Feasibility of sonographic localization of the inferior epigastric artery before ultrasound-guided paracentesis

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ABSTRACT

Background: Ultrasound-guided paracentesis is commonly performed in the emergency department (ED) setting. Injury to the inferior epigastric artery (IEA) is an uncommon but potentially life-threatening complication of paracentesis. Use of anatomic landmarks has been recommended to avoid this structure. If feasible, sonographic localization of the IEA before ultrasound-guided paracentesis may provide the operator with anatomic mapping of this vascular structure.

Case reports: We present 5 cases demonstrating the feasibility of identifying the IEA in ED patients with ascites. Why should an emergency physician be aware of this? Sonographic localization of the IEA before ultrasound-guided paracentesis may provide a more reliable means of avoiding iatrogenic injury to this vessel. Further study is warranted to determine whether routine IEA visualization before paracentesis results in a decreased complication rate.

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1. Introduction

Needle aspiration of ascites fluid from the peritoneal cavity or paracentesis is routinely performed in the emergency department (ED) setting for both diagnostic and therapeutic purposes. Complications include infection and injury to anatomic structures such as solid organs and the inferior epigastric artery (IEA) [1-4]. This latter complication can have devastating consequences including hemorrhage, pseudoaneurysm formation, and death [5-7]. Prior investigation has shown that the use of ultrasound-guidance confers a greater success rate during paracentesis rather than a traditional landmark approach [8]. The use of sonography also reduces complications and may in turn decrease costs [9].

To date, no known studies or case descriptions exist for use of ultrasound to identify the IEA during paracentesis. Although a standard emergency medicine procedure textbook recommends use of ultrasound to identify ascites, no mention is made of sonography for IEA identification [10]. Rather, the recommendation is to use a traditional avoid-by-landmarks approach, staying lateral to the rectus sheath to avoid the IEA [10]. Some authorities recommend using ultrasound to identify fluid pockets amenable to paracentesis, with the goal of improving paracentesis success rates and minimizing complications; however, we are unaware of standard recommendations for identifying the IEA [8,9,11,12].

Two locations for performing needle insertion in paracentesis have been described, at the avascular midline lower abdomen and the lateral, lower quadrant [11]. The lateral lower quadrant is generally preferred, as it offers a thinner abdominal wall with less collateral vessels and a larger pool of ascites fluid. In addition, rising obesity has caused increases in midline wall thickness, which can decrease ease of use of the midline site for large volume paracentesis [11,13].

The IEA typically arises from the external iliac artery just superior to the inguinal ligament. The artery then courses superiorly and medially to enter the rectus sheath. Several studies have attempted to define the usual anatomic location of the IEA [14-16]. These studies, however, did not focus on patients with ascites who may have altered anatomy due to abdominal distension. We reviewed charts over a 13-month period from November 2011 to December 2012 to identify patients on whom we documented visualization of the IEA during paracentesis performed in the ED. In this retrospective case series, we describe 5 cases of ED patients with ascites in whom the use of ultrasound to identify the IEA was feasible. We also describe the sonographic technique for identifying this important structure. This study was approved by the medical center institutional review board (IRB) and was not part of any other study.

2. Case reports

2.1. Case 1

A 65-year-old man with a history of hepatitis C and alcoholic liver disease presented to the ED with abdominal pain and distension. He
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A 46-year-old man presented to the ED with complaints of abdominal pain, distention, and nonbloody diarrhea. He noted recent jaundice. Physical examination revealed a tense, distended, diffusely tender abdomen. Bedside ultrasound was positive for ascites. The left IEA was identified sonographically before performing ultrasound-guided paracentesis (Fig. 1). Five liters of ascites fluid were removed without complication. The patient reported symptomatic improvement and was admitted to the gastroenterology service for further care.

2.2. Case 2
A 62-year-old man with a history of alcoholic liver disease and bleeding gastric varices presented with abdominal pain and shortness of breath. Physical examination revealed a tense, grossly distended abdomen. Using bedside ultrasonography, the location of the right IEA was marked (Fig. 2). Large volume paracentesis was then performed in the ED with removal of 5 L of peritoneal fluid. There were no complications. The patient reported improved symptoms and was subsequently admitted.

2.3. Case 3
A 36-year-old man with a history of hepatitis B presented as a walk-in with complaints of fluid retention and swelling of the abdomen, scrotum, and bilateral lower extremities. He also noted occasional hematemesis, epistaxis, shortness of breath, and urinary retention. He noted hemorrhoids and was taking furosemide 20 mg daily. Examination revealed an afibrile male with abdominal protuberance, shifting dullness, a positive fluid wave, and anasarca. Diagnostic and therapeutic ultrasound-guided paracentesis was performed. The left IEA was identified in the lower quadrant, and needle insertion was performed lateral to that site. Two liters of cloudy yellow fluid was removed, and fluid analysis was negative for spontaneous bacterial peritonitis. He was discharged with increased doses of diuretics after a 2-day admission (Video 1).

2.4. Case 4
A 57-year-old man with a history including hepatitis C, cirrhosis, and hepatic encephalopathy was transferred to the ED for evaluation of liver failure and altered mental status. He had undergone a therapeutic paracentesis 4 days prior. Jaundice, bibasilar crackles, abdominal fluid wave, right upper quadrant tenderness, and asterixis were noted on examination. Bedside ultrasonography was used to identify the IEA and mark an optimal site for paracentesis, which was conducted without complication. He required 2 additional therapeutic paracenteses during a 2-week admission and was treated for spontaneous bacterial peritonitis and hepatic encephalopathy.

2.5. Case 5
A 40-year-old woman with a history of cirrhosis, hepatitis C, alcohol dependence, and transjugular intrahepatic portosystemic shunt was transferred to the ED from an outlying hospital for abdominal pain, vomiting, and worsening transaminitis. Of note, paracentesis had been performed 4 times in the 6 weeks before presentation, most recently a large volume (5 L) of paracentesis just before transfer. On evaluation, she was afibrile and tachycardic with a distended, tight, diffusely tender abdomen. The IEA was identified. Right lower quadrant diagnostic and therapeutic paracentesis were performed, obtaining 2 L of fluid. The patient was subsequently admitted to the gastroenterology service. She improved to discharge with lactulose, a short antibiotic regimen, and diuresis.

3. Sonographic technique for identifying the IEAs
In each of the cases described, a Sonosite M Turbo with a 6- to 13-MHz 25-mm linear array transducer was used. All procedures were done with static ultrasound guidance by junior-level resident physicians under the supervision of a single ED attending physician with more than 10 years of experience in the use of ultrasound. The attending also has experience as an emergency ultrasound fellowship director. In all cases, the IEA was identified. There were no complications from the procedure in any case.

3.1. Technique
The IEA is identified along its course in the lower abdomen by scanning with a high-frequency transducer, beginning at the mid-inguinal ligament and proceeding superomedially toward the umbilicus. Commonly, the IEA may be seen as a round, pulsatile, hypoechoic structure flanked by 2 inferior epigastric veins (see Fig. 1). In patients with a particularly large amount of ascites, a more lateral starting point may be required. If the IEA is not visualized just above the inguinal ligament or if this area is difficult to access due to the patient’s body habitus, an alternate approach may be used. First, place the transducer in a transverse...
plane in the anterior axillary line over the patient’s pannus or distended abdomen. Next, slowly slide the transducer medially, maintaining a transverse plane. If the IEA is not visualized initially, repeat this lateral-to-medial approach from a more cephalad starting position. Applying increasing amounts of pressure may allow improved visualization of the artery and the peritoneal-ascites interface but may also compress the flanking veins. Of note, other small vessels may also be seen during these maneuvers. These structures may be collateral or branch vessels, and, if seen, their positions should also be noted and avoided during paracentesis.

4. Discussion

Use of ultrasound to identify the IEA in ED patients with ascites before paracentesis has not been described previously. We present a series of cases that show feasibility of use of ultrasound for this purpose. Ultrasound guidance and visualization of anatomy are more frequently being incorporated as standard of care for procedures. Although ultrasonography has long been recommended to avoid injury of anatomic structures, visualization of the IEA has not been routinely discussed [12]. Tirado et al noted that the IEA may be identified and avoided during paracentesis in their review of ultrasound-guided procedures in the ED [17]. Our study expands on this concept by describing the feasibility of IEA identification in the context of actual ED patients with ascites.

Abdominal wall vessel anatomy may be more variable in patients with ascites, causing these vessels to lie outside the boundaries of recommended anatomic landmarks. Murthy et al [6] suggested that, in patients with ascites, the IEA is displaced laterally due to abdominal wall distension and stretching and is therefore more likely to be injured during paracentesis. Several investigators have attempted to define the anatomic location of the IEA [14-16]. One study used Doppler ultrasonography to approximate the ideal location of the IEAs among a random sample of patients in an attempt to define optimal sites for laparoscopic port placement to minimize risk of vascular injury. At the levels of the umbilicus and the anterior superior iliac spine, they found that the IEA did not lie in excess of 6 cm from midline on either side, with a median distance less than 5 cm [14].

Additional studies have been performed with computed tomographic scan and cadaveric dissection. One study using abdominal and pelvic computed tomographic scan to map the epigastric vessels for laparoscopic “safety zones” described the mean distance from the midline to the epigastric vessels as 5.88 cm at the level of the umbilicus, 5.32 cm midway between the umbilicus and pubic symphysis, and 7.47 cm at the level of the pubic symphysis. Although this study excluded conditions such as ascites that may alter the location of the epigastric vessels, it demonstrated that the IEA was significantly more lateral to the midline in patients with a body mass index greater than 26.3 m²/kg. Specifically, in this group, the mean distances were 6.9 cm at the umbilical level, 6 cm at the midway level, and 8.1 cm at the pubis [15]. Epstein et al [16] performed cadaveric dissections of the IEA to determine the optimal site for laparoscopic trocar placement. These authors recommended insertion more than two-thirds of the way from the midline to the anterior superior iliac spine. They noted that IEA branch positions are highly variable but may also be injured. These branches are less likely to be encountered inferiorly and lateral to the IEA itself [16]. The value of these studies’ findings in patients with ascites is unknown. It is not clear how the course of the IEA varies in patients with abdominal distention due to ascites.

The precise incidence of IEA injury is unknown and may be underestimated. Several studies have attempted to establish the incidence of hemorrhagic complications from paracentesis. Runyon [18] suggested a rate of approximately 1%. Mercaldi and Lanes [9] showed an overall hemorrhagic complication rate of 0.8% (0.27% with ultrasound guidance and 1.25% without). Pache and Bilodeau [7] reported an incidence of 0.2% for severe hemorrhagic complications and 0.02% for death (n = 4729) in their retrospective study. De Gottardi et al [4] performed a prospective study on complication rates from paracentesis in 515 patients with cirrhosis, finding a 1.6% rate of major complications. To date, there are very few prospective studies of complication rates from paracentesis.

Although rare, potentially serious complications of paracentesis are well documented [1-3]. Sobkin et al [1] described IEA injury in 8 patients (40% of their study group) that resulted in massive abdominal wall hemorrhage. Mulpuru et al [2] described a case of life-threatening, large rectus sheath hematoma from IEA branch bleeding. Several other case studies have described IEA pseudoaneurysms as complications of paracentesis in patients with ascites [6,19]. Preprocedural external skin mapping of the IEA using ultrasound has been described for procedures other than paracentesis, such as transabdominal lymph node biopsy, from which hemorrhagic complications are also rare [20]. In addition, use of ultrasound to evaluate the IEA before harvesting of the internal mammary artery for coronary revascularization procedures has been described [21].

Use of ultrasound to identify the IEA during paracentesis appears feasible and has little or no added risk or cost. Based on the feasibility demonstrated in this small number of cases, the authors have adopted IEA identification as a routine and easily incorporated step in ED paracentesis for patients with ascites. The precise time to obtain images of the IEA was not recorded or recoverable from time stamps for these cases. Our anecdotal experience suggests that little extra time is required, and we estimate that this structure can be identified in less than a minute by even novice scanners. Further study to determine precise image acquisition times among providers of varied experience may be warranted.

5. Conclusion

Complications involving injury to the IEA are well documented. Current landmark techniques do not allow for visualization of the IEAs during paracentesis, and the anatomic course of the IEA may vary in patients with ascites. The feasibility of IEA identification with ultrasound makes this technique a valuable preparatory step for paracentesis in the ED setting. Additional larger studies may demonstrate a decrease in complication rates from paracentesis by routine incorporation of sonographic IEA visualization.

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References


