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Original Article

Arterial phase CT for the detection of splenic injuries in blunt trauma: would it improve clinical outcomes?

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ABSTRACT

Objective: To determine if the addition of an arterial phase abdominal computed tomography (CT) improves clinical outcomes in patients with blunt splenic injuries.
Methods: Retrospective review of patients who underwent CT of the abdomen revealing splenic injuries. Clinical management in these patients was determined.
Results: Fifty-one of three thousand five hundred twenty-five patients had splenic injuries. Twenty-five patients underwent nonsurgical management, and 3 failed. The theoretical additional arterial phase resulted in a 62% increase in mean effective dose compared to the portal venous phase alone.
Conclusions: Routine use of arterial phase CT in blunt trauma patients may not be warranted as there is minimal improvement in outcomes.

1. Introduction

Computed tomography (CT) is the diagnostic imaging test of choice for evaluation of the hemodynamically stable patient with blunt abdominal trauma [1]. In particular, CT is accurate in identifying injuries to the spleen, one of the most commonly injured organs following blunt trauma [2,3].

Standard abdominal CT protocols for the evaluation of blunt trauma are performed in the portal venous phase which optimizes the enhancement of the solid organs including the spleen [1]. Obtaining delayed images has been advocated to help differentiate between injuries with active extravasation and those with pseudoaneurysms or arteriovenous fistulas (contained vascular injuries) [4,5]. More recent evidence suggests that arterial phase imaging of the spleen improves detection of contained vascular injuries compared to portal venous phase imaging alone [6,7]. As the presence of contained vascular injuries portends an increased risk of failed nonsurgical management, improved detection of such lesions could alter patient management [8–10]. However, the extra phase has the limitation of added radiation exposure to the patient. Furthermore, most patients with blunt trauma who undergo abdominal CT do not have any intraabdominal injuries and therefore would not benefit from arterial phase images [11,12]. It is also not known if improved detection of contained vascular splenic injuries seen only on arterial phase CT improves patient outcomes.

Due to the low rate of splenic injuries in patients who undergo CT following blunt trauma, routine use of a dual-phase protocol may result in additional radiation expose to the majority of patients with no added clinical benefit. Therefore, the exact role of dual arterial and portal venous phase imaging in patients with blunt trauma is not yet well defined. The purpose of this study is to determine if the addition of an arterial phase to standard portal venous phase imaging would result in improved clinical outcomes in patients undergoing CT for blunt abdominal trauma. We hypothesize that the limited additional clinical benefit does not outweigh the risks of increased radiation dose.

2. Material and methods

2.1. Data collection and study group

We performed a retrospective study of consecutive patients who underwent an abdominal and pelvic CT scan for blunt trauma in the emergency department of a Level 1 trauma center. The study was Health Insurance Portability and Accountability Act compliant and approved by the institutional review board. A waiver of informed consent was obtained owing to its retrospective nature.

Patients were eligible if they were greater than 15 years of age and underwent an abdominal CT scan with intravenous (iv) contrast from January 1, 2012 to December 31, 2013. Patients greater than 15 years of age were included as the management of adolescent patients with blunt abdominal trauma is similar to that of adults [13,14]. A search of the radiology database for the keyword *trauma* in CT examinations of

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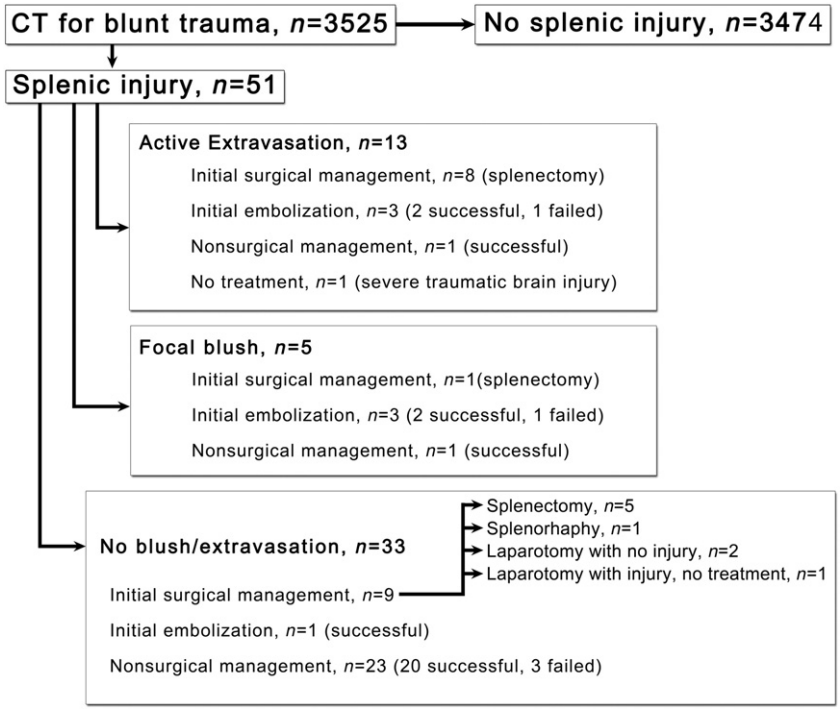

Figure. Flow chart of the study population showing the CT findings and patient outcomes.

the abdomen and pelvis was performed. Per our institutional protocol, all radiology examinations performed in trauma patients have the history of "pain s/p trauma" in the clinical history section of the examination request. To ensure that all cases of blunt trauma were included, a wide variety of additional key words was also searched including *MVA*, *MVC*, *motor vehicle*, *fall*, and *assault*. The radiology reports were screened to ensure the history of blunt trauma.

The radiology reports were reviewed to identify all cases of acute splenic injury. All cases with original radiology reports negative for acute splenic injury were considered to be negative. The CT images of patients with splenic injuries were then independently reviewed by two reviewers (M.C., G.F.; both board certified radiologists with subspecialty training in abdominal imaging) blinded to the original radiology reports and any additional clinical information. This review confirmed the presence of a splenic injury and categorized patients as having no splenic blush, definite active extravasation from the spleen, or focal splenic blush. Active extravasation was defined as linear or nonfocal regions of high density (density equal to or greater than blood pool) in and/or around the spleen. A *focal blush* was defined as a focal region of high density similar to that of blood pool within the spleen that was not considered active extravasation. Any discrepancies between the two reviewers were resolved in consensus. The splenic injuries were graded according to the American Association for the Surgery of Trauma injury scoring scales by one reviewer (XX) [15].

2.2. Primary outcome

The primary outcome for this study was potential benefit from an arterial phase CT. Patients were considered to potentially benefit from an arterial phase if they had a splenic injury and failed nonoperative management requiring a splenectomy. Specific therapy for all patients with splenic injuries was determined by review of the electronic medical record. Initial treatment was categorized as initial splenectomy, initial angiography with splenic embolization, successful nonsurgical management, or failed nonsurgical management. Successful nonsurgical management was defined as admission for observation without splenectomy or angiographic embolization and subsequent discharge from the hospital in stable condition with respect to splenic pathology. *Failed nonsurgical management* was defined as the need for splenectomy or angiographic embolization after an initial attempt of nonsurgical management.

2.3. CT Technique

All CT examinations were performed on one of two GE 64-detector row scanners (VCT, GE Medical Systems, Milwaukee, WI, USA). Scans were performed using a detector configuration of 64×0.625, beam collimation of 40 mm, 120 kVp (140 kVp for patients weighing over 350 lb), pitch of 1.375, gantry rotation of 0.5 s, and a variable mAs using automated dose modulation (GE Smart mA) with a prescribed noise index of 32. All images were reconstructed axially using a hybrid reconstruction algorithm technique employing a combination of filtered back projection (60%) and iterative reconstruction (40%) at a thickness/interval of 1.25/1.25 mm and 5/5 mm, using a standard body filter. Nonoverlapping 1.25-mm data sets were used to obtain routine coronal and sagittal reformations at a thickness and interval of 5/5 mm. Scans were performed from the top of the diaphragm through the bony ischium. All scans were obtained during a single portal venous phase (80-s delay after injection) after the iv administration of 125 cc of Omnipaque 350 (GE Healthcare) at a rate of 2–2.5 cc/s.

2.4. Radiation dose analysis

The effective doses were estimated using commercial dose monitoring software (Radimetrics, Bayer Healthcare LLC, Whippany, NJ, USA) that uses an anthropomorphic whole body phantom and Monte Carlo methodology. This software displays the original scan and provides the effective dose estimates in mSv and individual organ equivalent dose estimates based on the conversion and weighting factors described in the International Commission on Radiological Protection 103 [16]. This software has an interactive tool which allows the Z-axis of the scan to be altered, and the effective doses are recalculated using the new scan range. This method was used to model the theoretical additional scan required for the arterial phase from the same starting