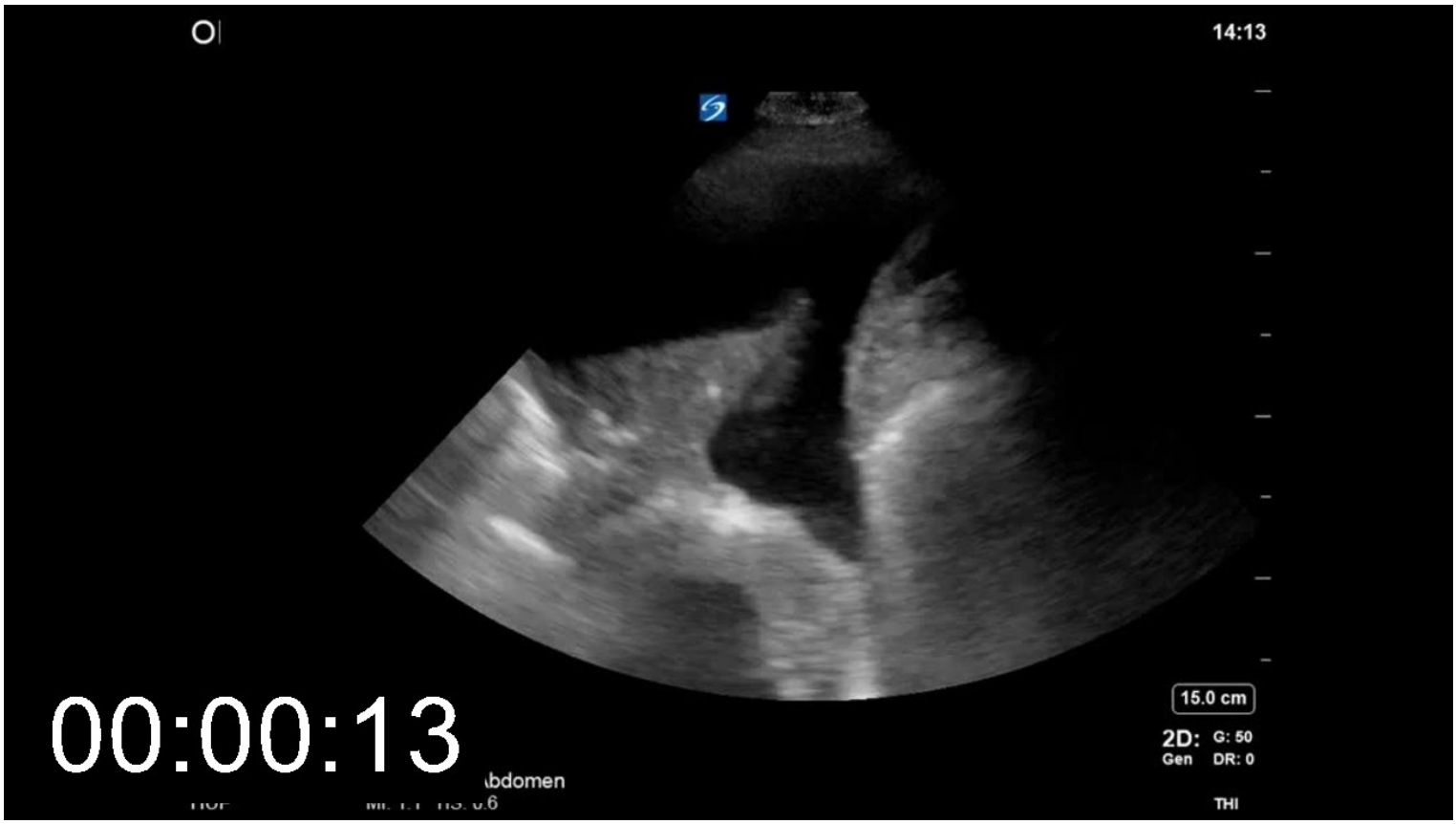
Chapter 7: Ultrasound-Guided Thoracentesis

KEY IMAGES

Left lung base

Video 07-01: Left lung base

This video shows the left lung base in a patient with a large simple effusion. The spleen and overlying diaphragm are on the right side of the screen. The densely atelectatic lower lobe can be seen moving with respirations. Also visible is the heart (in this case a short axis view). The heart can be seen to have a decreased ejection fraction, which was the underlying cause of this effusion.



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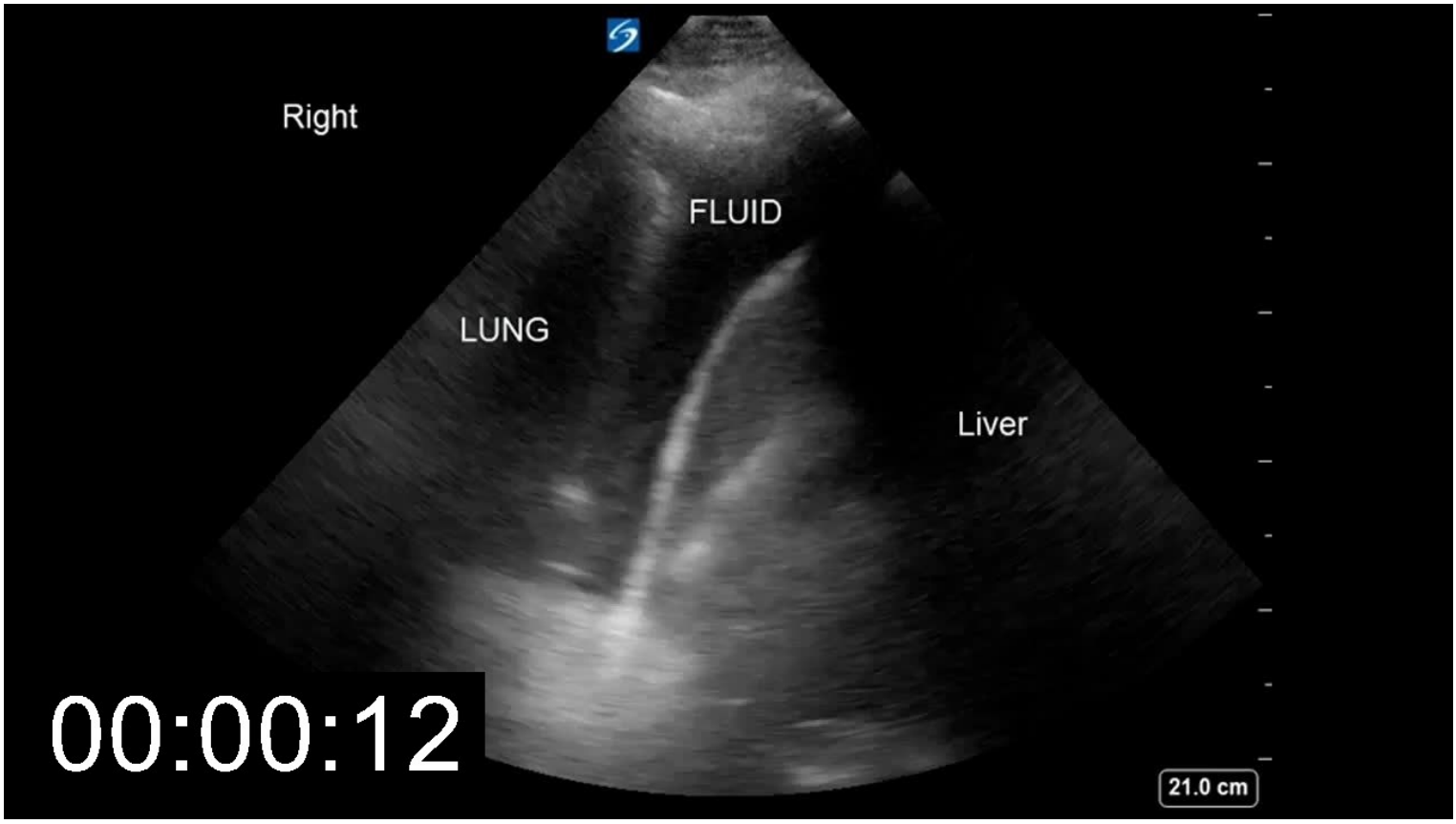
Hand position, patient able to sit

Figure 7-1

Right lung base

Video 07-02: Right lung base

This video shows the right lung base, where the liver and overlying diaphragm are on the right side of the screen. Anechoic fluid is labeled, and during the respiratory cycle the grey air artifact can be seen coming in as a curtain from the left side of the screen. Also visible is a rib shadow that can be distinguished from the fluid using posterior acoustic enhancement.



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Hand position, supine patient

Figure 7-2

Rib shadow

Identify your target rib to ensure needle goes superior to rib

Video 07-03: Rib shadow

In this video the operator is sliding the probe superiorly through a large effusion. Initially the diaphragm and underlying viscera are visible on the right side of the screen. As the probe slides superiorly the rib shadows can be seen moving across the screen from left to right. They can be distinguished from fluid using the posterior acoustic enhancement of the fluid. Notable is the large area of atelectatic lung in the effusion.

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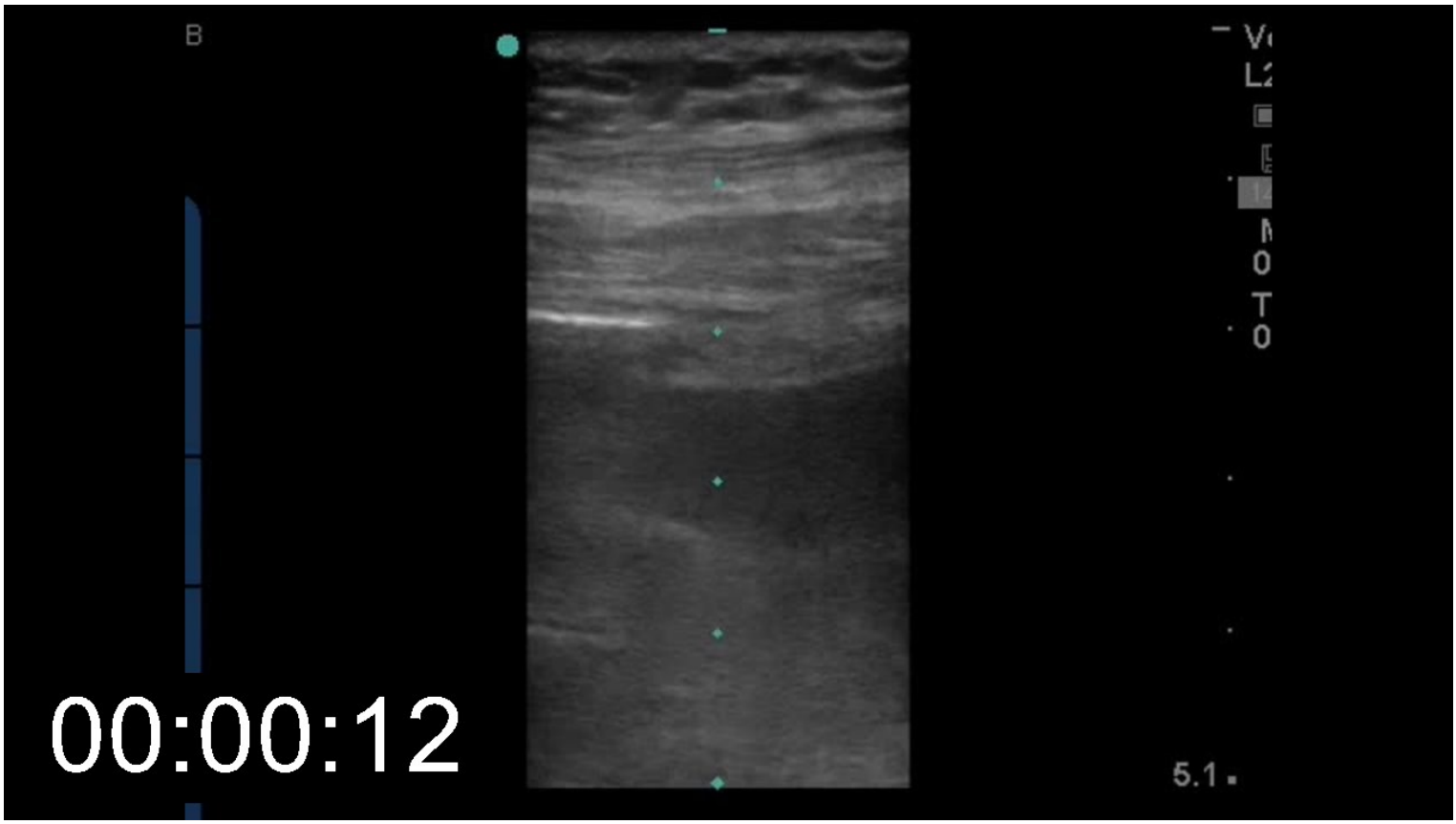
Depth measurement, still image

Superior to a rib, measure depth of soft tissue and depth of fluid

Video 07-04: Depth measurement

The linear transducer prevents visualization of deeper structures, but allows a high resolution evaluation of the soft tissues and measurement of the depth of the effusion. In this case, the effusion can be seen to be very shallow at the location selected, with 2.1 cm of tissue and only 1-2 cm of free fluid. This effusion would be considered high risk for thoracentesis, and real-time guidance should be considered if the tap is indicated.



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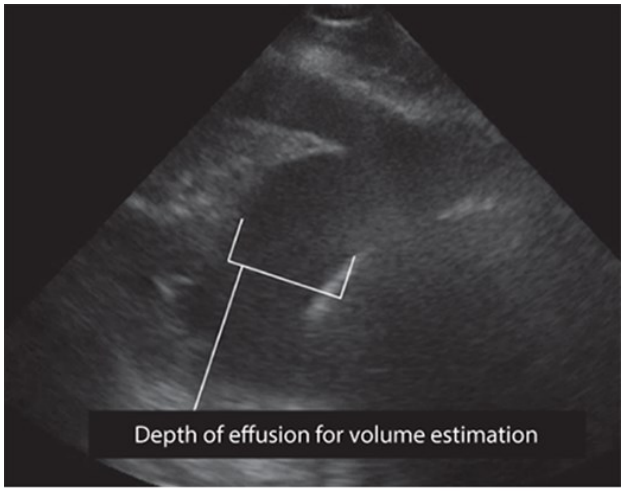
Volume estimation

Measure from lung to diaphragm

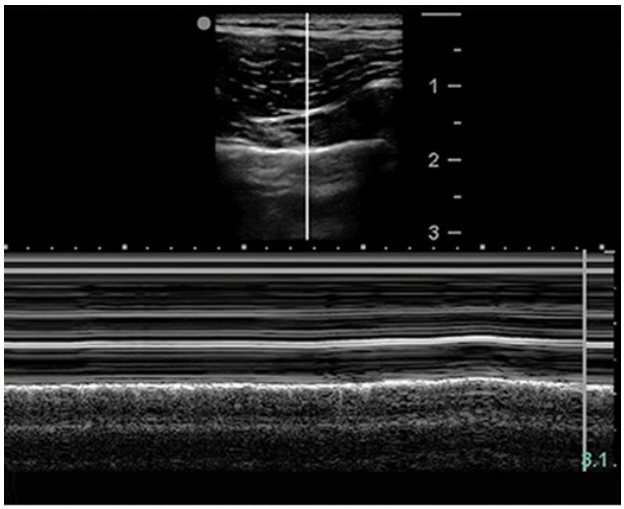
Figure 7-3



Lung sliding

Confirm presence BEFORE and after procedure

Figure 7-4



ACQUISITION TIPS

- Check for lung sliding both before and after the procedure (see Chapter 6 for details).
- Ideally, sit the patient upright hunched over with arms folded (to abduct the scapulae) and shoulders supported by a table or Mayo Stand to open up the posterior rib spaces. Patients unable to sit should be positioned (usually supine) in such a way as to expose the fluid pocket and overlying skin for a field of sterile prep.

Ideal patient positioning	Picture of target area
	

- Positively identify either the liver or spleen and the overlying diaphragm to ensure that the fluid space you are targeting is pleural.
- Avoid the paraspinal area, as anatomy of neurovascular bundle is less consistent there.
- Safe access can be acquired in the space bordered by a vertical line 5 to 10 cm lateral to the spine to the midaxillary line. The midscapular line is the traditional target in the spontaneously breathing patient.
- The curvilinear probe is optimal as it gives views of the rib space above and below. The linear array probe gives higher resolution images, but can be more challenging to identify the location of lung and diaphragm. The cardiac probe can also be used, but the small footprint may make it harder to show the ribs. The indicator dot is oriented toward the patient's head.
- Adjust gain to make sure fluid looks black.
- Identify ribs, and ensure that hypoechoic space is not rib shadow. Use posterior acoustic enhancement to differentiate rib shadow from effusion.
- Once the diaphragm is found, slide superiorly to find the lung curtain.
- An ideal pocket should typically be at least 3 cm deep and extend at least one rib space above and below the target site throughout the respiratory cycle.
- Evaluate effusions for loculations and echogenicity.

- Hold probe at exactly the same angle at which the needle will advance.
- Measure the depth of the soft tissue (to the fluid) and the depth of the fluid.
- If using a two-step technique, mark the site above the rib with pen cap or skin marker.
- Pass needle over upper margin of rib to minimize likelihood of puncturing the intercostal vessels, which run deep to the lower margin of the rib.

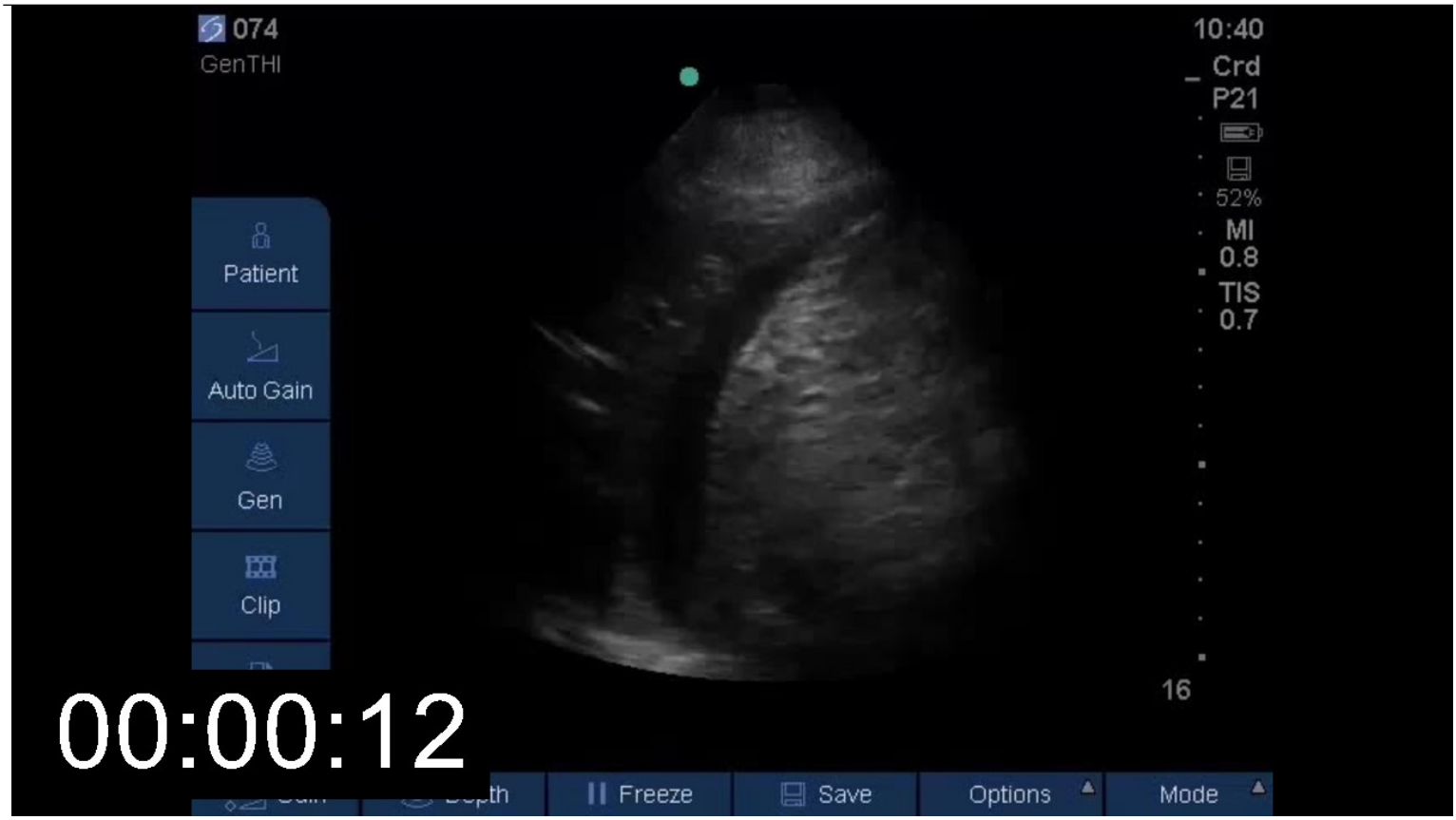
INTERPRETATION AND PITFALLS

- **Soft-tissue depth:**
  - **The pleura is highly innervated.** This depth is ideal for injecting anesthetic.
  - If you are more than a centimeter deeper than the measured depth without hitting fluid, the most common error is misalignment of the needle (not the same angle against the skin as the ultrasound was when taking the picture).
  - The pleura can “tent” over the needle tip, and a twisting motion can help pass a thickened or hardened pleura.
  - If your needle is not at least 1 cm longer than the measurement of soft-tissue depth, change to another needle.
- **Fluid depth:** This depth lets you know how much fluid you would have to pass through to hit a lung or other structures.
  - Should be at least 3 cm for a marked procedure.
  - If <3 cm, consider changing to real-time guidance.
  - Fan through a range of angles to ensure awareness of nearby structures.
  - Atelectatic lung usually floats away from a blunted or safety needle, but adherent lung that is stuck to the surface of the pleura can't move.
- **Fluid volume:** Approximate fluid volume in milliliters is the maximum distance from lung to diaphragm in millimeters × 16 at end expiration.
- **Lung sliding:** See Chapter 6 for details on acquiring images.
  - If lung sliding becomes absent during the procedure, there is probably an iatrogenic pneumothorax.
  - If lung sliding was not present prior to the procedure, then ultrasound is limited in its ability to assess for iatrogenic pneumothorax.
- **Loculated fluid:** Thin white lines demonstrating a complex collection. Usually seen in infection or malignancy. Fairly strong predictor of exudative effusion.
- **Echogenic fluid:** Similarly seen more frequently in exudative effusions and hemothorax.
- **Pleural thickening:** Scar tissue, infection, and malignancy can cause the pleura to appear as a bumpy, thickened stripe instead of a thin white stripe.
  - Don't pass a needle through one of these thickened sections.
- **Atelectatic lung:** Floating soft tissue mass within effusion that transmits ultrasound. Do not sample with a needle.
- **Rib shadow:** Appears hypoechoic, like fluid, does not have posterior acoustic enhancement, and has overlying rib.

EXAMPLES OF PATHOLOGY

Video 07-05: Small effusion

There is a thin rim of anechoic fluid visible outside of the hepaticized lung of this patient with pneumonia. There is, however, no safe way to access the fluid, as the needle enters from the top of the screen, and would have to travel through lung tissue to get to the fluid.



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Video 07-06: Dense atelectasis

Initially, this video may be confusing, as there is no clear anchoring structures other than the rib shadows. During respiration, however, the liver can be seen on the right side of the screen with overlying diaphragm. It then becomes clear that the opacity on chest radiograph initially thought to be effusion is actually just densely atelectatic tissue seen as hepatization above the diaphragm.

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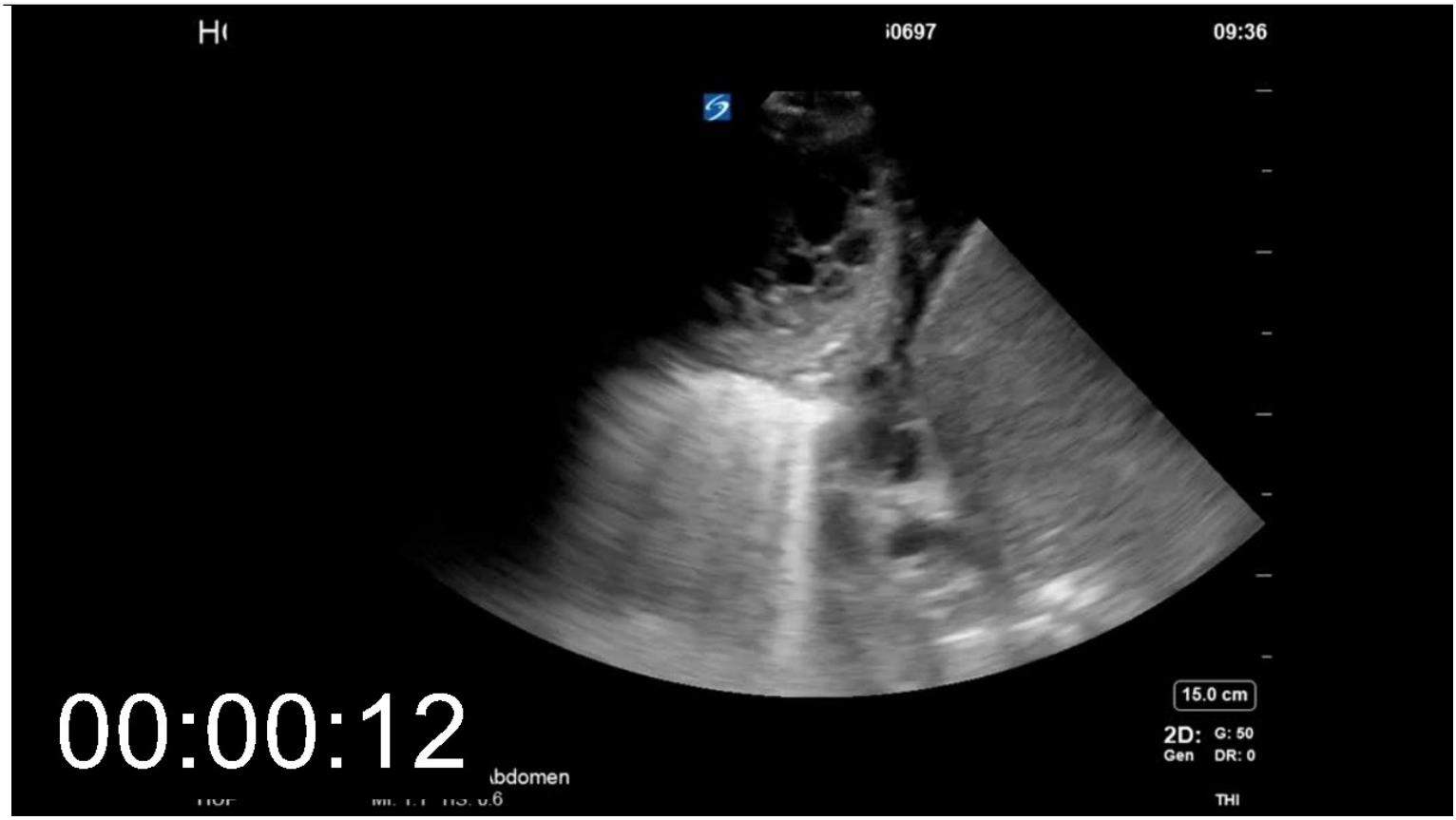
Video 07-07: Loculated effusion

In this video the diaphragm and a rib shadow can be seen on the right side of the screen. The atelectatic lung tissue and the anechoic free fluid in the pleural space, however, can be seen to have multiple thin hyperechoic tendrils attaching lung to pleura and diaphragm. These are septations or loculations in this case. Also, deep to the atelectatic lung can be seen the shred sign with B-line artifacts in the partially aerated lung deep to the atelectasis.



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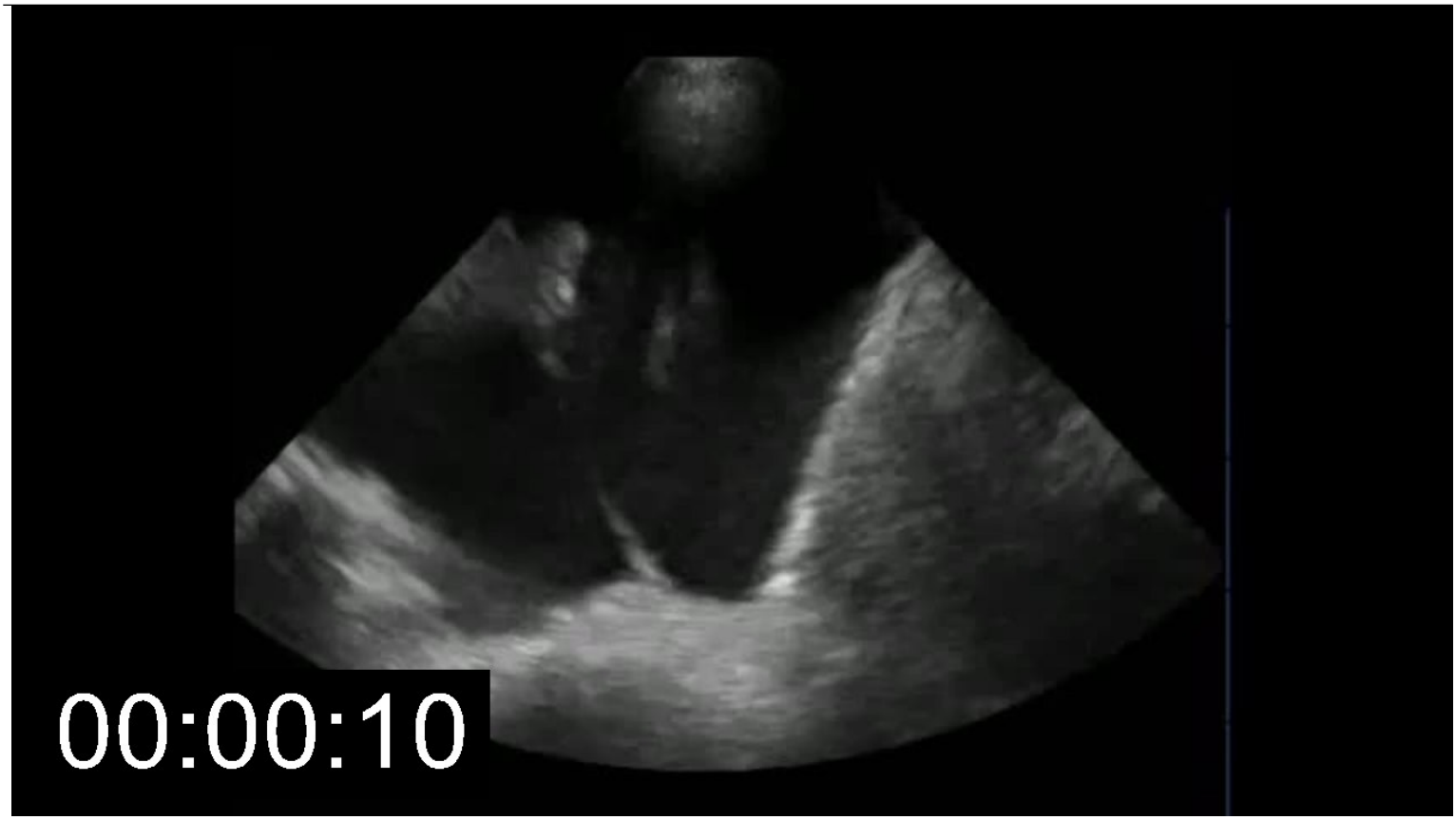
Video 07-08: Single loculation

The atelectatic lung in this video can be seen to have a single thick hyperechoic tendril tacking it down toward the diaphragm. Otherwise the fluid appears anechoic, with the diaphragm and spleen on the right and the atelectatic lung on the left. While this is not as clearly inflammatory as the previous video, it does suggest an inflammatory process.



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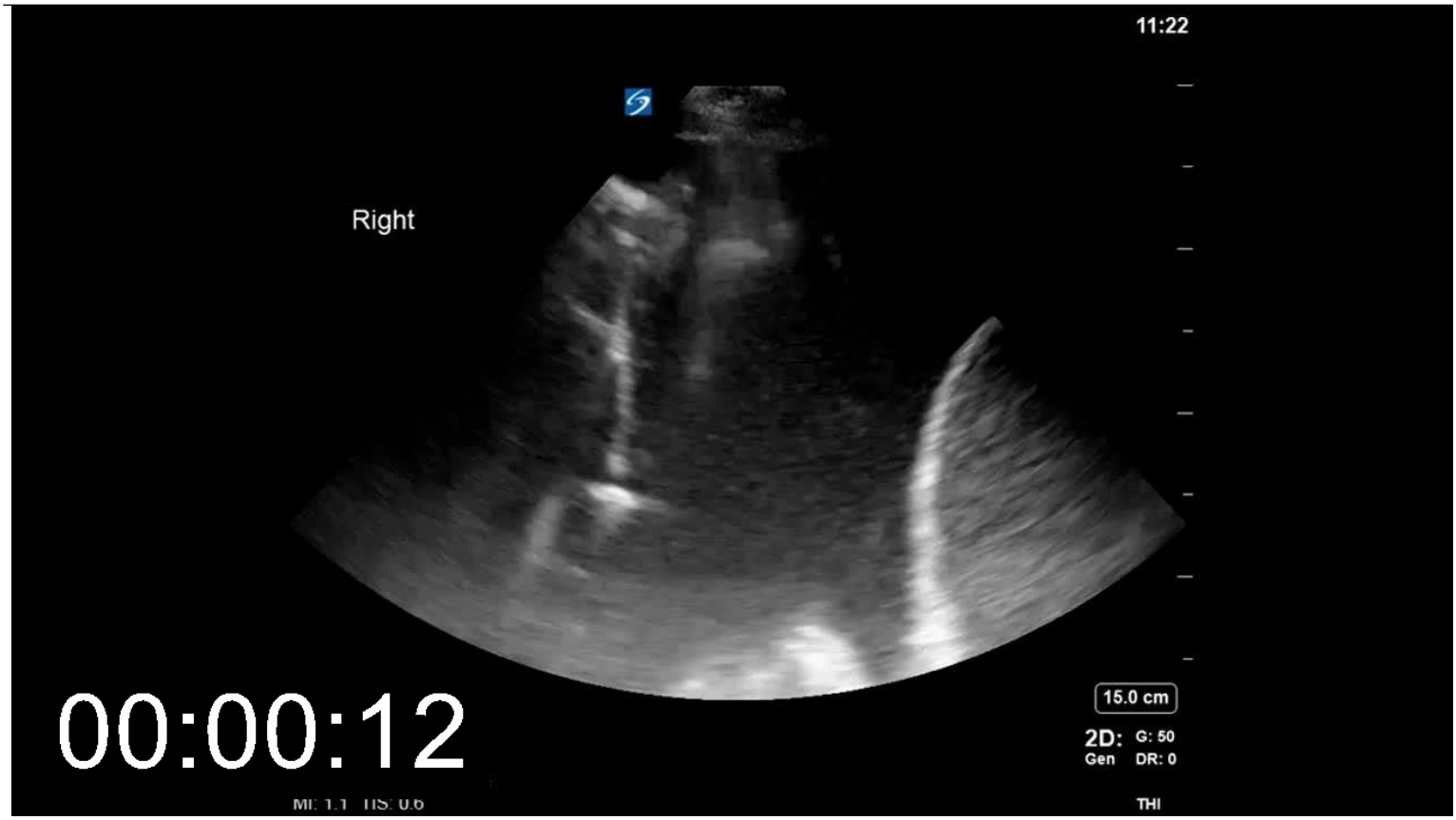
Video 07-09: Pleural mass

In this video there is a hyperechoic structure in the pleural space just superior to the diaphragm. This patient was known to have a pleural malignancy with a malignant effusion.

Play Video

Video 07-10: Large effusion

This large effusion has a notably increased echogenicity to the fluid. While it is safe to perform a thoracentesis on this fluid, there is an elevated concern for exudative effusion. This pattern of echoic fluid has been referred to as the plankton sign among other names.



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