

It's Alive!!! How to use a simple tissue phantom

to teach liver biopsy, abscess drainage, and percutaneous cholecystostomy procedures

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The Problem

- Percutaneous liver procedures are commonly performed, and are associated with rare but potentially significant risks
- Trainees are limited in their ability to familiarize themselves with these procedures prior to the patient encounter, particularly for less frequent procedures such as abscess drainage, percutaneous cholecystostomy
- Simulation methods can be helpful in procedural training
- Commercially-available simulation models may be costly and have limitations for repeated percutaneous access

Aim/Goal

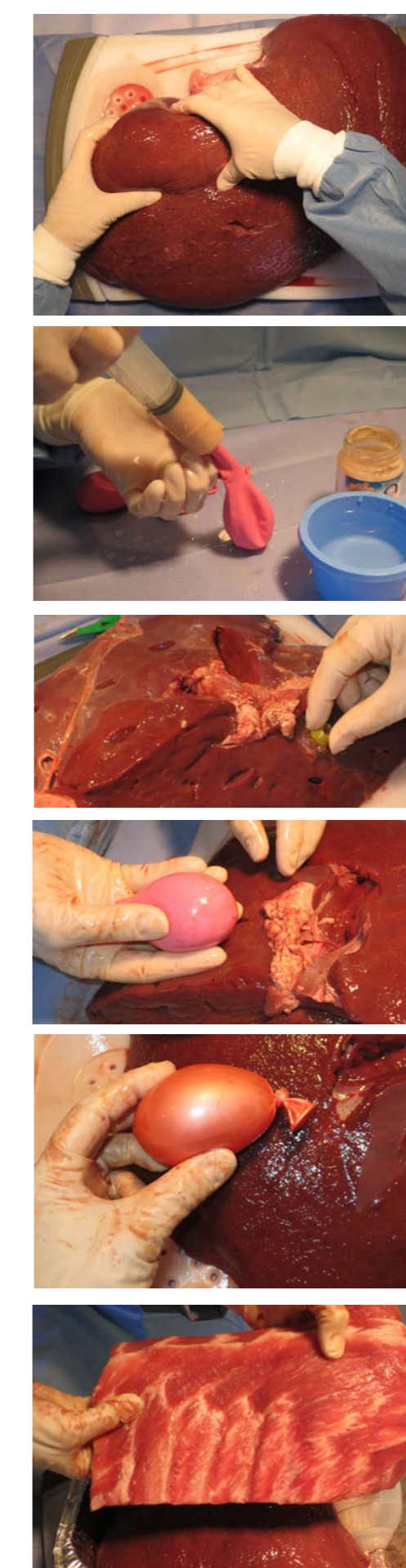
- Design a simple and inexpensive method of creating a tissue phantom that simulates hepatic nodules, abscesses and acute cholecystitis
- Implement the model in a program to teach radiology residents to perform liver biopsy, abscess drainage and percutaneous cholecystostomy tube placement procedures

The Intervention

- Two procedure models are constructed from one whole bovine liver, simulating echotexture of human liver
- Latex balloons containing banana-strawberry puree infant food are placed into livers to simulate abscesses
- Olives simulate metastases
- Balloons containing water and infant food sutured to liver, simulate infected gallbladders
- Porcine rib layer is used to simulate sonographic impediments to ultrasound and physical feel of rib spaces

The Results/Progress to Date

- 6 models have been created and used in 3 sessions of resident/fellow teaching of biopsies and drainage procedures
- Teaching sessions led by two abdominal interventionalists :
 - 20 minute didactic lecture
 - 70 min hands-on practice with the models
- In a prior study utilizing only a biopsy model, statistically significant improvements in trainee confidence and procedural knowledge:
 - Sekhar A., Sun MRM, and Siewert B. Academic Radiology 2014 : 21: 902-908



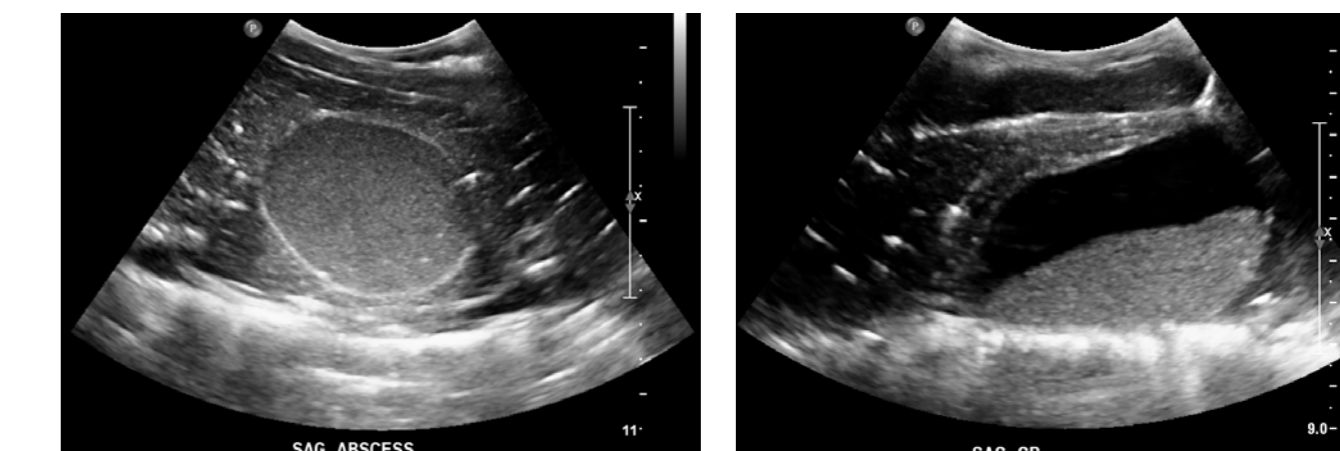
[Click images for videos of each step!](#)



[Click images for videos of procedures!](#)



Radiology residents performing drainage procedures using the phantoms



Sonographic appearance of "abscess" and "gallbladder"

Lessons Learned

- A tissue phantom can be easily created for teaching percutaneous biopsy and drainage procedures
- Model can be adapted for targeted and non-targeted liver biopsy, liver abscess drainage, and percutaneous cholecystostomy procedures
- Provide trainees with experiential learning in a supervised environment with immediate feedback

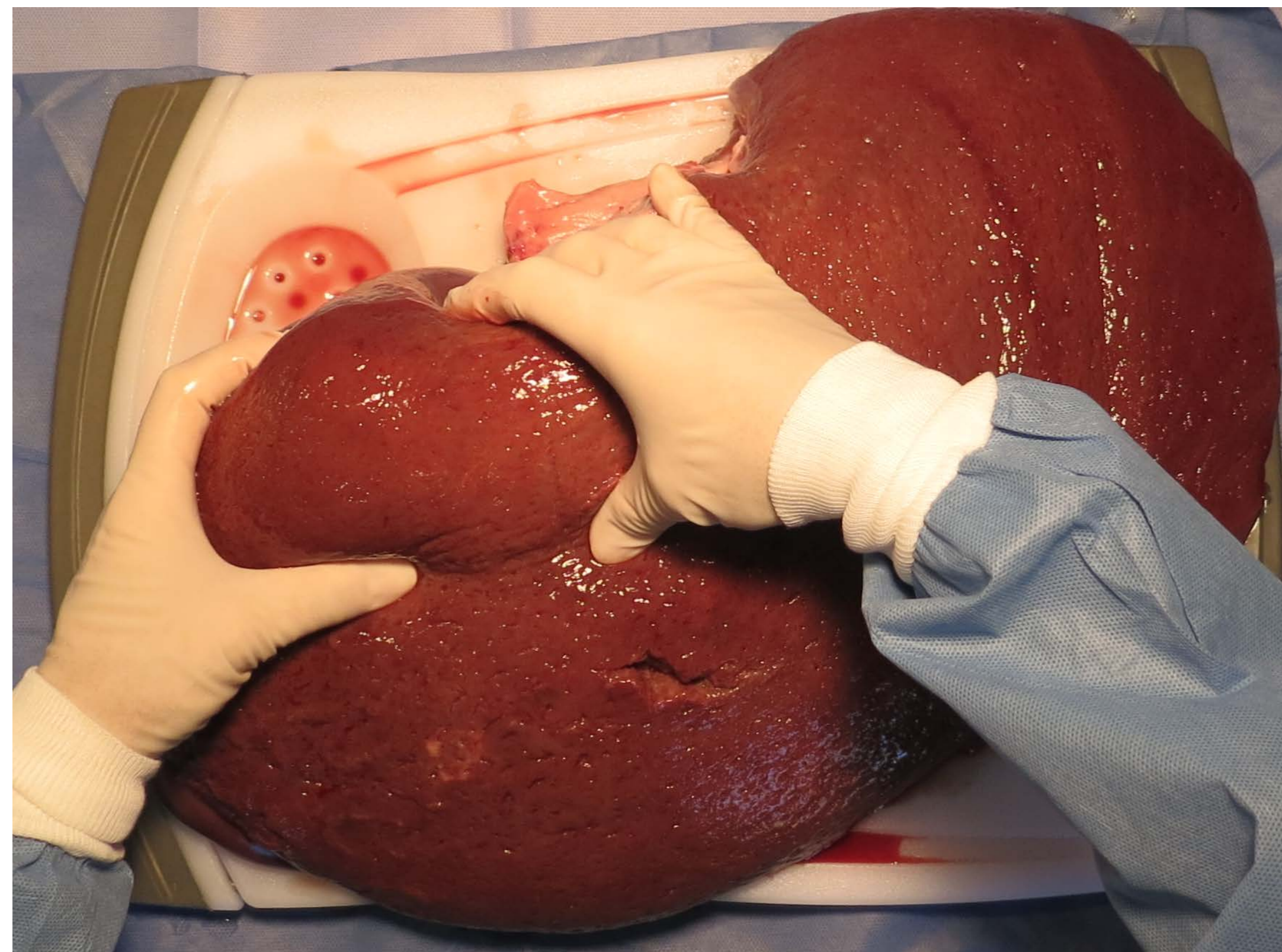
Next Steps/What Should Happen Next

- Continue to incorporate teaching sessions into resident education
- Survey based assessment of resident experience of drainage procedures using the models

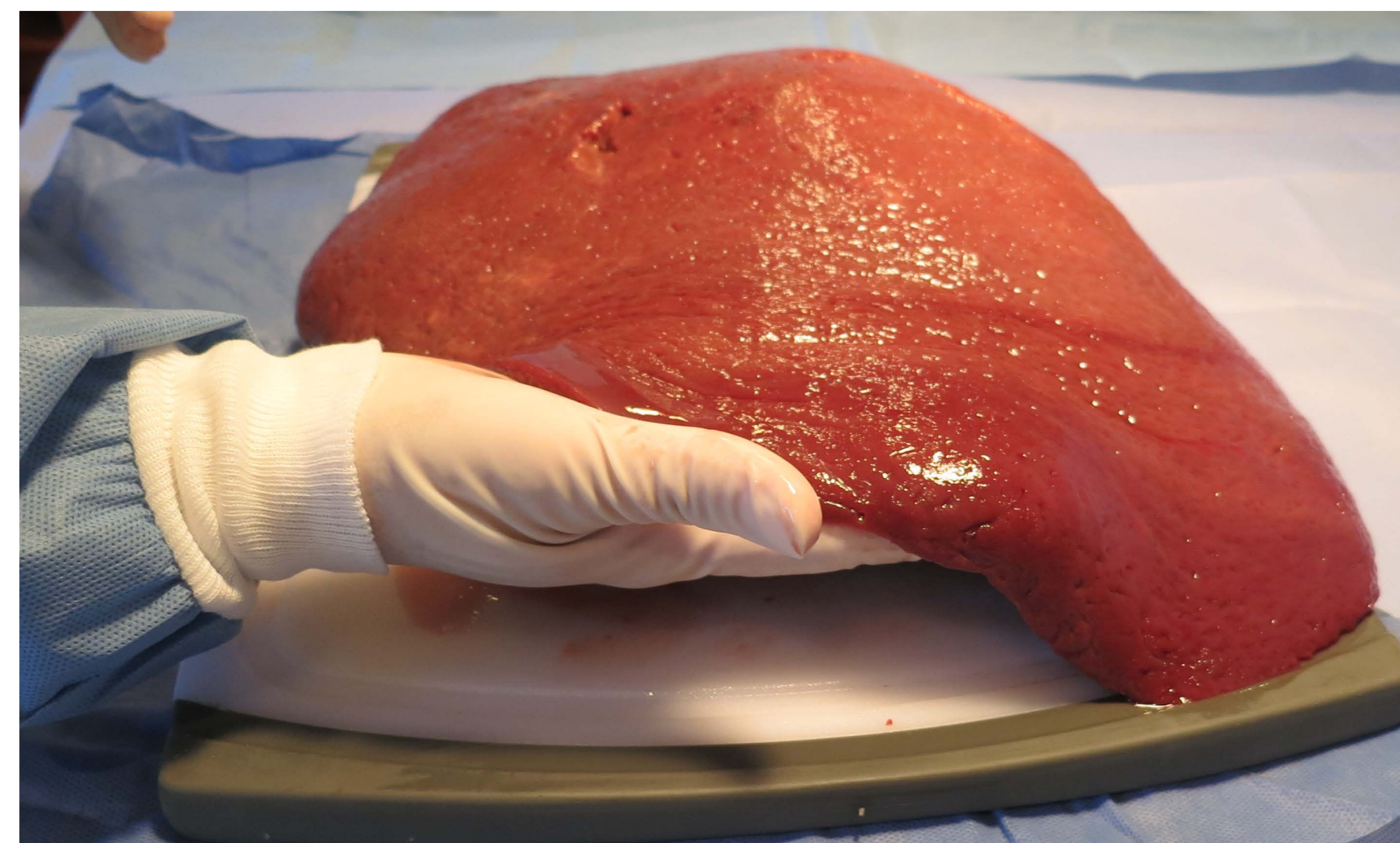
Constructing the Phantom: Prepare the liver

- Drain blood from liver over sink
- One bovine liver can be used to make two models

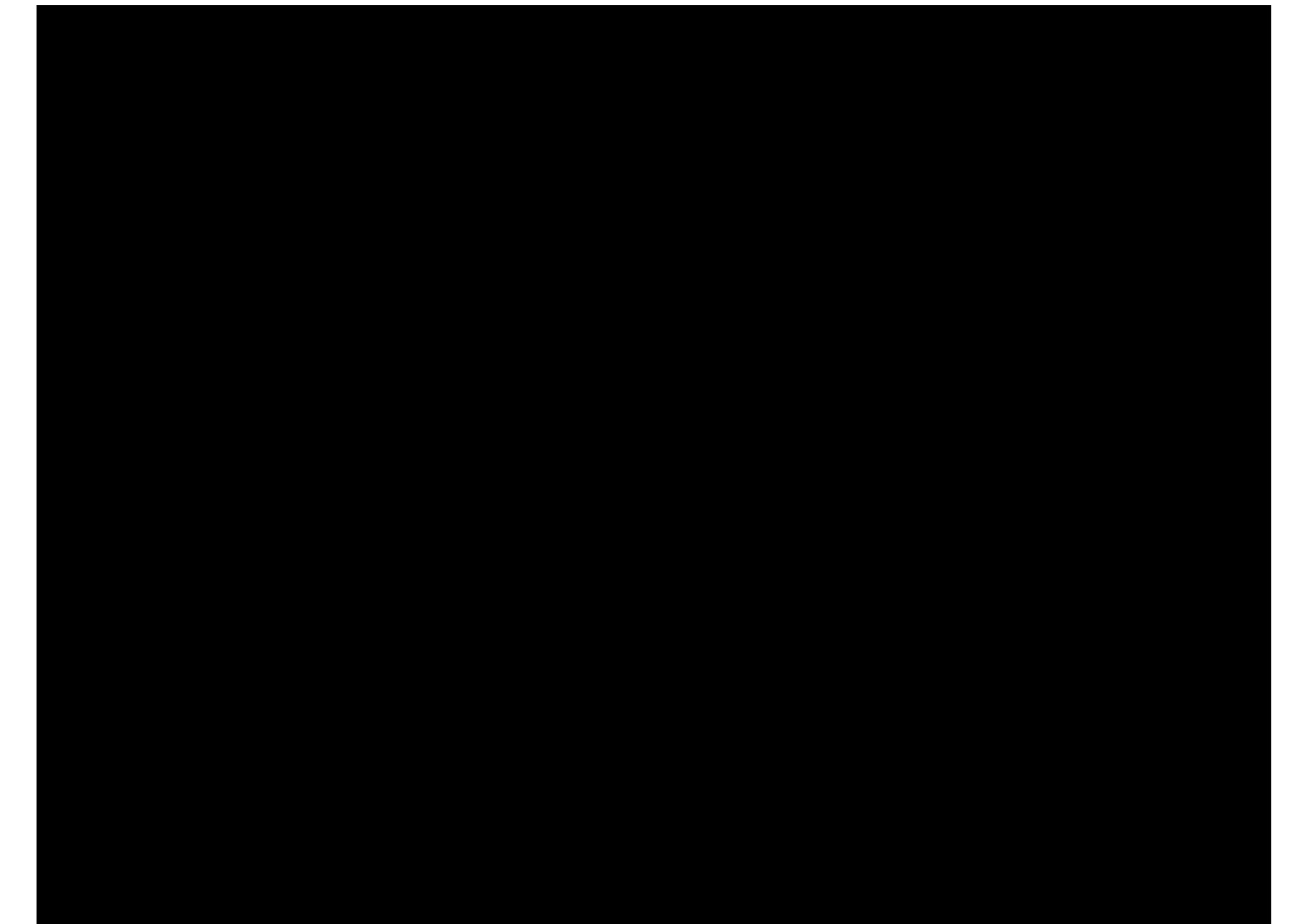
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- Liver dome (thicker portion)
- Use for targeted and non-targeted biopsy



- Portion with free edge of liver
- Use for abscess drainage and percutaneous cholecystostomy (gallbladders sit under free edge)

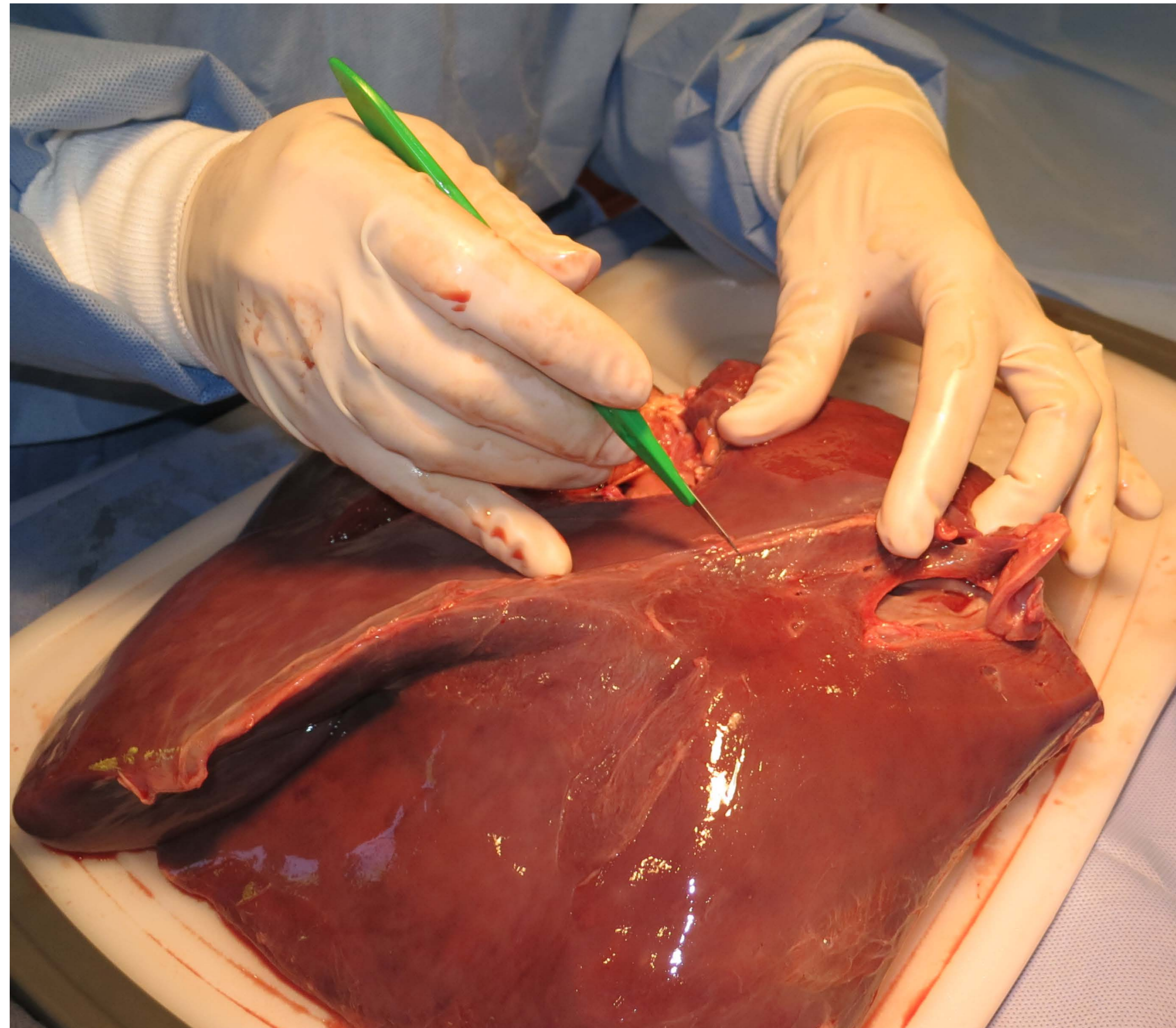


- Use a large knife to divide the halves

Constructing the Phantom: Add "tumors"

- Turn liver over and place lesions from undersurface
Reduces acoustic artifact from air in near field

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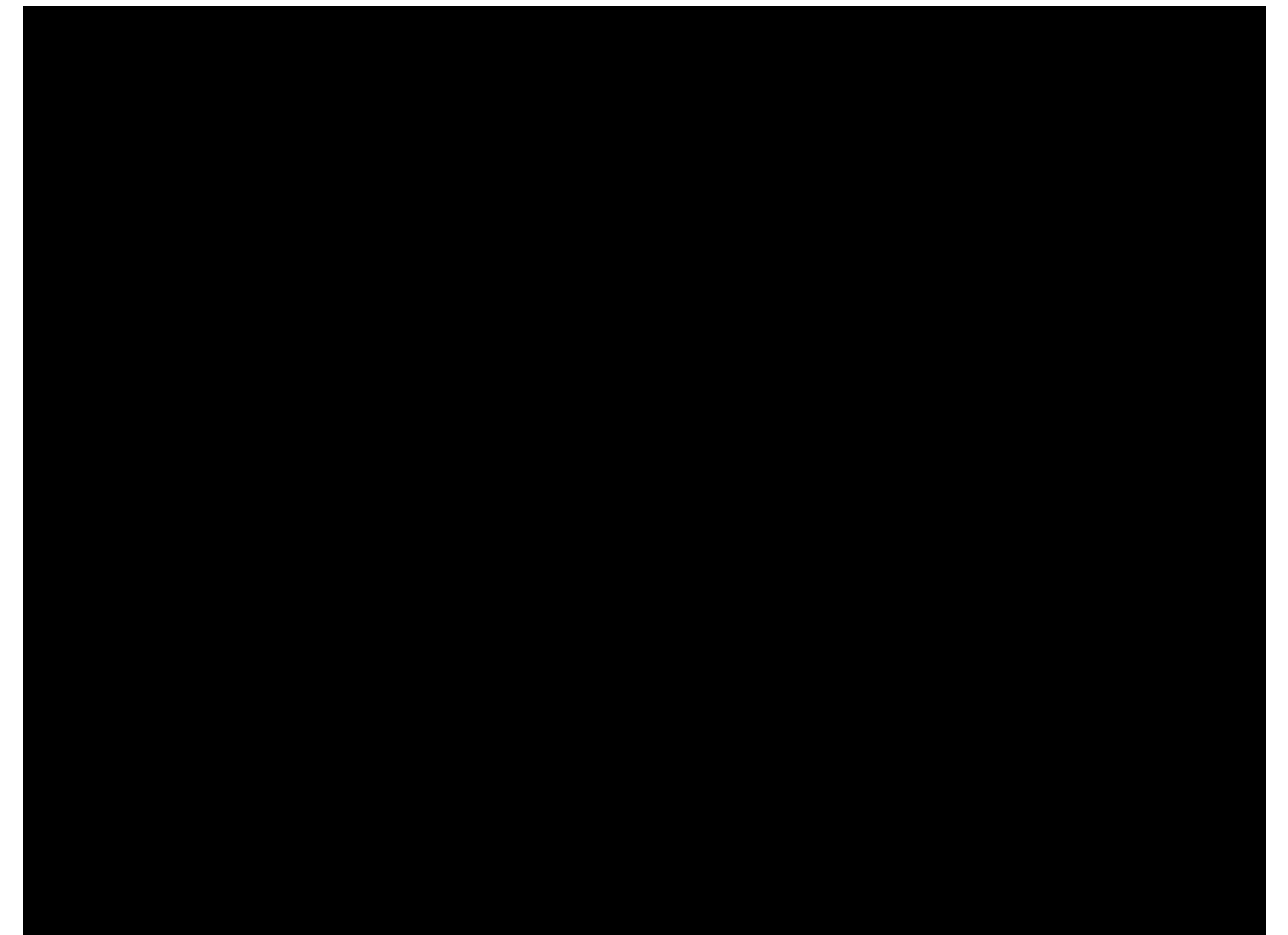
- Incise deeply with #10 blade scalpel; widen incision w/finger



- Insert olives coated in ultrasound gel



- Place approximately 10-12 olives as target lesions



Assemble “abscesses” and “gallbladders”

- Prep the balloons by partially inflating with air first to allow them to distend
- Fill balloons with 60-120 cc baby food mixture
- Puree only will give you an “abscess”; half puree and half water will yield a “gallbladder with sludge”

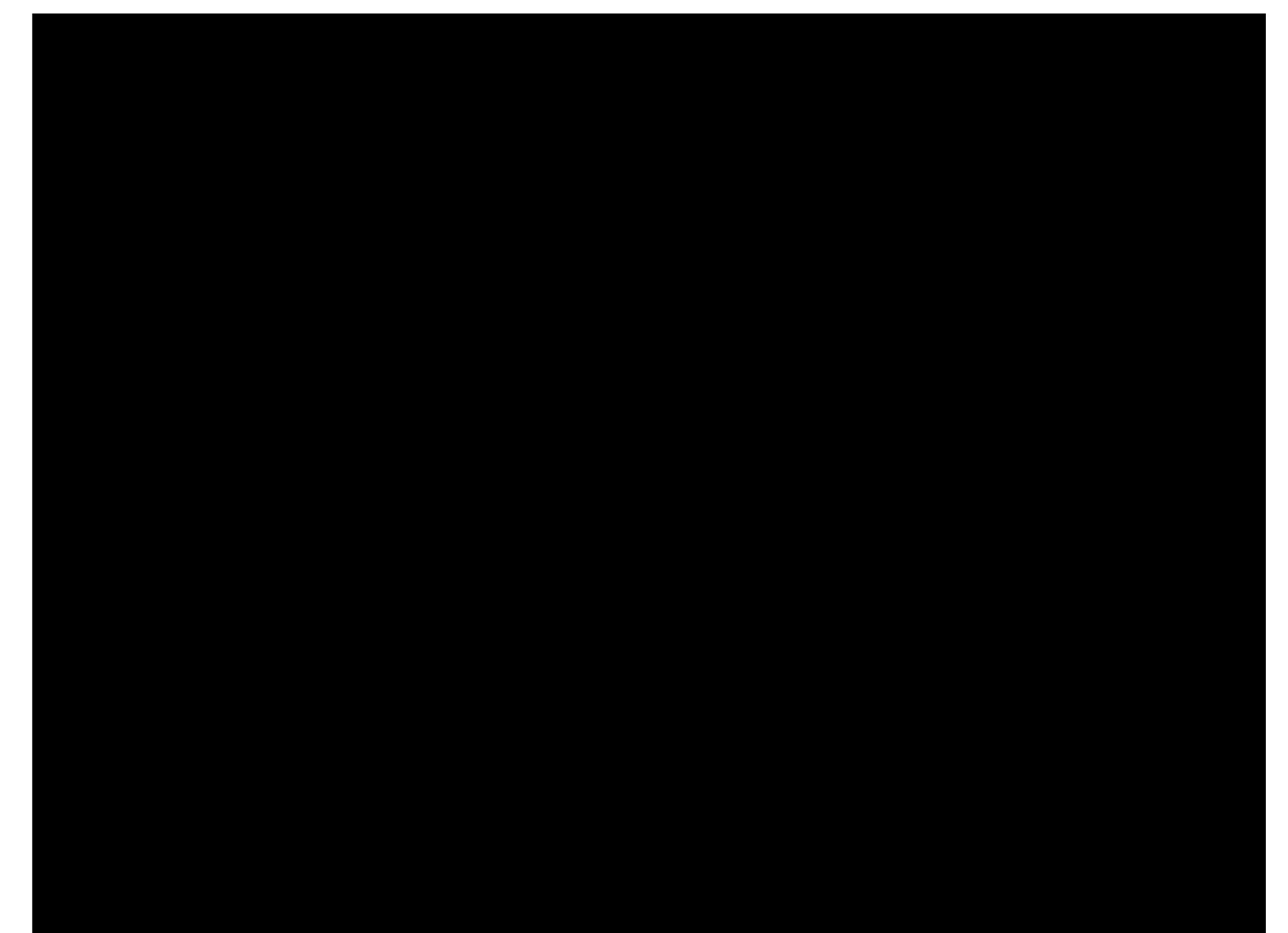
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• 100 cc of banana-strawberry puree creates an “abscess”



• Use different color balloons to denote “abscess” or “GB”

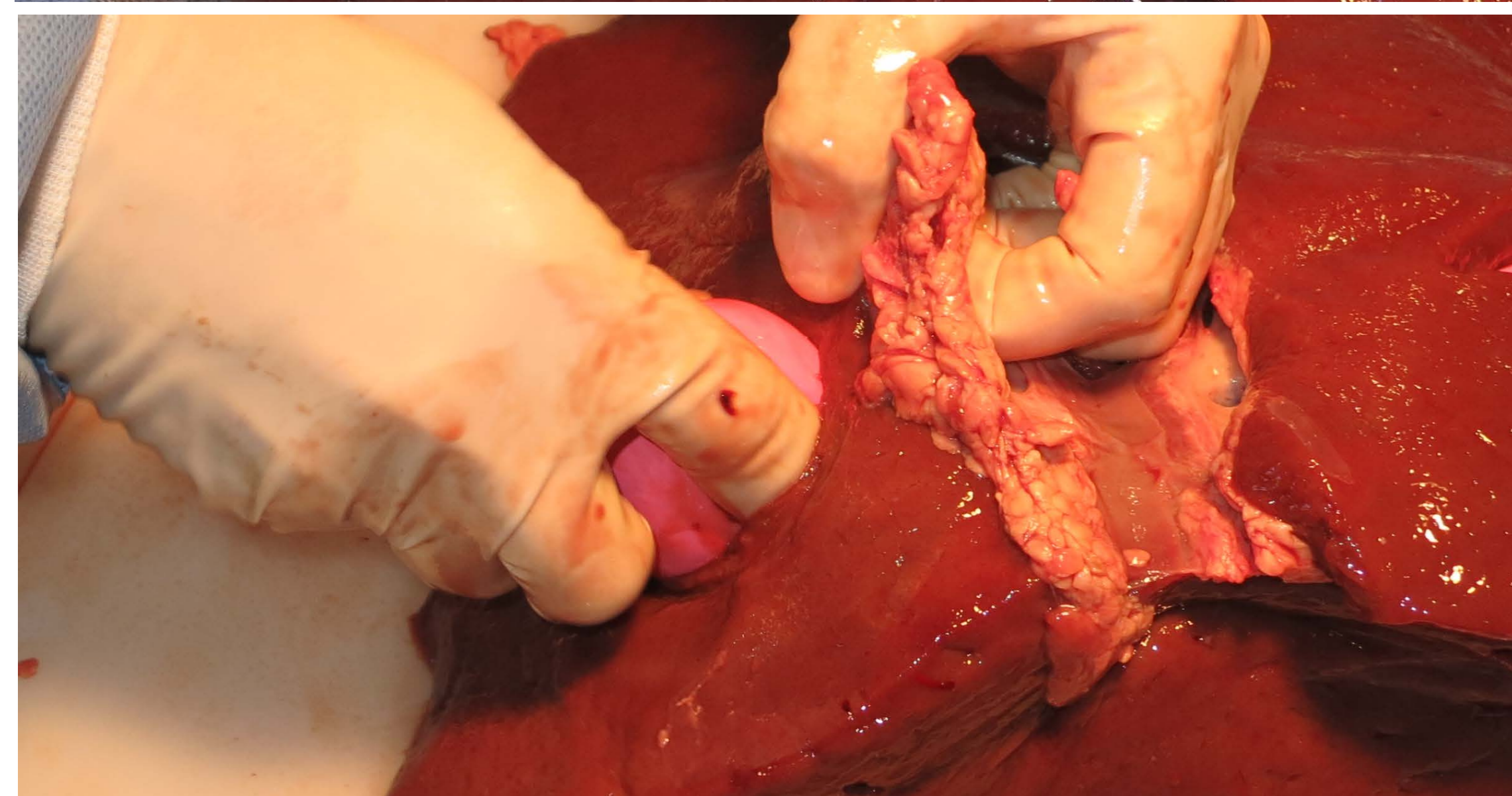
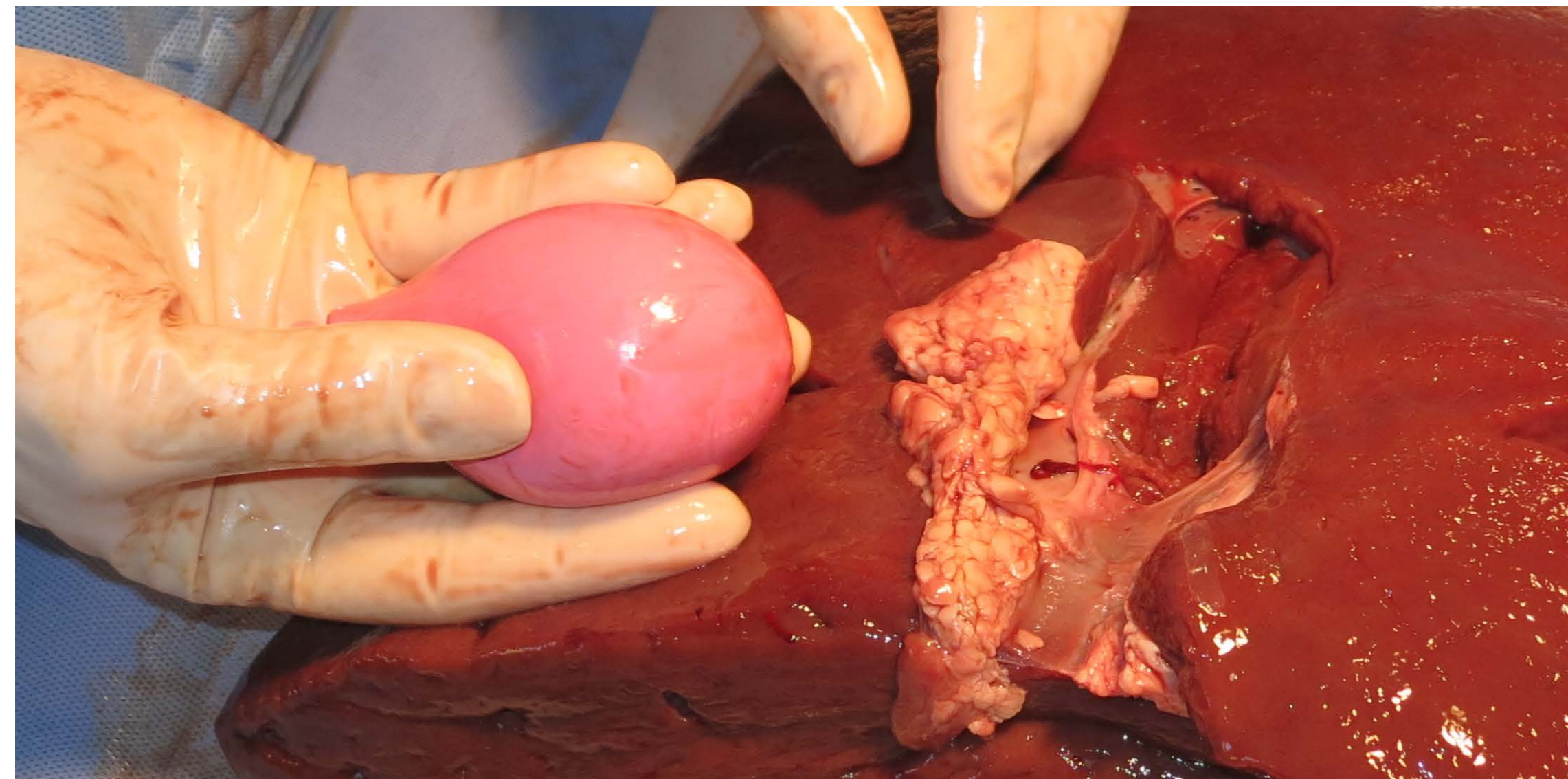


• Allow air to escape before tying off balloon (this is messy!)

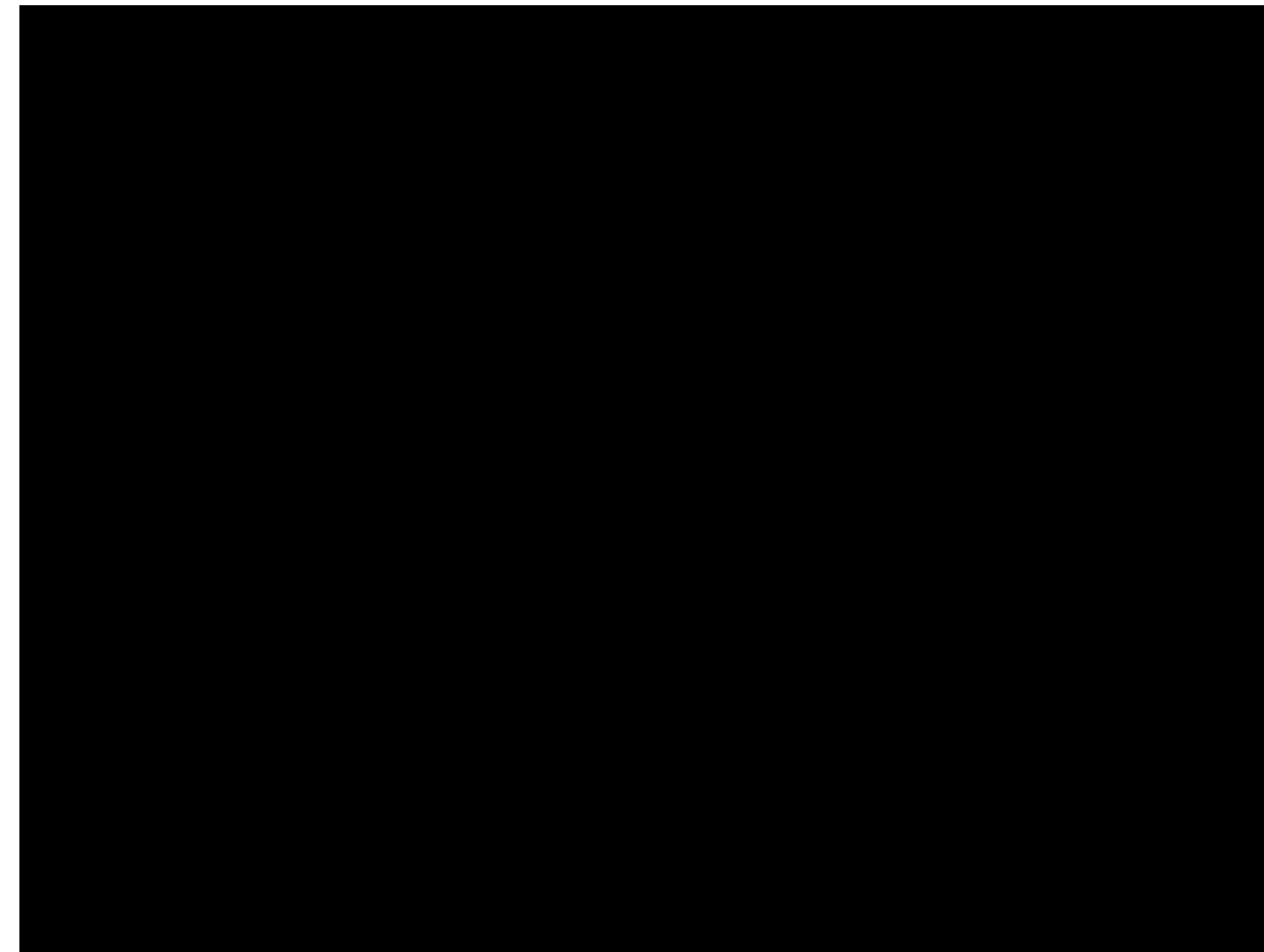
Constructing the Phantom: Add “abscesses”

- Turn liver over and place lesions from undersurface
Reduces acoustic artifact from air in near field

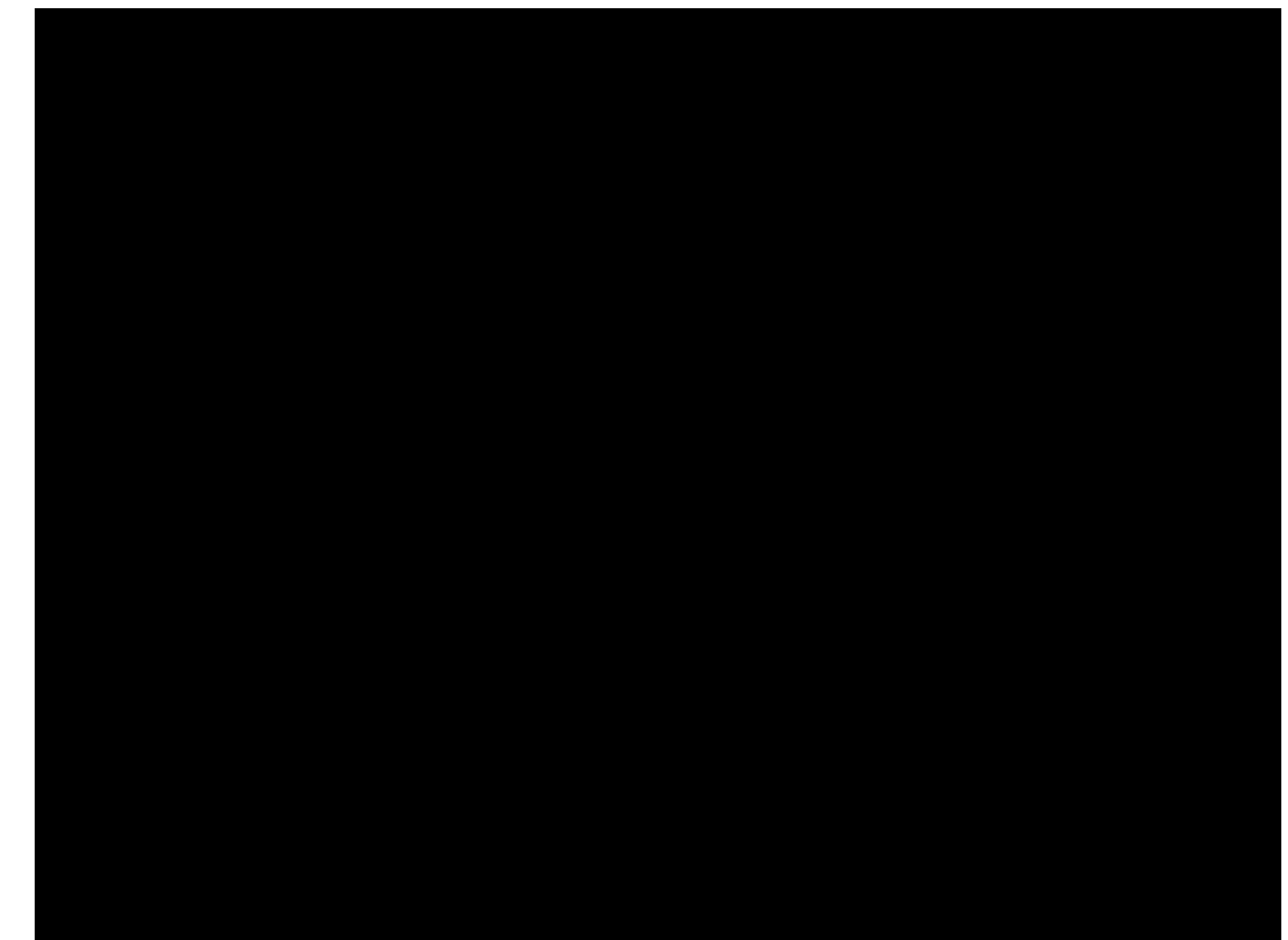
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- Incise deeply with #10 blade scalpel; finger dissect; insert balloon coated in ultrasound gel



- Suture abscesses in place using upholstery thread. A blunt tipped darning needle will help prevent needlesticks and easily penetrates liver



- Ultrasound appearance of abscess being drained

Constructing the Phantom: Add “gallbladders”

- Suture gallbladder (balloon filled with water and puree) to liver
Place along undersurface of free edge
We place two gallbladders on our models

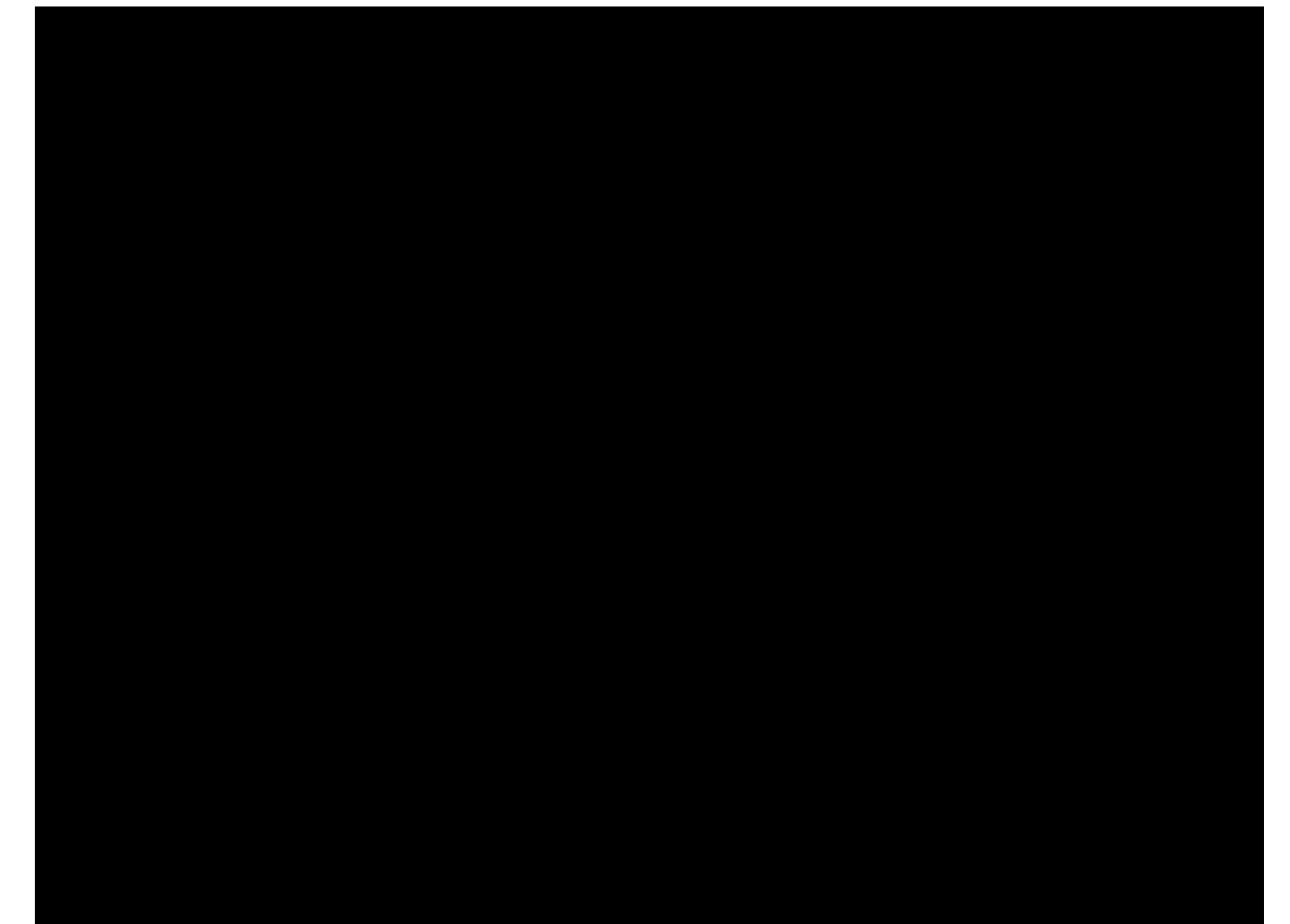
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• Suture gallbladder at the “neck” (knotted end of balloon).



• Two or more gallbladders can be used for more potential targets.

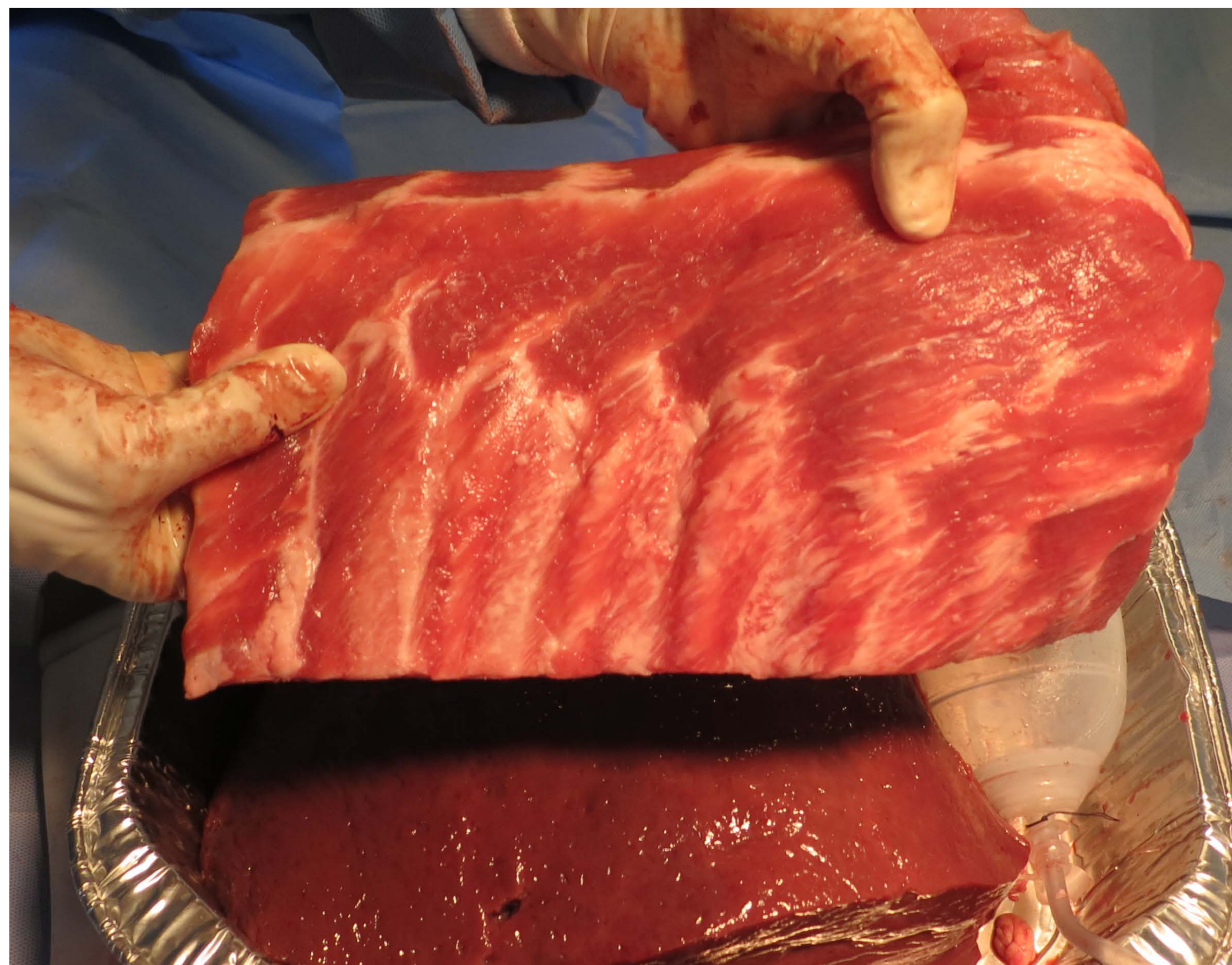


• It is easiest to form the knot first and then tighten over the balloon. A blunt tipped darning needle will help prevent needlesticks and easily penetrates liver.

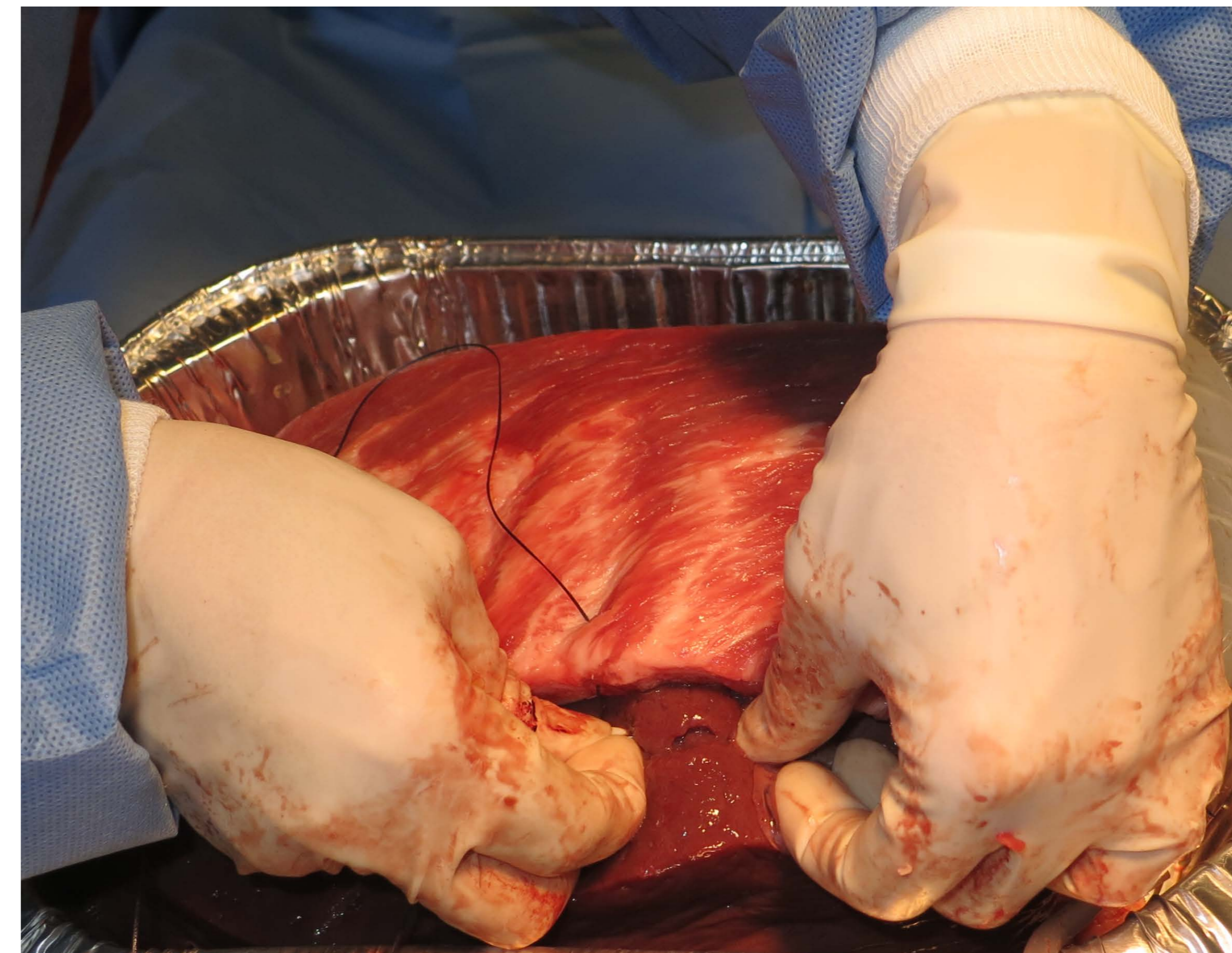
Completing the Phantom: Add rib layers

- Turn liver over and place rib slab on top
Coat liver and undersurface of slab with ultrasound gel
Reduces acoustic artifact from air in near field

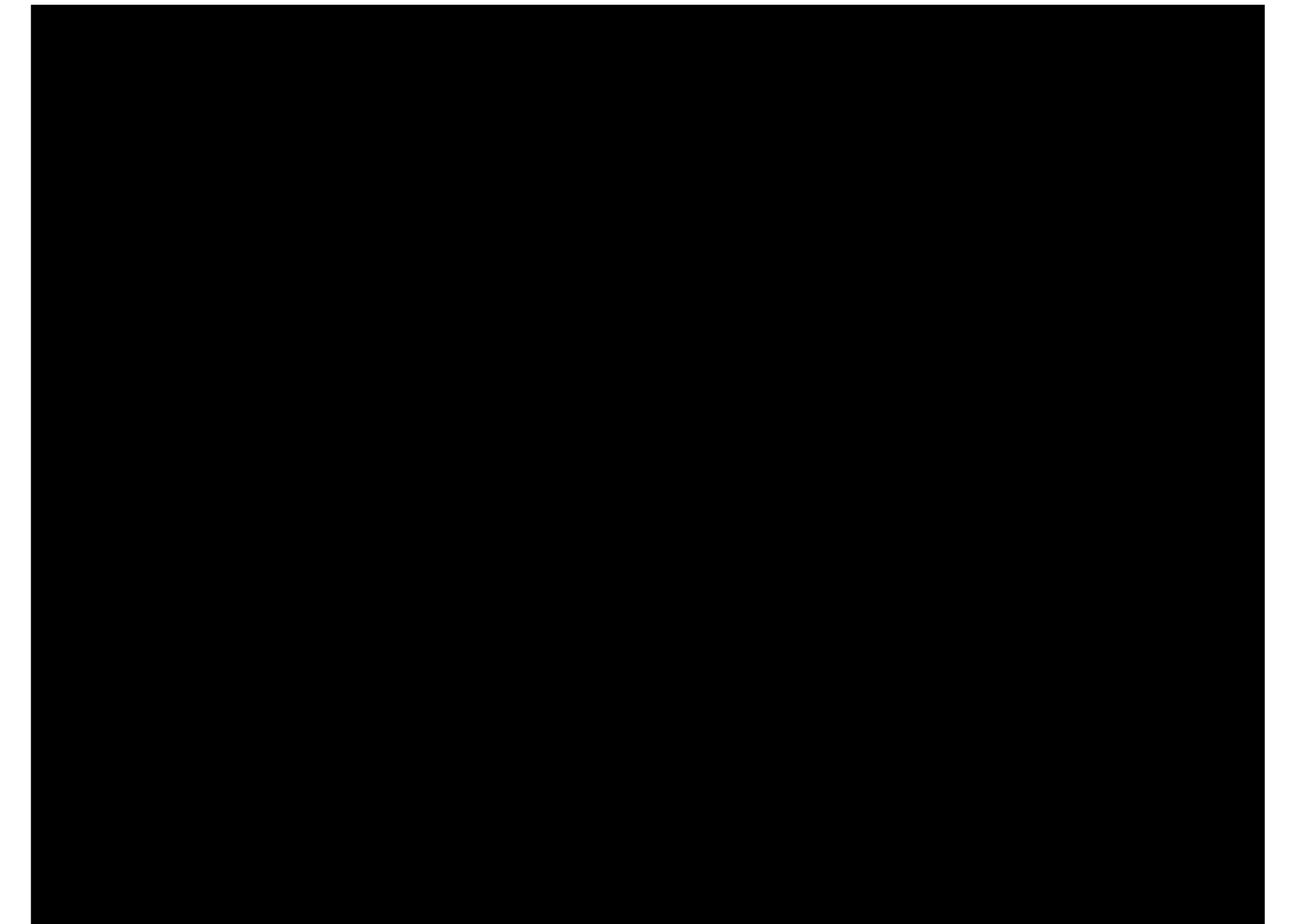
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- Place ribs over liver.
- The section containing only muscle is easier for beginners to access; portion containing bones is more challenging.



- A running stitch is used to secure the ribs in place. Use large bites (the liver tears easily).



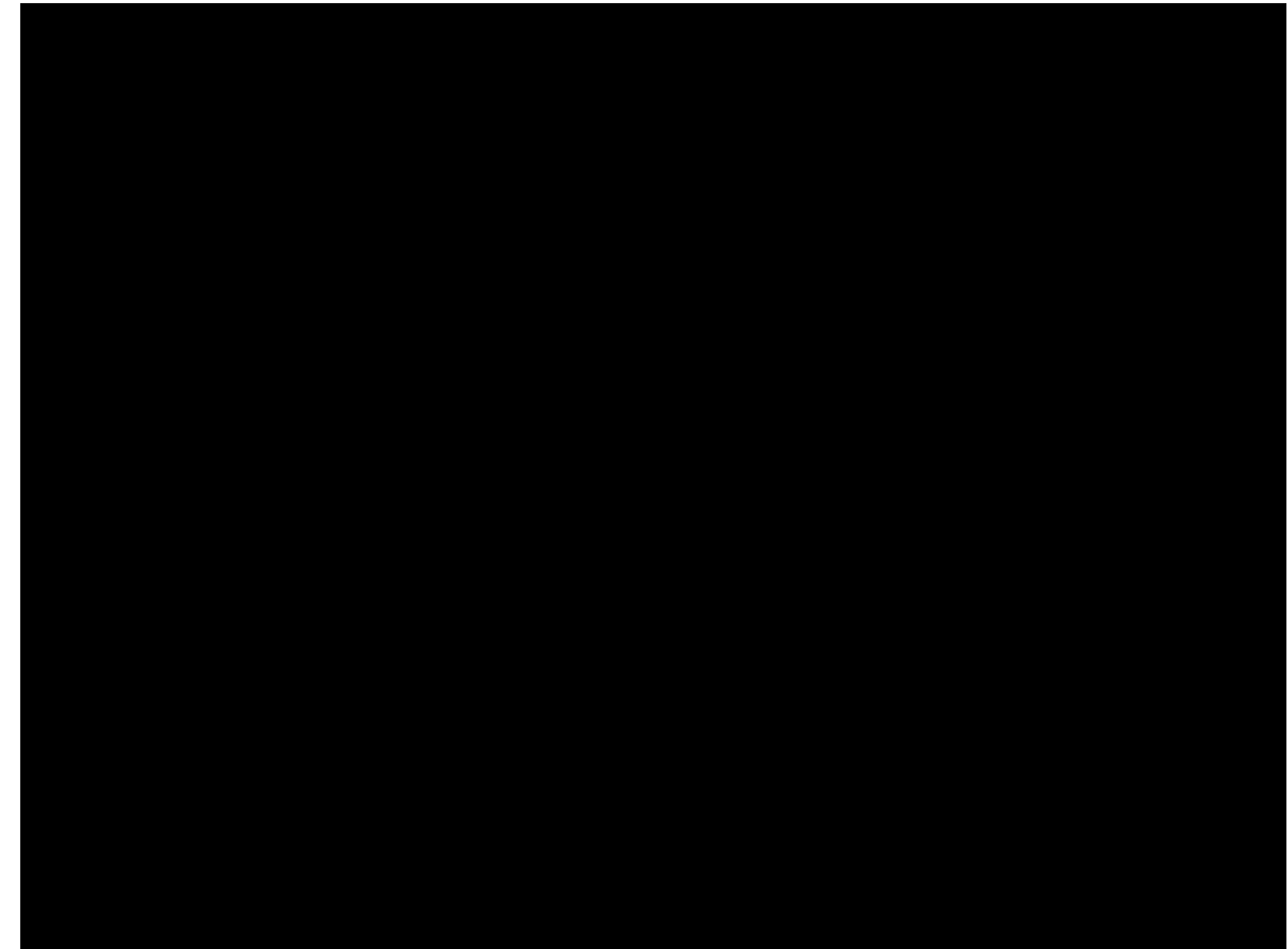
- Suture ribs in place using upholstery thread. A blunt tipped darning needle will help prevent needlesticks and easily penetrates liver.

Technique – targeted liver biopsy

Steps demonstrated on the model:

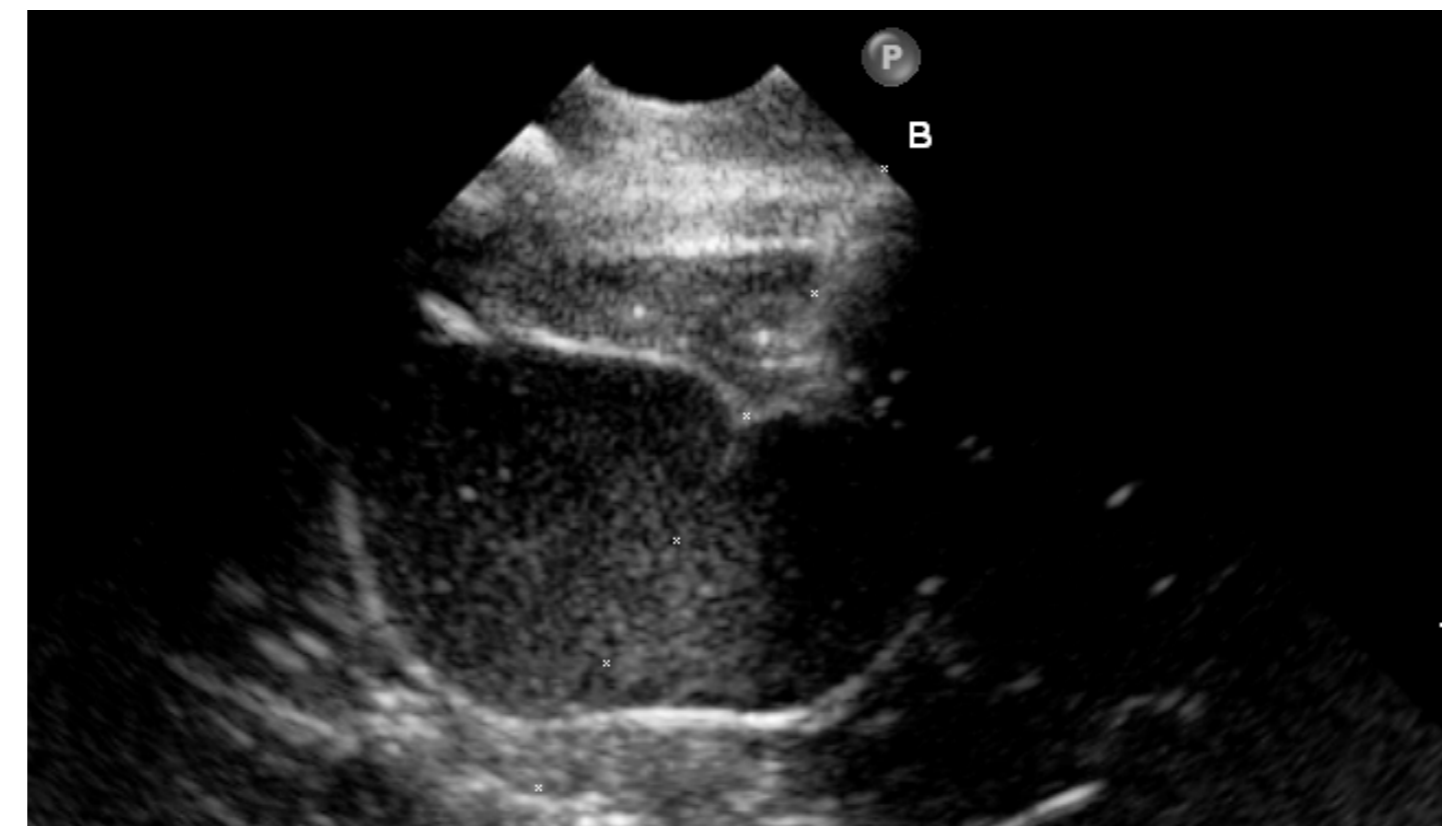
- Needle advanced to margin of lesion, allowing for respiratory motion
- Position confirmed and biopsy obtained

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Technique – drainage catheter placement

- Steps demonstrated on the model:
- Catheter, mounted on metal stiffener and internal trocar, passed into abscess.
- Sharp trocar withdrawn.
- Catheter deployed into collection, holding stiffener in position.
- Stiffener withdrawn.



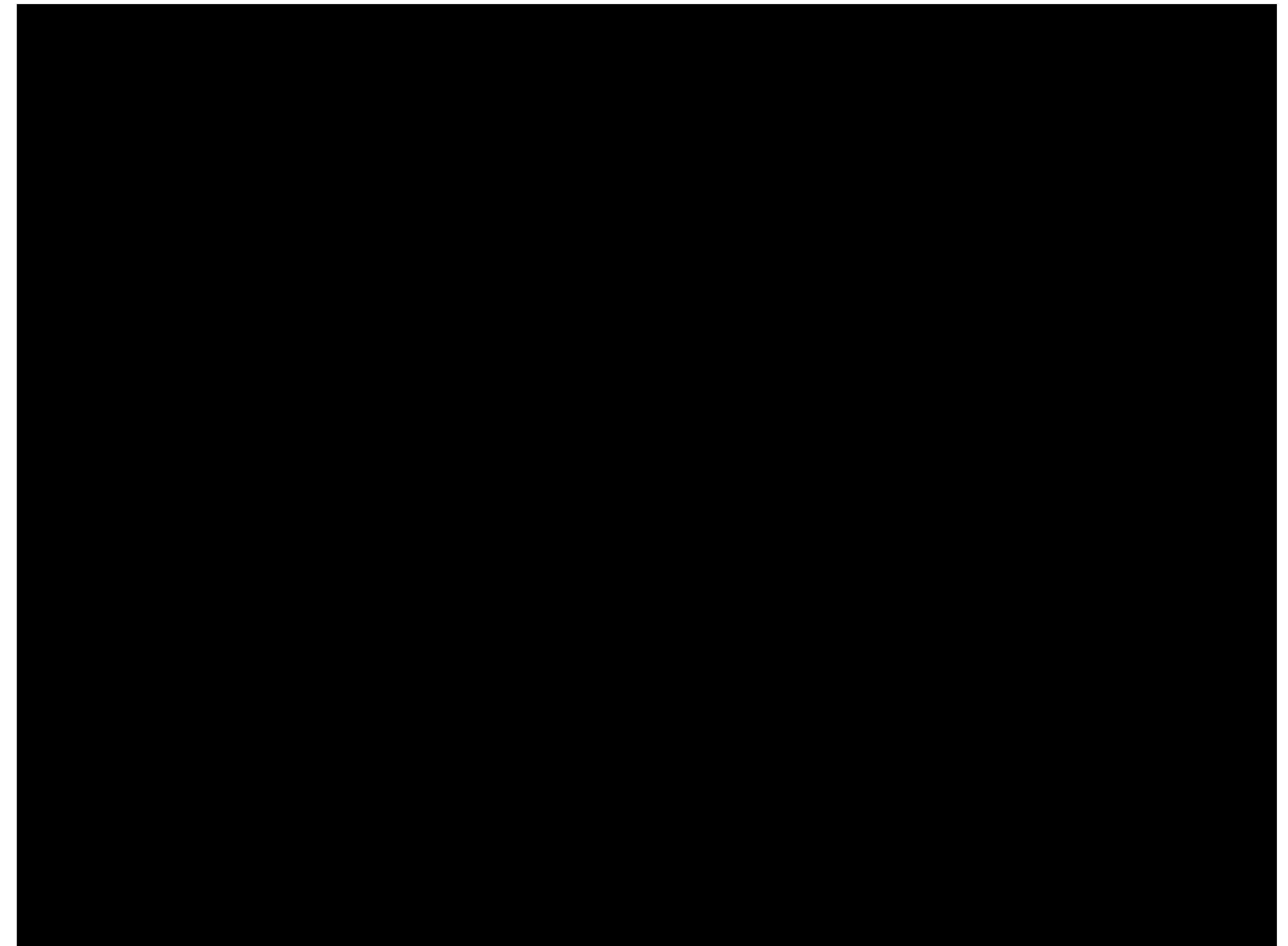
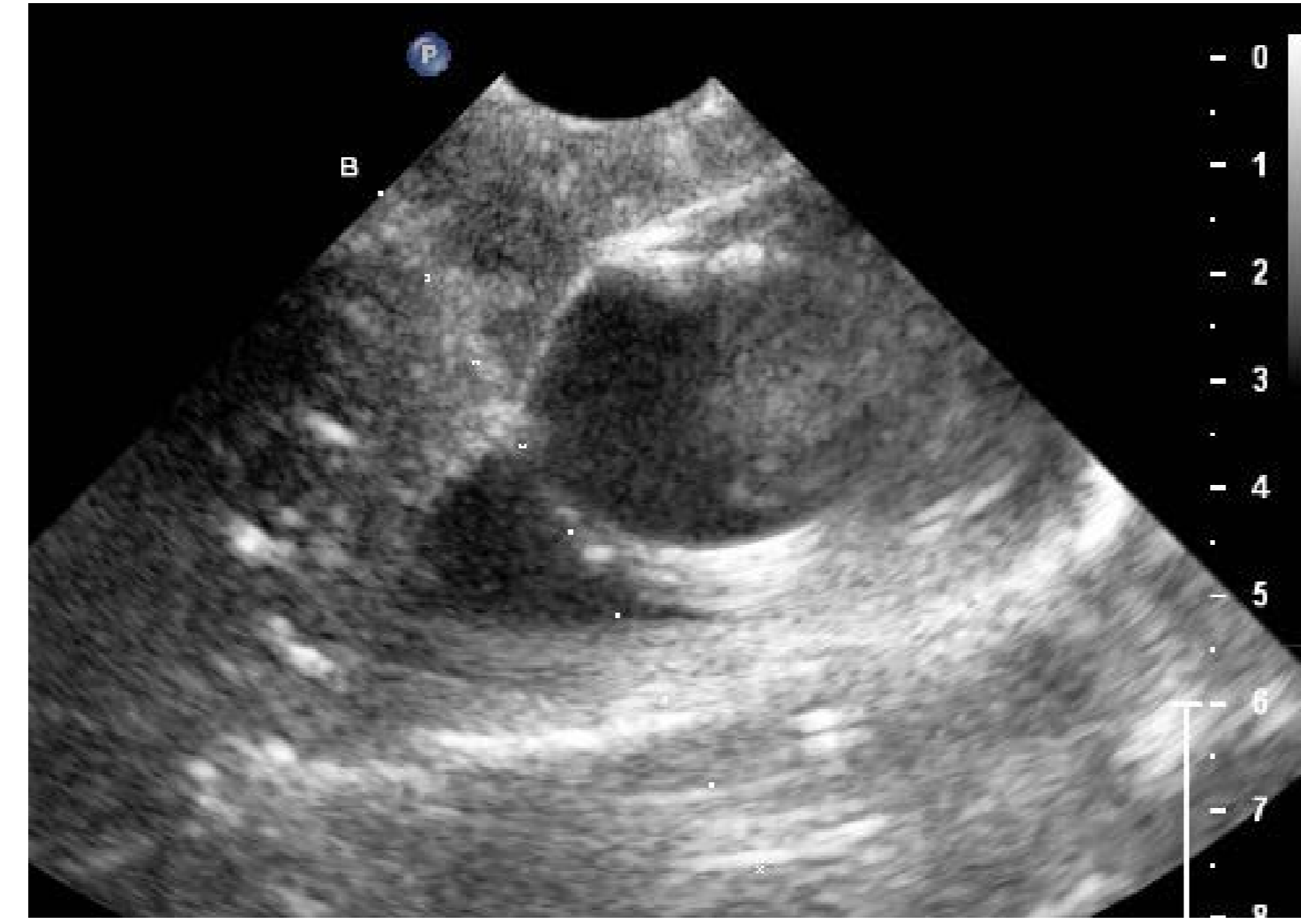
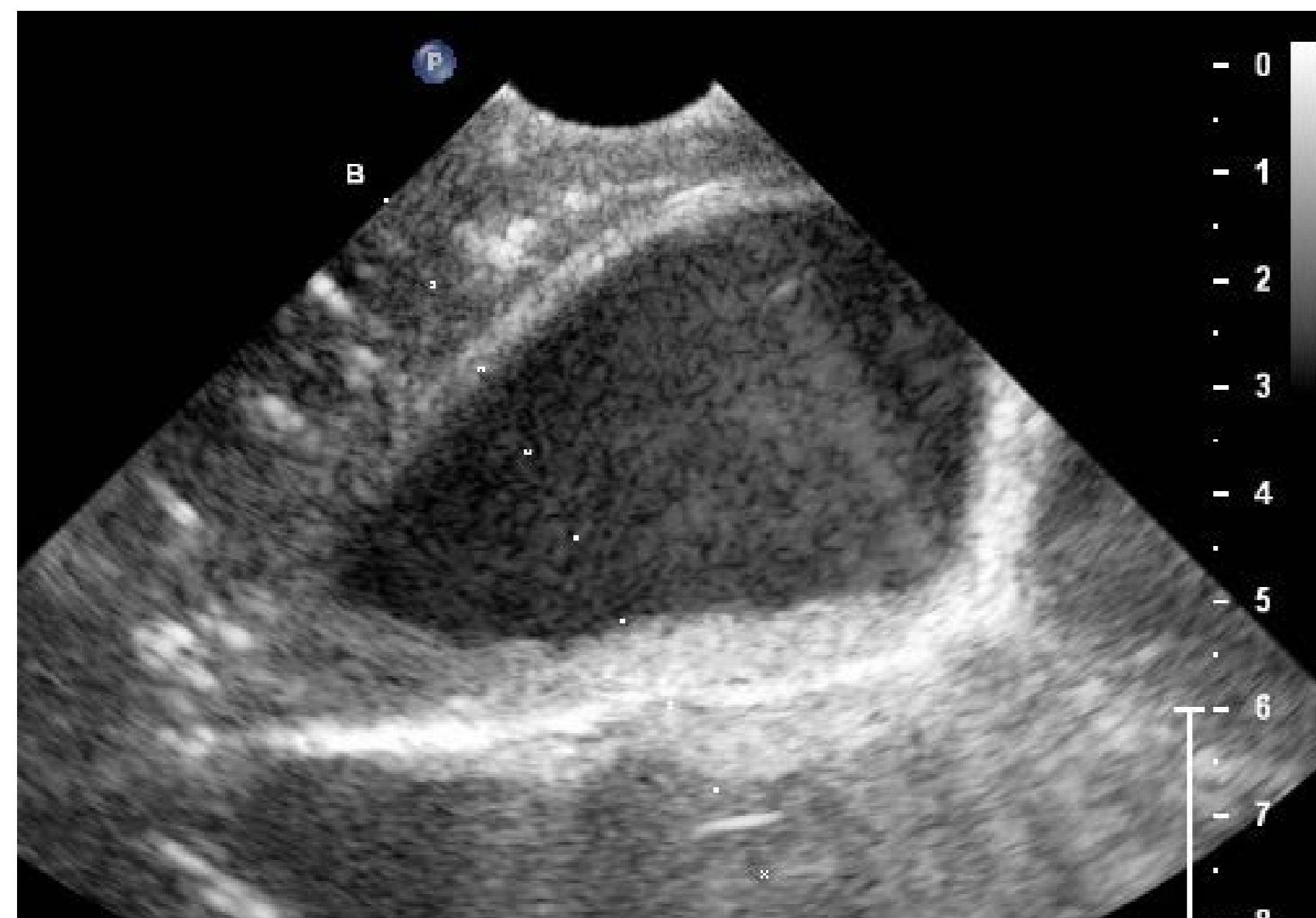
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•Still images: trocar-mounted catheter accessing abscess and pigtail catheter deployed in abscess.

Gallbladder drainage: results

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- Cine clip: Evacuation of gallbladder in simulated cholecystostomy tube placement
- Gallbladder can be refilled via same catheter prior to next use



Acknowledgements

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