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CT scan-detected pneumoperitoneum: An unreliable predictor of intra-abdominal injury in blunt trauma

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ABSTRACT

Introduction: Free intra-peritoneal air in blunt trauma is a classic sign associated with hollow viscus injury, traditionally mandating laparotomy. In blunt abdominal trauma, the CT scan has become the diagnostic modality of choice. The increased sensitivity of CT scans may lead to detection of free intra-peritoneal air that is not clinically significant.
Objective: To characterize conditions and findings that allow for the safe observation of blunt trauma patients with free air and to propose a patient management algorithm to decrease rates of non-therapeutic laparotomy.
Design: A retrospective review of 5877 blunt trauma patients who had an abdominal CT scan upon admission to our hospital from 2003 to 2011. A secondary CT review was performed by a single radiologist to further characterize the CT findings in the 74 patients with free air reported on initial scan. Management and hospital course were reviewed in these patients.
Results: Of the 74 patients with intra-abdominal free air, 36 patients with a benign clinical picture were observed and 38 patients underwent urgent exploratory laparotomy. Eleven patients received a non-therapeutic laparotomy. The majority (61%) of patients, 45 of 74, had free air and no significant injury suggesting the presence of benign free air. Patients who had intra-abdominal injury also typically had other clinical or radiologic signs of injury. Findings that were highly predictive of intra-abdominal injury in the setting of free air were free fluid ($P < 0.001$), radiographic signs of bowel trauma ($P < 0.001$) as well as clinical and/or radiographic seatbelt sign ($P = 0.004$).
Conclusions: CT scans may detect free air that is not always clinically significant. Free fluid, seatbelt sign or radiographic signs of bowel trauma in the presence of pneumoperitoneum is highly predictive of injury and these patients should be explored. Based on the results of our study, we created an algorithm to aid in identifying those patients with intra-abdominal free air who may be observed safely.

Introduction

Free intra-peritoneal air after blunt trauma has traditionally mandated exploratory laparotomy given its association with hollow viscus injury.[2–4] In abdominal trauma evaluation, the CT scan has increasingly become the diagnostic modality of choice and is highly sensitive to detection of small amounts of intraperitoneal air.[1] Advances in technology, increasing CT scan sensitivity, may result in detection of benign free air.[2,5–14] Reports of benign free air in both the trauma and general population range from 10 to 78%.[5,7,14] These cases are most commonly associated with chest trauma and pneumothorax, but also occur as a result of ventilator barotrauma,[9] tracheal injury[10] and cardiopulmonary resuscitation.[11]

The rate of non-therapeutic laparotomy in blunt and penetrating trauma is reported from 6 to 32%.[15,16] Complications, including infections, obstruction and wound dehiscence, have been reported at a rate of 12% from non-therapeutic laparotomies.[15] Although it may not be possible to eliminate non-therapeutic laparotomies altogether, they should be minimized to decrease hospital length of stay and complication rates. At our institution, we have successfully managed select patients with intraperitoneal free air without exploratory laparotomy. Additionally, we have performed non-therapeutic laparotomies on blunt trauma patients who had free intra-abdominal air on CT scan. We sought to characterize indications and conditions that allow for the safe

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observation of blunt trauma patients with free air, to ultimately decrease the rates of non-therapeutic laparotomy and complications thereof.

Methods

A retrospective chart review was carried out to include all blunt trauma patients who underwent an abdominal CT scan upon admission to our Level 1 trauma center from January 1, 2003 to December 31, 2011. A total of 5877 blunt trauma patients were identified and charts were reviewed for presence of free intra-abdominal air on CT scan radiology report. Prior to 2006, the CT scans were performed using a Siemens Volume Zoom 4-slice spiral CT scanner. After 2006, the CT scans were performed using a Phillips Brilliance 64-slice spiral CT scanner. All CT scans were analyzed using 5 mm-thick axial cuts in lung and soft tissue windows. Seventy-eight of the 5877 patient charts reviewed reported free air by CT scan. The discovery rate of free air was similar between the two scanners, 1.74% prior to 2006 and 1.15% from 2006 to 2011. Four patients were excluded secondary to family wishes or other non-survivable injury. The management and hospital courses of the 74 patients with free intra-abdominal air were reviewed. A single unblinded radiologist performed secondary review of their CT scans and further characterized patterns of free air and other associated findings. The patients were then categorized based on whether or not they underwent exploratory laparotomy, and if so, whether the laparotomy was therapeutic. A therapeutic laparotomy was defined as a laparotomy in which any significant intra-abdominal injury was found. This group was then subdivided into two groups: those patients who were noted to have a gastrointestinal tract perforation and those with other clinically-significant injuries. Patients who were initially managed non-operatively were identified as being safely observed or obtaining a delayed laparotomy. We characterize patients with benign free air as those who were safely managed non-operatively and those who underwent a non-therapeutic laparotomy. Clinical data recorded were demographics, presence of seat belt sign, abdominal exam, FAST results and haemodynamic status. Haemodynamic instability was defined as blood pressure below 100 mmHg systolic with or without associated tachycardia or a code event, either en route to our center, in the stabilization bay or any time prior to laparotomy. Fisher exact test for categorical data was used to examine statistical significance. Student's *t* test was used to examine quantitative data. Statistical analysis was conducted with PRISM 5 software (GraphPad Software, Inc.).

Results

Of the 5877 blunt trauma patients with abdominal CT scans upon admission to our facility, 78 were found to have free intraperitoneal air, for an overall incidence of free air of 1.3% (Fig. 1). Four of the 78 patients were excluded from the study. Three patients had care withdrawn by family prior to laparotomy; two were secondary to devastating head injury and the other in accordance with the patient's advanced directive. The fourth patient died en route to the operating room. These patients were excluded because further characterization into benign and clinically-relevant free air was not possible. Of the 74 patients with free air, 38 underwent urgent exploratory laparotomy (Fig. 1). Twenty-eight of these patients had significant injuries identified during exploration: 15 with gastrointestinal tract perforation and 13 with other significant intra-abdominal injuries (Fig. 1). Operative findings in these 13 patients included diaphragmatic rupture, active haemorrhage, and/or bladder injury. Ten patients who underwent immediate exploration had non-therapeutic exploratory laparotomies (Fig. 1). Thirty-six patients, with a benign clinical picture as determined by the attending physician, were initially treated non-operatively with observation and serial abdominal exams. Of the 36 patients, 34 were successfully managed non-operatively (Fig. 1). Two patients in this group were later taken to the OR after a change in clinical status. One was

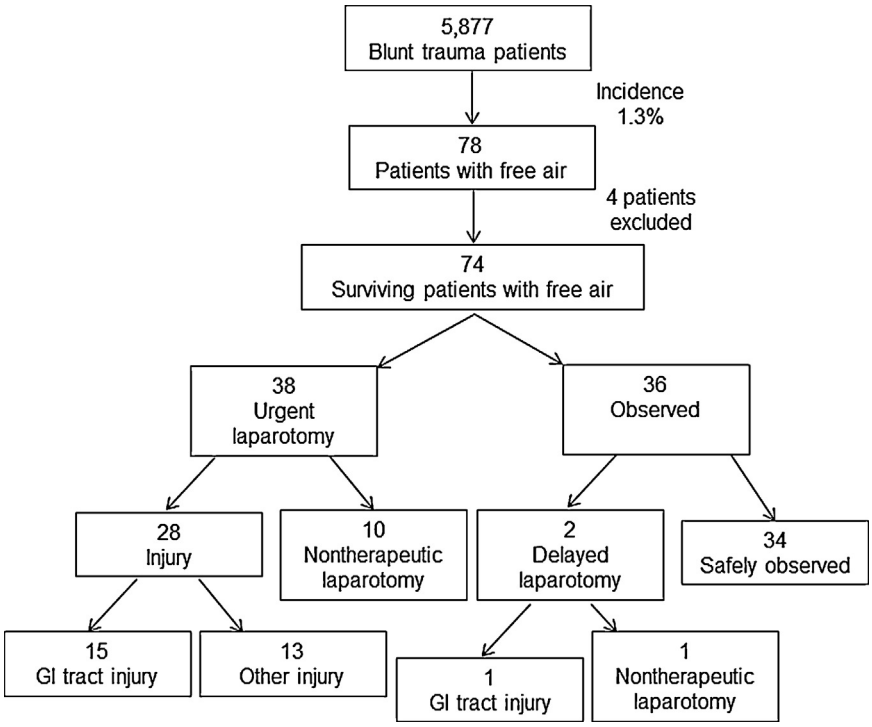

Fig. 1. Diagram of patient cohort included in study.