Lumbar Puncture

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Learning Objectives

- Discuss lumbar puncture indications and contraindications
- Review and understand lumbar spine anatomy
- Review lumbar puncture procedure steps
- Review and discuss ultrasound guided lumbar puncture

Indications

Urgent	Diagnosis Requires LP	LP Supplements Diagnosis	Therapeutic
CNS Infection	Idiopathic Intracranial Hypertension	Neurosarcoidosis	Intrathecal Chemotherapy
Suspected SAH	Normal Pressure Hydrocephalus	CNS Vasculitis	Intrathecal Antibiotics
	Neurosyphilis	Multiple Sclerosis	Contrast Injections
	CNS Lymphoma	Neurodegenerative Diseases	Spinal Anesthesia
	Carcinomatous Meningitis		
	Autoimmune Encephalitis		
	AIDP		

Contraindications

- Increased intracranial pressure
- Coagulopathy
- Respiratory compromise
- Suspected epidural abscess

Bleeding risk

Bleeding anywhere within the central nervous system has the potential for devastating neurologic consequences; therefore, multiple societies have chosen to classify pain procedures such as vertebral augmentation and procedures with risk of epidural bleeding as being associated with high bleeding risk (32), and the AABB has chosen to recommend a "fairly liberal" platelet count of 50 × 10^9/L as the threshold for lumbar puncture (69). This is supported by the C17 guidelines committee (84), which recommends transfusion at a platelet count threshold of 50 × 10^9/L for diagnostic lumbar puncture for newly diagnosed pediatric patients with leukemia and a threshold for transfusion of 20 × 10^9/L for pediatric patients in stable condition requiring lumbar puncture. Similar studies and recommendations are not available to establish an INR threshold.

of ≤ 2.0–3.0‡
Platelets: transfuse if < 20 × 10^9/L

IVC filter placement and removal‖
Lumbar puncture¶
Nontunneled chest tube placement for pleural effusion
Nontunneled venous access and removal (including PICC placement)
Paracentesis
Peripheral nerve blocks, joint, and musculoskeletal injections§
Sacroiliac joint injection and sacral lateral branch blocks§
Superficial abscess drainage or biopsy (palpable lesion, lymph node, soft tissue, breast, thyroid, superficial bone, eg, extremities and bone marrow aspiration)
Thoracentesis
Transjugular liver biopsy#
Trigger point injections including piriformis§
Tunneled drainage catheter placement‡
Tunneled venous catheter placement/removal (including ports) ‡

Patel et al J Vasc Interv Radiol 2019;30(8):1168-1184.e1

Anticoagulant Black Box Warnings

WARNING: (A) PREMATURE DISCONTINUATION OF ELIQUIS INCREASES THE RISK OF THROMBOTIC EVENTS

(B) SPINAL/EPIDURAL HEMATOMA

See full prescribing information for complete boxed warning.

(A) PREMATURE DISCONTINUATION OF ELIQUIS INCREASES THE RISK OF THROMBOTIC EVENTS: Premature discontinuation of any oral anticoagulant, including ELIQUIS, increases the risk of thrombotic events. To reduce this risk, consider coverage with another anticoagulant if ELIQUIS is discontinued for a reason other than pathological bleeding or completion of a course of therapy. (2.4, 5.1, 14.1)

(B) SPINAL/EPIDURAL HEMATOMA: Epidural or spinal hematomas may occur in patients treated with ELIQUIS who are receiving neuraxial anesthesia or undergoing spinal puncture. These hematomas may result in long-term or permanent paralysis. Consider these risks when scheduling patients for spinal procedures. (5.3)

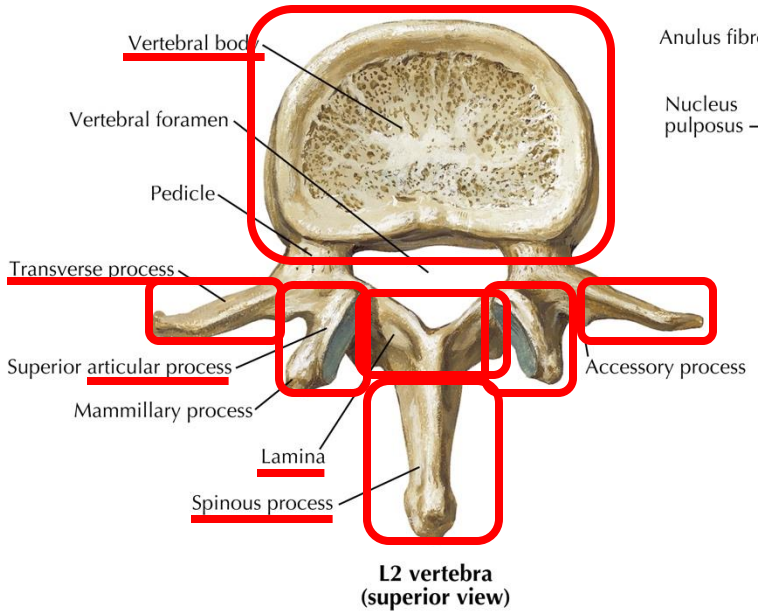
ACP

Antithrombotic Recommendations

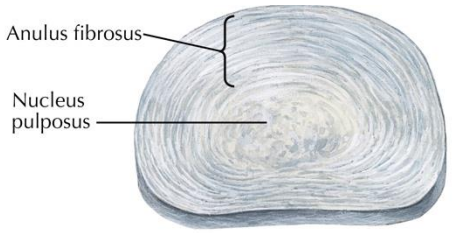
Antiplatelets	Withhold	First Dose After LP	Anticoagulants	Withhold	First Dose After LP
Aspirin	Continue	No Delay	Warfarin	5 days, check INR	12 Hours
Clopidogrel	7 Days	6 Hours	LMWH Prophy	12 Hours	4 Hours
Prasugrel	7 Days	6 Hours	LMWH Treatment	24 Hours	4 Hours
Ticagrelor	7 Days	6 Hours	IV Heparin	4 to 6 Hours	1 Hour
Dipyridamole	24 Hours	6 Hours	Xa Inhibitors	24 Hours	6 Hours
			Dabigatran	48 Hours	6 Hours

Adapted from Dodd et al. Association of British Neurologists clinical guideline. Pract Neurol 2018;18(6):436–46

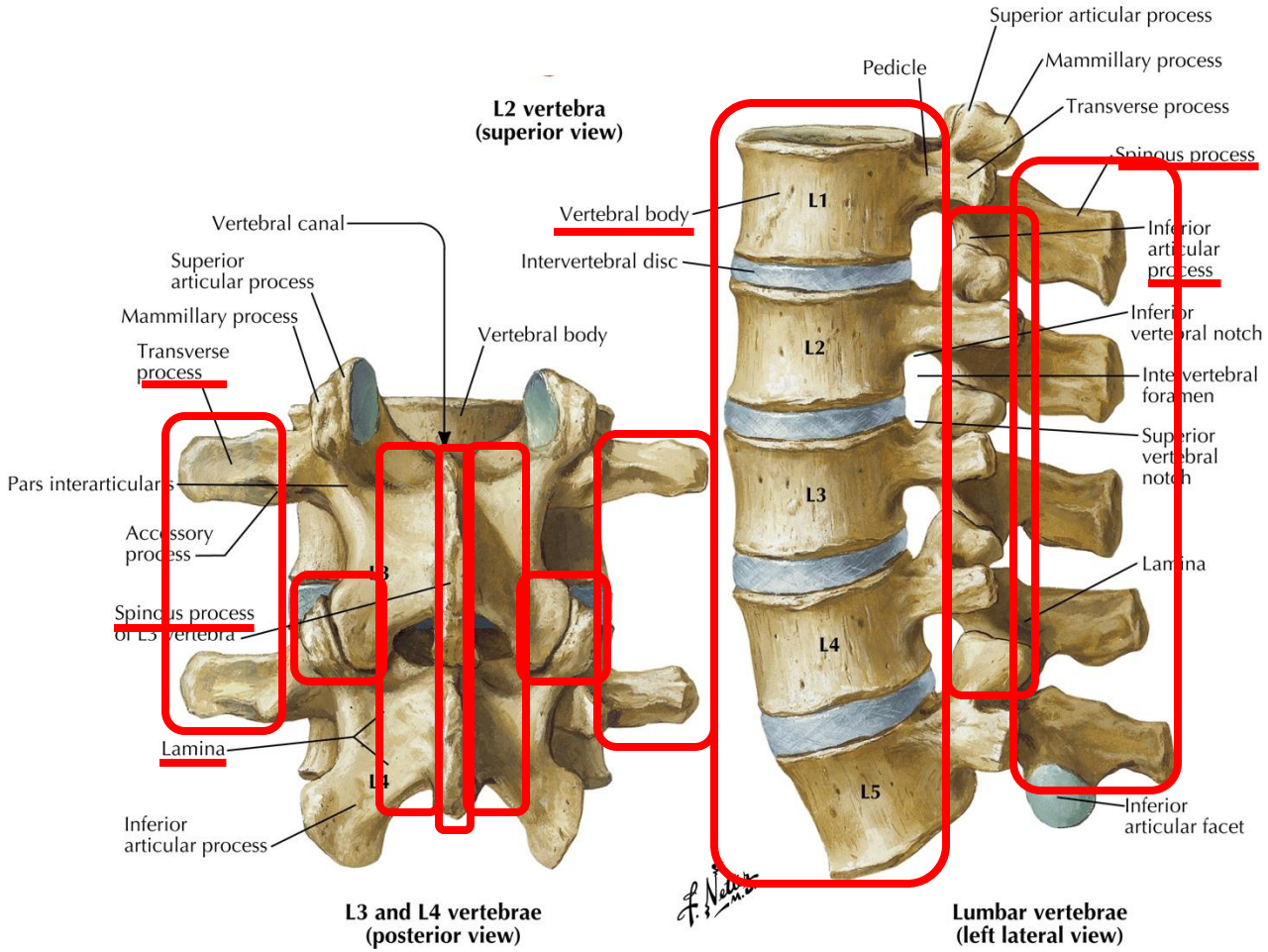
Lumbar Spine Anatomy



L2 vertebra
(superior view)



Intervertebral disc



Netter Atlas of Human Anatomy 8th ed. Elsevier; 2022.

Pre-Procedure Steps

- **Obtain informed consent**
- Review contraindications
- Position the patient: Left lateral decubitus (most common) or sitting
- Gather lumbar puncture tray with 22G spinal needle, sterile gloves
- Mark the site at L3-L4 or L4-L5 (iliac crest ~L4)

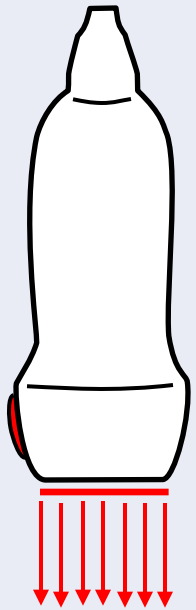
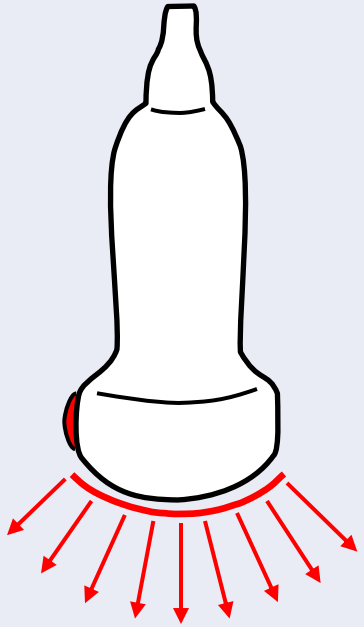
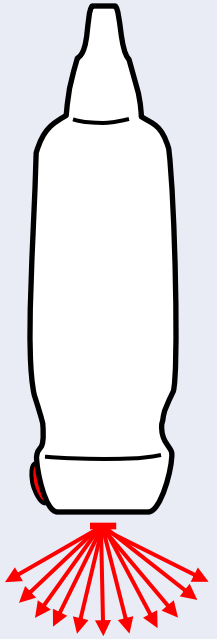
Procedure Steps

- Open tray, wear mask and sterile gloves
- Clean with povidone-iodine, allow to dry, apply drape
- Infiltrate skin with lidocaine for local anesthesia
- Insert the spinal needle bevel up, in a slight cephalad angle
- Advance slowly, feel a ”pop” as needle passes the ligamentum flavum
- Remove stylet, measure opening pressure, obtain samples
- Replace stylet before removing needle

Why Use Ultrasound?

- Accurately identifies lumbar spine level
- Improves success rates (~10% higher vs landmark technique)
- Reduces complications such as post-LP headaches, back pain
- High-quality images are easy to obtain

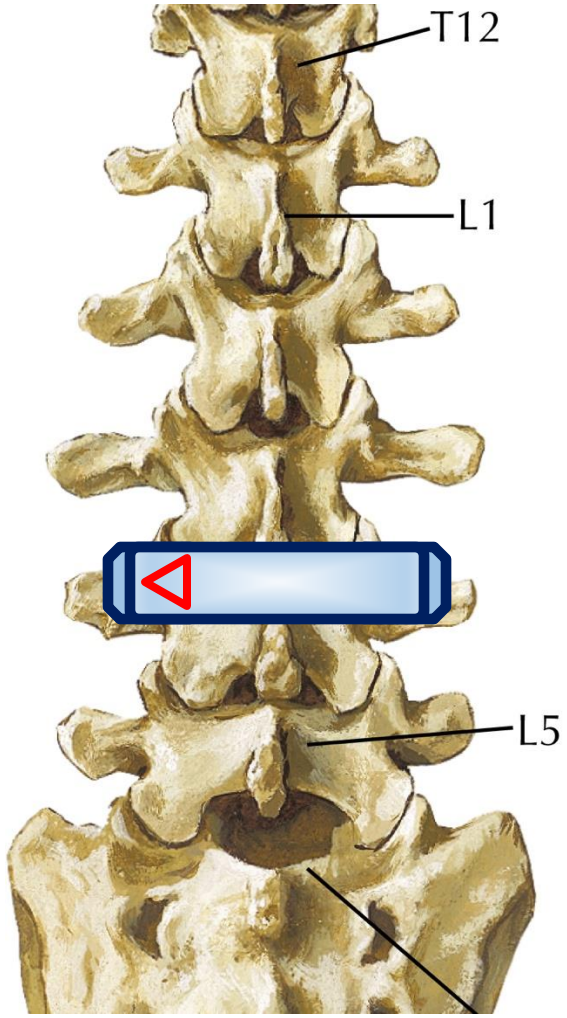
Transducer Selection

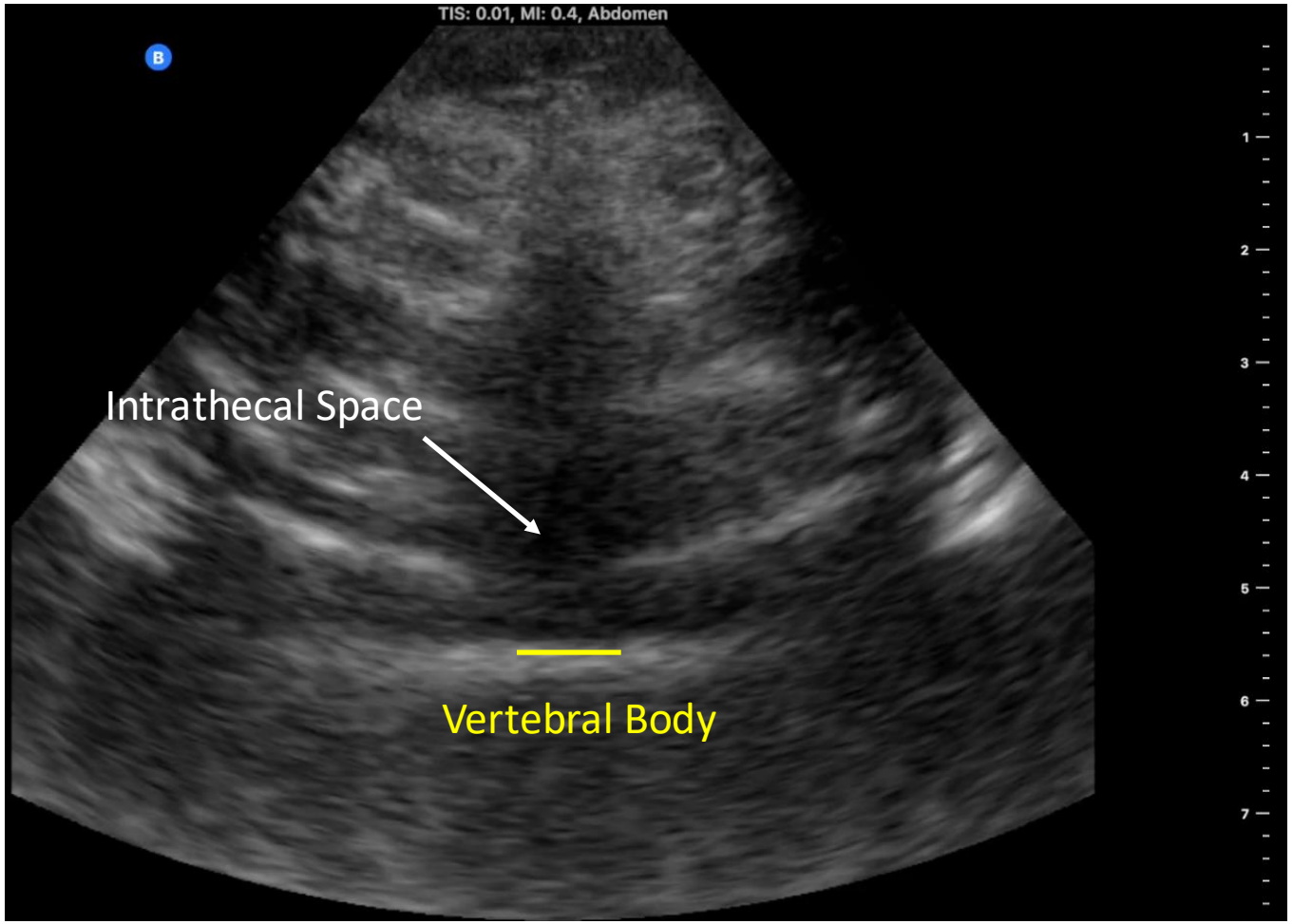
Higher Frequency	Lower Frequency	
Linear	Curvilinear (Convex)	Phased-Array
		
Up to 6 cm	Greater than 6 cm	

Lumbar Spine Ultrasound

- Parasagittal Transverse Process View
- Parasagittal Articular Process View
- Parasagittal Oblique View
- Midline Sagittal Spinous Process View
- Transverse Interspinous View
- Transverse Spinous Process View
- Transverse Oblique Foraminal View

Transverse Interspinous





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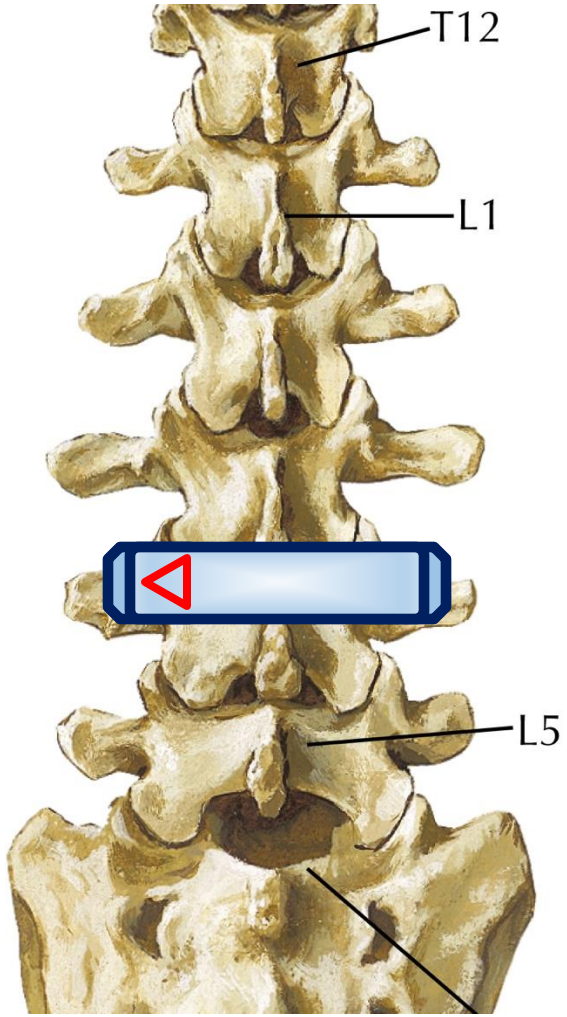
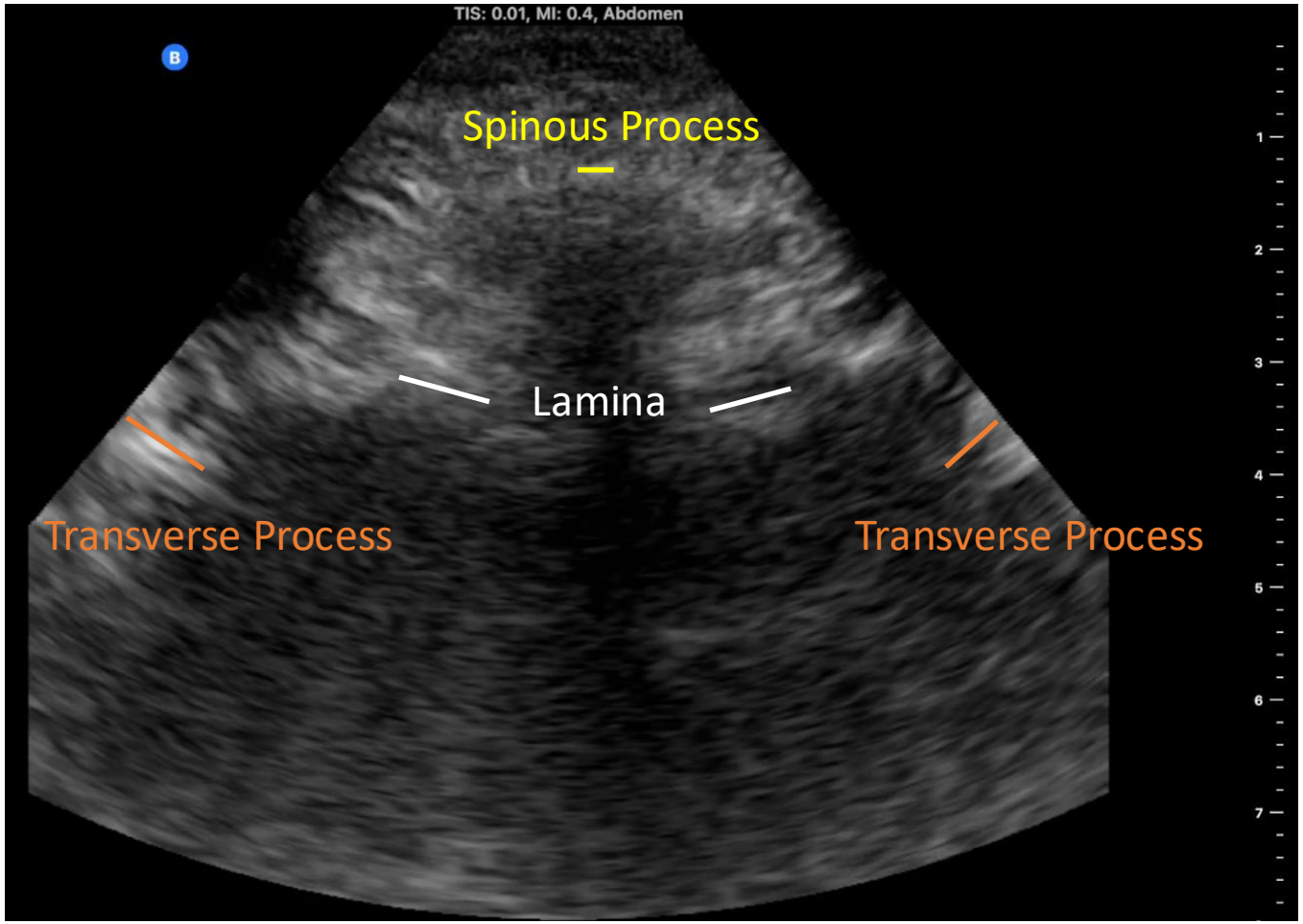
Transverse Spinous Process





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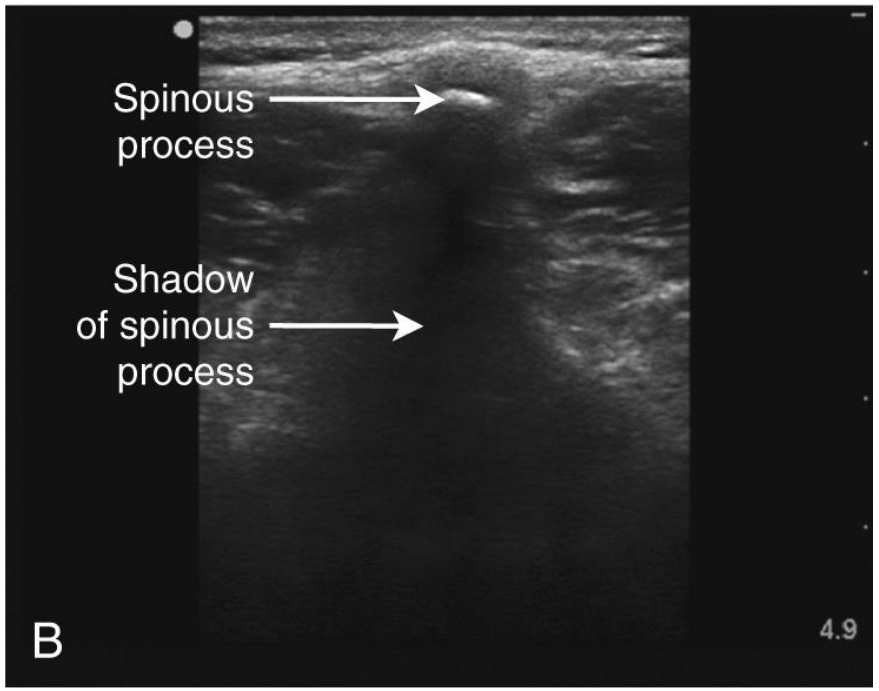
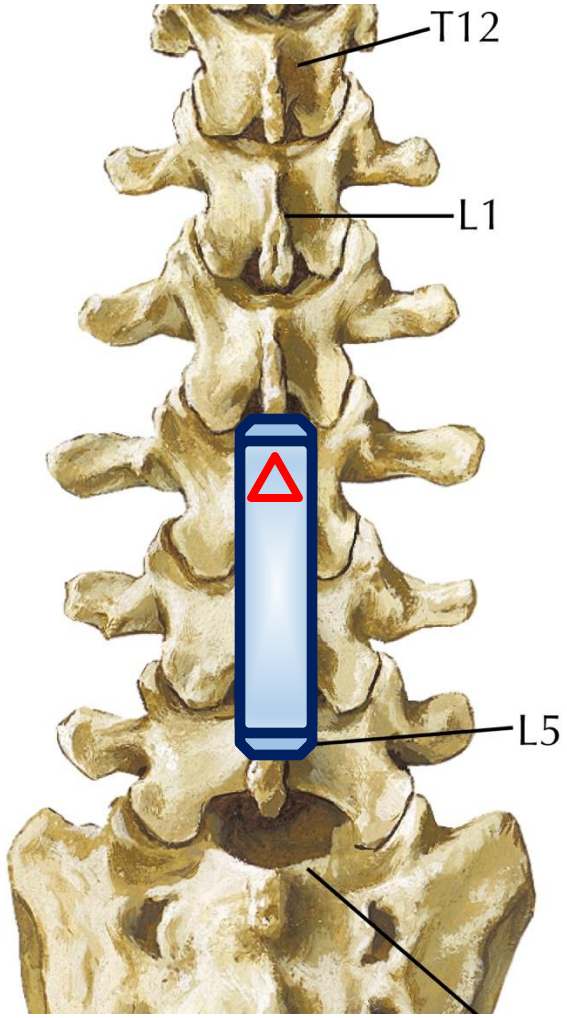
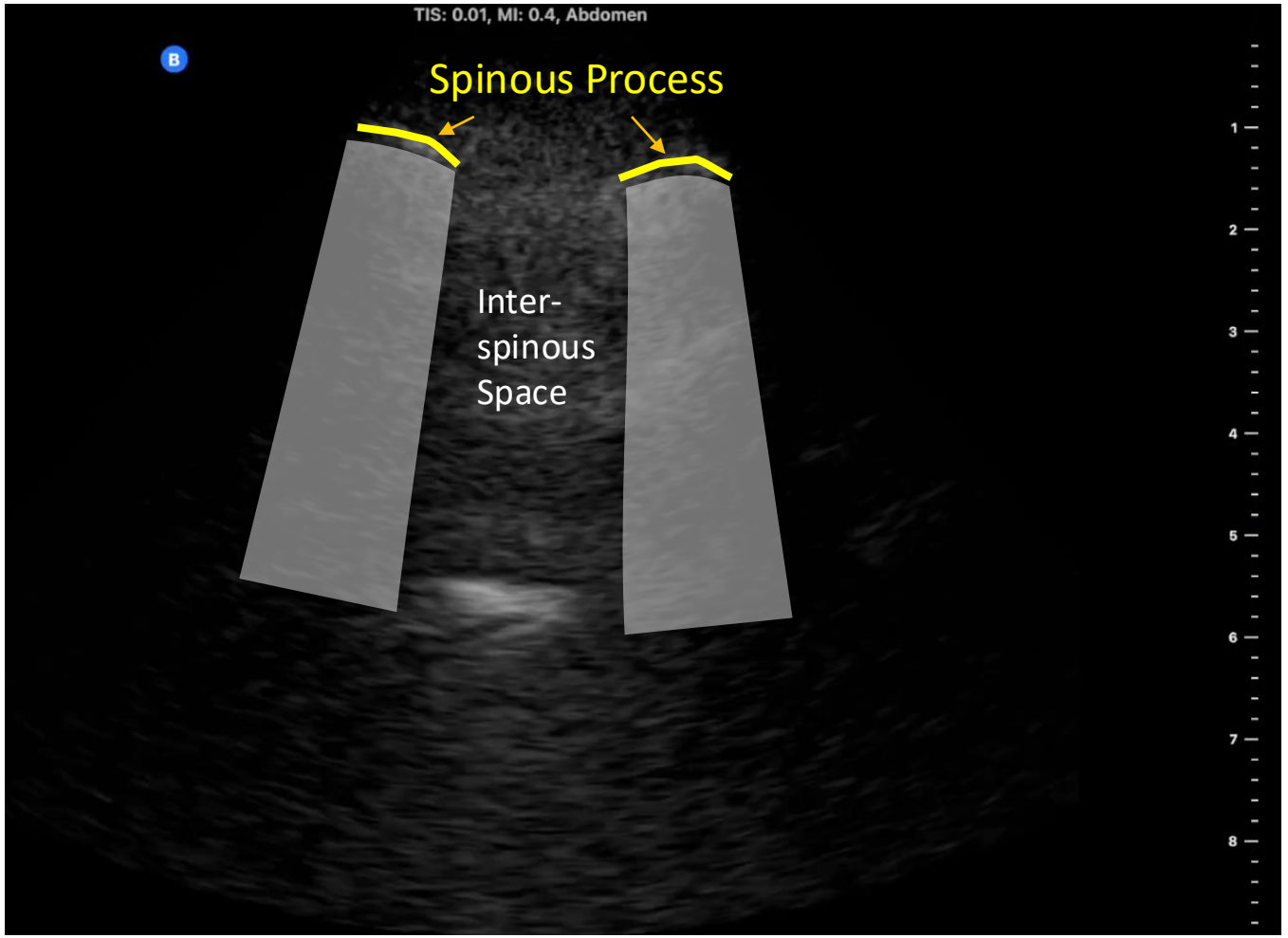
Mark Midline in Transverse View



Soni N. Point of Care Ultrasound. 2nd ed. 2019

Midline Sagittal Spinous Process





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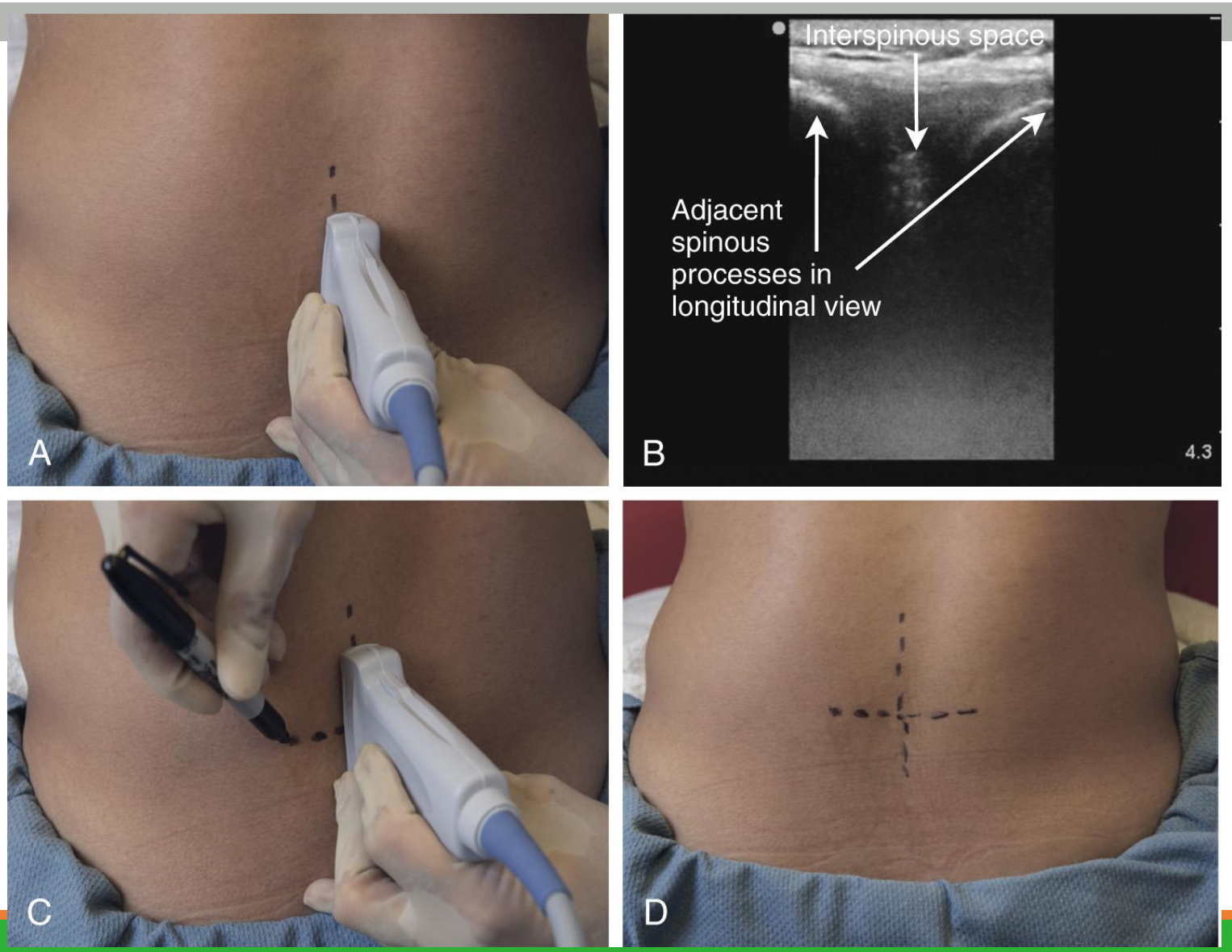
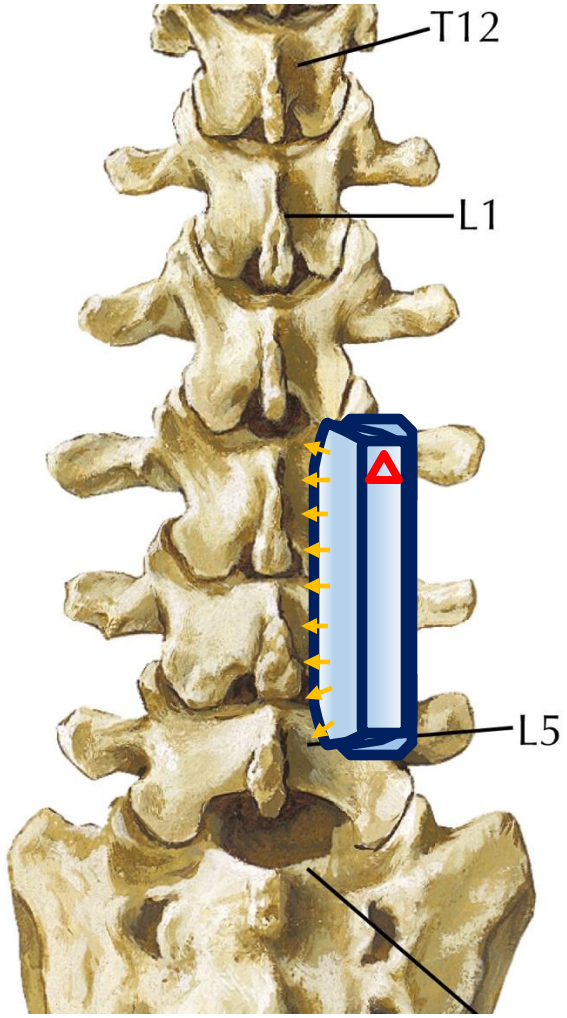
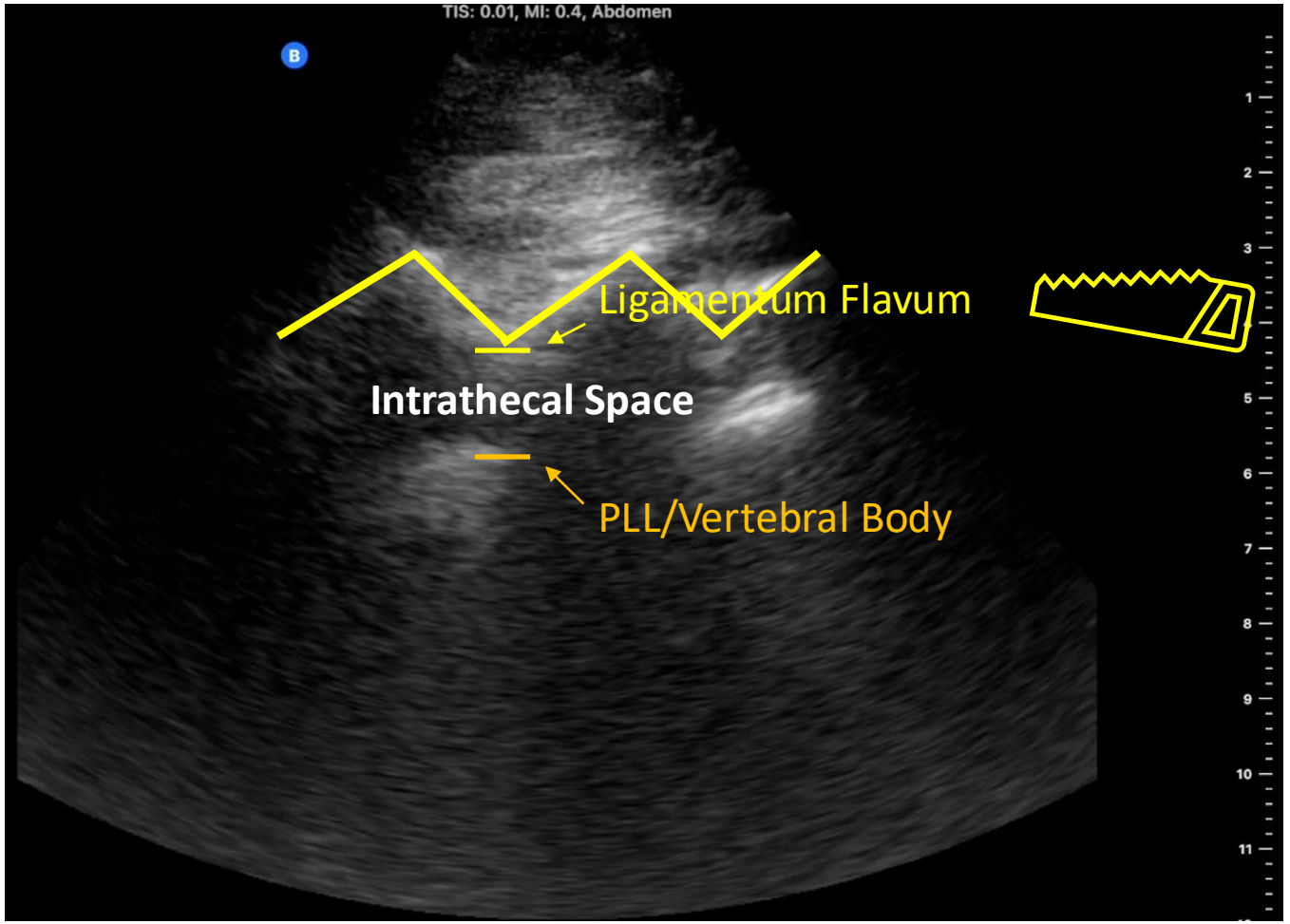
Mark Interspinous Space in Longitudinal View



Soni N. Point of Care Ultrasound. 2nd ed. 2019

Longitudinal Paramedian View: Estimate Depth





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Cerebrospinal Fluid Analysis

Send CSF for

- Cell count and differential
- Glucose concentration
- Protein concentration
- Gram stain and bacterial culture
- Other tests: PCR, Immunoglobulins, LDH, Cytology

Cerebrospinal Fluid Findings

Test	Normal	Subarachnoid Hemorrhage	Bacterial	Viral
Opening Pressure (cmH_2O)	6-20	Normal or ↑	↑	Normal or ↑
Appearance	Clear	Bloody, xanthochromic	Turbid	Clear
WBC (per mm^3)	<5	Normal to ↑	1000	100
RBC (per mm^3)	<1	↑↑	Normal	Normal
Protein (mg/dL)	18-58	Normal to ↑	↑	Normal or ↑
Glucose (mg/dL)	Variable	Normal	↓	Normal
CSF:Serum Glucose	0.6	Normal	<0.4	Normal

Larry Jameson J et al. Harrison's Principles of Internal Medicine, 20th ed. 2018
Seehusen DA et al. Am Fam Physician 2003;68(6):1103–8.

Complications

- Post LP headache
- Infection
- Bleeding
- Cerebral herniation
- Radicular pain or low back pain
- Epidermoid tumor: Rare

Take Home Points

- Perform lumbar puncture at the L3-L4 or L4-L5 interspace
- Use static ultrasound guidance to improve success rates
- Mark the midline in transverse spinous process view
- Mark the interspinous space in longitudinal (midsagittal) view
- If possible, estimate depth and spinal needle length using the longitudinal paramedian view
- Always replace the stylet before needle repositioning or removal