Journal of Diagnostic Medical Sonography
2024, Vol. 40(1) 113–116

DOI: 10.1177/87564793231200189
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Sonographic Assessment of a Ruptured Testicle From a Gunshot Wound: A Case Study

Shannon Anderson, MSED[1], Amy Bro, PhD[1], Malinda Harris, BS[2], and Kimberly Bensyl, AAS[2]

Abstract

High-resolution sonography is a valuable imaging technique to evaluate scrotal trauma. Scrotal injuries can be caused by both blunt and penetrating forces, causing harm to the testicles and other scrotal contents. This case study follows the diagnosis of a gunshot victim's testicular injury and how the use of sonography plays a major role in both the diagnosis and surveillance of testicular rupture. The initial sonogram identified mild enlargement and an irregularity of the right testicle. Hemorrhage surrounding the right testicle, soft tissue emphysema, scrotal wall edema, and some echogenic debris and/or a foreign body in the scrotum were also identified. Testicular rupture is a rare but serious injury and prompt medical attention is necessary in such cases to reduce long-term complications, including, but not limited to, infection, disability, and loss of the testicle.

Keywords

Sonography, ruptured testicle, computed tomography angiography, and scrotal gunshot wound

An estimated 327 citizens, in the United States, are shot every day and sustain traumatic or fatal injuries.[1] In the United States, firearm injury is currently the 12th leading cause of death, which is up from its 13th place ranking in 2020.[2] Although generally not life-threatening, traumatic injuries to the scrotum and testis are rare but occur most often after assault by a firearm.[3] A prompt diagnosis and intervention are critical to avoid complications such as infection, infertility, and testicular loss.[3]

Diagnostic medical sonography is an imaging technique used to assess a variety of conditions and traumatic injuries affecting the scrotum and testes. In this case study, a rare instance is described, in which a scrotal sonogram revealed evidence of testicular rupture from a gunshot wound. This case study will be put into context by reviewing the existing literature regarding gunshot wounds, in general, as well as the scrotum and testis specifically.

Case Report

A young male presented to the trauma service department, of a level 1 trauma center, in acute distress after sustaining gunshot wounds to the right upper and lower extremities. The patient underwent a computed tomographic angiography (CTA) specific to his upper and lower right extremities, which showed a tibia fracture, tissue swelling, and multiple small, retained bullet fragments. The right scrotal area was partially imaged on the CTA and demonstrates evidence of a small bone fragment, located within the scrotum (See Figure 1).

Next, a scrotal sonogram was completed. Multiple grayscale sonographic and color Doppler sonographic images of the scrotum were obtained utilizing an Aplio i800 (Canon Medical Systems, Tustin, California) ultrasound equipment system and a multifrequency i18LX5 linear transducer. The sonogram demonstrated no evidence of an obvious hematoma within the right testicle. However, the right testicle demonstrated an irregular contour (See Figure 2) and was measured to be mildly enlarged when compared with the left testicle. The testicles measured approximately 3.7 cm × 2.6 cm × 3.1 cm on the right and 3.6 cm × 2.2 cm × 2.6 cm on the left.

Both testicles demonstrated arterial and venous flow at the time of the sonogram, with the right testicle showing hypervascularity during color Doppler interrogation

[1]Southern Illinois University, Carbondale, IL, USA
[2]Radiology, Carle Health, Urbana, IL, USA

Received August 7, 2023, and accepted for publication August 21, 2023.

Corresponding Author:
Shannon Anderson, Southern Illinois University, 1365 Douglas Drive, Carbondale, IL 62901, USA.
Email: sanderson@siu.edu

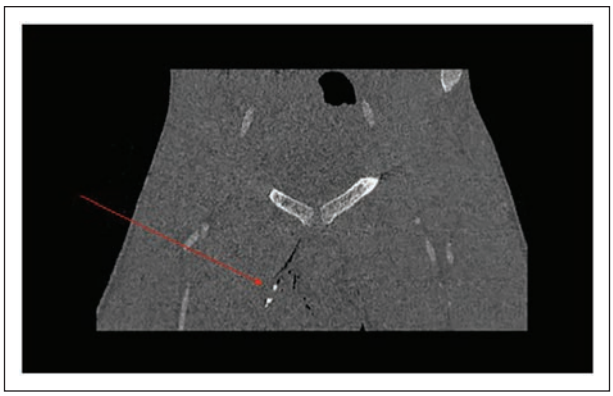

Figure 1. A coronal computed tomographic angiography image is provided, which showed evidence of a small bone fragment located within the scrotum (indicated with a red arrow).

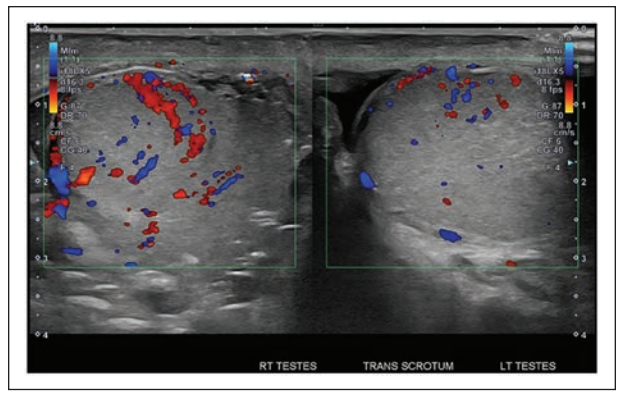

Figure 3. Dual transverse views with color Doppler allow for the comparison of vascularity in the right and left testicles. The right testicle demonstrated hypervascularity during color Doppler interrogation.

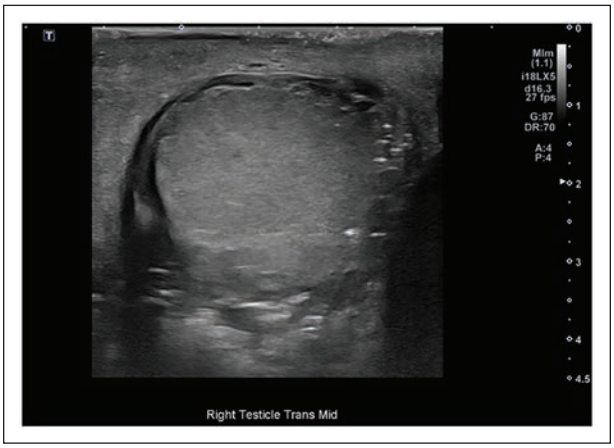

Figure 2. The right testicle is shown as it was imaged in the mid-transverse plane and demonstrated an irregular surface contour.

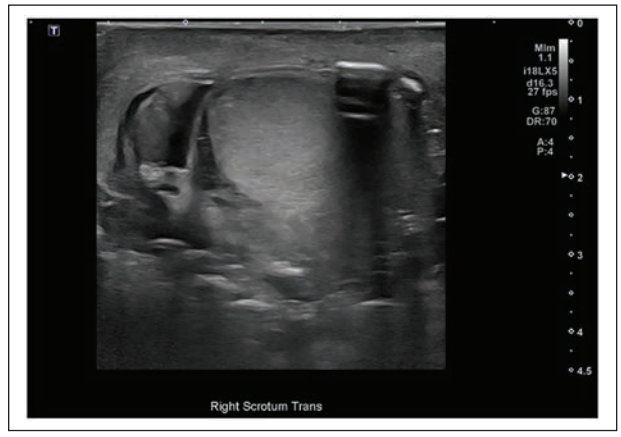

Figure 4. The right testicle was imaged in the transverse plane and showed mild hemorrhage surrounding the right testicle, as well as scrotal wall edema and soft tissue emphysema.

(See Figure 3). There was mild hemorrhage surrounding the right testicle as well as scrotal wall edema and soft tissue emphysema (See Figure 4). The sonogram also showed some echogenic debris and/or foreign bodies in the scrotum (See Figure 5). These findings raised concern for acute right testicular injury and the urology department was consulted.

The patient was assessed by a urologist and found to have a significant scrotal hematoma on the right side that was tender to palpation. The patient was brought to the operating room for emergent exploration surgery of the right scrotum to diagnose between right testicular rupture versus hematoma. Consistent with the sonographic findings, the exploration found significant disruption of the right tunica with extravasation of the testicular contents. The scrotum was copiously irrigated with saline/antibiotic irrigation, the redundant spermatic tissue was excised, and the tunica was sutured closed. Several skin injuries were copiously irrigated and sutured closed as well. The left side of the scrotum palpated healthy and normal and thus not explored surgically.

After approximately 6-week postsurgical intervention, the patient was assessed again with a scrotal sonogram. Unlike the previous acute sonographic finding, of right testicular enlargement, the subsequent examination showed that the right testicle measured smaller than the left. The testicles measured approximately 2.54 cm $\times$ 1.66 cm $\times$ 2.05 cm on the right (See Figure 6) and 3.53 cm $\times$ 1.82 cm $\times$ 2.42 cm on the left (See Figure 7). Normal arterial and venous Doppler waveforms were demonstrated in the right testicle. The left testicular images were considered unremarkable.

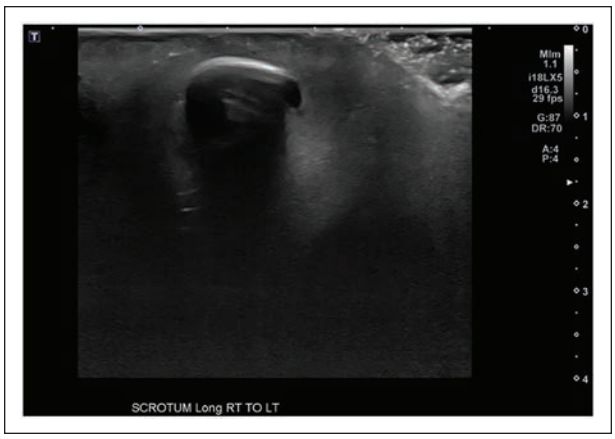

Figure 5. A grayscale sonographic image is provided that demonstrated evidence of a foreign body, within the scrotum.

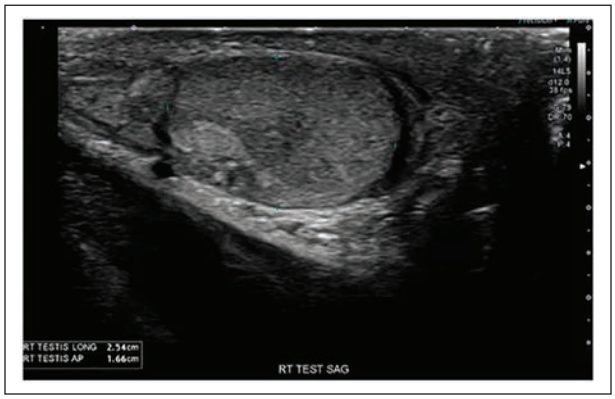

Figure 6. The right testicle was re-imaged in the sagittal plane, as a follow-up examination and included measurements of the maximum longitudinal and anteroposterior diameter.

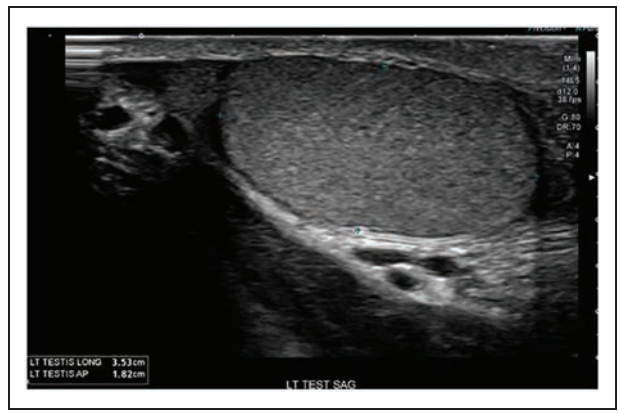

Figure 7. The left testicle was re-imaged in the sagittal plane, as a follow-up examination and included measurements of the maximum longitudinal and anteroposterior diameter.

Discussion

The testicles produce sperm and testosterone, which make them a vital component of the male reproductive system. They are housed in the scrotum and are enveloped by a protective structure known as the tunica vaginalis, which is derived from the embryonic process. Each testicle is suspended within the scrotum by a spermatic cord that contains blood vessels, nerves, and the vas deferens, a tube that transports sperm from each testicle. The vas deferens joins with the seminal vesicle to form the ejaculatory duct. The paired ejaculatory ducts pass through the prostate gland, adding secretions from the prostate that are essential for sperm function, and empty into the urethra.[4]

Scrotal and testicular injuries are most commonly due to penetrating trauma by firearm and account for $< 1\%$ of trauma-related injuries.[3] The patient in this case study underwent emergent exploration surgery due to the concern for acute right testicular injury from a gunshot wound. The utilization of CTA was crucial for assessing the injury and identifying bullet fragments, while scrotal sonogram played a vital role in diagnosing the extent of testicular injury and guiding subsequent management. The surgical intervention on this patient involved copious irrigation, excision of redundant spermatic tissue, and suturing of the tunica vaginalis. Postsurgical surveillance through scrotal sonography demonstrated a decrease in the size of the right testicle, which could be attributed to the resolution of acute trauma-related edema and swelling.

The presented case study detailed testicular trauma that resulted from a gunshot wound and offers a unique contribution to the field of trauma medicine and urology. It also provides insights into the diagnostic approaches for managing such injuries. An extensive search of the literature, within the last 5 years, indicated that while cases involving radiology and gunshot wounds have been documented,[5,6] this case study stands out due to its incorporation of multiple diagnostic imaging techniques, surgical intervention, and surveillance, yielding a comprehensive understanding of the injury and its outcomes.

The uniqueness of this case study lies in the integration of CTA and scrotal sonogram to comprehensively evaluate the extent of injury. The initial CTA images revealed not only the ballistic trajectory of the bullets but also partial imaging of the scrotal area, raising concerns for potential scrotal involvement. A subsequent scrotal sonogram played a pivotal role in identifying testicular irregularities, hypervascularity, and the need for immediate surgical exploration. This thorough diagnostic approach distinguishes the current case from other reports, where the extent of scrotal involvement might not have been as rigorously assessed. This approach

offers a more holistic view of the injury's progression, surgical outcomes, and long-term effects.

In comparison with similar cases within recent years, where radiologic imaging was used to assess gunshot wounds, a collective review focused more on the preoperative imaging and immediate surgical interventions, without including the postoperative follow-up. The utilization of both sonography preoperatively and as a subsequent follow-up evaluation was another unique aspect of this case study.

A comparable case study published by Kadouri et al, detailed how scrotal gunshot injuries were managed with computed tomography (CT) and surgical intervention, without detailed sonographic imaging preoperative or postoperative.[7] The outcomes were reported in terms of surgical success, with no mention of subsequent size changes. In contrast, the current case study approach included not only immediate intervention but also detailed assessments of testicular size and preservation of arterial and venous flow. This diagnostic surveillance enhances our understanding of the functional outcomes and potential complications, from these types of injuries.

This case study does have several limitations that should be noted. First, the bone fragment that was noted on the CTA was not documented in either the surgical or follow-up report. It is possible that the bone fragment was removed via irrigation during the surgery; however, this was not specifically noted. Second, the patient did not receive a CT of the scrotum, which may have allowed for further insight into the injury. In addition, this case only focused on a single patient, so further research with larger sample sizes is needed to provide more definitive evidence for the management of scrotal gunshot wounds. Finally, there is limited existing literature regarding scrotal gunshot wounds specifically; as such, more research into this area is warranted to better understand treatment options and outcomes for these types of injuries.

Conclusion

This case study stands out in its comprehensive evaluation of testicular trauma resulting from a gunshot wound, employing both sonography and CTA, surgical intervention, and a diagnostic follow-up assessment. Early and thorough scrotal exploration is recommended by the American Urological Association in all patients suspected of testicular rupture to prevent infection, chronic pain, testicular loss, infertility, and altered self-image.[8] The uniqueness of this case contributes to our understanding of testicular trauma management by highlighting the importance of combining diagnostic imaging techniques and provides insights into postoperative outcomes.

Ethics Approval

The SIUC Institutional Review Board has reviewed this project and determined it does not meet the regulatory definition of human subjects' research at 45 CFR 46.102.

Informed Consent

Informed consent was not sought for the present study because all case data were de-identified and/or aggregated and followed ethics committee or IRB guidelines (also referred to as the Honest Broker System).

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: The authors Shannon Anderson and Amy Bro are JDMS Article Reviewers.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Shannon Anderson https://orcid.org/0009-0004-3376-8558
Amy Bro https://orcid.org/0000-0001-7462-2126

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Objectives: After studying the article, you should be able to:

- Describe testicular firearm trauma.
- Identify the importance of high-resolution sonography in trauma patients.
- Explain common findings of testicular rupture.

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1. Which is the most common cause for traumatic injury to the scrotum and testes?
   A. A motor vehicle accident
   B. An assault by a firearm
   C. A high fall
   D. An assault by force

2. Which type of imaging modality was first used to evaluate the patient in the case study and diagnose a small bone fragment located within the scrotum?
   A. Diagnostic medical sonography (DMS)
   B. Computed tomography angiography (CTA)
   C. Magnetic resonance imaging (MRI)
   D. Magnetic resonance angiography (MRA)

3. Which is true regarding the 6-week post-surgical ultrasound?
   A. The right testicle decreased in size
   B. A foreign body remained
   C. There was vascularity to the right testicle
   D. A complex fluid collection was seen

4. Which is a long-term effect of a testicular rupture?
   A. Hydrocele
   B. Lesions
   C. Hematoma
   D. Infertility

5. Following the initial CTA images, a subsequent scrotal sonogram played a pivotal role in identifying _____, and the need for immediate surgical exploration.
   A. Testicular irregularities, hypervascularity
   B. A large hole, the ballistic trajectory of the bullets
   C. Testicular size, the ballistic trajectory of the bullets
   D. Hypervascularity, testicular size

Journal of Diagnostic Medical Sonography
2024, Vol. 40(1) 118–121

DOI: 10.1177/87564793231188423
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An Asymptomatic, Iatrogenic Hemobilia Detected by Contrast Enhanced Ultrasound of the Gallbladder CME

Guido Menozzi, MD[1], Andrea Ricci, MD[2], Francesca Maria Farina, MD[2], Garlassi Elisa, MD, PhD[1], Valeria Maccabruni, MD[1], Barbara Marani, MD[1], Laura Arletti, MD[3], and Carlo Grendene, MD[2]

Abstract

Hemorrhage within the biliary system (hemobilia), is an infrequent complication that can arise during percutaneous procedures involving the liver. The clinical diagnosis of hemobilia is often challenging, as symptoms are quite unspecific and often display a late onset. In such cases, sonography of the gallbladder can play a crucial role in the early detection of hemobilia. A case report is provided of a 72-year-old man who underwent a sonography-guided percutaneous biopsy of a 22-mm focal lesion, within the eighth segment of the liver. In this patient, asymptomatic active hemobilia was promptly identified through contrast-enhanced ultrasound (CEUS) which was performed immediately after the invasive procedure. Crucially, this postprocedural complication may have gone undiagnosed without an early postprocedure grayscale visual analysis and CEUS evaluation, since the patient was completely asymptomatic. In conclusion, a grayscale sonogram of the gallbladder is suggested and should be considered before and immediately after percutaneous invasive procedures of the liver. In the instances where suspicion of hemobilia arises, CEUS can be used to assess the presence of active bleeding. Implementing this type of imaging protocol may possibly reveal a higher frequency of hemobilia than is commonly reported.

Keywords

Hemobilia, percutaneous liver procedure, liver, gallbladder, and postprocedure complication

Hemorrhage occurring within the biliary system, or hemobilia, is a rare complication with an estimated prevalence of less than 3%.[1] This is mainly observed following percutaneous liver procedures (e.g., needle biopsy, placement of drainage catheter, or tumor ablation) and is caused by an iatrogenic communication between a biliary duct and an adjacent blood vessel.[1–4] Its diagnosis is often challenging due to the absence of specific symptoms. In this regard, sonography of the gallbladder plays a crucial role in identifying hemobilia. A grayscale sonogram allows for the visualization of blood as bright material within the gallbladder.[5] Moreover, the utilization of contrast-enhanced ultrasound (CEUS) is highly valuable as it allows for detection of active bleeding, within the gallbladder, thus aiding in the diagnosis of active hemobilia.[6]

A case report is provided in which asymptomatic hemobilia, following a percutaneous liver biopsy, was detected through CEUS immediately after the procedure. In addition, a discussion is provided on how routinary implementation of ultrasound-guided postprocedural evaluations might help to unveil a likely underdiagnosed complication of percutaneous liver interventions.

[1]Center of Diagnostic and Interventional Ultrasound (Infectious Diseases Department), Azienda USL—IRCCS di Reggio Emilia, Reggio Emilia, Italy
[2]Internal Medicine Unit, Department of Medical and Surgical Sciences for Children and Adults, Azienda Ospedaliero—Universitaria Policlinico di Modena, University of Modena and Reggio Emilia, Modena, Italy
[3]Hematology Department, Azienda USL—IRCCS di Reggio Emilia, Reggio Emilia, Italy

Received March 9, 2023, and accepted for publication June 29, 2023.

Corresponding Author:
Guido Menozzi, MD, Center of Diagnostic and Interventional Ultrasound (Infectious Diseases Department), Azienda USL—IRCCS di Reggio Emilia, Viale Risorgimento, 80, 42100 Reggio Emilia, Italy.
Email: pelikan128@gmail.com

Case Report

A 72-year-old man, with a history of diffuse large B cell lymphoma, underwent an ultrasound-guided percutaneous biopsy of a 22-mm focal lesion in liver segment VIII. For the biopsy, four punctures with an 18-G Tru-Cut needle (Acecut; TSK laboratory, Japan) were performed. Both a platelet count and international normalized ratio (INR) were within the normal range. The patient was not taking any anticoagulant or antiplatelet drugs and he had no history of prior bleeding incidents. Before the procedure, a sonogram of the gallbladder was performed with a 5.0-MHz curvilinear transducer (Aplio i800; Canon Medical Systems, Otawara, Japan), which revealed an anechoic lumen. Immediately after the procedure, instead, a thick layer of slightly echogenic material appeared in the dependent portion of the gallbladder lumen (See Figure 1). This echogenic material moved within the gallbladder slowly but spontaneously. A CEUS examination of the gallbladder was immediately performed with injection of 1.2 mL of SonoVue (Bracco, Milan, Italy). Using this contrast agent, the gallbladder lumen revealed an intense and slowly forming layer of enhancement, starting at 34 seconds after the intravenous injection, in the most dependent portion. The enhanced layer was more intense than the liver parenchyma, whereas it appeared simultaneously and with the same intensity in the portal branches (See Figure 2). Subsequent CEUS examinations (performed 4 minutes, 2 hours, 24 hours, and 48 hours after the procedure) revealed a completely anechoic gallbladder lumen, whereas at the same time intervals, a slightly hyperechoic layer in the lumen persisted, unchanged, on the grayscale sonogram. The patient's blood count and bilirubin were assessed 24 hours after the procedure and the resulting values were in the reference range.

Follow-up sonographic evaluations after 30 days and 5 months from the biopsy revealed an anechoic gallbladder lumen with some hyperechoic, round, 6- to 8-mm-wide structures, resembling gallstones. These structures were found to be adherent to the wall and attributable to blood clots (See Figure 3). From a clinical point of view, the patient was completely asymptomatic, as confirmed up to 5 months after the procedure.

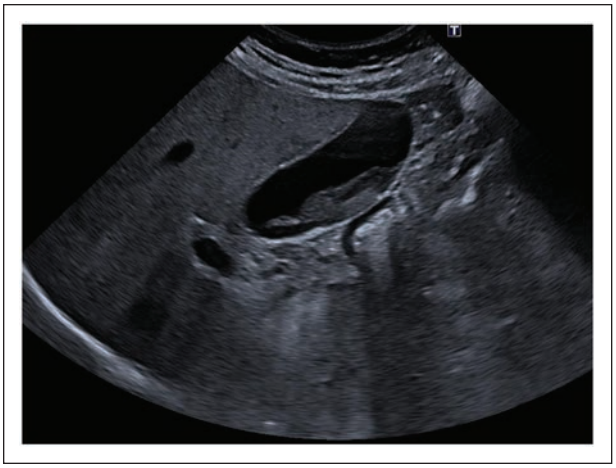

Figure 1. A grayscale gallbladder sonogram showed the presence of an echogenic structure (maximal thickness = 12 mm) layered within the gallbladder lumen.

Discussion

In recent years, hemobilia, which may also be secondary to malignancy, inflammation, infections, and trauma, arises in more than 50% of cases as a complication of hepatobiliary interventions, which are increasingly used as a diagnostic as well as treatment option in several settings.[3]

The clinical picture of hemobilia may be insidious, as symptoms are quite unspecific and often display a late onset.[7,8] As for clinical imaging, hemobilia often presents on grayscale sonography as mass-like intracholecystic material, as reported by Laing et al.[5] Indeed, there is a scarcity of data concerning the sonographic assessment of the gallbladder, in patients with hemobilia. Be that as it may, hemobilia should be promptly suspected and actively investigated in the context of ultrasound-guided percutaneous liver procedures. In fact, these types of intervention would inherently require the ultrasonographer or sonologist to pay more attention to this complication, for which sonography of the gallbladder serves as a sensitive and readily available diagnostic technique. Indeed, in the context of an ultrasound-guided percutaneous liver biopsy of focal liver lesion, we usually investigate the gallbladder lumen by grayscale sonography both before and immediately after the procedure. In this case, a CEUS examination was performed due to the appearance of sludge layering in the dependent portion of the gallbladder lumen. This easily allowed the immediate identification of an active bleeding inside the lumen of the gallbladder and its rapid resolution after 4 minutes only. Some elements in this case suggest that the bleeding was from a biliary-venous communication, since the enhancement of the gallbladder lumen appeared 34 seconds after the contrast injection, simultaneously and with a visual intensity comparable to blood in intrahepatic portal branches. Furthermore, the bleeding resolved spontaneously in 4 minutes, which may suggest that the source could be a low-pressure vessel. Crucially, this case of hemobilia would have gone undiagnosed without an early postprocedure grayscale visual analysis and CEUS evaluation, since the patient was completely asymptomatic.

Two hemobilia cases with CEUS images of the gallbladder have been reported in the literature. Cokkinos

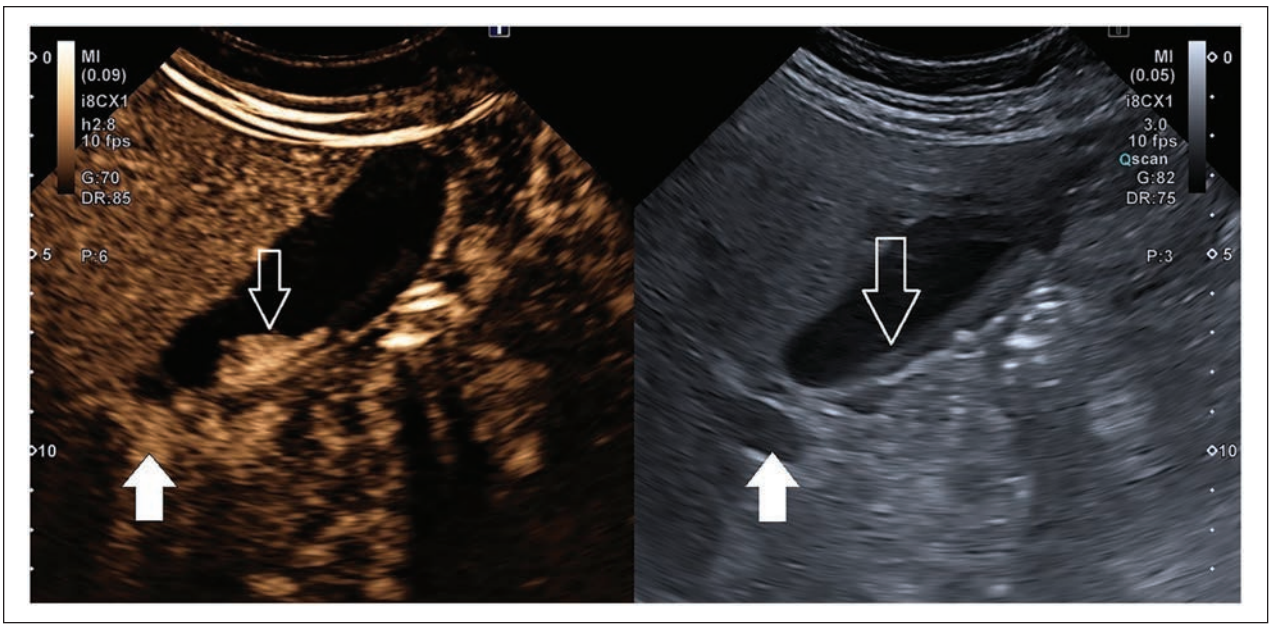

Figure 2. On the left, the contrast-enhanced ultrasound image, taken during the portal venous phase, 34 seconds from contrast injection. The image demonstrated a layer of enhancement in the dependent portion of the gallbladder lumen (length = 30 mm; thickness = 10 mm). The lumen enhancement appeared simultaneously in the portal branches and its visual intensity appeared higher than the liver parenchyma, and comparable to portal blood. On the right, the same image is displayed with a grayscale sonogram. Solid arrows indicate the right main portal branch. The open arrows are used to indicate the gallbladder lumen.

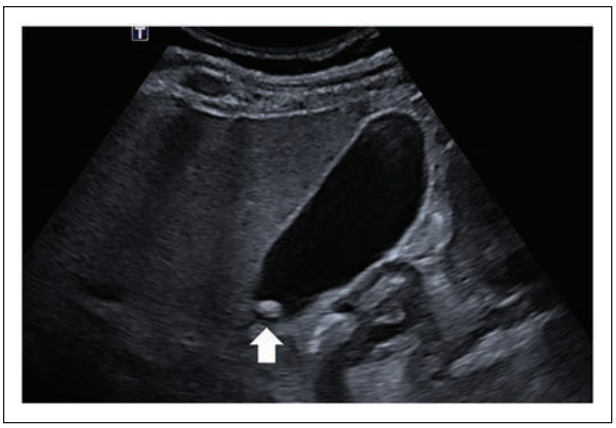

Figure 3. A grayscale gallbladder sonogram. The solid arrow shows the presence of a stone-like image, 8 mm in diameter, which is adherent to the gallbladder wall.

et al[9] reported on a spontaneous bleeding arising from a polyp of the gallbladder wall: in this case, contrast-induced enhancement of the hyperechoic material in the lumen appeared 83 seconds after contrast injection. In the case of Francica et al,[10] the authors reported the presence of active bleeding after thermal ablation of a liver tumor since they detected an enhancement of the material inside the lumen. However, in this case, the time of enhancement from contrast injection was not stated. In both previously reported cases, the intensity of the echoes from contrast bubbles, inside the gallbladder lumen, was much lower than that of liver parenchyma. Notably, a different pattern of contrast-induced enhancement was exhibited in the present case, as contrast bubbles appeared 34 seconds after injection, were layered in the dependent portion of the gallbladder wall, and displayed an intensity, which was higher than liver parenchyma and comparable to blood in the portal veins.

Conclusion

This clinical example may suggest that a comparative grayscale gallbladder sonogram should be performed before and immediately after percutaneous invasive procedures of the liver. It may also be important, in those cases when the appearance of echogenic material is detected, that CEUS may be used to confirm active bleeding. Routinary implementation of this type of post-procedure imaging protocol may reveal a higher frequency of (asymptomatic) hemobilia than is currently being reported.

Ethics Approval

This study has been performed in accordance with the ethical standards laid down in the Helsinki Declaration of 1975 and its late amendments.

Informed Consent

An additional informed consent was obtained from the patient whose identifying information is not included in this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Guido Menozzi https://orcid.org/0000-0001-8693-4290
Andrea Ricci https://orcid.org/0000-0002-4812-3750

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SDMS CME Credit – An Asymptomatic, Iatrogenic Hemobilia Detected by Contrast Enhanced Ultrasound of the Gallbladder

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Article: An Asymptomatic, Iatrogenic Hemobilia Detected by Contrast Enhanced Ultrasound of the Gallbladder
Authors: Guido Menozzi, MD, Andrea Ricci, MD, Francesca Maria Farina, MD, Garlassi Elisa, MD, PhD, Valeria Maccabruni, MD, Barbara Marani, MD, Laura Arletti, MD, and Carlo Grendene, MD
Category: Abdominal [AB]
Credit: 0.50 SDMS CME Credit

Objectives: After studying the article, you should be able to:

- Identify the cause of hemobilia.
- Describe the sonographic appearance of hemobilia.
- Discuss additional techniques for diagnosing hemobilia.

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1. What causes hemobilia?
   A. Arteriovenous fistula
   B. Biliary-angio communication
   C. Arteriovenous malformation
   D. Air in the biliary tree

2. Which structure can play a vital role in the diagnosis of hemobilia?
   A. Portal vein
   B. Common bile duct
   C. Hepatic artery
   D. Gallbladder

3. Which additional technique can aid in the diagnosis of hemobilia?
   A. Fusion imaging
   B. Administering contrast
   C. Elastography
   D. Color Doppler

4. Which describes the sonographic appearance of hemobilia?
   A. Echogenic material within the gallbladder
   B. Hypoechoic areas within the liver
   C. Comet tail artifacts within the biliary tree
   D. Hyperechoic material within the portal vein