Different Sonographic Pictures of Traumatic Hepatic Herniation and Reasons for Their Differences

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Sonographic features used in the diagnosis of diaphragmatic rupture with hepatic herniation have been reported in several previous studies. Most of those studies demonstrated the sonographic pictures, but did not discuss the reasons behind the formation of those particular pictures. We report three cases of traumatic hepatic herniation with different sonographic pictures and discuss the reasons for their differences. Case 1 represents a negative sonographic study even though the chest film showed the impression of the hepatic herniation. In case 2, sonography revealed a relatively small volume of herniated liver compared to the larger volume of hepatic herniation seen on chest film. In case 3, a complete illustration of the hepatic herniation in one fused sonographic image included disrupted diaphragm, herniated outline with waist-like configuration of the liver, separation of the liver and right kidney, and interposed bowel gas within the separated area. From these three cases, we can conclude that different locations, narrow or wide constriction of the herniated neck, and different degrees of severity of liver herniation would affect the specific sonographic picture.

KEY WORDS — diaphragm, hernia, liver, trauma, ultrasonography

Introduction

Chest radiography plays a primary role in screening patients with diaphragmatic injury [1]. On initial observations of chest films, however, an injured diaphragm may appear to be normal or extremely difficult to diagnose [2–4]. Liver scan remains the gold standard for diagnosis of hepatic herniation [5]. Sonography is advantageous in that it offers multiplanar images that can be used to assess the diaphragm and abdominal organs. Classification of sonographic findings for the diagnosis of diaphragmatic rupture and hepatic herniation was demonstrated by Kim et al [1]. We report three similar cases with different sonographic pictures and discuss the reasons for their differences.

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Case Reports

Case 1
A 65-year-old female was referred for liver scan due to a mass lesion in the right lower lung field and suspected hepatic herniation (Fig. 1A). The patient had chest pain on the right side of 3 weeks’ duration, but otherwise presented normal laboratory data and no history of trauma. A technetium phytate liver scan showed an upward protrusion of the hepatic parenchyma with a pinched or waist-like constriction at the level of the disrupted diaphragm (Fig. 1B). Sonography of the abdomen with 3.5 MHz sector and 5.0 MHz linear-array transducers (Aloka SSD-280; Aloka Co. Ltd., Tokyo, Japan) indicated no abnormality of the liver even at the location of the herniated section, as seen on the liver scan. Computed tomography of the abdomen also indicated the same hepatic herniation as seen on the liver scan. After remission of the chest pain, no treatment was recommended for the liver hernia and the patient was discharged.

Case 2
A 75-year-old man was referred for a liver scan due to the incidental discovery of a mass in the right lower lung field with suspected hepatic herniation (Fig. 2A). The patient had suffered a gunshot injury to the lower right chest area approximately 40 years previously and had recovered without surgery. A technetium phytate liver scan showed an upward protrusion of the liver parenchyma with a waist-like configuration of the liver (Fig. 2B). Sonography of the abdomen with a 3.5 MHz convex probe (Diasonic VST Master Series; Diasonic Ultrasound Inc., San Jose, CA, USA) showed an interrupted diaphragm with herniation of the hepatic parenchyma through this interruption resulting in a pinched or waist-like constriction (Fig. 2C). The inferior surface of the right lung was in direct contact with the herniated liver. No intervening diaphragmatic echogenic line was observed. The volume of herniated liver tissue observed in this sonograph was much smaller than the volume of the mass seen on the chest film. This was likely due to blocking of the sonographic beam by lung tissue. Since the patient presented with no secondary signs or symptoms, no surgery was prescribed.

Case 3
A 28-year-old female underwent a series of examinations upon arriving at our emergency room following a car accident. She suffered from head injury with brain concussion, multiple facial lacerations,

Fig. 1. Case 1: (A) chest film shows a mass lesion in the right lower lung field (hepatic herniation) with narrow waist-like constriction (arrow); (B) liver scan (anteroposterior view) shows an upward protrusion of the hepatic parenchyma with a waist-like constriction of the liver (arrow), corresponding to the mass seen on chest film in (A).
fractures of the right humerus, left radius, and right pubic bone. Chest X-ray revealed apparent elevation of the right diaphragm with hemothorax (Fig. 3A). Sonography of the abdomen with a 3.5 MHz linear-array probe (Aloka 620; Aloka Co. Ltd.) demonstrated a herniated outline of the liver with a waist-like configuration at the location of the disrupted diaphragm. Separation of the liver and right kidney and interposed bowel gas within the separated area were also noted (Fig. 3B). As traumatic rupture of the right diaphragm with hepatic herniation was suspected and because the patient was suffering from dyspnea, emergency thoracoscopy and chest tube insertion were performed and hemothorax with 400 mL of blood was drawn out. Technetium phytate liver scan 2 days after sonography further confirmed hepatic herniation (Fig. 3C). Exploratory thoracotomy confirmed protrusion of a large portion of the liver into the chest cavity through a linear anterior-to-posterior tearing in the center of the right diaphragmatic dome (Fig. 3D). No evidence of injury or abnormality in the abdominal viscera was noted. The liver was reduced into the abdomen. After surgery, the patient recovered satisfactorily and was referred to orthopedics for further treatment of her skeletal injuries.

**Discussion**

Sonographic features for the diagnosis of diaphragmatic rupture may be arbitrarily divided into direct and indirect findings. Direct findings reveal
the status of the diaphragm itself, whereas indirect findings are those that indicate the condition of adjacent structures or organs [1]. Kim et al classified the ruptured diaphragm by sonography as disrupted, nonvisualized, and floating in cases of left or right diaphragmatic rupture [1]. A disrupted diaphragm was defined as one with a focal discontinuity, whereas nonvisualized indicated failure to see a wide portion of the diaphragm. A floating diaphragm was diagnosed when the movement of the disrupted diaphragm could be observed using real-time ultrasonography. Indirect sonographic findings observed at the site of a ruptured diaphragm include fluid collection in the pleural or subphrenic space, or visualization of herniated viscera. Khan and Gould also reported cases of

Fig. 3. Case 3: (A) chest film shows apparent elevation of the right diaphragm with hemothorax; (B) abdominal sonography with a fused image obtained from the right oblique approach shows herniated outline of the liver with waist-like configuration, disrupted diaphragm (arrows), and interposed bowel gas (G) within the separated area between the liver and right kidney (RT-KID). (C) Liver scan (anteroposterior view) shows herniation of almost the whole volume of the right liver with upward migration of the liver. (D) Intraoperative photograph shows anterior-to-posterior tearing in the central tendon (arrows) of the right diaphragm (L = reduced liver; G = gauze).
localized eventration of the diaphragm with a paradoxical movement of the liver in relation to the diaphragm, again as observed with real-time ultrasonography [6].

Regarding the current three cases, case 1 had negative sonographic results. In case 2, the volume of herniated liver observed on ultrasound was smaller than the volume of the mass seen on chest film due to lung interruption. The liver scan and chest film indicated that the herniated site was more laterally located and the herniated constriction was less narrow in case 2 than in case 1. Therefore, although the volumes of the herniation were similar in both cases, the more narrow constriction of the herniation neck and the more medial location in case 1 resulted in the herniation being completely obscured by lung interruption. Further, the location of the herniated site in case 1, close to the center of the ribcage, made a good approach not possible. These reasons all accounted for the negative sonographic results observed in case 1.

In case 3, the sonographic findings of separation of the liver and right kidney and interposed bowel gas within the separated area have not been previously reported. These sonographic features likely resulted from tight trapping of the herniated hepatic parenchyma. No paradoxical movement of the liver and no obvious ascites were observed, probably due to the same reason.

From these three cases, we can conclude that different locations, narrow or wide constriction of the herniated neck, and different degrees of severity of liver herniation would affect the specific sonographic picture. A more thorough understanding of the appearance of both direct and indirect indicators of herniation in sonographic imaging and the reasons behind the formation of such features will improve diagnostic accuracy, especially in emergency situations.

References