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## A rare case of splenic pseudoaneurysm in pediatric splenic blunt trauma patient: Review of diagnosis and management



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### ABSTRACT

**INTRODUCTION:** Splenic pseudoaneurysms (SPA) are a rare but serious sequela of blunt traumatic injury to the spleen. Management of adult blunt splenic trauma is well-studied, however, in children, the management is much less well-defined.

**PRESENTATION OF CASE:** A 15 year-old male presented with severe abdominal pain of acute onset after sustaining injury to his left side while playing football. FAST was positive for free fluid in the abdomen. Initial abdomen CT demonstrated a grade III/IV left splenic laceration with moderate to large hemoperitoneum with no active extravasation or injury to the splenic vessels noted. A follow-up CT angiography of the abdomen demonstrated a splenic hypervascular structure suspicious for a small pseudoaneurysm. Splenic arteriogram which demonstrated multiple pseudoaneurysms arising from the second order splenic artery branches which was angioembolized and treated.

**DISCUSSION & CONCLUSION:** Questions still remain regarding the timing of repeat imaging for diagnosis of SPA following non-operative blunt splenic trauma, which patients should be imaged, and how to manage SPA upon diagnosis. More clinical study and basic science research is warranted to study the disease process of SPA in pediatric patient. We believe that our proposed management algorithm timely detect formation of delayed SPA formation and addresses the possible fatal disease course of pediatric SPA.

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### 1. Introduction

Splenic pseudoaneurysms (SPA) are a serious sequela of blunt traumatic injury to the spleen. Causes of SPA also include pancreatitis, peptic ulcer disease, and iatrogenic causes. They are very rare with fewer than 200 cases reported in English literature in 2006 and their incidence is virtually unknown. SPA have a high risk of rupture and have been reported to be fatal if left untreated in adults [1]. In the setting of trauma, SPA can form 1 to 8 days after the blunt splenic injury and could be missed on the initial imaging [2].

Management of adult blunt splenic trauma is well-studied. However, the management in pediatric patients is poorly defined [3]. With regards to SPA, only eleven pediatric case reports are found in the English literature. Although the American Pediatric Surgical Association does not recommend routine follow-up imaging in pediatric trauma patients regardless of grade of injury,

several reviews have described the potential benefits of follow-up CT imaging for detection of pseudoaneurysm [2,4].

Here, we share our experience at an urban level 1 trauma center of managing a hemodynamically stable pediatric patient who sustained a grade III/IV splenic laceration following blunt trauma with follow-up imaging demonstrative of splenic pseudoaneurysm and proposed algorithm to manage such a case.

### 2. Presentation of case

A 15 year-old male with no significant past medical history presented to the emergency room complaining of severe abdominal pain of acute onset after sustaining injury to his left side while playing football. His vital signs were within normal limits on arrival to the emergency room with a GCS of 15. The patient's physical exam was significant for mild tenderness to palpation of his abdomen without peritonitis. Primary survey included a Focused assessment with sonography for trauma (FAST), which was positive for free fluid in the abdomen. He remained hemodynamically stable throughout his initial evaluation.

A CT abdomen/pelvis was obtained, demonstrating a grade III/IV left splenic laceration with moderate to large hemoperitoneum.

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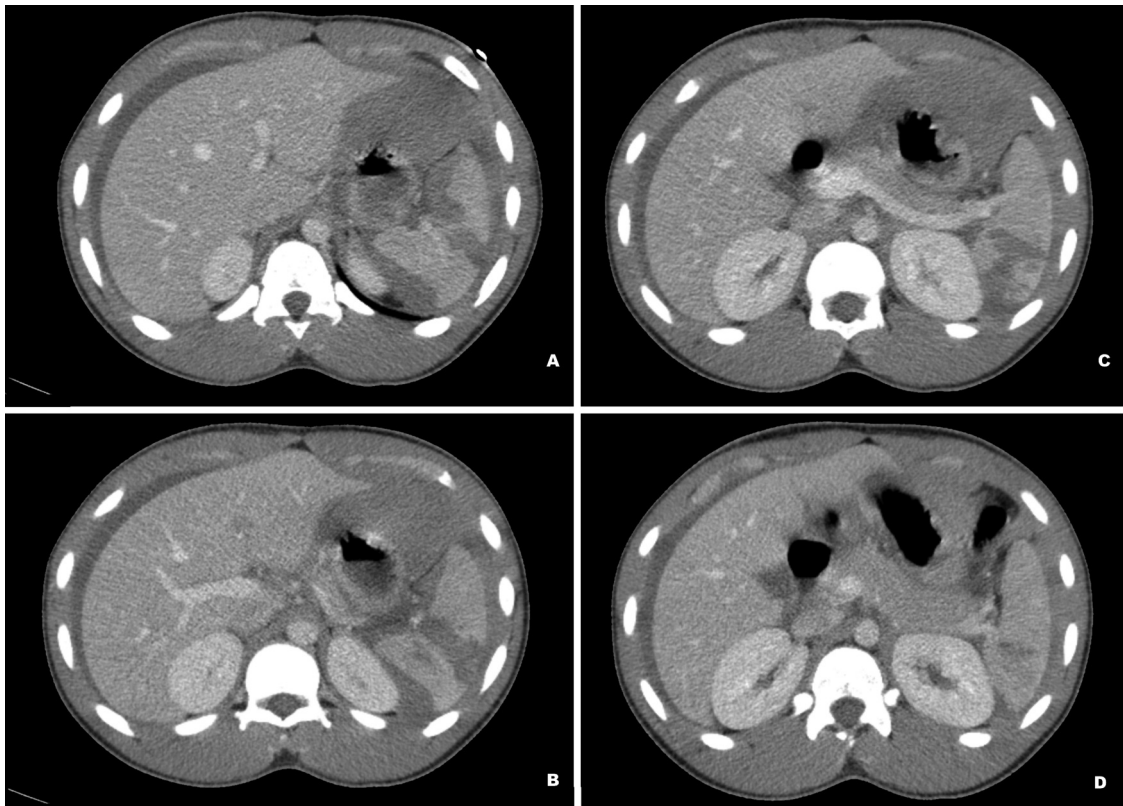


Fig. 1. Admission CT abdomen/pelvis with IV contrast demonstrating grade III/IV splenic laceration (A through D).

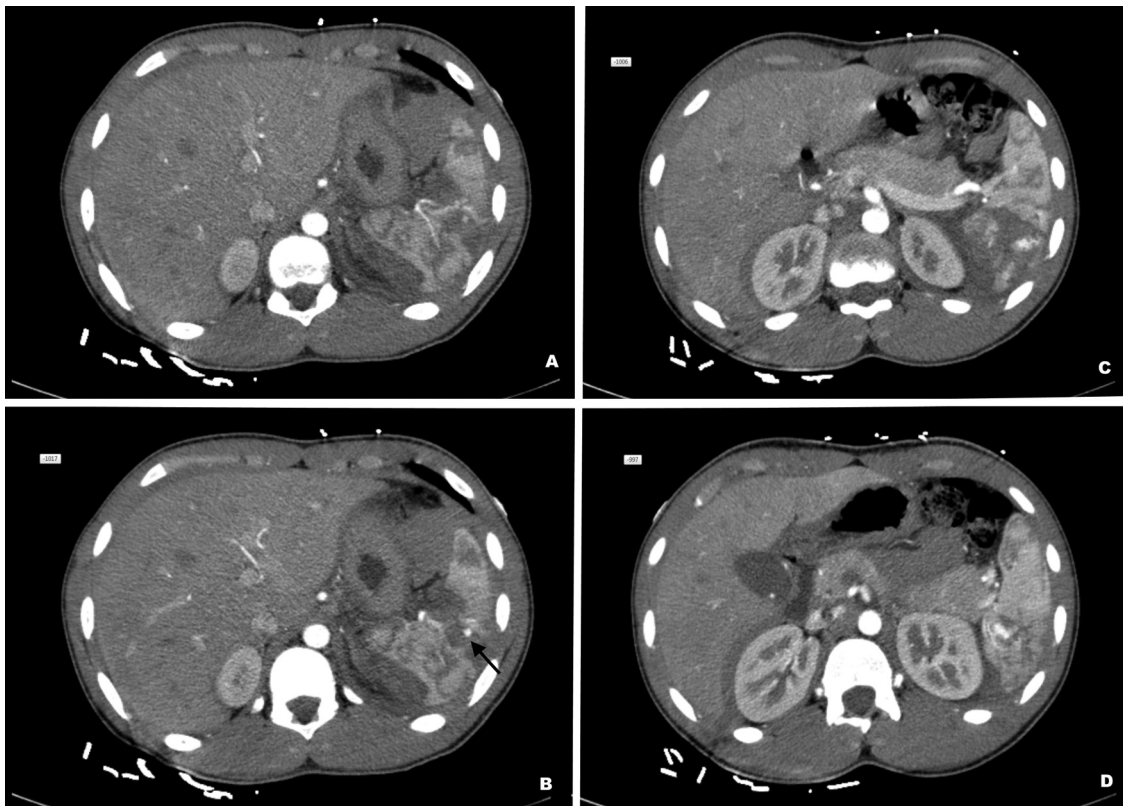


Fig. 2. Follow-up CTA abdomen/pelvis demonstrating (black arrow in B) 6 mm ovoid hypervascular structure within cleft of the splenic laceration suspicious for pseudoaneurysm (A through D).

No active extravasation or injury to the splenic vessels was noted (Fig. 1).

He was admitted to the surgical intensive care unit for further monitoring. Over the next 24 h serial labs were drawn with a hematocrit as follows: 34.5% > 33.2% > 30.1%. Serial abdominal exams and hemodynamic status remained stable throughout his admission. On hospital-day 3, a follow-up CTA abdomen/pelvis was obtained which demonstrated an approximately 6 mm ovoid hypervascular structure within the cleft of the splenic laceration suspicious for a small pseudoaneurysm (Fig. 2).

Interventional radiology was consulted and on hospital-day 5; they performed a splenic arteriogram which demonstrated multiple pseudoaneurysms arising from the second order splenic artery branches. Proximal coil embolization with 10 mm × 20 cm Boston Scientific interlock coil was performed without complications. A follow-up arteriogram demonstrated decreased flow (Fig. 3). He was observed for another 24 h post-procedure without event and was discharged the next day after receiving the pneumococcal and meningococcal vaccines. The patient was seen for follow up in our trauma clinic 5 days post-discharge without complaints.

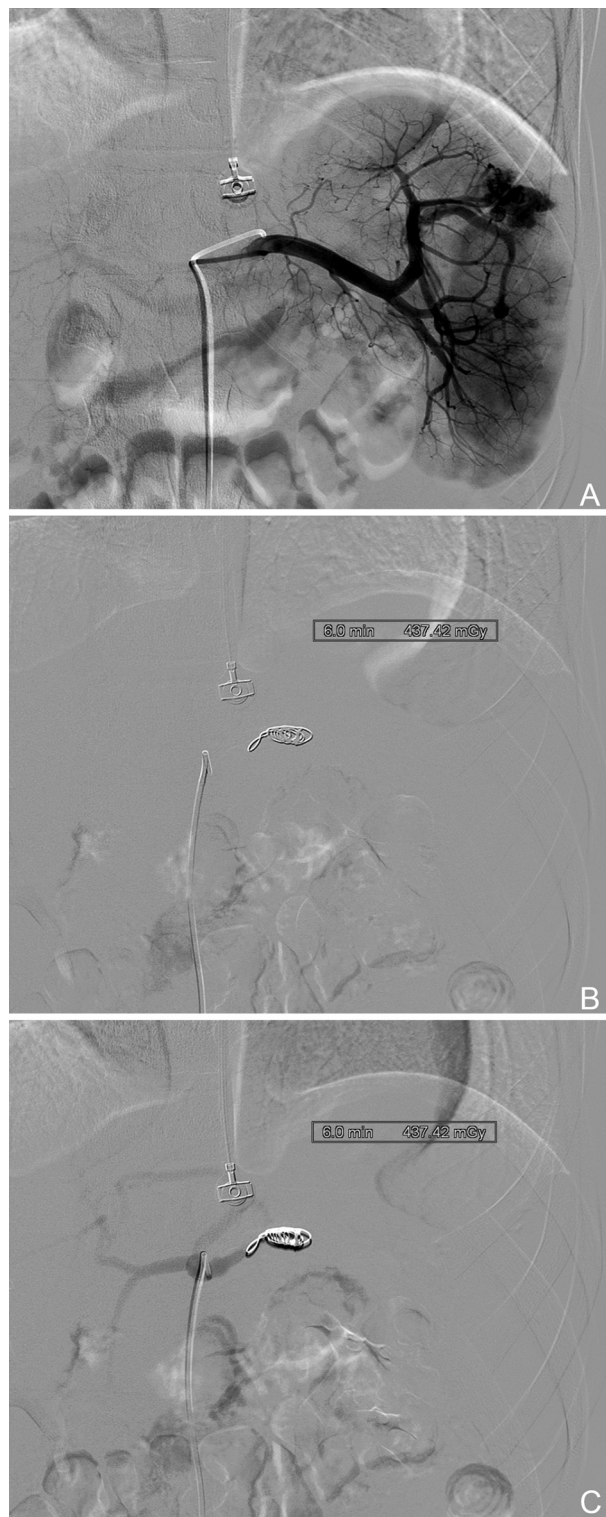
### 3. Discussion

Splenic artery pseudoaneurysms (SPA) remain a rare but potentially fatal pathology following blunt trauma which is managed non-operatively. Delayed splenic rupture is observed in approximately 6% of cases of adult splenic trauma. Most of these cases are caused by traumatic SPA [5]. Studies have demonstrated the benefits of repeated follow-up imaging and early intervention upon diagnosis of SPA [3]. Management of SPA can be operative entailing splenectomy with or without pancreatectomy or non-operative, using endovascular techniques. In recent studies, utilization of angioembolization has been demonstrated to decrease non-operative management failure rate in adults with blunt splenic injuries. However in children, there are no strong evidence-based guidelines that exist to help guide management of SPA.

Pediatric splenic trauma may be more suitable for non-operative management than that of adult because the differences in pathophysiology of the injury. The pediatric spleen has a fibrous capsule that is thicker than that of an adult, and lacerations in pediatric patients tend to occur in avascular planes. Furthermore, children have a superior ability to heal and regenerate than adults. Finally, risk of sepsis is significantly higher in children than adults after splenectomy [3].

One major controversy in management of pediatric blunt trauma patient is the utilization of predischarge or postdischarge follow-up imaging, usually 3–7 days after initial presentation [6–8]. The recommendation from the American Pediatric Surgical Association Trauma Committee against this practice is based on the fact that less than half of pediatric patient received follow-up imaging without reported complications. Due to small cases presented in literature, there is a lack of strong level I evidence to support the recommendation [9]. Safavi et al. showed in a retrospective study that follow-up Doppler Ultrasound found SPA in 7.7% of grade III splenic injuries and 17% of grade IV. Follow-up imaging found no SPA in grade I and grade II injuries. The 10 patients with SPA were observed for minimum of 5 days after diagnosis. One patient (10%) became unstable and underwent emergency splenectomy for delayed rupture [4]. The study showed that follow-up imaging may be useful in identifying SPA in grade III and IV splenic injury. However, the study is limited by the size of the sample population.

In 2008, Mayglothling et al. [9] described their experience of managing 97 adolescent patients with blunt splenic injury. In the study, Mayglothling presented their algorithm with aggressive



**Fig. 3.** Splenic artery angiography before coil embolization (A) demonstrating multiple pseudoaneurysms and after embolization (B,C) demonstrating stasis of flow.

angiography and embolization as a useful adjunct to non-operative management of adolescents with blunt splenic injuries. The trauma center performed splenic artery angiography screening for patients with grade III, IV or V splenic injury, contrast blush or pseudoaneurysm on CT. The authors also favored follow-up imaging 48–96 h post-injury in their treatment algorithm.

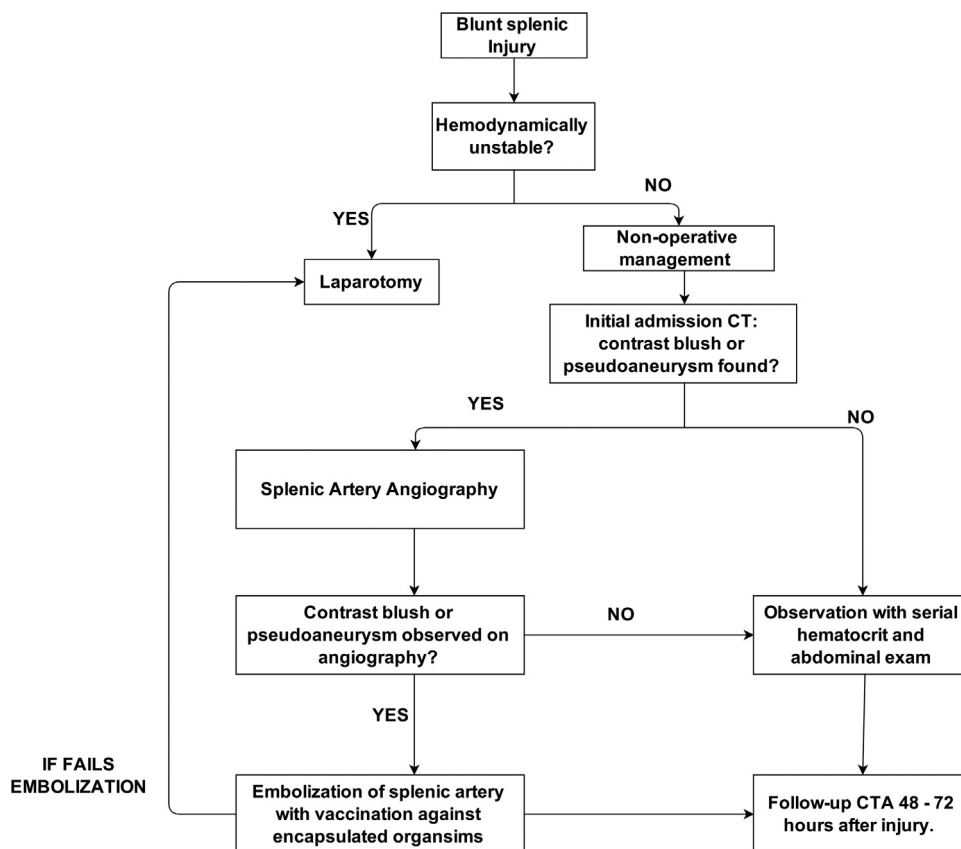


Fig. 4. Proposed treatment protocol for pediatric blunt splenic injury.

When compared to the direct catheter angiography, our patient’s follow-up CT angiography of the abdomen demonstrated an underestimation of the size and severity of the pseudoaneurysms. The difference in severity may possibly be the result of delayed formation of pseudoaneurysms. Also, DSA may be better at showing the smaller pseudoaneurysms that cannot be visualized on the CT scan.

Direct catheter angiography of the splenic artery has been assumed to be the gold standard to diagnose splenic artery pseudoaneurysm. With the advancing technology of interventional radiology, advanced blood vessel fluoroscopy techniques such as digital subtraction angiography (DSA) can provide high spatial resolution that allows the imaging of small vessels [1]. Also, treatment can be concomitantly performed during the same session. The procedure however, is invasive may cause associated complications. The use of Doppler sonography has also been described in the diagnosis of splenic aneurysms [10]. However, this mode of imaging may be limited by its operators and its low spatial resolution. The use of magnetic resonance imaging (MRI) has been reported [11].

Multiple detector computer tomography (MDCT) technology is the most utilized tool in critical care. CT can obtain high resolution images of the whole body in a short amount of time when compared to DSA and to MRI. Studies have shown that MDCT is favorably comparable to catheter angiography in detecting stenosis and small blood vessels [12,13]. CTA has also been shown to be safe and effective alternative to DSA for making decisions in cerebral aneurysm management [14].

Studies have shown that radiation from a single CT scan carries increased cancer risk. However, the magnitude of the risk is still unknown [15]. In 2000, Brenner et al. [16] of Columbia University have estimated that the lifetime risk of fatal malignancy from both abdominal and head CT examination is roughly 500 out of 600,000.

Although the risk is present, benefit of CT scan may outweigh the small increase in cancer risk in acute situations. Given that many of above sample populations received CT scans over a decade ago, the advancement of CT technology may have significantly decreased the radiation burden to children.

Our proposed protocol is based on more conservative approach than Mayglothling et al. (Fig. 4). Even though there may be an association between incidence of SPA and high grade splenic lacerations (i.e., grade III and IV splenic laceration), there is no strong clinical evidence to show benefits of aggressive angiography of these patients. We concur with Safavi et al. in the necessity of follow-up imaging before planned discharge because there is a potential risk of delayed splenic rupture in this population. The natural course of SPA in children needs to be further studied and defined.

4. Conclusion

The limited existing literature leaves us with a still unclear algorithm for the management of non-operative blunt splenic trauma in pediatric patients. Questions still remain regarding the timing of repeat imaging for diagnosis of SPA following non-operative blunt splenic trauma, which patients should be imaged, and how to manage SPA upon diagnosis. More clinical study and basic science research is warranted to study the disease process of SPA in pediatric patient. We believe that our proposed management algorithm timely detect formation of delayed SPA formation and addresses the possible fatal disease course of pediatric SPA.

Conflict of interest

The authors declare that they have no competing interests.

## Consent

Written informed consent was obtained from patient who participated in this case.

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## Ethical approval

N/A.

## Author contribution

Roger Chen Zhu – review of literature, preparation of case report, and writing of the paper.

Vadim Kurbatov – review of the paper.

Patricia Leung – review of paper and contribution toward the management of patient.

Gainosuke Sugiyama – reievw of Paper.

Valery Roudnitsky – contribution toward management and follow-up of the patient.

## Research registry number

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## Guarantor

Roger C. Zhu and Valery Roudnitsky, M.D.

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