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Delayed splenic vascular injury after nonoperative management of blunt splenic trauma

Alessandro Furlan, MD,[a,*] *Mitchell E. Tublin, MD,*[a] *Mitchell A. Rees, MD,*[a] *Dederia H. Nicholas, RN,*[b] *Jason L. Sperry, MD, MPH,*[b] *and Louis H. Alarcon, MD*[b]

[a] *Department of Radiology, University of Pittsburgh Medical Center and School of Medicine, Pittsburgh, Pennsylvania*
[b] *Department of Surgery, University of Pittsburgh Medical Center and School of Medicine, Pittsburgh, Pennsylvania*

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ABSTRACT

Background: Delayed splenic vascular injury (DSVI) is traditionally considered a rare, often clinically occult, harbinger of splenic rupture in patients with splenic trauma that are managed conservatively. The purpose of our study was to assess the incidence of DSVI and associated features in patients admitted with blunt splenic trauma and managed nonoperatively.

Materials and methods: A retrospective analysis was conducted over a 4-y time. Patients admitted with blunt splenic trauma, managed no-operatively and with a follow-up contrast-enhanced computed tomography (CT) scan study during admission were included. The CT scans were reviewed for American Association for the Surgery of Trauma splenic injury score, amount of hemoperitoneum, and presence of DSVI. Logistic regression models were used to investigate the risk factors associated with DSVI.

Results: A total of 100 patients (60 men and 40 women) constituted the study group. Follow-up CT scan demonstrated a 23% incidence of DSVI. Splenic artery angiography validated DSVI in 15% of the total patient population. Most DSVIs were detected only on arterial phase CT scan imaging. The American Association for the Surgery of Trauma splenic injury score (odds ratio = 1.73; $P = 0.045$) and the amount of hemoperitoneum (odds ratio = 1.90; $P = 0.023$) on admission CT scan were associated with the development of DSVI on follow-up CT scan.

Conclusions: DSVI on follow-up CT scan imaging of patients managed nonoperatively after splenic injury is common and associated with splenic injury score assessed on admission CT scan.

Introduction

Nonoperative management is increasingly preferred over splenectomy in hemodynamically stable patients presenting with blunt splenic trauma.[1,2] One of the important risks of this conservative treatment is delayed splenic hemorrhage and rupture. Although the exact incidence and mechanism of this complication is unknown, the delayed occurrence of splenic

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* *Corresponding author*. Department of Radiology, UPMC Presbyterian Shadyside, University of Pittsburgh, Suite 200 East Wing, 200 Lothrop Street, Pittsburgh 15213, PA. Tel.: +1 412 647-3550; fax: +1 412 647-7795.
E-mail address: furlana@upmc.edu (A. Furlan).

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vascular injuries and rupture of splenic pseudoaneurysms has been frequently reported as a possible cause.[3,4]

Contrast-enhanced computed tomography (CT) scan is the preferred imaging modality for the diagnosis and staging of splenic injury. The detection of splenic vascular injuries on CT scan predicts failure of nonoperative management and leads to further interventions such as angioembolization or surgery.[2,5,6] However, there is no consensus on the role of follow-up CT scan in patients managed with observation for the detection of delayed splenic vascular injury (DSVI)[7–10]—defined as vascular injury visible at follow-up CT scan study but not present on admission imaging (commonly described as pseudoaneurysm or "contrast blush").

The variation in practices on the use of follow-up CT scan is mainly because of the limited data available on this topic and on the lack of information on the natural history and mechanisms responsible for DSVI. Delayed splenic vascular injuries have been reported with variable percentages ranging from 3% to 15% with inconsistent association with the severity of splenic injury.[11–15] In addition, recent literature exploring the value of arterial phase imaging for the detection of splenic vascular injury suggests that the type of CT scan imaging protocol used may affect the sensitivity for the detection of DSVI.[16,17]

At our institution, hemodynamically stable patients with moderate (grade 2 or higher American Association for the Surgery of Trauma [AAST]) splenic injury score and managed conservatively undergo a contrast-enhanced abdominal CT scan at 48 h after admission with arterial phase imaging. The purpose of our study was to assess the incidence of DSVI and the associated clinical and imaging features in this population.

Materials and methods

Patients and data collection

This Health Insurance Portability and Accountability Act–compliant retrospective study was approved by the Institutional Review Board. The study was complied with the Health Insurance Portability and Accountability Act. Patient consent was waived.

A retrospective cohort analysis was conducted over a 4-y period (2011-2014) using the institution's Trauma Registry. Adult patients (aged ≥18 y) admitted to a Level 1 Trauma Center who suffered blunt splenic trauma without evidence of vascular injury on initial contrast-enhanced CT scan imaging and managed nonoperatively were included. Subjects were excluded if they underwent angioembolization immediately after the admission CT scan or if they did not have a follow-up contrast-enhanced abdominal CT scan with arterial phase imaging during the index hospitalization. For each patient, the following information was recorded: mechanism of injury, injury severity score (ISS), head, chest, and abdomen abbreviated injury scale (AIS), length of stay in the hospital, heart rate and systolic blood pressure on admission.

Imaging protocol and analysis

The admission and follow-up contrast-enhanced CT scans were performed with multidetector row CT scanners. In 72 of 100 cases (72%), the contrast-enhanced CT scan at admission included an arterial phase through the upper abdomen (including the spleen) followed by imaging in the portal venous phase ($n = 68$) or portal venous and delayed phase ($n = 4$). In this protocol, the spleen is included in the lower portion of the CT scan acquisition of the chest, and therefore imaged during the arterial phase. In the remaining 28 cases (28%), the contrast-enhanced CT scan did not include an arterial phase through the upper abdomen, and the spleen was imaged only during the portal venous phase ($n = 14$) or portal venous and delayed phase ($n = 14$). The variability in protocol of CT scan imaging at admission is due to the fact that 33% of the patients underwent CT scan at an outside hospital before being transferred to our institution. All follow-up contrast-enhanced CT scans included an arterial phase through the abdomen. In 97 of 100 cases (97%) the contrast-enhanced imaging in the follow-up CT scan study was made of a combination of arterial and portal venous phase, whereas in the remaining three cases (3%), only an arterial phase was obtained after contrast administration.

The CT scan studies were reviewed retrospectively and in consensus by two experienced abdominal radiologists blinded to results of angiography, patient's outcome, and clinical data. The radiologists assigned the grade of splenic parenchymal injury and grade of hemoperitoneum on the admission CT scan and the presence of splenic vascular injury on admission and follow-up CT scans. Splenic parenchymal injury was assessed using a 5-point scale according to the AAST splenic injury score.[18] The quantity of hemoperitoneum was assessed according to Marmery *et al.*[19] using five peritoneal compartments (perisplenic space, Morison's pouch, left and right paracolic gutters, and pelvis). The amount of hemoperitoneum was defined as small if blood was seen only in one or two compartments, moderate if blood was seen in three or four compartments, and large if blood was seen in all five locations (Heme grade). Splenic vascular injuries were assessed by detecting intrasplenic or perisplenic areas of contrast material extravasation similar in attenuation to an adjacent contrast-enhanced artery, also defined as contrast blushes.[19,20] For each patient, the following features of splenic contrast blushes were recorded: number, size (i.e., maximum transverse measurement), shape (i.e., round or oval, linear, and irregular), location relative to splenic laceration or hematoma (i.e., within the laceration/hematoma or within the unaffected parenchyma), and visual conspicuity. Visual conspicuity was assessed qualitatively using a 3-point scale: not seen, poorly seen, and well seen. The radiologists recorded the conspicuity of the contrast blush on the arterial and portal venous phase imaging. When more than one contrast blush was detected, the size, shape, location, and visual conspicuity were recorded only for the largest. The radiologists classified the findings as a contained vascular injury if the contrast blush was well-defined, if it was confined to the spleen and if it did not change in size or shape between the arterial and portal venous phase. An irregular area of contrast material extravasation within or outside the spleen that increased in size on the portal venous phase was considered active bleeding.[20] A DSVI was defined as a vascular injury visible at a follow-up CT scan study that was not present on the admission CT scan. Available splenic angiography reports performed after the