this study; all further references to

operative management exclude any other type of operation the patients may have received during their hospital stay. The operative and nonoperative groups were compared in terms of their demographics, arrival characteristics, CT time intervals, and outcome measures. Statistical analysis was performed using Stata 13 software (StataCorp, College Station, TX). Categorical variables were compared using a Pearson chi-squared test and continuous variables using a t-test with equal variance. Statistical significance was defined as a *P* value less than 0.05.

CT scan and operative reports were reviewed in detail to evaluate the correlation between CT findings and positive identification of intra-abdominal injuries requiring operative management. First, initial and repeat CT scan reports for each patient were reviewed and categorized as consistent with either the presence or absence of a CT indication for abdominal exploration. The presence of a number of findings in the radiologist's report was considered "indications for surgery" and these are listed in Table 1. We then reviewed the operative reports of patients who underwent abdominal exploration to determine whether a clinically significant intra-abdominal injury had been identified and a therapeutic surgery was performed. Patients successfully managed nonoperatively were determined not to have an intra-abdominal injury requiring exploration and therefore were "condition negative" for our sensitivity analysis. A sensitivity analysis was then performed to assess the ability of initial and repeat CT to detect a proven operative indication for an abdominal injury. Figure 1 demonstrates in a step-by-step manner how true and false negatives and positives were defined for this analysis. Finally, we compared the results for the initial and repeat CT scans.

## Results

We identified 108 patients who underwent repeat CT scan of the abdomen within 72 h and before any operative intervention. Of these initial 108 patients, 24 patients underwent repeat CT for purposes other than evaluation of the abdominal trauma and were excluded. Another 34 patients were excluded because of lack of adequate documentation. Our study cohort was comprised of the remaining 50 patients who underwent repeat CT specifically to evaluate blunt abdominal trauma after an initial trial of nonoperative management. These patients were 67.3% male with an average age of 40.1 y.

**Table 1 – CT indications for surgery.**

### CT findings

- Moderate-large free fluid without evidence of solid organ injury
- Signs of vascular injury or compromise
- Free air, bowel wall thickening, mesenteric edema, or other sign concerning for hollow organ injury
- Increasing free fluid or significant worsening of solid organ injury on repeat CT
- Radiology comment citing specific hollow organ injury

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