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Blunt splenic trauma: Can contrast enhanced sonography be used for the screening of delayed pseudoaneurysms?

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ABSTRACT

Purpose: To assess the value of contrast-enhanced sonography (CES) for the detection of delayed post-traumatic splenic pseudo-aneurysms, usually considered an indication for angiographic embolization.
Methods: Sixty-three consecutive hemodynamically stable trauma patients in whom admission CT displayed a splenic injury of grade II or higher (AAST classification), without evidence of vascular involvement, were included in the study. CES of the spleen using a second generation contrast agent was systematically performed within 48–72 h after admission, for the detection of a pooling of contrast media suggestive of pseudoaneurysm. Within 6 h after contrast-enhanced sonography, all patients underwent an abdominal CT for control purposes. CES results were compared to CT findings, which were considered the reference standard. This study received approval from the institutional ethical board.
Results: CES showed a blush of contrast consistent with a pseudoaneurysm in 6 of the 63 patients. All were confirmed at subsequent control CT. Pooling of contrast was found at CT in 2 patients in whom contrast-enhanced sonography was negative. There was no false positive CES examination for the suspicion of pseudoaneurysms. When compared to CT, the sensitivity, specificity, positive and negative predictive values of CES to suggest a pseudoaneurysms, were 75% (6/8), 100% (55/55), 100% (6/6), and 96% (55/57), respectively.
Conclusion: Our data suggest that CES may be useful for the screening of delayed traumatic splenic pseudoaneurysms: if a negative CES does not absolutely rule out a pseudoaneurysm, a positive CES warrants an angiography, without need of control CT.

1. Introduction

The spleen is the most commonly injured organ in blunt abdominal trauma patients. Non operative management (NOM) has become the mainstay of the treatment of blunt splenic trauma, because it allows for preservation of the immune splenic function, prevents postsplenectomy sepsis and avoids complications associated with laparotomy [1]. Some retrospective studies reported that, without specific treatment, the rate of failure of NOM was higher when CT showed a pooling of contrast media within the spleen parenchyma than when it did not [2,3]. Comparative series between CT and arteriography showed that a pooling of contrast on CT, defined as a "hyperdense focal well-circumscribed area of increased density compared with adjacent normally enhancing splenic pulp, completely within the spleen and frequently accompanied by a halo of low-density hematoma, which disappears on late portal phase", often corresponds to a pseudoaneurysm [2,4–8]. Although the beneficial role of angioembolization of splenic pseudoaneurysms is not yet unanimously recognized [9–11], most authors agree that embolization improves the success rate of NOM of splenic fractures [6,8,12–14].

It has been observed that between 38% and 74% of splenic pseudoaneurysms were only detected at control CT, performed between 24 and 72 h after admission [5,15,16]; such pseudoaneurysms are referred to as "latent" or "delayed" pseudoaneurysms. The advent of CES using second generation ultrasound contrast media recently has led practitioners to reexamine the value of sonography in blunt trauma patients, since CES now achieves sensitivities and specificities close to that of CT for the depiction of solid organ injuries [17,18]. Recent reports also showed that CES could depict intraparenchymal vascular injuries of the spleen [19–21]. However, no series evaluated whether this technique can be used for the systematic screening of post-traumatic splenic pseudoaneurysms.

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The objective of this study was to prospectively evaluate the capacity of CES to detect delayed posttraumatic splenic pseudoaneurysms on a consecutive series of patients with a grade 2 or higher splenic injury.

2. Methods

This prospective study was approved by the institutional review board (CER 04-207). A written informed consent was obtained from each patient before performing CES. The study was conducted over 7 years, from October 1, 2004 to September 30, 2011. Subjects enrolled in the study included all adults patients (>18 years old) admitted to our center after a blunt abdominal trauma, in whom a splenic injury of grade II or higher was depicted on admission CT examination, according to the American association for the surgery of trauma (AAST) classification [22].

Patients with a high grade splenic laceration (grade V) or active splenic bleeding on admission underwent immediate surgery, following our institution's guidelines, in accordance to the AAST based Mirvis classification (blush of contrast media is an indication for angiography and embolization, while extravasation of contrast mandates surgery) [3]. Splenic lacerations (grade II or higher) without vascular injury depicted on admission CT underwent CES within 48–72 h after admission, for detection of vascular injuries. A control CT was obtained within 6 h after CES was performed. If a vascular injury was depicted on control CT, an angiographic examination was obtained within the next 12 h to confirm the diagnosis and, if confirmed, an embolization was performed. Patients with grade I splenic lacerations were not included because they are less prone to develop pseudoaneurysm and failure of NOM than higher grades [16,23,24].

Exclusion criteria were: pregnancy, absence of informed consent and death from a non-spleen related injury within 48 h after admission. Clinical and surgical follow-up were performed in every patient until the time of discharge, to determine the rate of successful NOM. If an abdominal CT was performed, for any clinical reason, in addition to the control CT, it was also analyzed for the presence of a splenic pseudoaneurysm, and referred to as "delayed CT".

During the study period, a blunt splenic injury of grade II or higher was detected on admission CT in 116 adult patients. A high grade splenic laceration (grade V) or active splenic bleeding was found in 49 (42%) patients who underwent immediate surgery. Sixty-seven (58%) of the 116 patients were selected for NOM of the splenic injury.

65 of these 67 patients did not have a vascular injury on admission CT. Two of them were excluded from the study: one refused to participate in the study, the second was unconscious and thus unable to sign the informed consent. A control CES was performed within 48 and 72 h in the 63 remaining patients who formed our study population.

2.1. CT examinations

Admission abdominal CT images were acquired in the frame of a single-pass continuous whole-body protocol dedicated to polytrauma patients, consisting of a one sweep acquisition from the circle of Willis through the pubic symphysis, set up to obtain a mixed phase (both arterial and portal) on the liver and spleen. Whenever feasible, arms were positioned by the side of the head. From October 2004 to September 2010, CTs were performed on a 16-row Philips MX 8000 (Philips Medical Systems, Best, The Netherlands), using 16 mm × 1.5 mm collimation, pitch 1.35, gantry rotation period 0.5 s, tube potential 120 kV, tube charge per gantry rotation 180 mAs, reconstruction slice thickness 2.0 mm, 15 s after administration of a power-injected single bolus of 110 mL non-ionic intravenous contrast material (iomeprol 400 mgI/mL, Ioméron^{R}, Bracco, Manno, Switzerland), at a flow rate of 4 mL/s.

Beginning October 2010, CT was performed on a 64-row Discovery 750 HD scanner (GE Healthcare, Cleveland), using 64 mm × 1.25 mm collimation, pitch 0.984 mm, gantry rotation period 0.7 s, tube potential 120 kV, tube charge 115 mA, reconstruction slice thickness 2.0 mm, after administration of a power-injected single bolus of 120 mL of iohexol 350 mgI/mL (Accupaque^{R}, GE healthcare, Opfikon, Switzerland), at a flow rate of 4 mL/s. Scanning was automatically triggered, using a threshold of 100UH in the ascending aorta. Delayed images were obtained when a solid organ injury was detected on the initial series, to improve the detection rate of active bleeding.

Abdominal control CT was obtained using the same parameters as admission CT except scanning was performed on the spleen at both arterial and venous phases.

2.2. Ultrasonographic examinations

CES was performed by one of the two attending physicians on call for the emergency radiology unit, each with a prior experience of at least 100 CES abdominal examinations, using an Aloka SSD 5000 SV ultrasound device (2004 release), and a 3.5-MHz convex sector probe. The operator was aware of the patient's admission CT result. An initial analysis of the spleen parenchyma was first performed on a standard B-mode imaging. Then the operator switched on the pulse inversion harmonic mode, with a reduced mechanical index of 0.18. Two and a half mL of a second-generation contrast agent (sulfur hexafluoride, SonoVue^{R}, Bracco), were injected intravenously, using a 20-gauge catheter placed into an antecubital vein, followed by a 10-mL flush of saline water (0.9% NaCl). Serial images of the spleen were obtained every 3 s from the beginning of the injection, for a total duration of 3 min. A focal pooling of contrast medium during the arterial phase, with a similar enhancement as the splenic artery, surrounded by a normally enhancing or non-enhancing (injured) parenchyma, that can be retrieved after successive microbubble destructions (flushes) was considered positive for a vascular injury (pseudoaneurysm) [19,21]. The operator had to fill out a study form within 10 min after completion of the examination, for the presence of absence of a pooling of contrast suggestive of a pseudoaneurysm. It was not possible to report an examination as indeterminate.

2.3. Angiographic examination

Digital subtracted angiography examination was performed on a Siemens Axiom Artis angiographic device, using 100–200 mL of iohexol 270 mgI/mL (Accupaque^{R}, GE healthcare, Opfikon, Switzerland). Anteroposterior and oblique projections of the spleen were obtained after catheterization of the main splenic artery with an adapted 5F catheter, and also after selective catheterization of the distal branches with a 2.7F microcatheter (Terumo, Leuwen, Belgium). When splenic pseudoaneurysms were detected, selective embolizations were performed with either gelatin pledgets (Gelfoam, Pharmacia & Upjohn Company, Peapack, NJ) or 0.018 in. microcoils (Hilal, Cook Medical, Bloomington, IN).

3. Results

Of the 63 patients included in the series, 23 (37%) had a grade II splenic laceration, 24 (38%) a grade III, and 16 (25%) a grade IV, found at admission CT.