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Manual on-the-fly physician postprocessing of computed tomographic angiography data guides embolotherapy of atypical bleeding following paracentesis; a case report☆

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ABSTRACT

Major bleeding, typically due to laceration of abdominal wall arteries or venous varices, is a rare but serious complication of paracentesis. We report a case of major bleeding post paracentesis to evidence that a sequence of 1) customized post processing of computed tomographic angiography data for periprocedural guidance, followed by 2) transcatheter cyanoacrylate glue embolotherapy, is the optimal treatment of this complication.

1. Introduction

Major bleeding, typically due to laceration of abdominal wall arteries or venous varices, is an uncommon but serious complication of paracentesis [1,2]. Transcatheter embolotherapy is reported to be superior to surgical management for this complication [2]. However, neither produces optimal outcomes; mortality rates of 25% and 75% respectively have been reported in a recent meta-analysis [3]. The comorbidities prevalent in the population requiring paracentesis likely contribute to these outcomes. However delayed diagnosis, or poor characterization of the source of bleeding, may also be contributing factors. Case series to date of iatrogenic abdominal wall hemorrhage report CTA sensitivity for identification of the bleeding vessel of only 17 to 70% [3,4]. Other cases series report CTA sensitivity as high as 83%, but do not distinguish determination of bleeding source for the more general diagnosis of bleeding [5]. However, at most institutions, CTA exams are not postprocessed manually on-the-fly by diagnostic radiologists without reliance on computer algorithms or technologists.

We opine that with rapid expert CTA postprocessing, most bleeding vessels can be readily identified, significantly abbreviating intra-procedural identification of source of bleeding and significantly decreasing procedural time and effort. At our institution, all CTA examinations performed for the indication of bleeding are postprocessed by diagnostic radiologists. We create customized axial images while reviewing initial reconstructions at the scanner console. During post-processing we perform a full gamut of multiplanar reformatting, curved planar reformatting, and volume rendering with microvascular segmentation and pseudocolor multimasking. Output images are obtained on-the-fly for procedural planning and intraprocedural guidance.

Herein we report, to illustrate the benefit of our post-processing workflow, the successful management of a case of atypical catastrophic bleeding following a paracentesis.

2. Clinical history

A 71-year-old male with multiple comorbidities, including cirrhosis, coagulopathy, and refractory ascites requiring repeat paracentesis, was hospitalized for a urinary tract infection. At admission, the patient had an INR of 1.3 and a platelet count of 105,000/uL. In addition, the patient had been receiving daily subcutaneous Enoxaparin injections for deep venous thrombosis prophylaxis. To address the patient's discomfort with accumulating ascites, the clinical team elected to perform a bed side paracentesis. Although preprocedural ultrasound was used by the clinical team to mark a puncture site, real time duplex ultrasound guidance was not utilized for the procedure.

Three hours after the procedure, the patient's blood pressure

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decreased from a baseline of 126/72 mm Hg to 69/51 mm Hg, prompting his transfer to the Intensive Care Unit. A repeat hemoglobin at that time was 6.1 g/dL, a drop from 9.3 g/dL the morning of the procedure. The patient required intravenous fluid resuscitation and transfusion of blood products. Due to continued hemodynamic instability, the Interventional Radiology Service was consulted, and an emergent CTA was performed.

3. Computed tomographic angiography and post processing

A standard protocol CTA was performed with a Somatom Force Scanner (Siemens Medical Solutions, Forchheim, Germany). Non-contrast, arterial, and venous phase (90 second delay) phase scans were performed. 100 mL of Iohexol 350 mgI/mL contrast media (Omnipaque, GE Healthcare, Piscataway, New Jersey, U.S.A.) was injected at 4 mL/s followed by a 50 mL saline flush at the same rate. The total dose length product for the exam was 1300 mGy∗cm (20 mSv).

Full and focused field of view reconstructions of the areas of interest, using various slice thicknesses and intervals, were created with optimized kernels and iterative settings (see figure legends). Initial review of axial and multiplanar reformatted images demonstrated hemoperitoneum and acute arterial extravasation underlying the paracentesis puncture site in the right lower quadrant of the abdomen (Fig. 1).

The axial images were postprocessed on an advanced visualization application (Aquarius Intuition, Version 4.4.12 TeraRecon, Foster City, California, USA). Custom curved planar reformats and segmented multimasked pseudocolor volume renderings, focused on the pertinent vessels, were created expediently by the diagnostic radiologist while the patient, who continued to receive active hemodynamic resuscitation, was transferred to the interventional suite. The postprocessed images, ready for display prior to the procedure start time, demonstrated that the bleeding arose from a pseudoaneurysm supplied by a branch of the right T-11 posterior intercostal artery in detail (Fig. 2, Cine 1). The total time devoted to postprocessing was approximately 15 min.

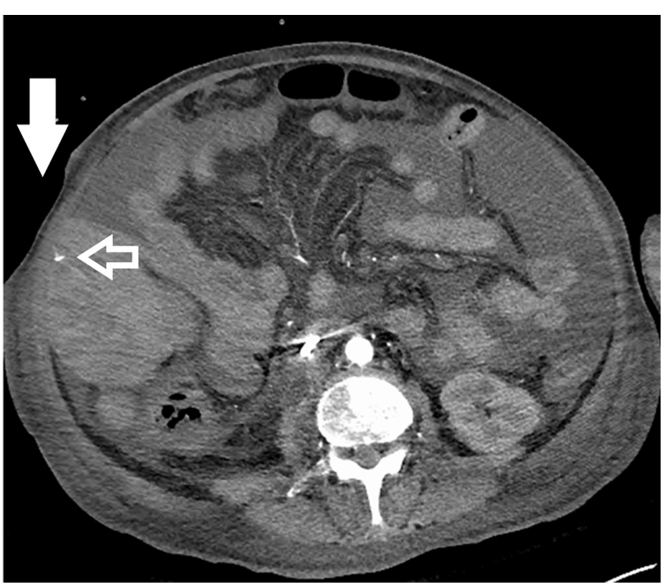

Fig. 1. Axial CTA image demonstrates acute arterial bleeding. Both active contrast extravasation (hollow arrow) and hemoperitoneum are evident. The access site of a recent paracentesis can be identified from an indentation of the skin caused by an overlying pressure dressing (solid arrow).

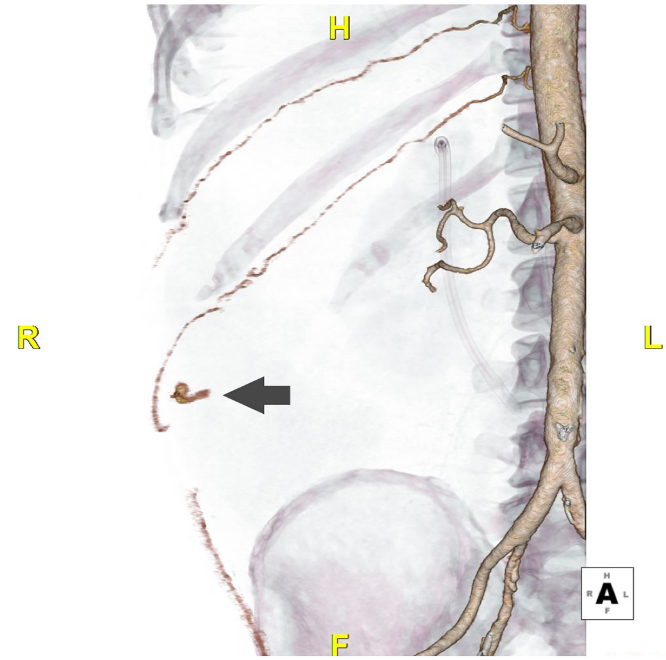

Fig. 2. Pseudocolored multimasked volume rendering illustrating the proximity of the anterior terminus of the right T-11 intercostal artery to a pseudoaneurysm (black arrow).

4. Transcatheter embolotherapy

In light of the post processed CTA images a flush aortogram was deemed redundant and omitted. Selective angiography of the right T-11 intercostal artery demonstrated a pseudoaneurysm in the right inferior abdominal wall with active extravasation (Fig. 3, Cine 2). The concordance of the findings on the CTA and catheter angiography was exact. As the abdominal wall has a rich collateral network of arteries, a selective angiogram of the right T-12 subcostal artery was also performed. While the second selective angiogram demonstrated the multiple small arterial anastomoses among the branches of the right T-11 intercostal, T-12 subcostal, inferior epigastric, and deep circumflex iliac arteries (Fig. 4, Cine 3), it did not show a major retrograde contribution of flow to the pseudoaneurysm. This confirmed that flow to the pseudoaneurysm was primarily via the right T-11 intercostal artery, as predicted by the CTA.

A coaxial microcatheter was used to embolize the posterior branch of the right T-11 intercostal artery with 1 part n-butyl Cyanoacrylate glue diluted in 4 part Lipiodol (Trufill, Codman & Shurtleff, Inc. Raynham, MA, USA). Glue was injected until it filled the target artery, the pseudoaneurysm, and spilled over into the adjacent collateral branches (Fig. 5, Cine 4). A post embolization angiogram of the right T-11 intercostal demonstrated cessation of extravasation. Selective angiography of the right deep circumflex iliac artery was performed confirming cessation of flow from collaterals (Fig. 6, Cine 5). The total procedure time from the arterial access to sheath removal was 54 min. The fluoroscopy time was 18.1 min with an estimated radiation dose of 7.5×10^4 uGy∗m^2. A total of 66 mL Iodixanol 320 (Visipaque, GE Healthcare, Piscataway, New Jersey, USA) was used.

Over the ensuing hours the patient improved hemodynamically, and his hemoglobin stabilized at 10.3 g/dL the next morning.

5. Discussion

Paracentesis is a safe and commonplace diagnostic and therapeutic procedure. Cirrhosis is the underlying etiology in 90% of the patients. Reports of major complications are rare, < 1% overall, a figure

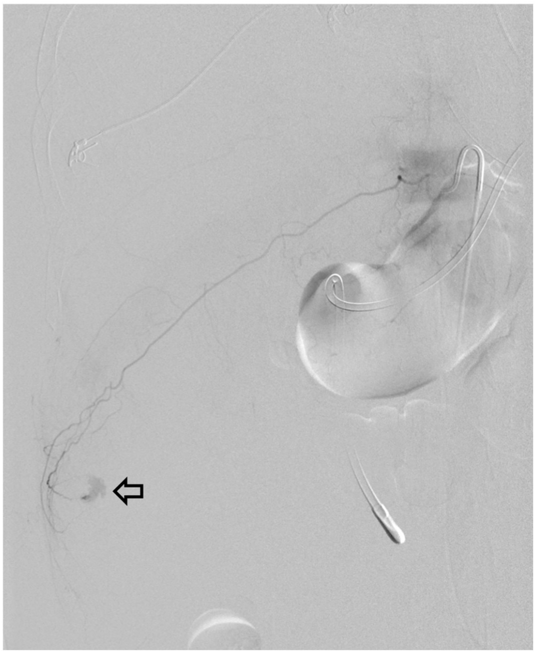

Fig. 3. Selective angiogram of right T-11 intercostal artery shows active contrast extravasation (black arrow) from a pseudoaneurysm subserved by branches of the right T-11 intercostal artery.

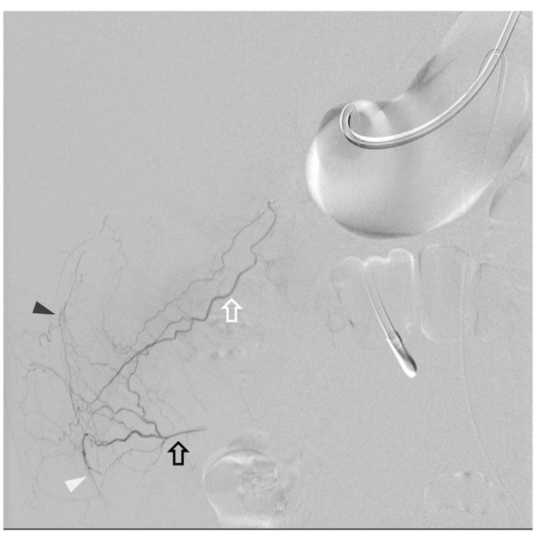

Fig. 4. Selective angiogram of the right T-12 (subcostal) artery (white arrow) shows anastomotic connections to branches of T-11 intercostal artery and the deep circumflex iliac artery (black arrow).

inclusive of infection, bleeding, and intestinal perforation. Hemoperitoneum, abdominal wall hematoma, and pseudoaneurysm are the complications most associated with mortality. Hemodynamically significant hemorrhage can manifest from minutes to up to one week following paracentesis [2]. Procedure associated vessel injury can present immediately as a “bloody tap” [2].

The source of hemorrhage post paracentesis can be an artery, an abdominal varix, or remain unidentified. In most cases the inferior epigastric artery is determined to be the source [2]. However, as our case demonstrates, diagnostic and interventional radiologists should have an understanding of the complex arterial anatomy of the abdominal wall. Other vessels, such as the deep circumflex iliac, intercostal and subcostal arteries, may on occasion be a primary or secondary source of bleeding [4].

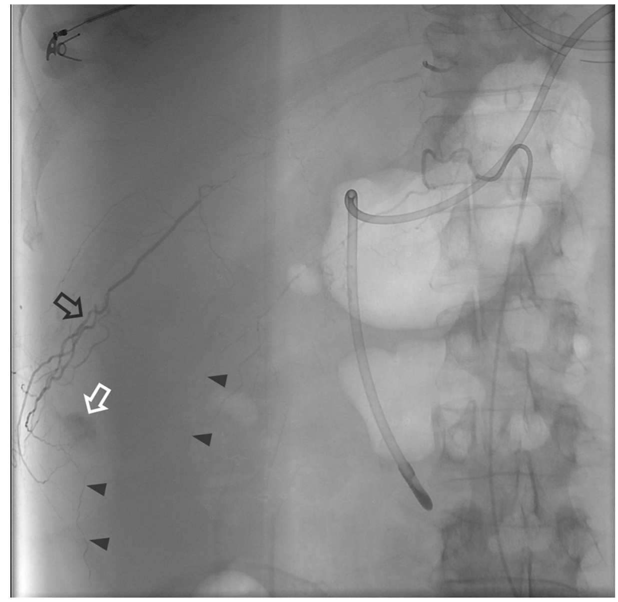

Fig. 5. Selective angiogram of right T-12 subcostal artery following embolization of T-11 intercostal artery. There is no evidence of continued bleeding. Stagnant embolic media can be seen difusely throughout the site of prior hemorrhage (white arrow), throughout the distal branches of the right T-11 intercostal artery (black arrow) and faintly within the surrounding small collateral arterial branches of the T-12 intercostal and the deep circumflex femoral arteries (black arrowheads).

With its fine spatial resolution, speed of acquisition, and multiphase, multiplanar and 4-dimensional image reconstruction capabilities, CTA has an ever-increasing role in the diagnosis of hemorrhage. CTA with expert postprocessing can consistently and precisely determine the source of bleeding, charting a map to the target vessel for the interventional radiologist while removing distracting extraneous information. With this map in mind, the interventional radiologist can navigate a catheter confidently to the target for confirmatory angiography and treatment, skipping intermediary steps, saving time and resources while improving patient outcomes.

It is important for radiologists, diagnostic and/or interventional, depending on the local division of labor, to be adept at advanced postprocessing of CTA, as this must be done expeditiously and in close collaboration during high urgency clinical scenarios. At our institution, the interventional service has 24/7 access to diagnostic radiologists for expert CTA postprocessing and information exchange, and we believe this to be the appropriate model at this time.

Real time Duplex ultrasound, given its resolution, multiplanar capability, ubiquitous availability, and portability to point of care, should be used throughout the critical portions of such invasive bedside procedures, irrespective of an operator's medical specialty. Simply “marking” for paracentesis should no longer be considered a standard of care. In this case, utilization of real time duplex ultrasound throughout the duration of the procedure may have avoided the complication of catastrophic hemorrhage.

6. Conclusion

Clinically significant bleeding following paracentesis is a rare but dire complication. In the opinion of the authors, the best sequence of therapy for this scenario is to first obtain a CTA with expert on-the-fly postprocessing to chart a detailed course to the culprit vessel for targeted embolotherapy. We believe that our workflow can optimize time and resource utilization and improve patient safety and outcomes (Fig. 7).

We encourage the routine use of real time duplex ultrasound for

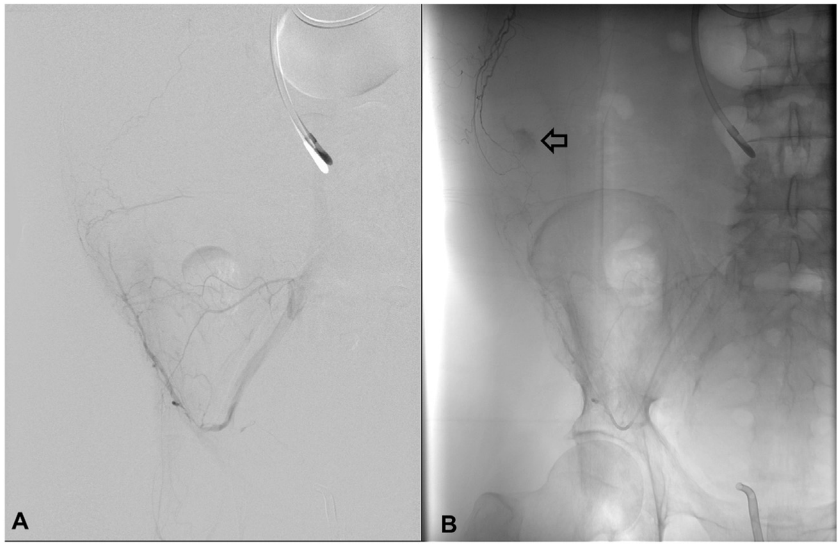

Fig. 6. (A) Selective angiogram of right deep circumflex iliac artery following embolization of T-11 intercostal artery. There is no evidence of continued bleeding. (B) Note that the dense embolic media within the branches of T-11 (black arrow) is hidden by the digital substraction process in this image.

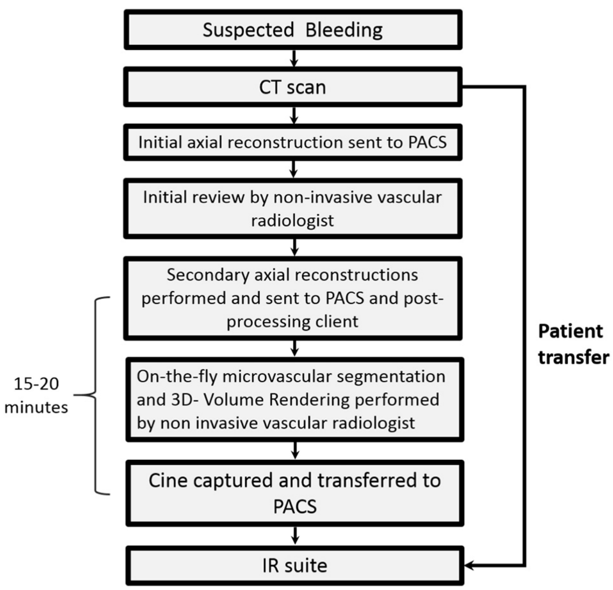

Fig. 7. CTA scan and on-the-fly tailored post-processing workflow for emergent procedural planning.

procedural guidance to avoid iatrogenic injury for all bedside procedures.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clinimag.2019.03.006.

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