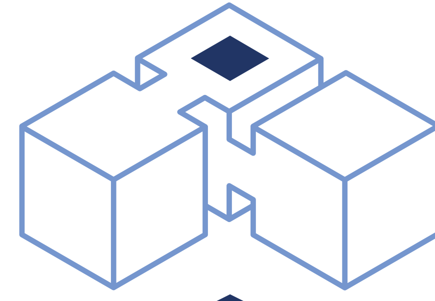

IBSA INTERNATIONAL ACADEMY

A DEEP DIVE INTO THE KNEE

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HEALTH COMMUNICATION HUB

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US METHODOLOGY
INTRODUCTION

KNOBOLOGY

Essential ultrasound machine controls, often referred to as “knobology,” are critical for optimizing image quality and diagnostic accuracy nowadays.

This brief introduction reviews the basic parameters required to correctly set up the ultrasound machine, to perform a ‘basic’ examination of the musculoskeletal system, obtaining as much information as possible from the tissues examined.

In particular, we will analyse the focus, depth, frequency, gain and freeze function.

CORE IMAGE CONTROLS

- **Depth:** Adjusts how deep the ultrasound beam penetrates tissue. Decreasing depth magnifies superficial structures, while increasing depth; it allows visualization of deeper organs at the cost of resolution and frame rate. Ideally, set depth to roughly 1 cm deeper than the structure of interest.

- **Focus:** Controls the beam's narrowest point to optimize lateral resolution. Place the focal point at or just below the target anatomy for the sharpest image.

- **Frequency:** Determines the balance between resolution and penetration. High frequencies provide better detail for superficial structures (e.g., tendons), while low frequencies are necessary for deep penetration (e.g., hip, gleno-humeral joint).

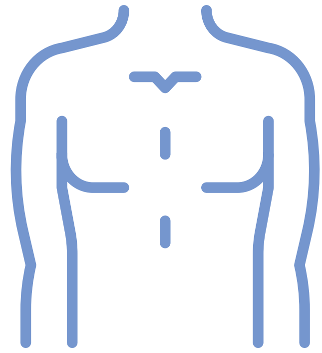
- **Gain:** Amplifies returning echoes to control overall image brightness.
  - **2D Gain:** Adjusts the whole image brightness.
  - **Time Gain Compensation (TGC):** Uses sliders to adjust brightness at specific depths to account for signal loss in deeper tissues.

- **Doppler:** Activates modes to visualize and measure blood flow velocity and direction. Specific buttons exist for Color Doppler (visualizing flow).

- **Pulse Wave (PW)**, and **Continuous Wave (CW)** Doppler for quantitative measurements.

- **Freeze Button:** One of the most frequently used keys, it pauses real-time scanning to produce a static image. This allows for:
  - **Cine Loop:** Scrolling back through previous frames to find the best image.
  - **Measurements:** Using calipers to measure structures or flow velocities while the image is static.
  - **Archiving:** Saving the selected image for clinical documentation.

ERGONOMIC OBJECTIVES IN ULTRASOUND EXAMINATION



Patient Positioning

- Ensure the patient is positioned comfortably and stably to minimize involuntary movements.
- Adjust the patient's height and orientation to allow a neutral posture for the examiner.
- Position the examined body part as close as possible to the examiner to reduce reaching.
- Use cushions or supports to maintain the required position without patient effort.
- Maintain the patient in a relaxed position to avoid muscle tension that may alter anatomy.

Examiner, Machine, and Probe Positioning

- Place the ultrasound machine on the same side as the examined region whenever possible.
- Adjust the machine height so the control panel is at or slightly below elbow level.
- Keep the transducer cable supported to avoid traction on the wrist or hand.
- Maintain neutral wrist, shoulder, and neck positions throughout the examination.
- Alternate hands or postures during prolonged examinations when feasible.

Image Visualization and Screen Setup

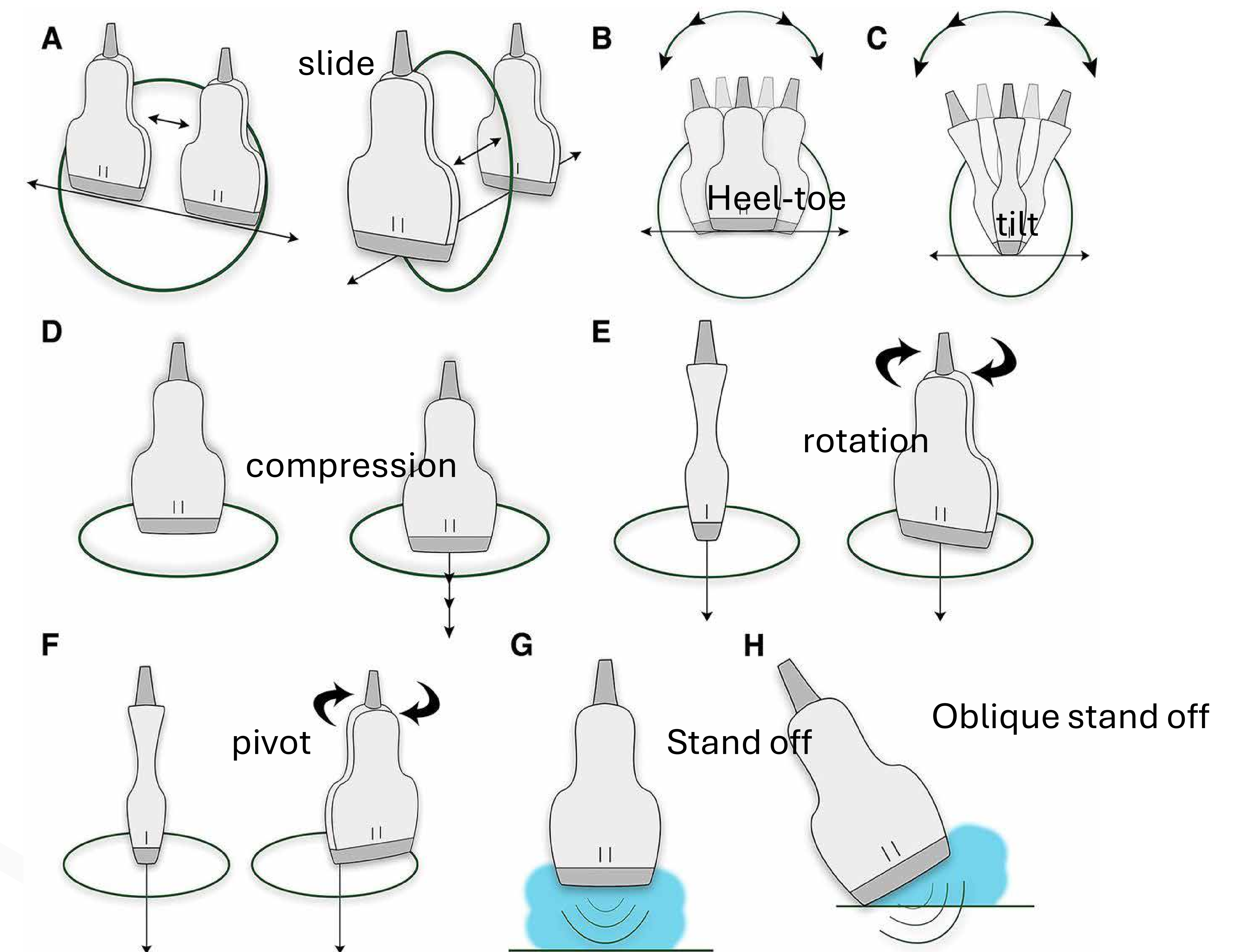
- Position the monitor directly in front of the examiner to avoid neck rotation or flexion.
- Adjust monitor height so the top of the screen is at or slightly below eye level.
- Optimize image settings (depth, gain, focus) to reduce examination time and repetition.
- Ensure adequate room lighting to avoid glare while maintaining clear screen visibility.
- Maintain a consistent line of sight between the probe, the patient, and the monitor.

Overall Ergonomic Goals

- Reduce cumulative musculoskeletal strain and fatigue.
- Improve examination efficiency and image quality.
- Promote long-term occupational health and sustainability for the examiner.

THE USE OF THE PROBE

- Probe orientation determines the direction of the ultrasound beam and the final image displayed on the screen.
- The transducer can be moved in the three spatial axes (x–y–z) to accurately explore anatomical structures.
- Sliding movements (proximal–distal and medial–lateral) are used to follow the course of structures.
- Tilting and rocking the probe allow perpendicular insonation of tissues, improving image quality.
- Perpendicular insonation is essential to reduce artifacts and avoid anisotropy, particularly in tendons and ligaments.
- Rotation of the probe (up to 90°) enables switching between longitudinal and transverse scanning planes.
- Heel–toe movements help follow curved anatomical surfaces while maintaining optimal beam orientation.
- For small or irregular structures (e.g., fingers), generous use of gel is recommended to ensure correct acoustic coupling.
- Appropriate probe handling is essential for optimal image quality, accurate interpretation, and standardized examination.



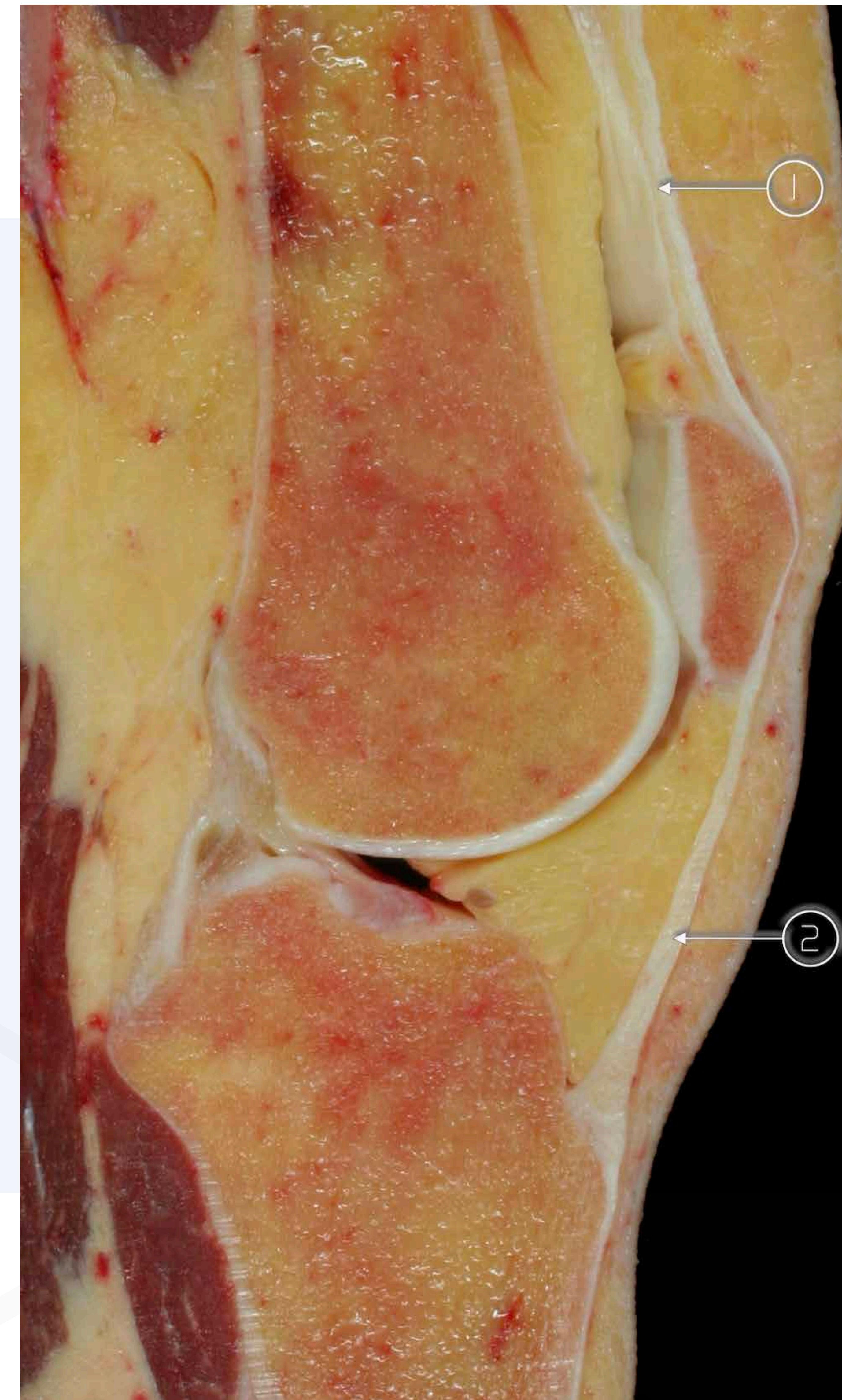
Hall MM *et al* Recommended musculoskeletal and sports ultrasound terminology: a Delphi-based consensus statement *British Journal of Sports Medicine* 2022;56:310-319

KNEE
ANATOMY

KNEE ANATOMY: SAGITTAL PLANE

Extensor system
Central sagittal section:

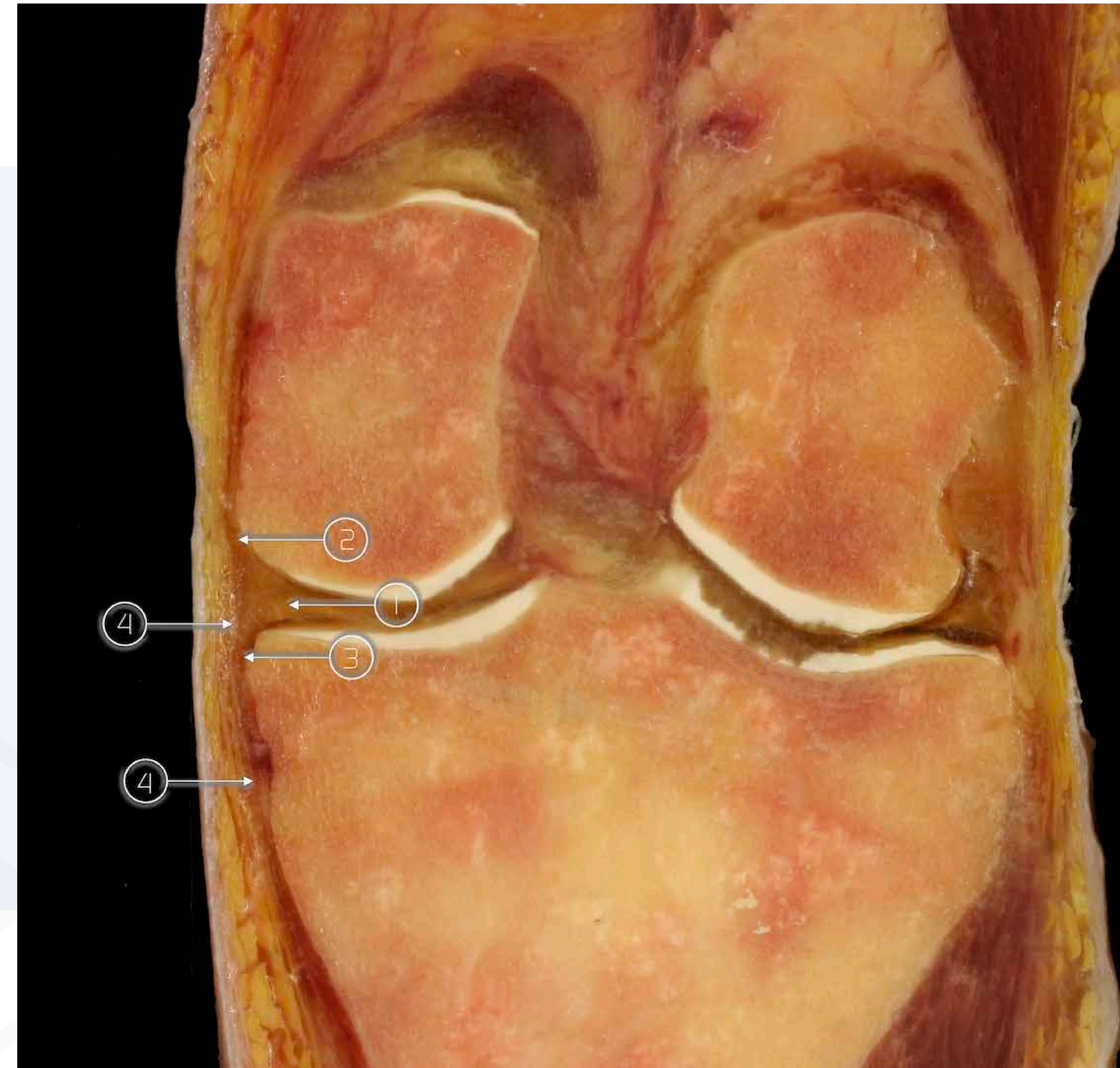
1. Quadriceps tendon
2. Patellar tendon



KNEE ANATOMY: CORONAL PLANE

Medial femoro-tibial joint and medial meniscus

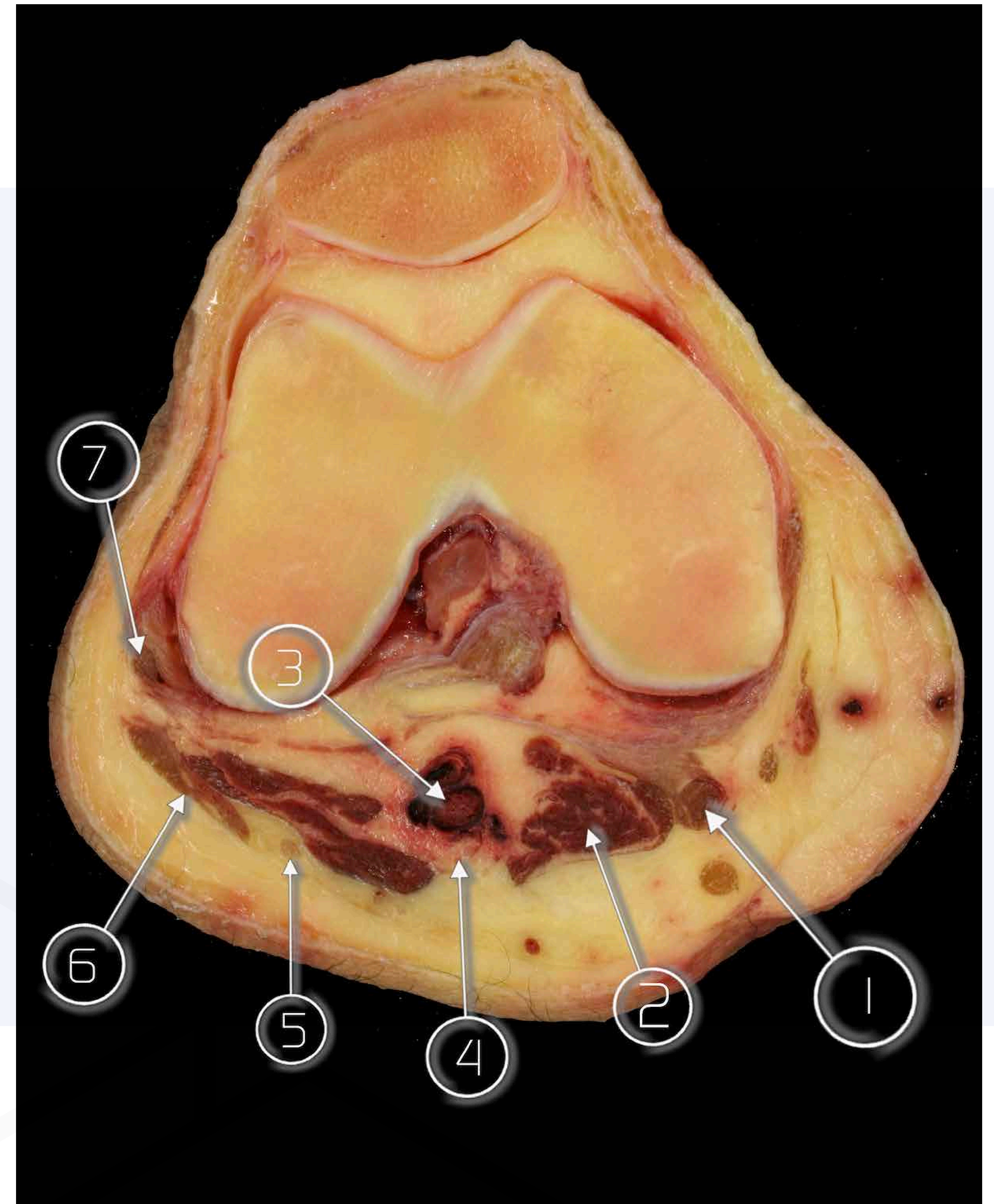
1. Medial meniscus
2. Menisco-femoral ligament (Deep MCL)
3. Menisco-tibial ligament (Deep MCL)
4. Superficial MCL

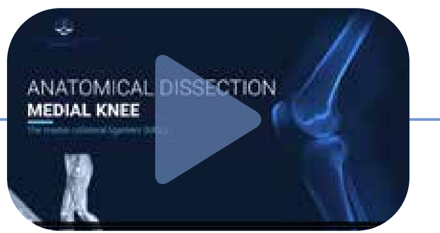


KNEE ANATOMY: TRANSVERSE PLANE

Posterior compartment
Intercondilar transversal section

1. Semimembranosus tendon
2. Medial gastrocnemius
3. Popliteal artery
4. Tibial nerve
5. Common peroneal nerve
6. Biceps femoris
7. Lateral collateral ligament

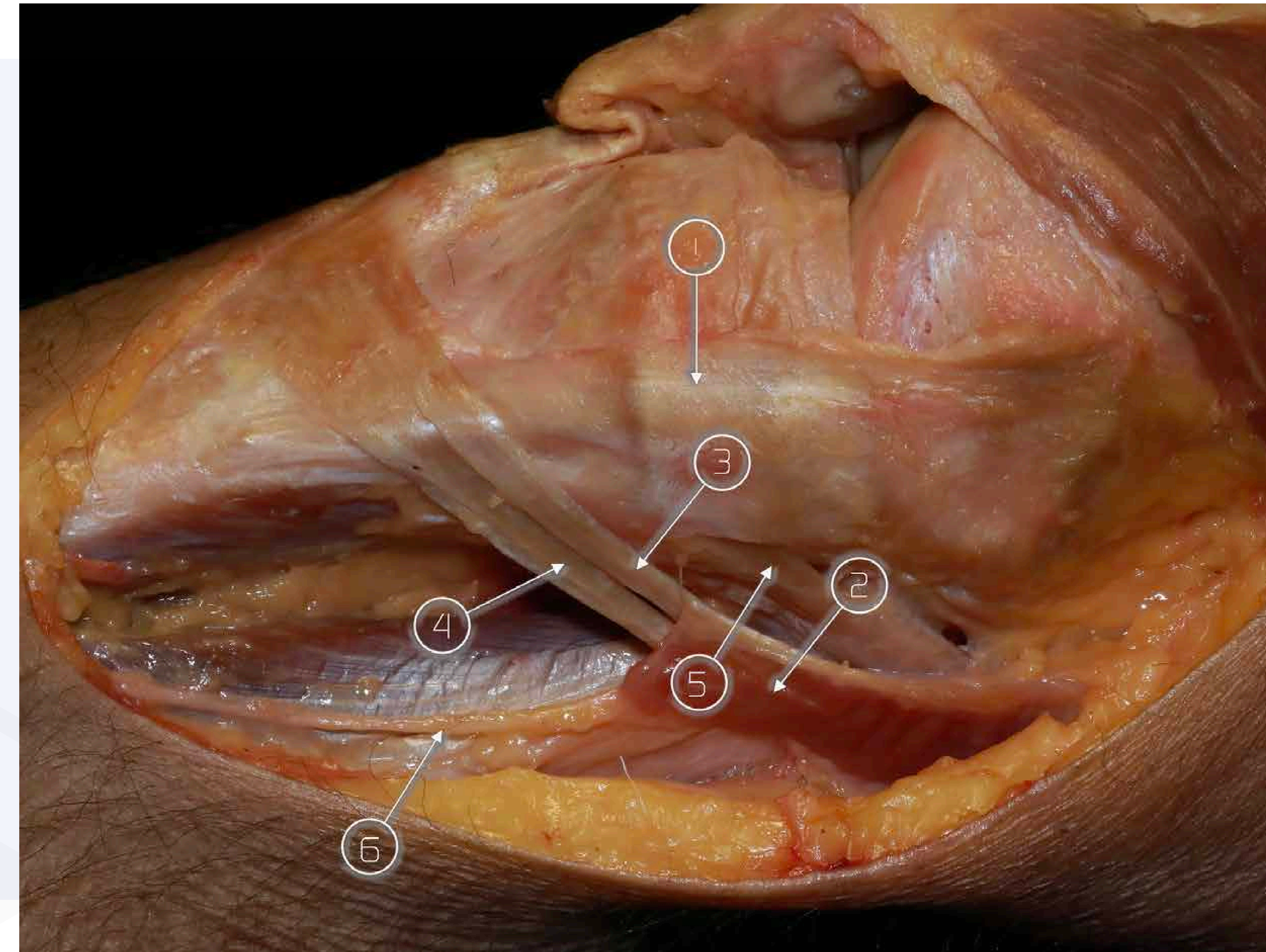




KNEE ANATOMY: MEDIAL KNEE

MCL and pes anserinus, right knee:

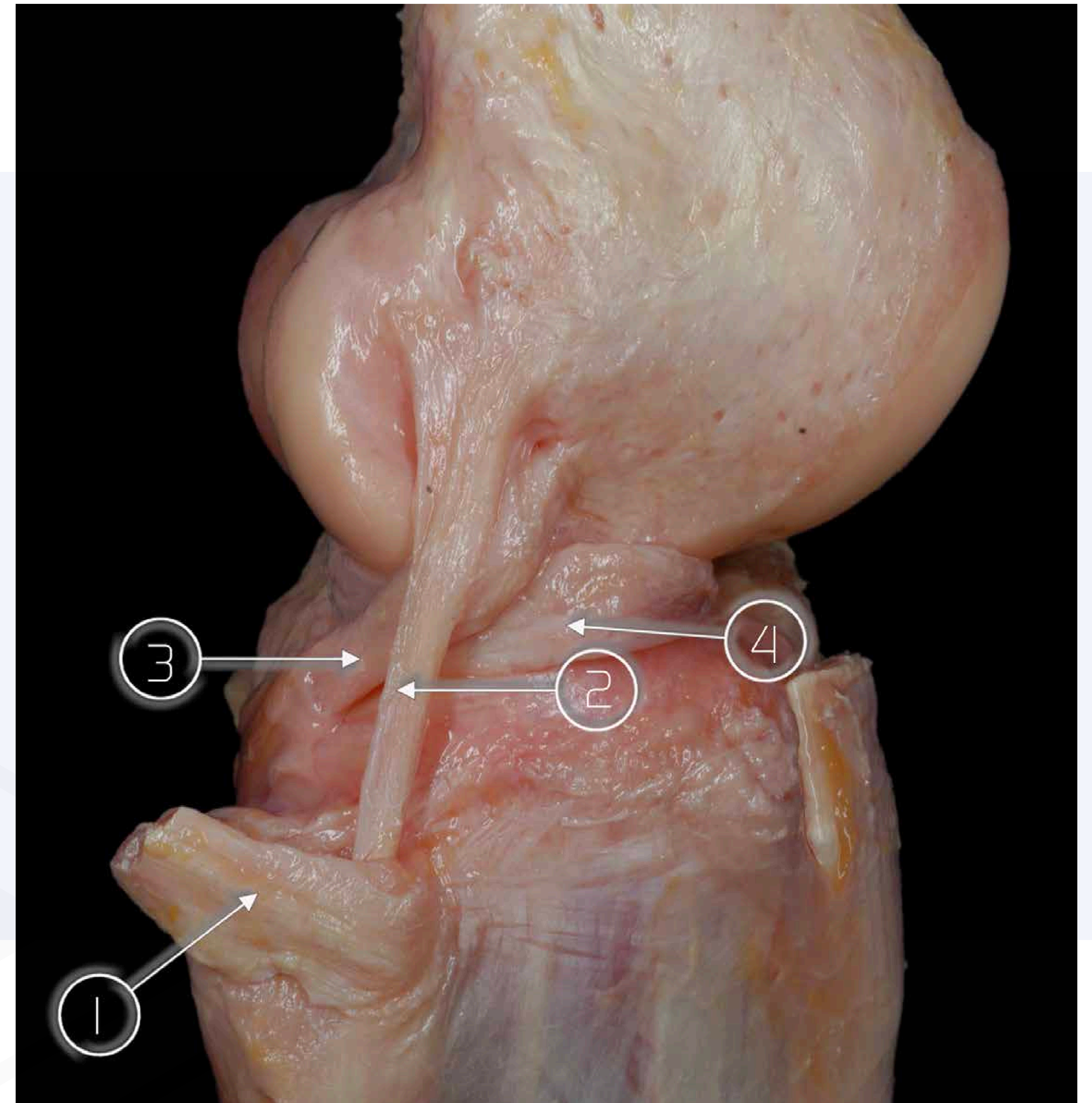
1. MCL
2. Sartorius tendon
3. Gracilis tendon
4. Semitendinosus tendon
5. Semimembranosus tendon
6. Saphenous nerve



KNEE ANATOMY: LATERAL KNEE

Lateral compartment, right knee

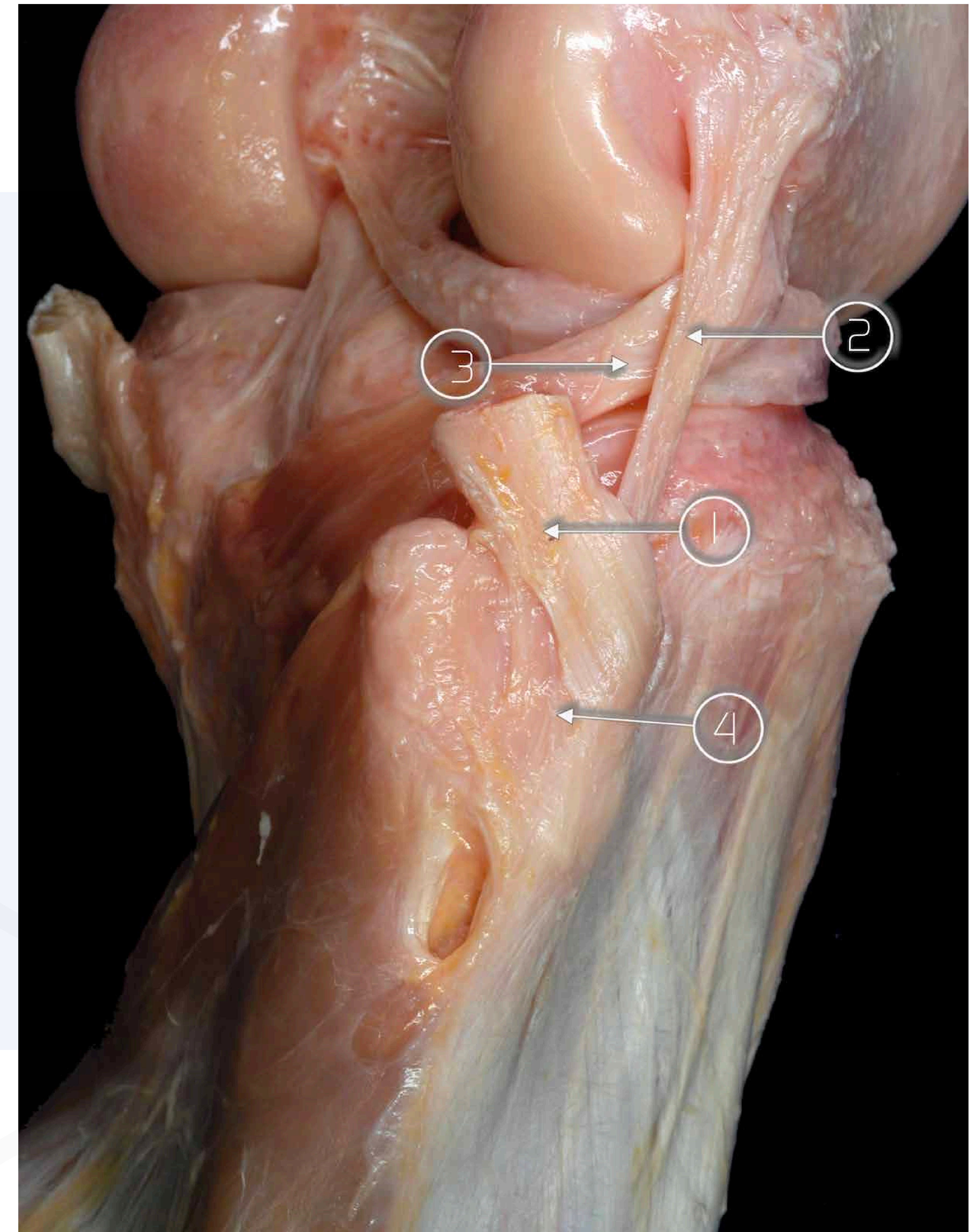
1. Biceps femoris tendon
2. Lateral collateral ligament
3. Popliteal tendon
4. Lateral meniscus



KNEE ANATOMY: LATERAL KNEE

Postero-lateral view of right knee:

1. Biceps femoris tendon
2. Lateral collateral ligament
3. Popliteal tendon
4. Head of fibula



US KNEE EXAM
INTRODUCTION

US KNEE EXAM: INTRODUCTION

- Knee ultrasound should be performed using a **systematic, standardized** scanning approach that **covers all anatomical** regions.
- A systematic examination does not preclude the assessment of **additional areas** beyond the site of clinical suspicion.
- When a **focal lesion** is suspected, a targeted evaluation should be integrated into the overall knee assessment.
- **Bony landmarks** are essential for orienting the examination and defining overlying soft tissues.
- **Structures** should be **assessed at least in longitudinal and transverse planes**, with continuous probe adjustment.
- **Perpendicular insonation is mandatory** to minimize anisotropy and avoid misinterpretation of artifacts.
- **Initial patient and probe positions serve as reference points** and may be adjusted based on the region examined and the diagnostic objective.

ULTRASOUND OF THE KNEE - UNIFIED CHAPTER (NORMAL AND PATHOLOGICAL)

This unified chapter provides a structured overview of knee ultrasound, integrating normal anatomy, key pathological conditions, and practical scanning methodology.

The examination is organized by anatomical compartments: anterior, medial, lateral, and posterior, reflecting functional anatomy and common clinical presentations.

For each compartment, standardized patient positioning, probe orientation, anatomical landmarks, and clinical applications are described.

The posterior knee is further subdivided into posteromedial, posterior middle, and posterolateral regions to ensure accurate assessment of musculoskeletal and neurovascular structures.

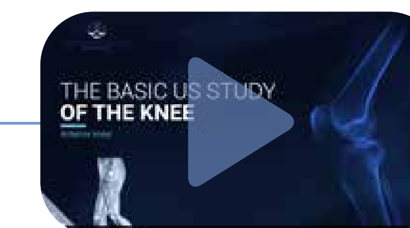
Dedicated summaries and checklists are intended to support daily clinical practice, teaching, and safe ultrasound-guided procedures.

COMPARTMENT	STRUCTURES	PATIENT POSITION	KEY LANDMARKS	CLINICAL APPLICATIONS
ANTERIOR	Quadriceps tendon (QT) Suprapatellar recess Femoral trochlea Patella Retinacula Patellar tendon (PT) Hoffa's fat pad	Supine Knee flexed 20-30° (adjusted according to structure examined)	Patella Femoral trochlea Tibial tuberosity	Effusion Synovitis Tendinopathy Enthesitis Traumatic lesions Ultrasound-guided injections
MEDIAL	Medial collateral ligament (MCL) Medial meniscus Pes anserinus tendons Pes anserinus bursa	Supine Slight knee flexion External rotation of lower limb	Medial femoral epicondyle Medial tibial plateau	Ligament injury Meniscal pathology Pes anserinus bursitis Tendinopathy
LATERAL	Iliotibial band (ITB) Lateral collateral ligament (LCL) Biceps femoris tendon Lateral synovial recess	Supine Knee slightly flexed	Lateral femoral condyle Fibular head Gerdy's tubercle	ITB friction syndrome Lateral instability Tendinopathy Effusion

REGION	STRUCTURES	PATIENT POSITION	KEY LANDMARKS	CLINICAL APPLICATIONS
POSTEROMEDIAL	Semitendinosus Semimembranosus Sartorius Medial head of gastrocnemius Baker cyst origin	Prone Knee slightly flexed	Semimembranosus-gastrocne-mius interval	Baker cyst
POSTERIOR MIDDLE (Popliteal fossa)	Popliteal artery Popliteal vein Tibial nerve	Prone Knee slightly flexed	Popliteal artery	Vascular pathology Neurovascular disorders
POSTEROLATERAL	Popliteus tendon Lateral head of gastrocnemius Common peroneal nerve	Prone Knee slightly flexed	Fibular head	Posterolateral corner pathology

REGION	KEY STRUCTURES	ULTRASOUND NOTES
Anterior knee Step 1	Quadriceps tendon Suprapatellar & parapatellar recesses Femoral trochlea & patellar retinacula Patellar articular surface (anterior) Patellar tendon Anterior bursae	Use bony landmarks for orientation. Assess tendons in long and short axis. Ensure perpendicular insonation.
Medial knee Step 2	Medial collateral ligament Medial femoro-tibial joint Medial meniscus (peripheral body & posterior horn) Pes anserinus tendons & bursa	Meniscal assessment limited to peripheral portions. Integrate targeted findings into global exam.
Lateral knee Step 3	Iliotibial band Lateral collateral ligament Popliteus tendon Biceps femoris tendon Lateral meniscus (peripheral body) Common peroneal nerve	Continuous probe adjustment required. Avoid anisotropy.
Posterior knee Step 4	Semimembranosus & medial gastrocnemius tendons and bursa Popliteal neurovascular bundle Meniscal posterior horns (peripheral portions)	Dynamic positioning may be required. Recognize ultrasound limitations.

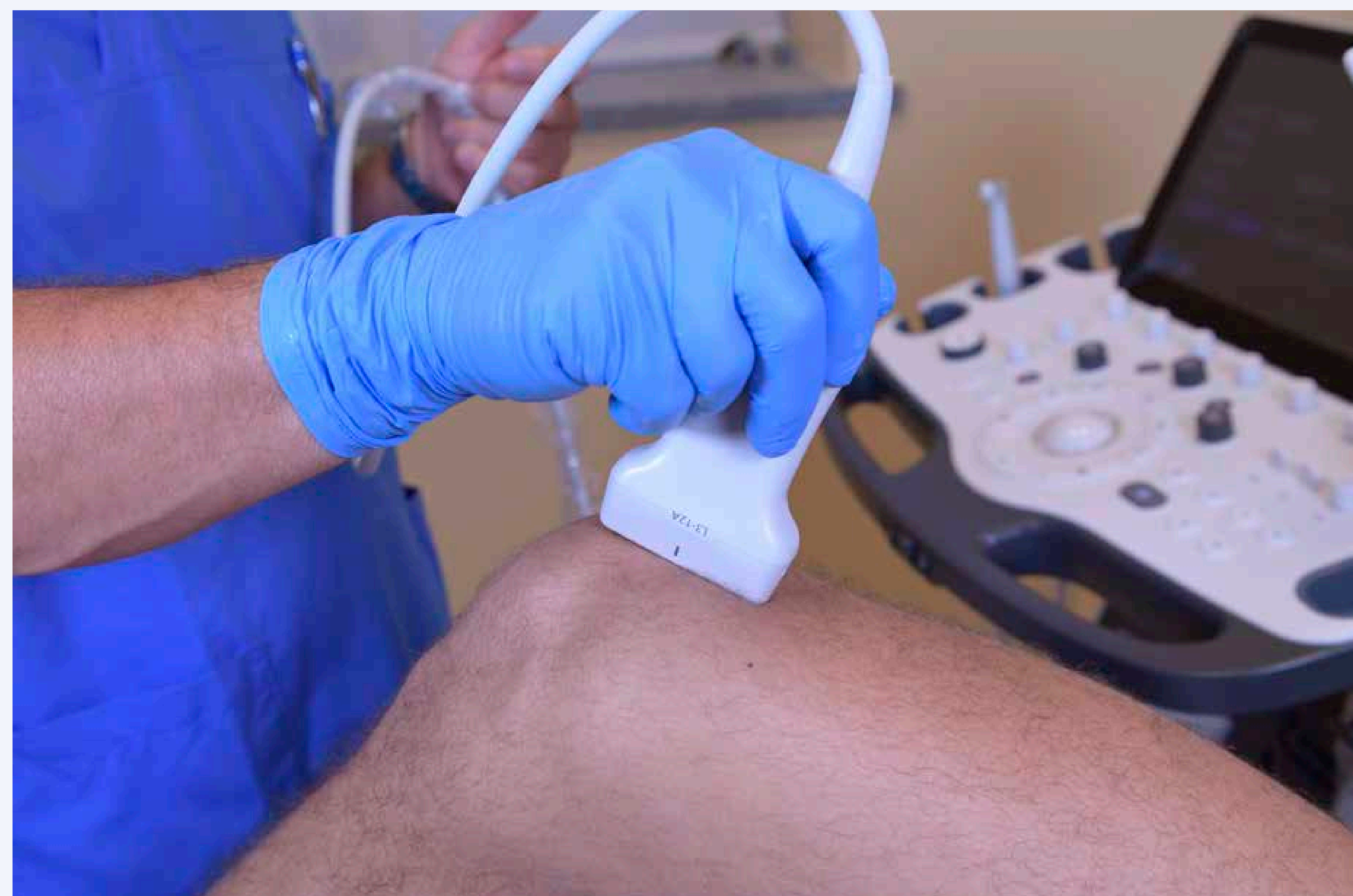
STEP 1
ANTERIOR KNEE



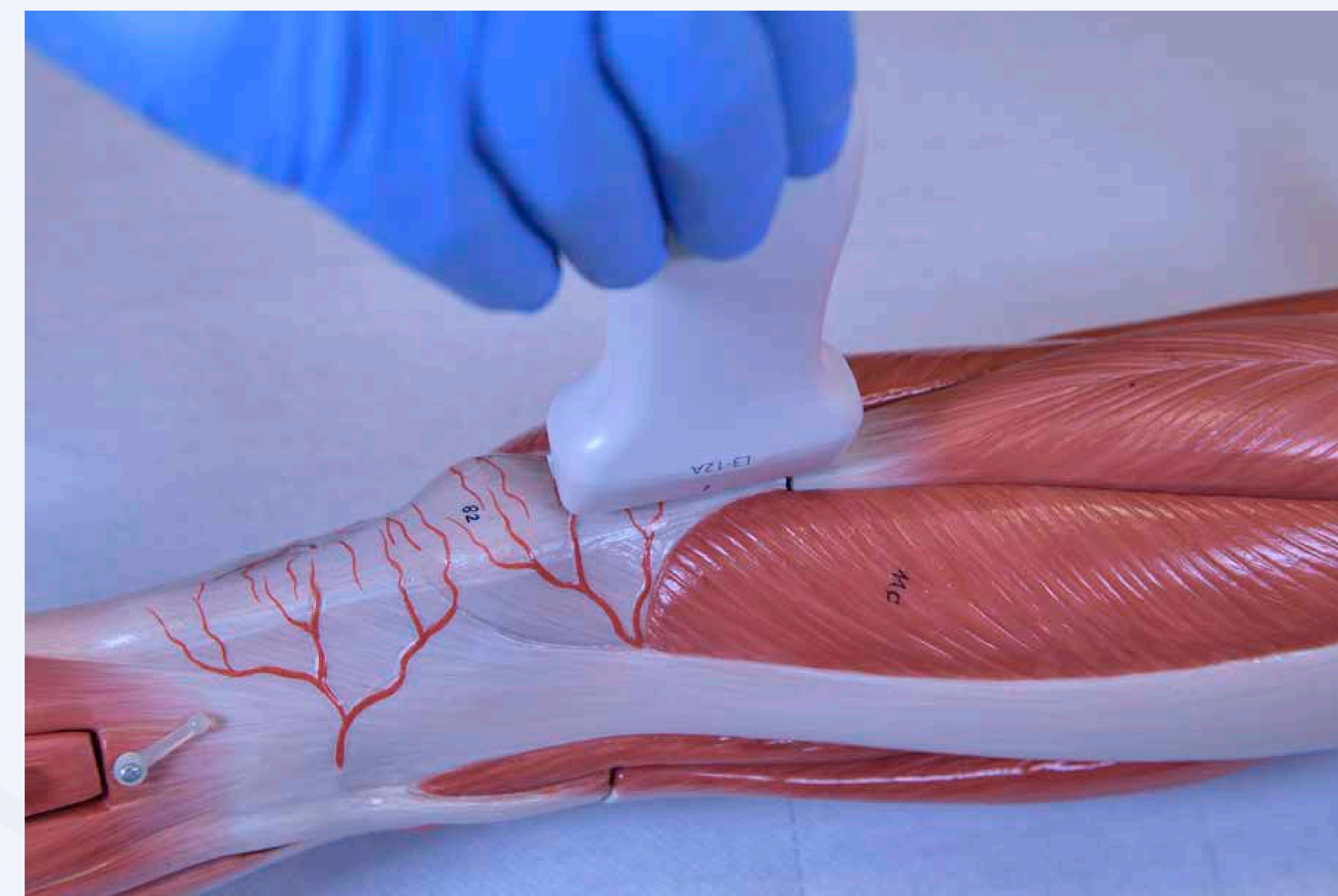
STEP 1 - ANTERIOR KNEE

- quadriceps tendon (QT)
- supra and parapatellar joint recess

Long axis



The patient lies supine with the knee flexed 30°, and the foot flat over the bed.

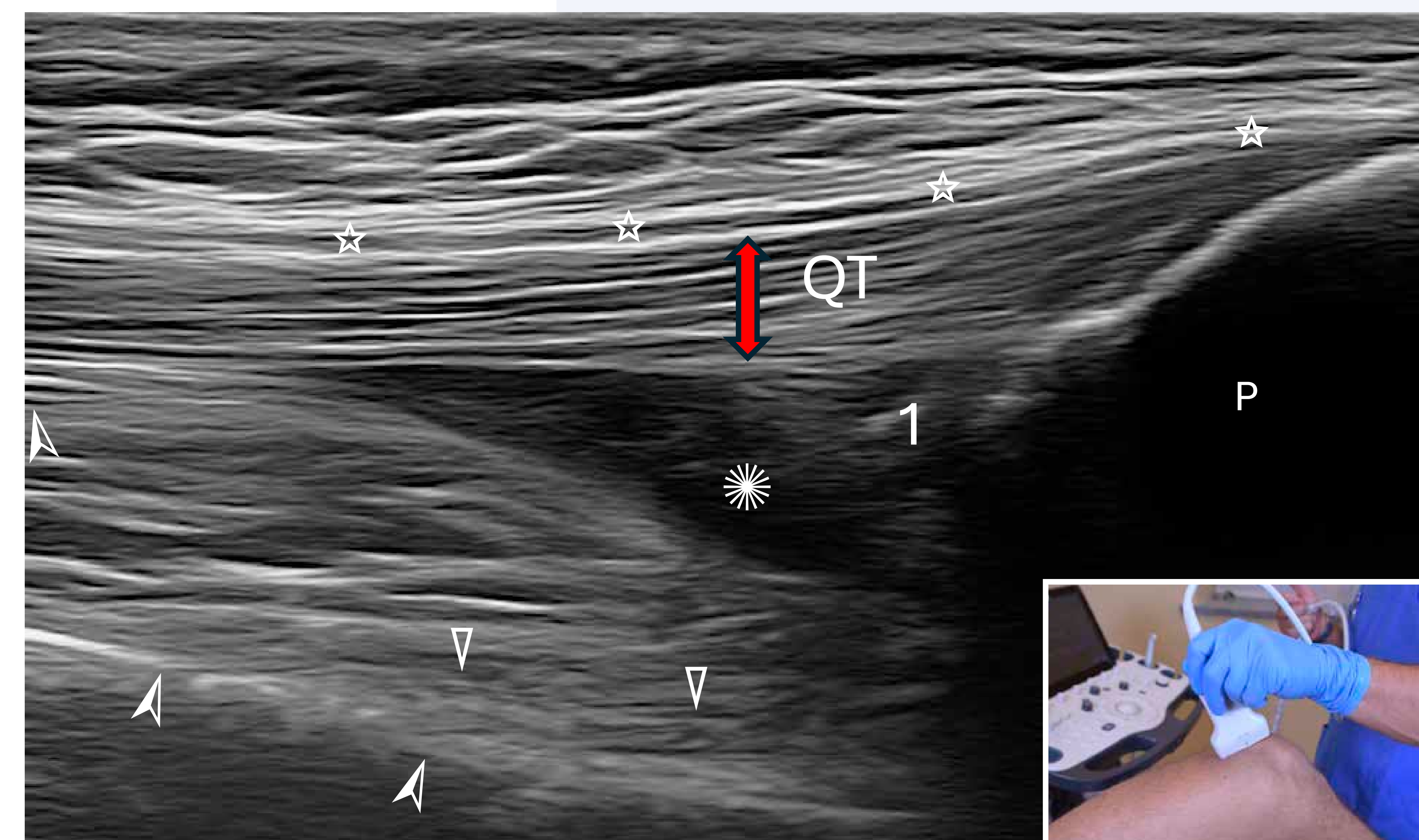


The transducer is placed longitudinally proximal to the patella, over the quadriceps tendon, with the end of the probe over the patella's base.

STEP 1 - ANTERIOR KNEE
- quadriceps tendon (QT)
- supra and parapatellar joint recess

Long axis

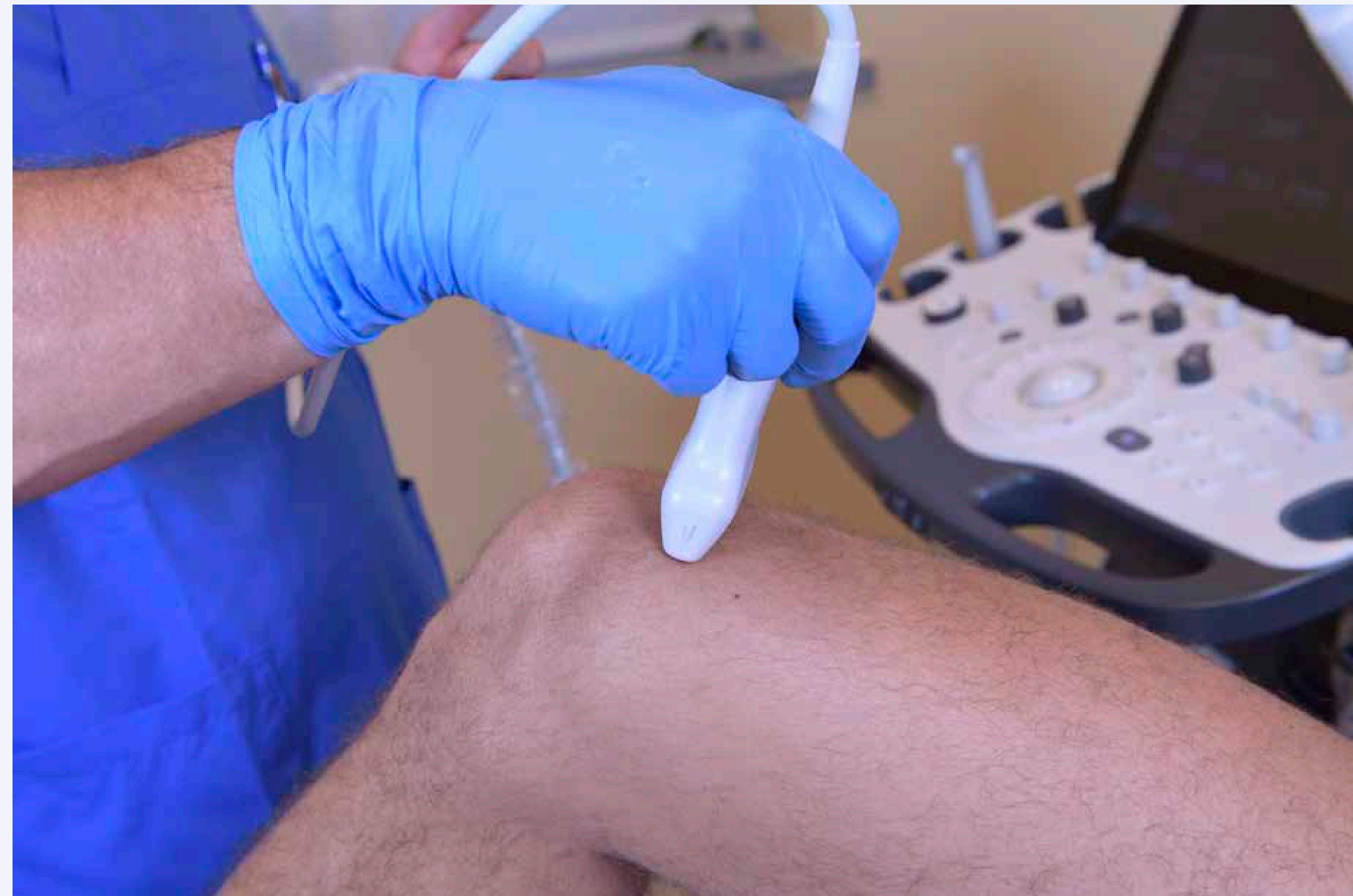
ASPECT	ULTRASOUND FINDINGS
Patient & probe position	Knee flexion to optimize visualization of quadriceps tendon fibers. The transducer is placed longitudinally proximal to the patella **(P)**, over the quadriceps tendon **(QT)**, with the end of the probe over the patella's base.
Bony landmarks	Inferior pole of the patella **(P)**; anterior femoral cortex (➢)
Superficial QT layer	Rectus femoris (✫).
Intermediate & deep QT layers	Vastus medialis, lateralis and intermedius **(red arrow)**.
Structures under the QT	Suprapatellar recess (✺), suprapatellar fat pad **(1)**, prefemoral fat pad (▻)
Dynamic assessment	Mediolateral probe movement to evaluate the full tendon and its relationship with VM and VL muscle bellies.



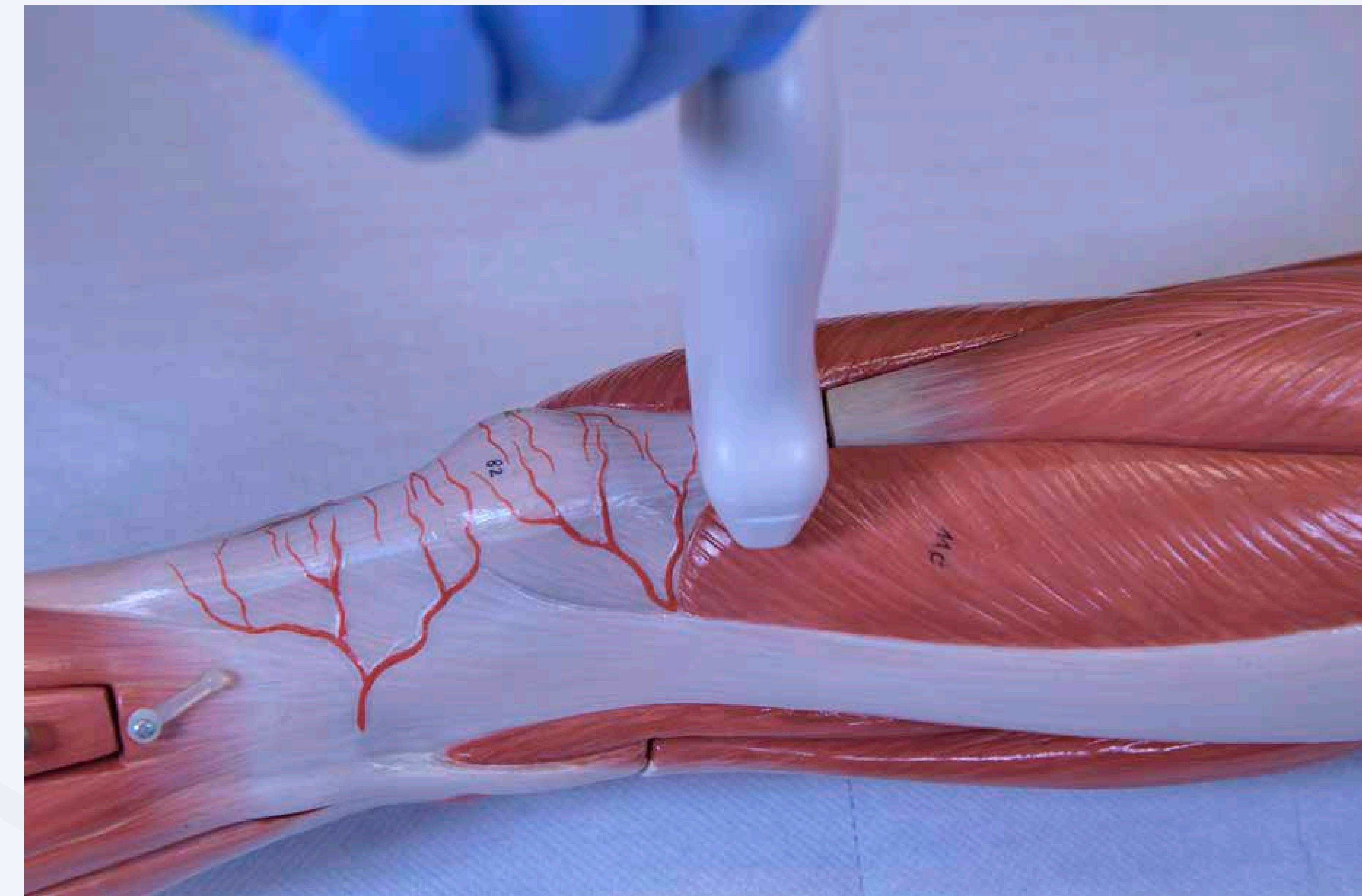
STEP 1 - ANTERIOR KNEE

- quadriceps tendon (QT)
- supra and parapatellar joint recess

Short axis



The patient lies supine with the knee flexed.



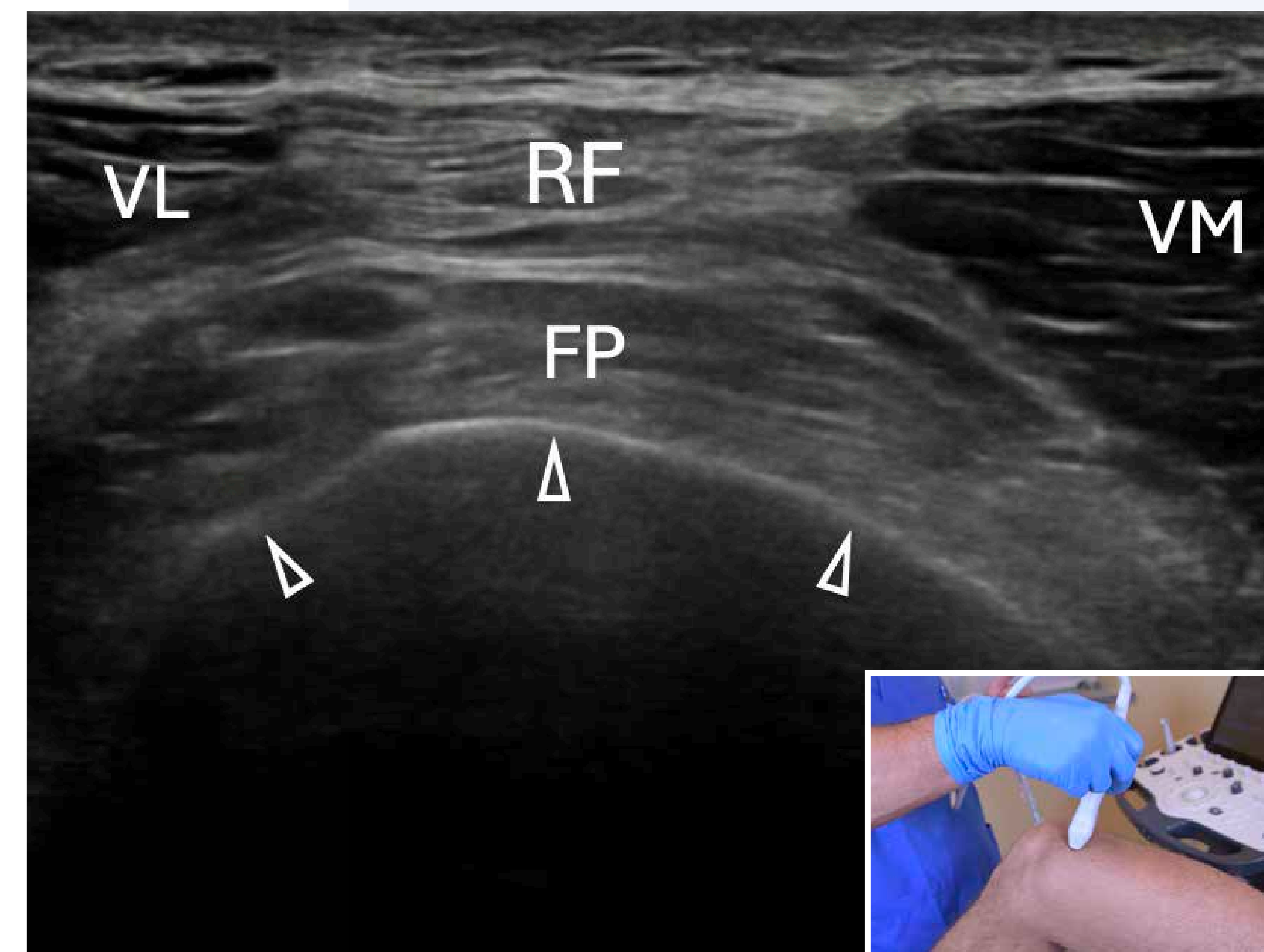
The transducer is placed **transversely to the quadriceps** over the patella's base.

STEP 1 - ANTERIOR KNEE

- quadriceps tendon (QT)
- supra and parapatellar joint recess

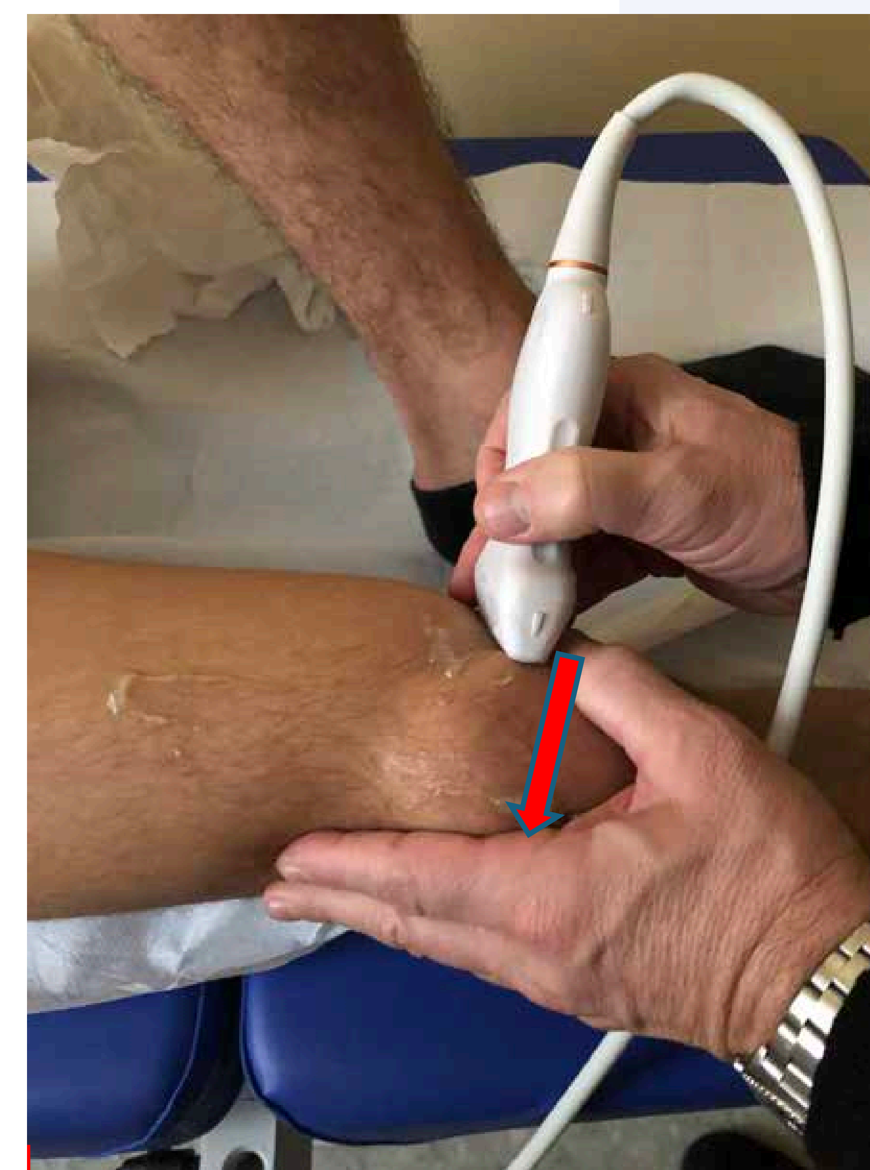
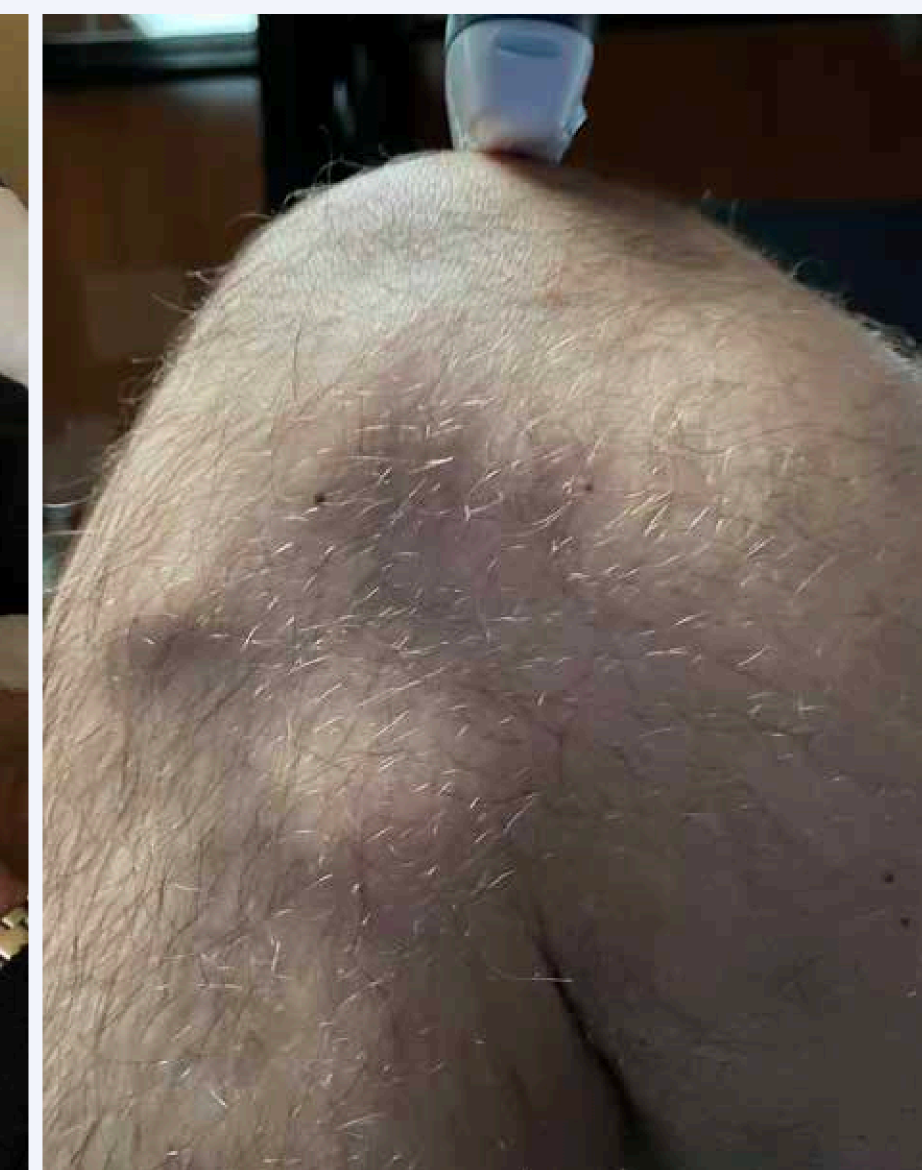
Short axis

ASPECT	ULTRASOUND FINDINGS
Scanning plane	Short axis view of the quadriceps tendon at varying distances from the patella.
Assessment focus	Evaluation of tendon integrity and detection of fluid in the suprapatellar recess: vastus lateralis **(VL)**, vastus medialis **(VM)**, rectus femoris **(RF)**, pre-femoral fat pad **(FP)**, hyperechoic anterior femoral cortex **(∆)**. For the vastus intermedius identification, we need a more proximal scan.
Dynamic assessment	Active or passive knee movement, quadriceps contraction and probe compression.
Tendon pathology	Partial or complete quadriceps tendon tears; intratendinous fluid (hematoma or inflammation).
Joint pathology	Effusion or synovitis at the suprapatellar recess.
Anatomical landmarks	Myotendinous junction of the quadriceps muscles; femoral shaft (▻).
Anatomical note	Rectus femoris MTJ is located more proximally than the other quadriceps components.
Interventional relevance	Optimal window for ultrasound-guided injection of the suprapatellar knee recess.



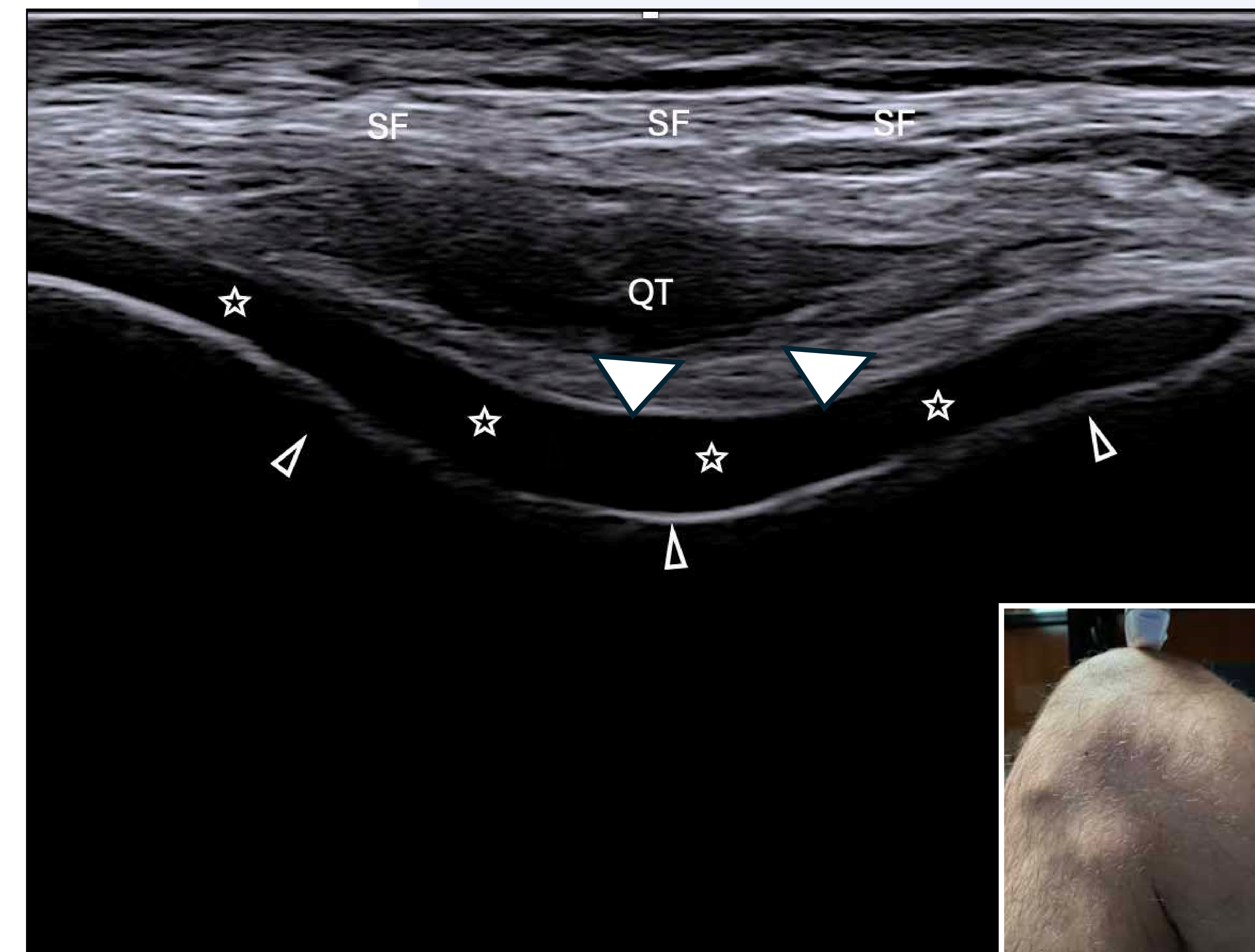
STEP 1 - ANTERIOR KNEE
Femoral trochlea, retinacula and patellar articular facet
Long axis

ASPECT	ULTRASOUND TECHNIQUE / KEY POINTS
Anatomical focus	Femoral trochlea, medial and lateral patellar retinacula.
Scanning orientation	Short axis to the lower extremity.
Clinical relevance	Ultrasound is accurate and reproducible for diagnosing patellar retinacular injuries.
Patient position (trochlea)	Supine position with the knee hyperflexed for the trochlea and extended for the retinaculum.
Probe position (trochlea)	Transverse (axial) placement over the proximal patella visualizing the femoral trochlea.
Patient position (retinacula)	Knee in extension.
Probe position (retinacula)	Transverse orientation to the lower extremity, spanning from patella to femoral epicondyle.

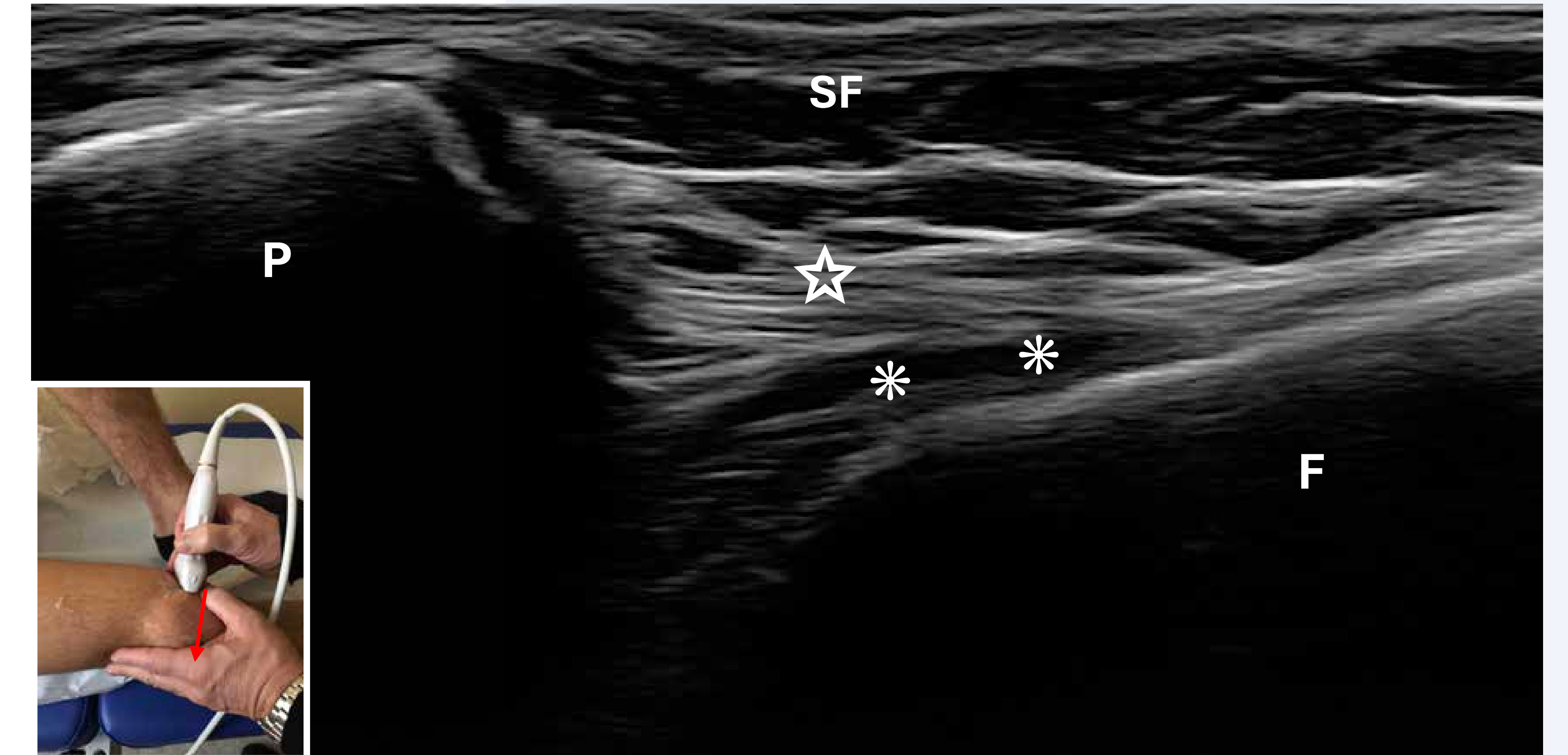
STEP 1 - ANTERIOR KNEE
Femoral trochlea
Transverse to the lower extremity

ASPECT	ULTRASOUND TECHNIQUE / KEY POINTS
Primary objective	Assessment of femoral trochlear cartilage and adjacent bony margins.
Key requirement	Clear visualization of the cartilage-bone interface.
Clinical applications	Detection of crystal deposits (intra- or pericartilaginous) and osteoarthritic cartilage lesions.
Cartilage thickness	Limited relevance; no validated cut-off values. Comparison should be intra-patient, same position.
Patient position	Knee hyperflexion.
Probe position	Transverse (axial) placement over the proximal patella visualizing the femoral trochlea.
Superficial structures	Subcutaneous fat **(SF)** and quadriceps tendon **(QT)**.
Cartilage landmark	Anechoic, V-shaped femoral trochlear cartilage (☆) and hyperechoic cartilage interface showed by white solid arrows
Osseous landmark	Hyperechoic, V-shaped femoral bony contour (▻).



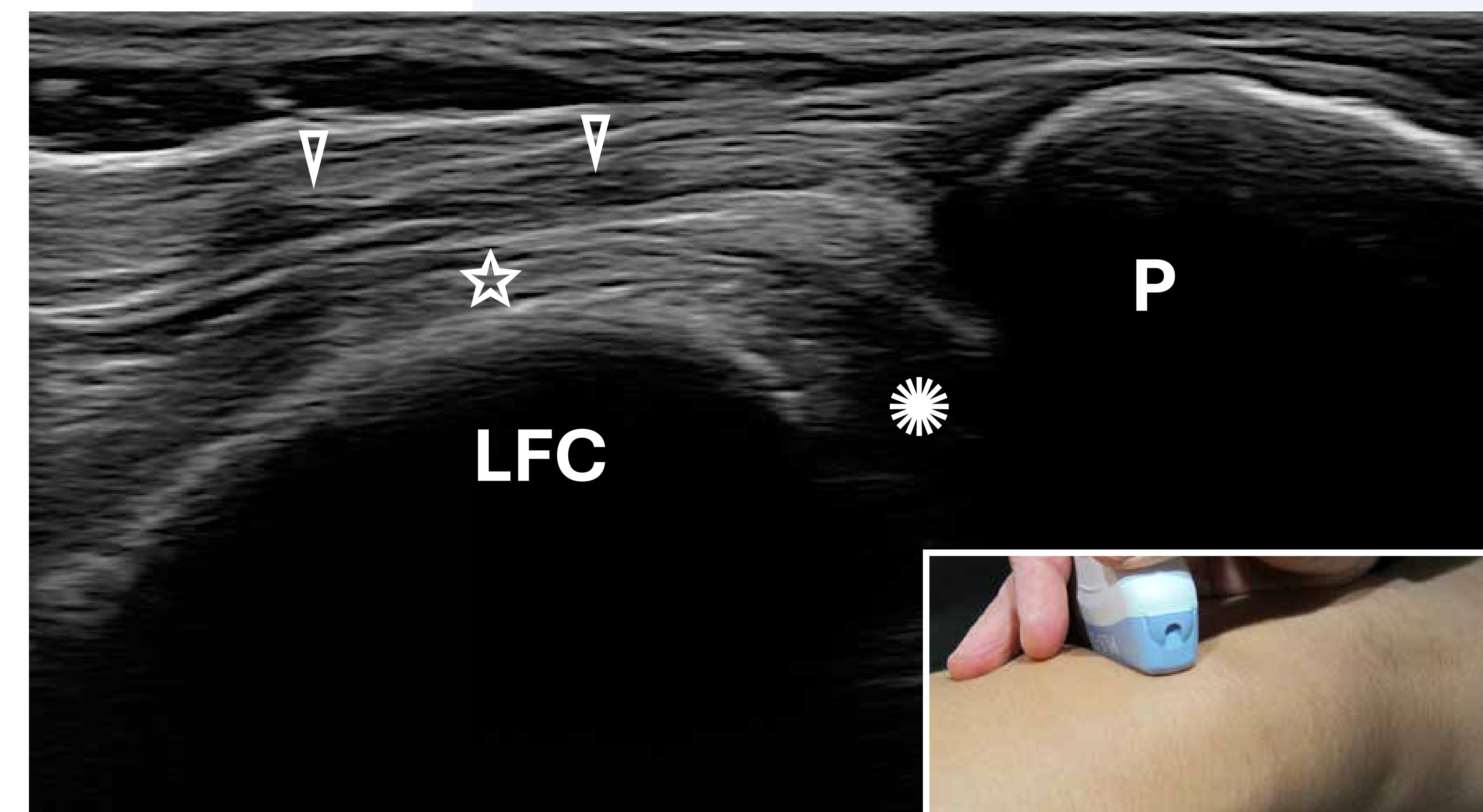
STEP 1 - ANTERIOR KNEE
Medial retinaculum and parapatellar joint recess

ASPECT	ULTRASOUND TECHNIQUE / KEY POINTS
Anatomical focus	Medial patellar retinaculum and parapatellar joint recess.
Scanning orientation	Short axis to the lower extremity. You can push the patella laterally.
Clinical relevance	Ultrasound is accurate and reproducible for diagnosing patellar retinacular injuries.
Patient position (retinacula)	Knee in extension.
Probe position (retinacula)	Transverse orientation to the lower extremity, spanning from patella to femoral epicondyle.
Superficial structures	Subcutaneous fat **(SF)** and retinaculum (☆). Below the parapatellar recess (✳).
Osseous landmark	Patella **(P)** and femur **(F)**.

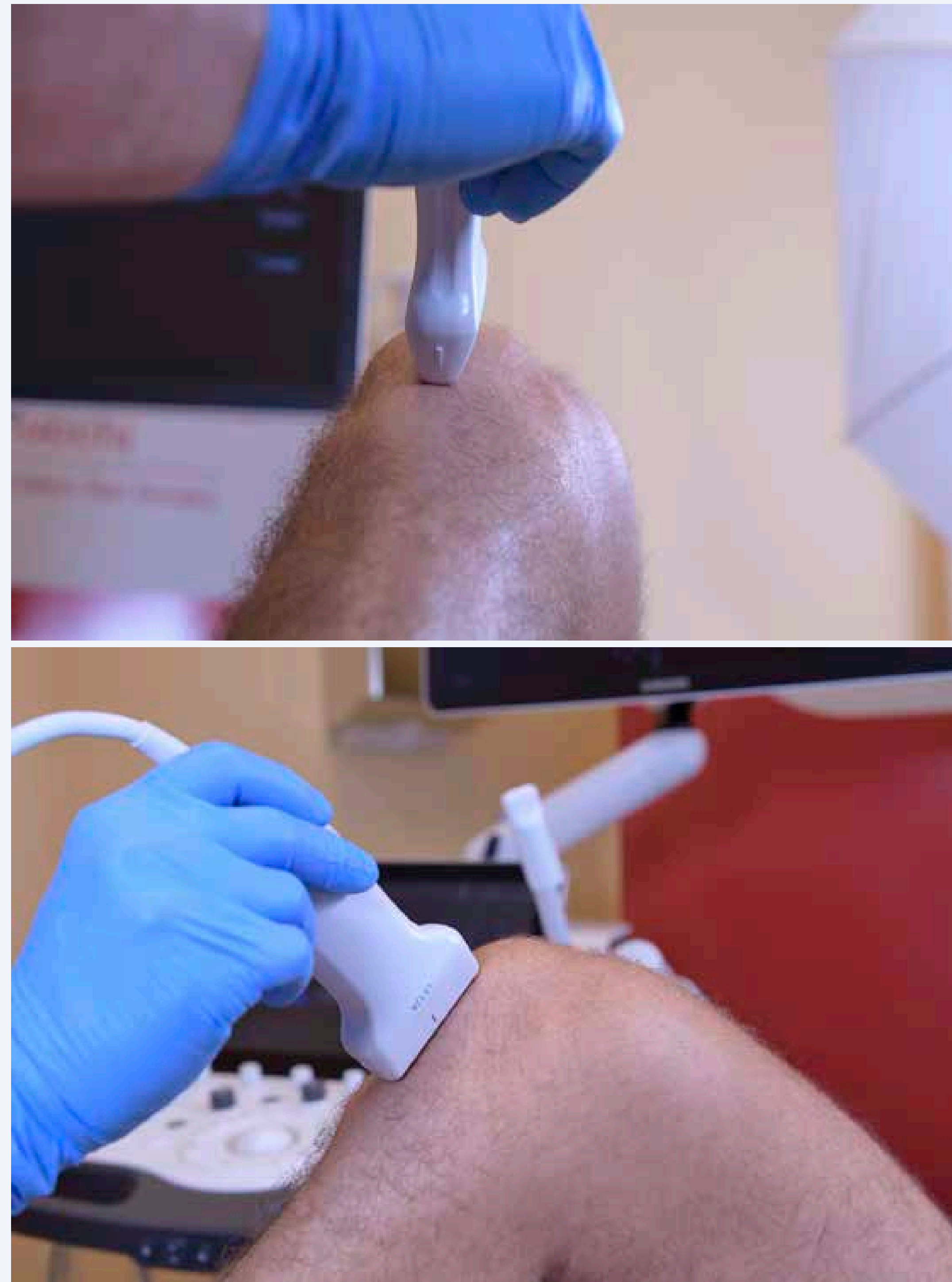


STEP 1 - ANTERIOR KNEE
Lateral retinaculum and parapatellar joint recess

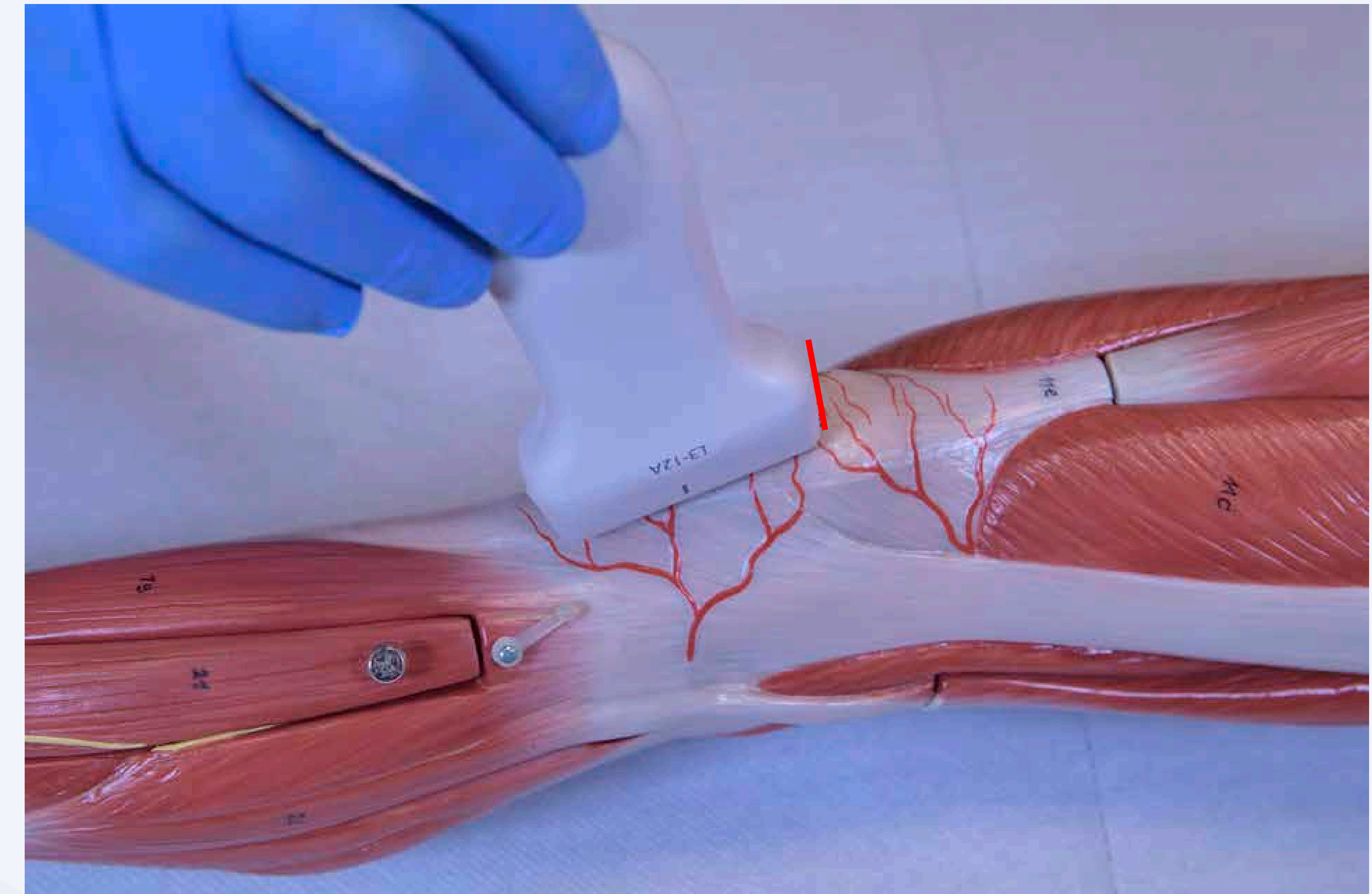
ASPECT	ULTRASOUND FINDINGS
Anatomical focus	Lateral patellar retinaculum and parapatellar joint recess.
Patient position	Initial assessment with the knee extended.
Scanning window	Region between the patellar edge and femoral condyle, over the knee joint (✺).
Parapatellar recess	Lateral parapatellar synovial recess (☆) between retinaculum (▻) and lateral femoral condyle **(LFC)**.
Osseous landmark	Lateral patellar cortex **(P)**, femoral condyle **(FC)**.
Dynamic assessment	Gentle probe compression to enhance detection of minimal synovial effusion.



STEP 1 - ANTERIOR KNEE
Patellar tendon
Long axis



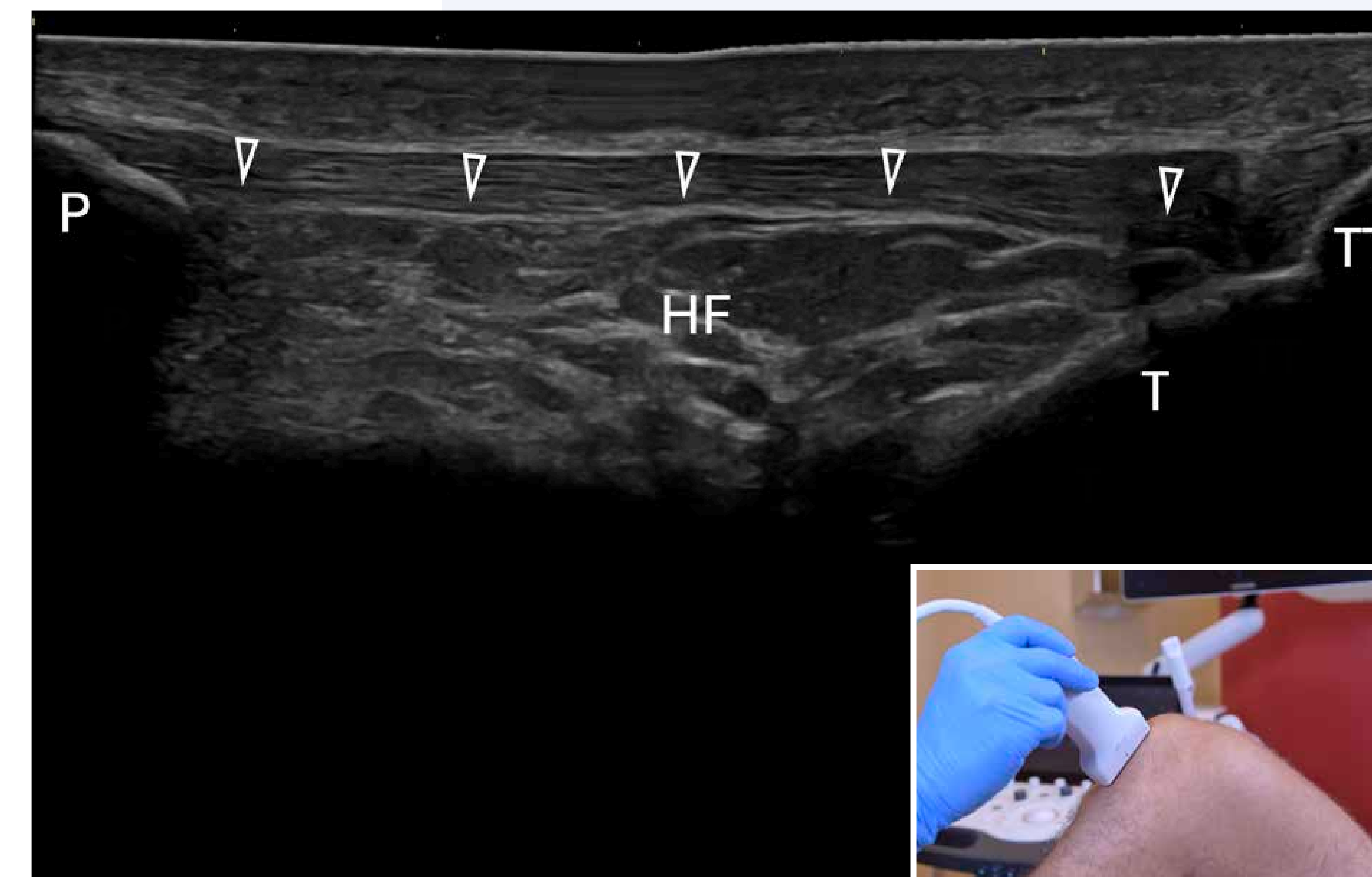
The patient lies supine on the bed with the knee flexed.



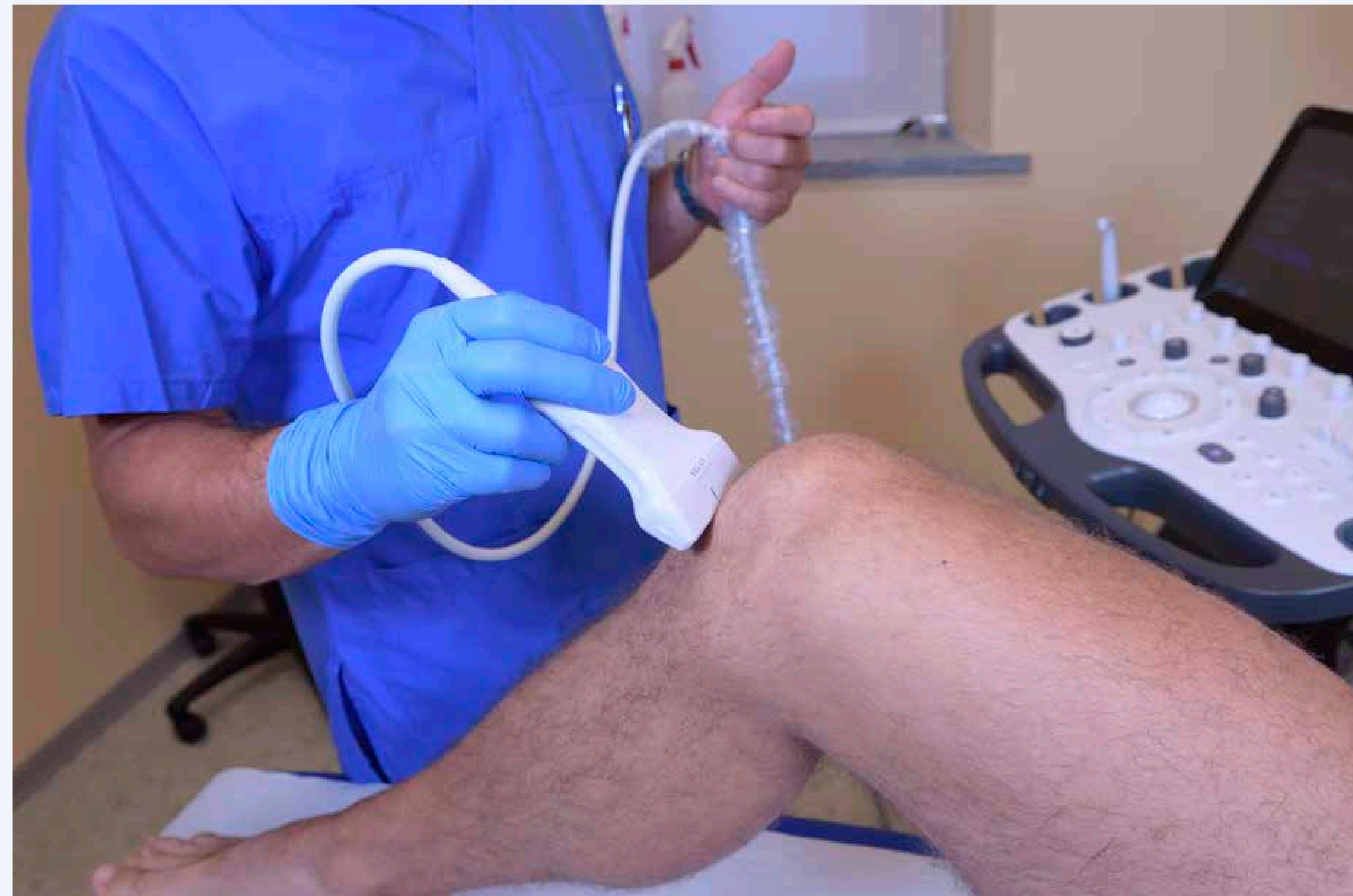
The transducer is placed longitudinally over the patellar tendon, with the orientation marker (red line) directed to the patient's head.

STEP 1 - ANTERIOR KNEE
Patellar tendon
Long axis

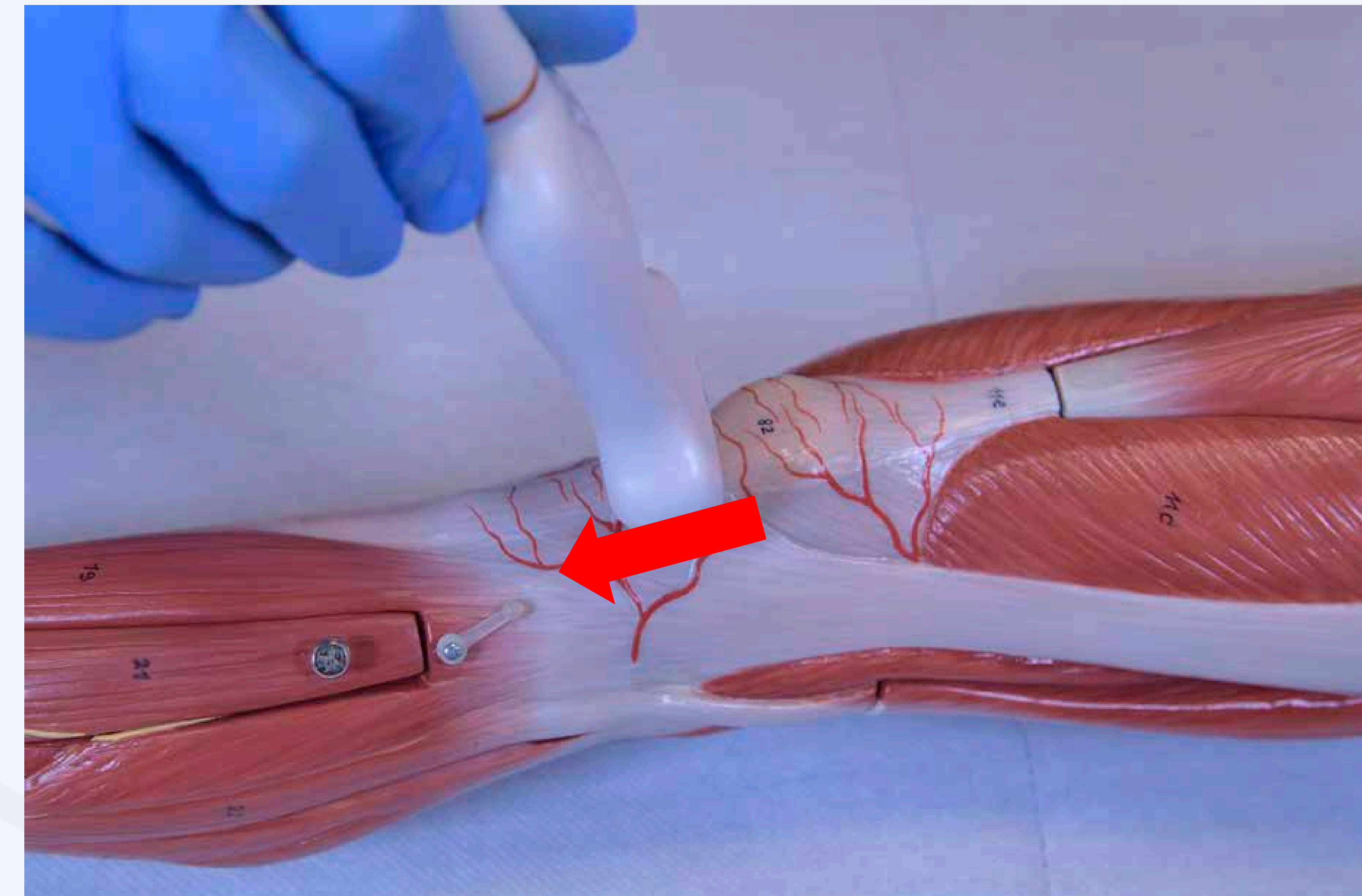
ASPECT	PATELLAR TENDON (LONG AXIS) - PRACTICAL POINTS
Patient position	Supine; knee in slight flexion (~20–30°) or supported to optimize fiber visualization; adapt to patient comfort and findings.
Probe position	Linear probe aligned longitudinally over the patellar tendon from the distal patella to the tibial tuberosity; use small tilts/heel-toe to maintain perpendicular insonation.
Key proximal landmark	Distal patella **(P)**: hyperechoic cortical line with shadowing; proximal tendon insertion at inferior pole. Survey inferomedial and inferolateral patellar margins.
Tendon appearance	Fibrillar structure (▻), predominantly hyperechoic when correctly insonated; confirm suspicious hypoechogenicity by changing angle (anisotropy check).
Deep soft-tissue landmark	Hoffa's fat pad **(HF)**: deep to tendon; evaluate for inflammatory changes (Hoffitis) and/or hyperemia when indicated.
Key distal landmarks	Proximal tibial cortex **(T)** and anterior tibial tuberosity **(TT)**: hyperechoic cortex with shadowing; distal tendon insertion at **TT**.
Clinical objectives	Enthesitis/enthesopathy; tendinopathy; traumatic tears; intratendinous abnormalities/ calcifications; Hoffitis; contribution to differential diagnosis of anterior knee pain.
Technical pitfalls	Anisotropy; excessive probe pressure; limited field-of-view (missing insertional footprint); static-only assessment. Mitigation: tilt/rock the probe, use minimal pressure, scan entire footprint, and add dynamic maneuvers.



STEP 1 - ANTERIOR KNEE
Patellar tendon
Short axis



The patient lies supine on the bed with the knee flexed.



The transducer is placed transversely (axial plane) over the distal patella and moved distally towards the ATT.

STEP 1 - ANTERIOR KNEE
Patellar tendon
Short axis

ASPECT	PATELLAR TENDON – TRANSVERSE (SHORT AXIS) VIEW
Scanning orientation	Transverse (short axis) scan across the patellar tendon.
Clinical rationale	Essential to evaluate the tendon along its full mediolateral extent and detect focal lesions missed in long axis view.
Patient position	Supine position with the knee in slight flexion.
Probe position	Transducer placed transversely over the tendon and swept proximally and distally.
Tendon appearance	Flat, oval, hyperechoic fibrillar structure in transverse section (▻).
Osseous landmark	Anterior tibial tuberosity **(ATT)** appearing as a rounded, bright hyperechoic contour.
Adjacent structures	Hoffa's fat pad located proximally, deep to the tendon.
Pathology detection	Focal tendinopathy, partial tears, asymmetrical involvement, contour abnormalities.
Technical note	Combine with dynamic assessment and side-to-side comparison for optimal evaluation.

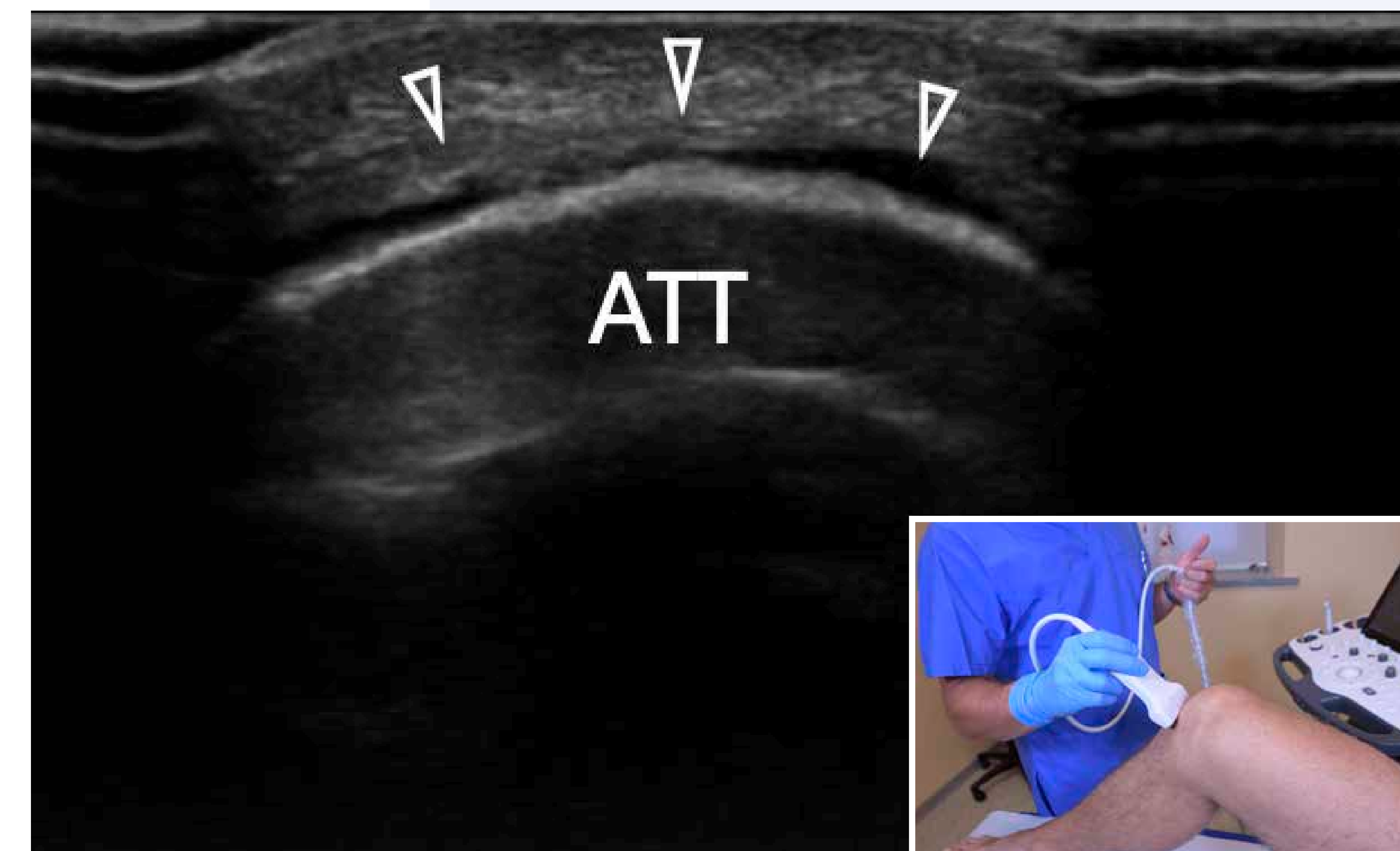


TABLE 1 - STAGE 1, summary: structures, positions and landmarks

Structure	Patient Position	Probe Orientation / Plane	Key Landmarks / What Should Be Seen
Quadriceps tendon	Supine, knee flexed	Long- and short axis	Fibrillar tendon inserting on superior patella; layered appearance proximally
Suprapatellar recess	Supine, ~30° knee flexion	Long axis over distal femur	Potential space between quadriceps tendon and femur; effusion/synovium if present
Femoral trochlear cartilage	Supine, knee hyperflexed	Transverse over trochlear bone	Anechoic V-shaped cartilage with clear cartilage–bone interface
Patellar surface	Supine, knee flexed or extended	Long- and short axis	Smooth hyperechoic cortical line of the patella
Patellar retinacula	Supine, knee extended with patellar displacement	Transverse patella-to-epicondyle	Thin fibrillar medial and lateral retinacula
Patellar tendon (long axis)	Supine, slight knee flexion	Long axis	Fibrillar tendon from inferior patella to tibial tuberosity
Patellar tendon (short axis)	Supine, slight knee flexion	Transverse with mediolateral sweeps	Flat/oval tendon contour across full width
Hoffa's fat pad	Supine, knee neutral or slight flexion	Long axis deep to patellar tendon	Echogenic fat with internal septa
Pre- and infrapatellar bursae	Supine, knee extended or slight flexion	Long- and short axis	Normally collapsed bursae; fluid if bursitis present

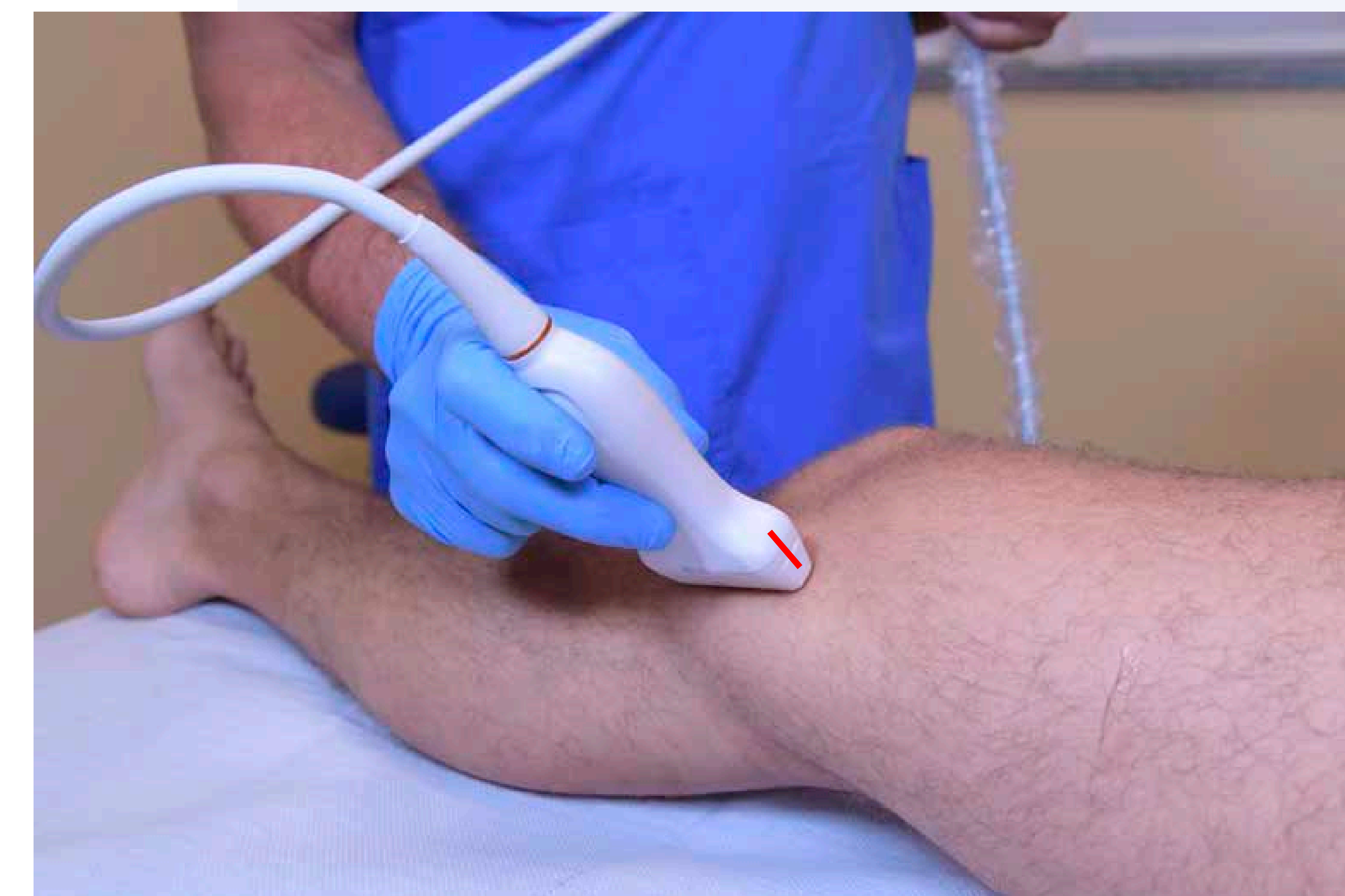
TABLE 2 - STAGE 1, summary: the most frequent technical pitfalls

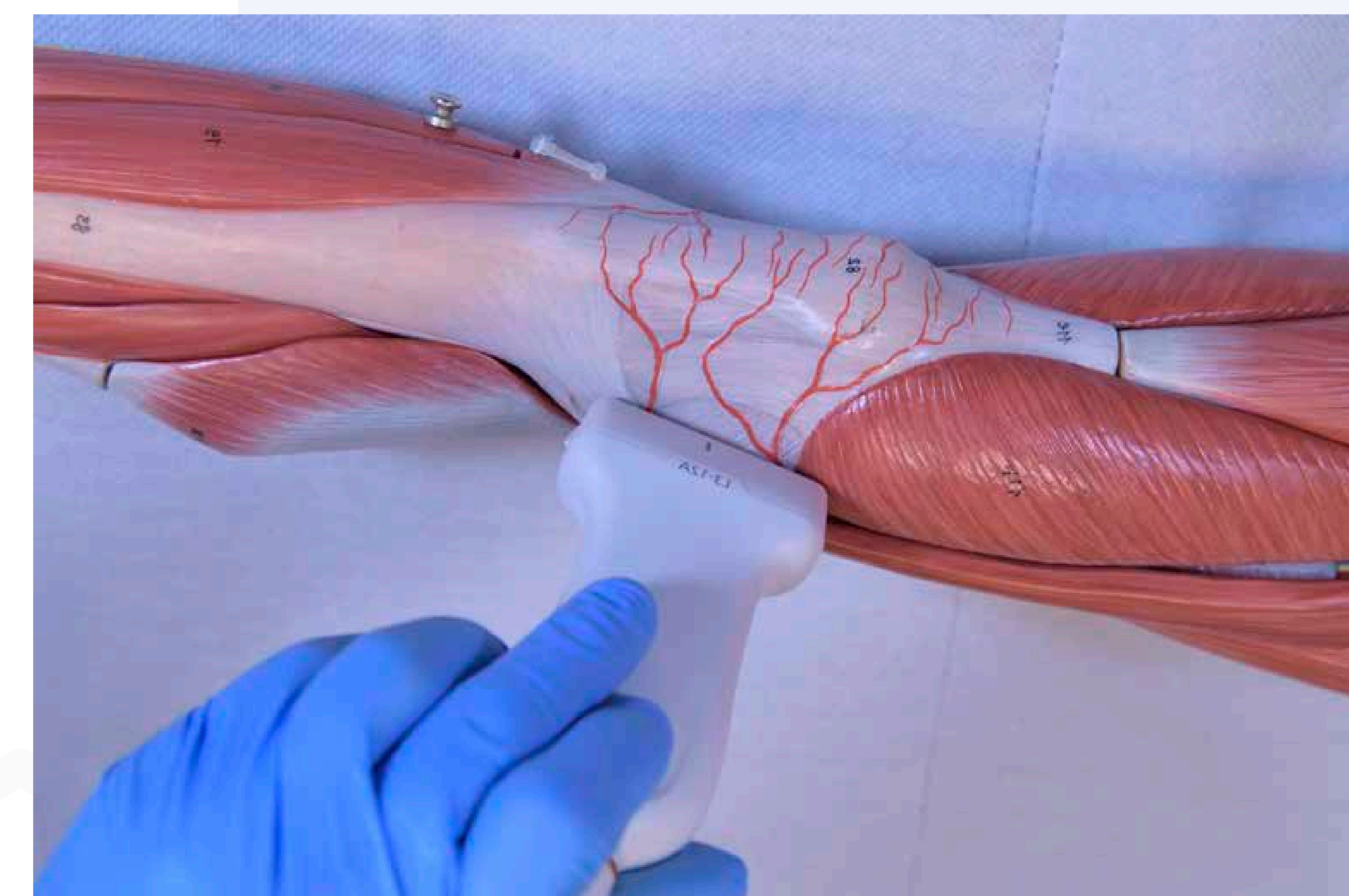
Pitfall	Underlying Cause	How to Avoid / Teaching Tip
Anisotropy of tendons (quadriceps or patellar tendon)	Ultrasound beam not perpendicular to tendon fibers.	Continuously adjust probe tilt to maintain perpendicular insonation; confirm findings dynamically.
False hypoechogenicity mimicking tendon tear	Anisotropy or excessive probe pressure.	Reduce transducer pressure and re-scan with different insonation angles.
Missed partial tendon tears	Static assessment only.	Always perform dynamic maneuvers (active/passive knee motion and probe compression).
Poor visualization of the suprapatellar recess	Inadequate knee flexion or excessive compression.	Start at ~30° knee flexion and adjust position; use gentle probe pressure.
Confusion between fat pads and synovial tissue	Similar echogenicity of Hoffa's fat pad, prefemoral fat pad, and synovium.	Use dynamic compression, Doppler if needed, and anatomical landmarks for differentiation.
Underestimation of joint effusion or synovitis	Excessive probe pressure or suboptimal scanning plane.	Minimize compression and scan in multiple planes.
Misinterpretation of trochlear cartilage thickness	Attempting absolute thickness measurement without validated cut-offs.	Focus on cartilage–bone interface and intra-patient comparison in the same position.
Failure to identify crystal deposits	Suboptimal visualization of cartilage interface.	Optimize knee hyperflexion and focus on the anechoic cartilage layer and its interfaces.

STEP 2
MEDIAL KNEE

STEP 2 - MEDIAL KNEE

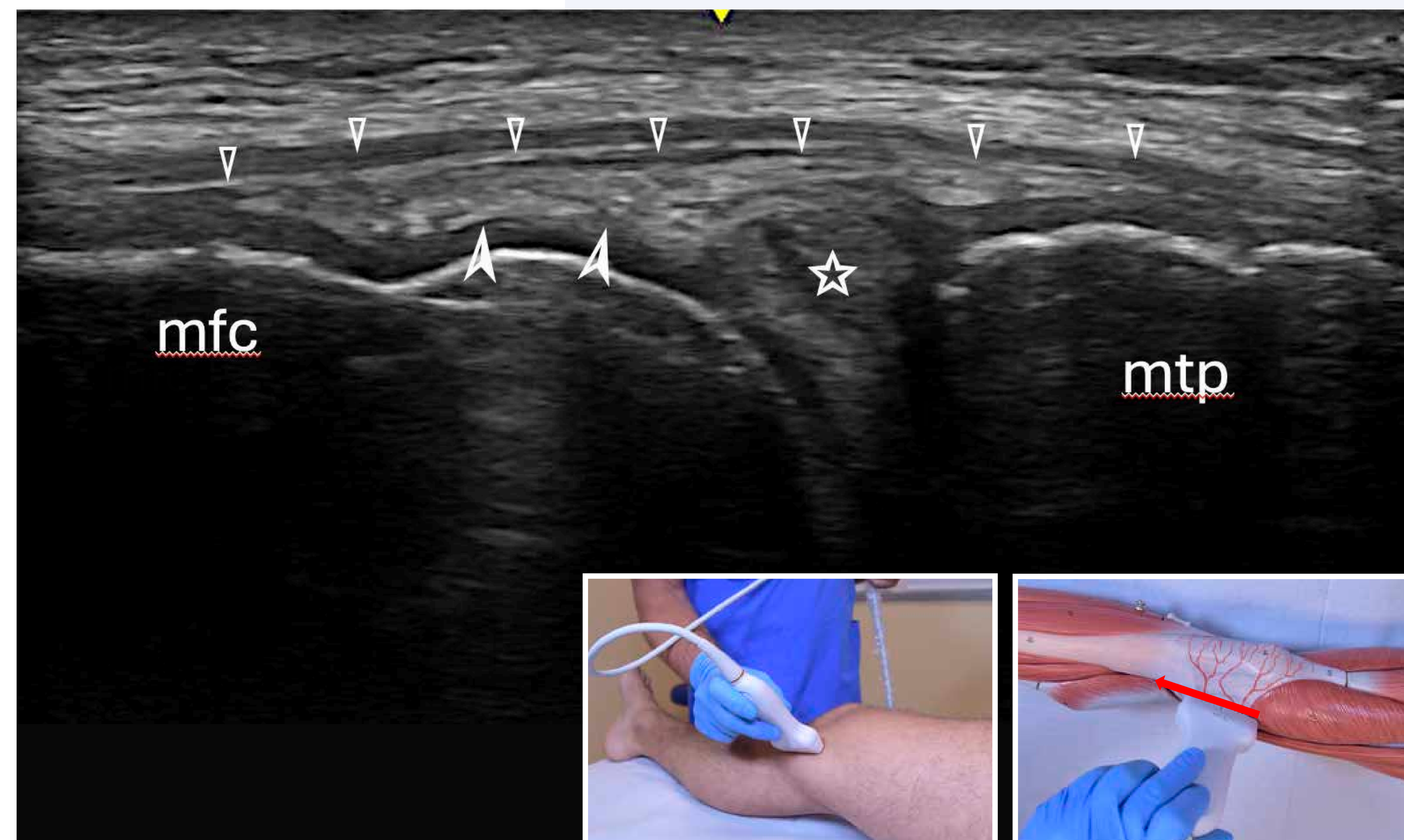
ASPECT	ULTRASOUND TECHNIQUE / CLINICAL RELEVANCE
Anatomical focus	Medial collateral ligament (MCL), pes anserinus tendons, and adjacent soft tissues.
Patient position	Supine; knee extended or slightly flexed (20–30°); lower extremity externally rotated 10–20°.
Probe orientation	Long axis placement over the medial knee; marker (red line) directed cranially.
Dynamic maneuver	Application of gentle valgus stress to assess MCL integrity.
Key landmarks	MCL fibers; pes anserinus tendons; inferior medial genicular artery pulsation.
Normal findings	Continuous fibrillar MCL; thin, well-defined pes anserinus tendons.
Clinical objectives	Detection of MCL injuries; evaluation of chronic changes; identification of pes anserinus tendinopathy or bursitis.
Technical tip	Dynamic stress and side-to-side comparison improve diagnostic confidence.





STEP 2 - MEDIAL KNEE
Long axis (mid III of medial FT joint)

STRUCTURE	ULTRASOUND APPEARANCE / ANATOMICAL DESCRIPTION
Medial femoral epicondyle	Proximal bony landmark from which the MCL is identified and followed distally.
Medial collateral ligament (MCL) – superficial portion (▻)	Fibrillar, predominantly hyperechoic structure extending from the medial femoral epicondyle toward the tibia.
Medial collateral ligament (MCL) – deep portion, meniscofemoral ligament (➢)	Deeper hyperechoic band closely related to the medial meniscus, contributing to meniscocapsular stability.
Medial meniscus – medial wall (☆)	Triangular echogenic structure adjacent to the deep MCL, representing the medial margin of the meniscus.
Medial femoral condyle (mfc)	Curved hyperechoic cortical surface providing a key osseous landmark.
Medial tibial plateau (mtp)	Hyperechoic cortical contour forming the distal bony reference of the medial compartment.

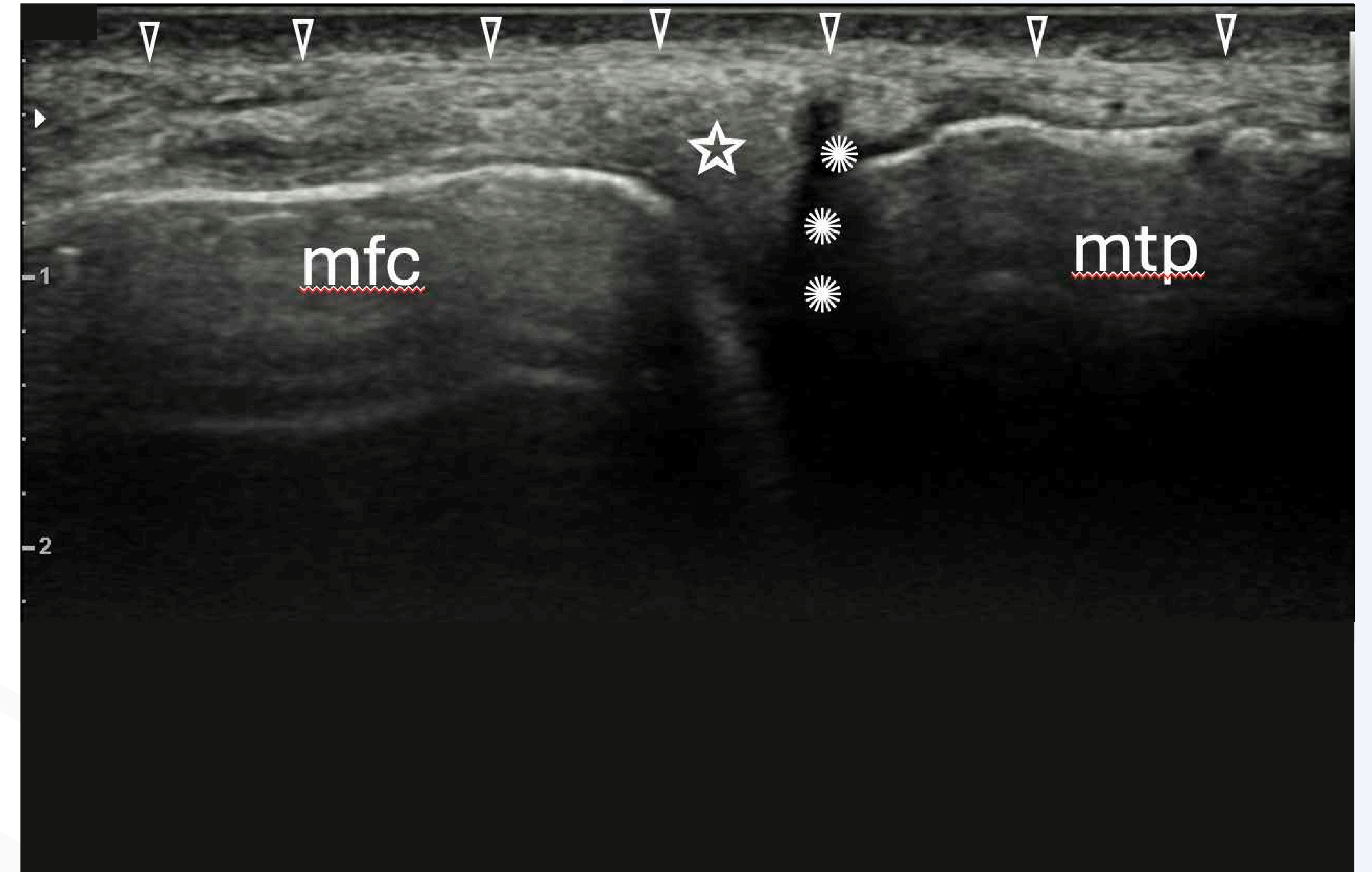


STEP 2 - MEDIAL KNEE
Valgus stress manoeuvre
Long axis

During the dynamic exam we can perform a valgus stress of the knee to emphasize the integrity (or otherwise) of the MCL.

We can identify:

- The **MCL** ligament integrity (▻).
- The **medial meniscus** with its **medial wall** (☆)
- The physiological increased space between meniscus and tibia, due to the valgus stress (✺)
- The hyperechoic curved shape of the cortex of the **medial femoral condyle (mfc)** and **medial tibial plateau (mtp)**



STEP 2 - MEDIAL KNEE
Medial collateral ligament (MCL)
Short axis

From the previous long axis position, the transducer is rotated 90° to obtain a short axis (transverse) view of the medial collateral ligament (MCL).

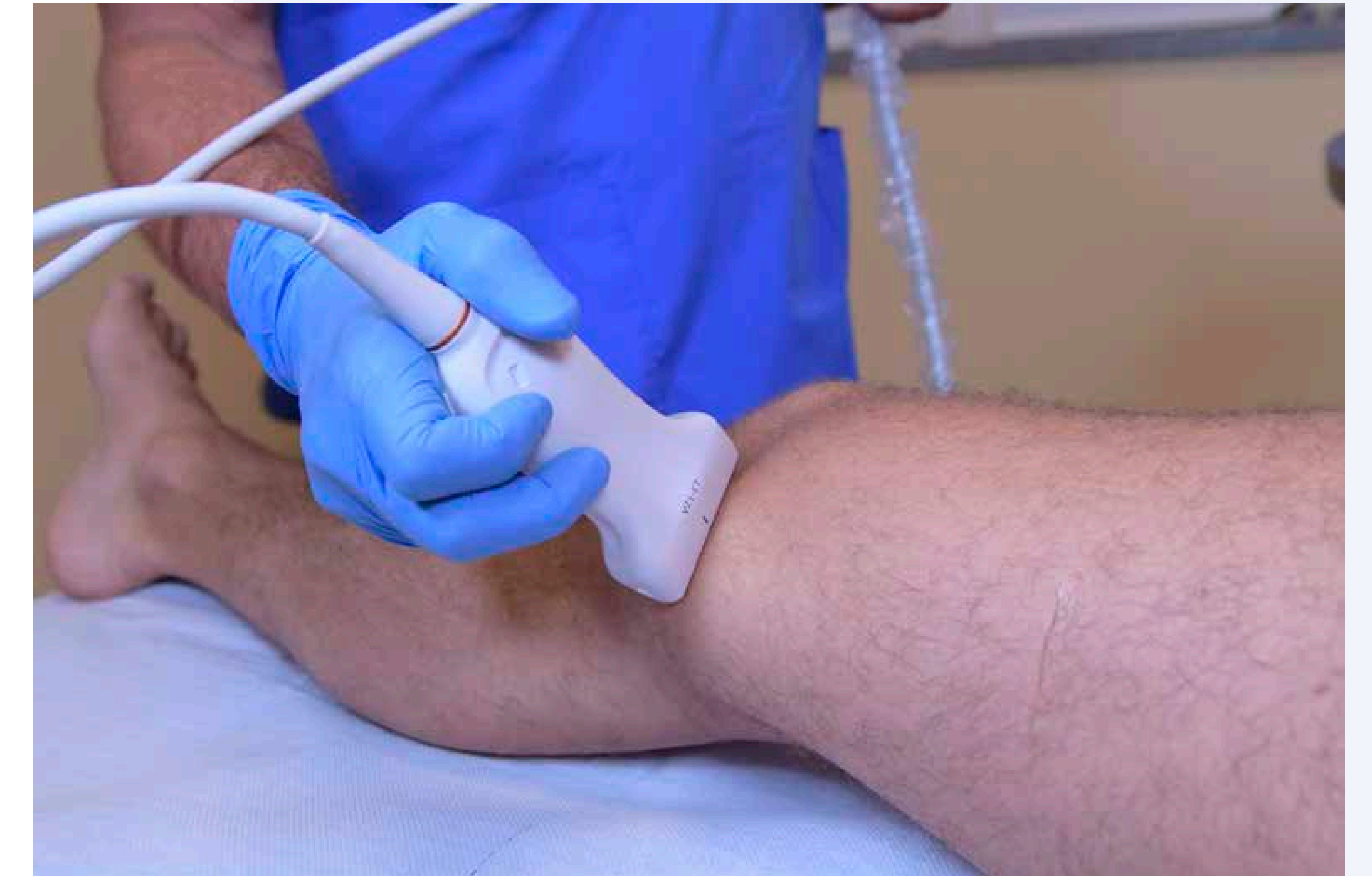
This view allows assessment of the ligament's anteroposterior thickness and contour and the detection of focal abnormalities.

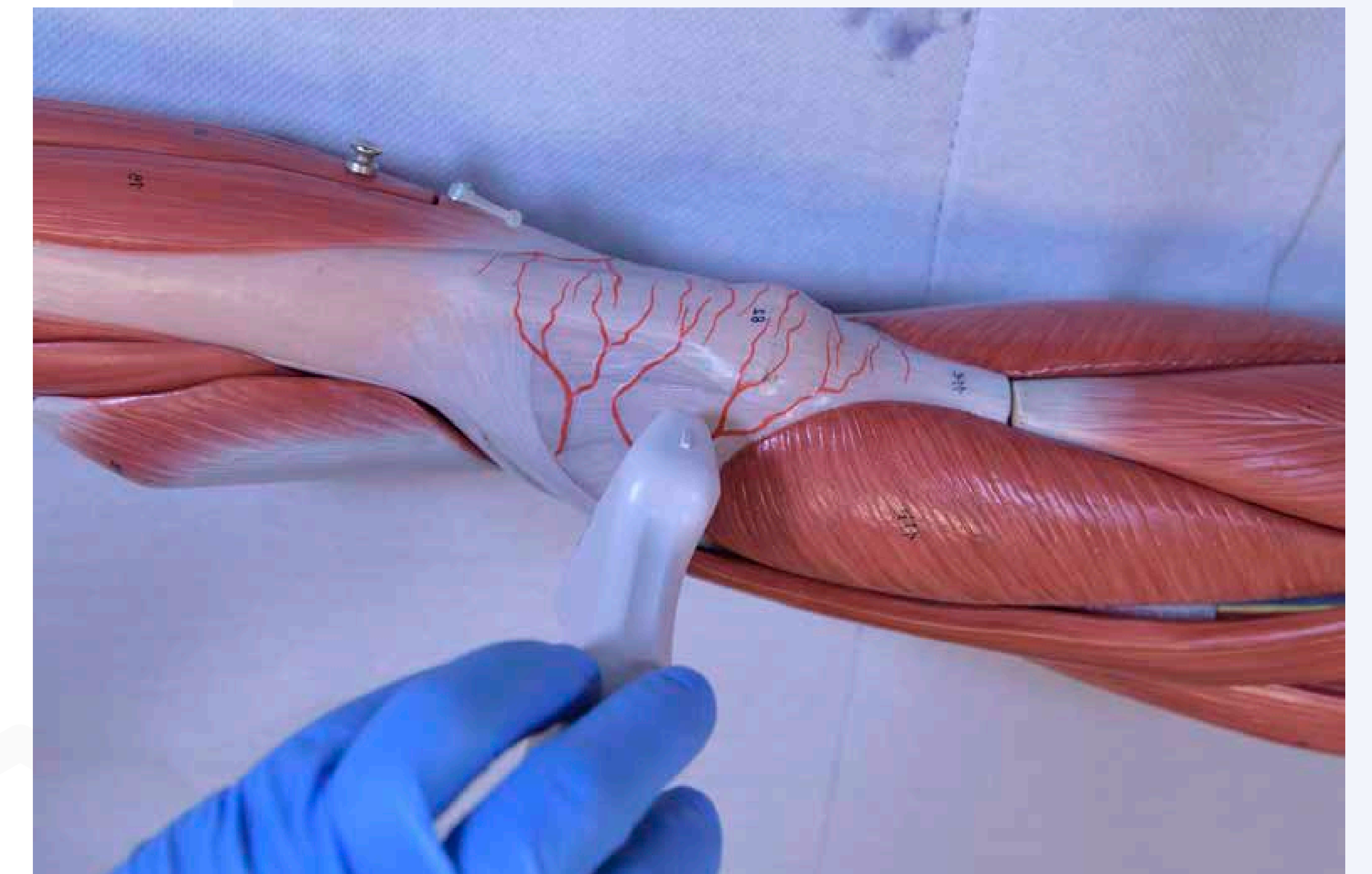
At this level, the posterior oblique ligament (POL) is not visualized as an independent structure. Instead, it appears as a continuation of the semimembranosus expansion, which was not described in the previous long axis image.

Therefore, this scan should not be interpreted as a direct visualization of the POL itself, but rather as a view of the posteromedial capsular complex related to the semimembranosus tendon.

In addition, the medial meniscus is visualized in short axis, which is particularly useful for differentiating intrinsic meniscal pathology from extra-meniscal findings, such as crystal deposits at the meniscocapsular junction.

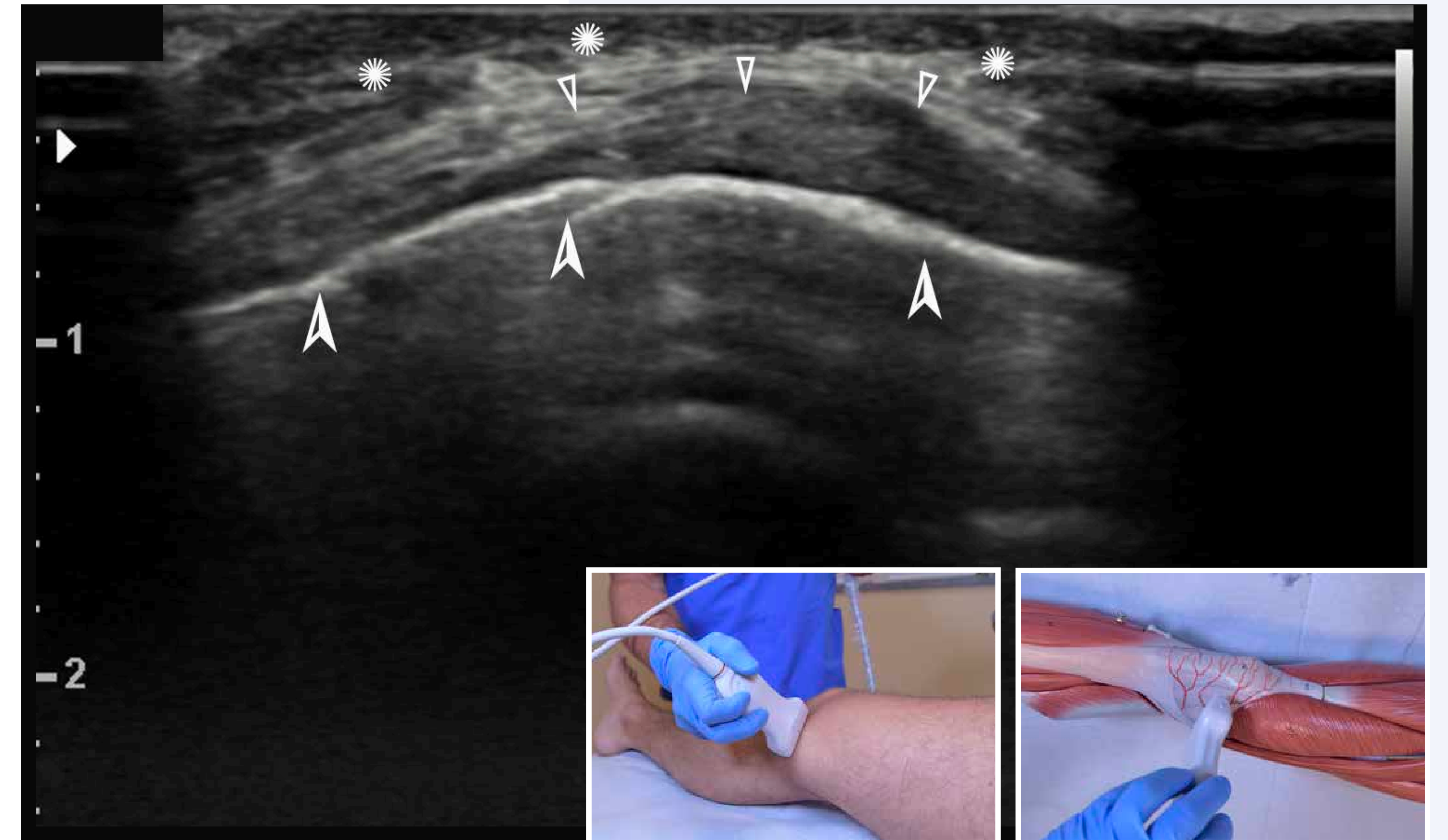
This transverse approach complements the long axis assessment and improves diagnostic confidence when evaluating medial knee pain.





STEP 2 - MEDIAL KNEE
Medial collateral ligament (MCL)
Short axis

STRUCTURE	ULTRASOUND APPEARANCE / ANATOMICAL DESCRIPTION
Bony landmarks	Depending on the probe position you can see the femur or the tibia.
Medial collateral ligament (MCL) - superficial portion (▻)	Fibrillar, predominantly hyperechoic structure extending from anterior to posterior, under the subcutaneous fat (✺).
Medial femoral condyle (MFC)	Curved hyperechoic cortical surface providing a key osseous landmark (➢).



STEP 2 - MEDIAL KNEE
Pes anserinus tendons
Long axis & short axis

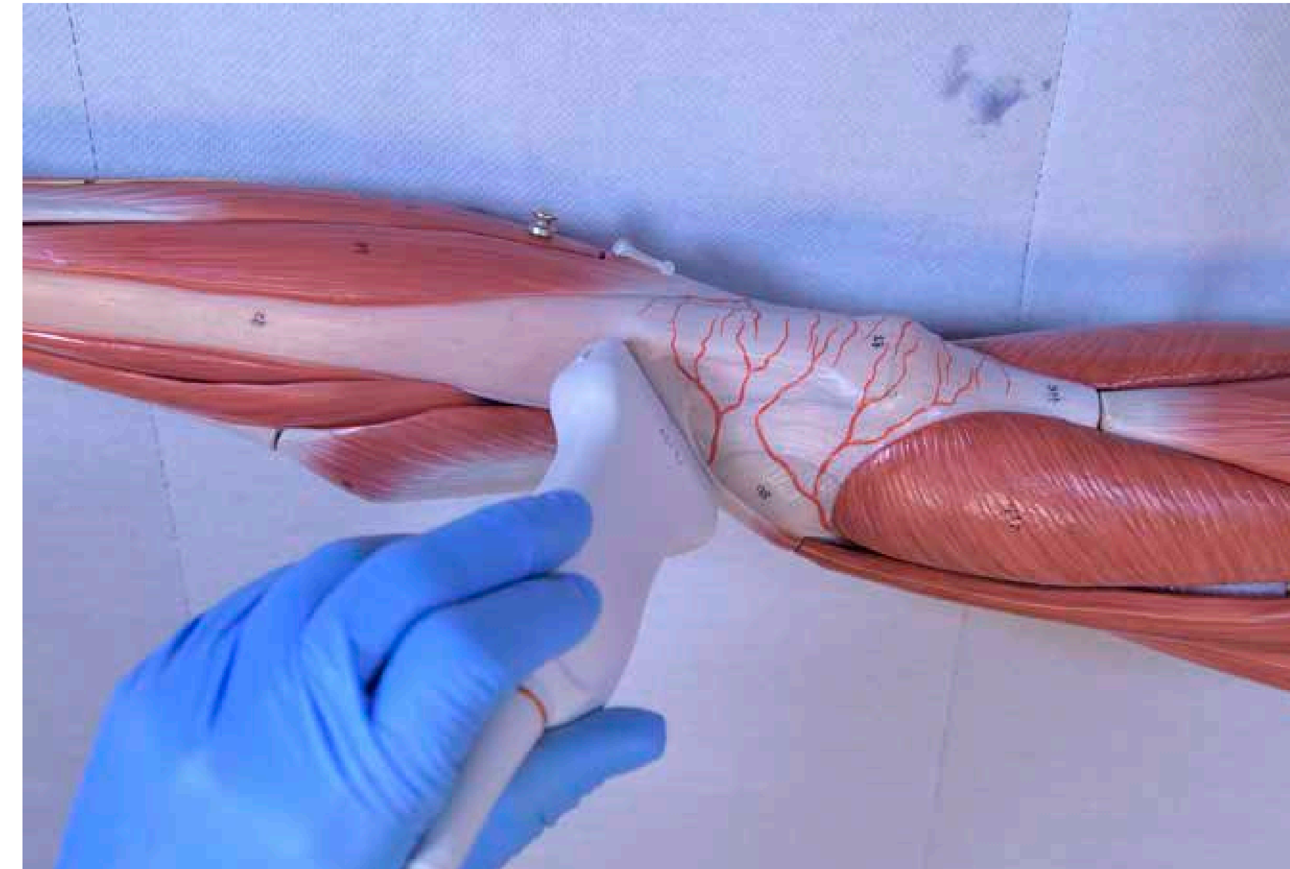
From the medial knee position used for medial collateral ligament assessment, the transducer is rotated obliquely to insonate the pes anserinus complex in long axis.

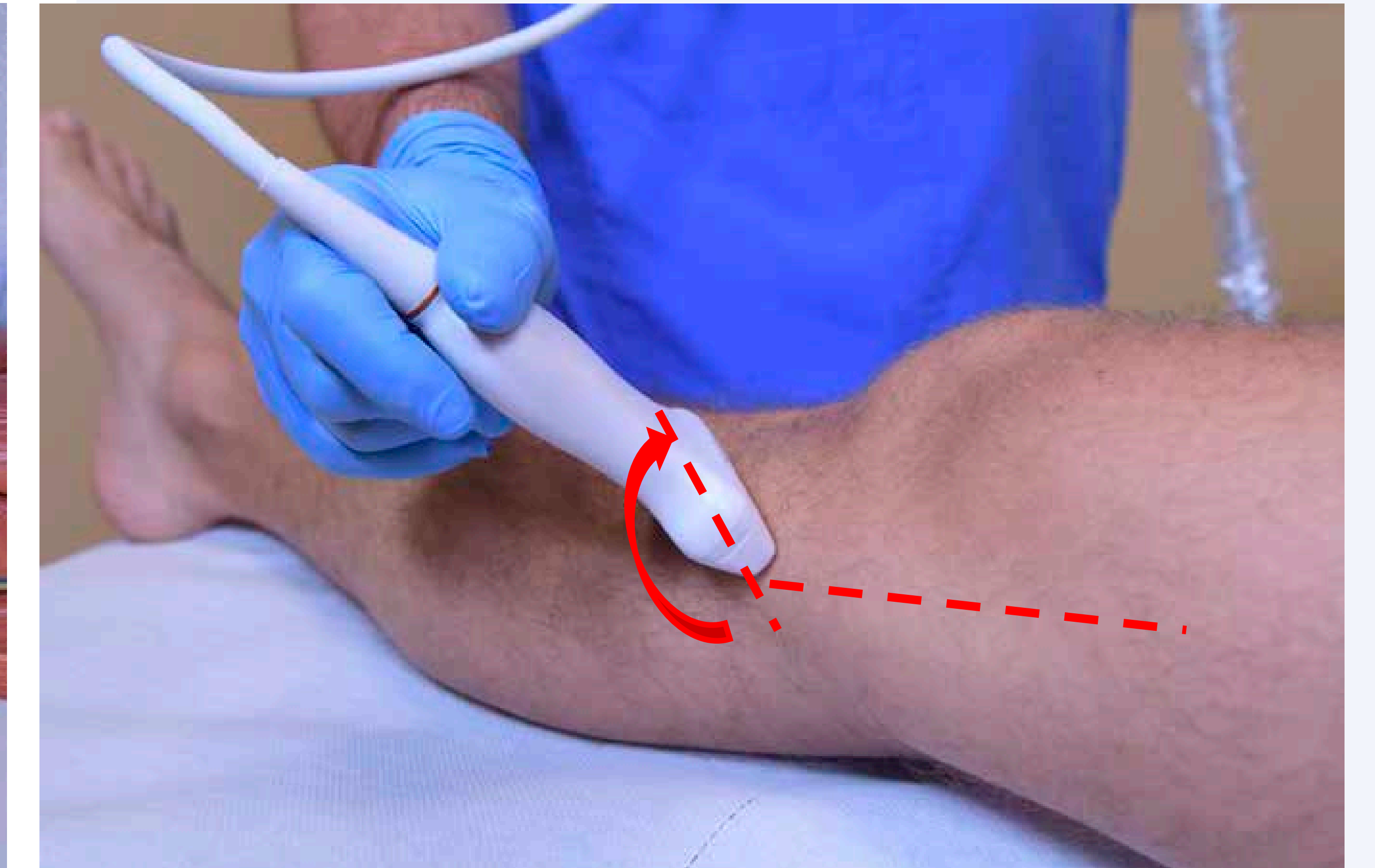
The pes anserinus is formed by the tendons of the sartorius, gracilis, and semitendinosus muscles, which converge toward their common insertion on the anteromedial aspect of the proximal tibia. In long axis view, these tendons appear as fibrillar, predominantly hyperechoic structures coursing obliquely toward the tibial insertion.

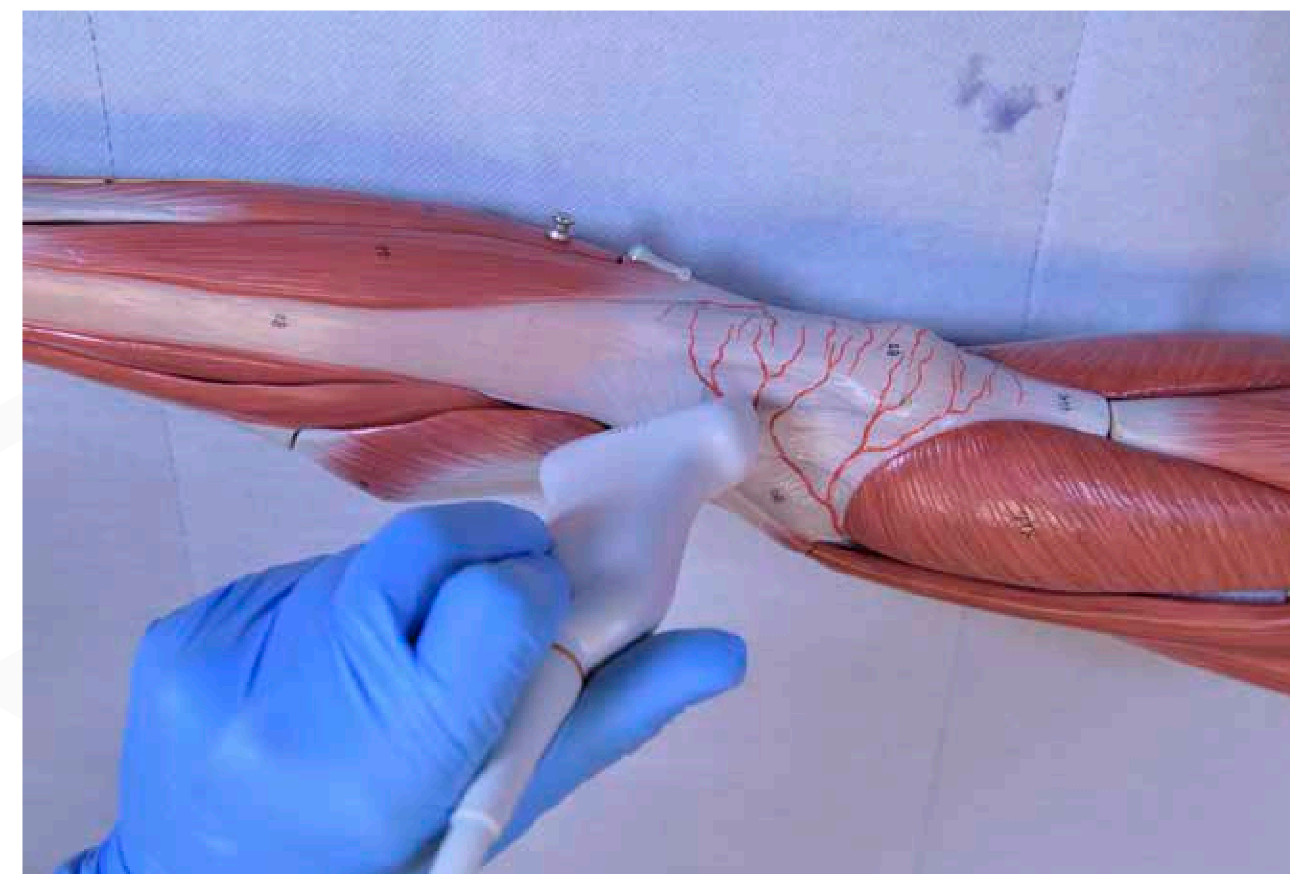
Identification can be challenging because the three tendons are closely apposed at their insertion and because of frequent anatomical variability in their relative position and degree of overlap.

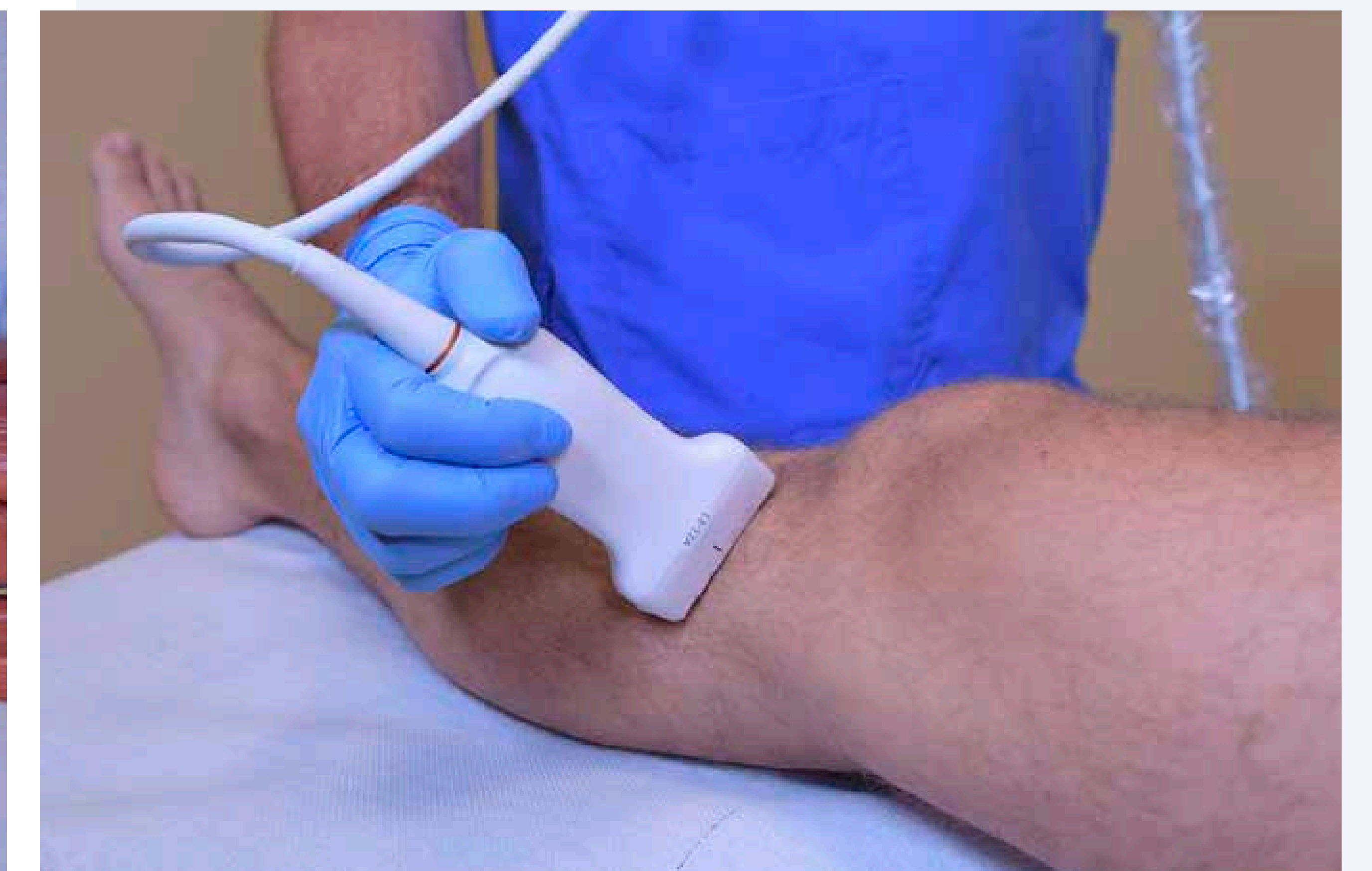
Short axis (transverse) scanning, performed by rotating the probe 90° is therefore essential to evaluate the pes anserinus complex along its full mediolateral extent and to improve differentiation between individual tendons.

A combined long- and short axis approach allows more reliable identification of pes anserinus tendons and improves detection of tendinopathy or pes anserinus bursitis.









STEP 2 - MEDIAL KNEE
Pes anserinus tendons
Short axis

The identification of the three tendons of the pes anserinus is not easy, especially at the tibial **(T)** insertion, where the tendons are overlayed.

We can identify:

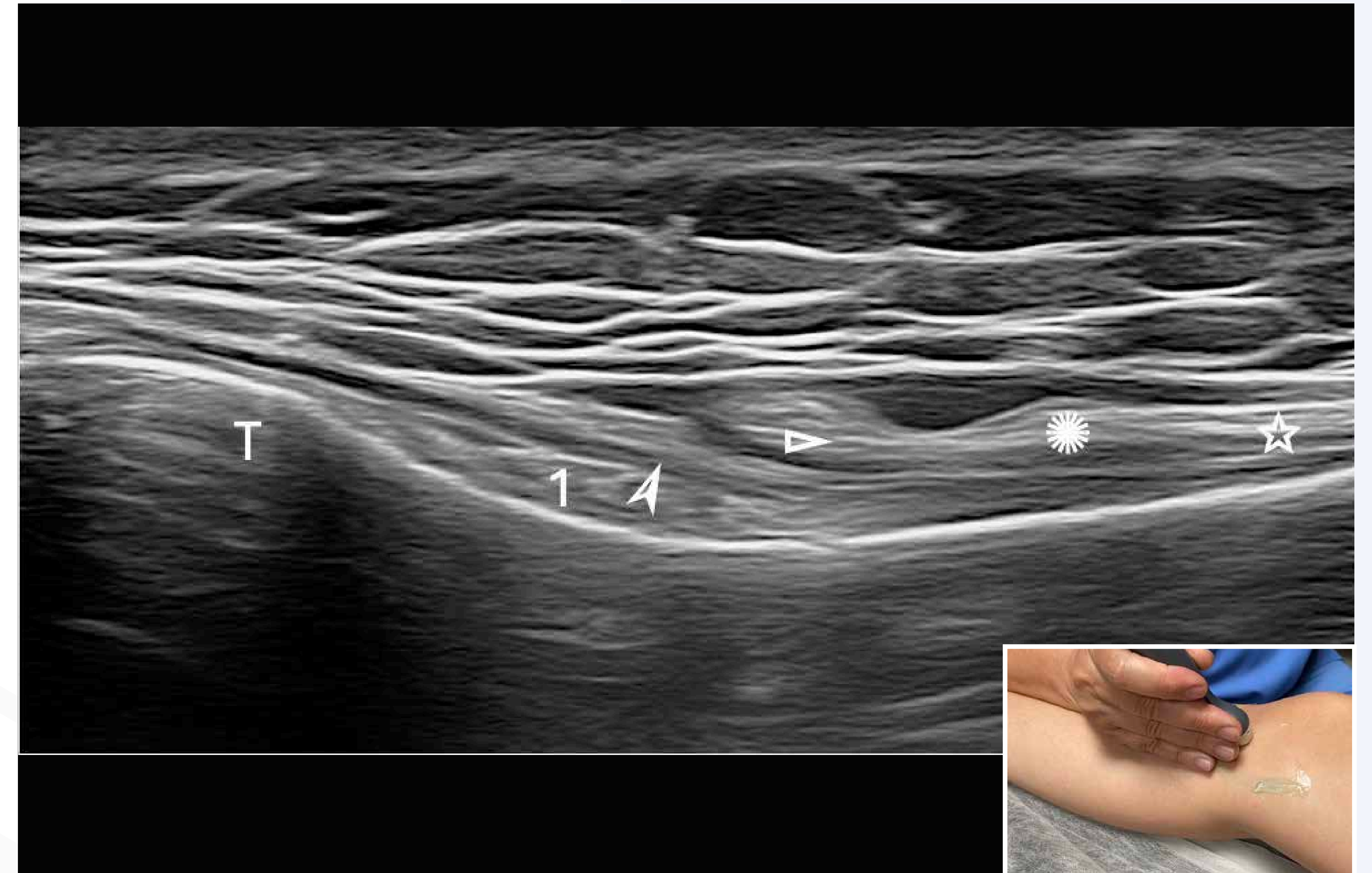
The sartorius tendon (▻)

The gracilis tendon (✺)

The semitendinosus tendon (☆)

In deeper plane the MCL (⩚)

Inferior geniculate neuro-vascular bundle **(1)**: you can use it as a landmark to immediately identify the pes anserinum distally, in a more superficial plane.



Tips & tricks for a correct medial knee study

Pitfall	Main Cause	How to Avoid / Teaching Tip
Failure to identify individual tendons	Close apposition of sartorius, gracilis, and semitendinosus tendons at insertion	Combine long- and short axis scans and perform mediolateral sweeps
Confusion with medial collateral ligament pathology	Anatomical proximity to the MCL	Trace tendons proximally and confirm their oblique course toward the tibia
Missed focal tendinopathy	Assessment limited to long axis view	Always include short axis evaluation of the full tendon width
Underdiagnosis of pes anserinus bursitis	Lack of dynamic compression	Apply gentle probe compression to confirm fluid distension
Misinterpretation due to anatomical variability	Variable tendon arrangement between patients	Use landmarks and accept variability as normal; compare sides when needed

STEP 3
LATERAL KNEE

This table provides a structured, image-oriented description of the ultrasound examination of the lateral knee, including patient and probe positioning, key anatomical landmarks, and expected ultrasound appearance of each structure.

The lateral synovial recess is included as part of the systematic assessment.

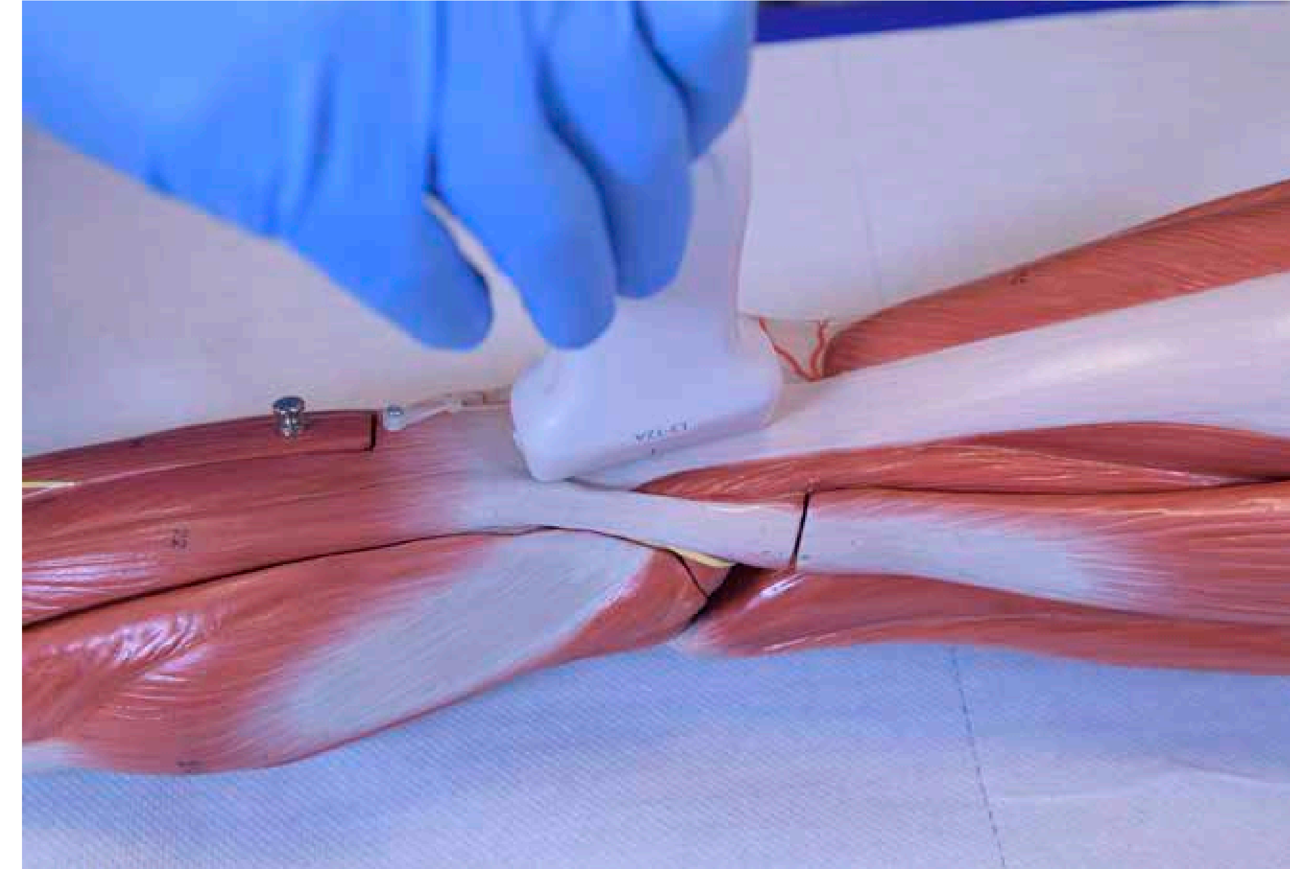
Structure	Patient Position	Probe Orientation / Plane	Key Landmarks	Ultrasound Description (Normal)
Iliotibial band (ITB)	Supine; knee extended or slight flexion (20-30°)	Long- and short axis over lateral knee	Lateral femoral condyle cortex	Thin, fibrillar, hyperechoic band superficial to the lateral femoral condyle
Lateral collateral ligament (LCL)	Supine; knee slightly flexed; mild internal rotation	Long axis from lateral femoral epicondyle to fibular head	Lateral femoral epicondyle, fibular head	Cord-like hyperechoic ligament extending to fibular head
Biceps femoris tendon	Supine or lateral decubitus; knee slightly flexed	Long- and short axis at fibular head	Fibular head, LCL insertion	Fibrillar hyperechoic tendon inserting on the fibular head
Lateral synovial recess	Supine; knee slightly flexed (20-30°)	Long axis over lateral femorotibial joint line	Lateral femoral condyle, lateral tibial plateau	Potential space; normally collapsed or with minimal fluid
Lateral meniscus (adjacent view)	Supine; knee slightly flexed	Long- and short axis at joint line	Lateral femoral condyle, tibial plateau	Triangular echogenic structure at joint line

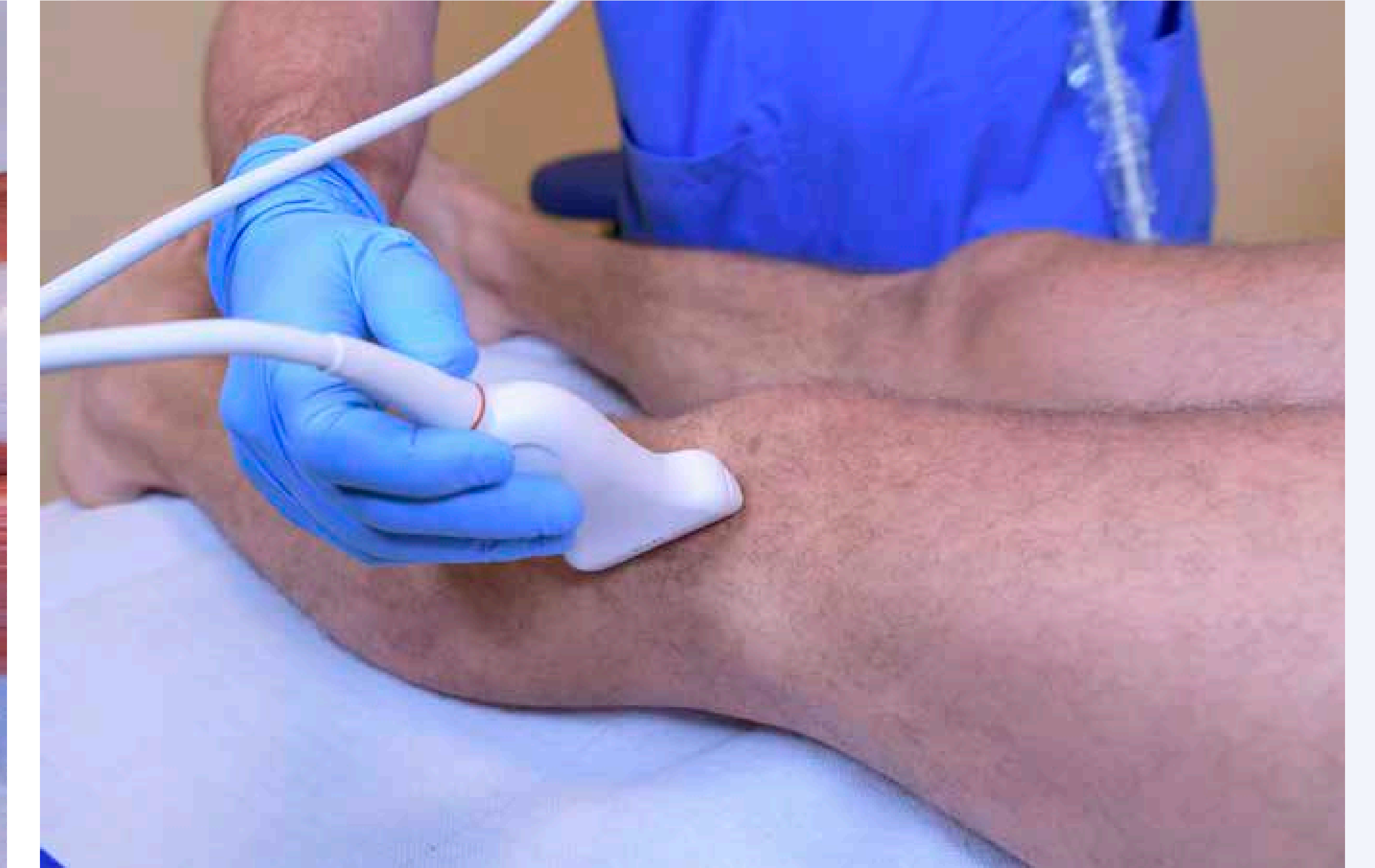
STEP 3 - LATERAL KNEE
Iliotibial band (IT)
Long axis

The patient is in the lying position on the bed with the knee flexed 20-30° and the inferior leg internally rotated from 10 to 20°.

For the study of the **iliotibial band**, start with the probe oriented longitudinally over the long axis of the thigh, remembering that the **IT** lies between the anterior and middle third of the knee.

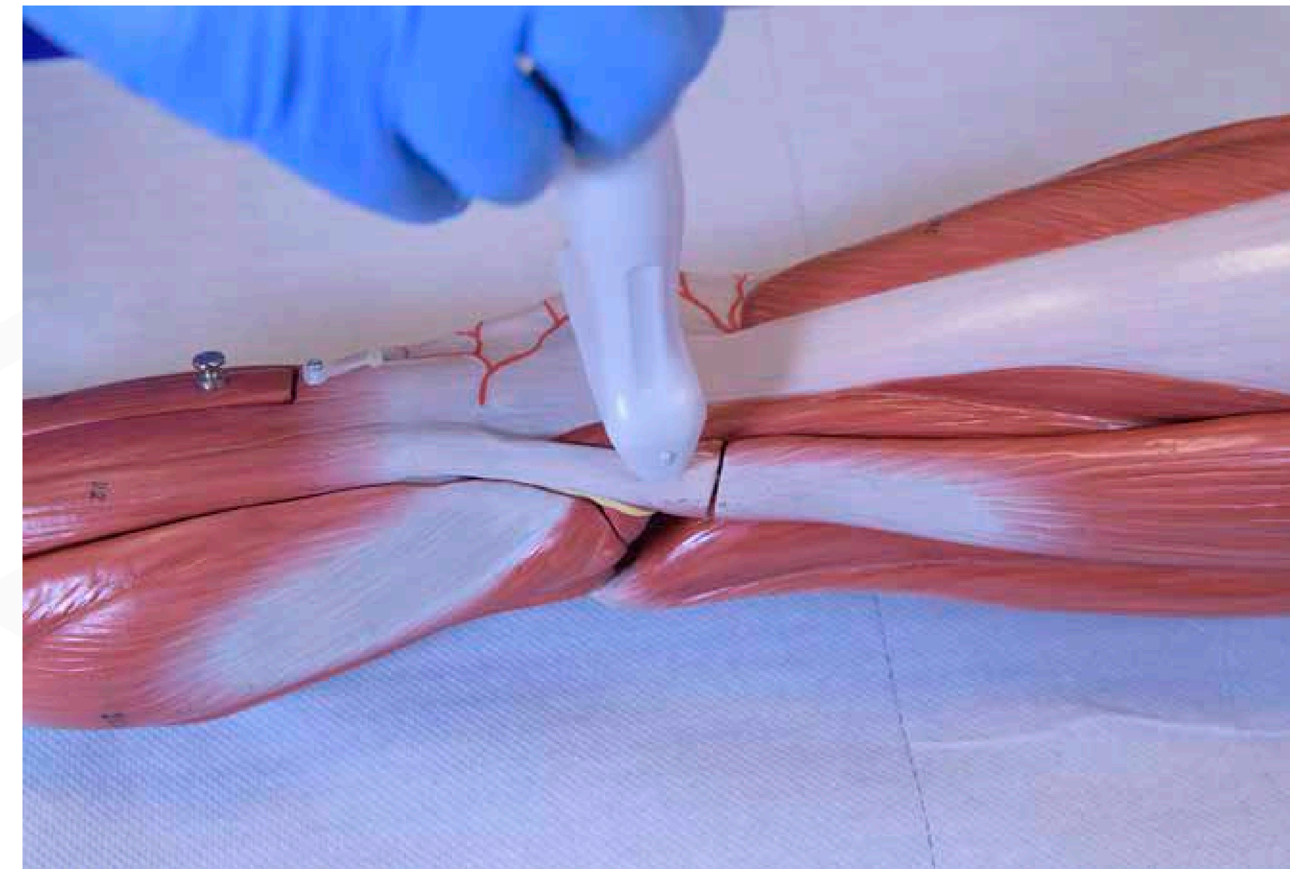
Follow the IT until the distal insertion on **Gerdy's tubercle** at the proximo-lateral aspect of the tibia.





STEP 3 - LATERAL KNEE
iliotibial band
Short axis

From the previous position, rotate the probe 90° for a correct insonation of the short axis of the **IT**.



This table summarizes the main insertions and attachments of the **iliotibial band (ITB)**, with their corresponding ultrasound appearance and key anatomical landmarks.

It is intended for image-based teaching and systematic ultrasound interpretation.

Insertion / Attachment	Anatomical Description	Key Landmarks	Ultrasound Appearance
Proximal origin (fascia lata)	Thickened lateral reinforcement of the fascia lata receiving fibers from the tensor fasciae latae and gluteus maximus.	Tensor fasciae latae, gluteus maximus, lateral thigh fascia.	Broad, fibrillar hyperechoic fascial structure continuous with surrounding fascia.
Kaplan fibers (femoral attachments)	Deep oblique fibers anchoring the ITB to the distal lateral femur.	Lateral femoral shaft and supracondylar region.	Short, obliquely oriented hyperechoic fibers inserting into the femoral cortex.
Relationship with lateral femoral condyle	Functional contact region rather than a true insertion; site of friction during knee motion.	Lateral femoral condyle cortex.	ITB visualized as a thin hyperechoic band gliding over the hyperechoic cortical surface.
Lateral patellar retinaculum	Fascial expansion contributing to lateral patellar stabilization.	Lateral patellar margin.	Thin hyperechoic fascial extension blending with retinacular fibers.
Distal tibial insertion (Gerdy's tubercle)	Primary distal insertion of the ITB on the anterolateral proximal tibia.	Gerdy's tubercle, lateral tibial cortex.	Focal hyperechoic band inserting onto a hyperechoic bony cortex with posterior acoustic shadow.

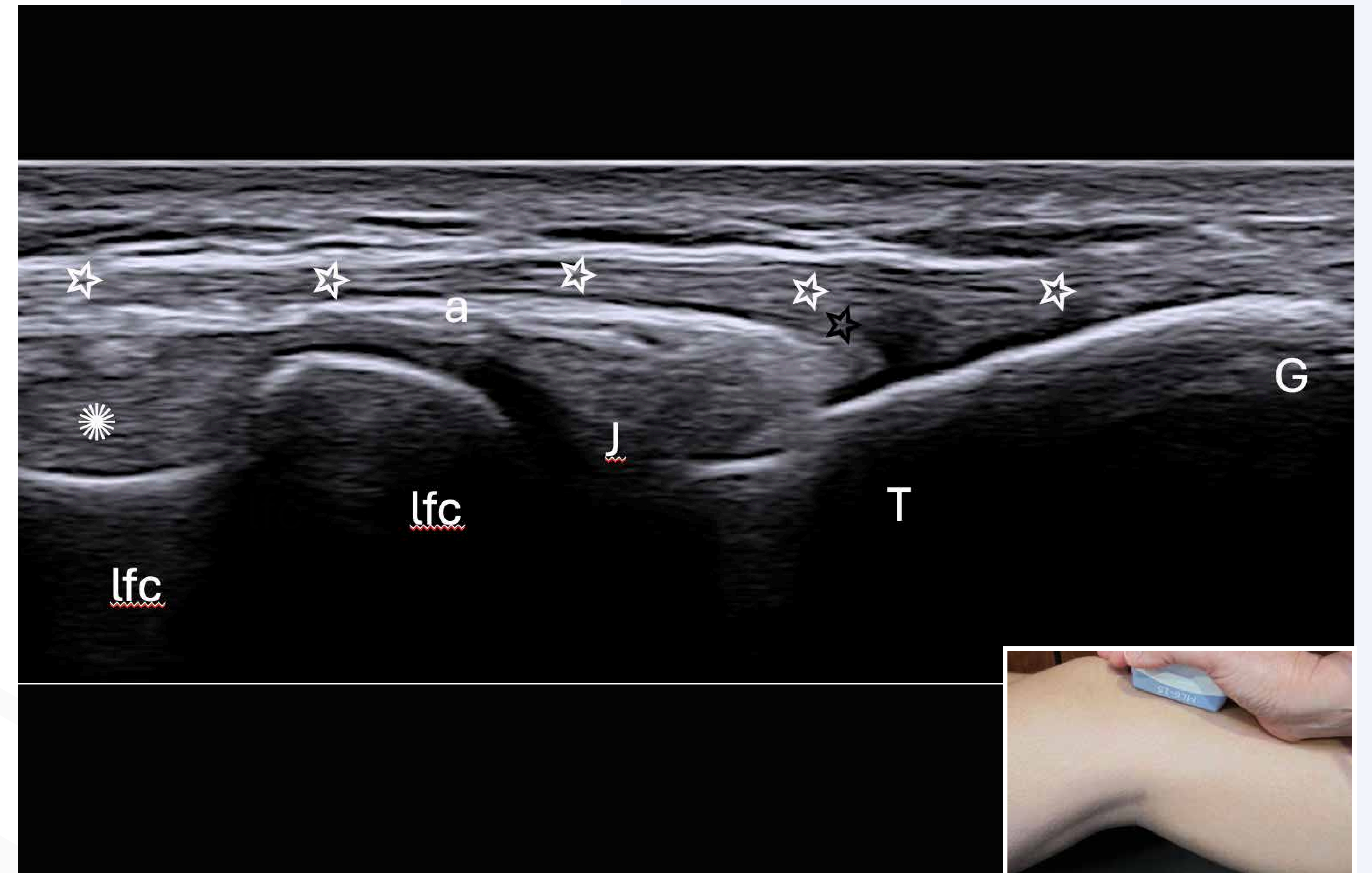
STEP 3 - LATERAL KNEE
Iliotibial band (IT), distal insertion
Long axis

Patient in supine position with limb in slight flexion.

Probe with upper portion resting on lateral femoral condyle and lower portion on Gerdy's tubercle.

We can identify:

- The **IT** (☆)
- The femoral cortex of lateral femoral condyle **(lfc)**
- The tibia **(T)** and Gerdy's tubercule **(G)**
- Popliteal tendon (✺)
- Lateral femoro-tibial joint **(J)**

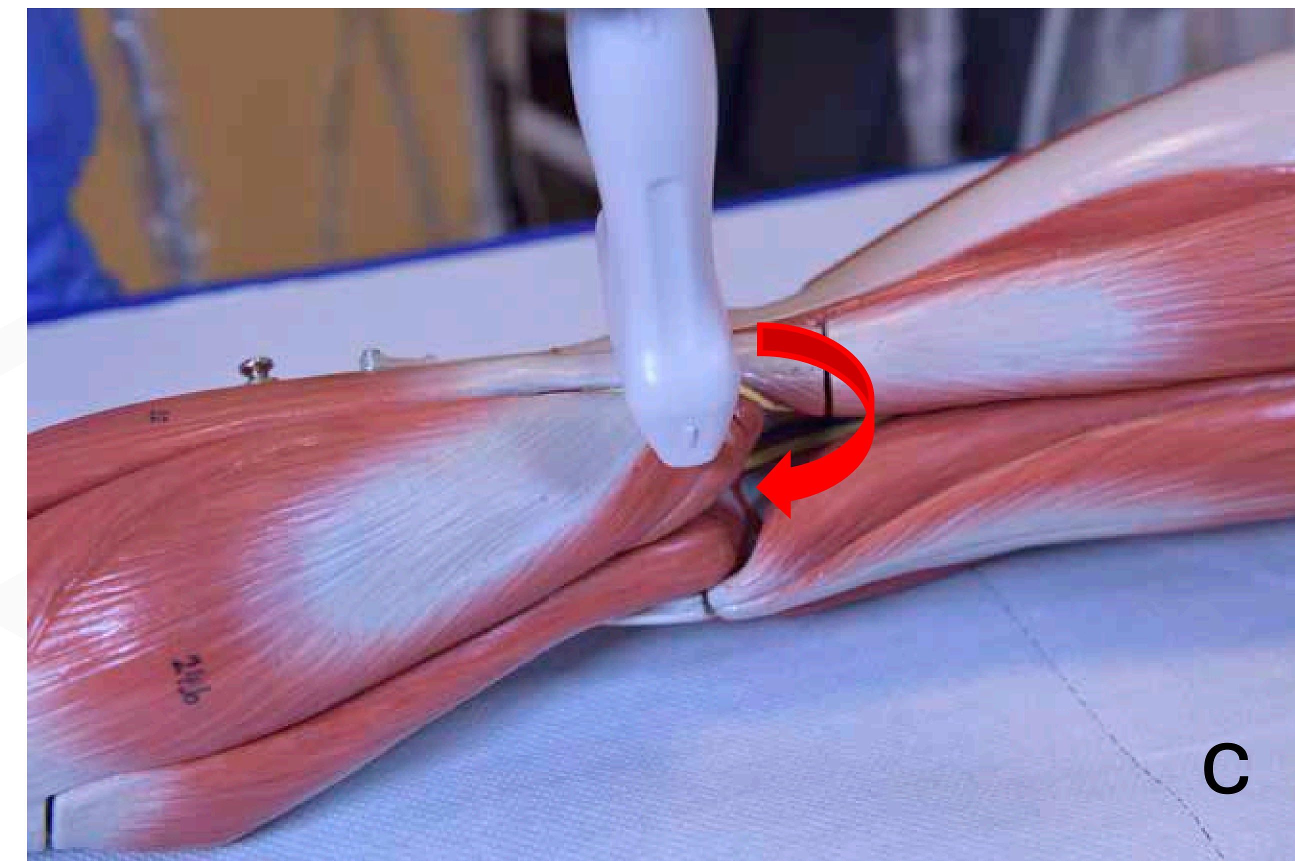


STEP 3 - LATERAL KNEE
Lateral collateral ligament (LCL)
Long axis

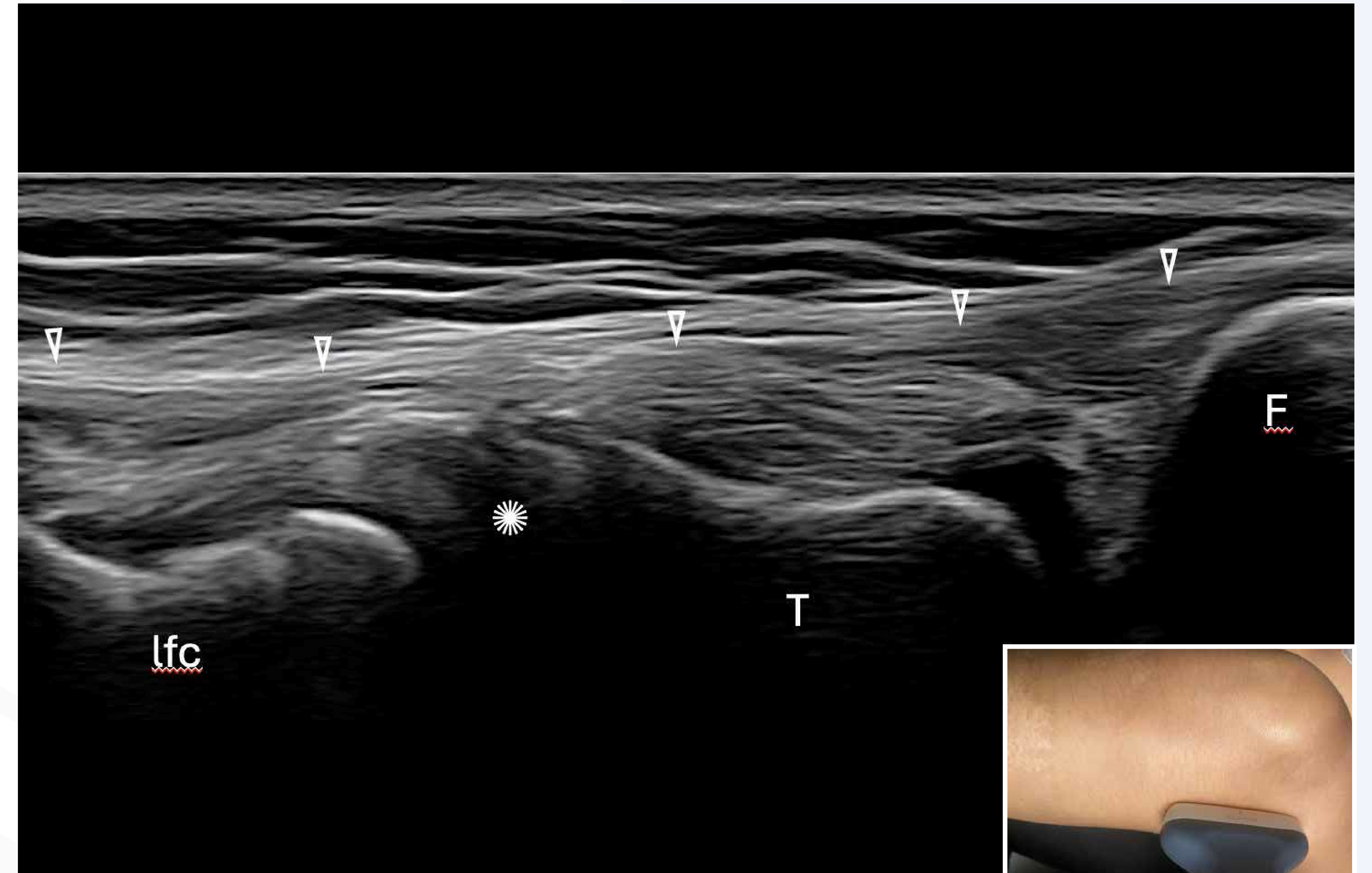
With the knee extended, place the lower edge of the probe on the **peroneal head** (☆) and then rotate anteriorly its upper edge (**red arrow**, in **a** and **b**) to reach the right insonation of the LCL, whose direction is toward the lateral femoral condyle **(a, b)**.

STEP 3 - LATERAL KNEE
iliotibial band
Short axis

For the short axis study of the **LCL**, rotate the probe 90° **(c)**.



STEP 3 - LATERAL KNEE
Lateral collateral ligament
Long axis



We can identify:

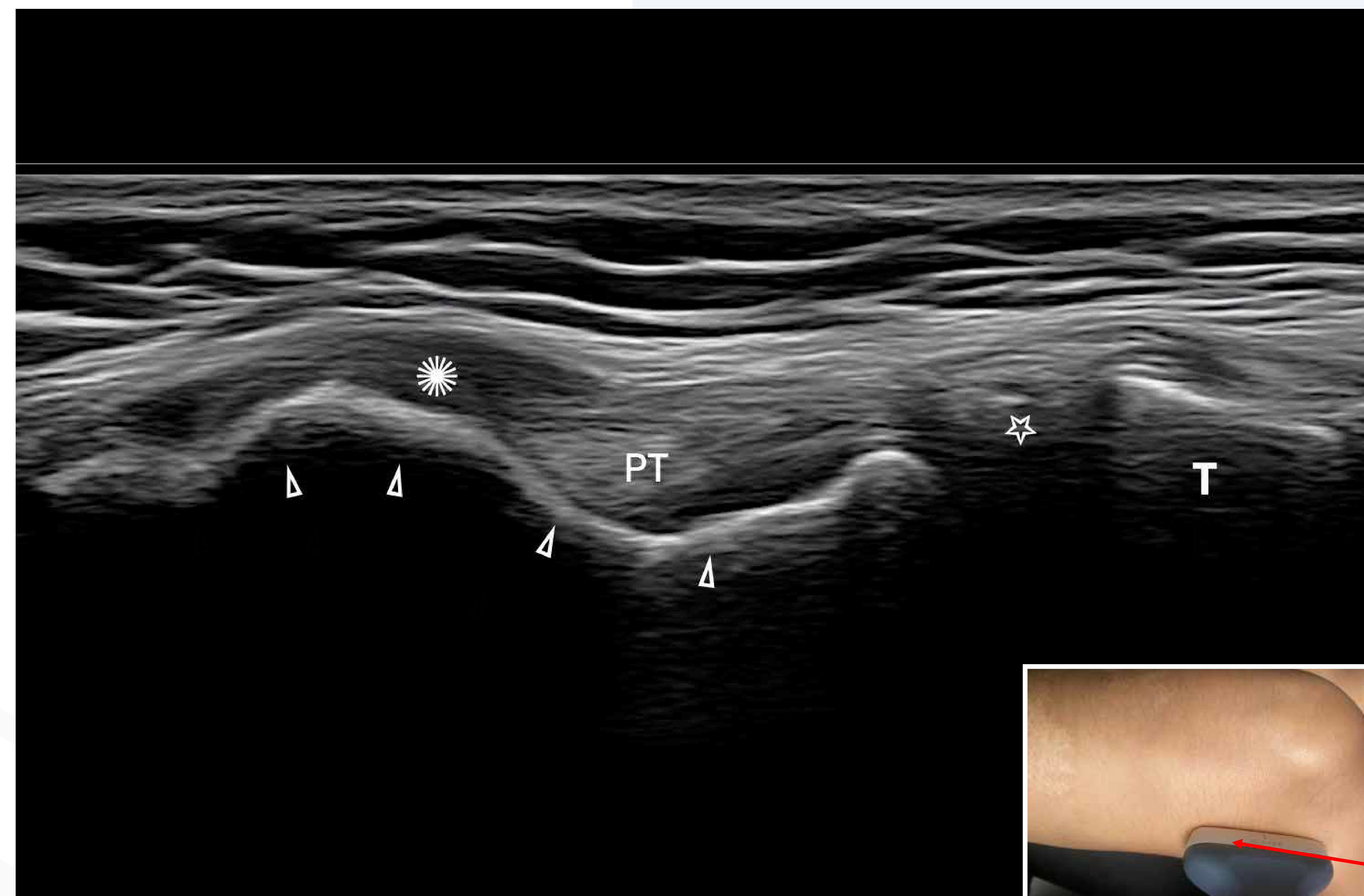
- The tip of the fibula **(F)**
- Tibia **(T)**
- The fibrillar hyperechoic image of the LCL (▻)
- Lateral meniscus (✺)
- The lateral femoral condyle **(lfc)**

STEP 3 - LATERAL KNEE
Lateral collateral ligament
Proximal insertion - Long axis

From the previous position, slide the probe proximally.

We can identify:

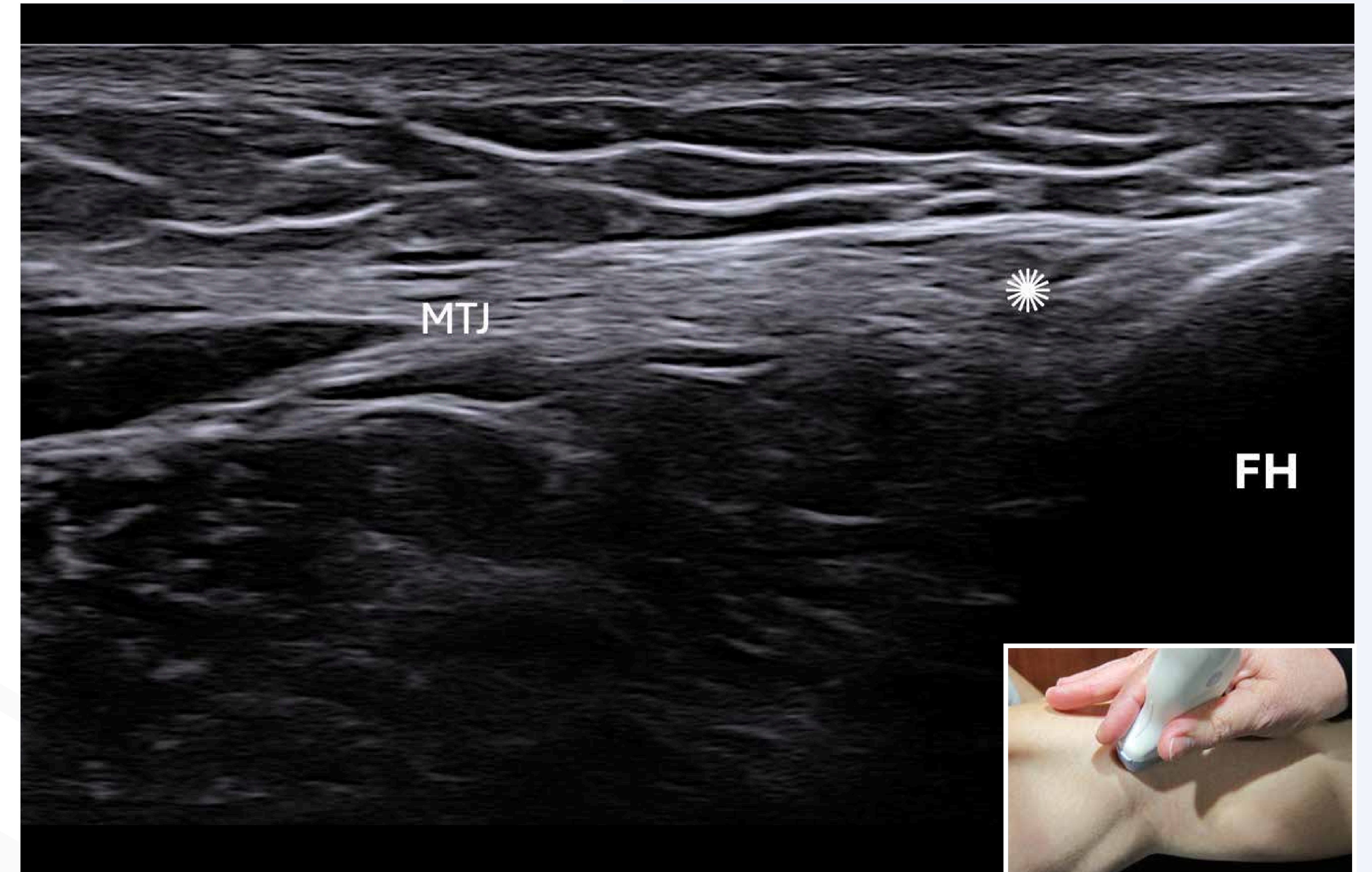
- Hyperechoic bony cortex of lateral femoral condyle (Δ)
- Hypoechoic image (anisotropy) of the proximal insertion of the LCL (✺)
- Lateral meniscus (☆)
- Popliteal tendon **(PT).**



STEP 3 - LATERAL KNEE
Biceps femoris
Distal insertion - Long axis

With the distal edge of the probe over the peroneal head and the proximal end oriented along the biceps femoris direction, we can identify:

- The lateral collateral ligament (✳)
- The myotendinous junction **(MTJ)**
- The head of the fibula **(FH)**

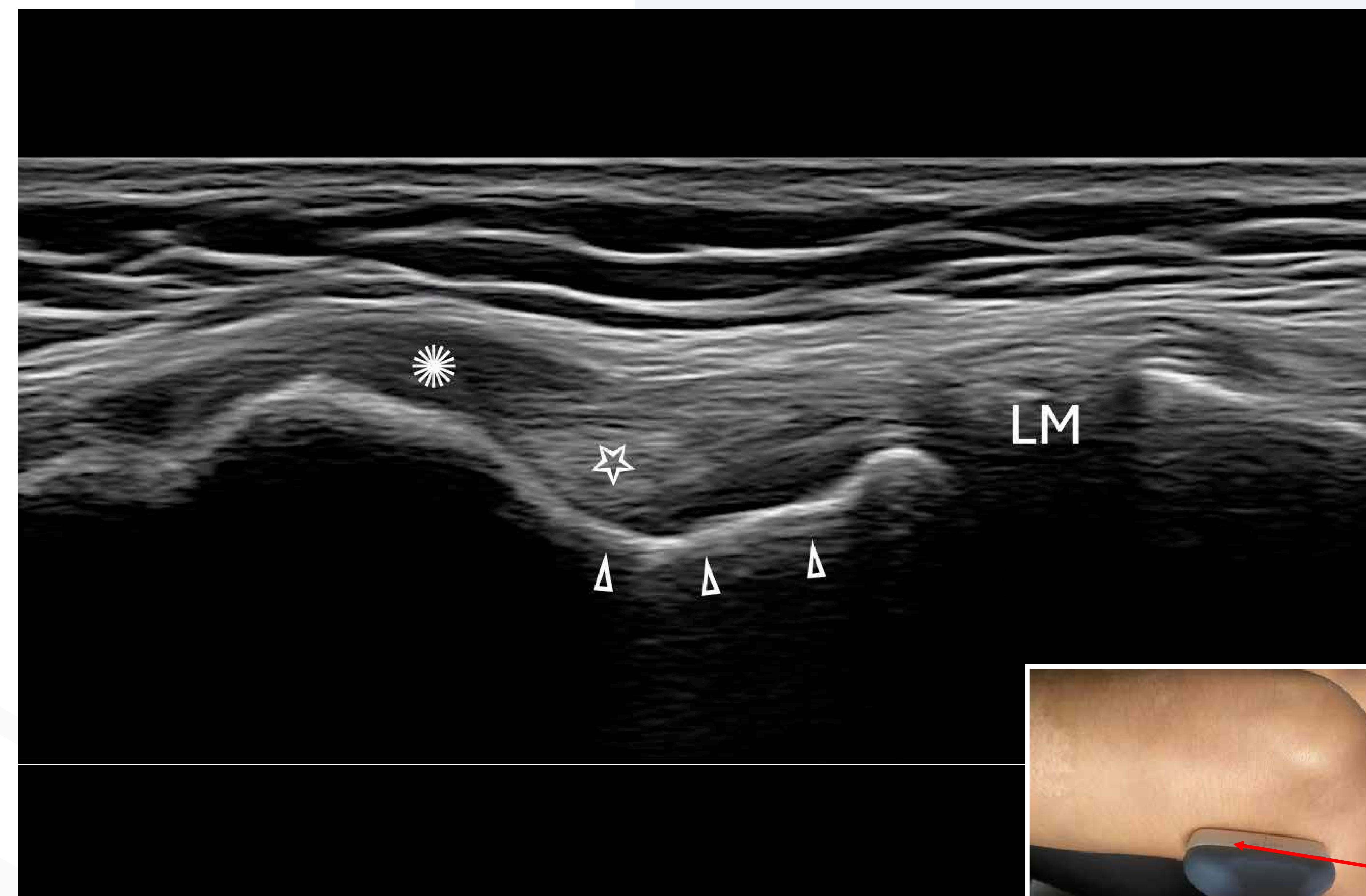


STEP 3 - LATERAL KNEE
Lateral collateral ligament
Proximal insertion - Long axis

From the previous position, slide the probe proximally, with the upper portion over the lateral femoral condyle and the lower portion directed toward the head of the fibula.

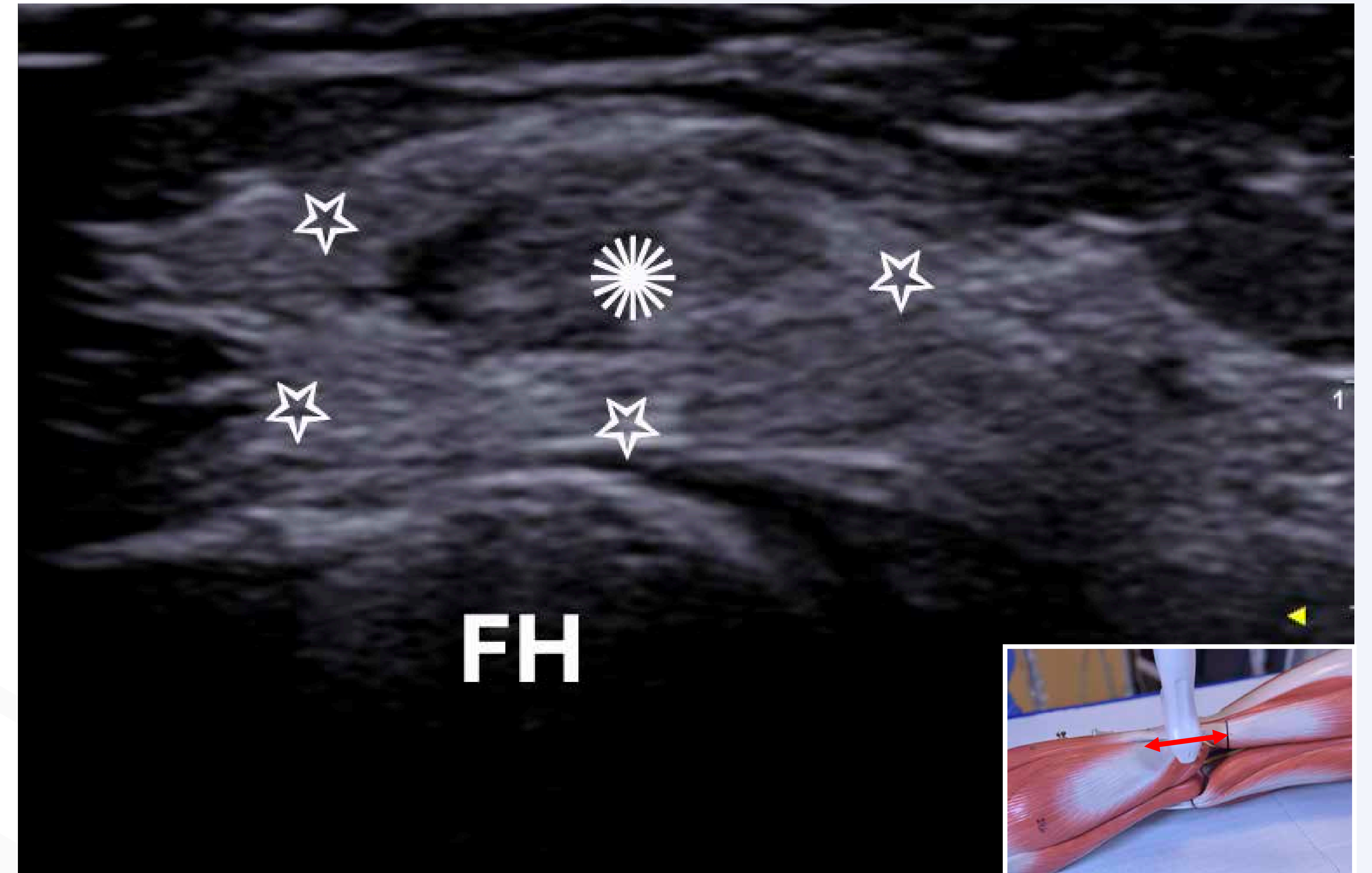
We can identify:

- The lateral collateral ligament proximal insertion with anisotropy (✺)
- Hyperechoic bony profile of the femur (▻)
- Popliteal tendon (☆) and lateral meniscus **(LM)**



STEP 3 - LATERAL KNEE
Lateral collateral ligament
Short axis

- Rotate now the probe 90°.
- Moving the probe in proximo-distal fashion, we can follow the tendon from its myotendinous origin to the distal insertion over the head of the fibula **(FH)**.
- We can identify the lateral collateral ligament (✺) surrounded by the biceps femoris (☆) tendon at the insertion point over the head of the fibula **(FH)**.



This table summarizes the most frequent technical and interpretative pitfalls encountered during ultrasound examination of the lateral knee region, including periarticular and intra-articular structures.

It is intended as a teaching and reference tool for systematic assessment.

Structure / Region	Pitfall	Main Cause	How to Avoid / Teaching Tip
Iliotibial band (ITB)	False hypoechogenicity mimicking tendinopathy or tear	Anisotropy due to non-perpendicular insonation	Use probe tilting and heel-toe maneuvers; confirm in two planes
	Missed focal thickening or localized pathology	Assessment limited to long axis view	Always include short axis mediolateral sweeps
Lateral collateral ligament (LCL)	Misidentification of the LCL as ITB or biceps femoris tendon	Close anatomical proximity and similar echogenicity	Trace the structure from femoral epicondyle to fibular head
	Underestimation of partial tears	Static assessment only	Apply gentle varus stress dynamically during scanning
Biceps femoris tendon	Confusion with LCL at the fibular head	Overlapping insertions	Identify proximal muscle belly continuity
	Missed enthesopathy or partial tear	Limited field of view at fibular head	Scan in long- and short axis and include the insertional footprint
Lateral synovial recess	Failure to detect small effusions or synovitis	Excessive probe compression	Use minimal pressure and dynamic knee movement
	Confusion between synovial tissue and fat	Similar echogenicity	Use dynamic compression and Doppler when indicated
Lateral meniscus (adjacent view)	Misinterpretation of crystal deposits as meniscal tears	Lack of short axis evaluation	Assess meniscus in transverse plane and correlate clinically
General lateral knee scan	Incomplete assessment of lateral knee pain	Focus on a single structure	Use a systematic lateral knee protocol including ITB, LCL, biceps, recess, and meniscus

STEP 4
POSTERIOR KNEE

Ultrasound of the Posterior Knee. The posterior knee is a complex anatomic region where musculoskeletal, neurovascular, and intra-articular structures coexist within a relatively small space.

From an ultrasound perspective, a compartment-based approach is essential to ensure a systematic, reproducible, and clinically meaningful examination.

In this section, the posterior knee is divided into three practical regions:

- **posteromedial**
- **posterior middle (popliteal fossa)**
- **posterolateral**

This subdivision reflects the anatomic organization, facilitates probe positioning, and mirrors the most common clinical scenarios encountered in daily practice.

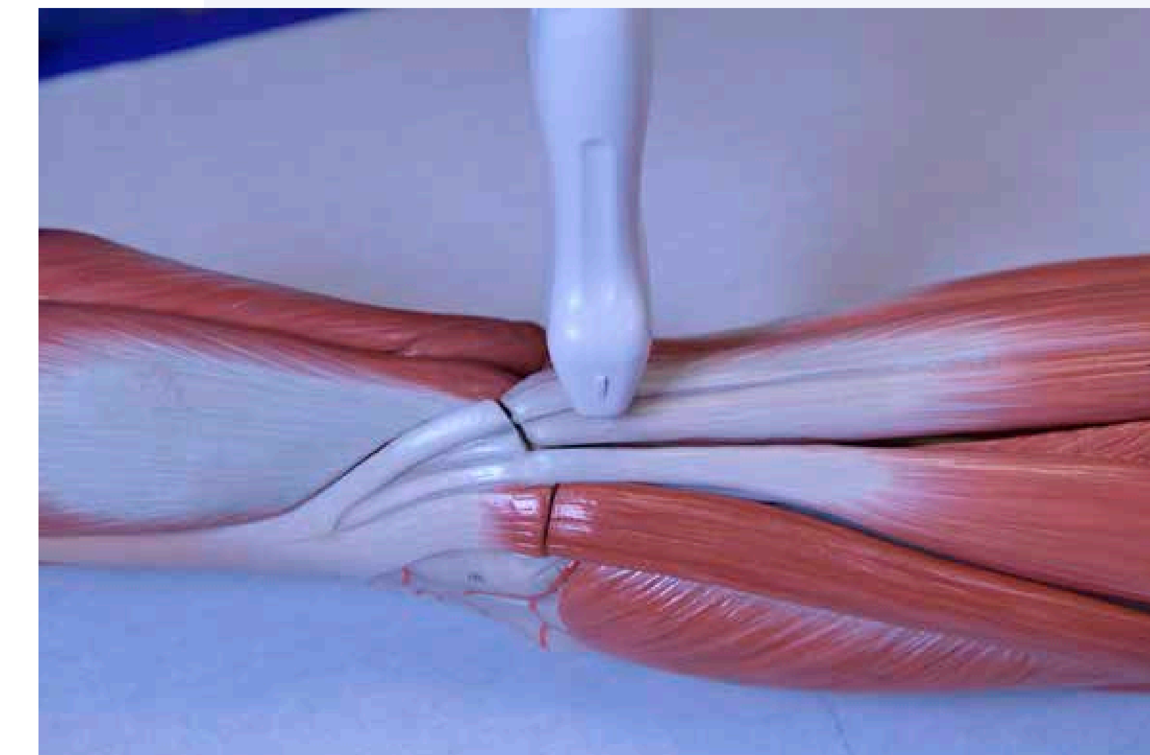
Each region is described with standardized patient positioning, probe orientation, key anatomic landmarks, normal ultrasound appearance, clinical objectives, and common pitfalls.

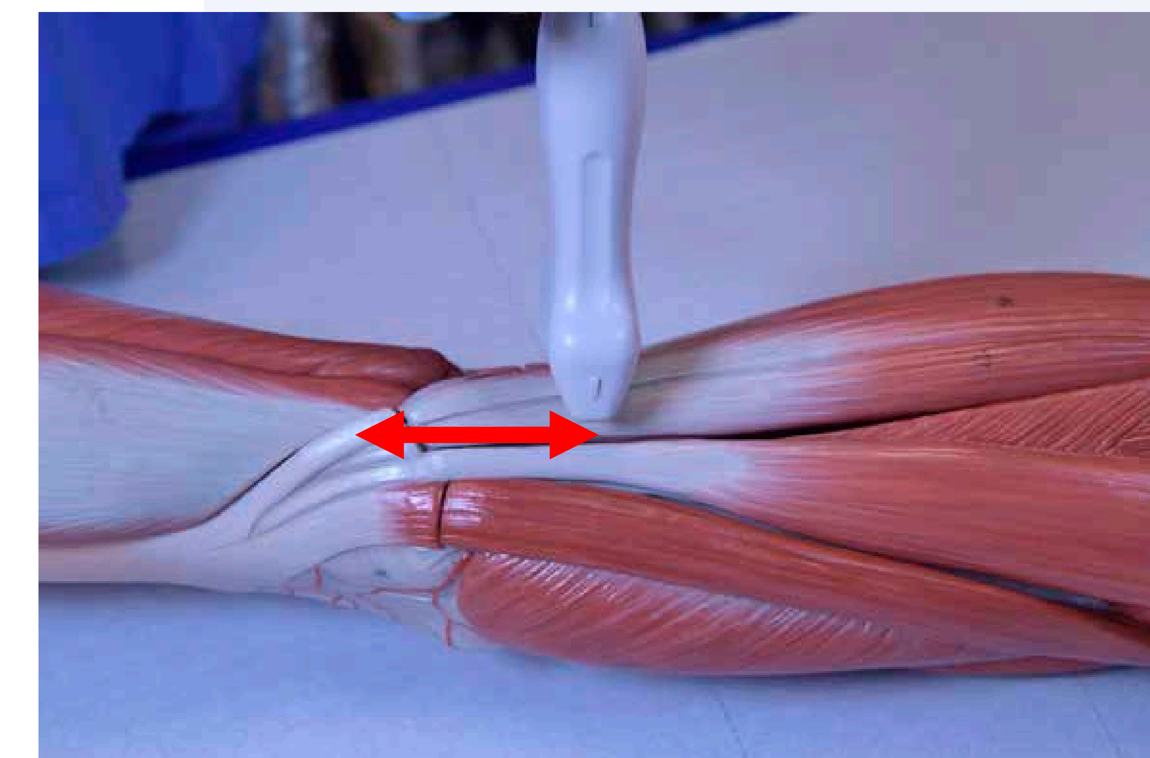
This structured approach aims to improve diagnostic accuracy, enhance teaching efficiency, and support safe ultrasound-guided interventions when indicated.

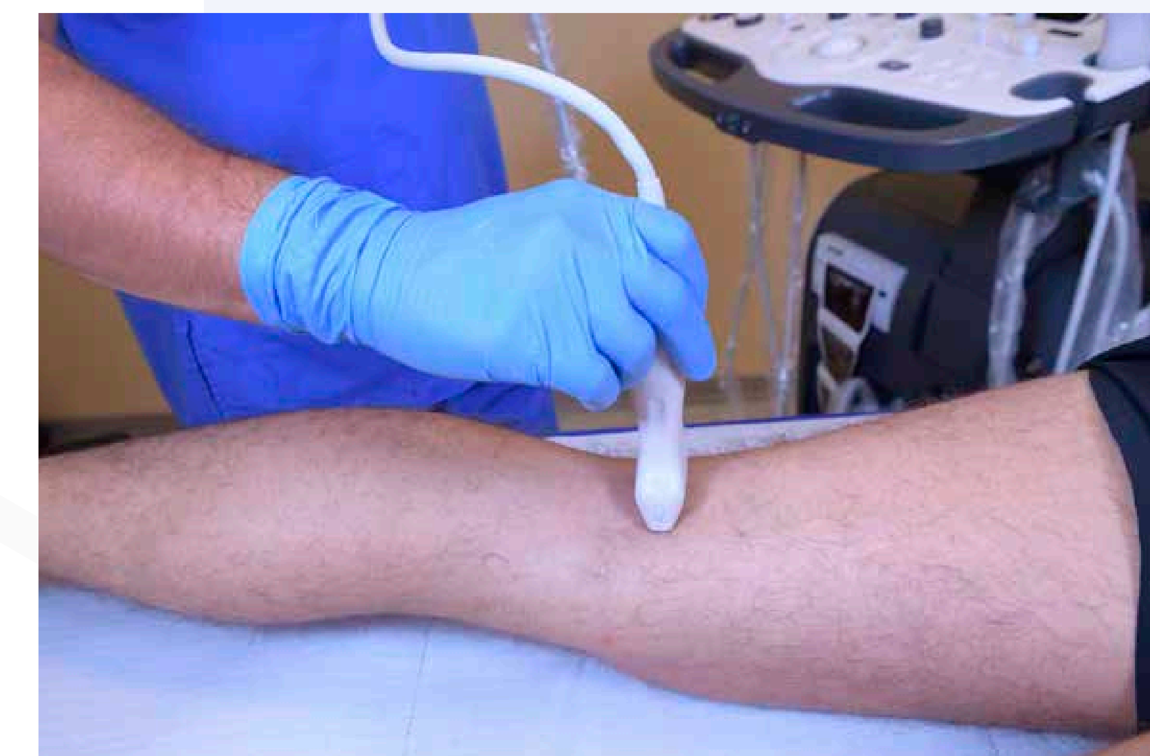
STEP 4 - POSTEROMEDIAL KNEE

Structures	Patient Position	Probe Position / Plane	Key Landmarks	Ultrasound Appearance	Clinical Application
Sartorius, semitendinosus, semimembranosus, medial gastrocnemius	Prone, knee slightly flexed	Long- and short axis posteromedial	Superficial semitendinosus over deep semimembranosus; medial gastrocnemius posterior	Fibrillar tendons; pennate muscle	Assessment of tendinopathy, Baker's cyst origin, posteromedial pain

The orientation marker must be directed to obtain an anatomical correspondent image on the screen: e.g. in the left knee orientation marker is laterally placed.







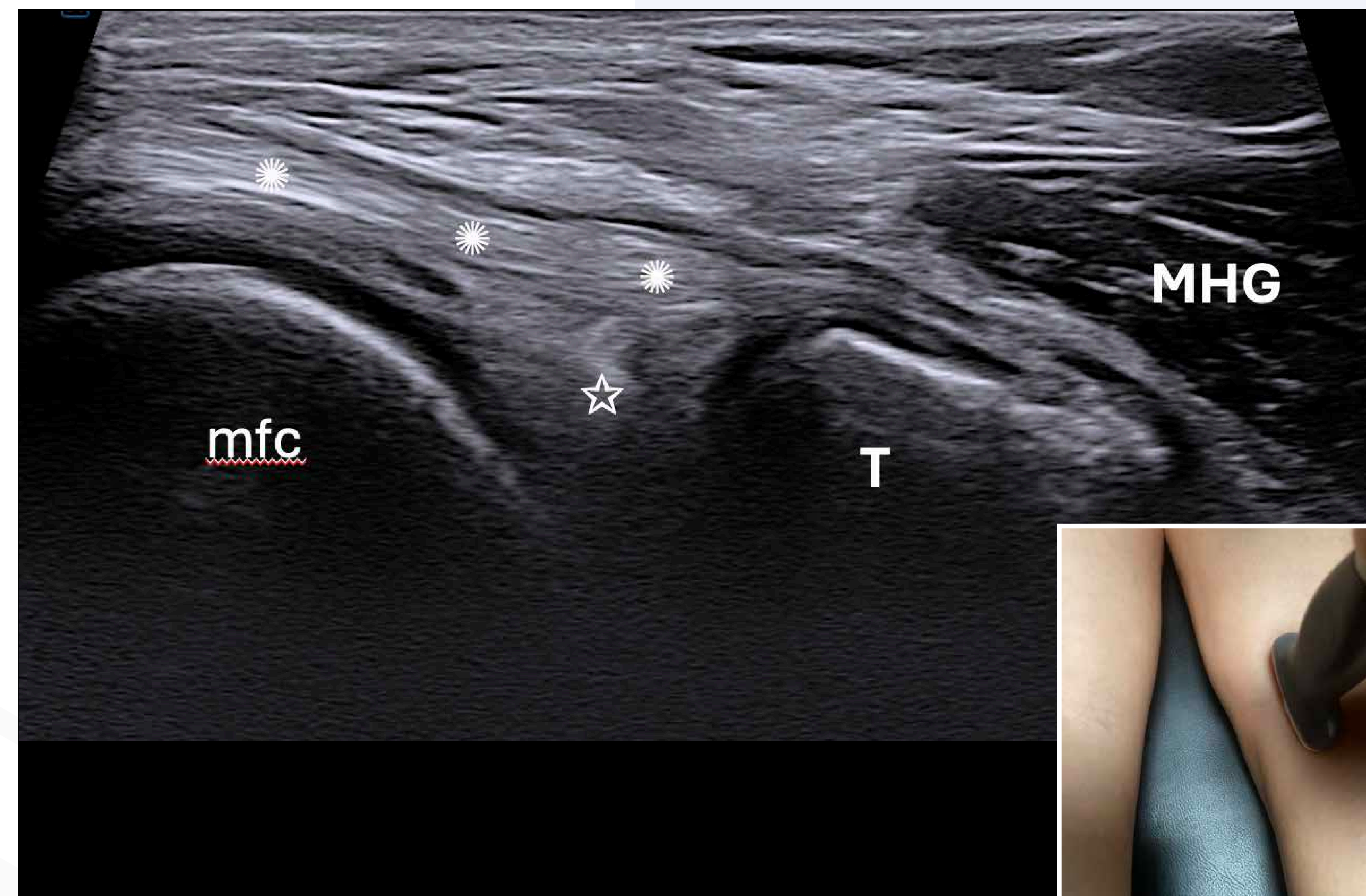
STEP 4 - POSTERIOR KNEE
Posteromedial knee
Long axis

From proximal to distal:

- The medial femoral condyle **(mfc)**
- The semitendinosus tendon **(✺)**
- The medial meniscus (☆)
- The medial head of gastrocnemius **(MHG)**
- Tibia **(T)**

NB: The **semitendinous bursa** is placed between the MHG and the semitendinous tendon and it is better studied in a transverse plane.

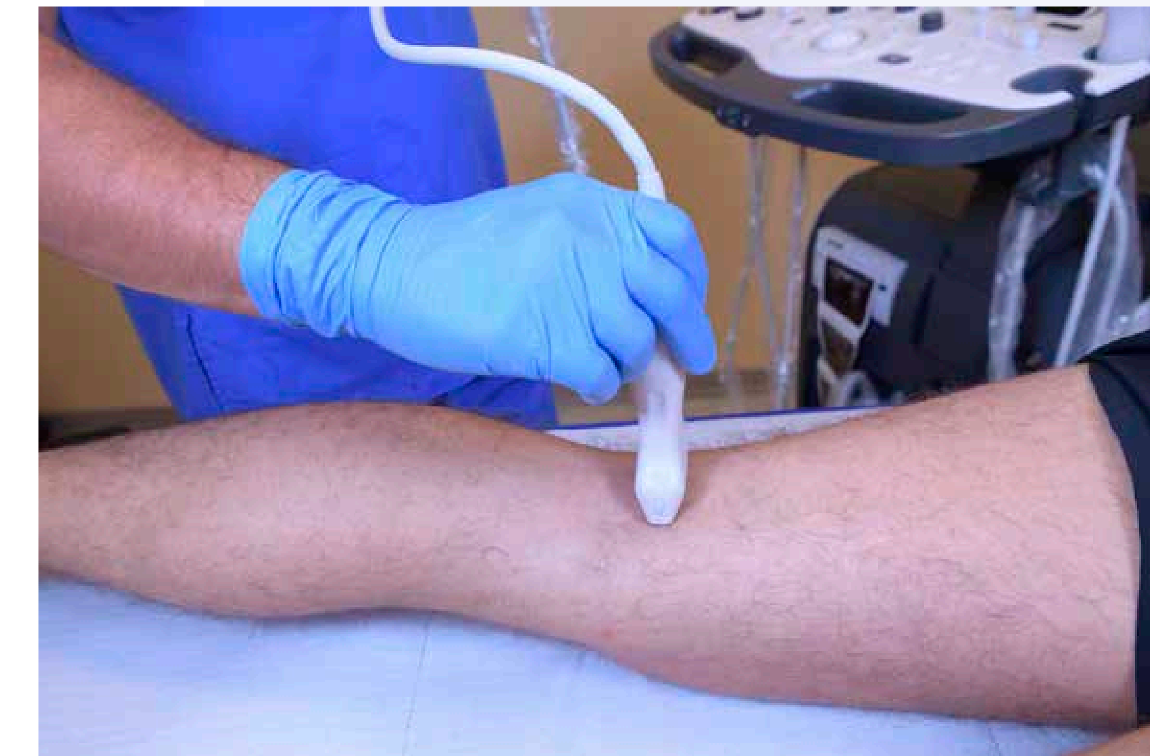
For the **cartilage study** of the posterior aspect of the **mfc**, a longitudinal plane is preferred.

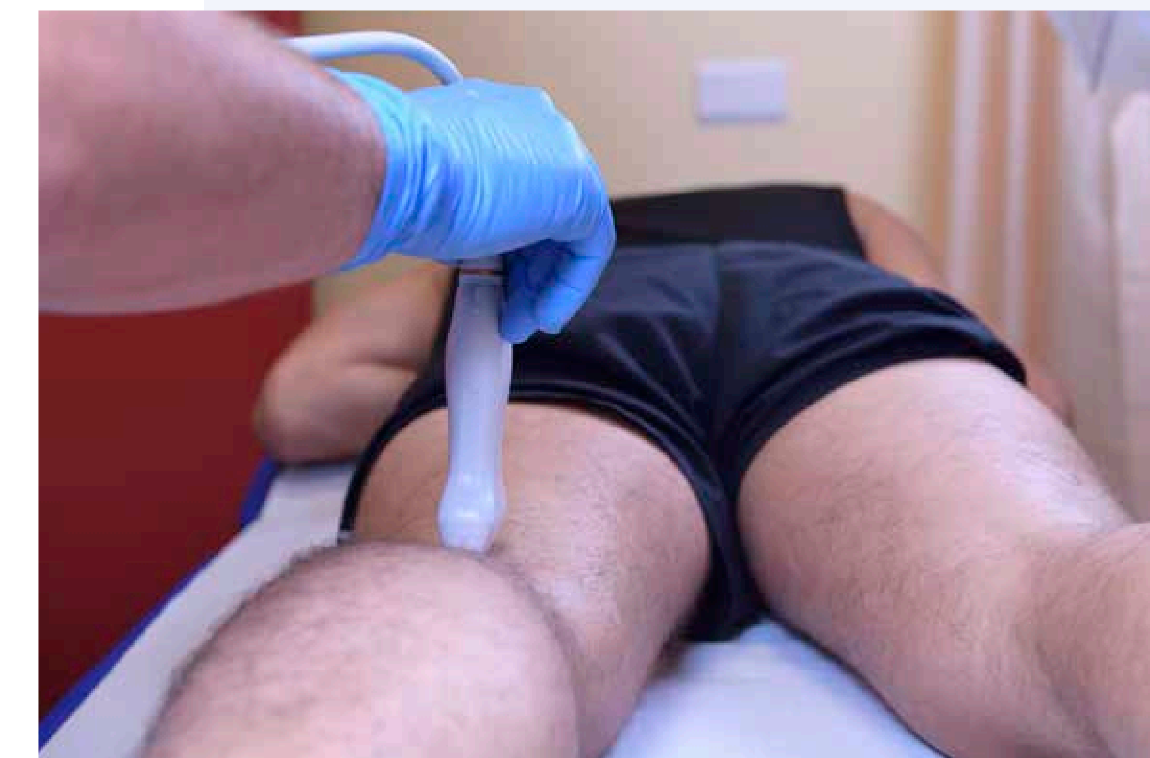


STEP 4 - POSTERIOR KNEE

Posterior middle knee
Popliteal neurovascular bundle and intercondylar fossa
Short & long axis

Structures	Patient Position	Probe Position / Plane	Key Landmarks	Ultrasound Appearance	Clinical Application
Popliteal artery, vein, tibial nerve	Prone, knee slightly flexed	Transverse and longitudinal central posterior	Popliteal artery as central landmark	Anechoic vessels, pulsatile artery, compressible vein; nerve fascicles	Detection of aneurysm, thrombosis, neurovascular compression



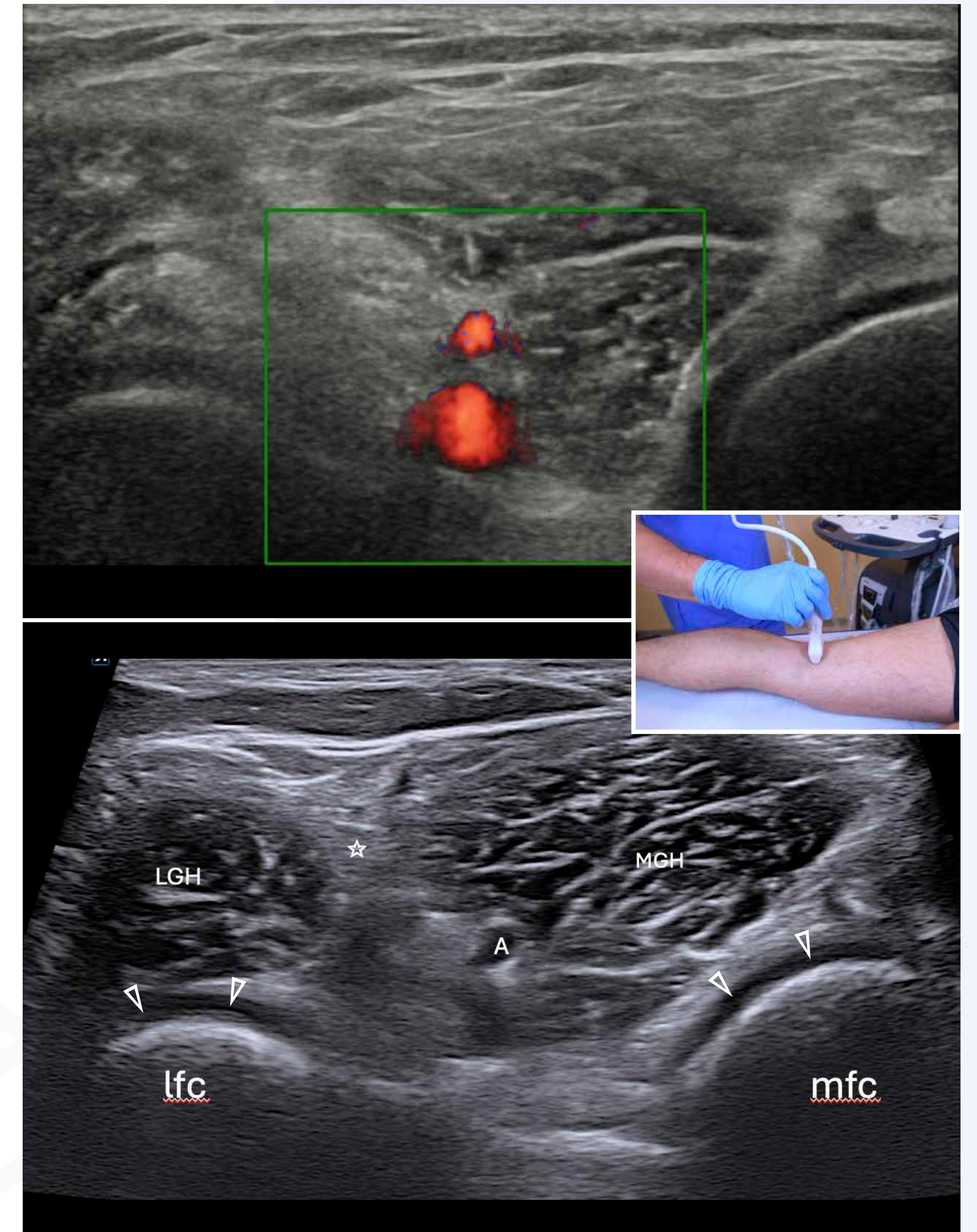


STEP 4 - POSTERIOR KNEE

Posterior middle knee
Popliteal neurovascular bundle and intercondylar fossa
Short axis

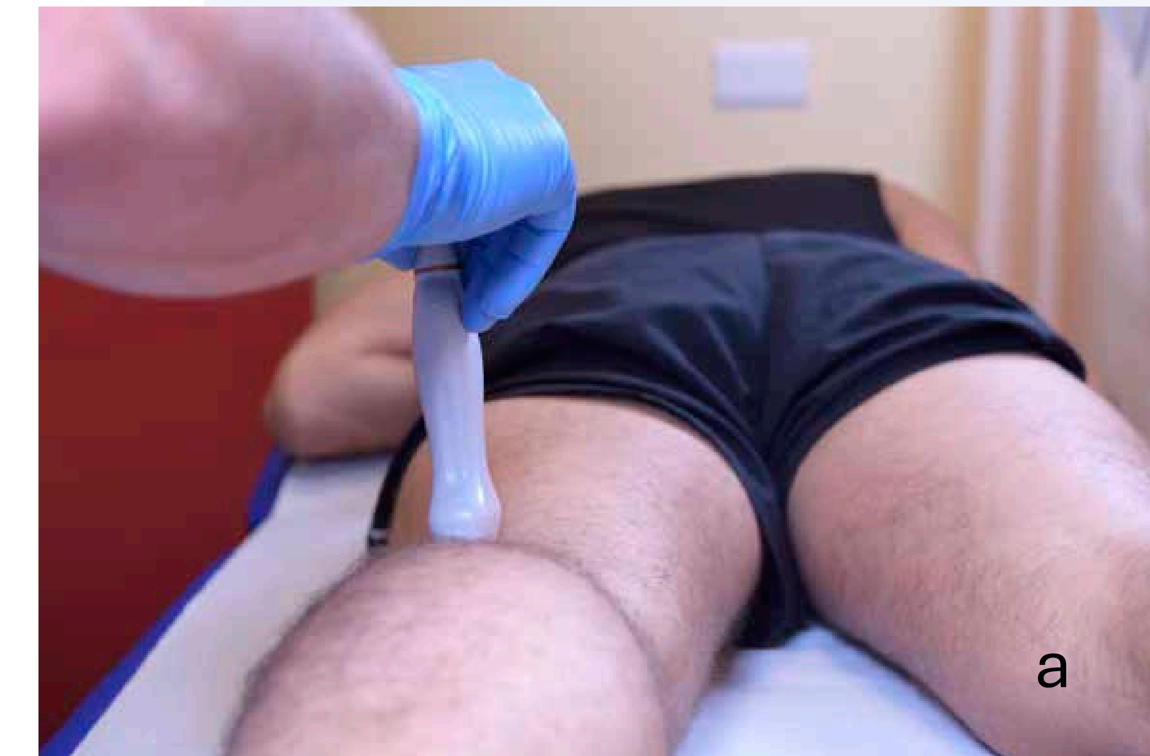
We can identify:

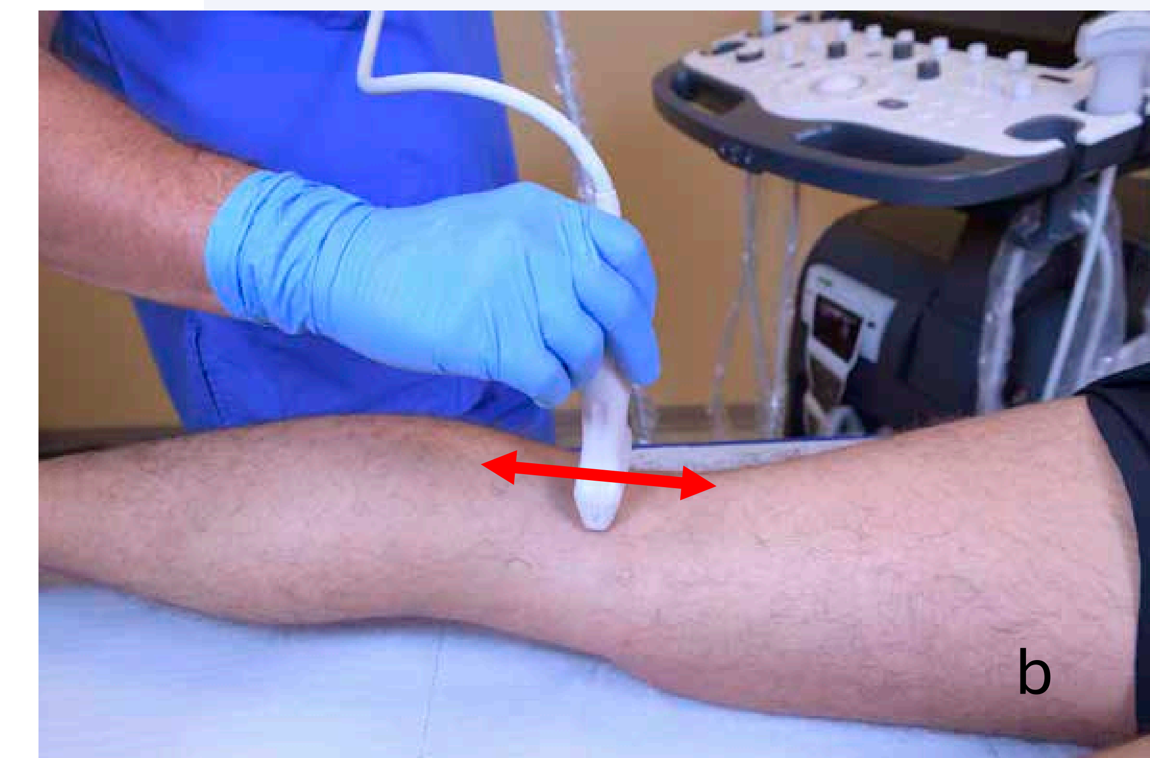
- Medial head of gastrocnemius **(MHG)**
- Popliteal artery **(A)**
- Medial and lateral femoral condyle (**mfc** and **lfc**)
- The anechoic condylar cartilage (▻)
- Tibial nerve (☆)



STEP 4 - POSTEROLATERAL KNEE

Structures	Patient Position	Probe Position / Plane	Key Landmarks	Ultrasound Appearance	Clinical Application
Popliteal artery, vein, tibial nerve	Prone, knee slightly flexed	Long- and short axis posterolateral knee	Posterolateral femoral condyle	Pennate muscle architecture with hypoechoic fibers	Assessment of muscular injury or strain
Popliteus tendon	Prone; knee flexed	Oblique long axis from posterolateral femoral condyle	Popliteal sulcus of the lateral femoral condyle	Hyperechoic tendon with oblique course	Evaluation of posterolateral corner pathology and rotational instability
Common peroneal (fibular) nerve	Prone or lateral decubitus; knee slightly flexed	Short axis at fibular neck; long axis tracing proximally and distally	Fibular head and neck; biceps femoris tendon	Oval to round structure with honeycomb fascicular pattern	Identification of nerve entrapment, trauma, and safe planning of interventions

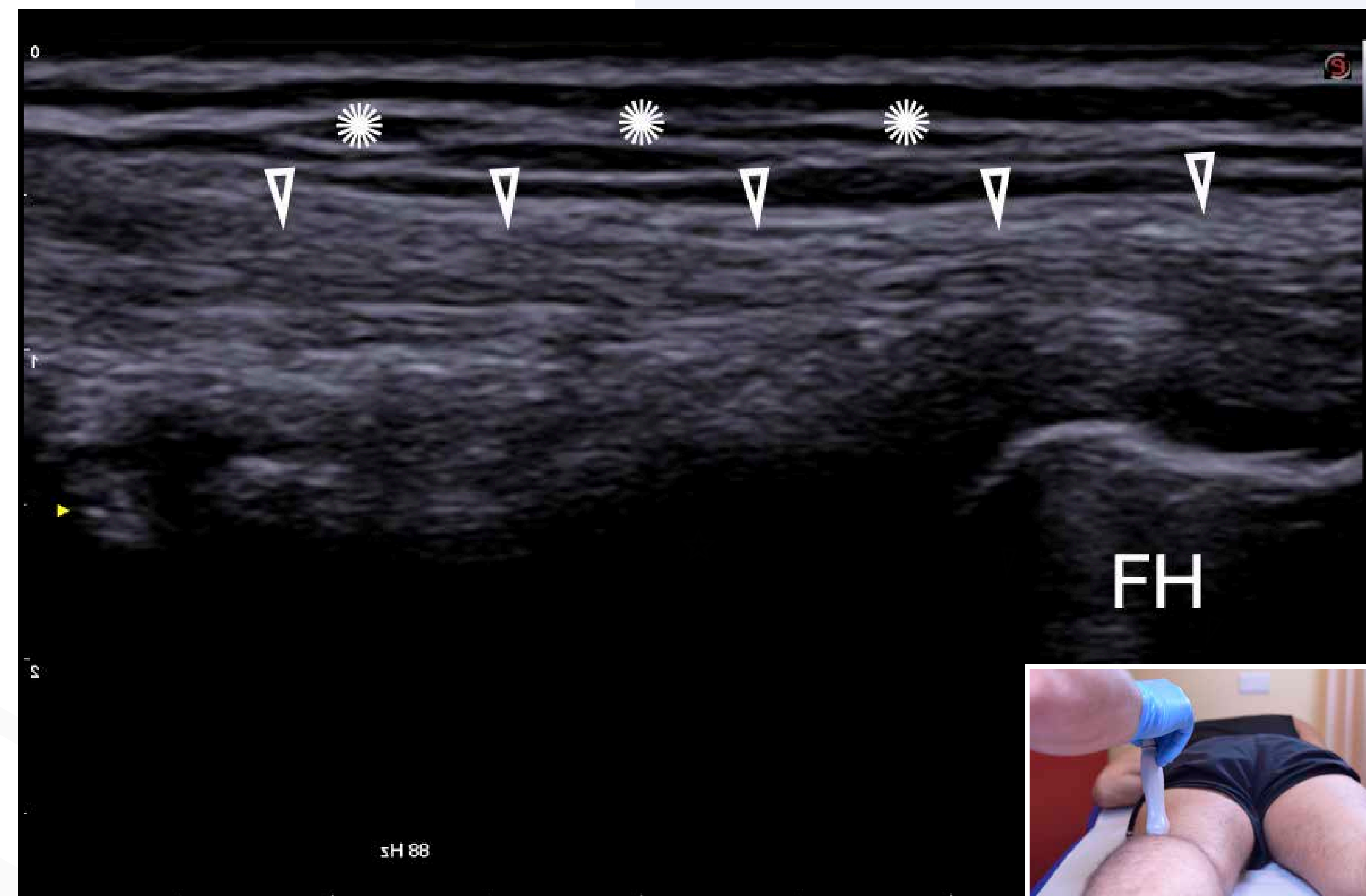

a


b

STEP 4 - POSTERIOR KNEE
Posterolateral knee
Biceps femoris
Long axis

We can identify:

- The subcutaneous fat (✺)
- The hyperechoic image of **biceps femoris** tendon (▻), that can be followed straight downward from its origin to the fibular head
- The hyperechoic curved shape of the **head of the fibula (FH)**



This table summarizes the main technical and interpretative pitfalls encountered during ultrasound assessment of the posterior knee.

Structure / Region	Pitfall	Underlying Cause	How to Avoid / Tips
Posteromedial tendons	Confusion between semitendinosus and semimembranosus tendons	Close anatomical relationship and similar echogenicity	Identify superficial (semitendinosus) versus deep (semimembranosus) layers and follow tendons proximally
Posteromedial compartment	False diagnosis of Baker's cyst	Incomplete assessment of the semimembranosus–medial gastrocnemius interval	Confirm the typical neck between semimembranosus tendon and medial head of gastrocnemius
Popliteal artery	Missed aneurysm or pseudoaneurysm	Limited field of view or lack of Doppler	Scan the vessel in long- and short axis and systematically use color Doppler
Popliteal vein	Missed deep vein thrombosis	Lack of compression or Doppler assessment	Always assess venous compressibility and venous flow
Popliteal fossa (general)	Confusion between vascular and cystic structures	Static assessment only	Use Doppler and dynamic compression
Posterolateral compartment	Missed popliteus tendon pathology	Non-systematic scanning of the posterolateral corner	Include targeted oblique scanning of the popliteus tendon
Common peroneal (fibular) nerve	Failure to identify the nerve	Focus limited to tendons and ligaments	Always identify the nerve at the fibular neck before concluding the examination
	Misinterpretation of the nerve as a tendon	Lack of short axis nerve assessment	Use short axis view to recognize the honeycomb fascicular pattern
Ultrasound-guided procedures	Iatrogenic nerve injury	Unrecognized peroneal nerve course	Trace the nerve proximally and distally prior to any intervention

US KNEE EXAM AND PATHOLOGY

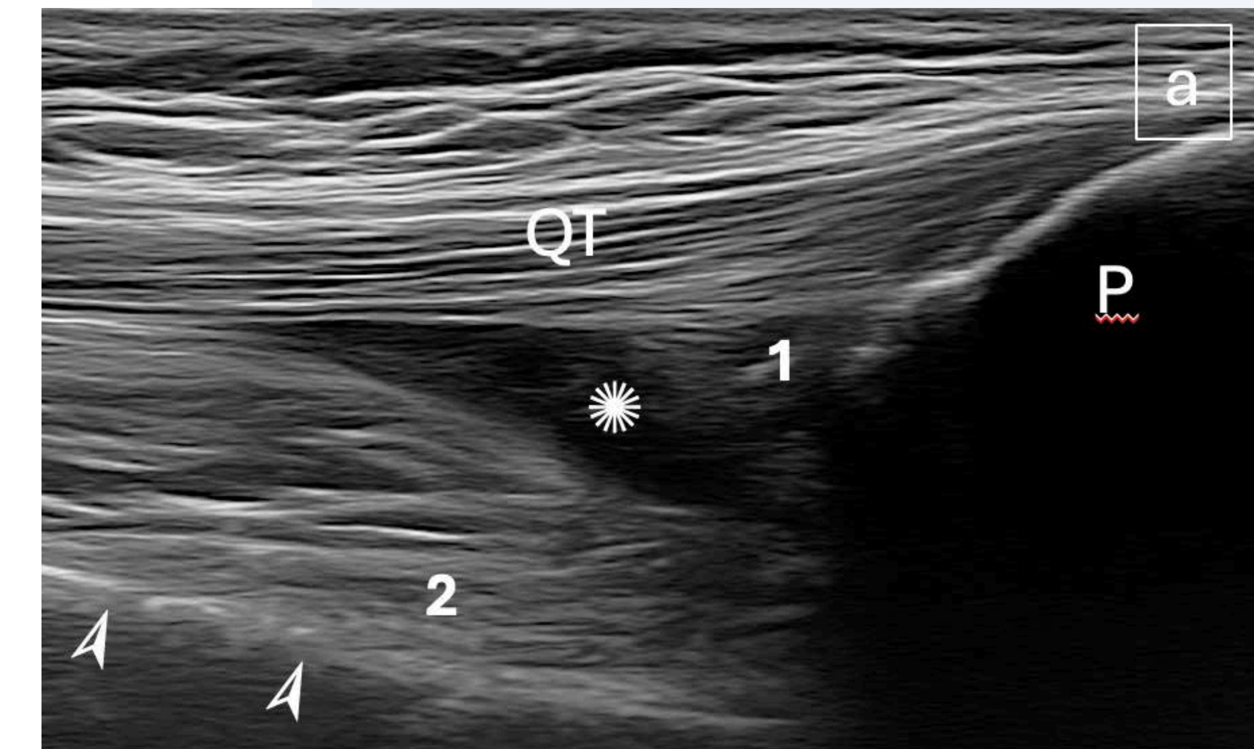
ANTERIOR KNEE
Long axis

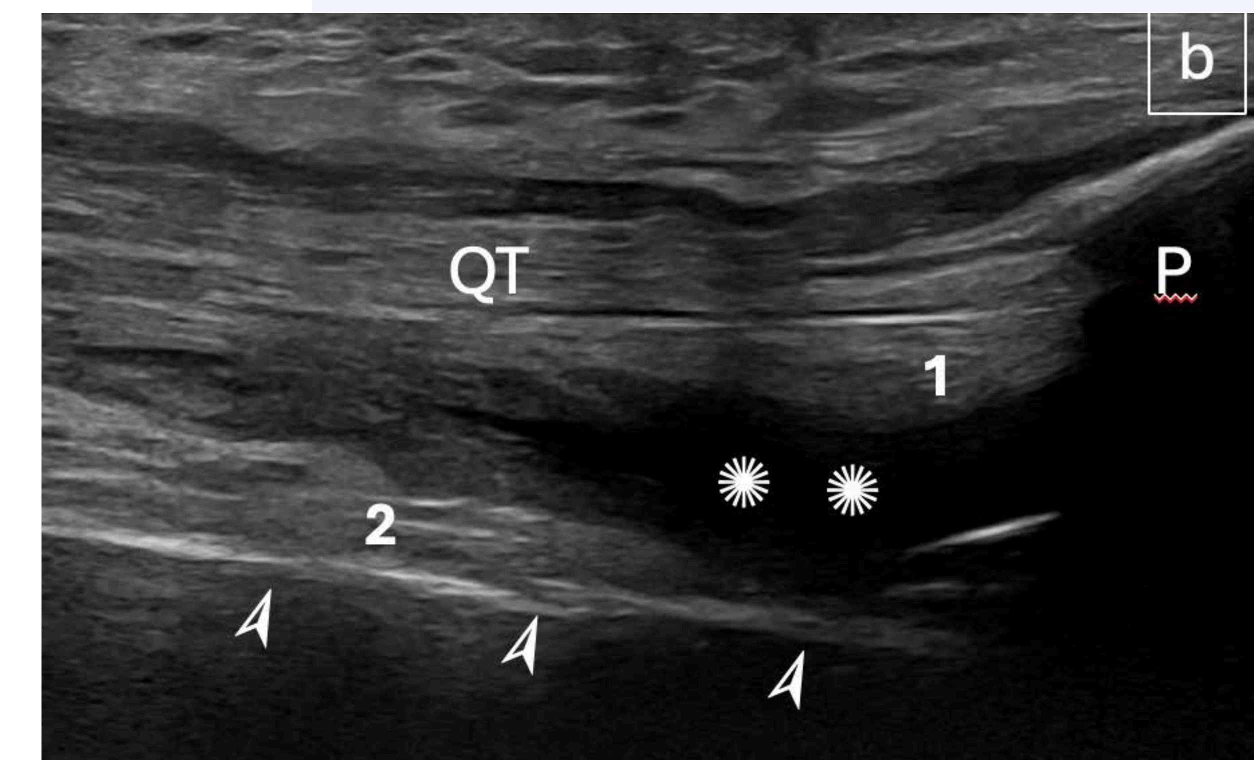
Indentified:
effusion with minimal synovitis, (effusion is anechoic, synovitis is hypoechoic)

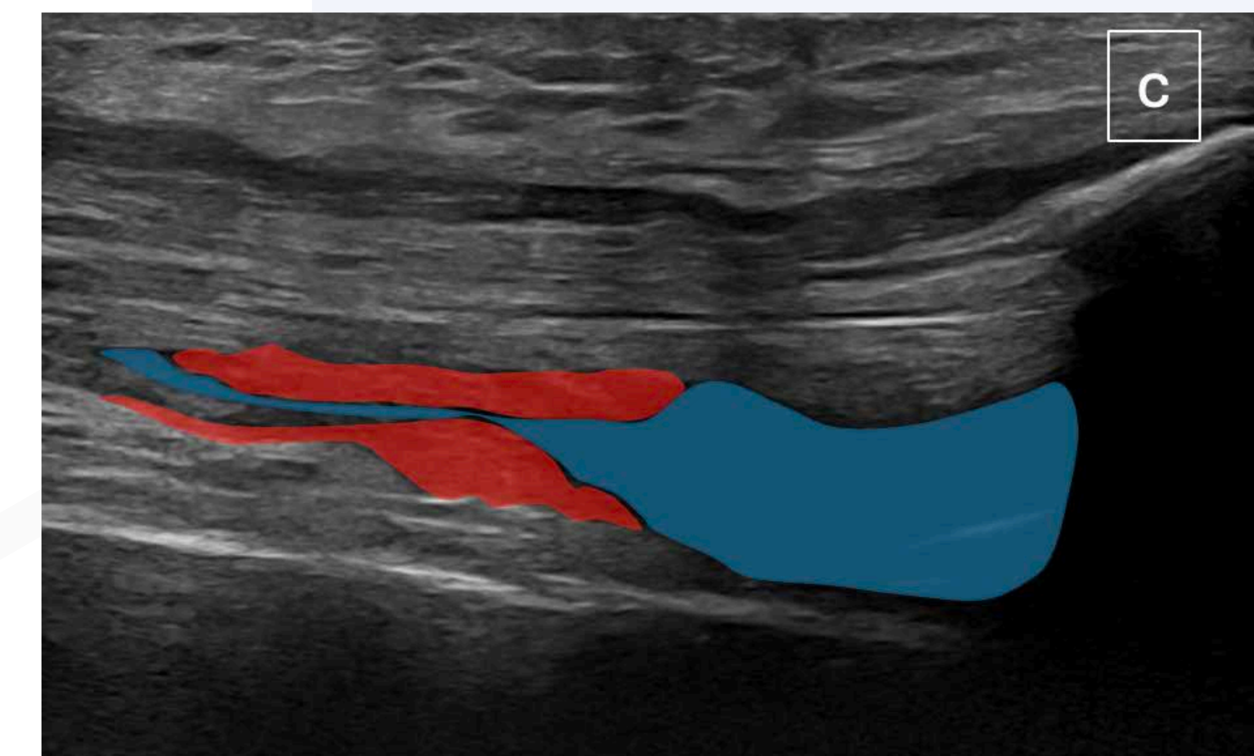
Between the **QT** and the anterior aspect of the femur (➢) we can identify two structures:

- **Image a:** The **suprapatellar synovial recess (✺)**, with small anechoic effusion with the **suprapatellar fat pad (1)**.
- **Image b:** The **prefemoral fat pad (2)**, **hypotrophic**, just anterior to the anterior and distal **femoral cortex** (➢), and increased effusion (✺✺), proximal patellar cortex **(P)**.
- **Image c = b:** Synovitis, **red area** and effusion, **blue area**.

We can dynamically compress this area with the probe in order to emphasize the presence of synovial fluid in case of minimal swelling.

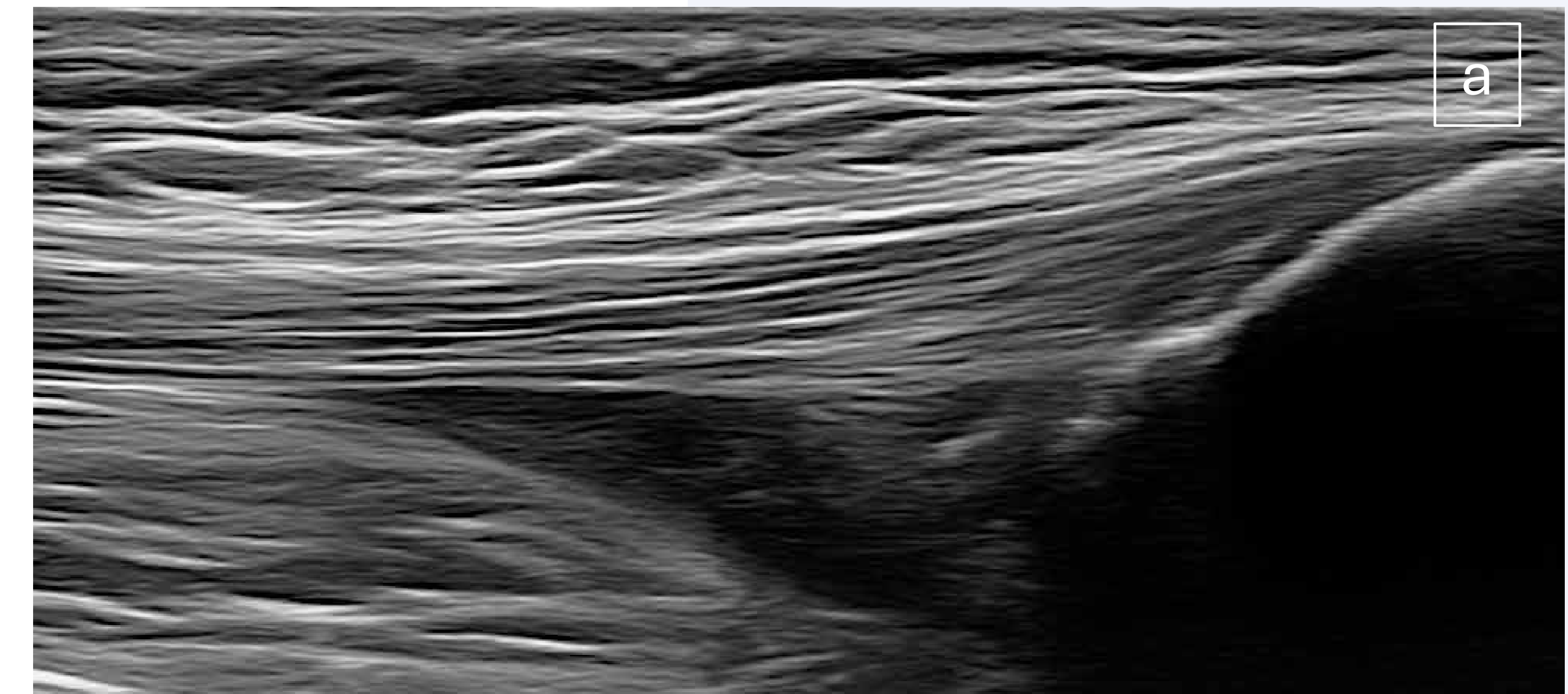


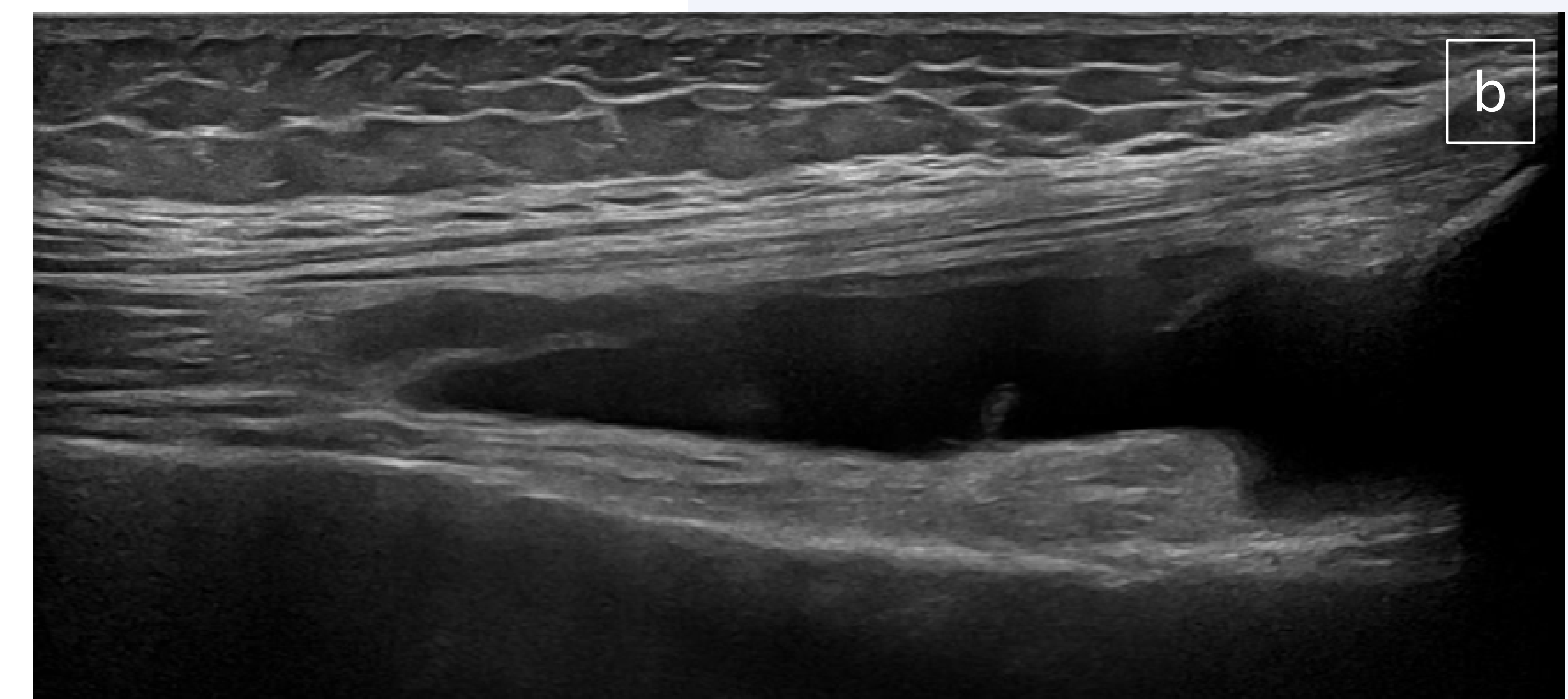


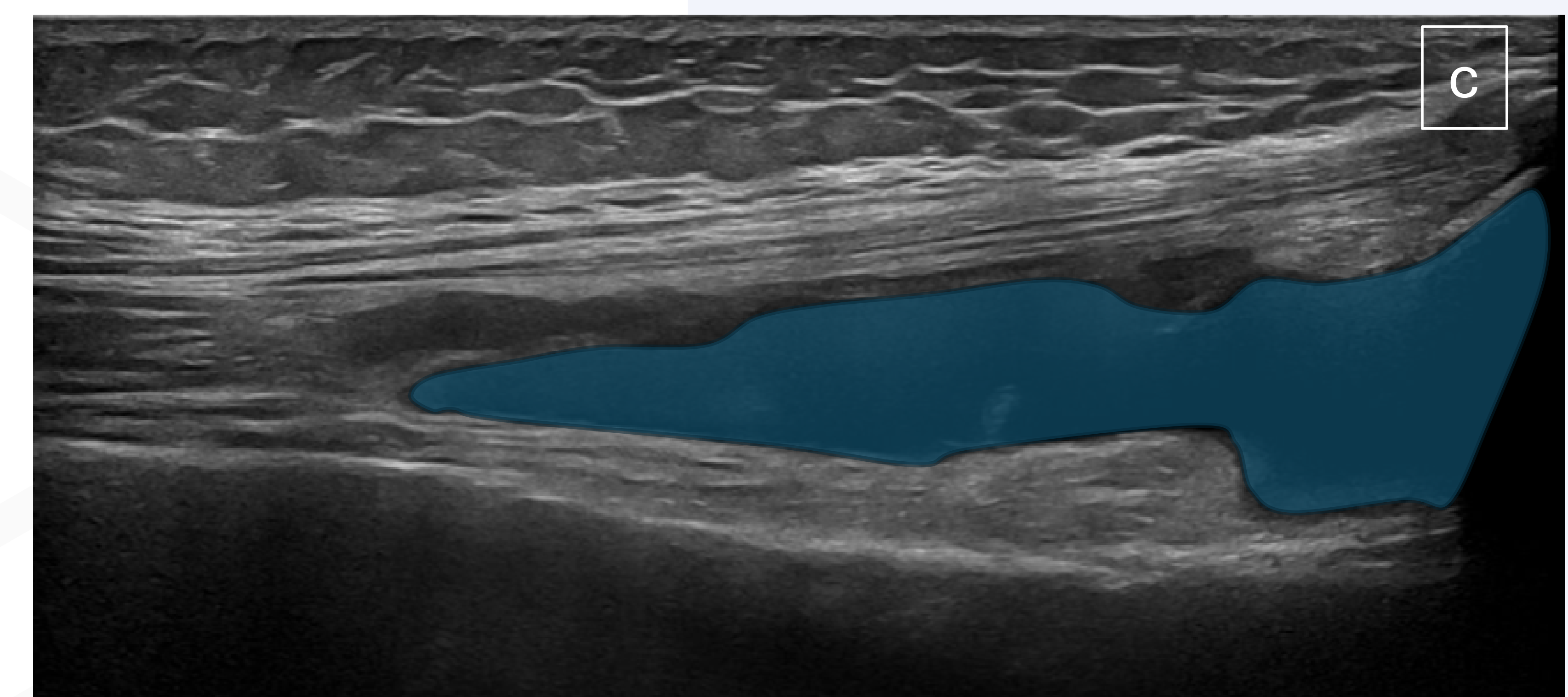


ANTERIOR KNEE
Long axis

Indentified:
effusion with hypoechoic synovitis,



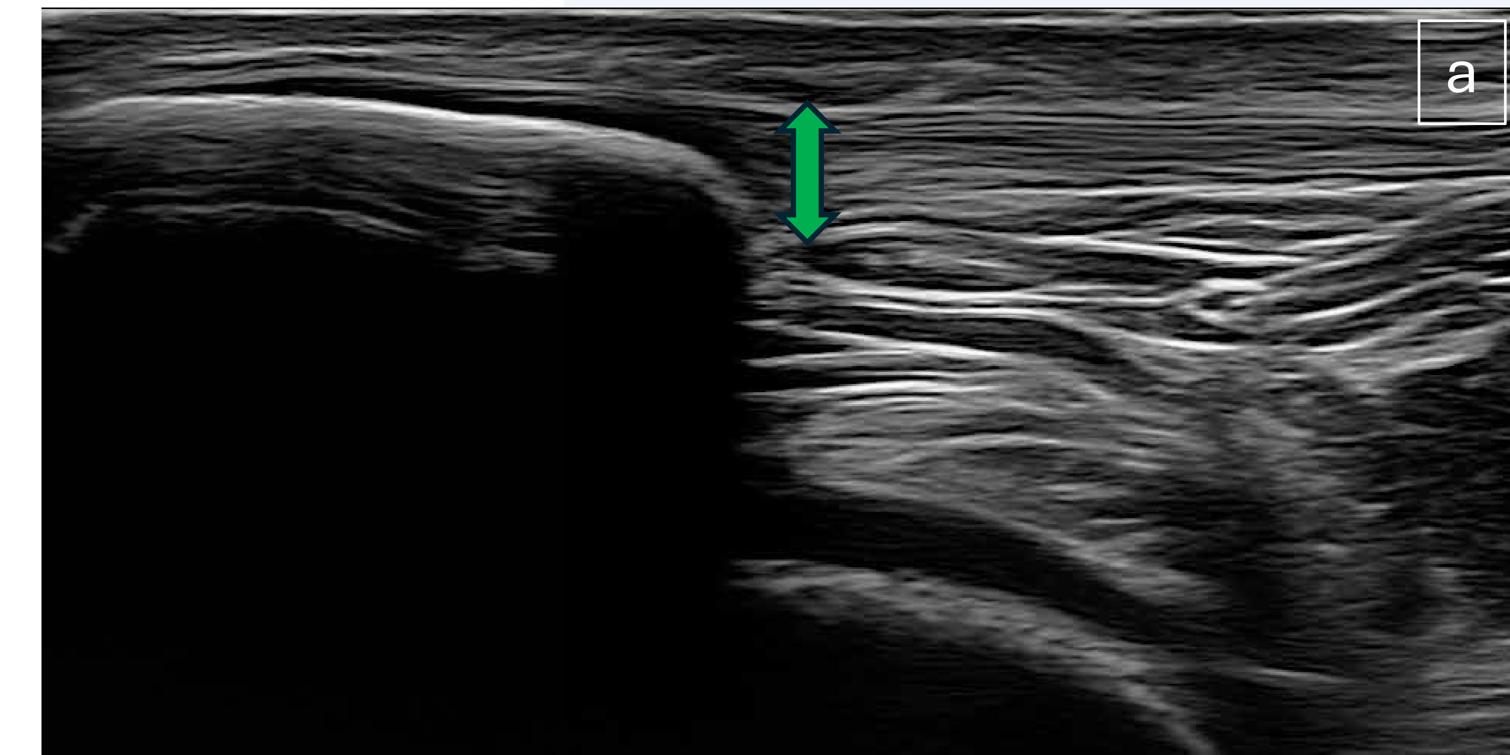


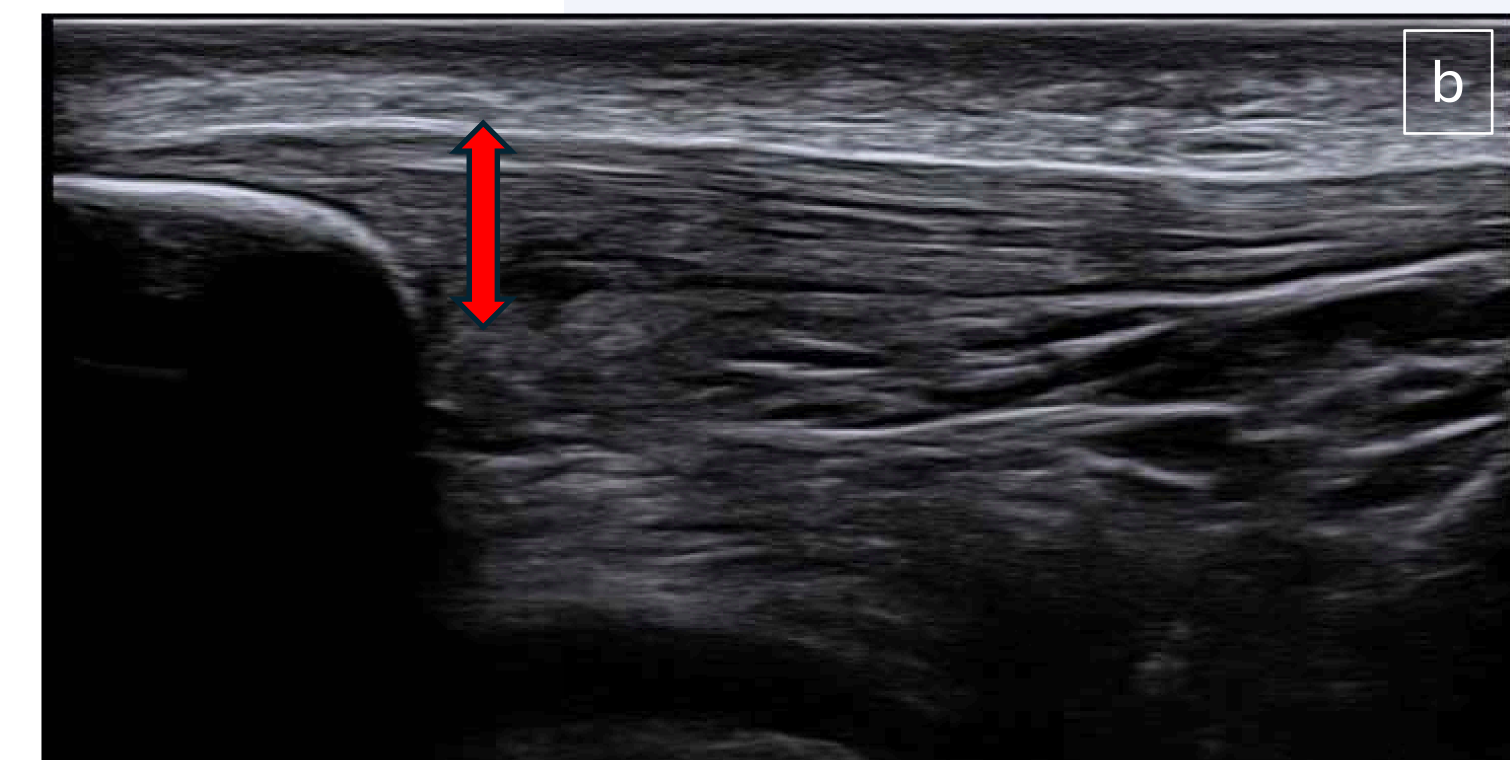


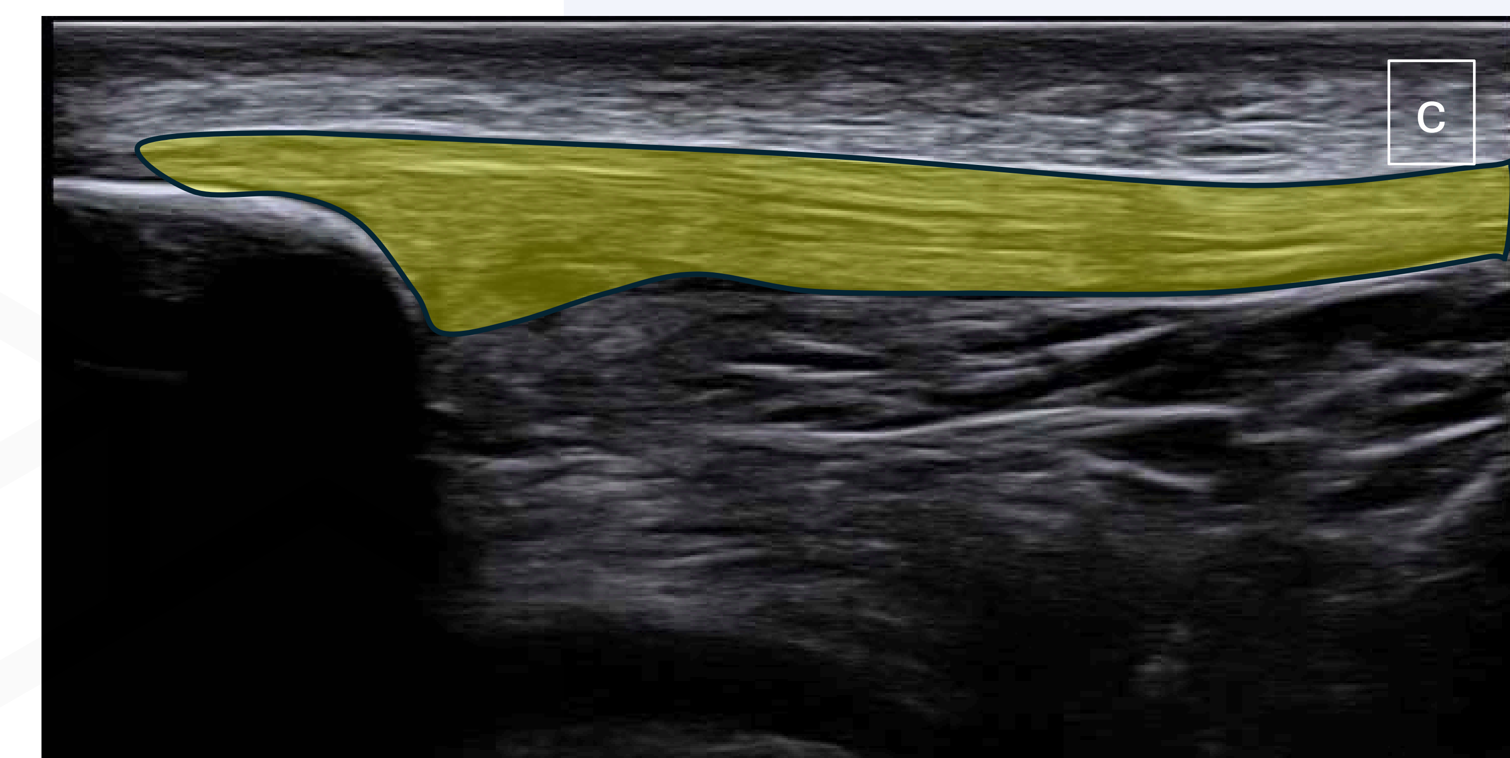
- Normal image **(a)**.
- Pathological image, **(b)**.
- Suprapatellar recess effusion as blue area **(c=b)**, with moderate synovitis.

ANTERIOR KNEE
Long axis

Indentified:
jumper's knee, early stage



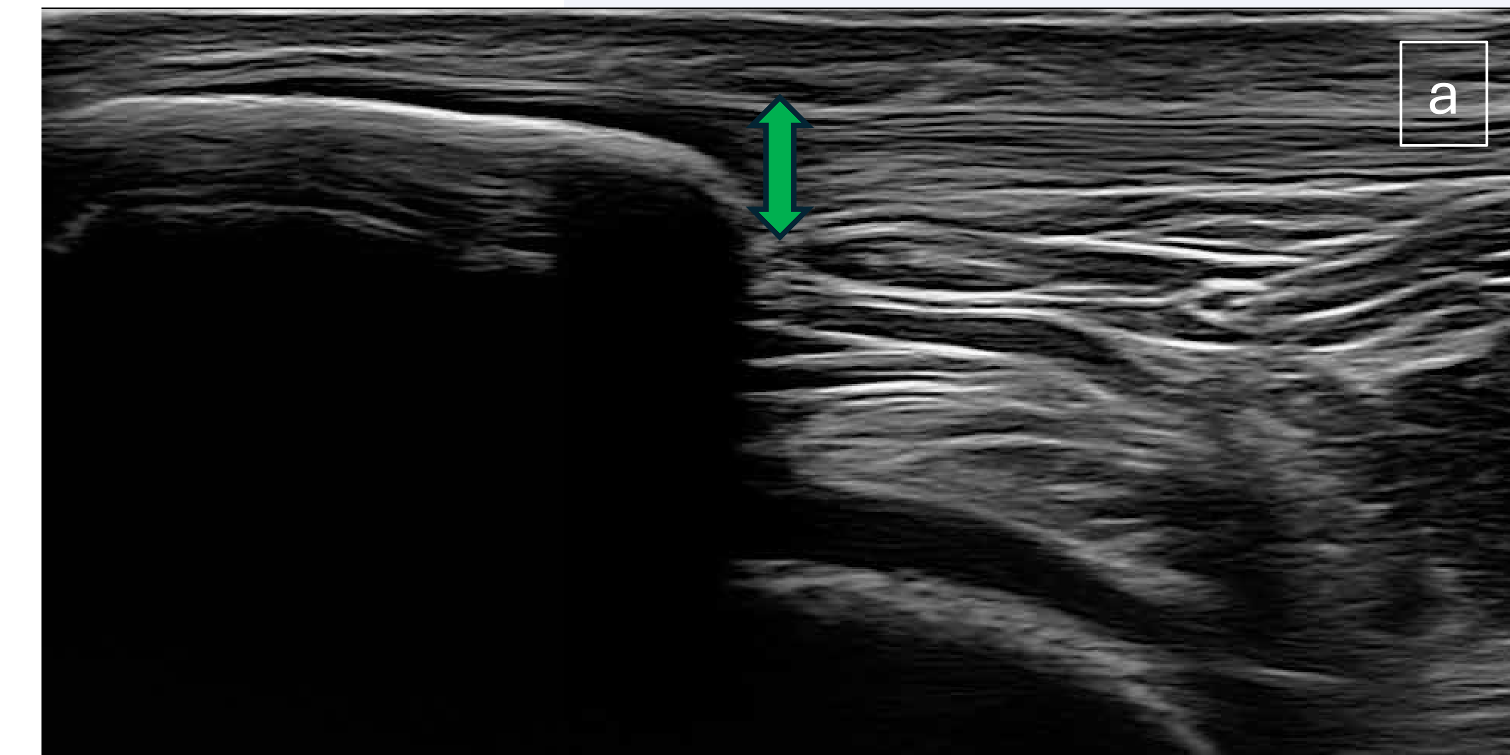


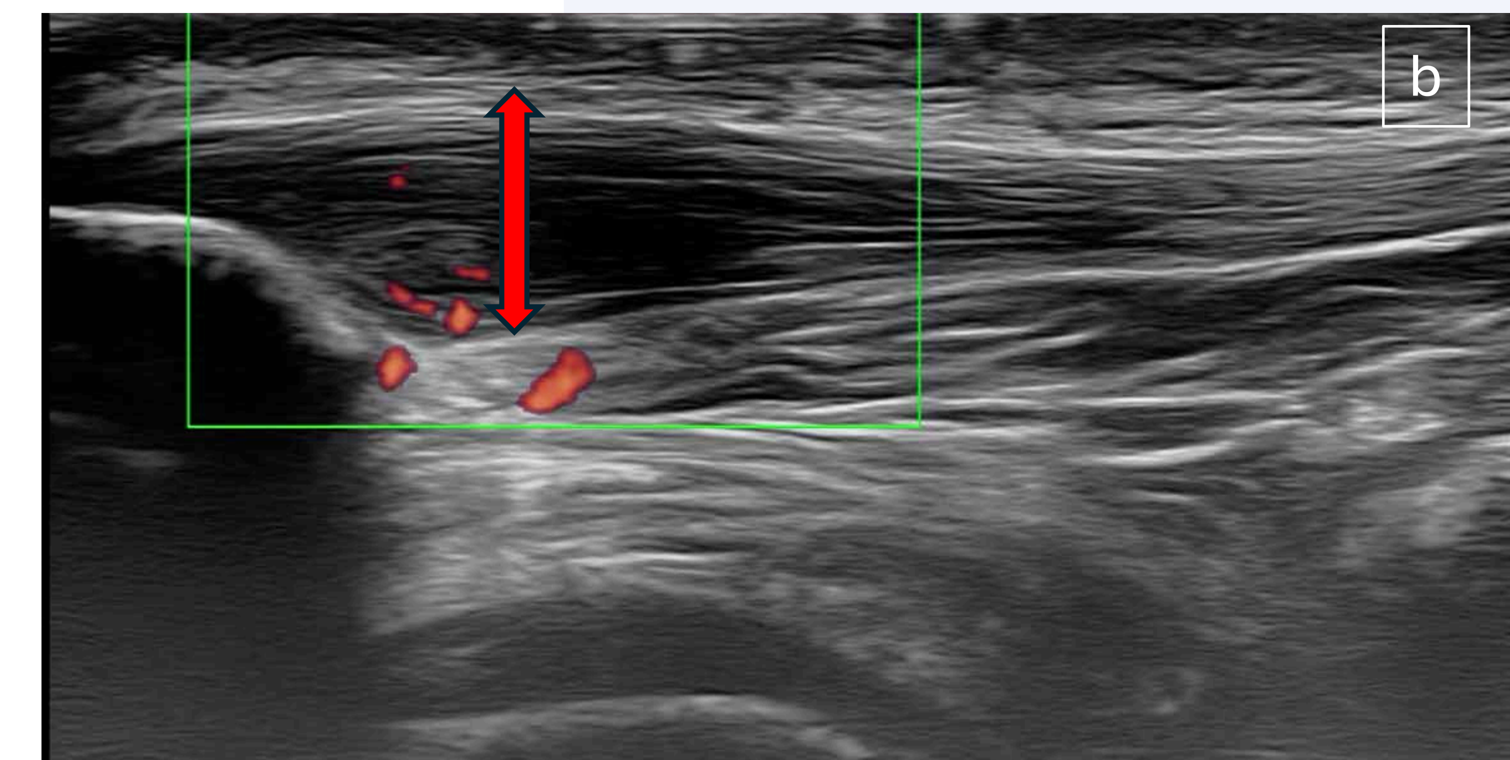


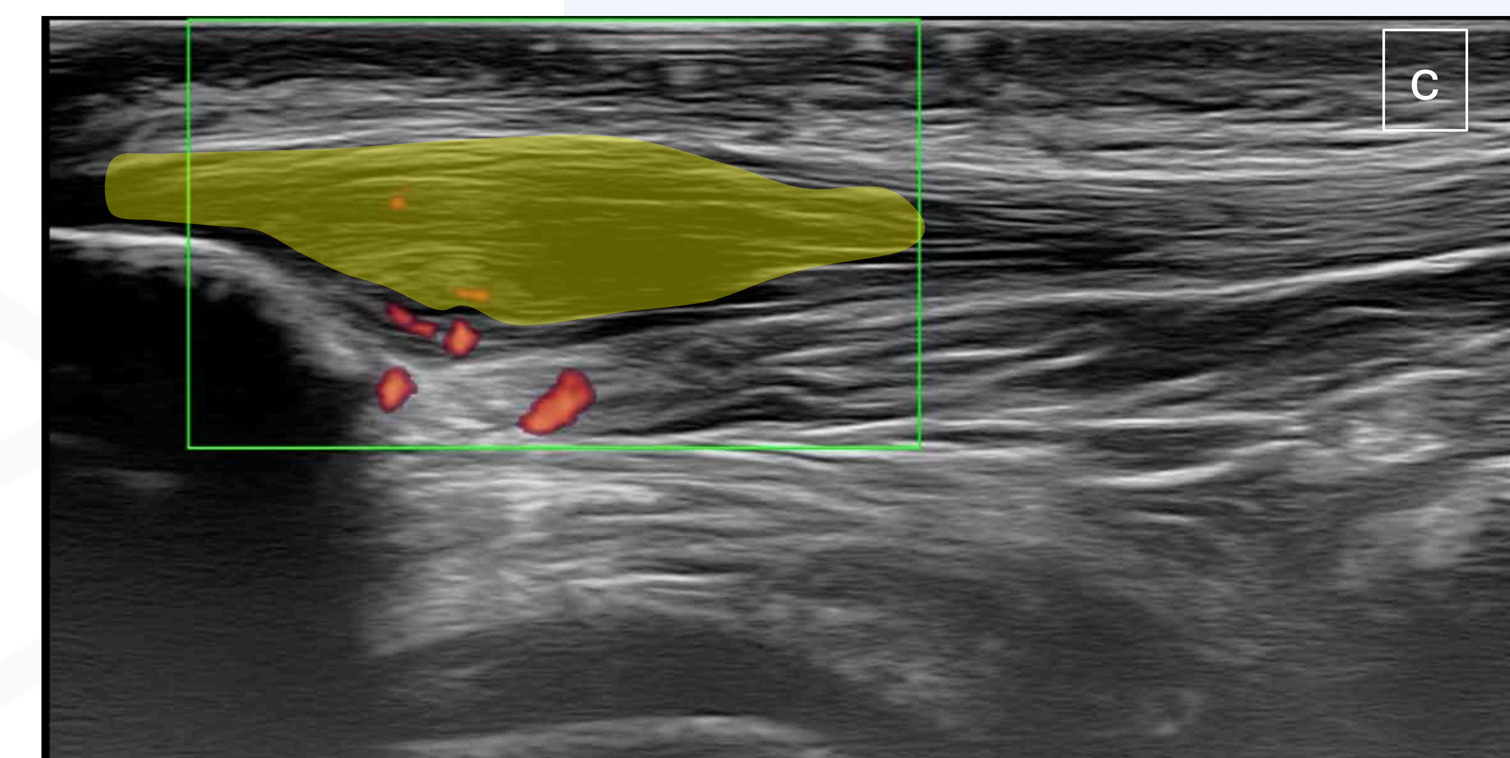
Tendinopathy of patellar tendon at patellar insertion: note the tendon thickening (**red arrow** in **b**) in pathological knee, and pathological tendon (in **yellow**) in **c.**

ANTERIOR KNEE
Long axis

Indentified:
jumper's knee, advanced stage







We can identify:

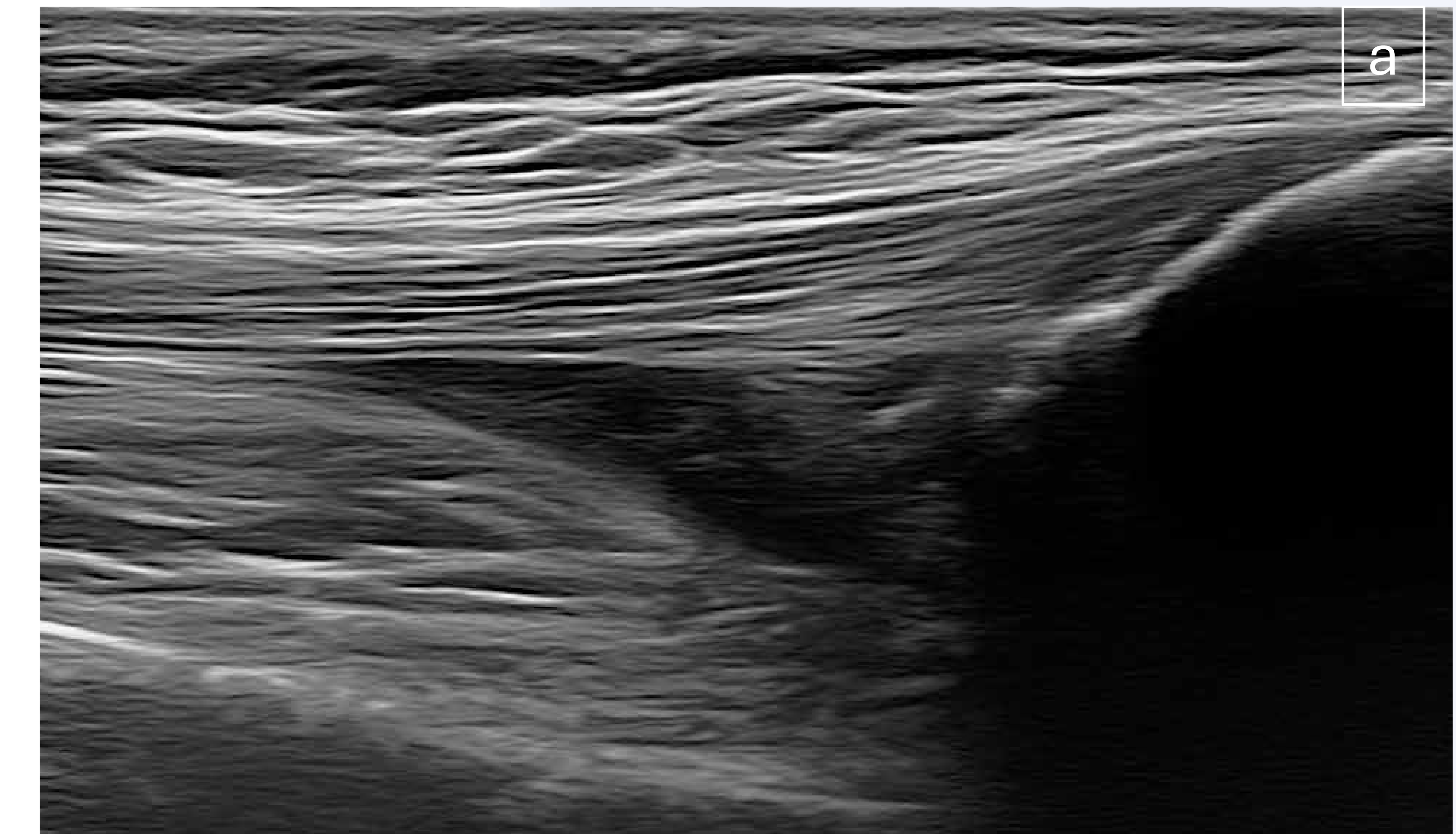
- Normal tendon **(a)**
- **b**: tendinopathy of patellar tendon at patellar insertion, note the tendon thickening (**red arrow** in **b**) in pathological knee, and pathological tendon hypoechoic aspect (in **yellow**, **c**)
- PWD + at patellar insertion, **b** and **c**

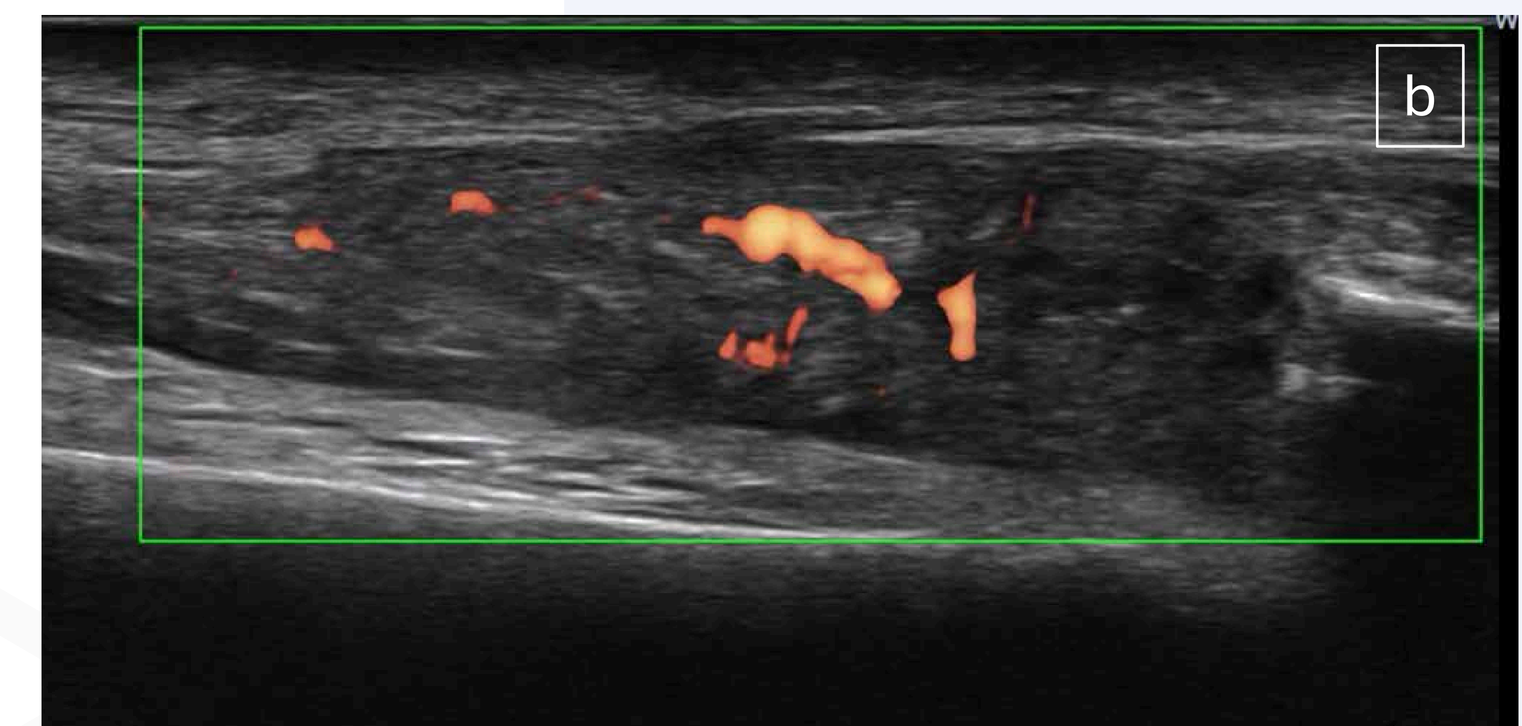
ANTERIOR KNEE
Long axis

Indentified:
effusion with hypoechoic synovitis

We can identify:

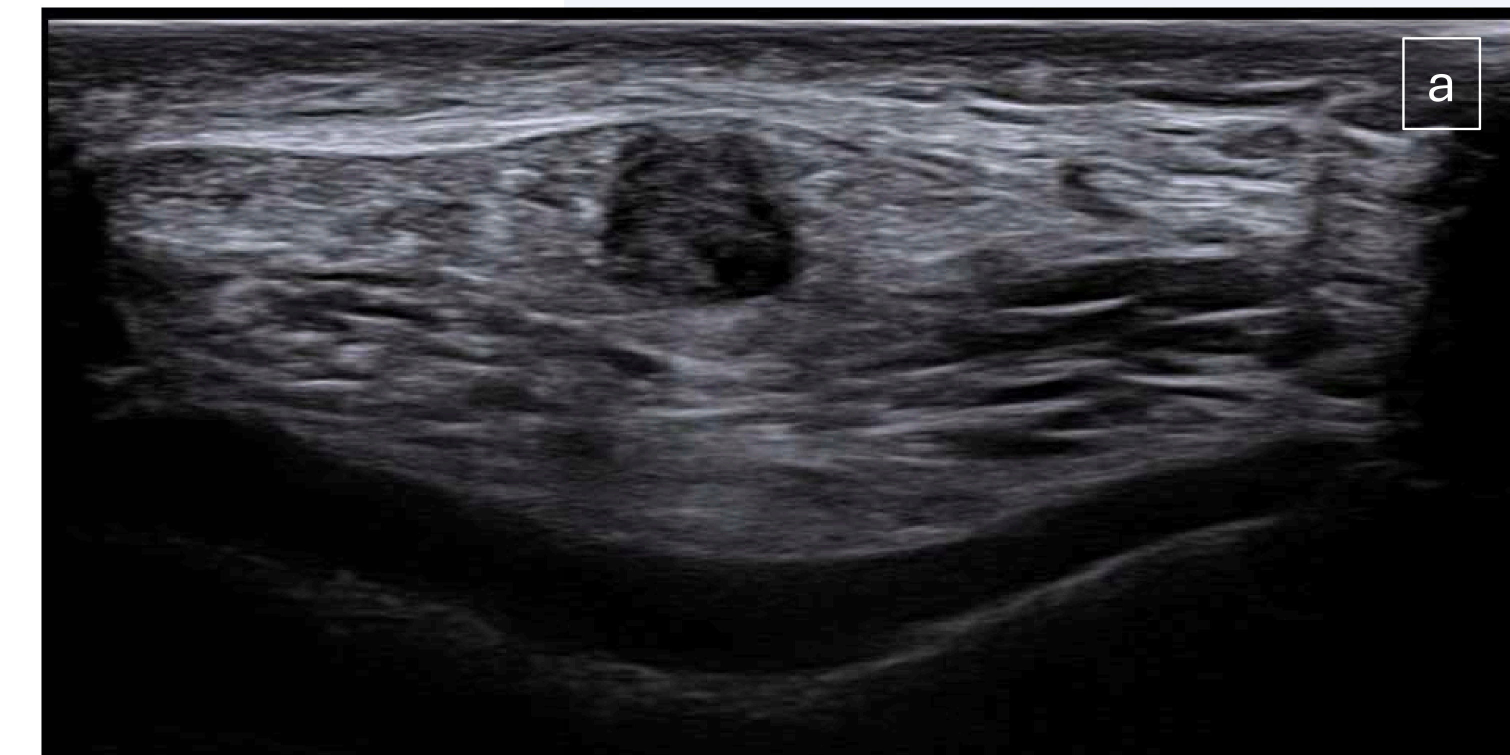
- Normal image, **(a)**
- Pathological image, **(b)**: doppler identify a grade 3 synovitis

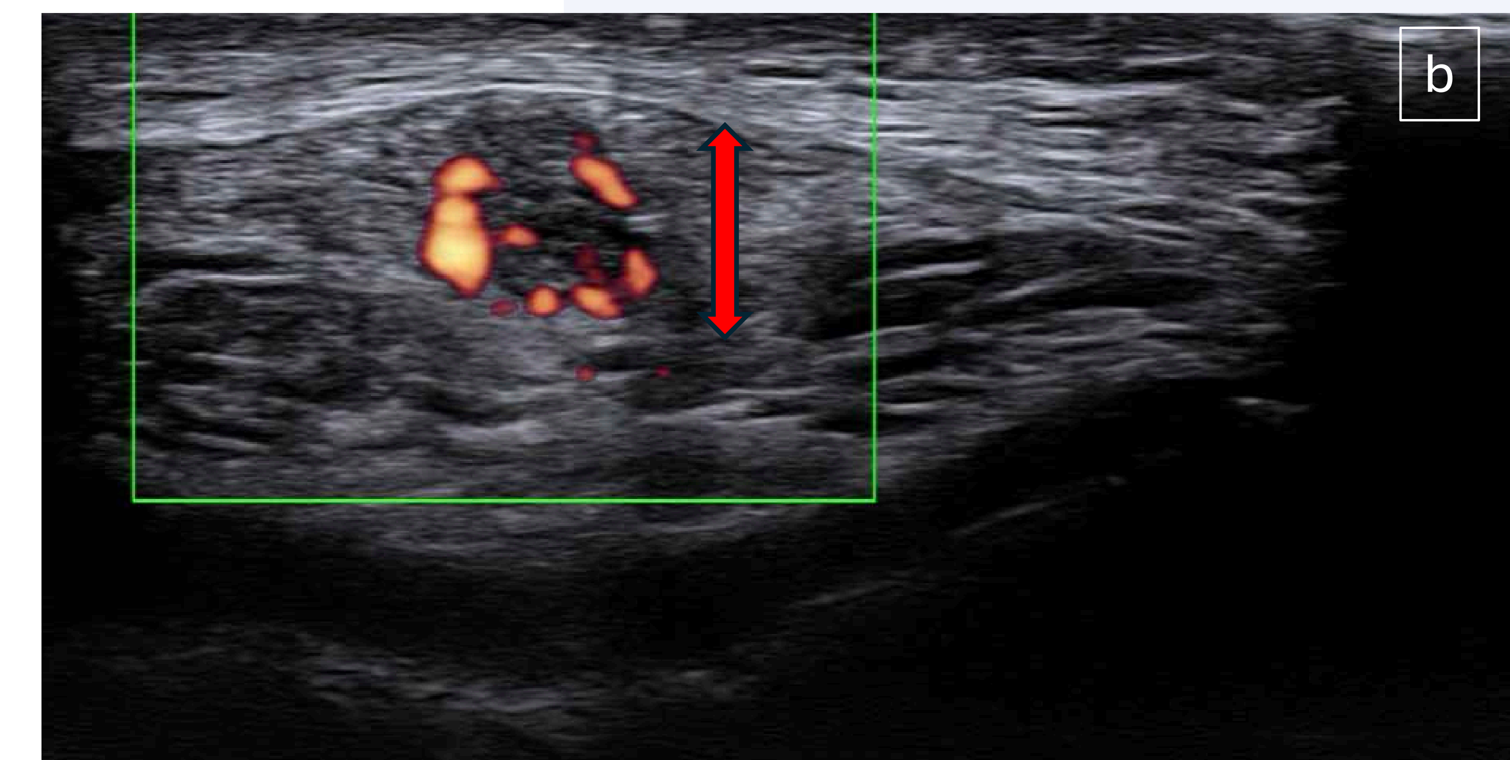


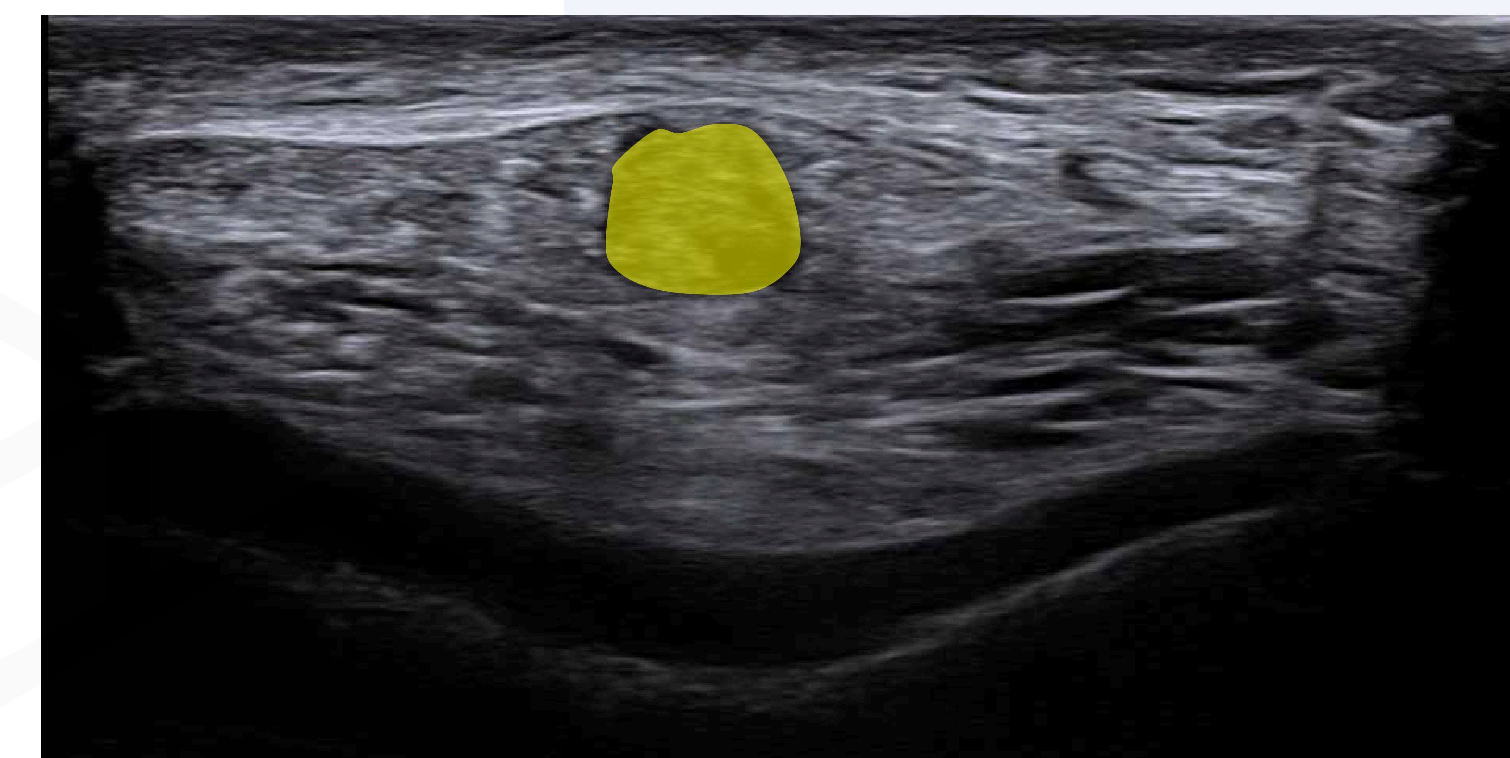


ANTERIOR KNEE
Short axis

Indentified:
insertional tendinopathy of quadriceps tendon







We can identify:

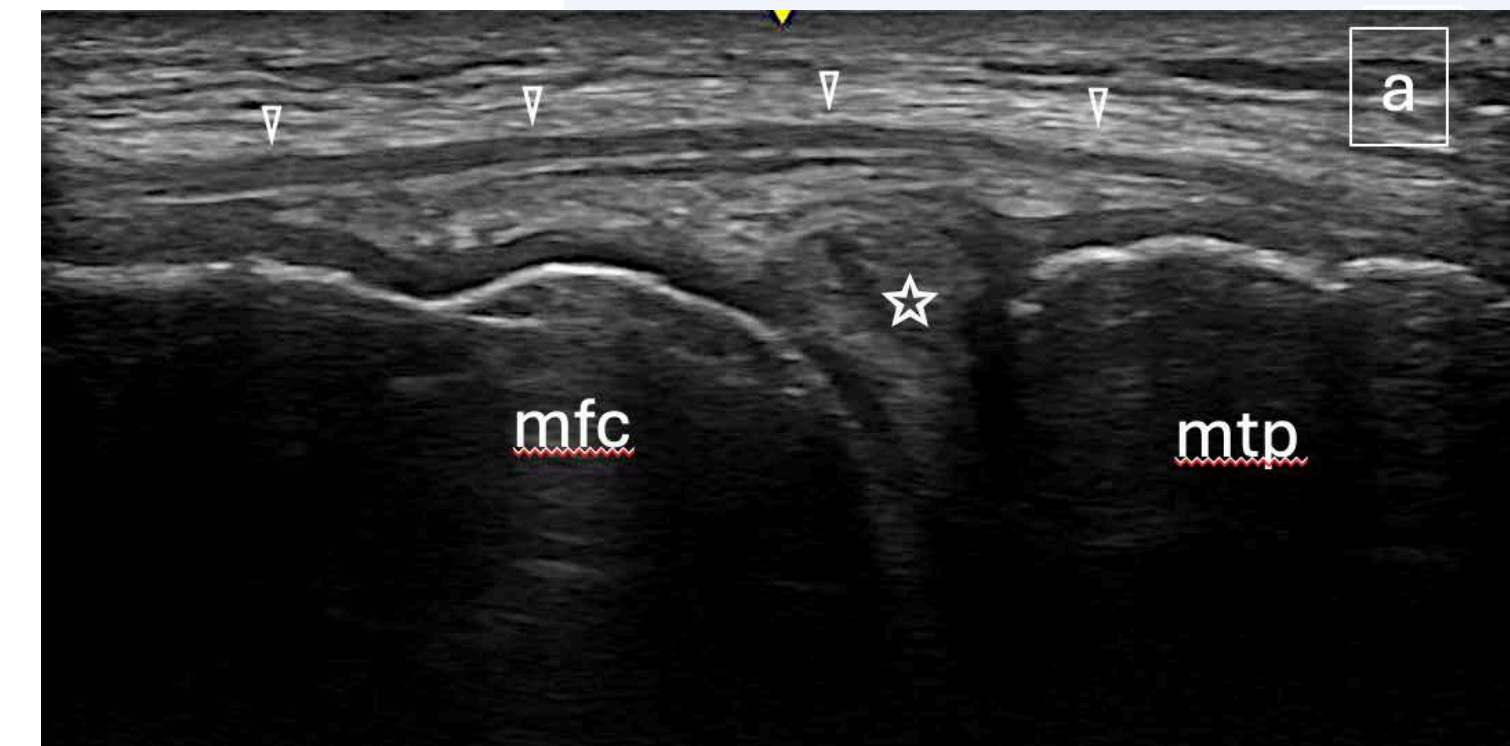
- **Image b:** tendon thickening (red arrow) and PWD +
- **Image c:** hypoechoic degenerative area inside the tendon (yellow area)

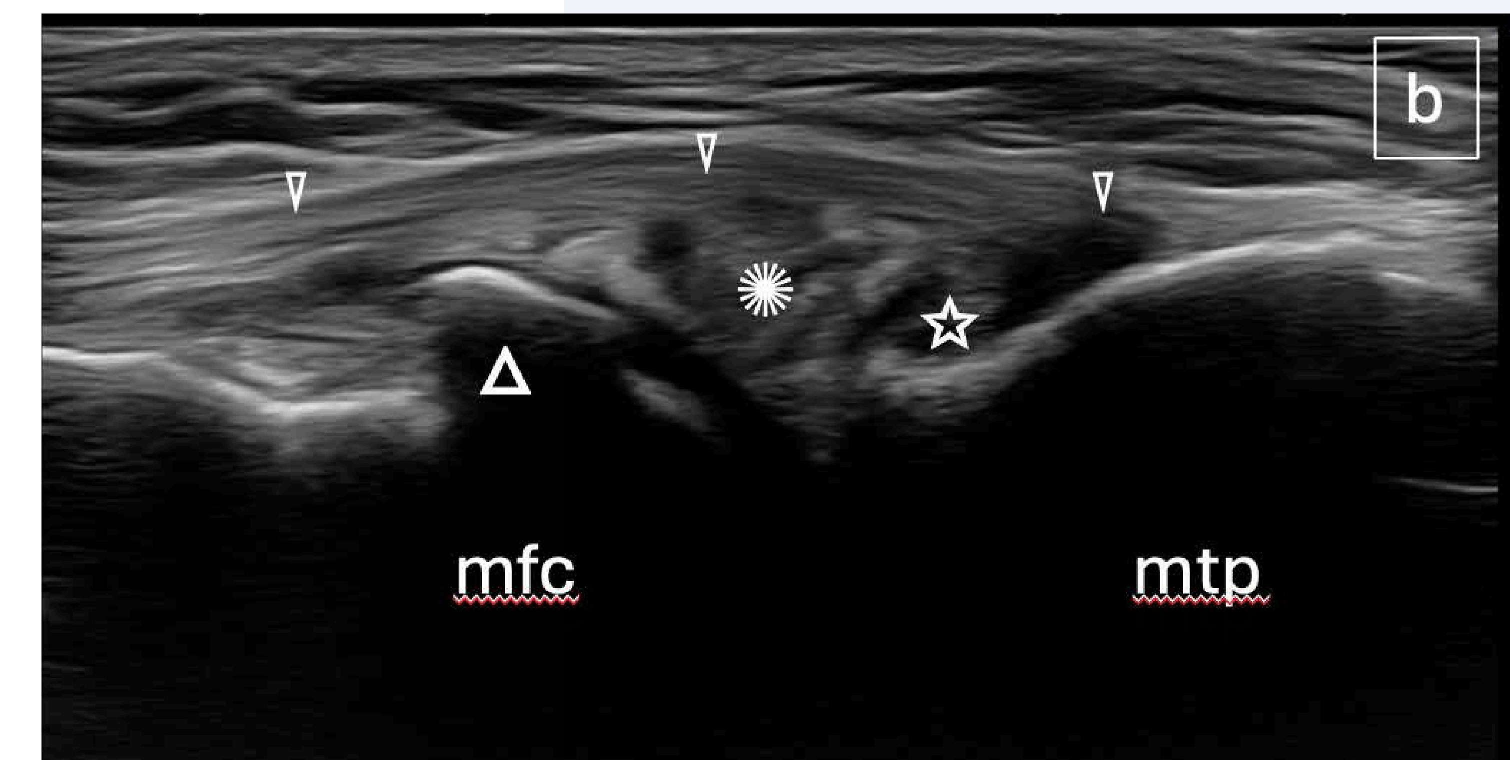
MEDIAL KNEE
Long axis

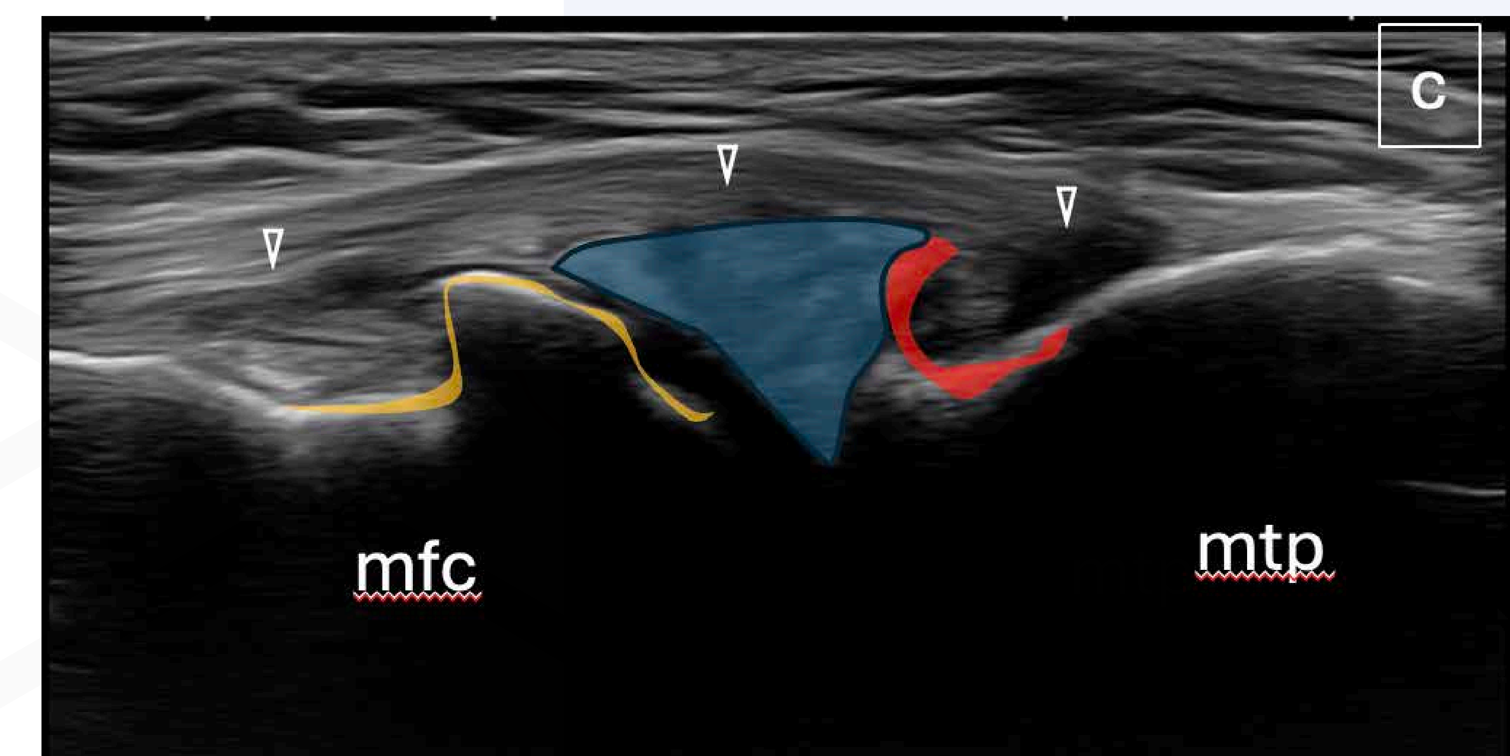
Indentified:
- Lesion of medial meniscus (MM)
- Chondrocalcinosis

We can identify:

- The **MCL** ligament integrity (▻, image **a**,**b**,**c)**.
- The normal **medial meniscus** with its **medial wall** (☆,image **a)**.
- The pathological degeneration of **MM** with chondrocalcinosis and hyperechoic areas inside the heterogeneous MM: (✺) in **b**, blue colored areas in **c**.
- The **medial femoral condyle (mfc)** and **medial tibial plateau (mtp)**, **a-b-c**.
- Osteophyte (△) in **b**; yellow profile in **c**.
- Cortical irregularity at the tibial bone (☆) in **b**, **red line** in **c**.





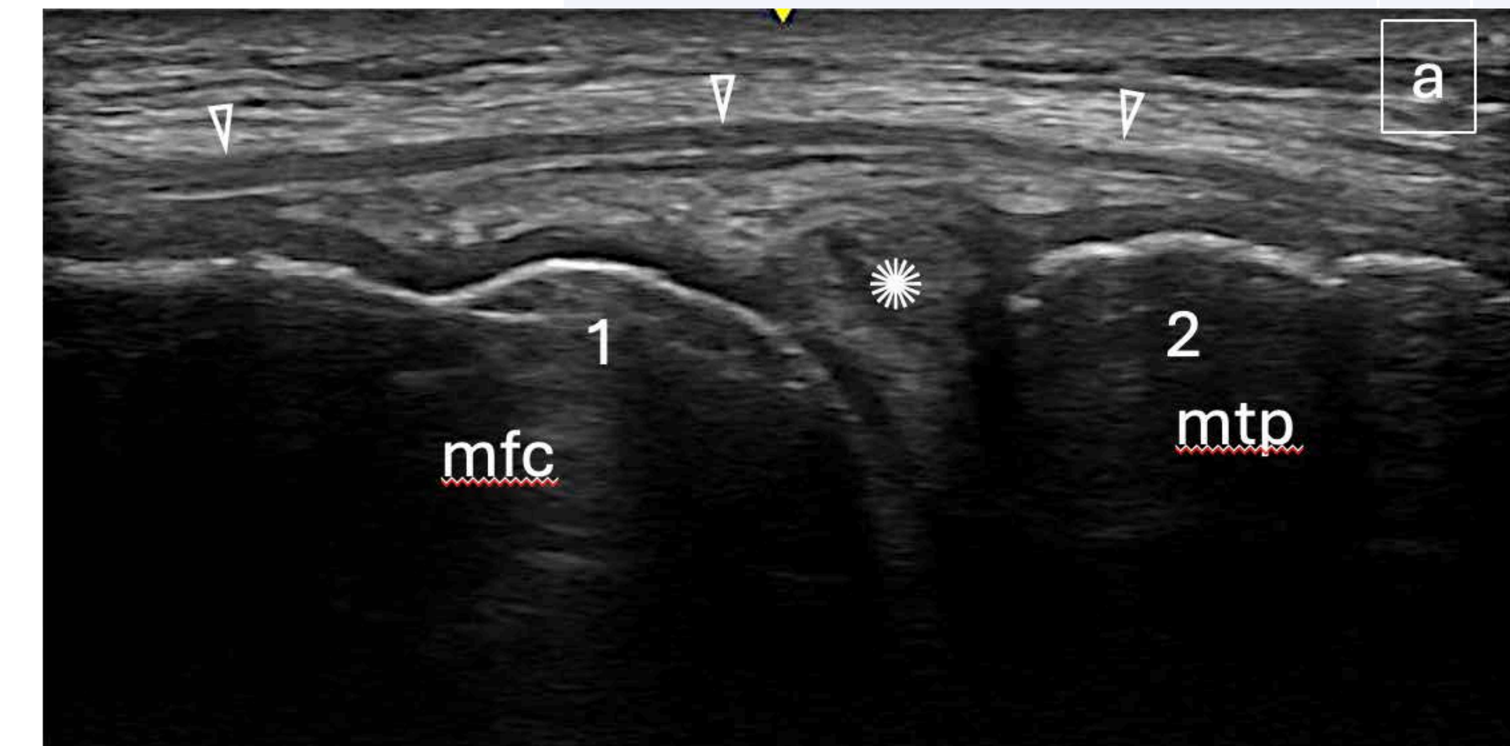


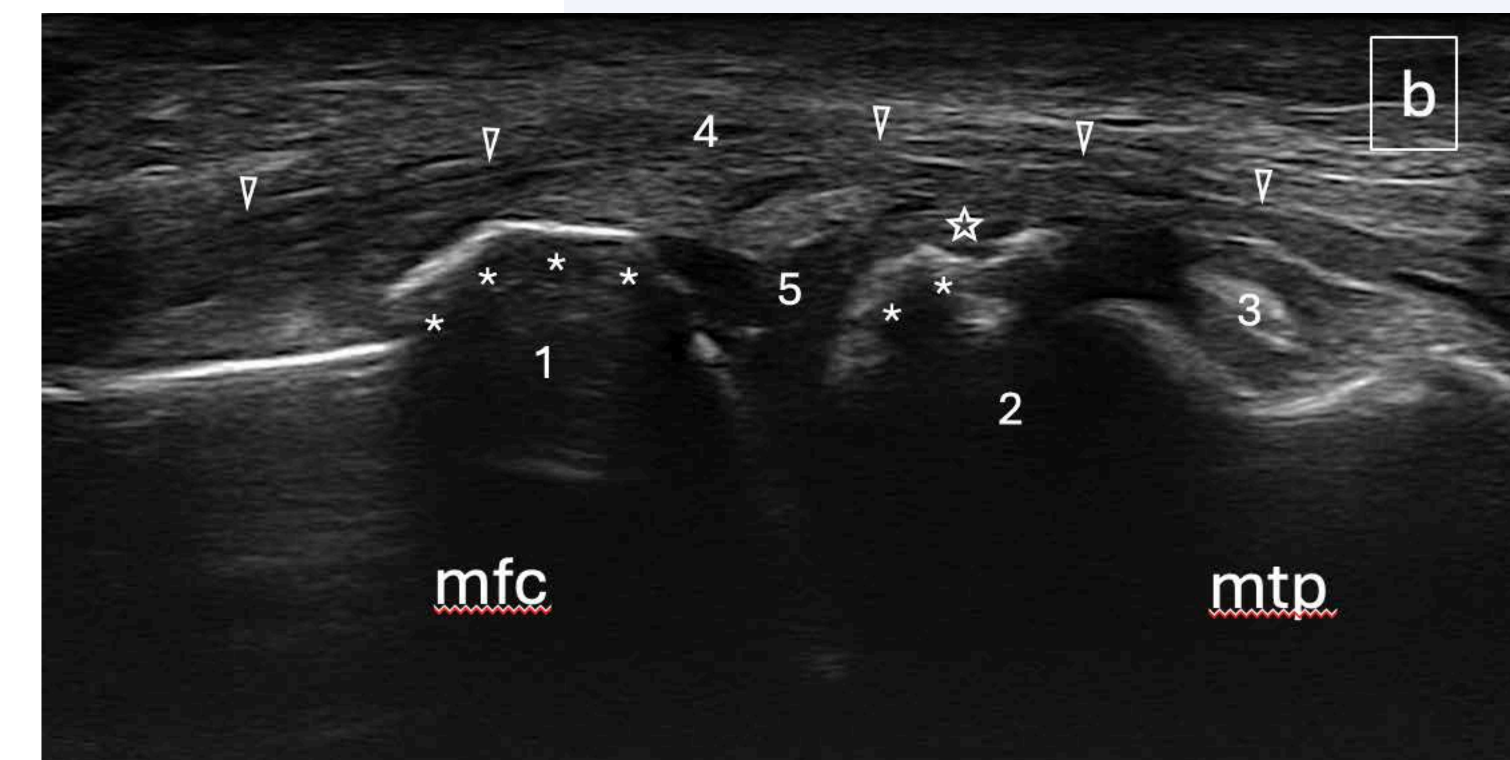
MEDIAL KNEE
Long axis

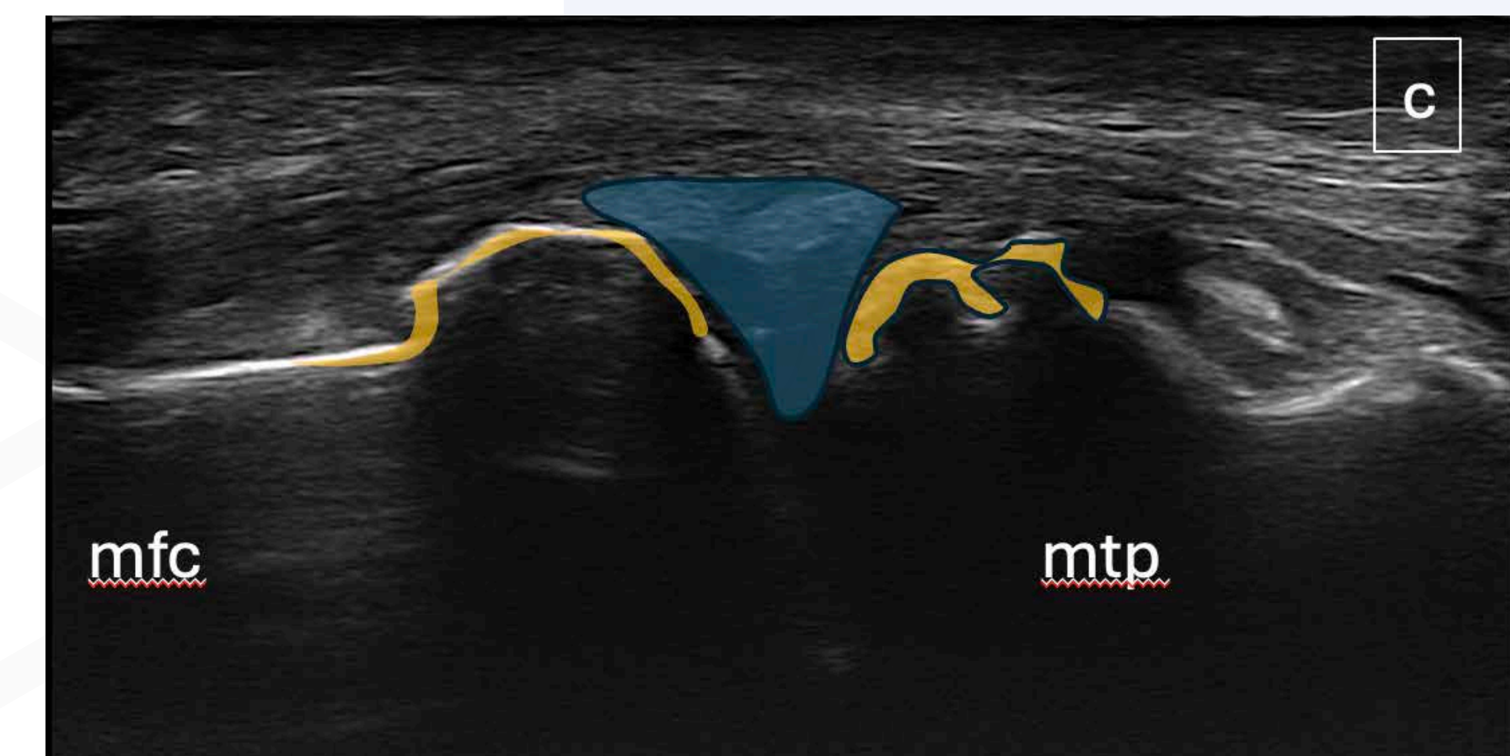
Indentified:
- **Lesion of medial meniscus**
- **Femoro-tibial osteophytes**

We can identify:

- Femoral condyle **(1)**.
- Tibial bone **(2)**.
- Semimembranosus tendon **(3)**.
- Medial collateral ligament **(4, ▻)**.
- Normal medial meniscus **(✺)** in **a**.
- Medial meniscus anisotropy **(5** in **b)**, blue area in **c**.
- Osteophyte **(*)** in **b**, yellow line in **c**.
- Cortical irregularity at the tibial bone **(☆)** in **b**, yellow line in **c**.





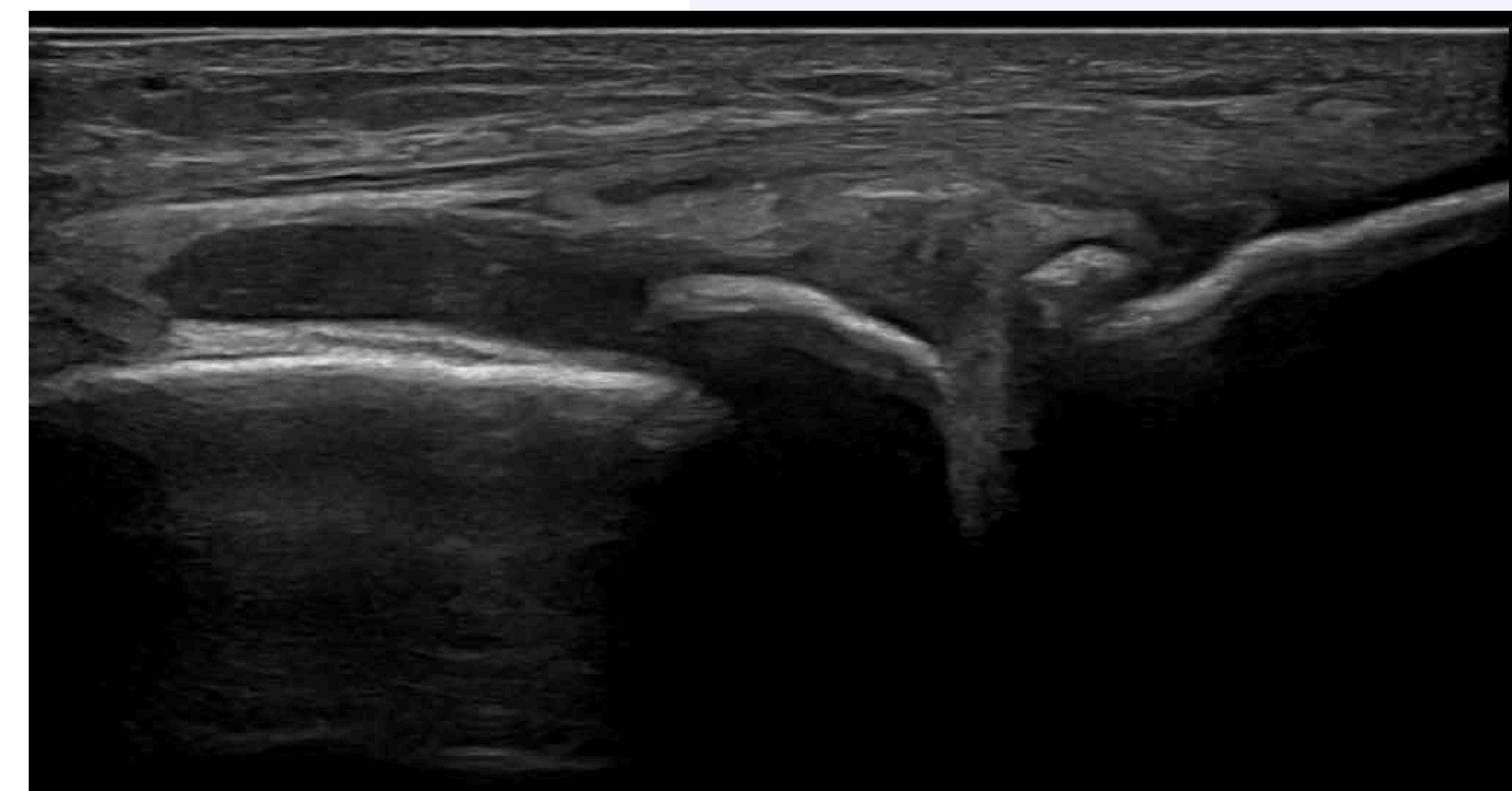


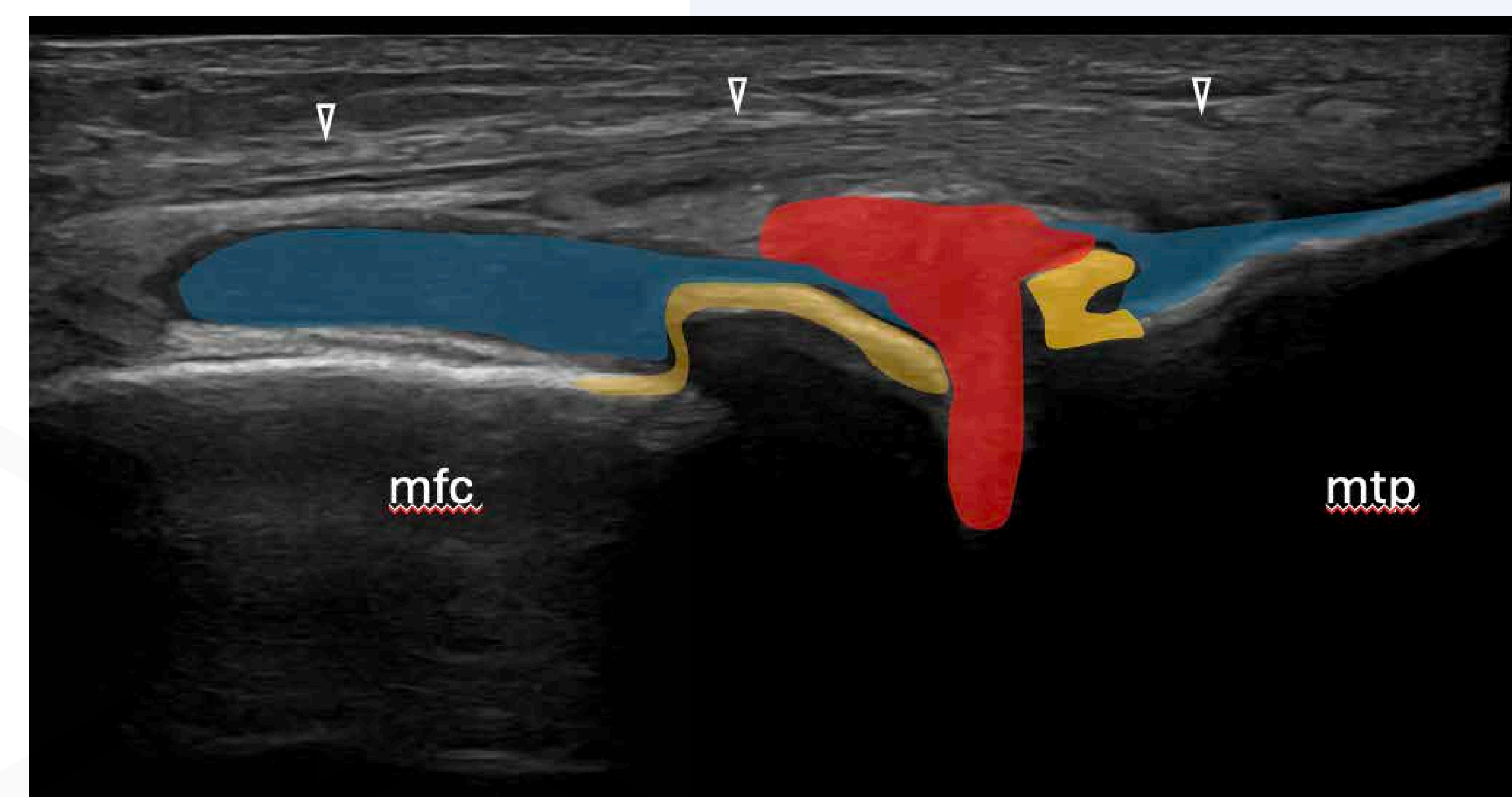
MEDIAL KNEE
Long axis

Indentified:
- Heterogeneity of medial meniscus
- Femoro-tibial osteophytes
- Effusion

We can identify:

- Femoral condyle **(mfc)**
- Tibial bone **(mtp)**
- Medial collateral ligament (▻)
- Medial effusion, **blue area**
- Medial meniscus hetherogeneity, **red** area
- Osteophyte, **yellow** line



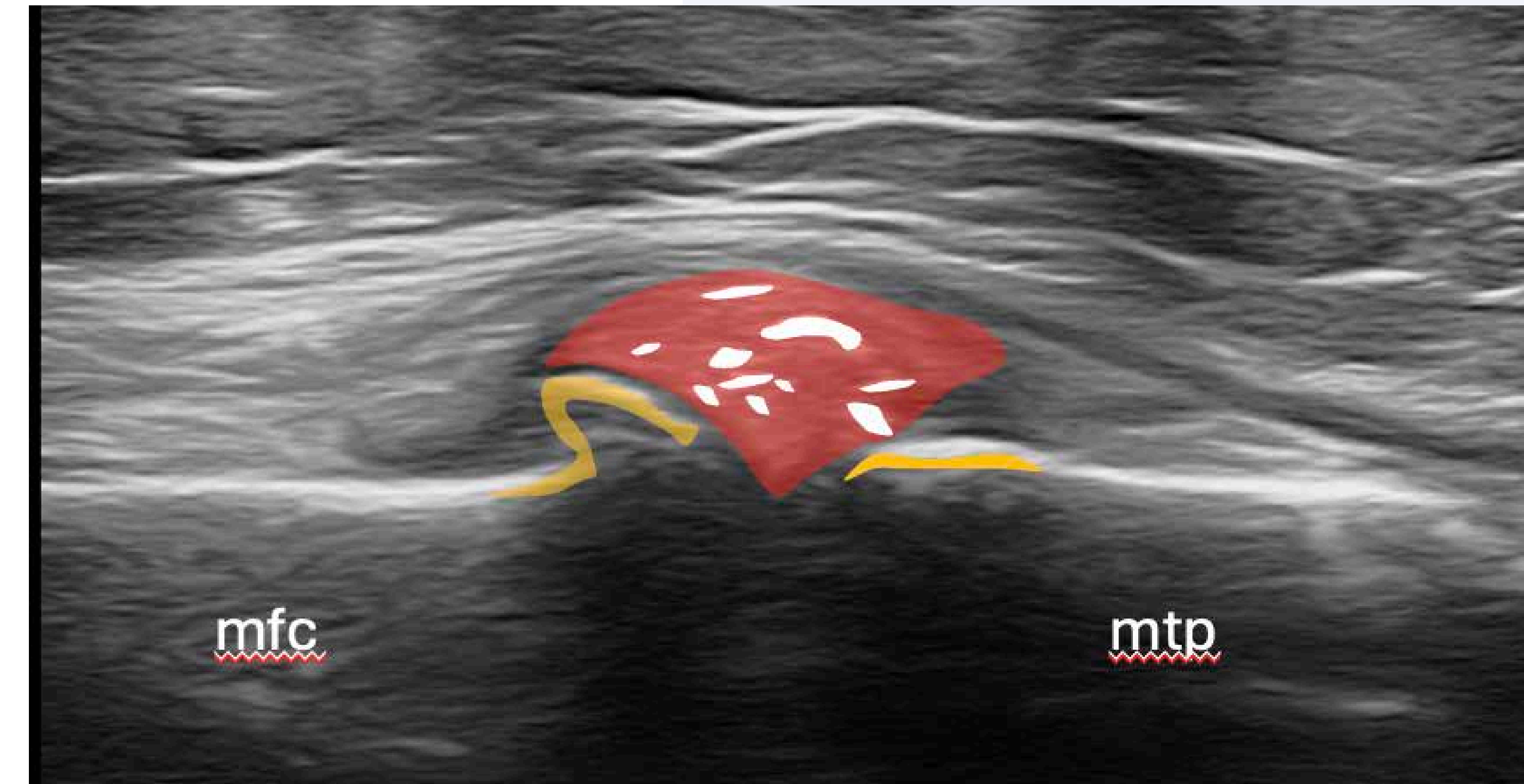


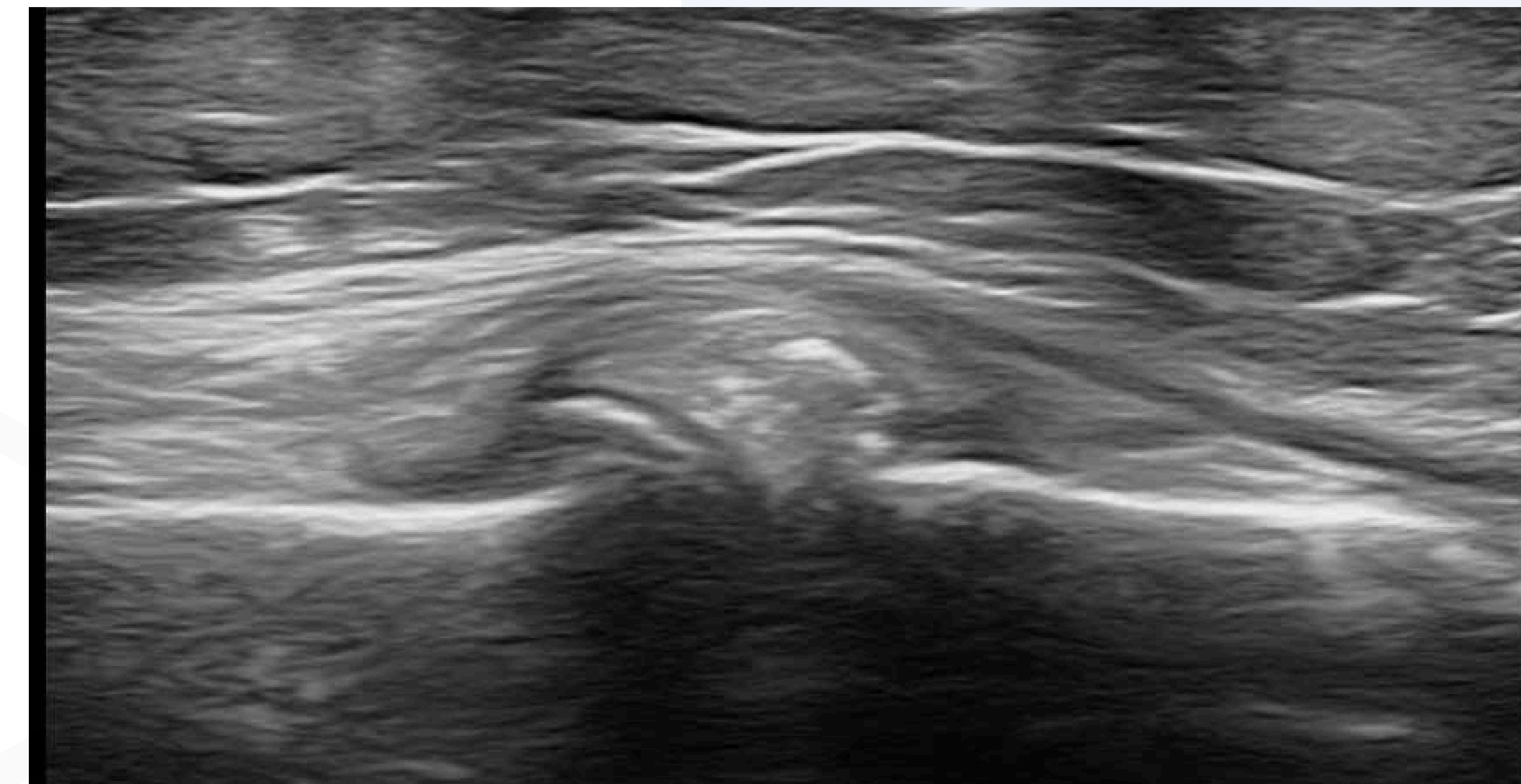
MEDIAL KNEE
Long axis

Indentified:
Chondrocalcinosis of MM

We can identify:

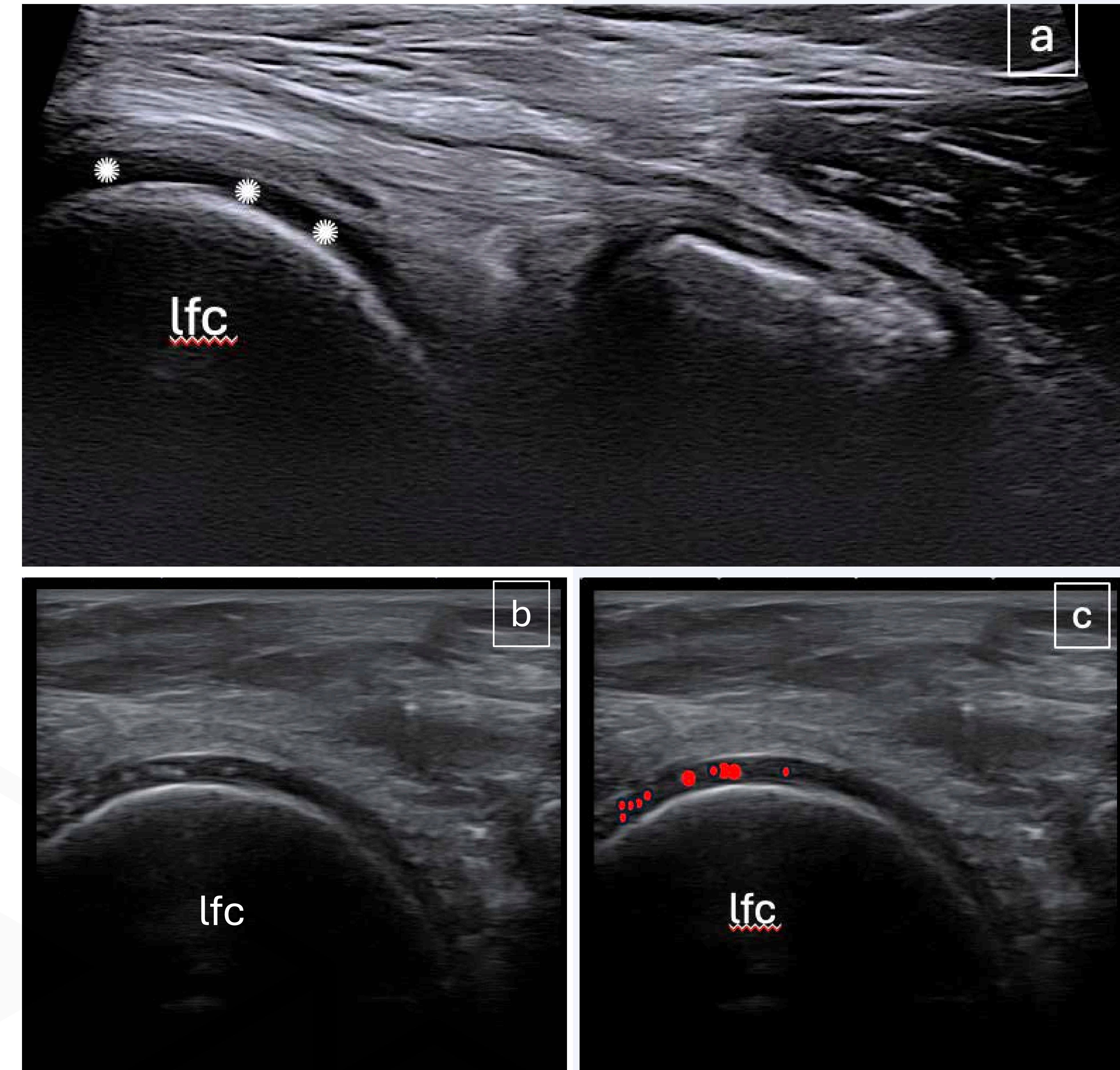
- Femoral condyle **(mfc)**
- Tibial bone **(mtp)**
- Medial meniscus extrusion **(red area)** with hyperechoic calcium deposit inside **(white spots)**
- Osteophyte, **yellow** line





Popliteal fossa
Lateral aspect, long axis

Indentified:
chondrocalcinosis of lateral condyle

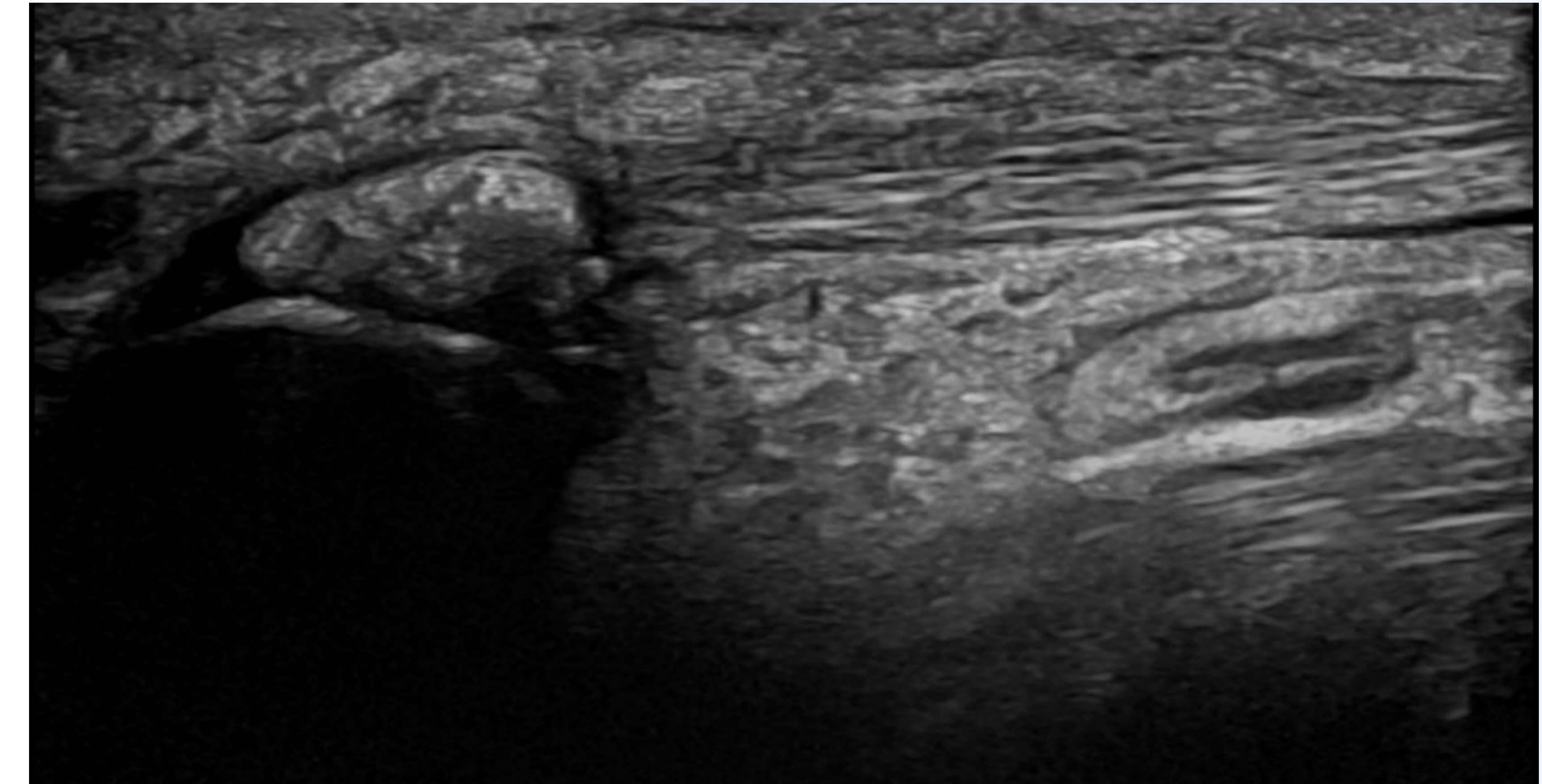


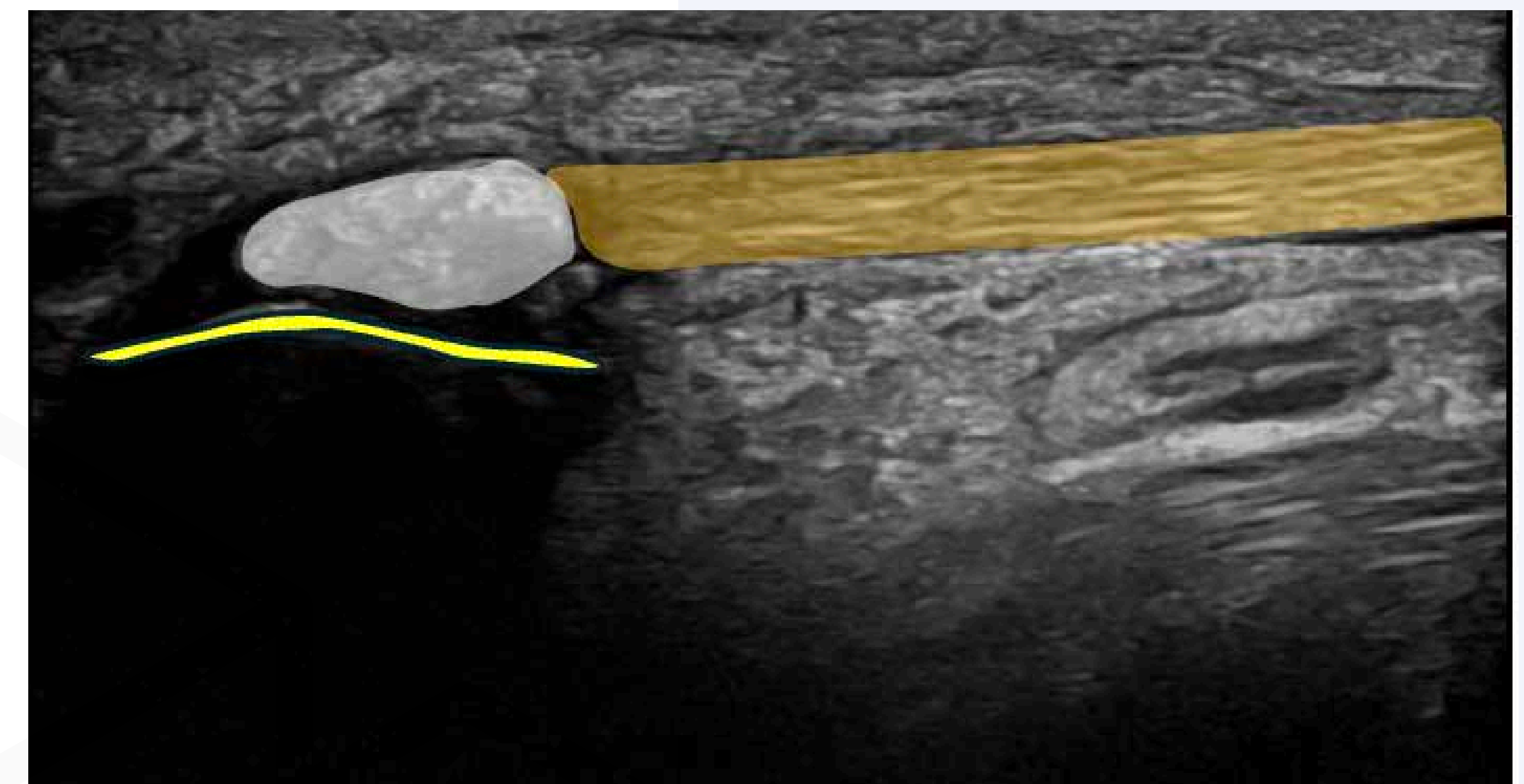
We can identify:

- Lateral femoral condyle **(lfc**: **a**, **b**, **c)**
- The normal homogeneous hypoechoic aspect of the cartilage **(✷, a)**.
- Pathological image, **b** and **c**: inside the anechoic cartilage we can see hyperechoic dots **(b)** representing the calcium pyrophosphate deposit: it is a chondrocalcinosis **(red dots**, **c)**.

Popliteal fossa
Enthesis, long axis

Indentified:
preinsertional calcification



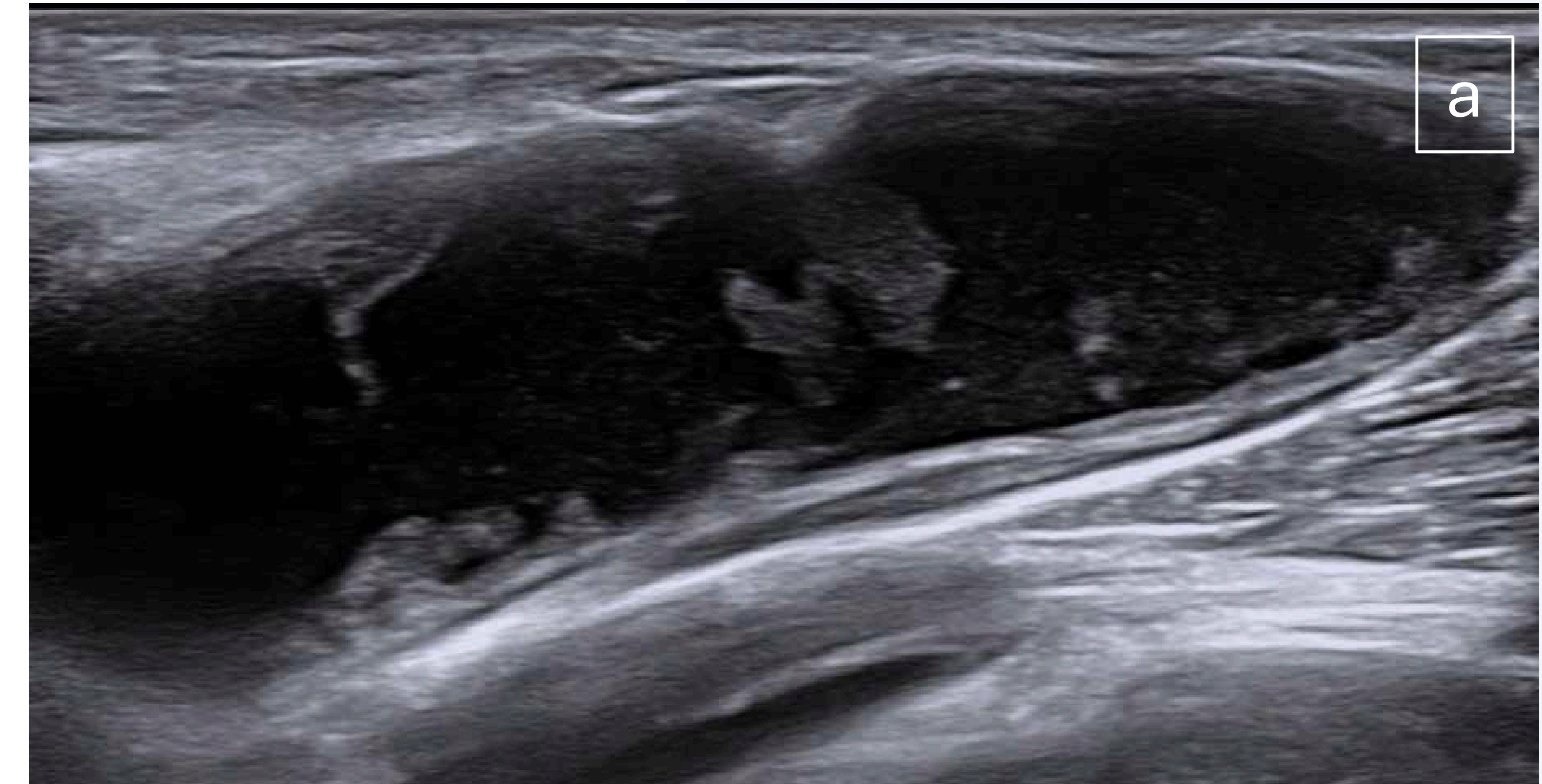


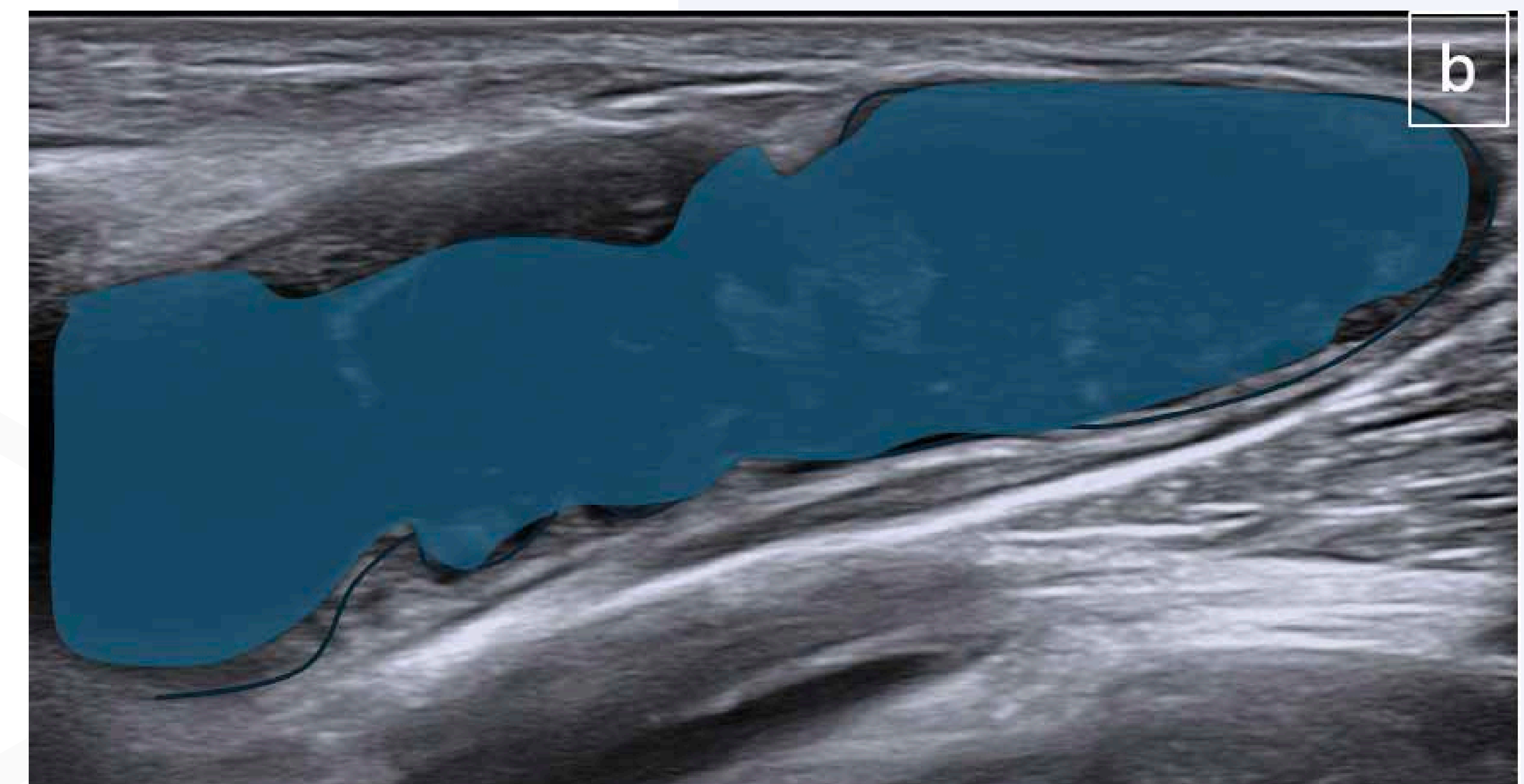
We can identify:

- Fibrillar hyperechoic tendon image **(yellow area)**
- Hyperechoic pre-entheseal calcification **(white area)**
- Hyperechoic bony profile, **yellow line**

Popliteal fossa
Medial aspect, long axis

Indentified:
Baker's cist





We can identify:

- Large hypo-anechoic image of the content, with hyperechoic aspect of the cyst capsule **(image a)**.
- In blue, the effusion **(image b)**.

This table provides a comparative ultrasound-oriented approach to the main causes of lateral knee pain, including periarticular and intra-articular structures.

The lateral synovial recess is incorporated as a key source of inflammatory or mechanical lateral knee pain.

Structure	Typical Clinical Context	Key Ultrasound Findings	Dynamic Maneuvers	Main Pitfall / Differentiation Tip
Iliotibial band (ITB)	Athletes; runners; cycling-related overuse; pain during repetitive flexion–extension	Focal or diffuse thickening; hypoechogenicity; friction-related changes over the lateral femoral condyle	Knee flexion–extension to assess friction	Avoid anisotropy; differentiate from LCL by superficial location and longitudinal course
Lateral collateral ligament (LCL)	Traumatic varus stress; instability sensation; focal lateral pain	Cord-like hyperechoic ligament; thickening or fiber discontinuity	Varus stress during scanning	Differentiate from ITB by deeper position and insertion on the fibular head
Biceps femoris tendon	Athletes; sprinting injuries; posterolateral pain near fibular head	Fibrillar tendon inserting on fibular head; tendinopathy or partial tear	Resisted knee flexion	Confirm muscular continuity proximally to avoid confusion with LCL
Lateral synovial recess	Inflammatory arthritis; mechanical synovitis; joint effusion with lateral pain	Anechoic or hypoechoic fluid distension; synovial hypertrophy; Doppler signal if active inflammation	Gentle probe compression and knee flexion-extension	Avoid excessive compression, which may obscure small effusions
Lateral meniscus	Mechanical symptoms; joint line tenderness; degenerative or traumatic context	Meniscal extrusion; altered echotexture; perimeniscal fluid or calcifications	Compression and dynamic joint motion	Differentiate intrinsic tears from perimeniscal crystal deposits
Popliteus tendon (when assessed)	Posterolateral pain; rotational instability	Thickened or hypoechoic tendon at femoral sulcus	Internal rotation of tibia	Often missed; requires targeted scanning

US GUIDED PROCEDURES

US GUIDED PROCEDURES: IN PLANE AND OUT OF PLANE TECHNIQUE

US-guided infiltration procedures allow for a significant reduction in infiltration error compared to blind/bony landmark procedures.
Learning how to perform an ultrasound-guided infiltration is like learning a technique, as is the case in orthopaedics with arthroscopy.

Once this technique has been acquired, with knowledge of ultrasound anatomy and understanding of the target to be reached in order to treat the clinical problem, it will be possible to treat different areas of the upper and lower limbs and the spine.

The time dedicated to practicing these procedures will, of course, determine the speed of the learning curve.

There are two ways in which an ultrasound-guided infiltration can be performed, using the in-plane or out-of-plane technique.

The choice of infiltration technique will depend on various parameters such as the anatomical region of the target and its topography, in particular the depth, size and type of lesion, and the substance to be injected: hyaluronic acid, steroids, PRP, anaesthetic, etc.

In-plane (long axis) technique shows the entire needle length parallel to the probe for continuous visualization, ideal for deeper targets

The **out-of-plane (short axis)** technique inserts the needle perpendicular to the probe, showing only the tip (a bright dot) and is better for superficial targets or when avoiding structures near the needle path.

In-plane offers better control, while out-of-plane is quicker for superficial access but requires skill to track the tip.

Rotate the needle between your fingers (like a drill) to make the reflections more prominent and help identify the tip; using needle rotation to enhance visibility.

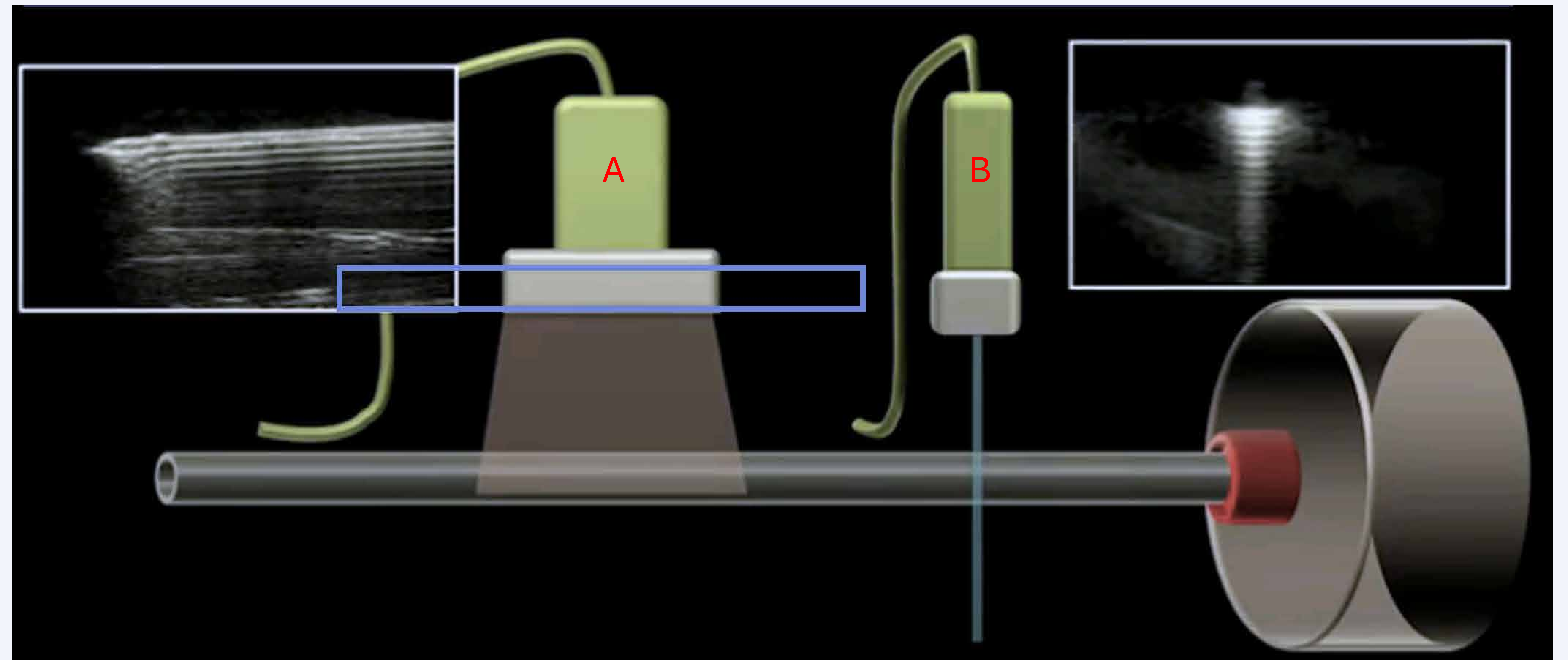
Choose the **correct needle length** based on the depth of the target.

Choose the **correct entry point** relative to the probe, based on the depth of the target to be reached, remembering that the more vertical the needle is, the worse the quality of the insonation and therefore of the image of the needle on the screen will be.

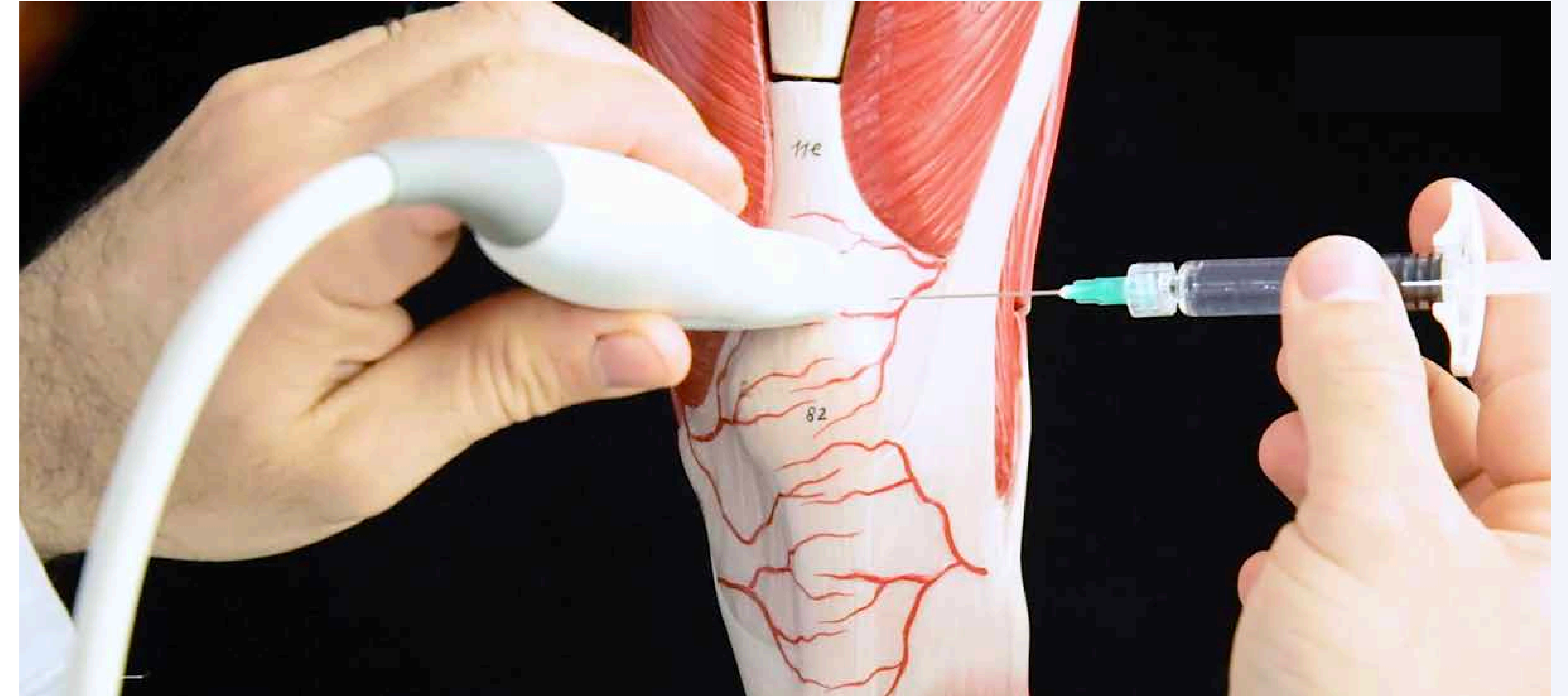
US GUIDED PROCEDURES: IN PLANE AND OUT OF PLANE TECHNIQUE

A: the probe is in «in plane» position, parallel to the needle. We can see the length of the needle.

B: the probe is in «out-of-plane» position, perpendicular to the needle. We can see a «white dot».



IN PLANE TECHNIQUE



Description

The needle is inserted parallel to the ultrasound transducer, so the entire needle shaft and tip are visible in the image as it travels toward the target.

How it Works

The transducer is positioned to create a long axis view of the needle, allowing real-time tracking of its entire path. The entire needle shaft and tip are visible as a continuous hyperechoic (bright) line on the screen.

Best For

Deep structures, vessels (arterial lines), joints, or when precise control is needed.

Procedure Steps

1. Align the probe to visualize the target structure in its long axis.
2. Insert the needle at one end of the probe, ensuring it remains within the narrow ultrasound beam.
3. Advance the needle while monitoring the tip in real-time until it reaches the target.

Key Advantage

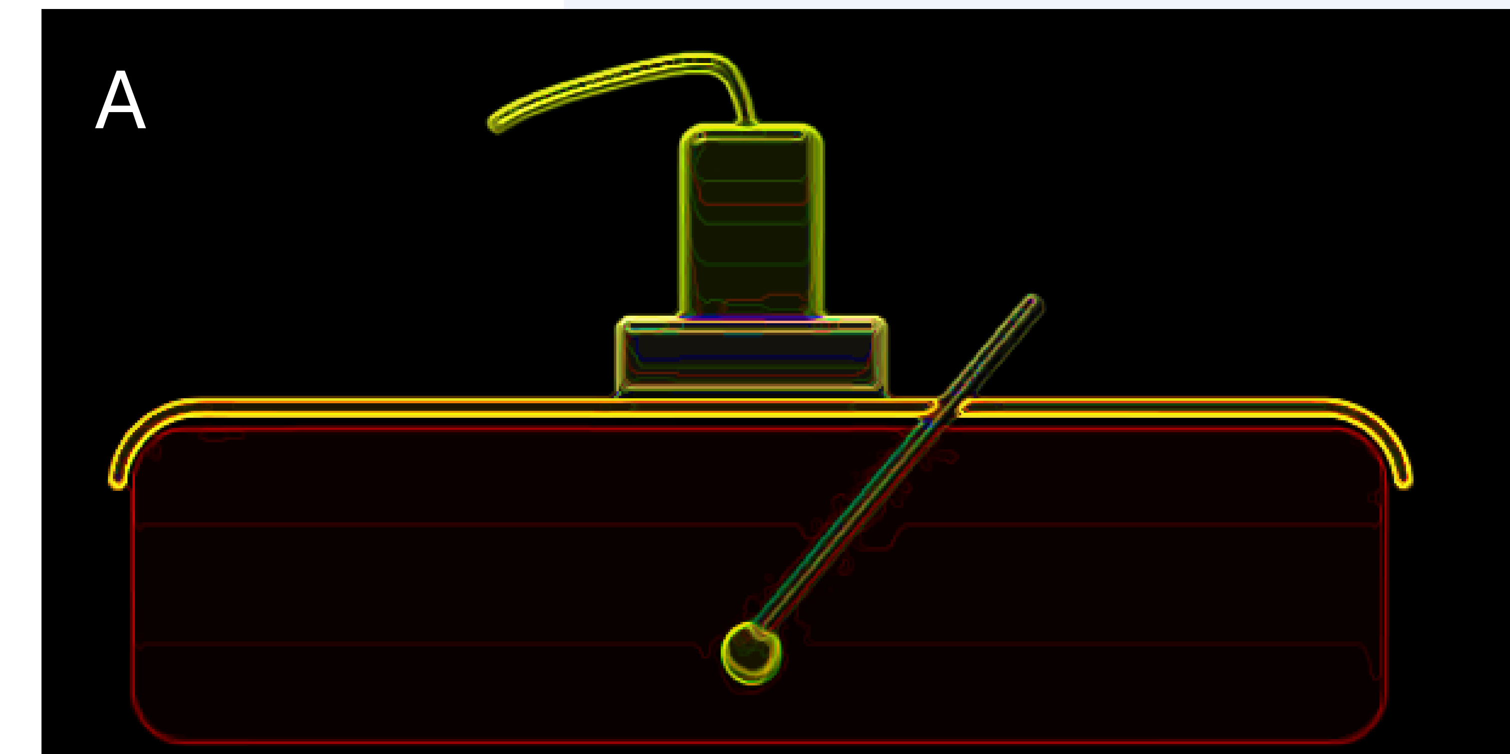
Offers the safest visualization of the entire needle trajectory, including the tip, which reduces the risk of accidental injury to adjacent structures.

Key Disadvantage

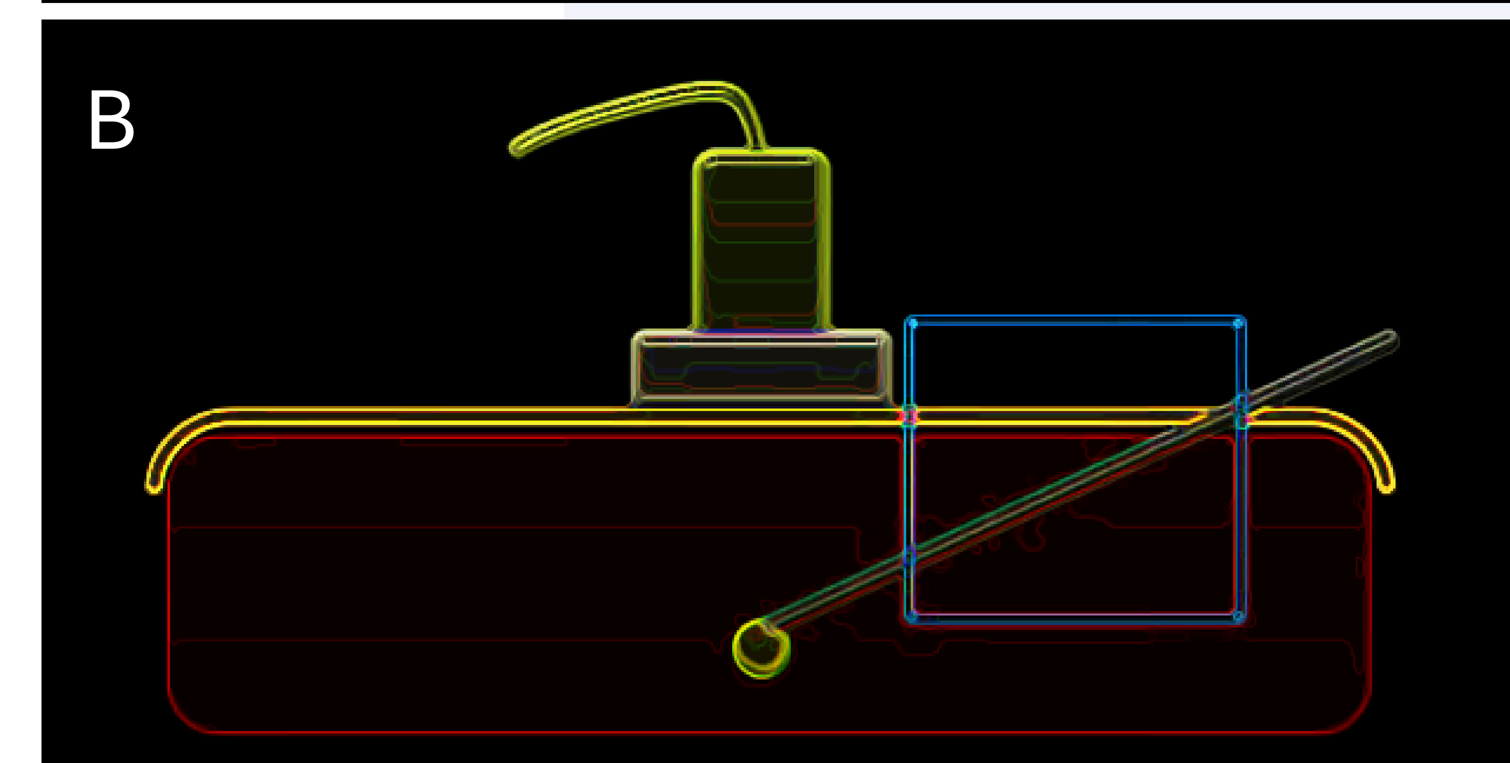
Technically difficult because the probe and needle must stay perfectly aligned; even minor deviations will cause the needle to “disappear” from the screen.

IN PLANE TECHNIQUE

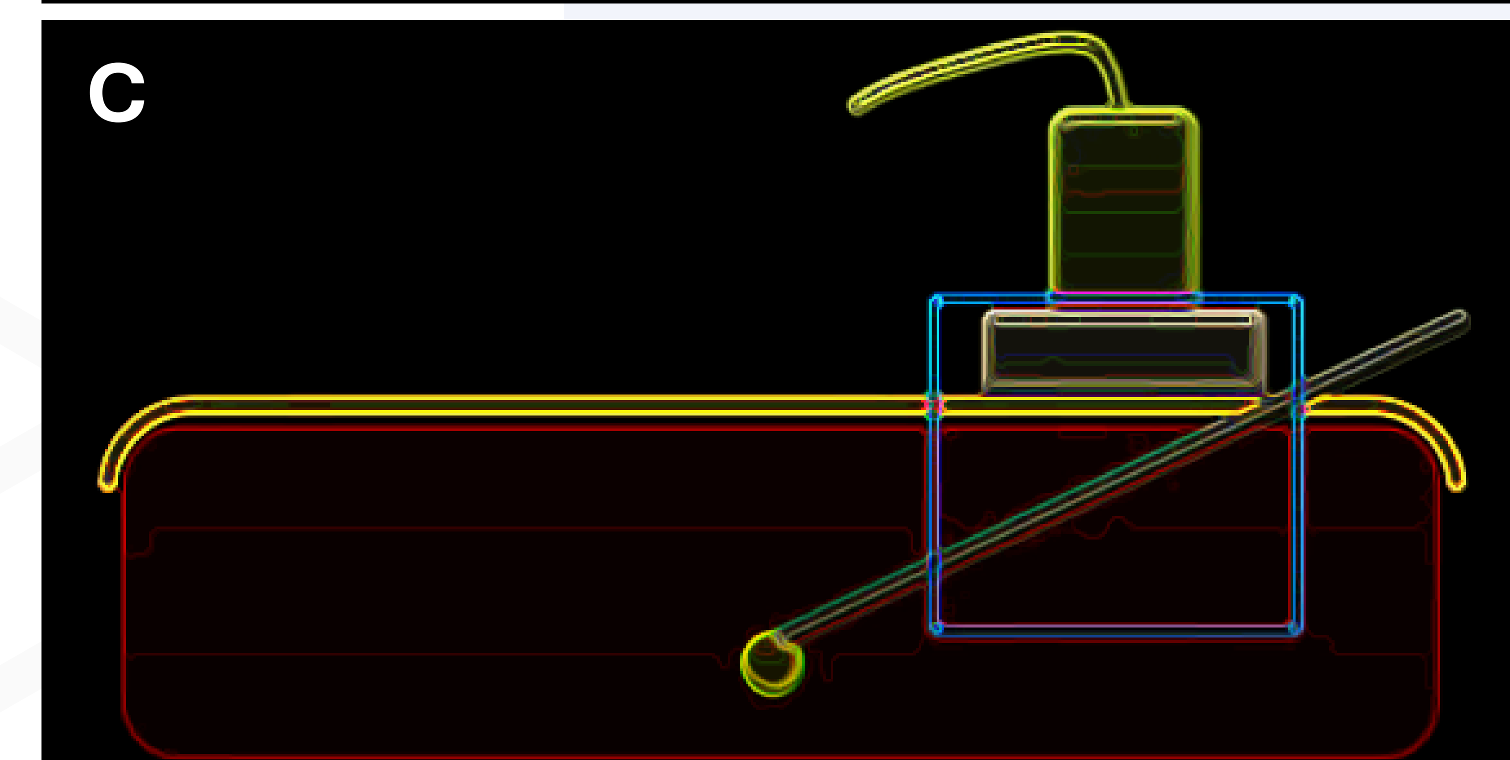
A. The needle is very tilted, the skin entry point is close to the edge of the probe, there is greater dispersion of the echoes and therefore the quality of the needle's visibility is reduced.



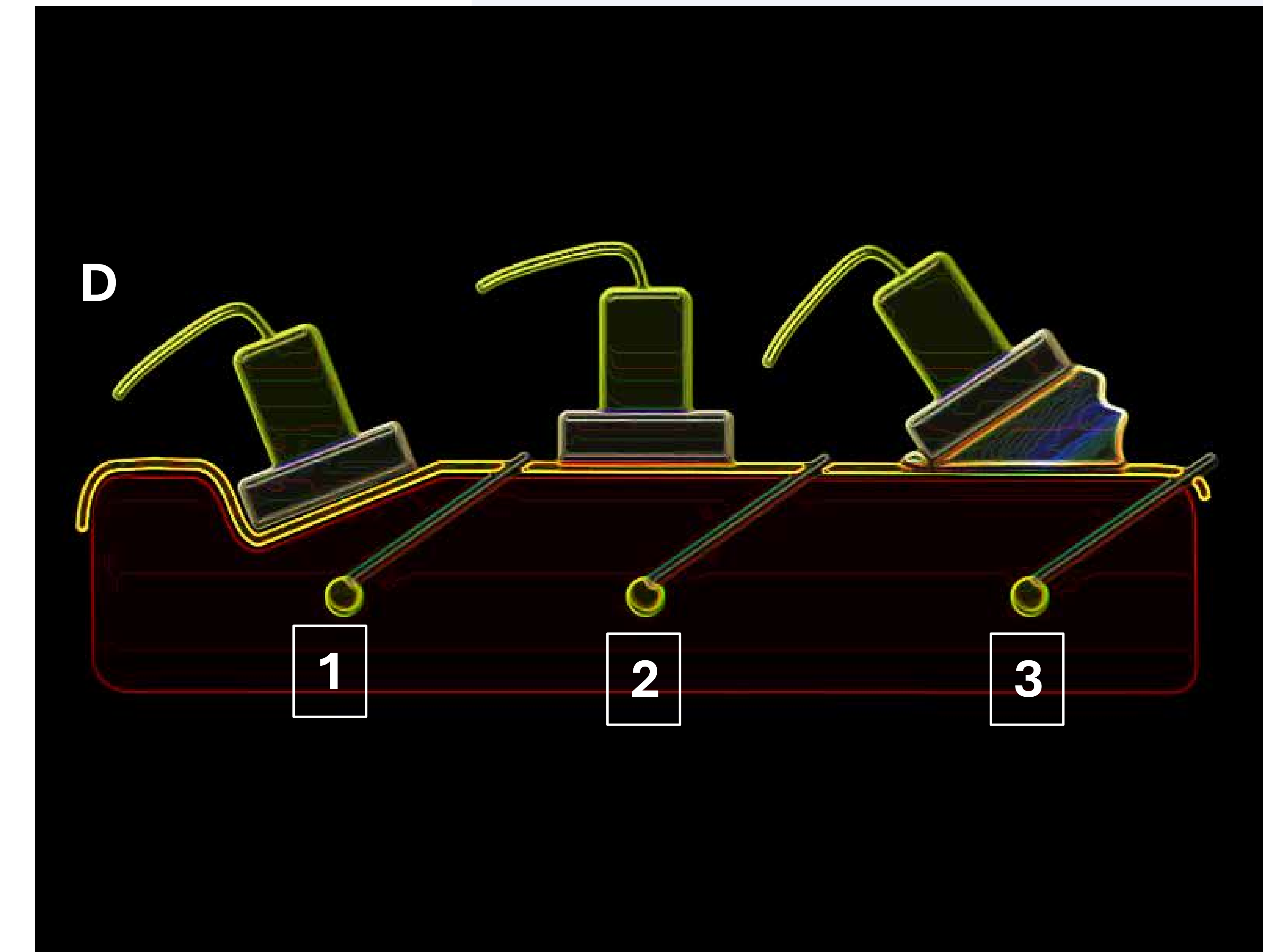
B. The needle angle is optimal, the skin entry point is further from the edge of the probe, and the image quality and needle visibility are improved. In this case, however, pay attention to the position of the infiltration target, especially if it is deep, because you will need a potentially longer needle.



C. The needle has been advanced beyond the probe insertion point. In this case, we will see the hyperechoic image of the needle, but the tip will not be visible. Therefore, the procedure will not only be incorrect but also potentially risk injury to any nearby vascular or nerve structures.

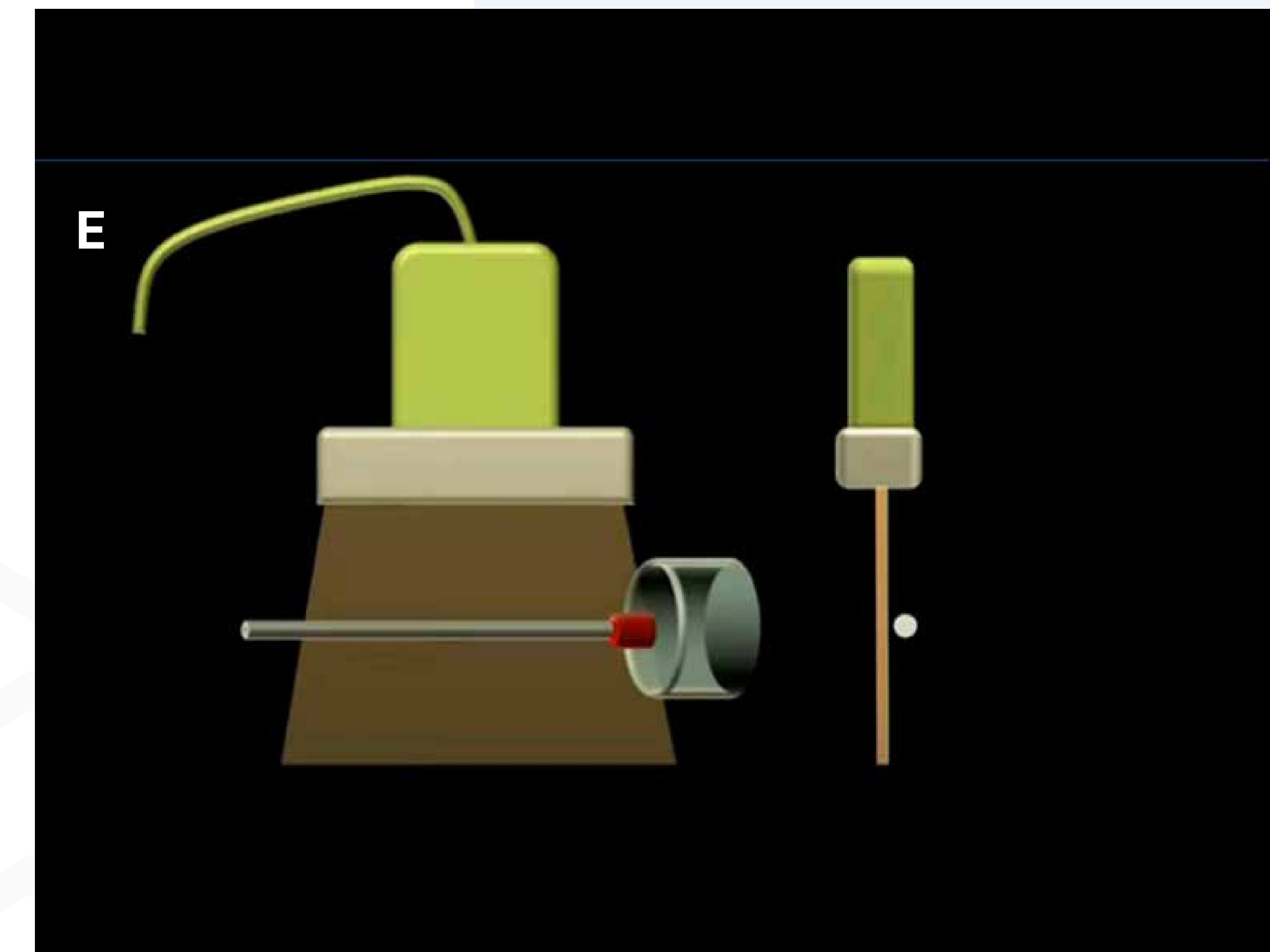


IN PLANE TECHNIQUE



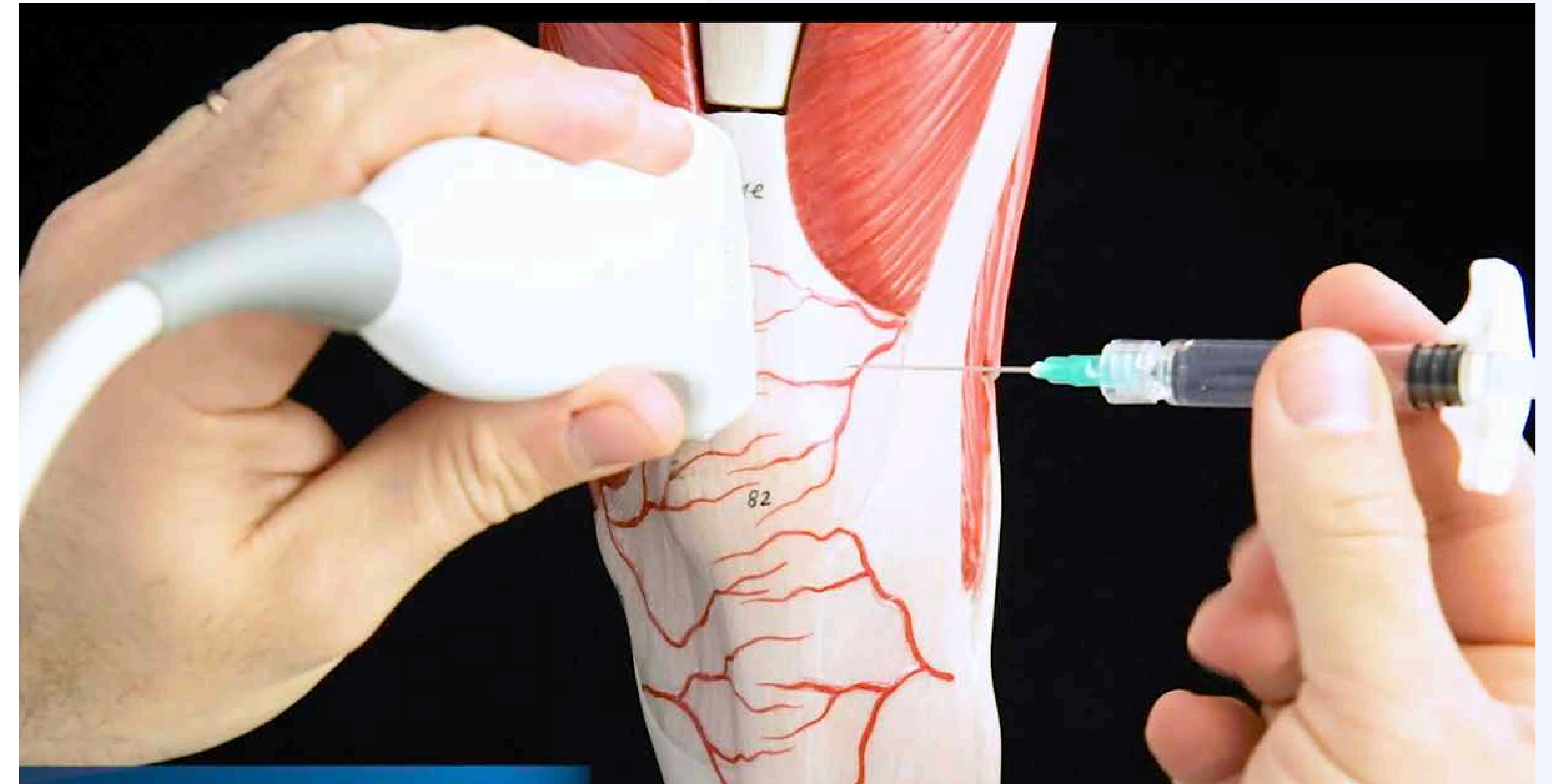
D. If the needle is at an optimal angle, more perpendicular to the ultrasound beam, the quality of the insertion and therefore of the image will improve.

To achieve this, we can:
1. Press on the skin, where possible, to achieve a more perpendicular insonation.
2. Choose a correct entry point and angle.
3. Use more gel to fill the gap between the skin and the probe.



E. The thickness of the ultrasound beam is similar to that of a credit card, therefore it is not sufficient for the needle to be
parallel to the long axis of the probe and 'covered' by it, but it must also be exactly within the ultrasound beam.

OUT OF PLANE TECHNIQUE



Description
The needle is inserted perpendicular to the transducer, appearing as a bright, hyperechoic dot in the image.

How it Works
The operator views the needle in "cross-section," seeing only the tip and shaft reflections as it moves into the plane.
The needle appears only as a small hyperechoic **dot** (cross-section) when it passes through the ultrasound beam.

Best For
Superficial targets (e.g., small joints), or when the needle path needs to be kept away from nearby nerves or vessels.

Procedure Steps
1. Center the target structure on the screen in its short axis view.
2. Insert the needle at the midpoint of the probe, a distance from the probe roughly equal to the target's depth (triangulation).
3. **"Walk-down" or "Creep" Method**: To track the tip, advance the needle until the dot appears, then slide the probe slightly forward until the dot vanishes, then advance the needle again until it reappears.

Key Advantage
Easier to learn and typically requires a shorter needle path through tissue, leading to less patient discomfort.

Key Disadvantage
Difficult to differentiate the needle tip from a segment of the needle shaft, which can lead to accidental "overshooting" and injury to deeper structures.

KNEE APPROACHES
FOR IA US GUIDED INFILTRATION

KNEE APPROACHES FOR IA US GUIDED INFILTRATION

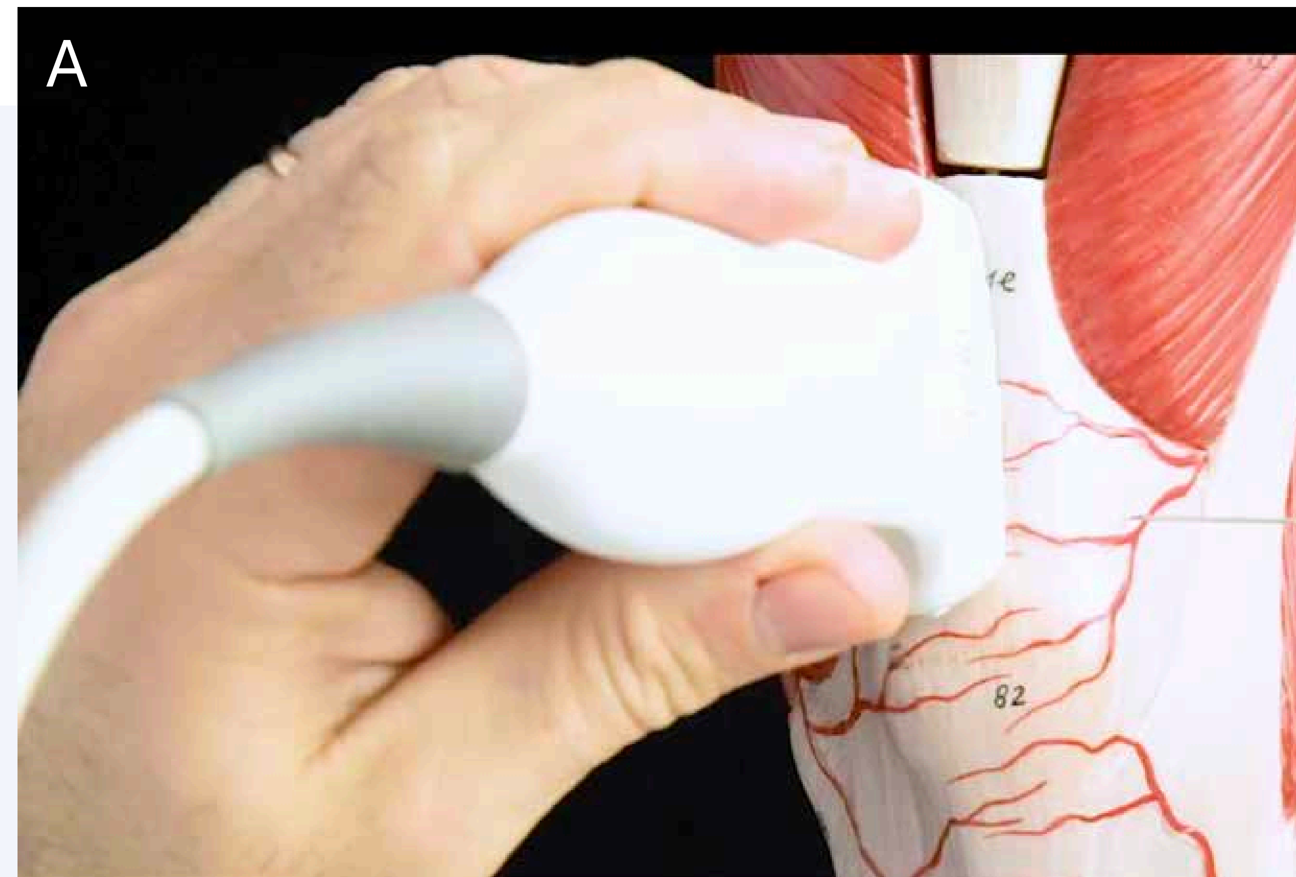
More access options for same articulation

Supero lat approach

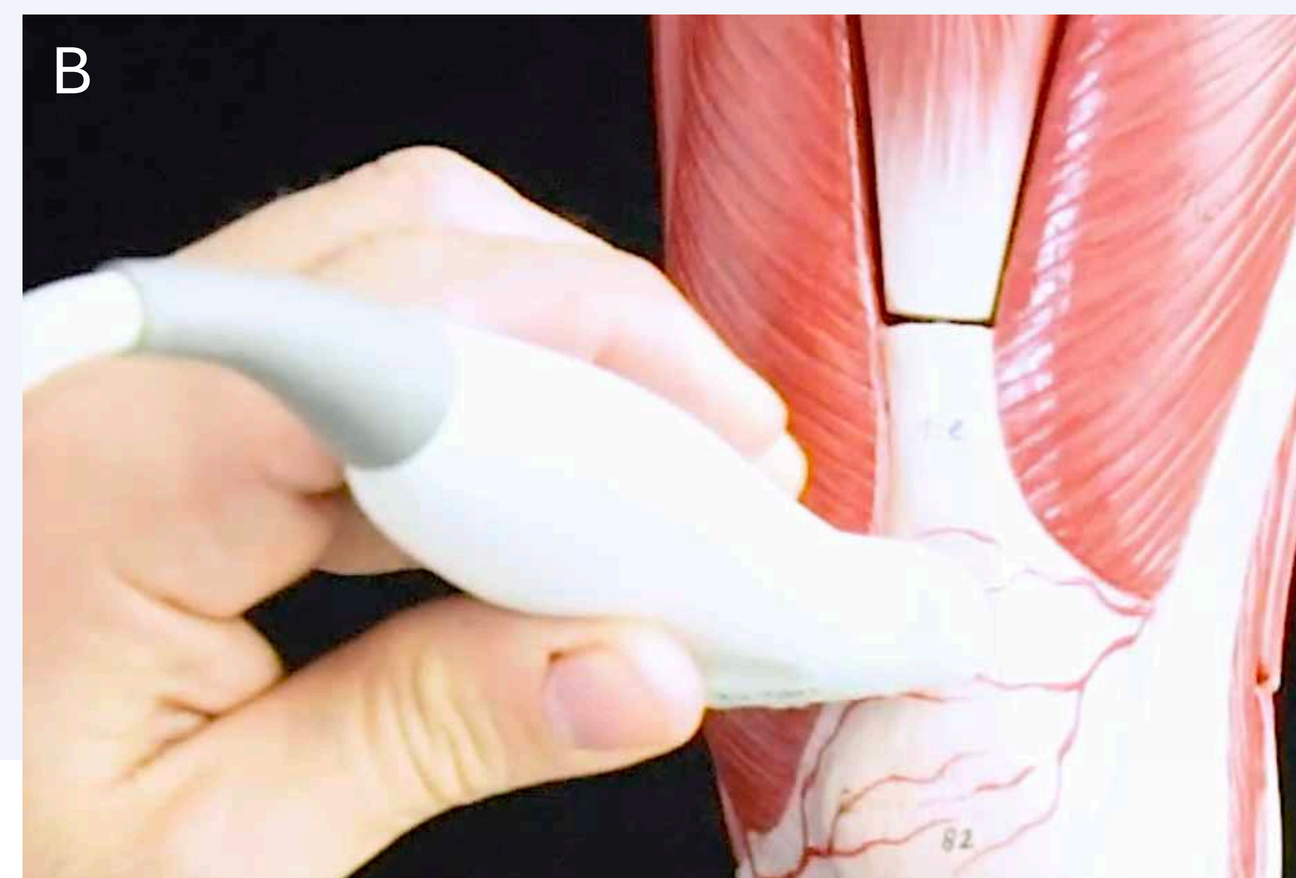
Infero medial approach

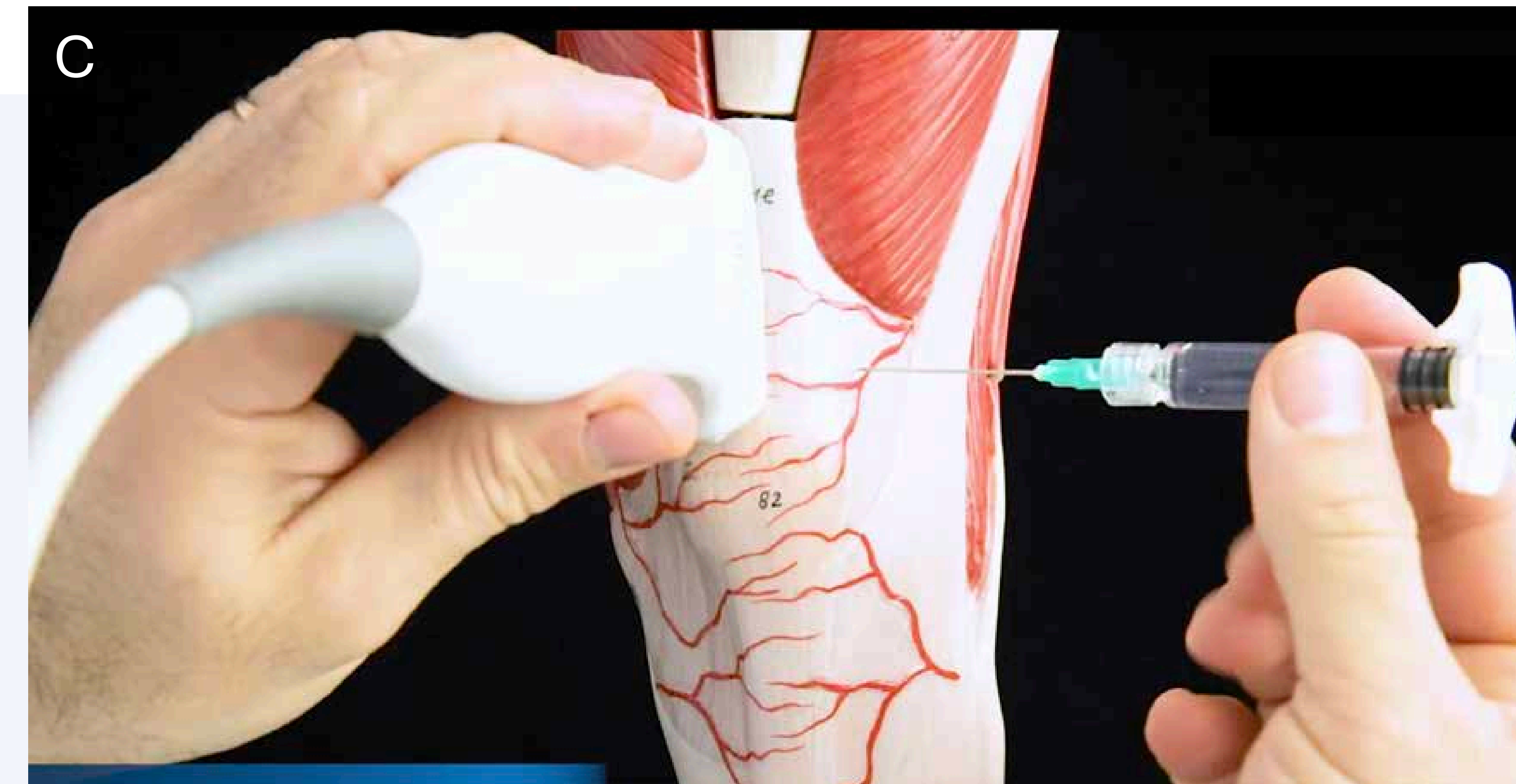
Infero lat approach

KNEE APPROACHES FOR IA US GUIDED INFILTRATION

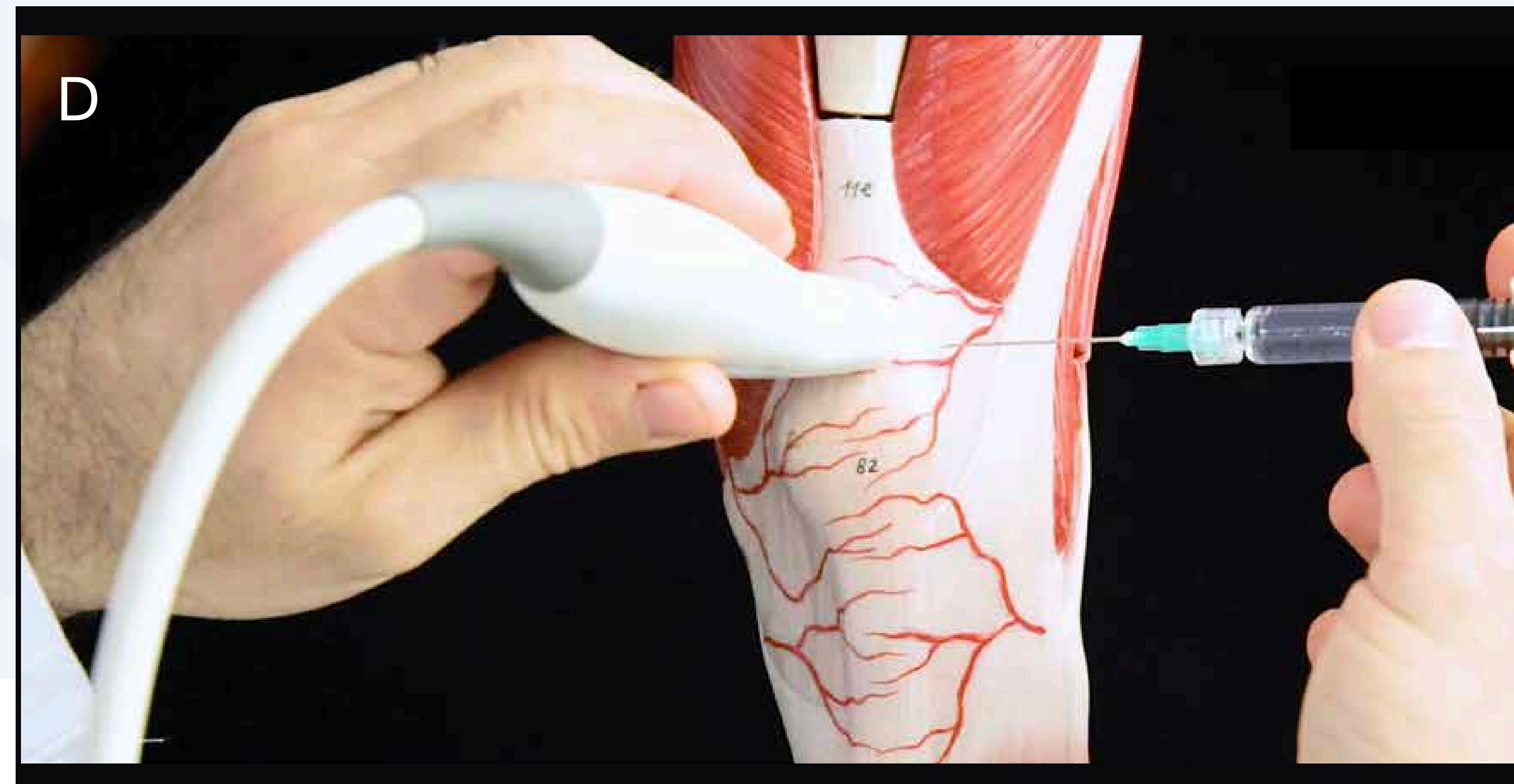


Study the suprapatellar recess
in long **(A)** and short **(B)** axis.

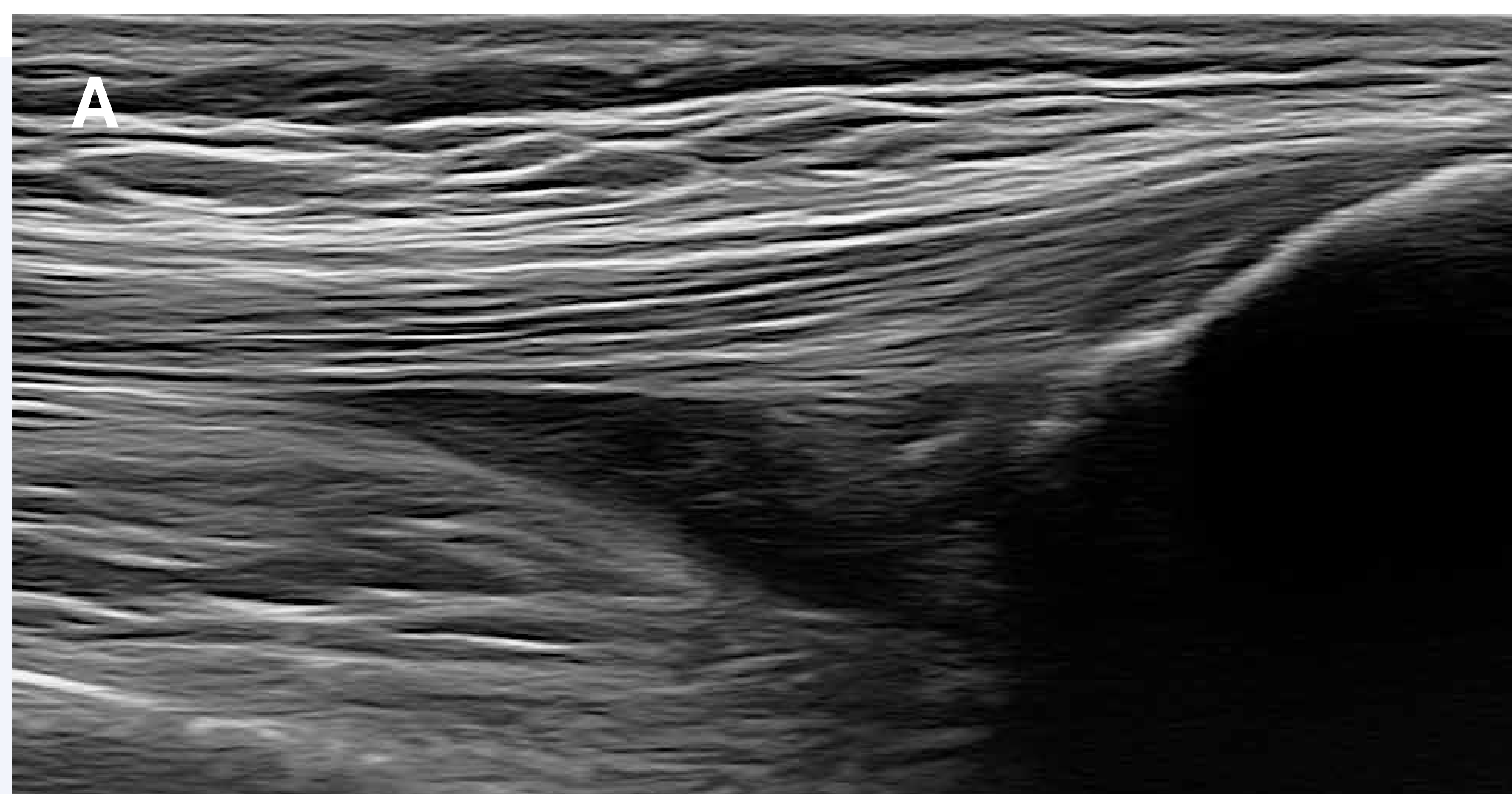




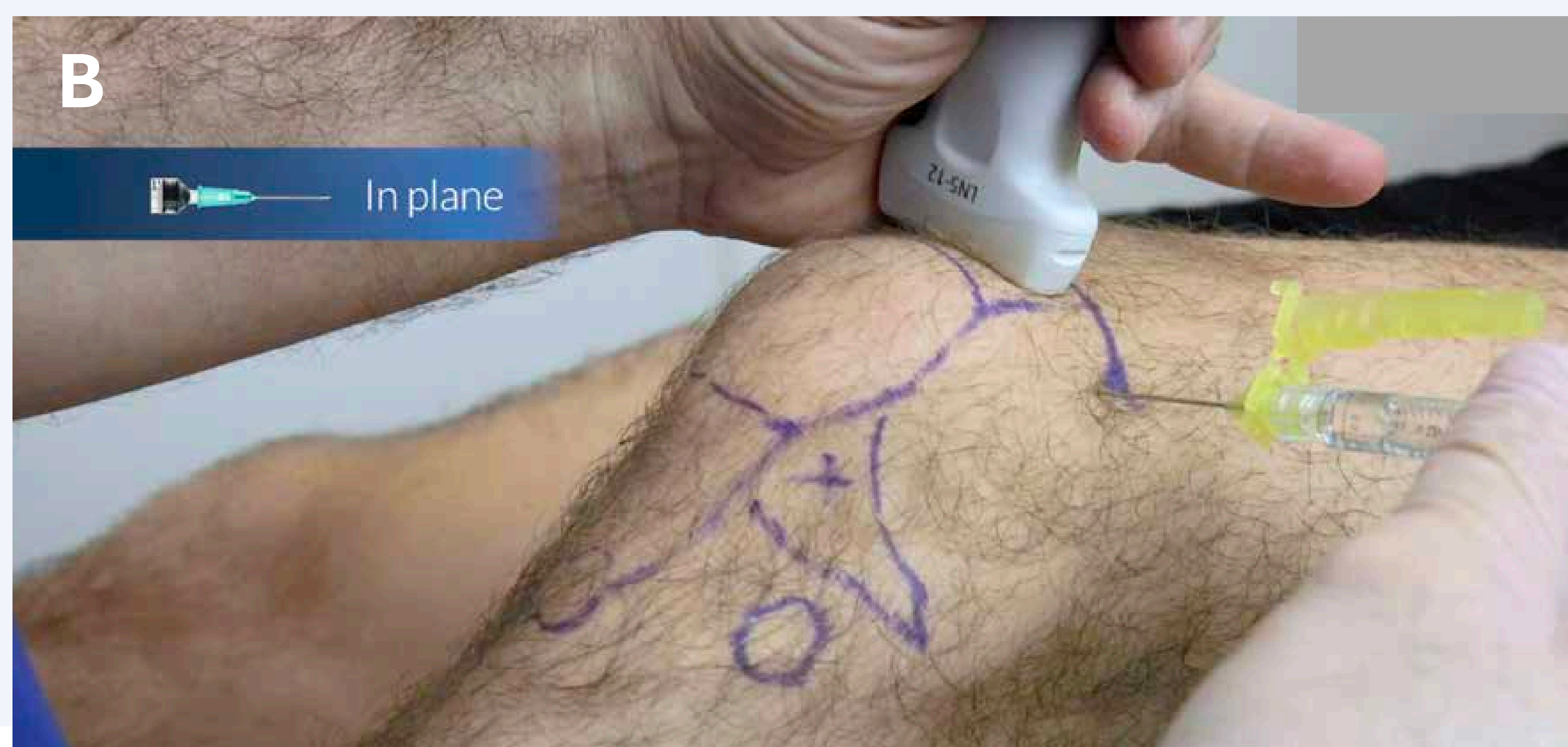
Depending on your preference, you can insert the needle
and inject in the short **(C)** or long **(D)** axis.

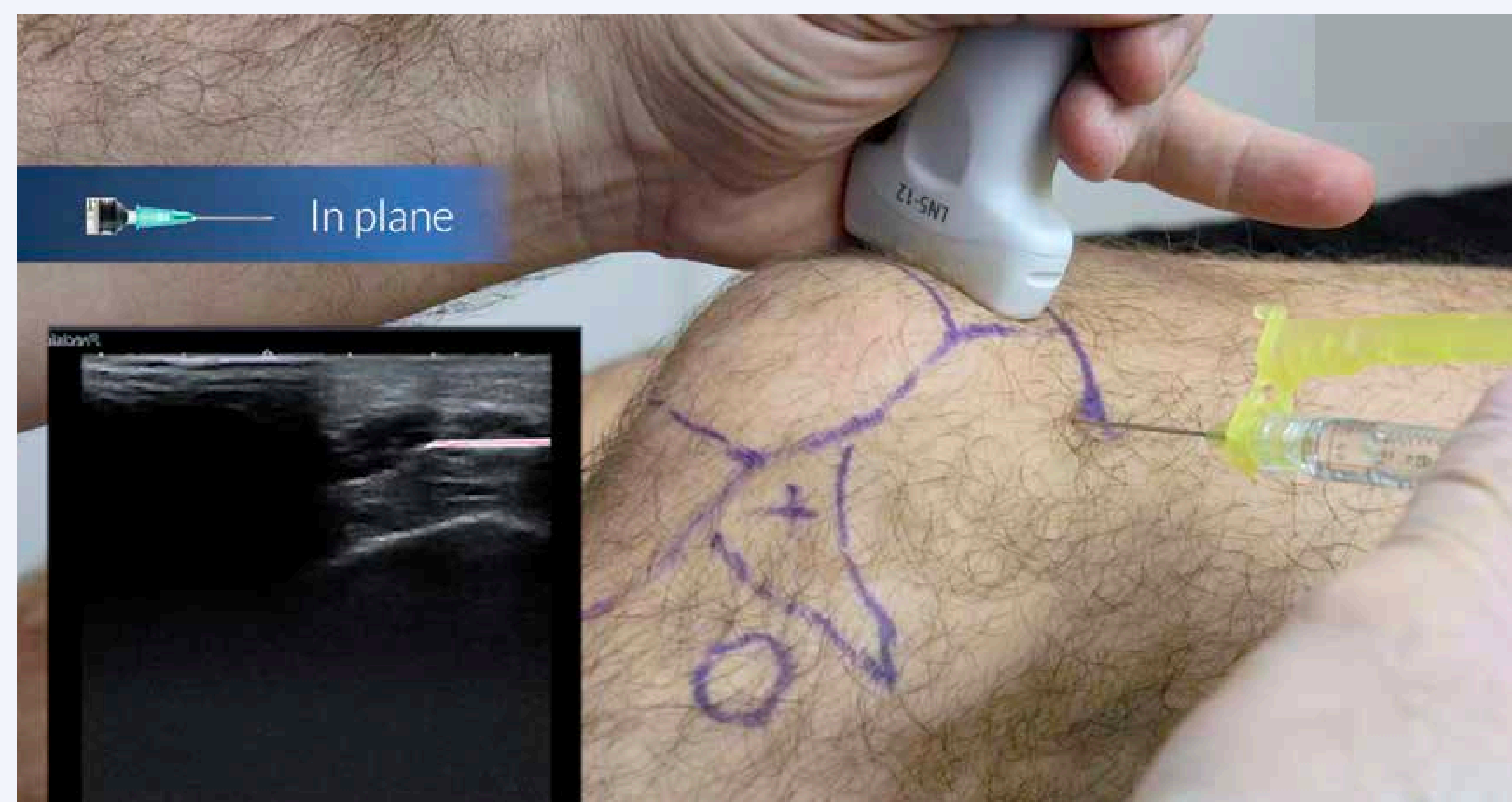


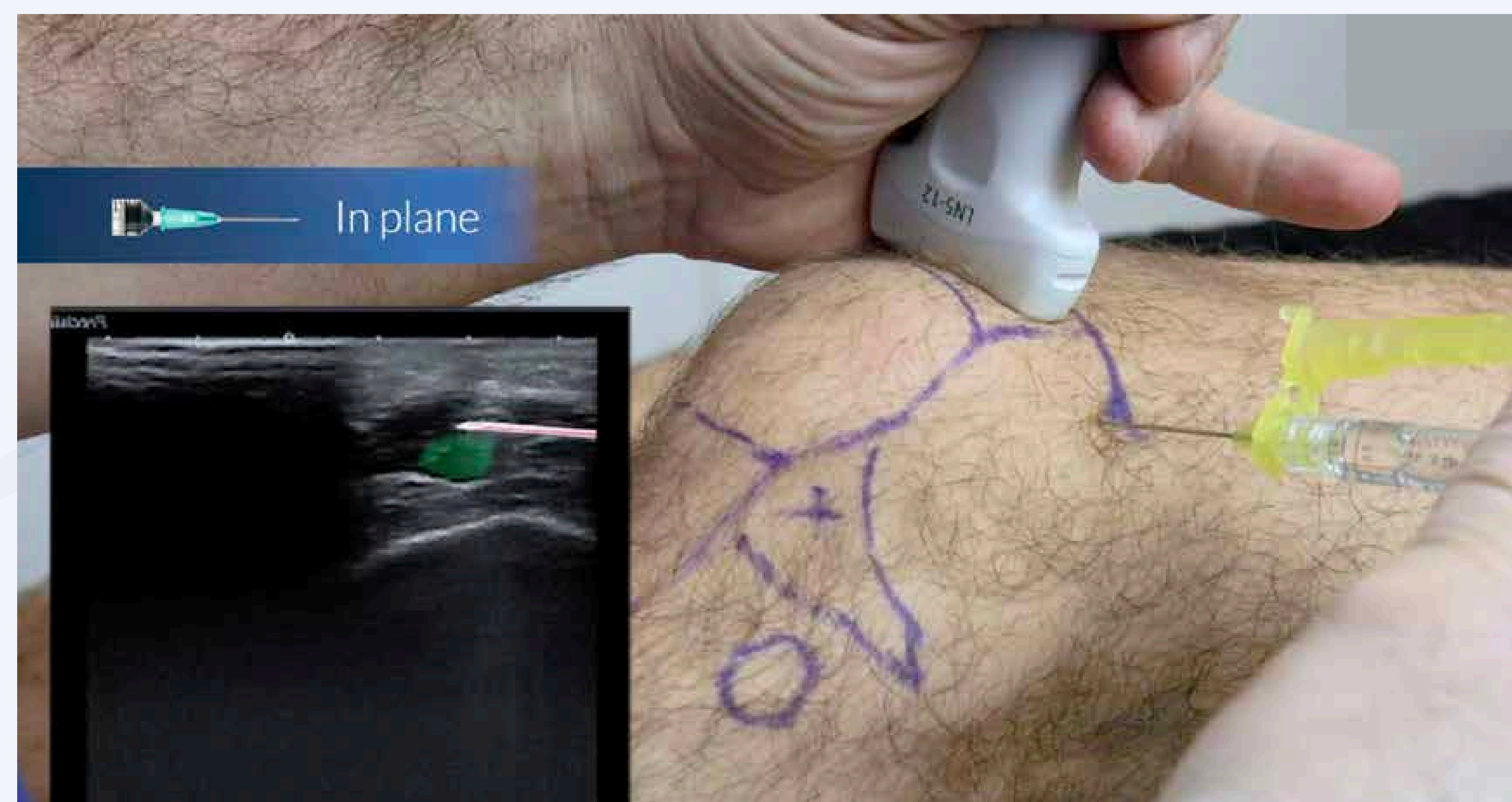
KNEE APPROACHES FOR IA US GUIDED INFILTRATION



Study the suprapatellar recess
in long **(A)** and short **(B)** axis, identifying the better
entry point of the needle.







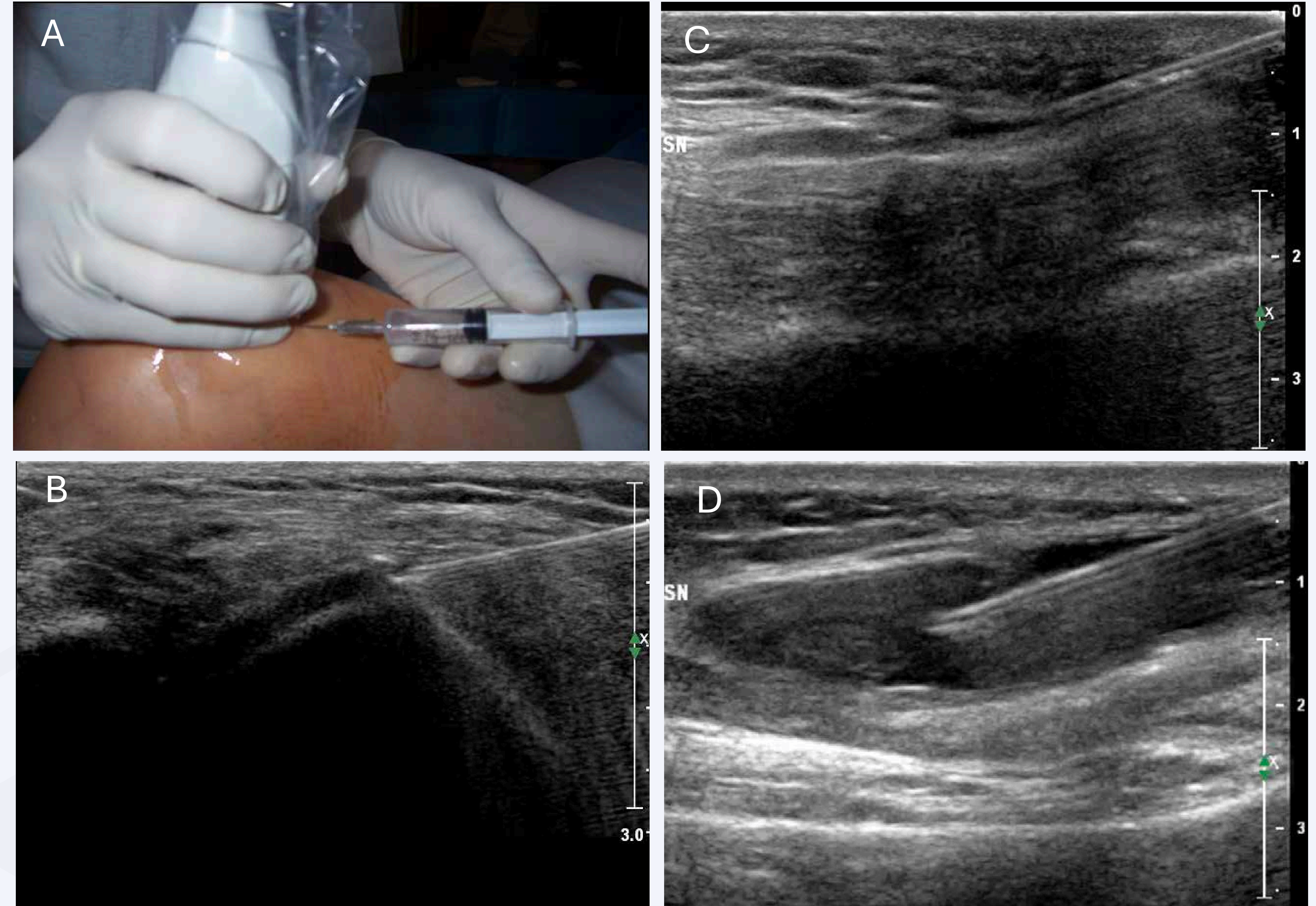
Once you have verified the depth of the recess in relation to the skin, choose an entry point for the probe that allows you to keep the needle sufficiently parallel to the probe in order to improve the quality of the imaging during the procedure.

You can use the PWD to check the flow of the liquid injected into the joint recess.

KNEE APPROACHES FOR IA US GUIDED INFILTRATION

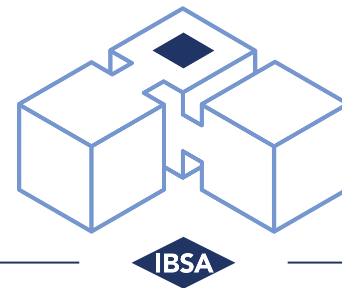
In the superolateral approach, it is also possible to choose an axis that is not orthogonal to that of the thigh, but oblique **(A)**.

The sequence of images shows the corresponding ultrasound image **(B)**, the entry of the needle **(C)**, and the dilation of the recess due to the entry of fluid into the joint **(D)**.



COMPARISON SUMMARY

Feature	In Plane (IP)	Out of Plane (OP)
Needle-to-Probe	Parallel	Perpendicular
Visibility	Entire shaft and tip	Cross-sectional “dot”
Primary Use	Nerve blocks, deep injections	Vascular access (IV/Arterial lines)
Ease of Use	Challenging to stay in beam	Easier to find target center
Main Risk	Poor alignment with target	Underestimating tip depth



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