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Delayed Rupture of a Normal Appearing Spleen After Trauma: Is Our Knowledge Enough? Two Case Reports

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABEF 1 Luigi Romeo
E 2 Dario Andreotti
E 1 Domenico Lacavalla
E 1 Silvia Ferro
E 1 Matteo Tondo
B 3 Elisabetta Salviato
E 1,2 Savino Occhionorelli

1 Department of Morphology, Surgery and Experimental Medicine, Sant'Anna University Hospital, University of Ferrara, Ferrara, Italy
2 Surgical Department, Emergency Surgery Unit, Sant'Anna University Hospital, Ferrara, Italy
3 Department of Radiology, Unit of Vascular and Interventional Radiology, Sant'Anna University Hospital, Ferrara, Italy.

Corresponding Author: Luigi Romeo, e-mail: luigi.romeo@live.com
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Case series
Patients: Male, 45-year-old • Male, 73-year-old
Final Diagnosis: Delayed splenic hemorrhage
Symptoms: Heamorragic shock
Medication: —
Clinical Procedure: —
Specialty: Surgery

Objective: Unusual clinical course

Background: Non-operative management is considered the gold standard for hemodynamically stable patients with splenic injuries. Delayed splenic rupture is a well-known complication of non-operative management in splenic trauma, with a relevant impact on mortality and morbidity. Most of the reported cases of delayed splenic rupture presented splenic injury at admission imaging or no imaging investigations were performed. We report 2 cases of delayed splenic rupture after blunt trauma, in which multidetector computed tomography (CT) scan at admission did not show any splenic injury.

Case Report: Two patients were admitted to our emergency surgery unit after abdominal trauma with left rib fractures, but no solid organ injuries were detected at CT scan. Some days after the trauma, both patients suddenly developed hemorrhagic shock due to splenic rupture and required emergency splenectomy.

Conclusions: Trauma patients' management and follow-up remains challenging for surgeons, because of sudden clinical changes that can occur. Delayed splenic rupture with inconspicuous admission CT scan is a rare event. In some cases, it seems to be related to a poor CT quality, but this explanation cannot be adopted in all cases. Moreover, there is no standardization for imaging follow-up in the case of a normal CT scan at admission, in order to prevent delayed hemorrhage. In this context, every element that can identify patients with higher risk of delayed splenic rupture is of great importance. We suggest that lower left rib fractures can be associated with delayed splenic rupture, and we propose some explaining hypothesis.

MeSH Keywords: Abdominal Injuries • Case Reports • Rib Fractures • Splenic Rupture

Abbreviations: **ED** – Emergency Department; **NOM** – nonoperative management; **CT** – computed tomography; **FAST –** focused assessment with sonography for trauma; **DSR** – delayed splenic rupture; **BP** – blood pressure; **HR** – heart rate; **ISS** – injury severity score; **AAST** – American Association for the Surgery of Trauma; **OR** – operatory room; **ICU** – Intensive Care Init; **US** – ultrasonography; **CEUS** – contrast enhanced ultrasonography

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Background

The spleen is the most frequently injured organ in blunt abdominal trauma [1]. However, there is a wide variability in the grade of splenic injuries and clinical conditions of patients presenting at the Emergency Department (ED), ranging from low-grade asymptomatic injuries to hemodynamically unstable splenic rupture.

The initial assessment of blunt trauma starts with the evaluation of hemodynamic status and basic diagnostic tools. In case of hemodynamic stability, multidetector computed tomography (CT) scan represents the gold standard for the assessment of the splenic damage after a blunt trauma in order to choose the best treatment [2], because of its high sensitivity and specificity in detecting and staging splenic injuries.

During the last decades, the treatment of splenic traumatic injuries has changed from splenectomy to non-operative management (NOM), which consists of observation and monitoring with or without the aid of angioembolization [2], in order to preserve immunological function of the spleen. However, patients treated with NOM can develop failures, with a raise in mortality and morbidity if compared with immediate splenectomy. Delayed splenic rupture (DSR) is a rare complication that can occur after splenic injury. Baudet was the first to described DSR [3]. It is defined as the rupture of the spleen 48 hours after a trauma with a previous asymptomatic period.

We report 2 cases of DSR after a blunt abdominal trauma with no evidence of splenic injuries at the admission CT scan, but affected by left rib fractures.

Case Report

Case 1

A 45-year-old Caucasian male arrived at the ED of Sant'Anna University Hospital of Ferrara after a left thoracoabdominal falling trauma from 3 meters high which occurred while he was working. He had no relevant medical history.

At admission, his blood pressure (BP) was 150/100 mm Hg, his heart rate (HR) was 97 bpm, and his oxygen saturation was 92%. The patient did not lose consciousness and no sign of head trauma was found on physical examination.

He underwent focused assessment with sonography for trauma (FAST), chest x-rays and cervical spine x-rays that showed left rib fractures from third to tenth rib. Subsequent chest CT scan without administration of contrast agent was performed in order to better assess the thoracic injuries. It showed bifocal rib fractures from seventh to tenth left rib, 2 cm left anterior pneumothorax and lung contusion. After these findings, the ED physician decided to admit the patient to the acute care surgery unit.

The day after, the patient underwent a chest and abdominal CT scan with contrast agent that did not discover any abdominal injury (Figure 1). During the subsequent days of hospitalization, the patient's conditions remain stable and serial blood samples showed stability in blood hemoglobin levels. Considering the negative abdominal findings, the patient did not undergo follow-up imaging.

On day 5 after the trauma, the patient's conditions suddenly deteriorated, with hypotension and shock. After fluid resuscitation and hemodynamic stabilization, contrast-enhanced CT scan was performed. This demonstrated abundant fluid collection in left hypochondrium surrounding the spleen associated with splenic rupture (Figures 2, 3).

The patient was urgently taken to operatory room (OR) by an experienced surgeon. The emergency laparotomy found an abundant hemoperitoneum secondary to a V grade splenic injury. No other injuries were detected after an accurate exploration of the peritoneal cavity. The surgeon evacuated the blood clots, performed a splenectomy, and placed 1 abdominal drain in splenic lodge.

After surgery, the patient spent his early post-surgical period in the intensive care unit (ICU). On postoperative day 6, the patient returned to acute care surgery ward; he was definitely discharged on post-operative day 16, at 21 days after the trauma.

Case 2

A 73-year-old Caucasian male was taken to the ED of our hospital after a car accident with head and thoracoabdominal blunt trauma. The patient's comorbidities were hypertension, in treatment with hypotensive drugs, and hypercholesterolemia. His surgical history included appendectomy.

When he arrived at the ED, he was hemodynamically stable: his BP was 140/85 mm Hg, HR was 90 bpm, and oxygen saturation was 90% without oxygen mask. He complained of headache and chest pain bilaterally, but physical examination did not show anything relevant. His laboratory tests were normal. In particular, the patient's hemoglobin value was 14.6 g/dL and coagulation values were normal.

The patient underwent chest x-rays, pelvic x-rays, and FAST that showed only fracture of the left femoral neck. He was submitted to contrast-enhanced CT scan, which confirmed the fracture of left femoral neck and found rib fractures from fourth to twelfth rib on the left chest and from sixth to eighth rib on

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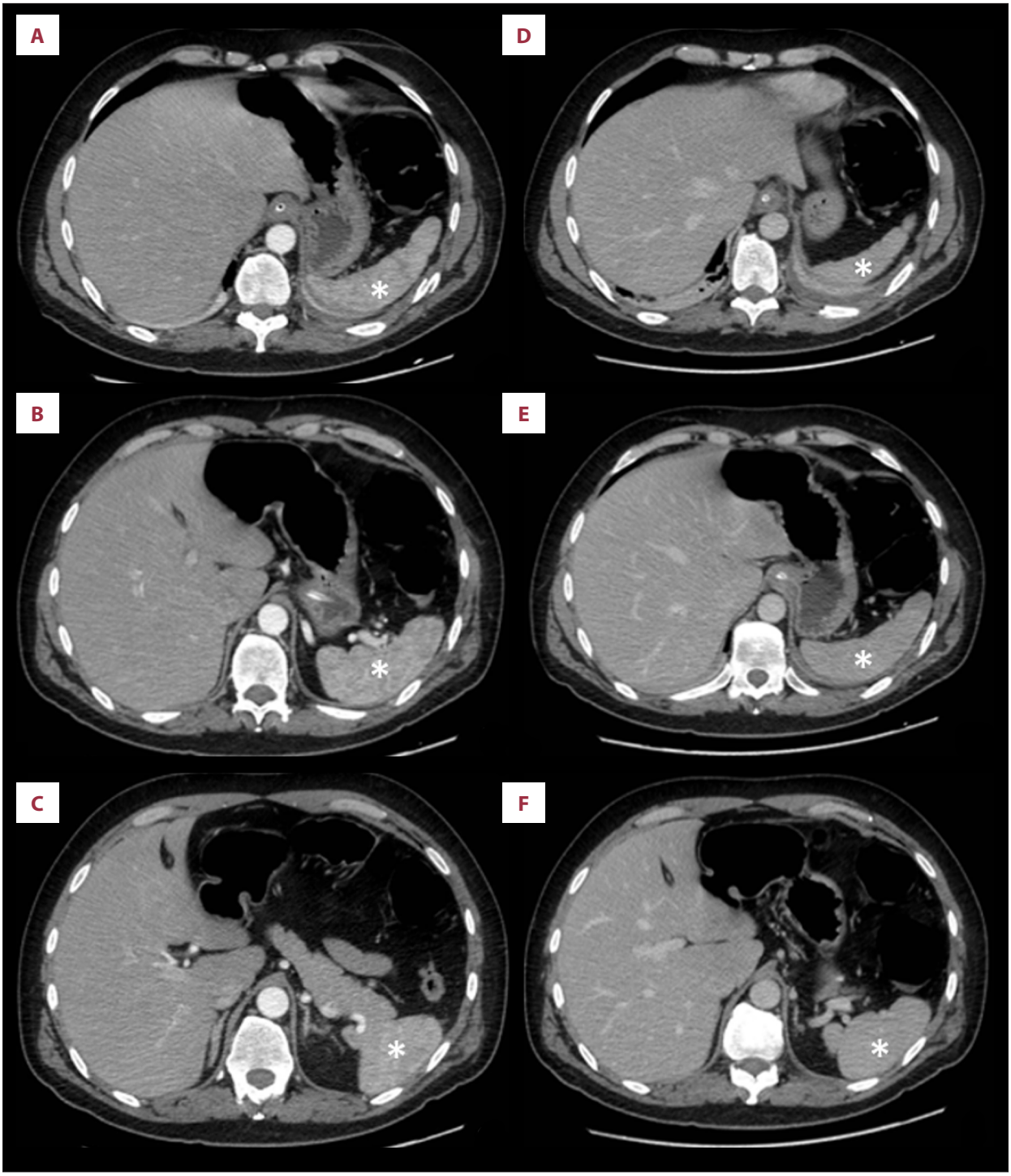

Figure 1. Arterial phase (**A–C**) and venous phase (**D–F**) showing a normal spleen (white asterisks).

the right chest, in absence of pleural fluid or pneumothorax. Abdominal scans did not show solid organ injuries, free abdominal fluid, or air (Figure 4). He was admitted to the acute care surgery unit for observation. As in the previously reported case, laboratory tests were stable and no subsequent abdominal imaging was taken.

Two days after admission, the patient suddenly developed hypotension and tachycardia. He underwent contrast-enhanced CT scan that showed an 11 cm splenic hematoma with active bleeding, and free peritoneal fluid in peri-splenic, perihepatic and left perirenal space, between intestinal loops and in the pelvis (Figure 5).

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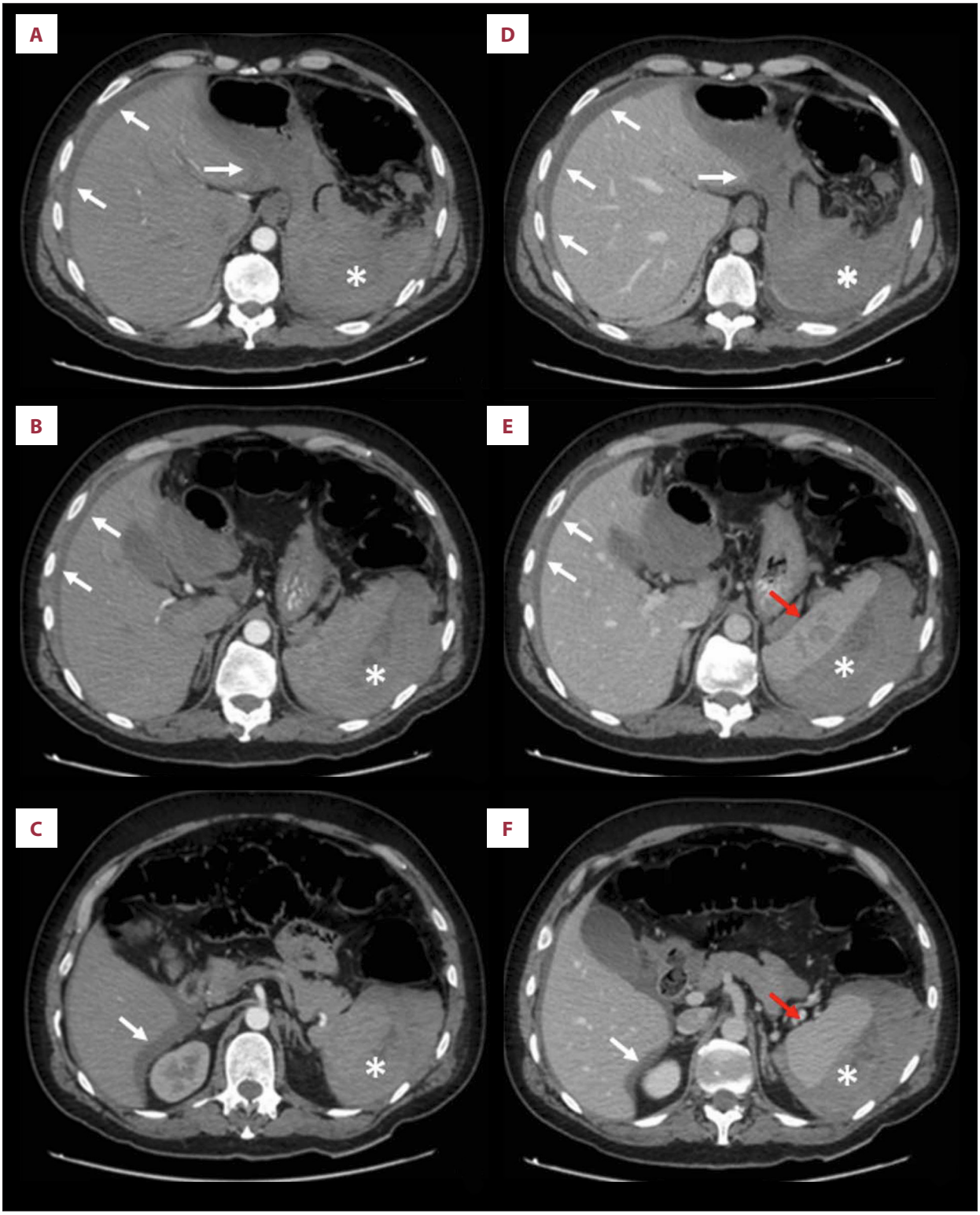

Figure 2. Arterial phase (**A–C**) and venous phase (**D–F**) showing injured splenic parenchyma (red arrows) surrounded by clots and fluid (white asterisks) and perihepatic fluid (white arrows).

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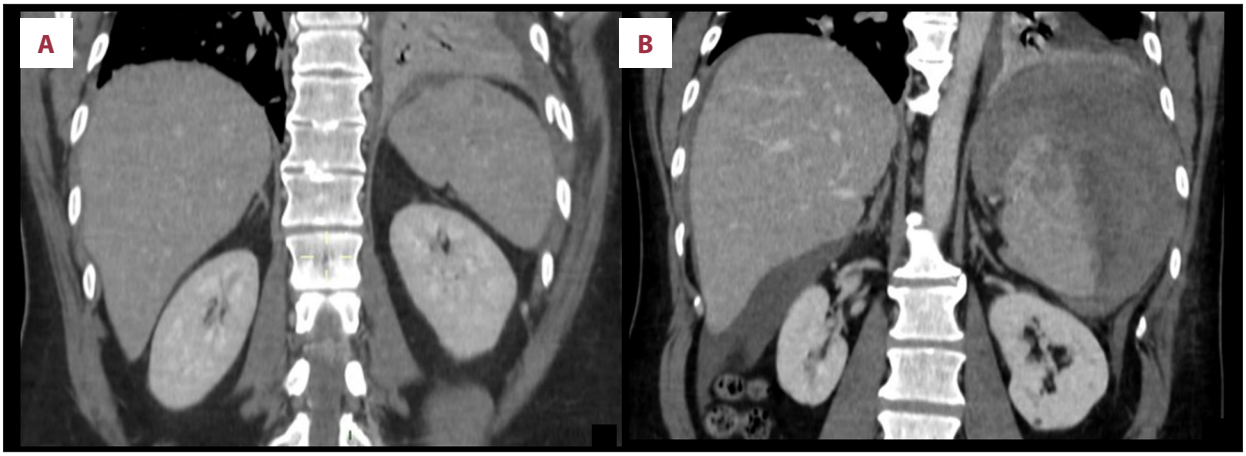

Figure 3. Coronal computed tomography scans reconstruction showing normal spleen at admission (**A**) and spleen surrounded (**B**) by a large hematoma on fifth day after admission.

The patient was taken to the OR by an experienced surgeon. Laparotomy showed abundant hemoperitoneum, splenic rupture, and hepatic laceration involving VII-VI segments. No other injuries to abdominal organs were found. Splenectomy and hepatic hemostasis, also using human gelatin-thrombin matrix and oxidized and regenerated cellulose, were performed. The surgeon placed 2 abdominal drains: one on the right side under the liver and one on the left side in the splenic lodge. After surgery, the patient was admitted in ICU for post-operative monitoring.

On day 3 after surgery, the patient developed septic shock, with hypotension requiring amine administration, fever and neutrophilic leukocytosis (WBC 14 000/µL). Physical examination did not show clear signs of an abdominal source of infection. However, the day after WBC dropped to 3000 µL and abdominal drainages drained fecal material.

The patient underwent relaparotomy that demonstrated a wall necrosis of right colon with fecal peritonitis, so right hemicolectomy with side-to-side isoperistaltic hand-sewn ileocolic anastomosis was performed. In the end, the surgeon decided for open abdomen. One re-exploration of the peritoneal cavity was performed on postoperative day 2: no fluid collections were found, and the bowel and anastomosis appeared in good conditions. Abundant peritoneal lavage was performed. The fascial edges were definitively closed 5 days after surgery. A tubular pelvic drain was placed.

Moreover, the patient underwent also a prosthetic replacement of the left femoral neck 15 days after the trauma. He was transferred from ICU to rehabilitation medicine ward where he underwent a rehabilitation program before being definitively discharged home 3 months after the trauma.

Discussion

Since the last years of the 1960s, when it was first proposed [4], NOM has gradually become a viable alternative to splenectomy or conservative surgery for hemodynamically stable splenic injuries in absence of other indications for laparotomy [2], because it preserves immune functions of the spleen and avoid the risks of surgery. It consists of monitoring patient's clinical evolution, with or without the aid of angiography and angioembolization. Many studies have demonstrated that NOM is safe, in particular, for low American Association for the Surgery of Trauma (AAST) grade splenic injuries [1,5]. However, literature reports the failure rate for NOM of approximate 10% [6], with significant morbidity and mortality compared with immediate surgical treatment. The incidence of failure increases with the severity of the splenic injury.

An accurate evaluation of splenic involvement after blunt trauma is an important requirement for correct selection of patient that can benefit from NOM. After primary evaluation, CT scan is considered the gold standard in the assessment of solid organ injuries after both blunt and penetrating abdominal trauma, with sensitivity and specificity in detecting splenic injuries that approximate 100% [2]. However, some studies have demonstrated that a CT scan could underestimate vascular involvement in splenic trauma and splenic injuries grade. Although the majority of these studies are older studies, the one by Carr et al. (2012) investigated the accuracy of modern multidetector CT scanners [7]. This study demonstrated the limits of CT scan in evaluating real splenic injury grade, in particular in a case of hilar involvement.

DSR is defined as the rupture of the spleen after 48 hours after the trauma, with a previous asymptomatic period. It is a rare but well-known complication of splenic trauma and it is one of the causes of failure of NOM. In most cases, this complication

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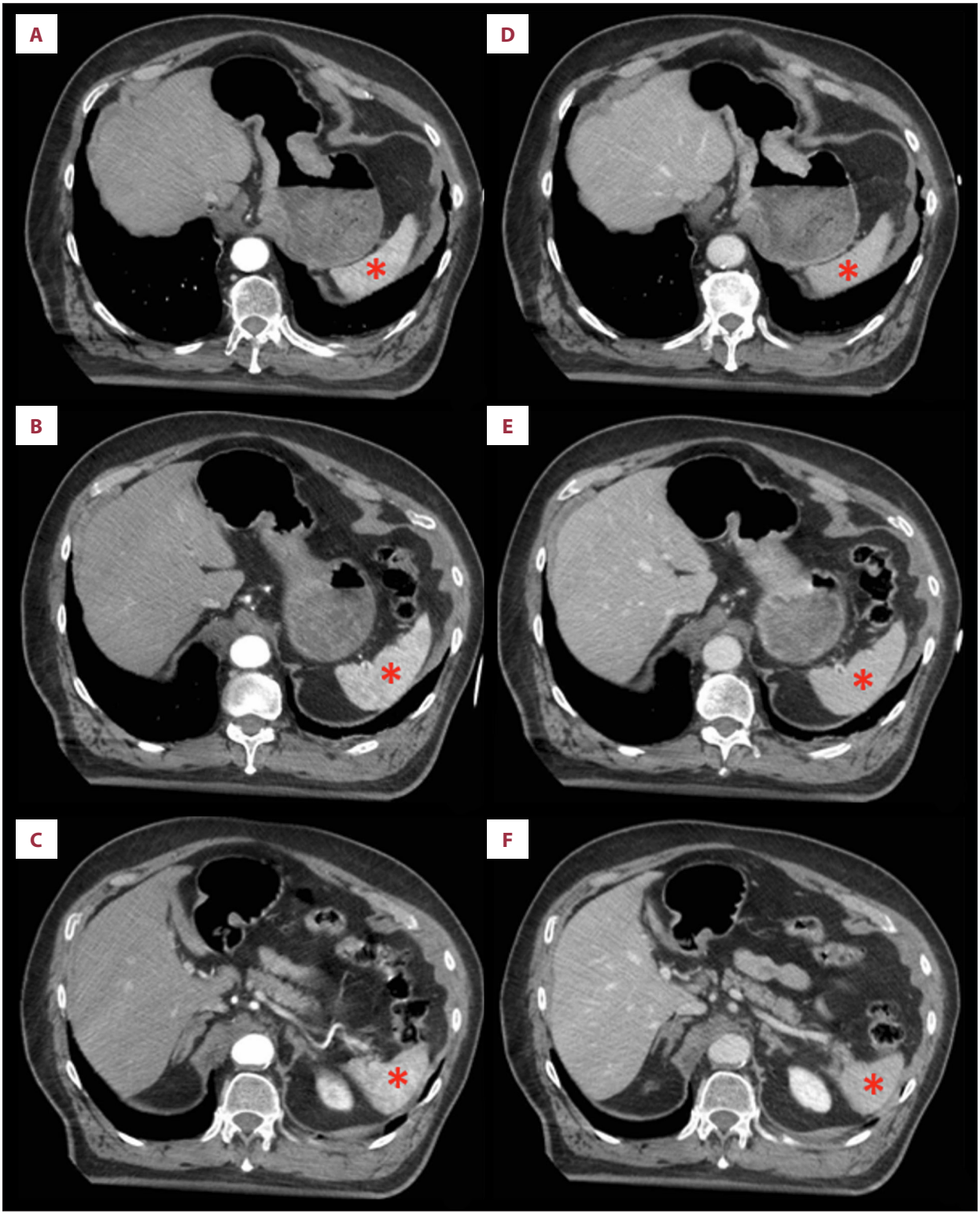

Figure 4. (**A–F**) Computed tomography at admission: spleen appears without injuries (red asterisks).

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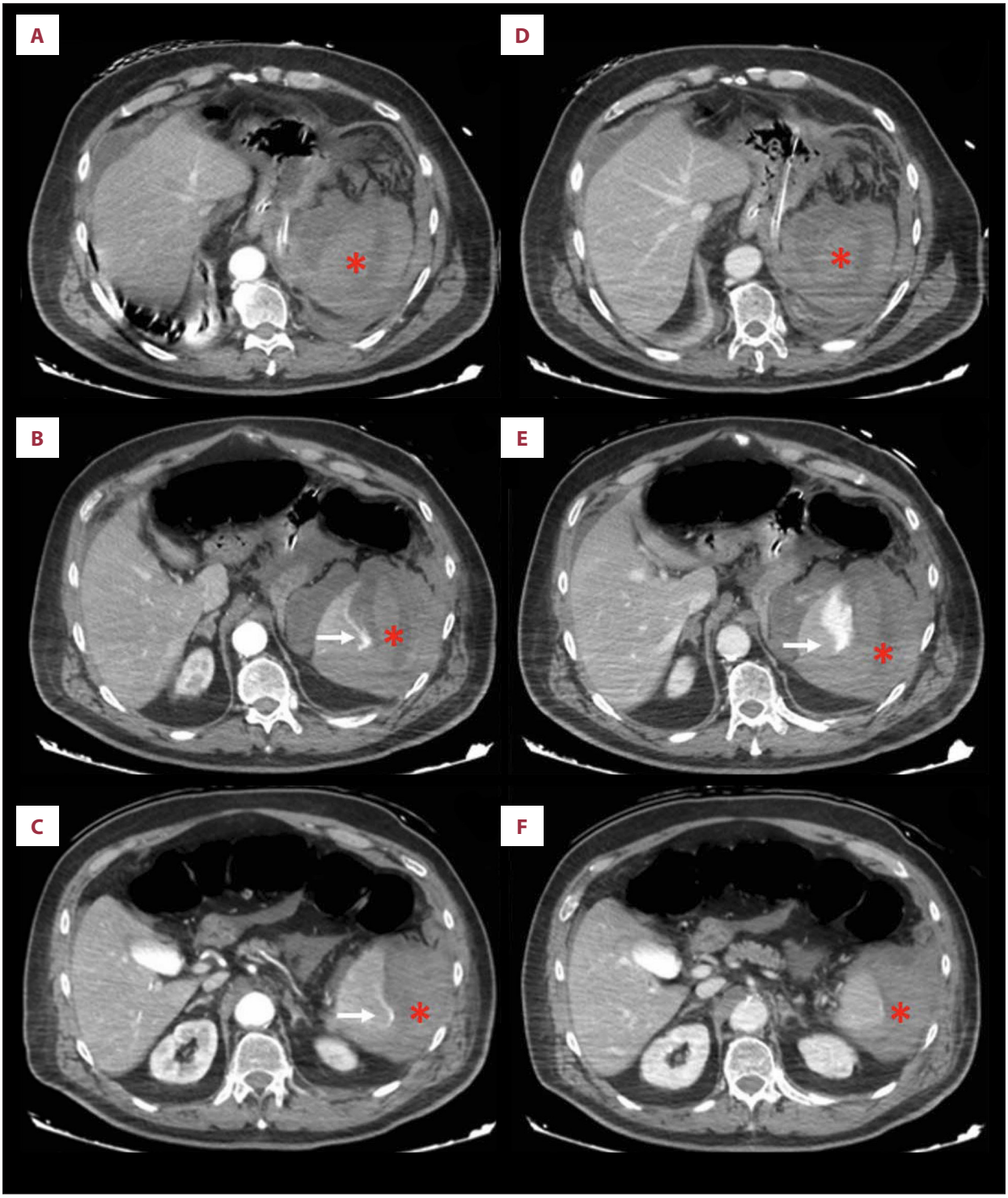

Figure 5. (**A–F**) Computed tomography demonstrated rupture of the spleen with a clot surrounding it (red asterisks) and a contrast blush (white arrows).

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occurs within a week from the trauma, but cases that occur months after the trauma have been reported [8,9]. In cases of delayed rupture, the mortality rate is relatively high if compared with the mortality rate for acute splenic rupture (5% to 15% versus 1%). However, the pathogenesis remains unclear. Nowadays, scientific evidence suggests that many factors are predictive of NOM failure, such as age, hemodynamic status, need for blood transfusion, grade of splenic injury or Injury Severity Score (ISS) [9,10], but none of these factors are strictly associated with DSR.

In the most cases of DSR, CT scans at admission can identify some splenic post-traumatic lesions that can be related to failure, like parenchymal pseudoaneurysms, subcapsular hematomas, and splenic pseudocysts [11]. However, some cases of DSR with normal appearing spleen at admission CT scans have been reported in the English literature, both before [12] and after [13] the introduction of multidetector CT scan.

Recently, the Western Trauma Association (WTA) reported the results of a multicentre retrospective series of delayed splenic bleeding after trauma, with inconsistent multidetector CT scan at admission [14]. The authors retrospectively screened 6867 patients with splenic injury, and they found 32 cases (0.4%) of delayed splenic rupture with normal CT scan at admission. They renamed this particular subgroup of delayed splenic rupture: "delayed splenic hemorrhage". In the WTA study, 2 expert radiologists in trauma imaging retrospectively reviewed admission CT scans of these patients and judged 23 cases out of 32 cases (72%) to be poor quality, while 9 cases out of 32 cases (28%) were judged as technically adequate. This highlights that a great part of delayed splenic hemorrhage can be explained by inadequate imaging at the admission. However, this explanation cannot be adduced for a relevant portion of these cases (28%), suggesting that other pathogenetic mechanisms can be involved in this occurrence. In addition, this study reported that 28 patients presented other left side injuries, such as left renal and adrenal injuries and left rib fractures as a sign of high-energy impact, and that the latter can produce artifacts on CT scan, leading to undiagnosed splenic injury.

Ribs fractures are known to be associated with high impact energy in trauma patients [15] and are traditionally considered a risk factor for associated abdominal solid organ injuries [16]. Reported frequency of rib fractures with associated abdominal organ injuries are about 10% to 15% [17]. In particular, left lower rib fractures are present in 40% of splenic injury after blunt trauma [10].

The 2 cases we report here highlight some lack in medical knowledge about a rare and not completely understood complication of NOM. The physicians involved in management of patients with a history of high energy trauma should be aware of the risk of delayed splenic hemorrhage, even if the admission CT scan did not show any splenic involvement. We suggest that delayed splenic hemorrhage can be related to left rib fractures and physicians should be aware of the possible occurrence of this complication.

Despite literature suggesting that the main part of these cases can be related to inadequate radiological investigations [14], we suppose some other mechanisms that can explain delayed splenic hemorrhage, in addition to poor quality of imaging proposed by Harmon et al. [14].

Other mechanisms include: 1) a direct action of the fracture edges on the splenic capsule and parenchyma, maybe after patient mobilization, which may produce delayed laceration. 2) A primary injury of the spleen too little to be detected at CT scan, where ribs fractures are an indirect sign of a high-energy trauma. 3) An "annoying" action played by left rib fractures during the CT images acquisition, which lead to undetected injuries.

There are not clear recommendations in the literature about timing and modalities for both short-term and long-term follow-up imaging for splenic traumatic injuries. CT scan offers excellent sensitivity and specificity but exposes a patient to a relevant dose of ionizing radiations and for this reason its use as diagnostic tool for routine follow-up is debated [17]. Ultrasonography techniques (US), and in particular contrast-enhanced ultrasonography (CEUS), has demonstrated good diagnostic accuracy in detecting solid organ injuries after blunt abdominal trauma and is considered a viable alternative in their monitoring [17,18]. On the other hand, performing routine follow-up US seems to be not recommendable for patients with inconspicuous CT scan at admission. A recent retrospective study analyzed the findings of routine simple US follow-up in this group of patients and found that US showed a little free abdominal fluid amount in only 0.9% of patients, and none of them required additional therapeutic procedures [19]. In this context, the identification of those elements that can stratify the risk for a patient to develop delayed splenic rupture appears of great importance.

Conclusions

The management of major trauma patients remains challenging because of the risk of sudden changing of clinical conditions. Rib fractures are the expression of high-energy trauma. Thus, the physicians involved in the treatment of patients with rib fractures should stay alert and consider the anamnestic information about trauma energy and dynamic. Therefore, patients with a history of complex thoracoabdominal trauma might benefit from close follow-up imaging with US, or CEUS where available, in order to detect any evolving solid organ

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injuries that can be missed at admission imaging. Despite the intrinsic limitations of case reports, the 2 cases we report on here might suggest that lower left rib fractures can serve as an "alarm bell" for delayed splenic rupture, also in patients without evidence of splenic injury at admission. However, the reason for this association remains unclear. We tried to provide some hypothesis and solutions and we hope that this paper can stimulate scientific debate and research in order to increase our knowledge about this topic.

In conclusion, the main take-home message of this paper is that trauma patients with a history of high energy impact and ribs fractures should be strictly monitored and followed up with close imaging.

Conflict of interest

None.

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