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V CONGRESSO NAZIONALE ORTHOPEA

COORDINATORE: PAOLO PERAZZO



Ultrasound Guided Interventional Procedures in Pain Management (knee – shoulder – hip)

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INTRODUCTIONS

The application of ultrasonography in pain medicine (USPM) is rapidly growing in the field of interventional pain management. Traditionally, spine interventional procedures for pain management have been performed with imaging guidance such as fluoroscopy and, rarely, computed tomography (CT) scan or magnetic resonance imaging. Over the last few years, there has been an overwhelming interest in USPM as evidenced by the multitude of published reports; however, most of these publications are feasibility studies, case reports, or technical reports, with only 1 randomized controlled trial (RCT). It is therefore challenging to discuss evidence-based medicine for ultrasound (US) guided pain procedures in comparison to those in regional anesthesia. Because ultrasonography allows direct real-time visualization of various soft-tissue structures, it quickly became an established technique in peripheral nerve blocks in regional anesthesia when most of the conventional techniques are landmark based or “blind”.



INTRODUCTIONS - 2

Ultrasonography in interventional pain management is still

a new field in evolution.

The existing evidence will be classified into the 2 main areas of interest: US-guided cervical and lumbar spine injections.

We excluded peripheral applications (intercostal nerve block, suprascapular nerve block,...) because the available literature contains only proof-of-concept or feasibility studies.



INTRODUCTIONS - 3

- ❖ Ultrasound-Guided Lumbar Spine Injections
- ❖ Cervical Spine Injections

Ultrasound is a valuable tool for imaging soft-tissue structures and bony surfaces, guiding needle advancement and confirming the spread of injectate around the target, without exposing health care providers and patients to the risks of radiation.



TABLE 1. Summary of the Evidence for Ultrasound in Lumbar Spine Injections

Study (Year)	No. Subjects	Study Design	Comparative Technique	Outcome
Shim et al ⁶ (2006)	20 Patients (101 injections)	Nonrandomized crossover trial	Fluoroscopy	95% Success
Galiano et al ⁸ (2007)	40 Patients, 20 in each group	RCT	CT scan	85% (17/20) Success

TABLE 2. Summary of the Evidence for Ultrasound in Cervical Spine Injections

Study/Year	Block Type	No. Subjects	Study Design	Comparative Technique	Outcome
Eichenberger et al ¹² (2006)	Third occipital block	14 Volunteers/ 28 injections	Prospective observational cohort trial	Fluoroscopy	82% Success
Narouze et al ¹¹ (2009)	Cervical nerve root	10 Patients	Prospective observational cohort trial	Fluoroscopy	100% Success
Kapral et al ¹⁴ (1995)	Stellate ganglion block	12 Patients	Nonrandomized crossover trial	N/A	100% Success
Gofeld et al ¹⁸ (2009)	Stellate ganglion block	7 Patients	Observational study	Fluoroscopy	100% Success



KNEE

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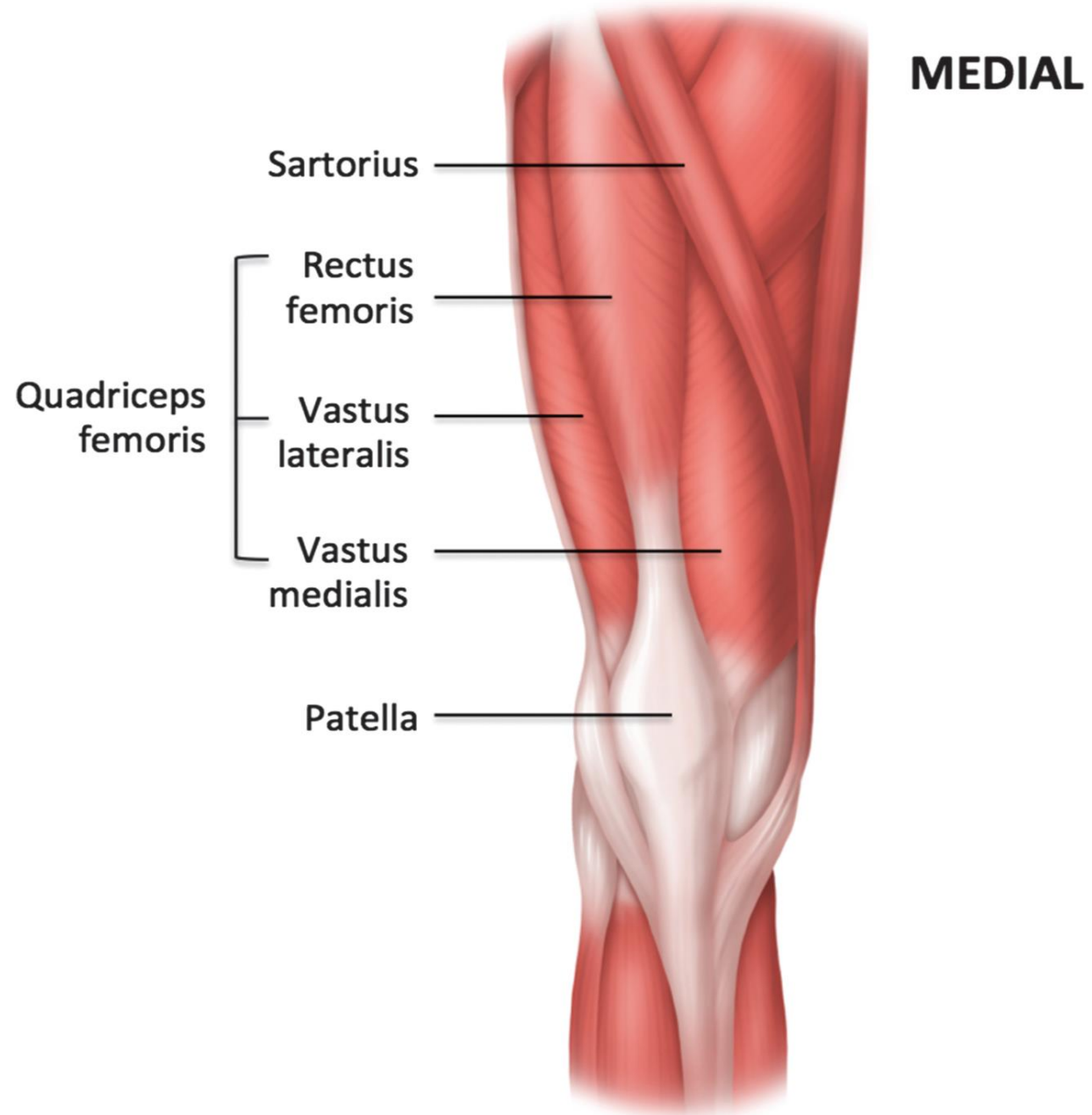


FIGURE 1. Anterior view of the thigh and knee. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

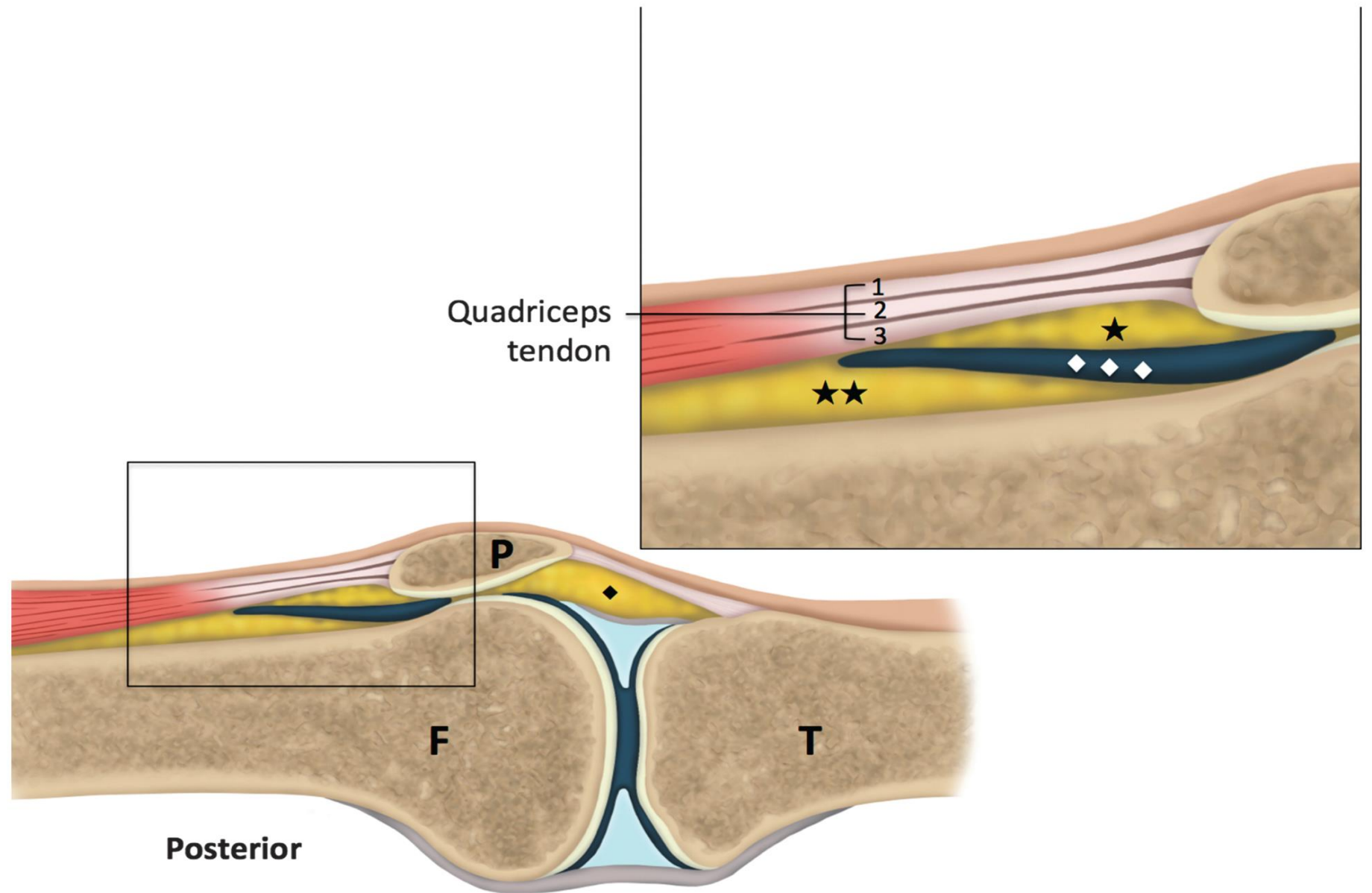


FIGURE 2. Lateral view of the knee showed the details of the trilaminar nature of the quadriceps tendon. The insert on the right upper corner was the expanded view of the rectangle over the quadriceps tendon. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.


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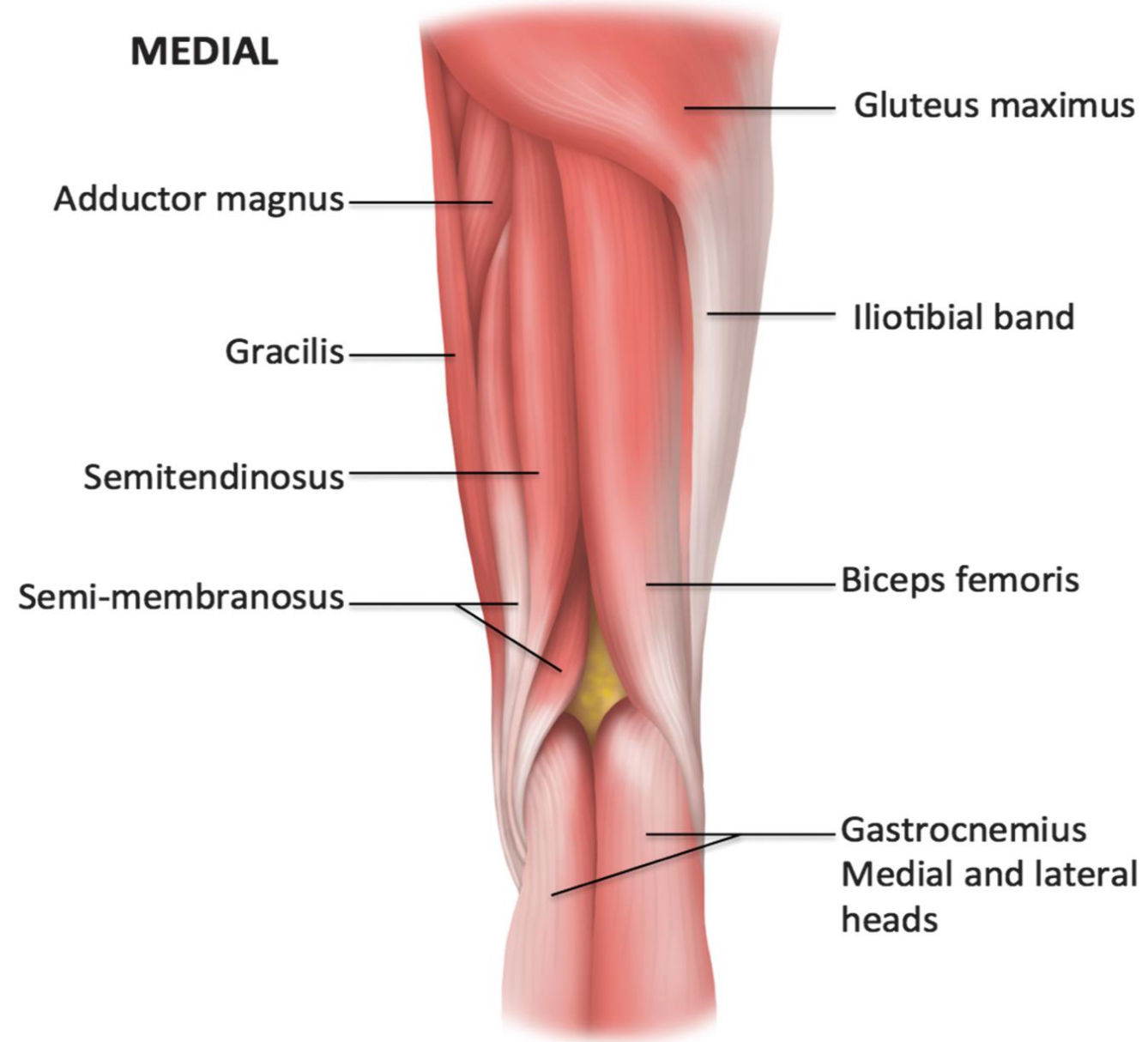
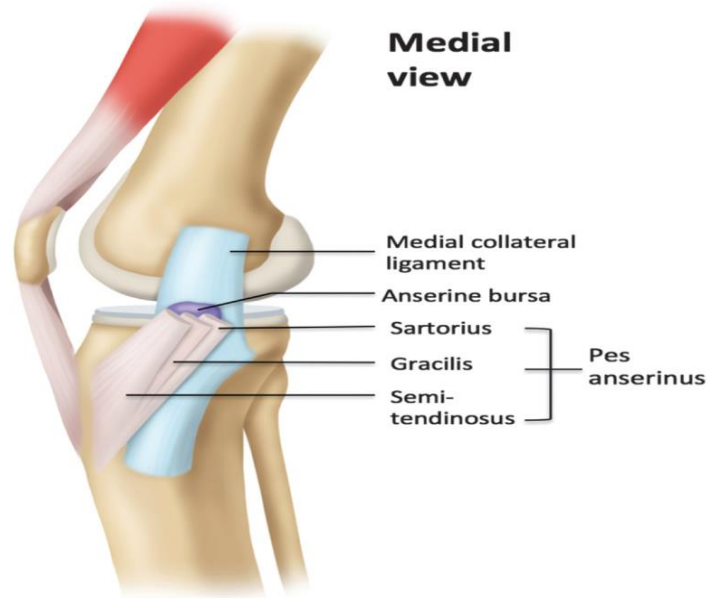
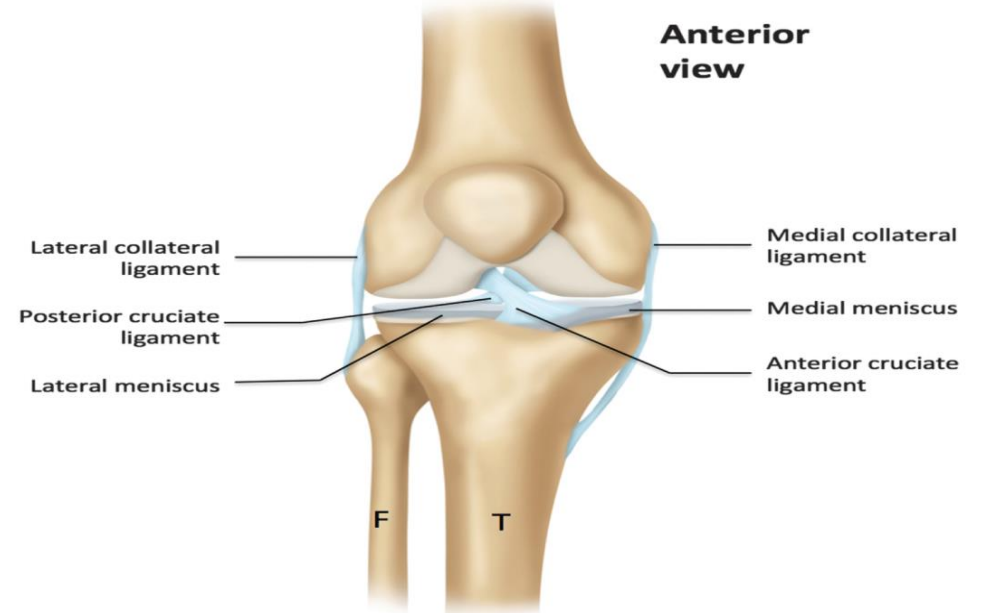


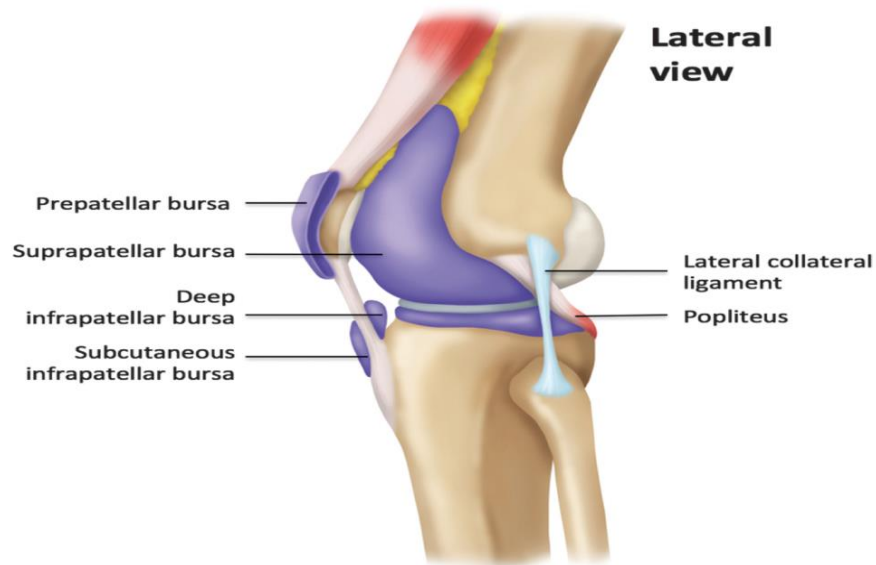
FIGURE 3. Posterior view of the thigh and knee showed the flexors of the knee. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.



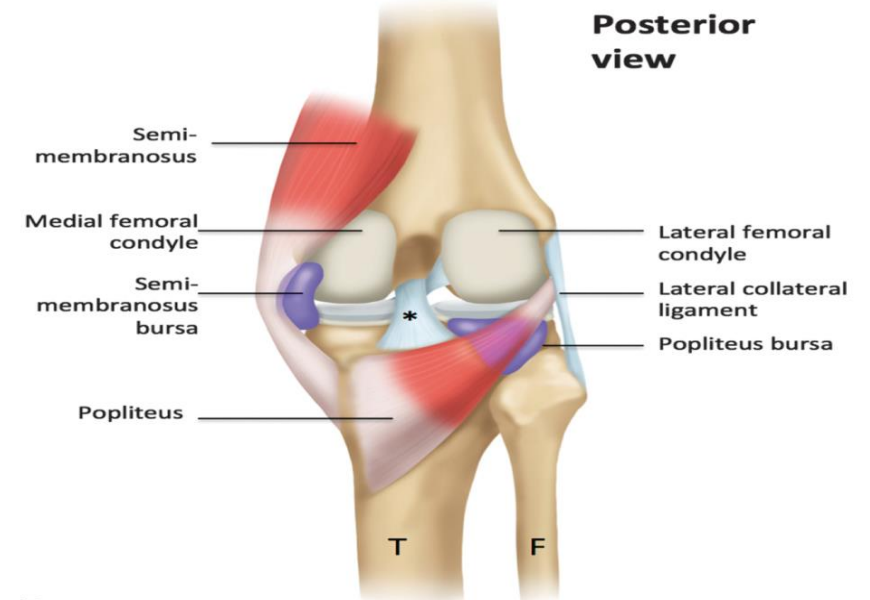
A



B



C



D

FIGURE 4. Four views of the knee showed the ligaments and bursae. A, Medial view. B, Anterior view. C, Lateral view. D, Posterior view. In the posterior view, the medial head of gastrocnemius was removed to reveal the IA structures. F indicates fibula; T, tibia. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.


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TABLE 1. Bursae of the Knee

Bursa		Location Between
Anserine	Pes anserinus	Tibia and medial collateral ligament
Subcutaneous prepatellar	Skin	Anterior surface of patella
Suprapatellar	Quadriceps tendon	Femur
Subcutaneous infrapatellar	Skin	Tibial tuberosity
Deep infrapatellar	Patella tendon (ligament)	Anterior surface of tibia
Semimembranosus	Semimembranosus tendon	Medial head of gastrocnemius
Popliteus	Popliteus tendon	Lateral condyle of tibia

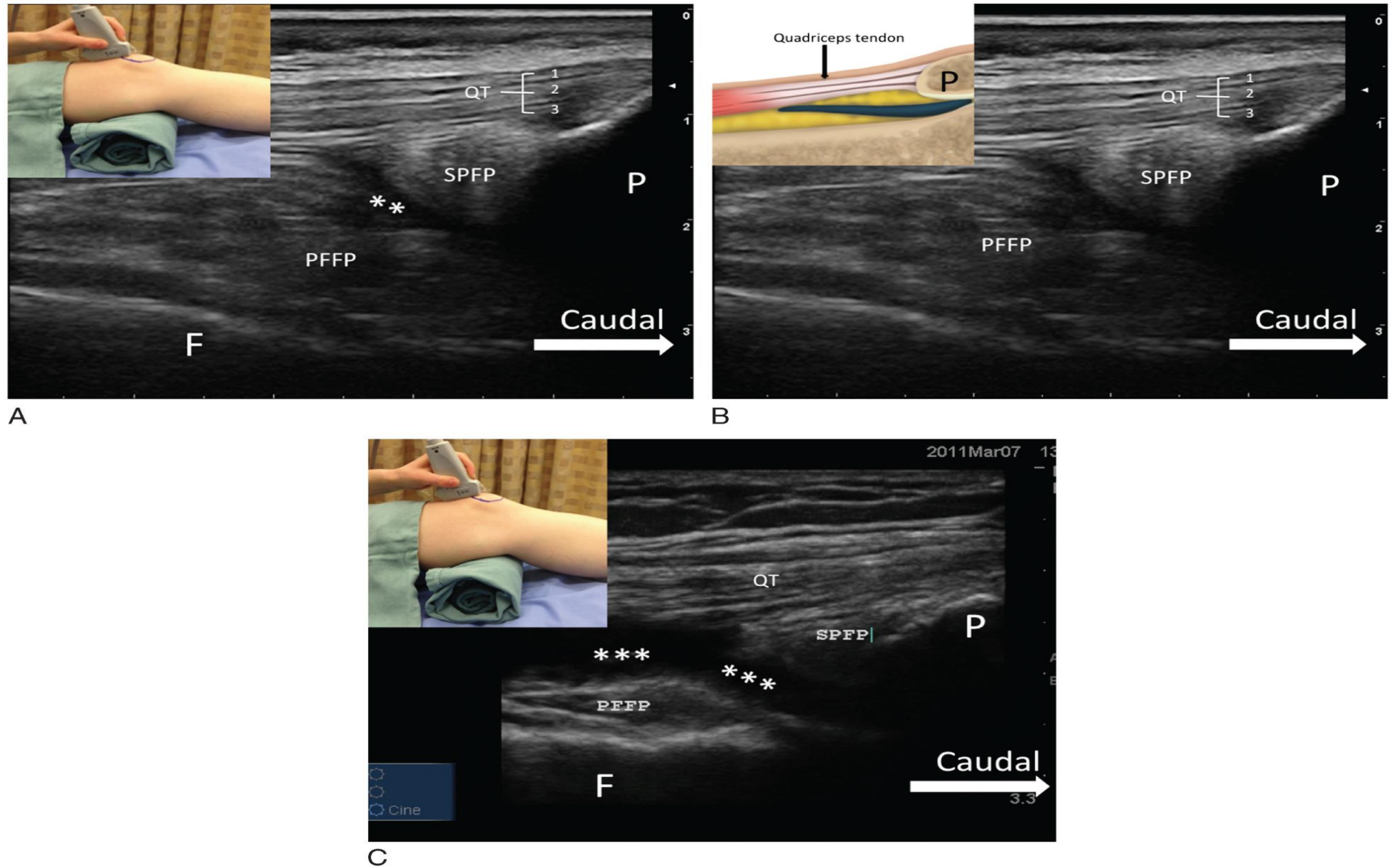


FIGURE 5. A, Sonogram of the suprapatellar view of the normal knee. The insert showed the position of the patient and the ultrasound probe. B, Sonogram of the details of quadriceps tendon. C, Sonogram of the suprapatellar view of a patient with knee effusion. Note the presence of effusion fluid filling the space between prefemoral fat pad and quadriceps tendon. SPFP indicates suprapatellar fat pad; PFFP, prefemoral fat pad; P, patella; F, femur. ** indicates the SPR. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

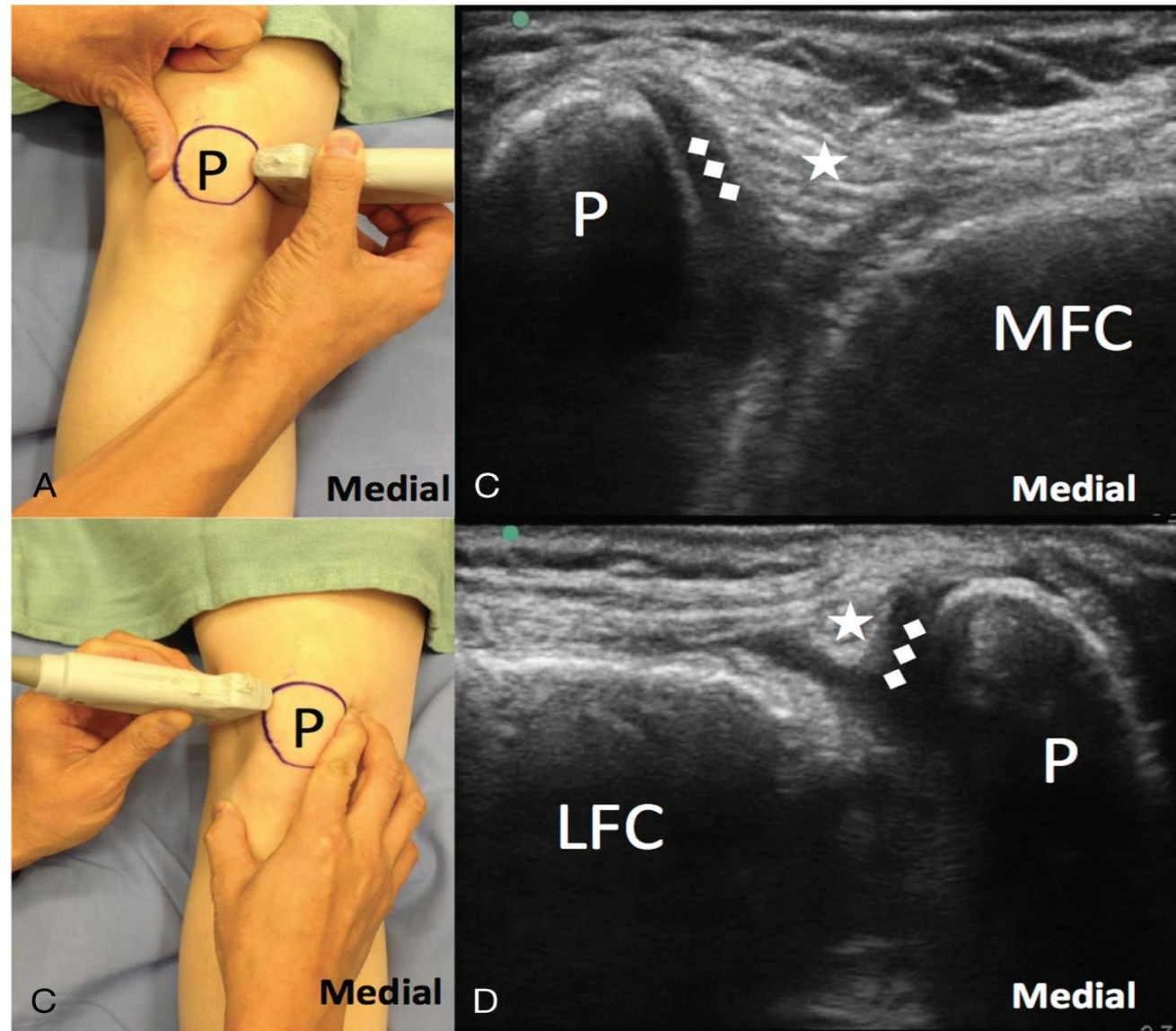


FIGURE 6. A and C, Pictures show the position of the ultrasound probes and the manipulation of the patella by the examiner. The patella was pushed to the medial and lateral sides, respectively in A and C. B and D, The respective sonograms (B and D) show the medial and lateral views, respectively. MFC indicates medial femoral condyle; LFC, lateral femoral condyle. Stars indicate the Hoffa fat pad; chain of trapezoid indicates the cartilage. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

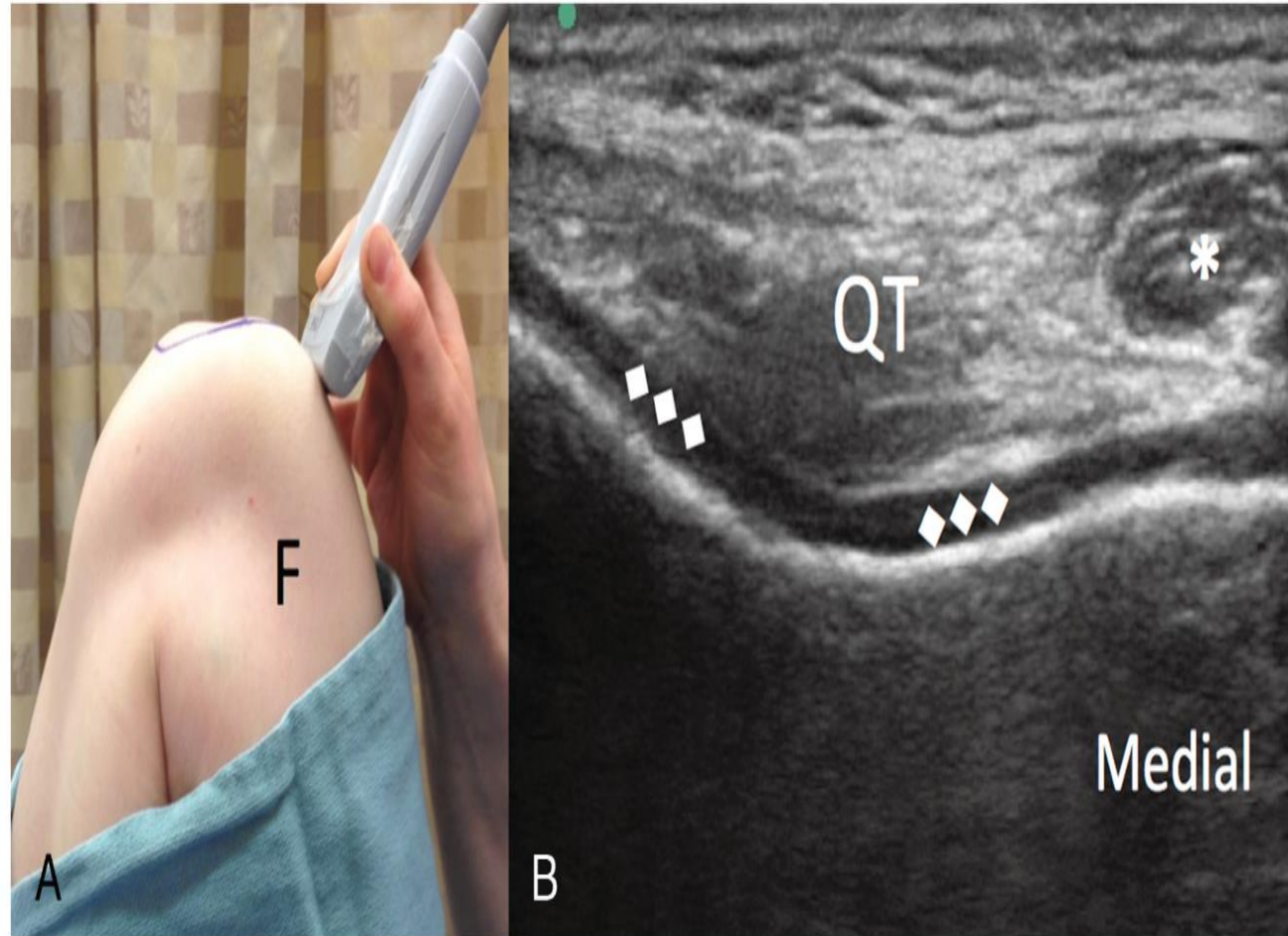


FIGURE 7. Sonogram of both femoral condyles. The picture on the left shows the position of the knee and the ultrasound probe. The hyaline cartilage was marked with trapezoids. QT indicates quadriceps tendon. *Muscle of vastus medialis. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

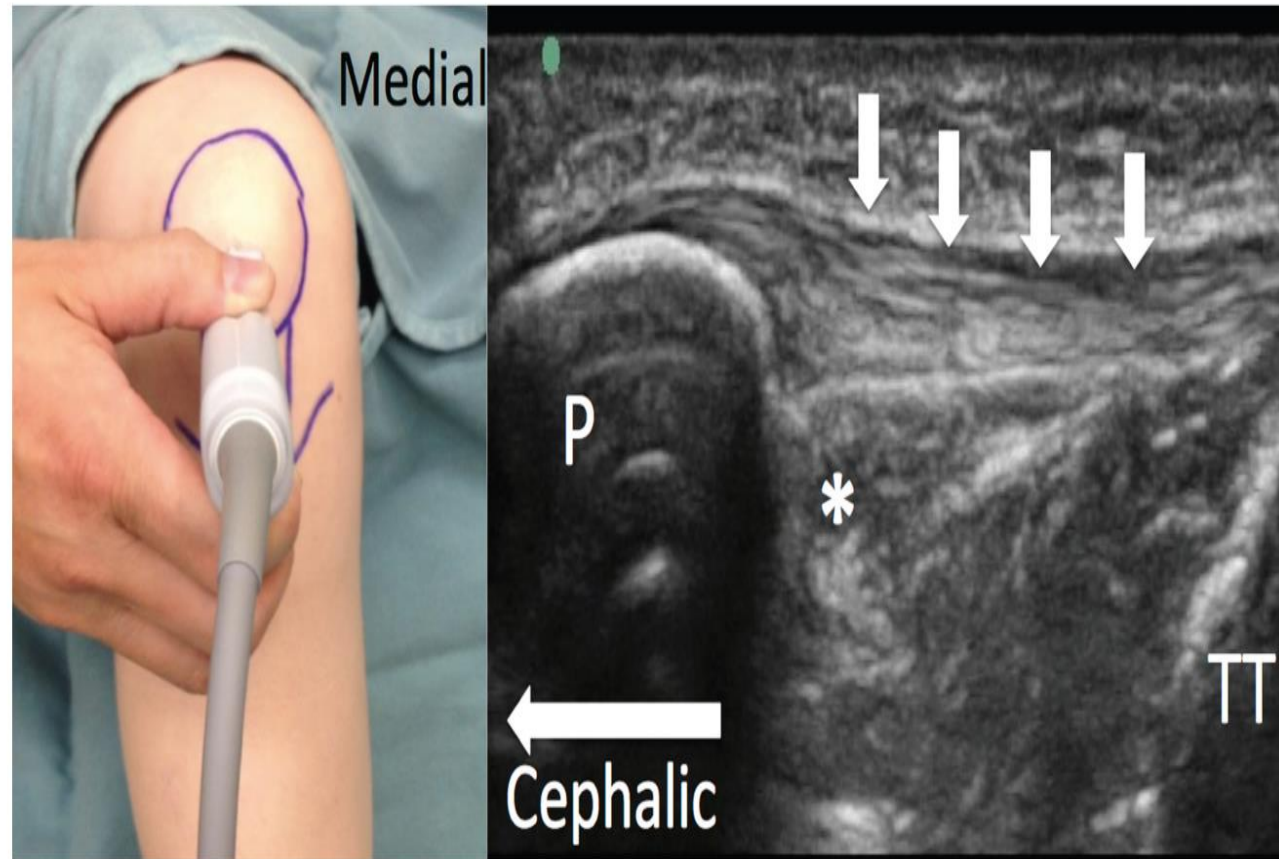


FIGURE 8. Sonogram of the infrapatellar region. The picture on the left shows the position of the ultrasound probe. The arrow indicates the patella tendon, and * indicates the Hoffa fat pad. T indicates tibia; TT, tibial tuberosity. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

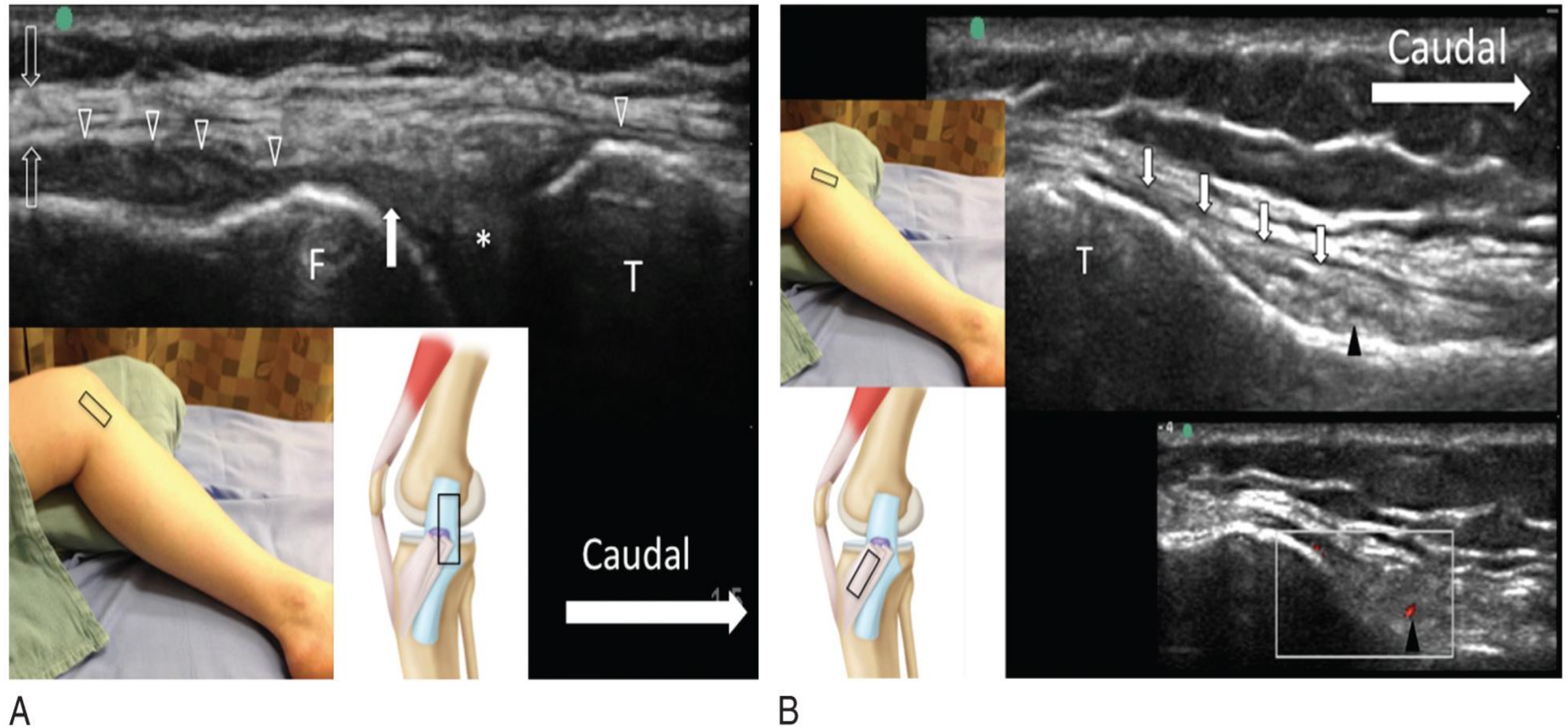
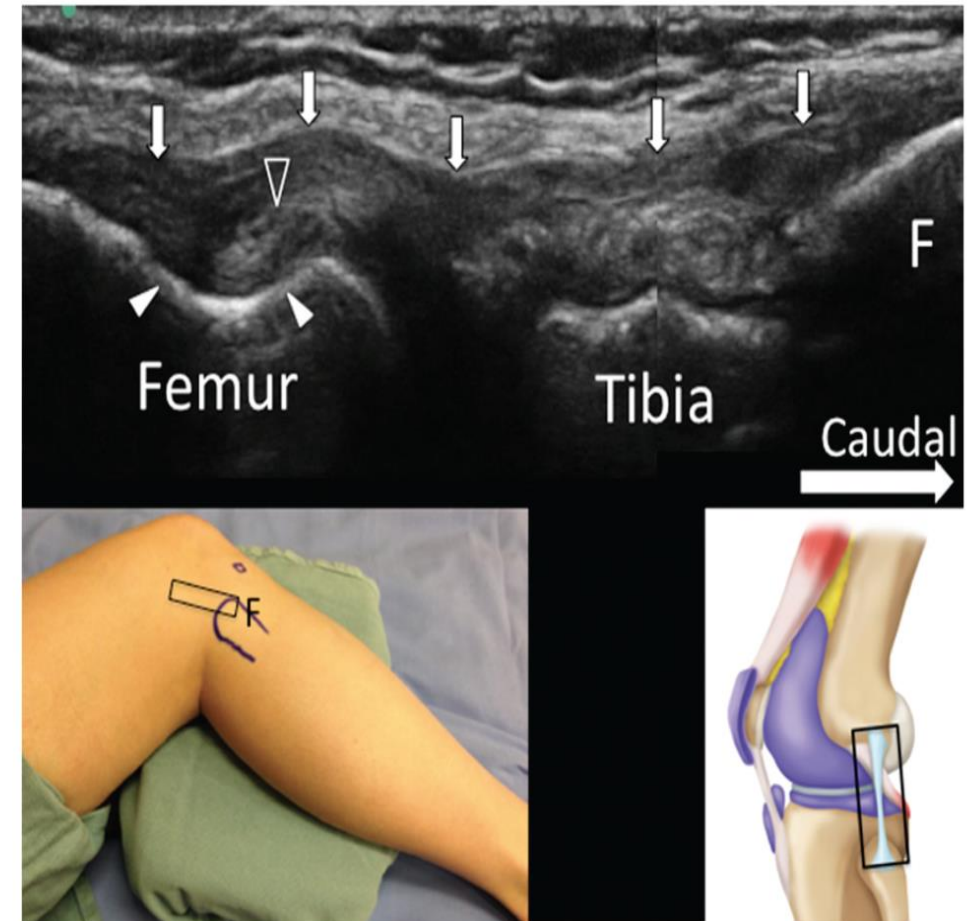
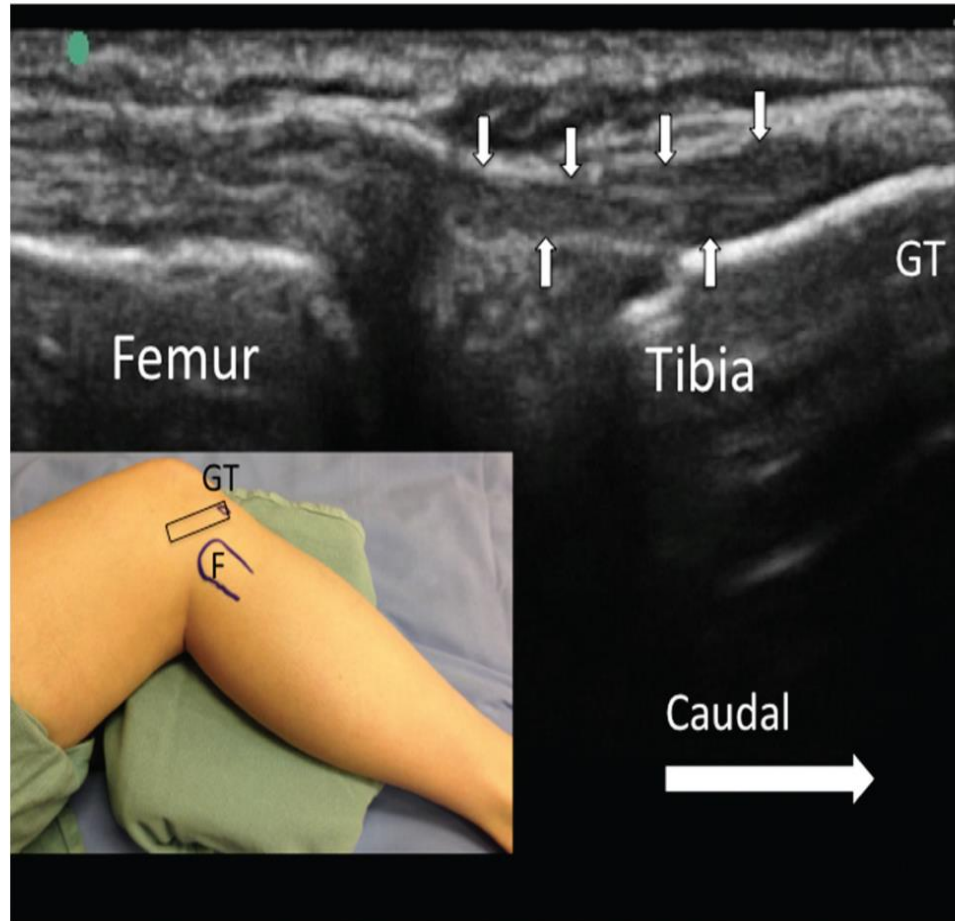


FIGURE 9. A, Sonogram of long-axis view of the medial collateral ligament. Open arrowheads indicate superficial layer of the collateral ligament, which is deep to the superficial fascia (open arrows); closed arrow, the deeper meniscofemoral ligament connecting the meniscus (*) and the femur (F). B, Sonogram of long-axis view of the pes anserinus complex inserting into the anterolateral aspect of the tibial metaphysis. At this level, the 3 tendons of sartorius, gracilis, and semitendinosus cannot be differentiated from each other. The lower diagram is the color Doppler showing the inferior medial genicular artery (dark arrowhead). The inserts show the position of the probe and patient as well as the corresponding anatomical structures in the sonogram. Note that the leg was externally rotated and rested on a small pillow. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.



A

B

FIGURE 10. A, Sonogram of the long-axis view of iliotibial band (hyperechoic structures indicated by the arrows) inserting into the Gerdy tubercle (GT). The GT and the fibula (F) were marked on the skin. B, Sonogram of the long-axis view of lateral collateral ligament (arrows) inserting into the fibular head. The popliteus tendon (open arrowhead) is seen deep to the collateral ligament at this level and inserted in the small fossa (closed arrowheads) located on the lateral aspect of the lateral femoral condyle. The insert shows the position of the probe and the position of the patient. The leg was internally rotated resting on a small pillow. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

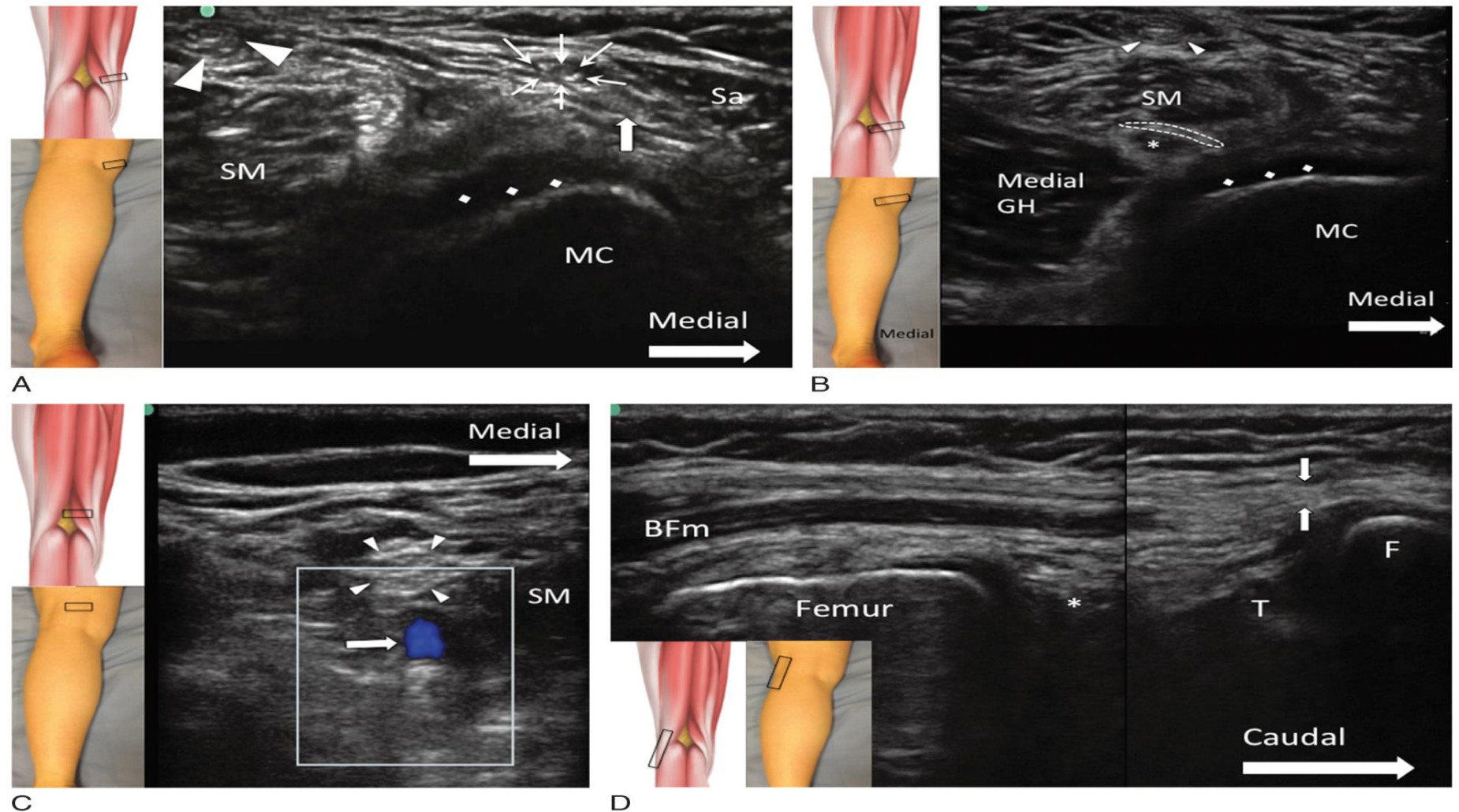


FIGURE 11. A, Sonogram showing the various muscles and tendons in the posteromedial region of the knee. Deep to the sartorius muscle (Sa), the tendon of gracilis (arrow) and saphenous nerve (line arrows) were revealed. Semitendinosus tendon (closed arrowheads) was seen as a round hyperechoic structure resting on the semimembranosus muscle (SM), similar to “a cherry on the cake.” B, By moving the ultrasound lateral to the medial femoral condyle (MC), the medial head of gastrocnemius (GH) and its tendon (asterisk) were revealed. Between the space between the medial head of gastrocnemius and semimembranosus muscle is the semimembranosus or semimembranosus-gastrocnemius bursa (outlined by dotted line), which is hypoechoic in normal state because of the apposition of synovial walls. Because of lack of fluid in normal state, one should apply very light pressure to the ultrasound probe to reveal its presence. The hyaline cartilage was indicated by white rhombi. C, Sonogram of the central portion of the posterior knee. Color Doppler shows the popliteal artery (blue structure indicated by the arrow). The sciatic nerve was also revealed posterior to the artery. D, Sonogram of the biceps femoris in the posterolateral region of the knee. The biceps muscle (BFm) continues as a tendon (arrows) inserting into the fibular head (F) as a clear hyperechoic structure. * Indicates lateral meniscus; T, tibia. The inserts in each figure show the position of the patient, the position of the probe, and the anatomical structures corresponding to the sonogram. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.


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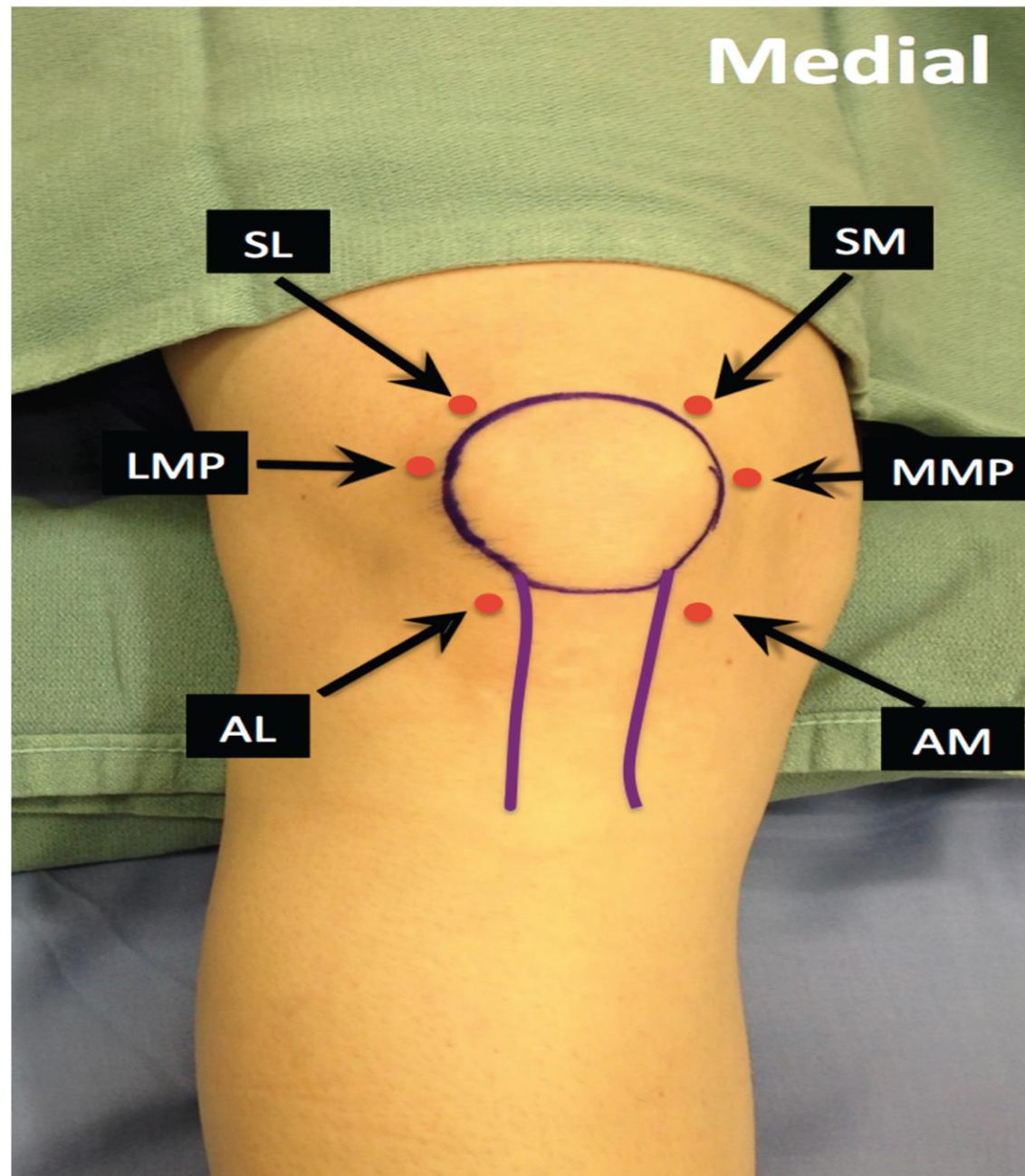


FIGURE 12. Diagram shows the various landmark-based approach. The dark dots mark the sites of needle entry; the arrows show the direction of needle entry. The knee was put in extension for SL, superomedial (SM), LMP, and MMP approaches. The AM and AL approaches are performed with knee in 90-degree flexion with or without the modification of degree of flexion as suggested by Waddell et al.¹² Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.

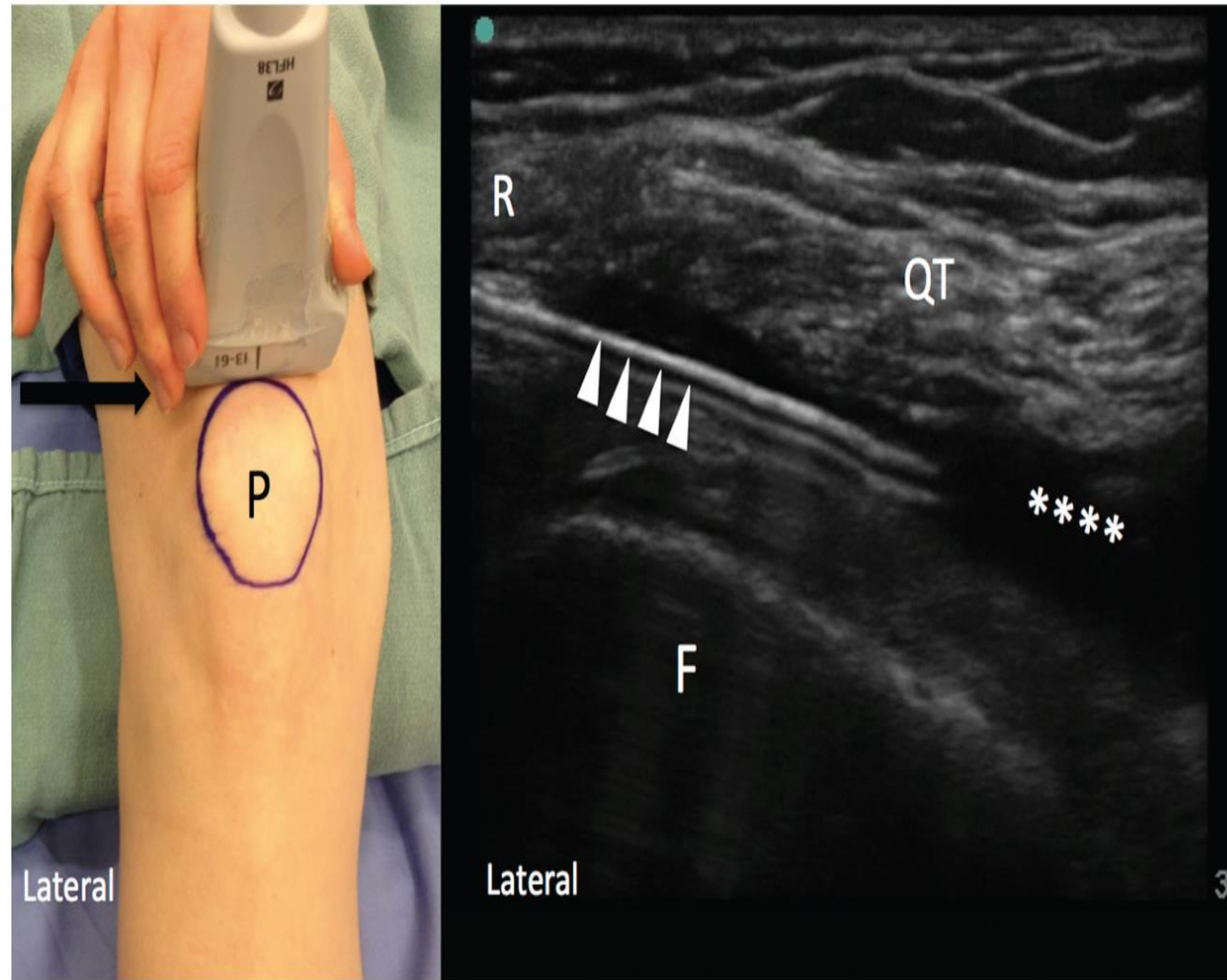


FIGURE 13. Picture shows the injection technique. The ultrasound probe is placed between the patella and quadriceps tendon initially and then turned 90 degrees upon visualization of the SPR. The needle is then approached from lateral to medial to avoid puncturing the quadriceps tendon. The needle is indicated by the arrowheads and the SPR by asterisks (****). R indicates retinaculum; Q, quadriceps tendon; F, femur. Reproduced with permission from Dr Philip Peng from Philip Peng Educational Series.



SHOULDER


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TABLE 1. Comparison Among 3 Applications of USPM

	Peripheral	Axial	MSK
Target structures	Peripheral soft tissue	Spine	Bursa/joint/tendon
Ultrasound visualization of target structures	Good to moderate	Poor to moderate	Good to moderate
Conventional or existing technique for injection	Mostly blind	Image guided	Mostly blind
Level of difficulty*	I–II	II–III	I

*The level of difficulty was based on a meeting and survey of the founding members of USPM Special Interest Group (SIG) in Innsbruck, May 2009. The level of difficulty was appraised based on 4 criteria and was classified into level I (basic), level II (intermediate), and level III (advanced).

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TABLE 2. Comparison of the 3 Common Imaging Modalities for Pain Management Intervention

	Fluoroscopy	CT Scan	Ultrasound
Soft tissue visualization	None to poor	Excellent	Good
Radiation risk	+ - + + *	++	-
Cost †	+++ - + + + +	+++++	++ - + + +
Portability	+	-	++ - + + +
Infrastructure	++	+++++	-
Real-time guidance	+	-	+
Bone imaging	Excellent	Excellent	Poor-good
Deep structures imaging	Reliable	Reliable	Unreliable

*The amount of radiation increases with the use of real-time and digital subtraction angiography.

†The cost is variable depending on the models and the institution pricing.

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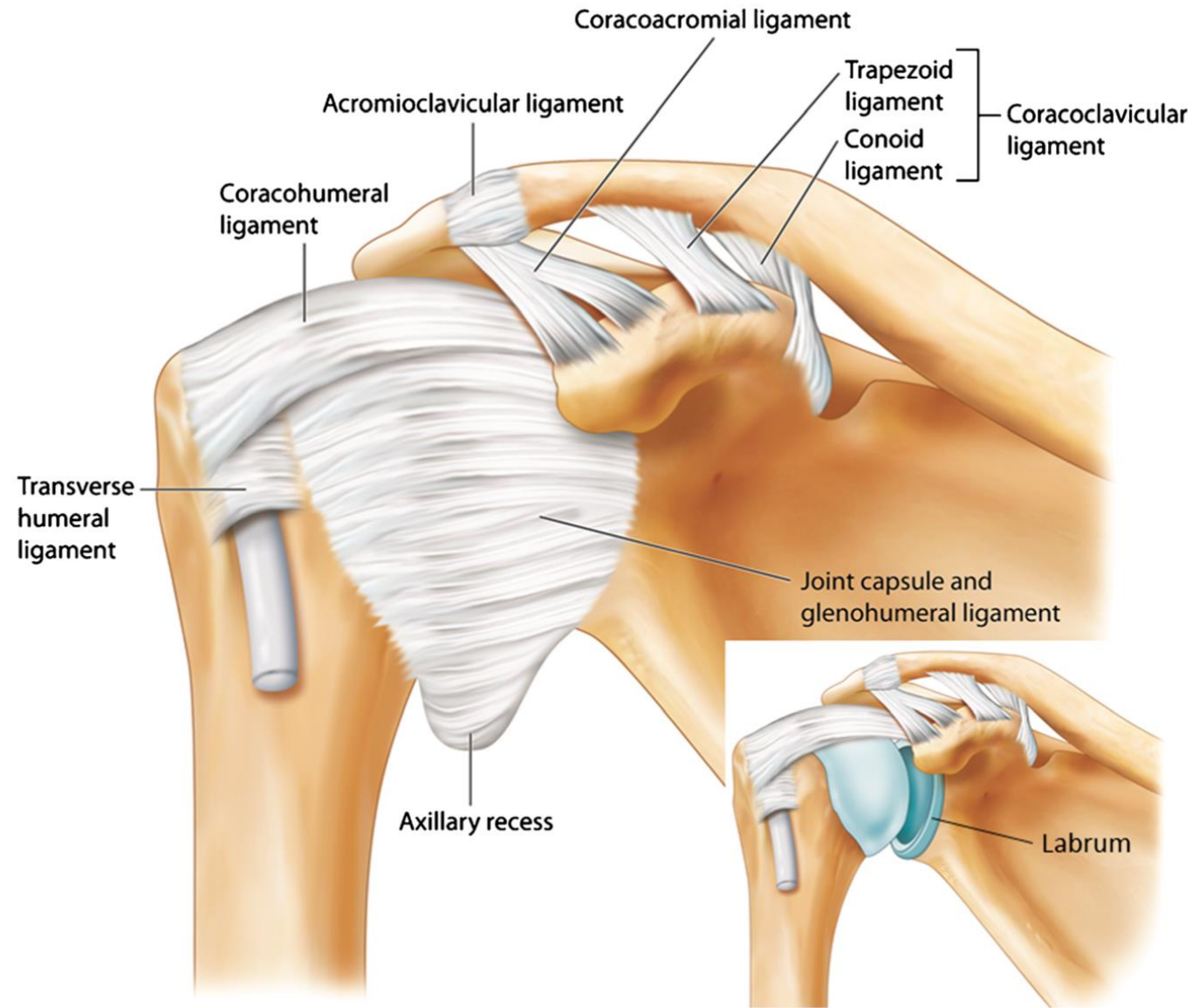


FIGURE 1. Glenohumeral joint showing various ligaments and the joint capsule. The anterior capsule is reinforced by the superior, middle, and inferior GHL. The insert shows the articular surface, the glenoid process, and the labrum. Reprinted with permission from usra.ca.

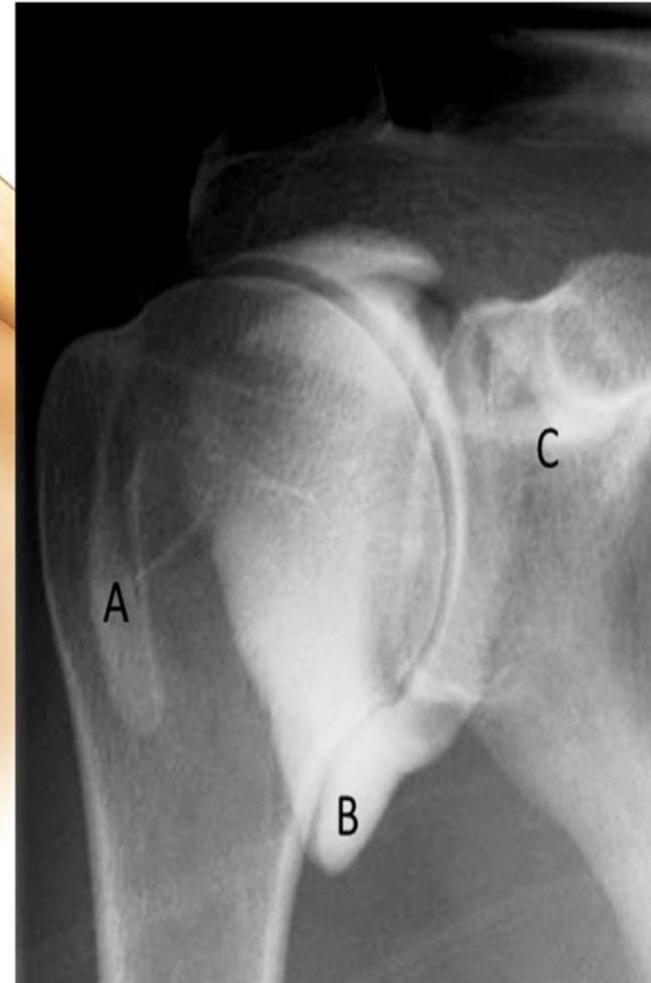
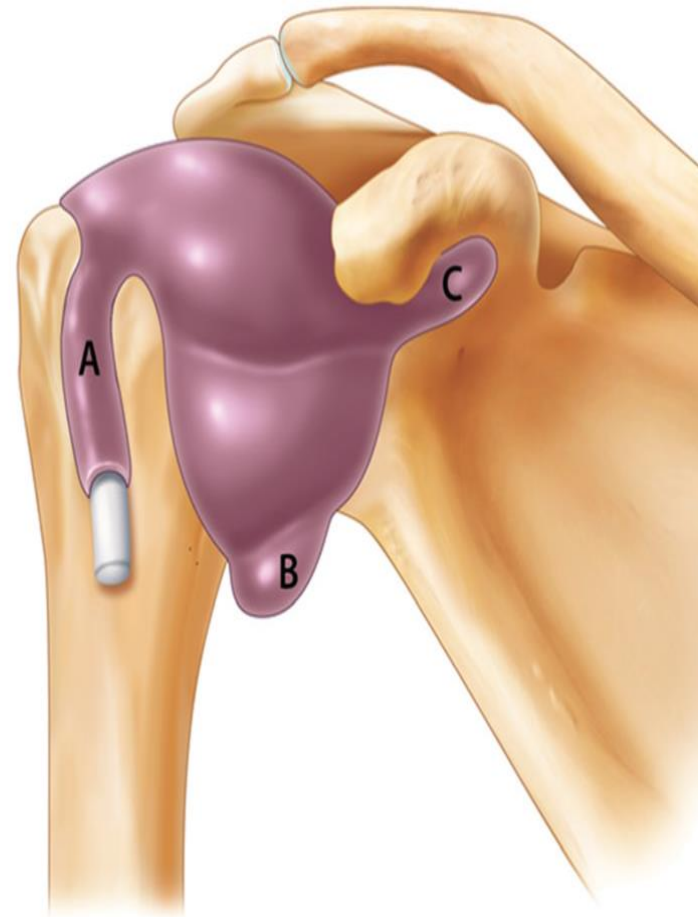


FIGURE 2. The drawing of 3 main recesses of the joint (left): (A) the biceps tendon sheath, (B) the axillary pouch, (C) the subscapular recess, and the corresponding radiographic (arthrogram) appearance (right). Reprinted with permission from usra.ca.

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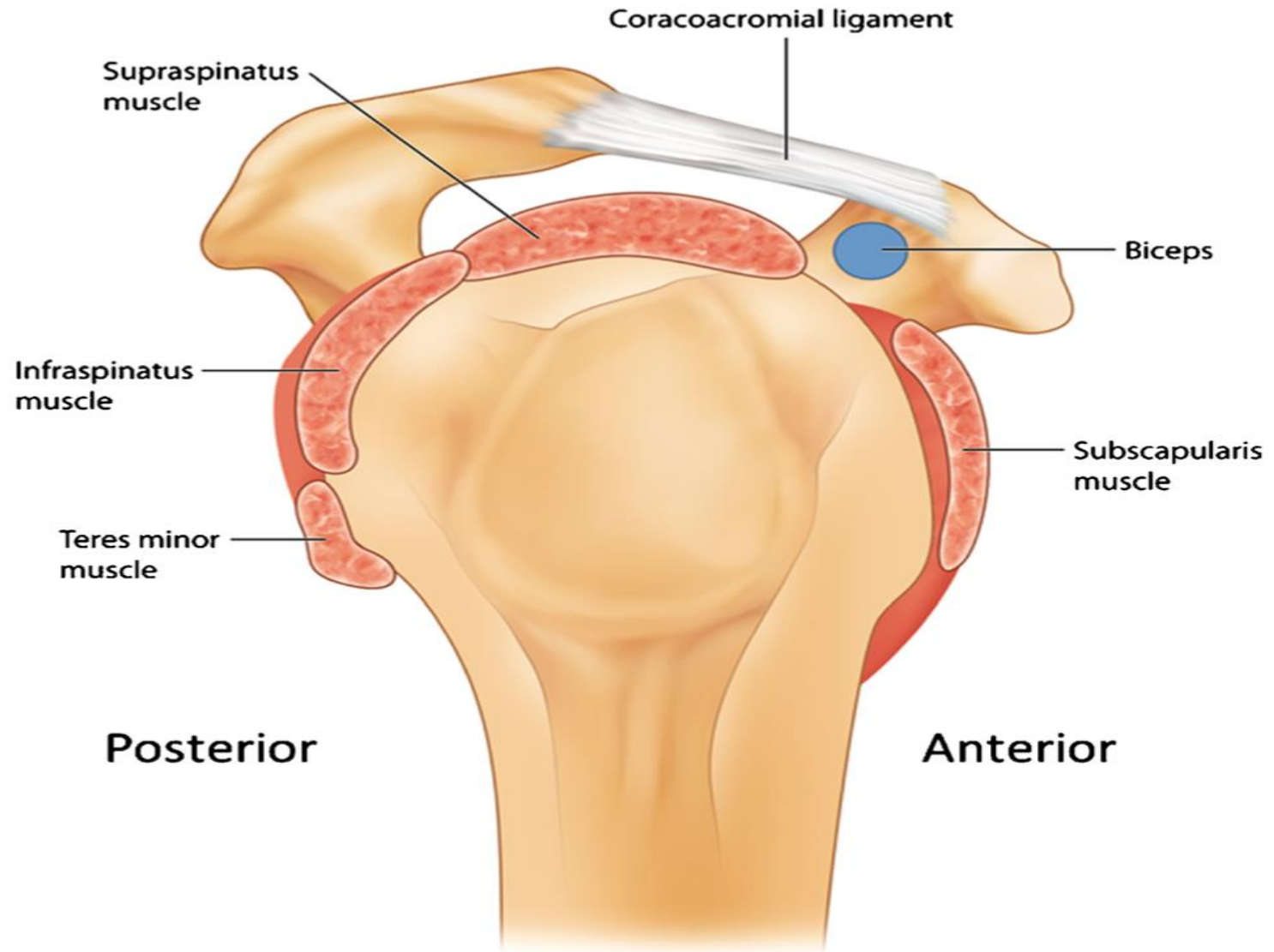


FIGURE 3. A schematic diagram showing the arrangement of the 4 rotator cuff muscles: subscapularis, SS, IS, and TMi. Reprinted with permission from usra.ca.

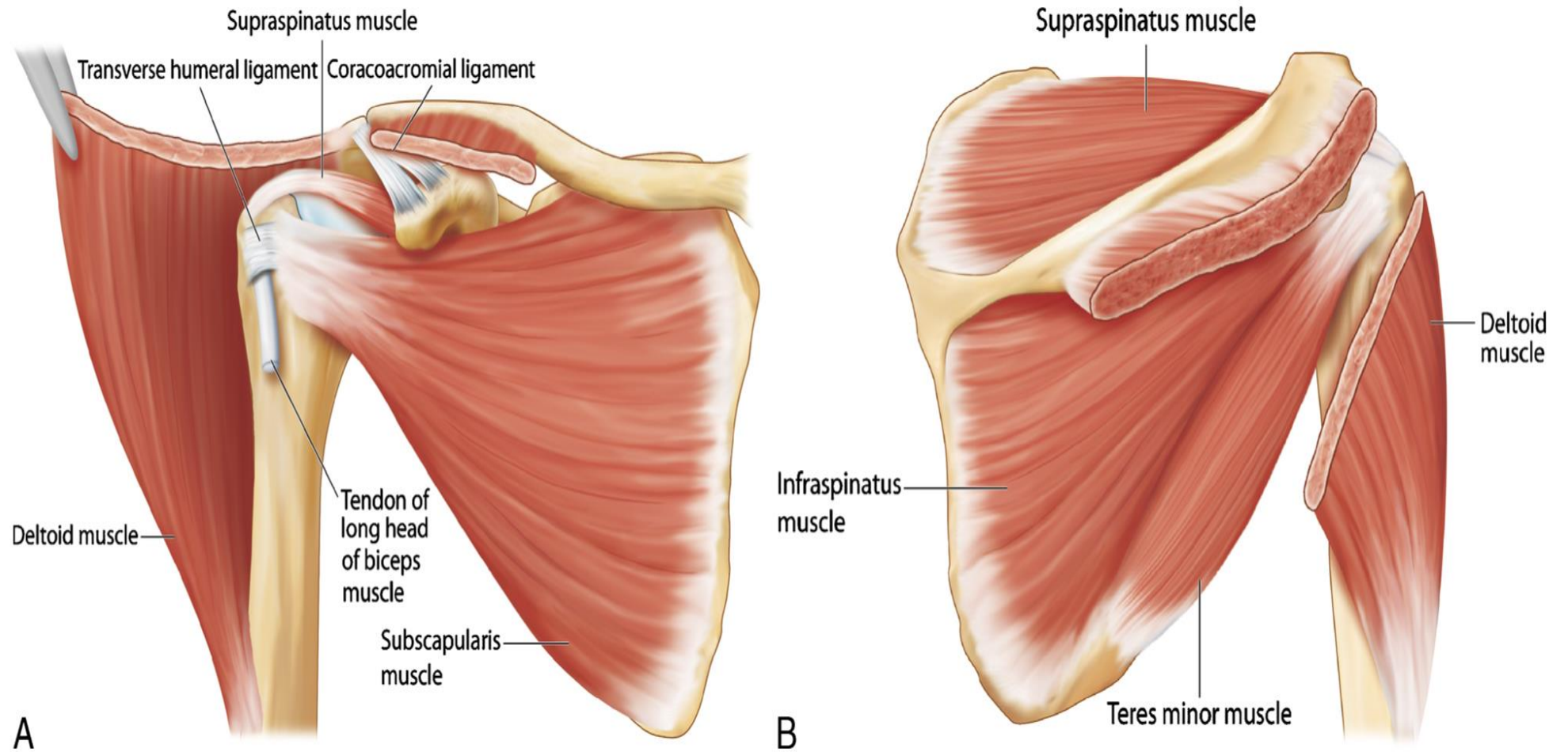


FIGURE 4. A, Anterior view of the shoulder showing the subscapularis and SS muscles. The anterior portion of the deltoid muscle was reflected to show the underlying rotator cuff muscle. B, Posterior view of the shoulder to show the IS and TMi muscle. The posterior portion of the deltoid muscle was partially removed to show the underlying muscle. Reprinted with permission from usra.ca.

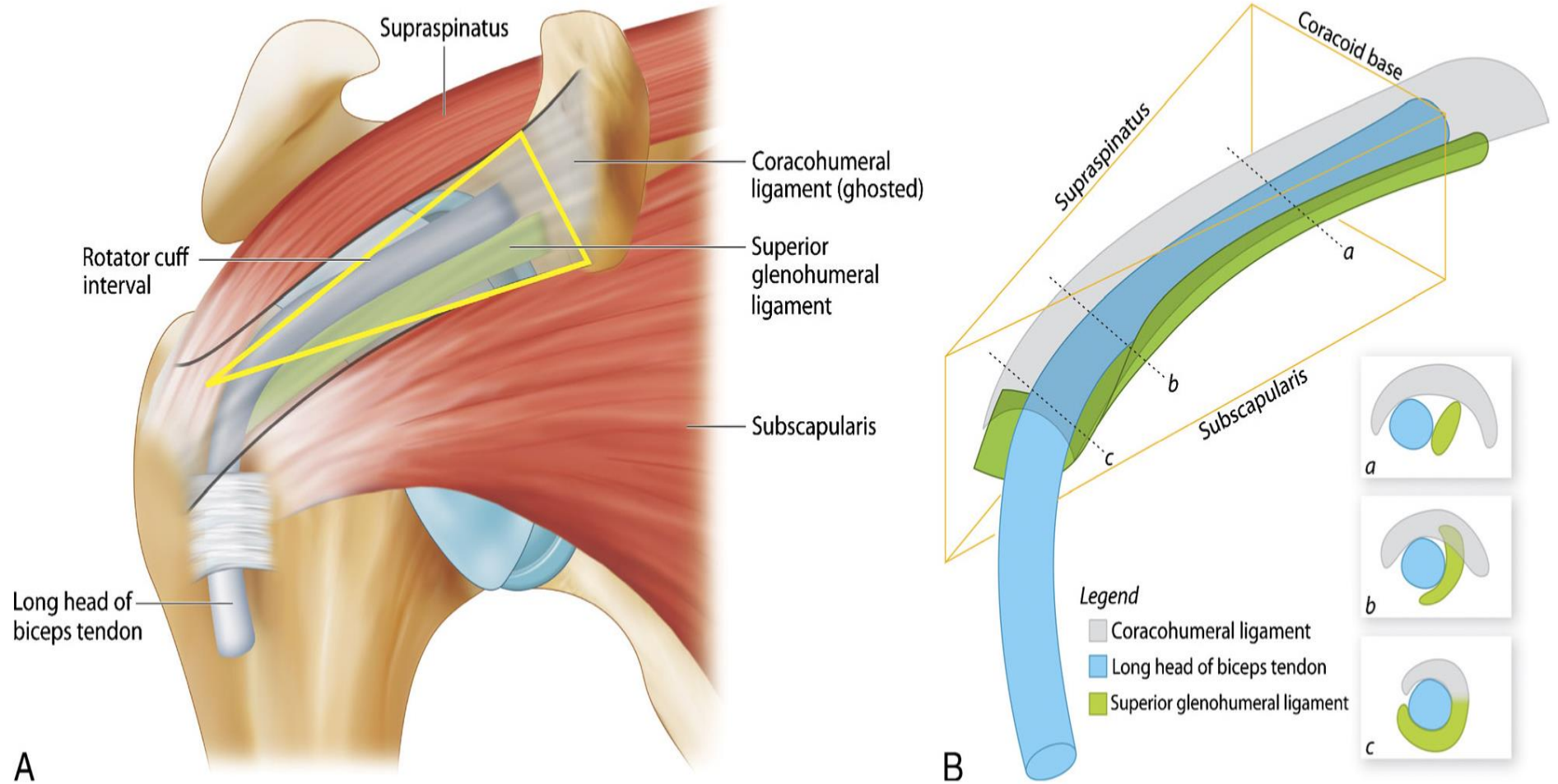


FIGURE 5. A, The anterosuperior view showing the rotator cuff interval, which is a triangular space between the tendons of subscapularis (anterior) and SS (posterior) muscles and the base of the coracoid process. The roof is the CHL (ghosted) and the contents are the LHB tendon (blue) and SGHL (green). B, The cut-out of the rotator cuff interval to show the content. The SGHL, a focal thickening of the GHJ capsule, runs anterior to the tendon of the LHB initially (position a). The SGHL maintains a close relationship with the LHB tendon and subsequently inserts into a small depression above the lesser tuberosity (position b), contributing to the biceps reflection pulley (position c) to prevent the dislocation of the LHB tendon. Reprinted with permission from usra.ca.

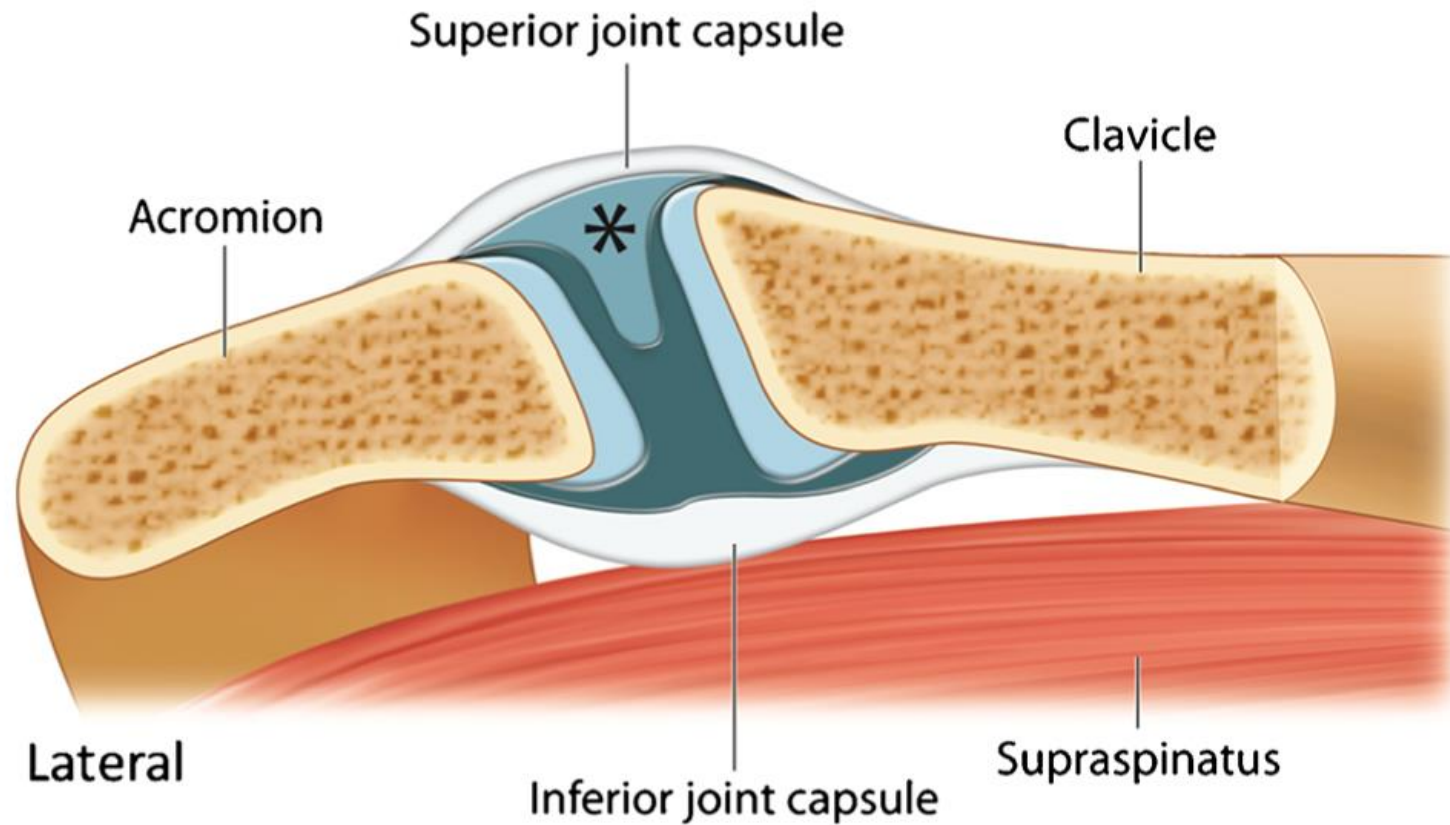


FIGURE 6. The ACJ is a synovial joint with the articular surfaces separated by a wedge-shaped fibrocartilaginous disk (asterisk). The inferior surface of the joint is in direct contact with the subacromial bursa and SS muscle and may play a role in the development of the impingement syndrome. Reprinted with permission from usra.ca.

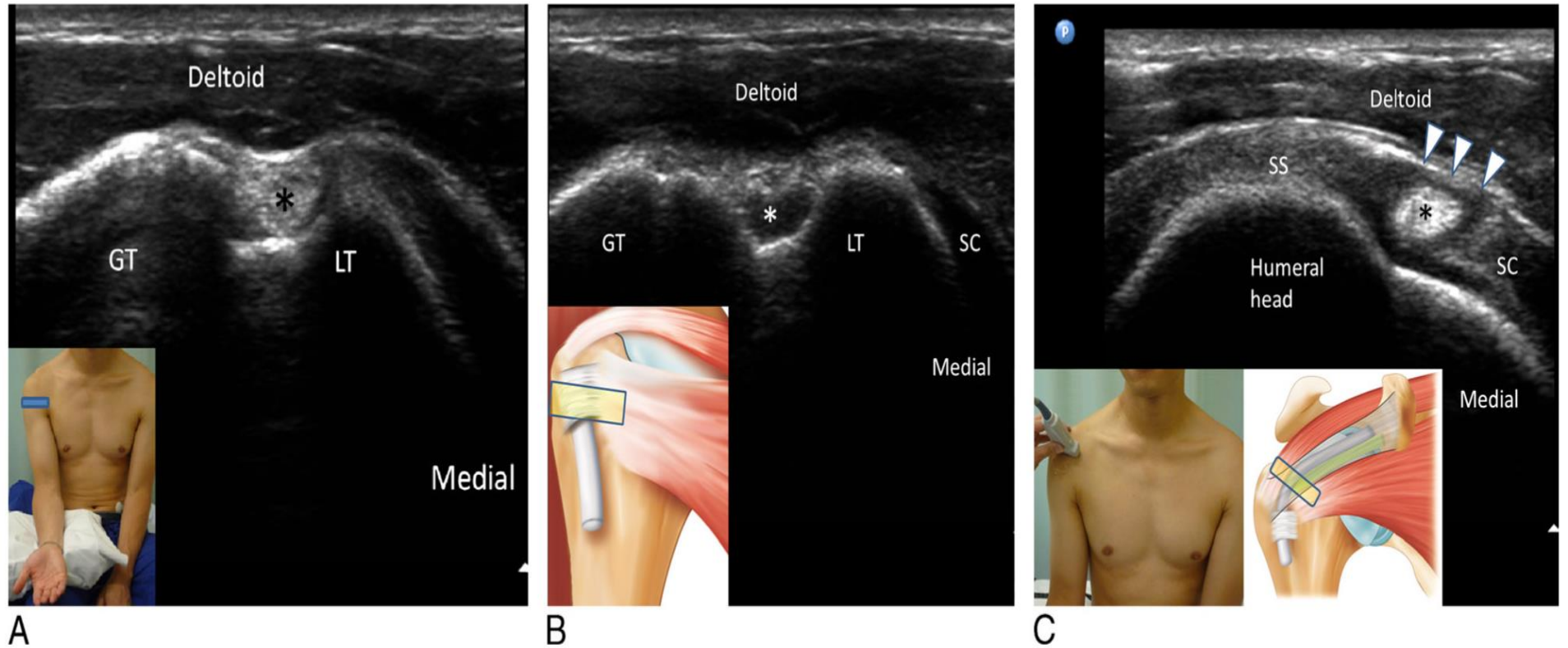
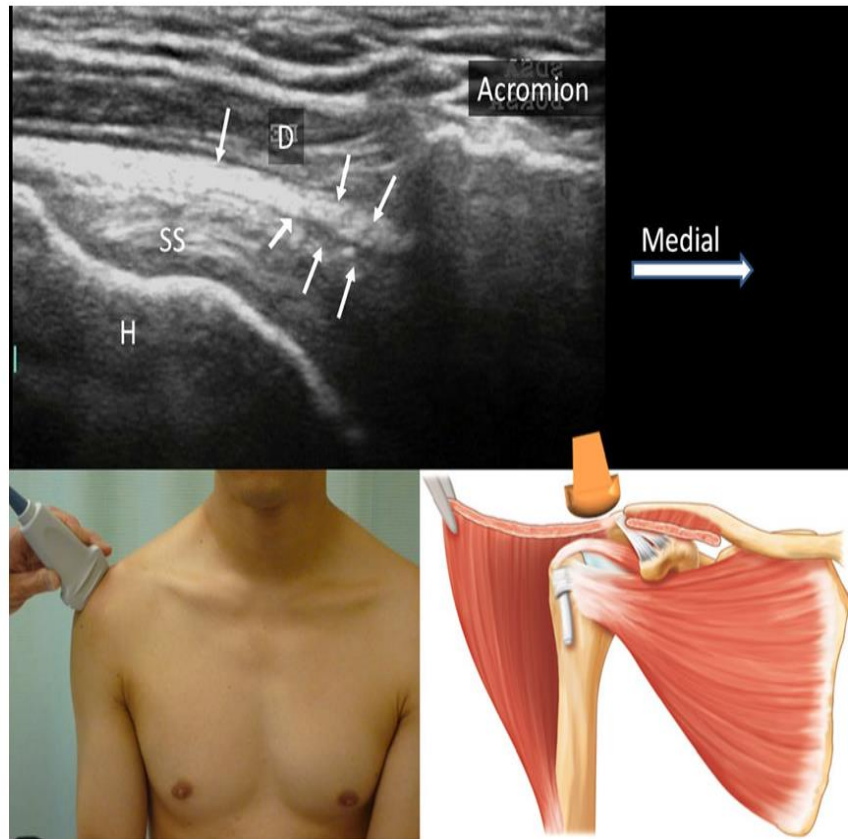
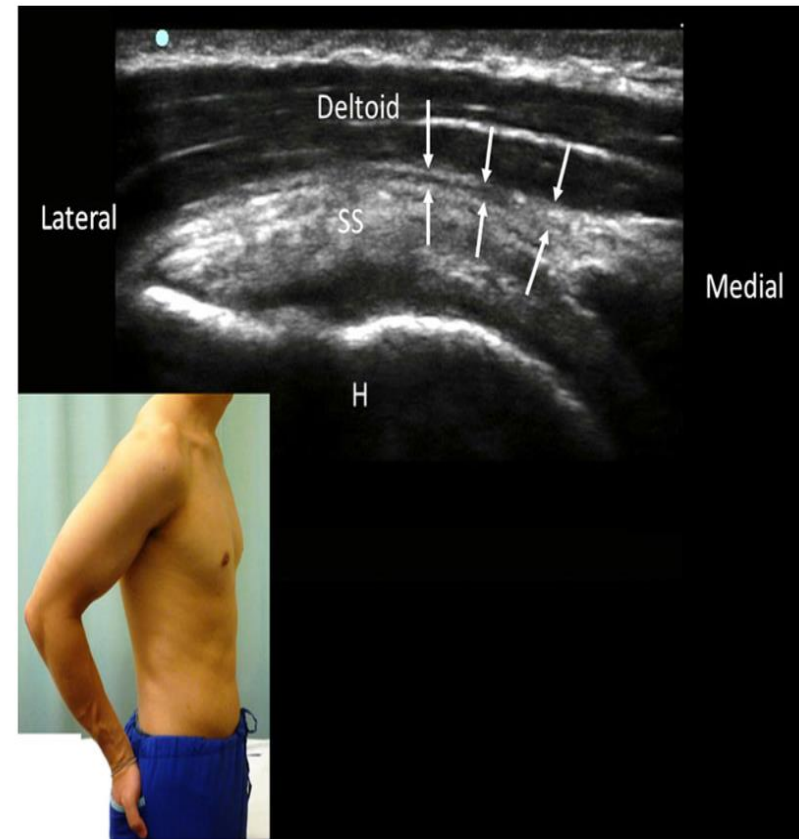


FIGURE 7. A, Ultrasound image showing the presence of LHB tendon (asterisk) within the bicipital groove. The insert shows the position of the patient and the linear ultrasound probe. Note that the LHB tendon appears hyperechoic. B, Ultrasound image similar to A with a different tilt of the ultrasound probe. The image illustrates the anisotropy with the LHB tendon (asterisk) changed from a hyperechoic to a hypoechoic structure. The insert shows the position of the probe and the corresponding anatomic structures underneath. C, By moving the ultrasound probe more proximally along the orientation of the LGH tendon, a view of rotator cuff interval is shown. The LHB tendon (asterisk) is always hyperechoic at this level and sandwiched between the SS tendon laterally and subscapularis tendon medially. The CHL (arrowheads) forms the roof of the interval. The insert on the left shows the orientation and position of the probe, and the insert on the right shows the probe position and the structures underneath it. GT indicates greater tuberosity; LT, lesser tuberosity; SC, subscapularis. Reprinted with permission from usra.ca.



A



B

FIGURE 8. A, Ultrasound image of the SASDB. The SS tendon is seen attached laterally onto the greater tuberosity of the humeral head (H). The insert on the left shows the position of the patient and the ultrasound probe; the one on the right shows the probe and the structures underneath. The deltoid muscle shows the underlying SS muscle. B, Ultrasound image of the SS tendon when the arm is put in the modified Crass position. Note that the portion of the SS tendon lateral to the acromion process is significantly increased by this maneuver. The insert shows the position of the modified Crass position. H indicates humeral head; D, deltoid muscle. Line arrows outline the peribursal fat of the SASDB. Reprinted with permission from usra.ca.

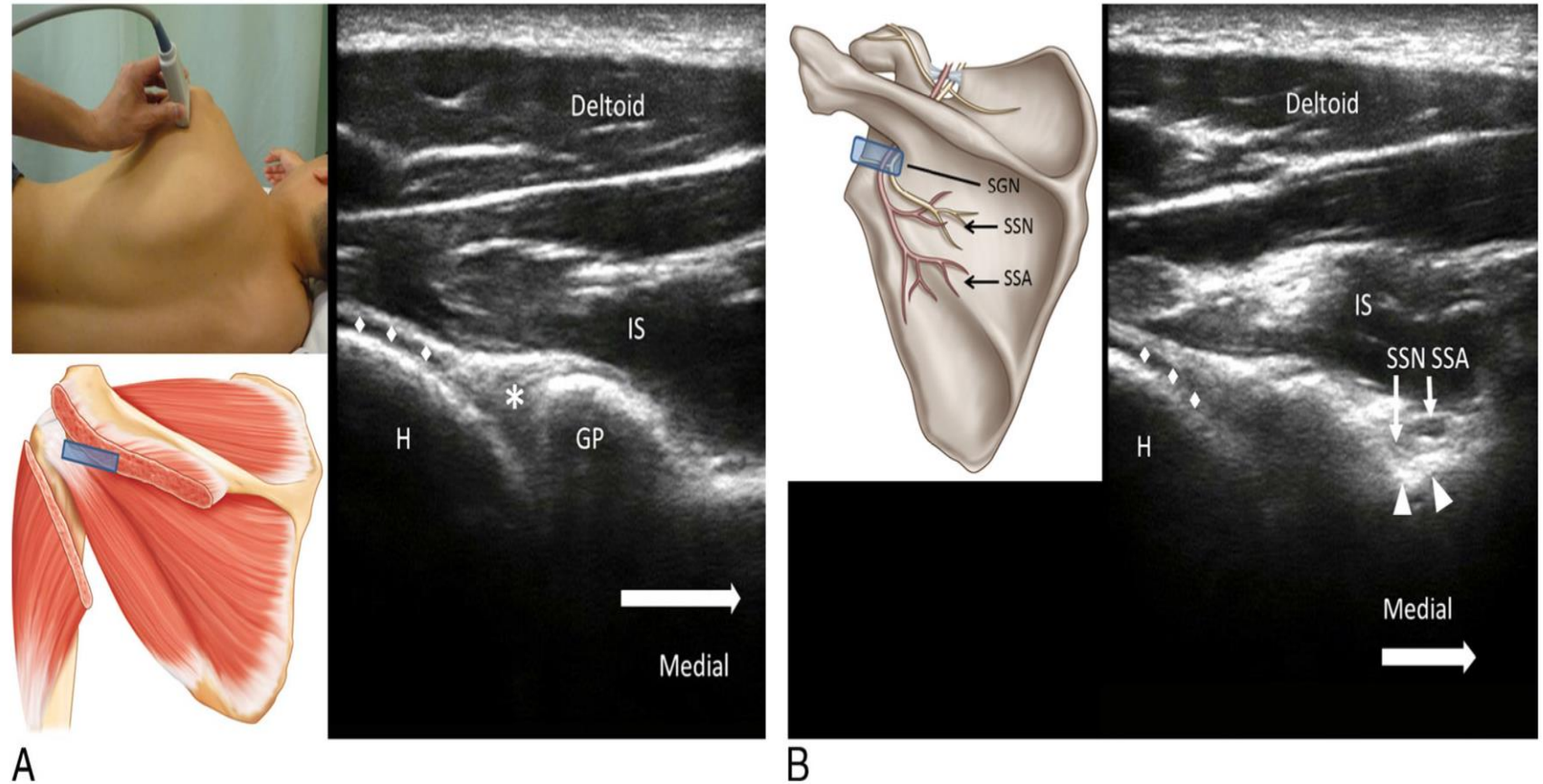


FIGURE 9. Ultrasound image of the posterior GHJ. The glenoid process and humeral head both appear as hyperechoic structures with anechoic shadow. The insert on the top shows the position of the patient and the ultrasound probe, whereas the one below shows the probe position and the structures underneath. B, Ultrasound image of the spinoglenoid notch by moving the ultrasound probe slightly medially. The insert shows the position of the probe and the spinoglenoid notch, as well as the suprascapular neurovascular bundle. H indicates humeral head; GP, glenoid process; SSN and SSA, suprascapular nerve and artery (line arrows in ultrasound image); SGN, spinoglenoid notch (arrowheads). *Glenoid labrum. ♦Articular cartilage of the humeral head. Reprinted with permission from usra.ca.

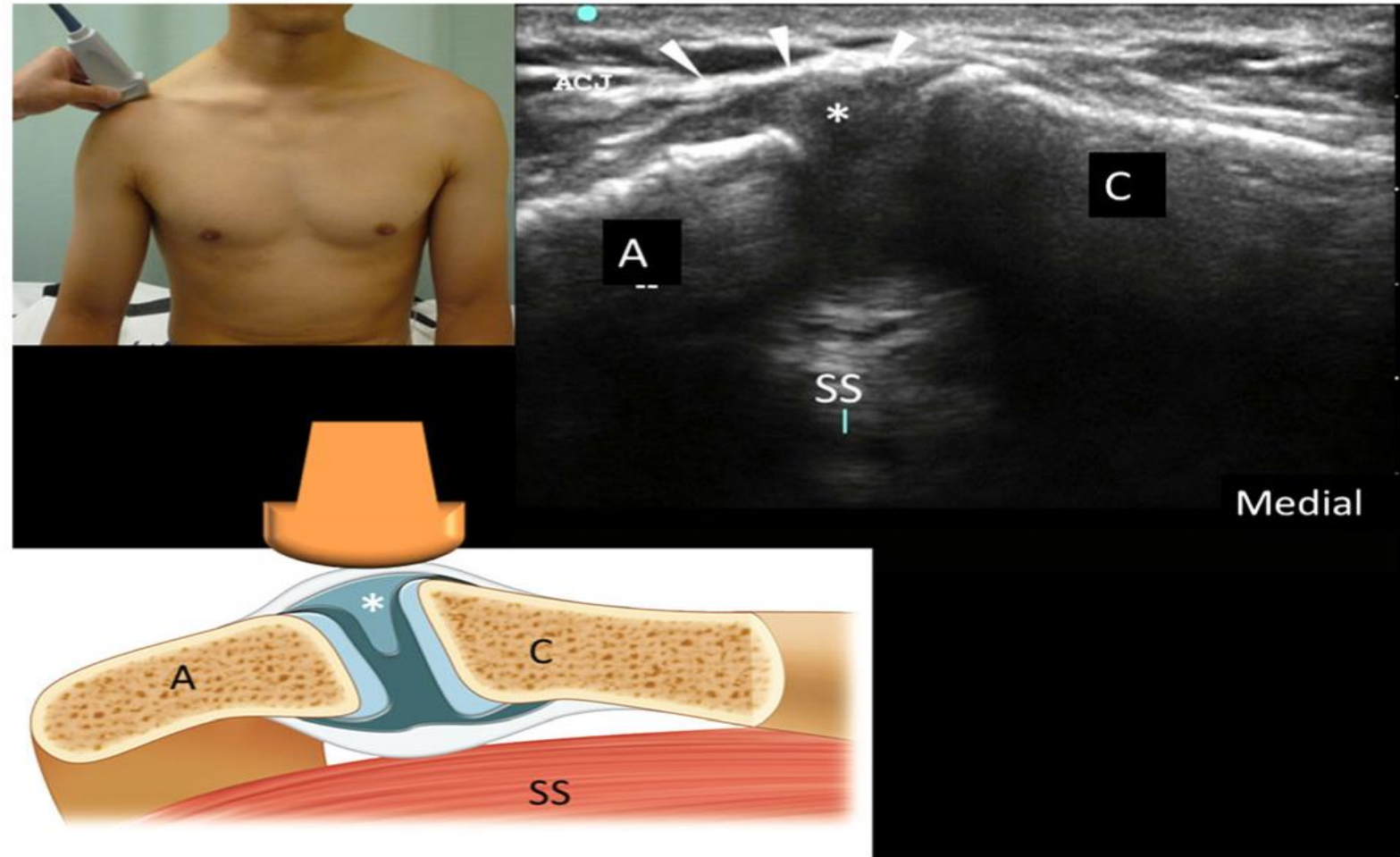


FIGURE 10. Ultrasound image of the ACJ. The upper insert shows the position of the probe and the patient, and the lower insert shows the position of the probe and the structures underneath. A indicates acromion process; C, clavicle. *Wedge shape fibrocartilaginous disk. Arrowheads point to the superior joint capsule. Reprinted with permission from usra.ca.

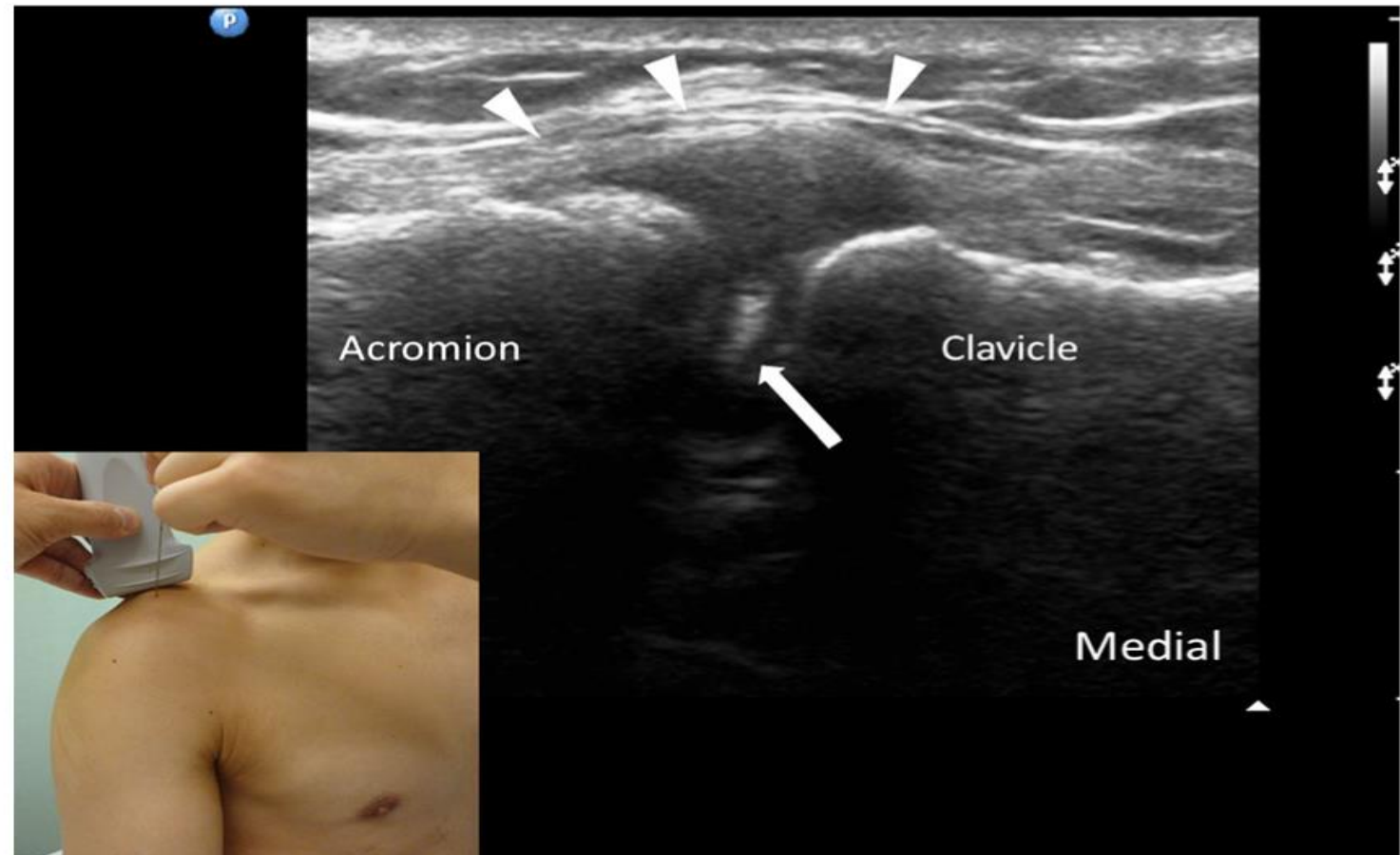


FIGURE 11. The insert shows the position of the ultrasound probe and the needle with the out-of-plane technique. The corresponding ultrasound image shows the ACJ with the image of the needle (solid arrow). The arrows outline the superior joint capsule. Reprinted with permission from usra.ca.

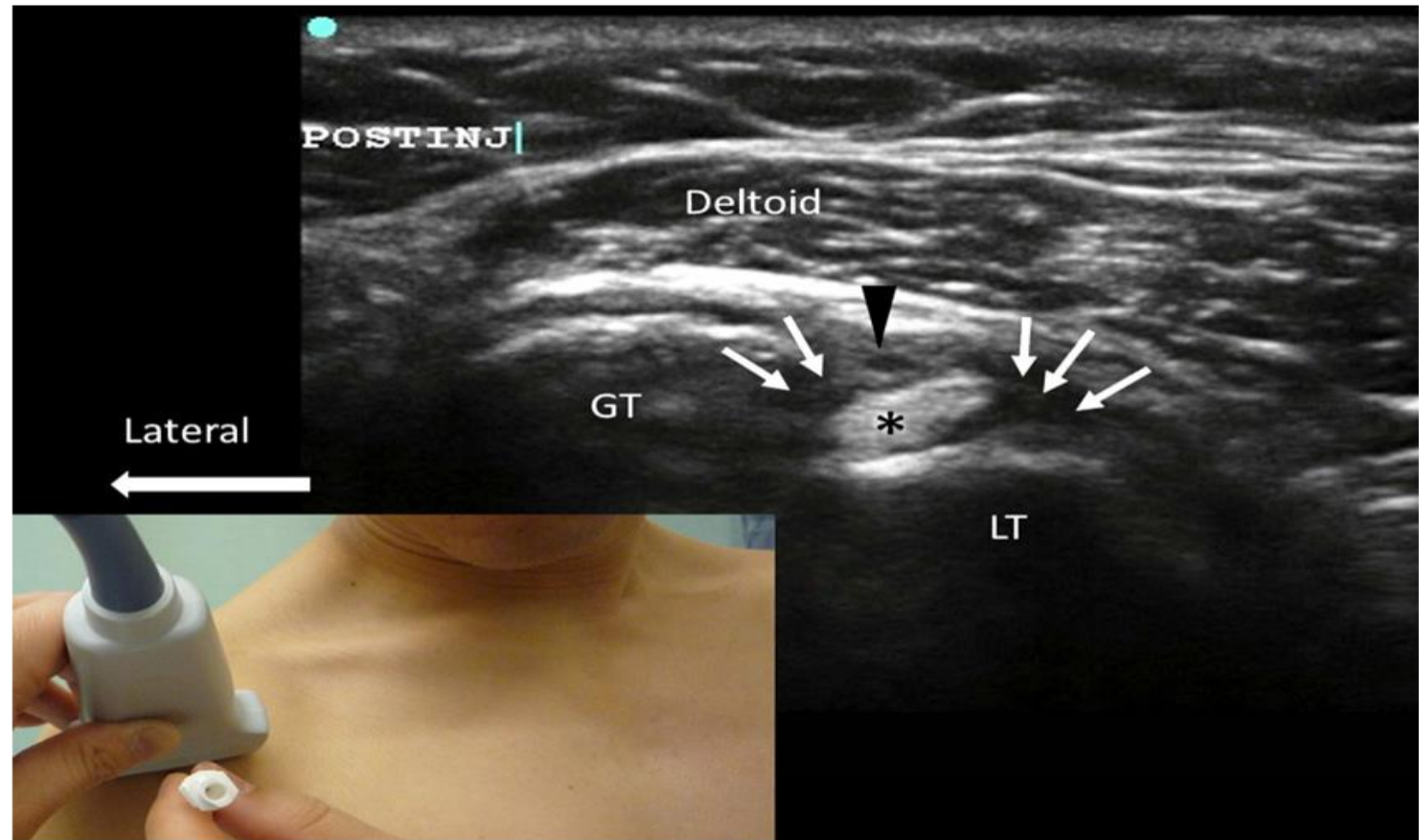


FIGURE 12. The insert shows the position of the ultrasound probe and the needle with the out-of-plane technique. The local anesthetic is seen surrounding the bicep tendons in the bicipital groove (line arrows). The black arrowhead points to the anterior circumflex artery. GT indicates greater tuberosity; LT, lesser tuberosity. Reprinted with permission from usra.ca.

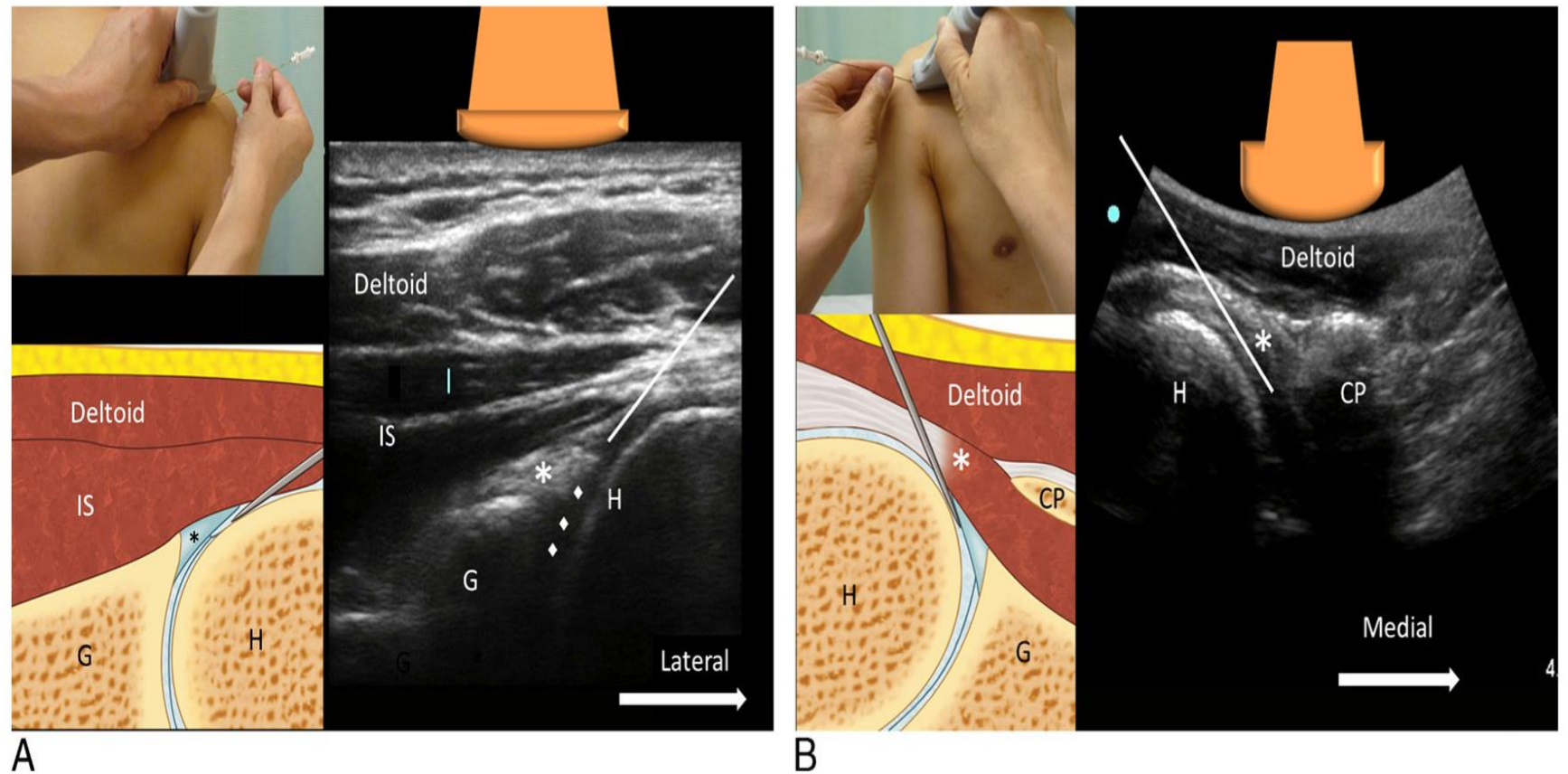


FIGURE 13. A, Posterior approach to the GHJ. The insert (left upper) shows the position of the ultrasound probe and the needle with in-plane technique. The corresponding ultrasound image (right) is shown with the line representing the needle path, which was directed between the free edge of the labrum (*) and the hypoechoic articular cartilage (•) of the humeral head (H). G indicates glenoid. Insert in the lower left shows the anatomic drawing of the ultrasound image. B, Anterior approach to the GHJ. The insert (left upper) shows the position of the ultrasound probe and the needle with in-plane technique. The corresponding ultrasound image (right) is shown with the line representing the needle path, which was inserted from the lateral side of the probe aiming at the medial border of the humeral head (H). CP indicates coracoid process. *Subscapularis tendon. Insert in the lower left shows the anatomic drawing of the ultrasound image. Reprinted with permission from usra.ca.

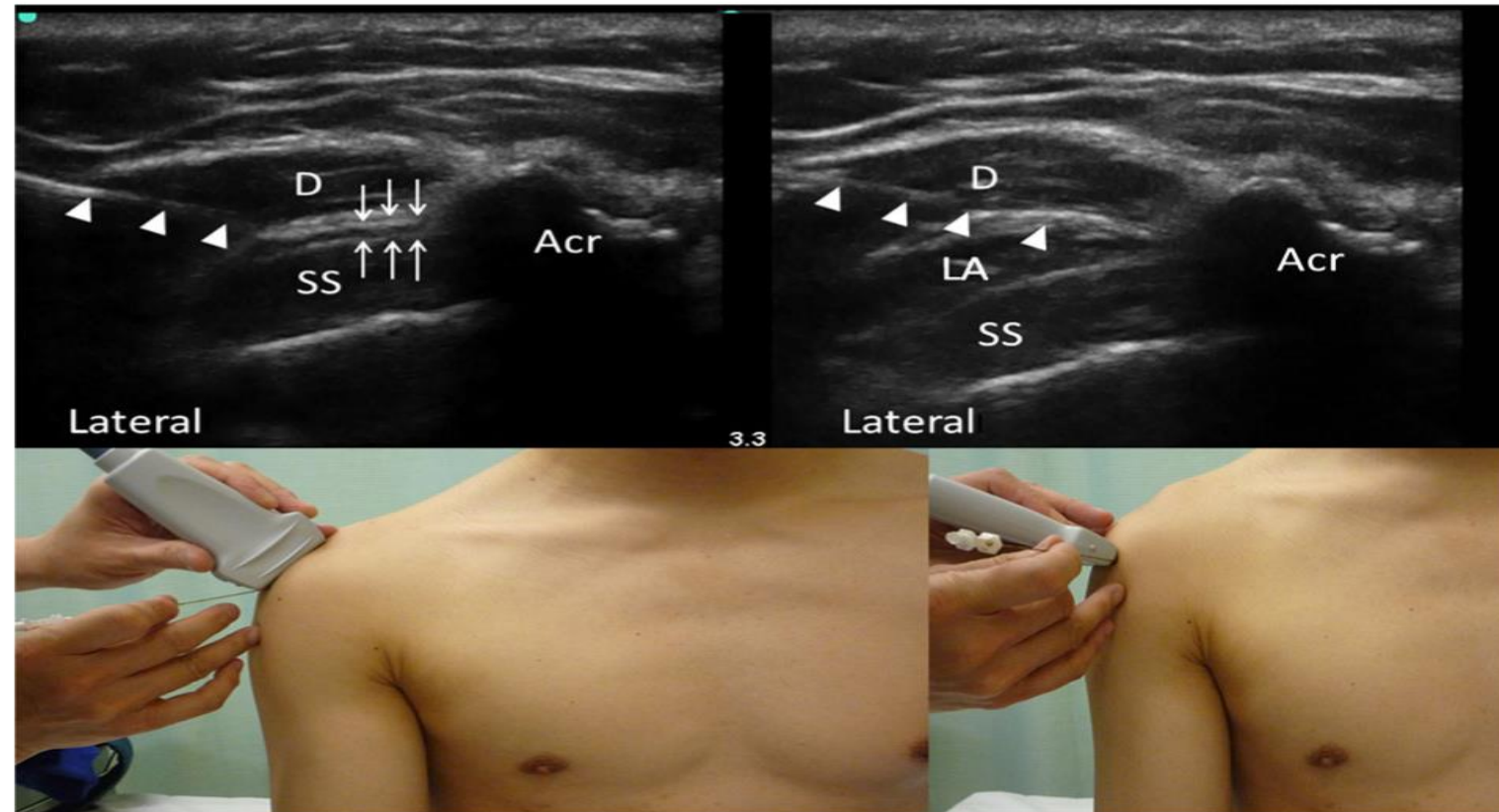


FIGURE 14. The insert on the left shows the position of the ultrasound probe and the needle with the in-plane technique. Note that the medial end of the ultrasound probe is placed over the acromion (Acr). However, in a patient with a slim body build, the probe can be placed in another orientation as shown in the right insert. The ultrasound image on the left shows the needle (arrowheads) inserted with in-plane technique to the SASDB, as highlighted by the peribursal fat (line arrows). The image on the right shows the presence of local anesthetic following the injection, with the separation of the deltoid muscle (D) and SS tendon. Reprinted with permission from usra.ca.



HIP

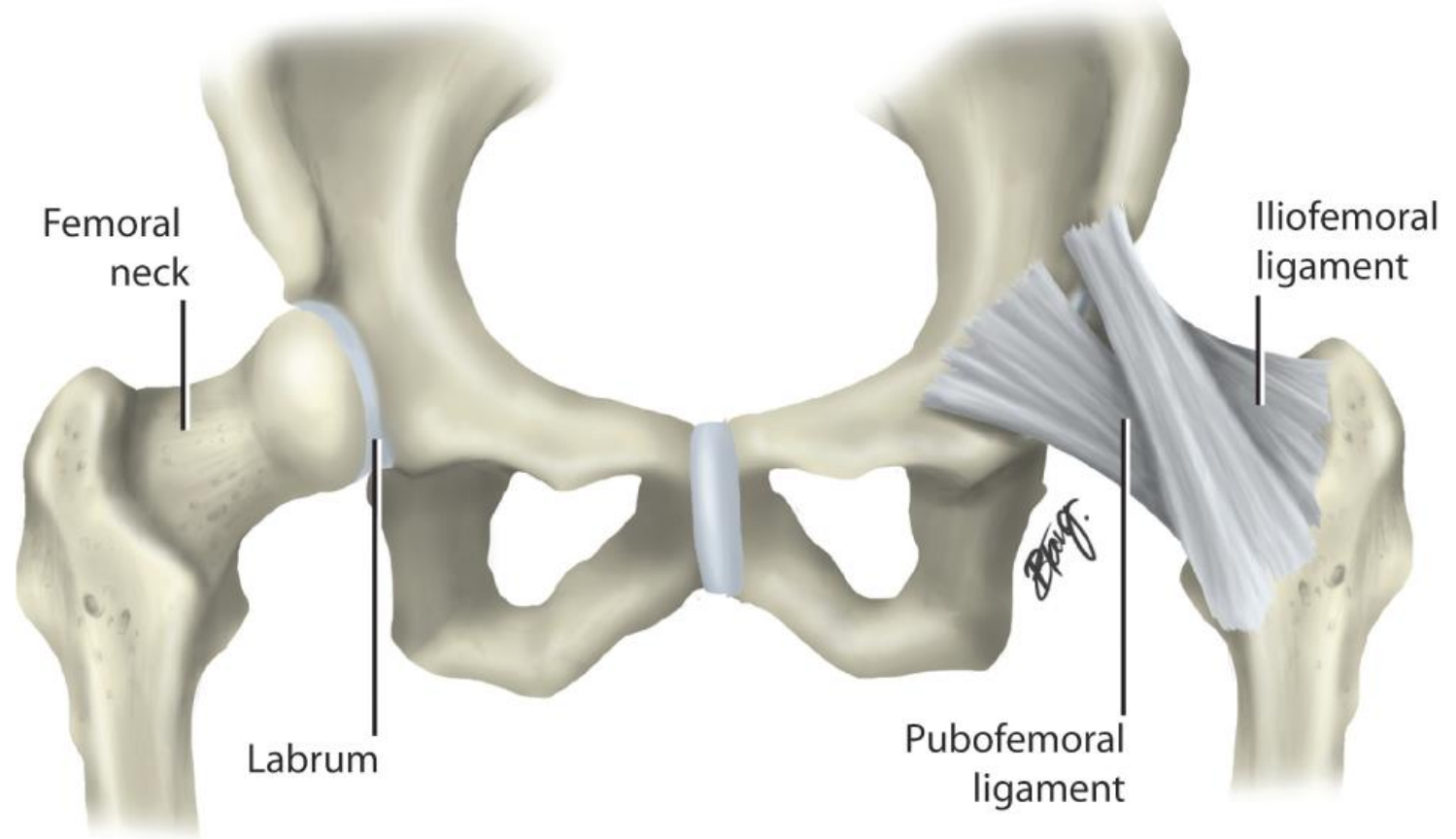


FIGURE 1. Front view of hip joint, the labrum (left), and the hip ligaments. Ischiofemoral ligament cannot be seen from this view because of the posterior location. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.

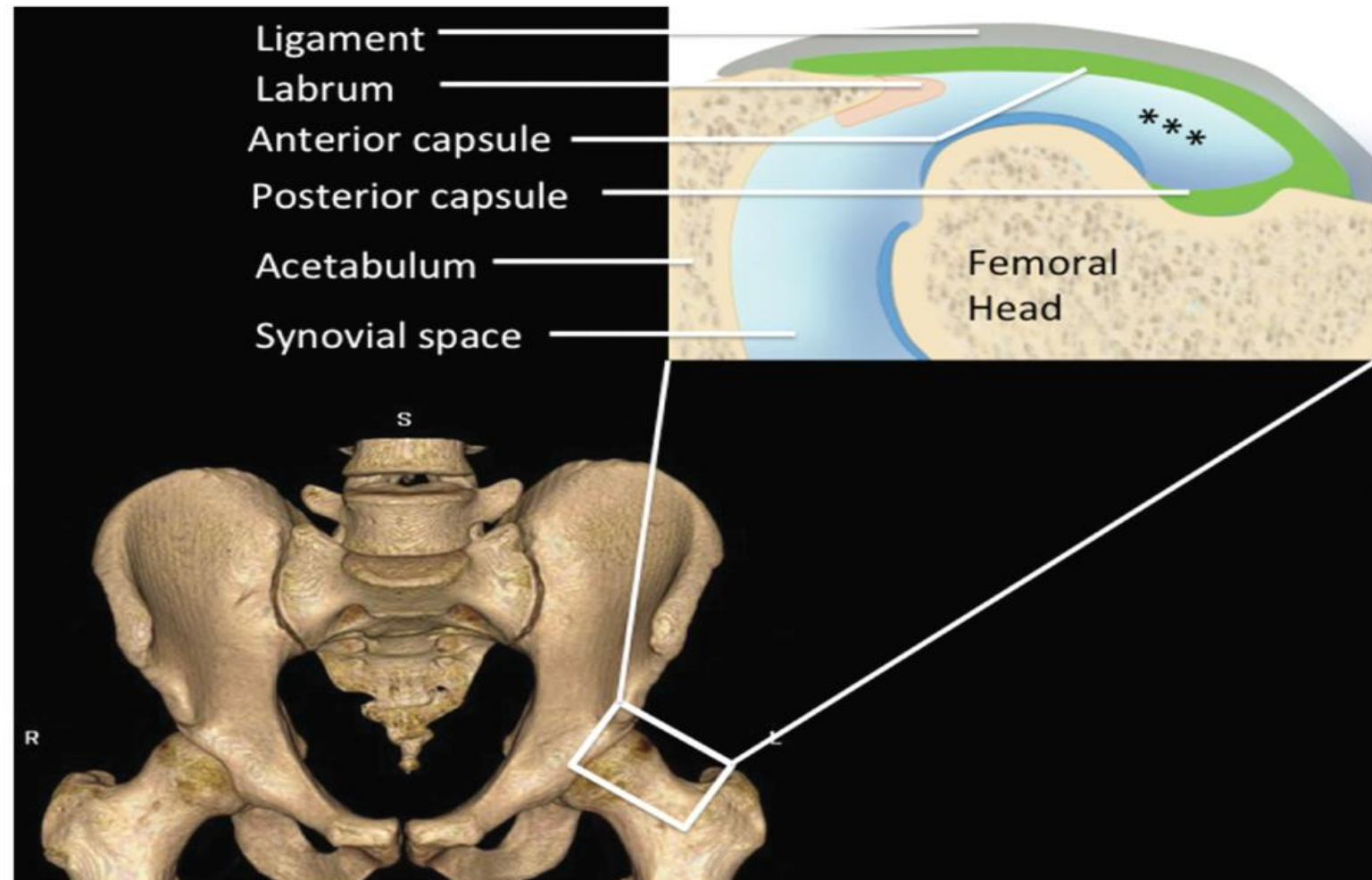


FIGURE 2. Figure shows the anterior synovial recess (***). Under normal circumstances, the amount of synovial fluid in the recess is kept at a minimum. This figure shows a hip with effusion for demonstration. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.

- Psoas M. _____
- Iliacus M. _____
- Tensor fascia
lata M. _____
- Rectus femoris M. _____
- Pectineus M. _____
- Adductor longus M. _____
- Sartorius M. _____

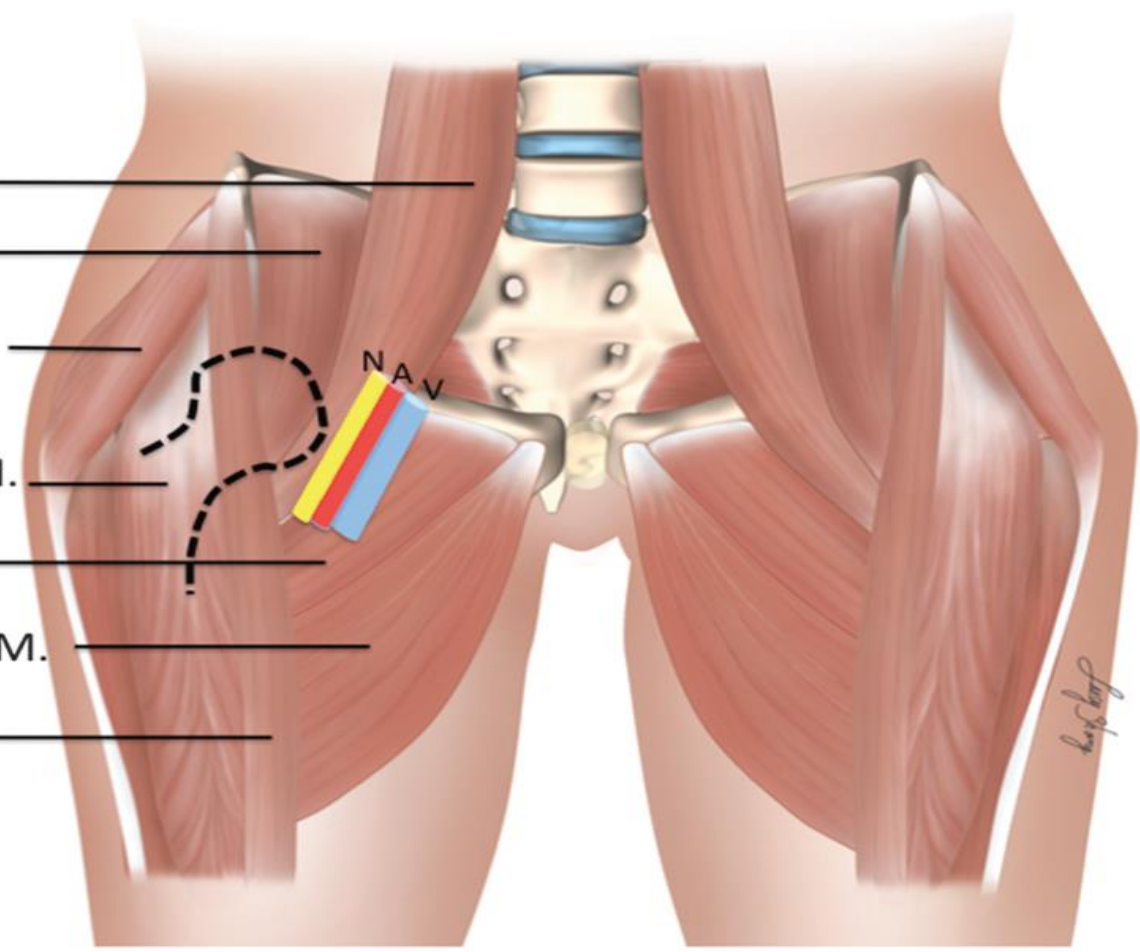


FIGURE 3. Muscles (M) around hip joint. The femoral head and neck (in dotted line) and the schematic of femoral neurovascular bundle are shown here for reference. V indicates femoral vein; A, femoral artery; N, femoral nerve. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.

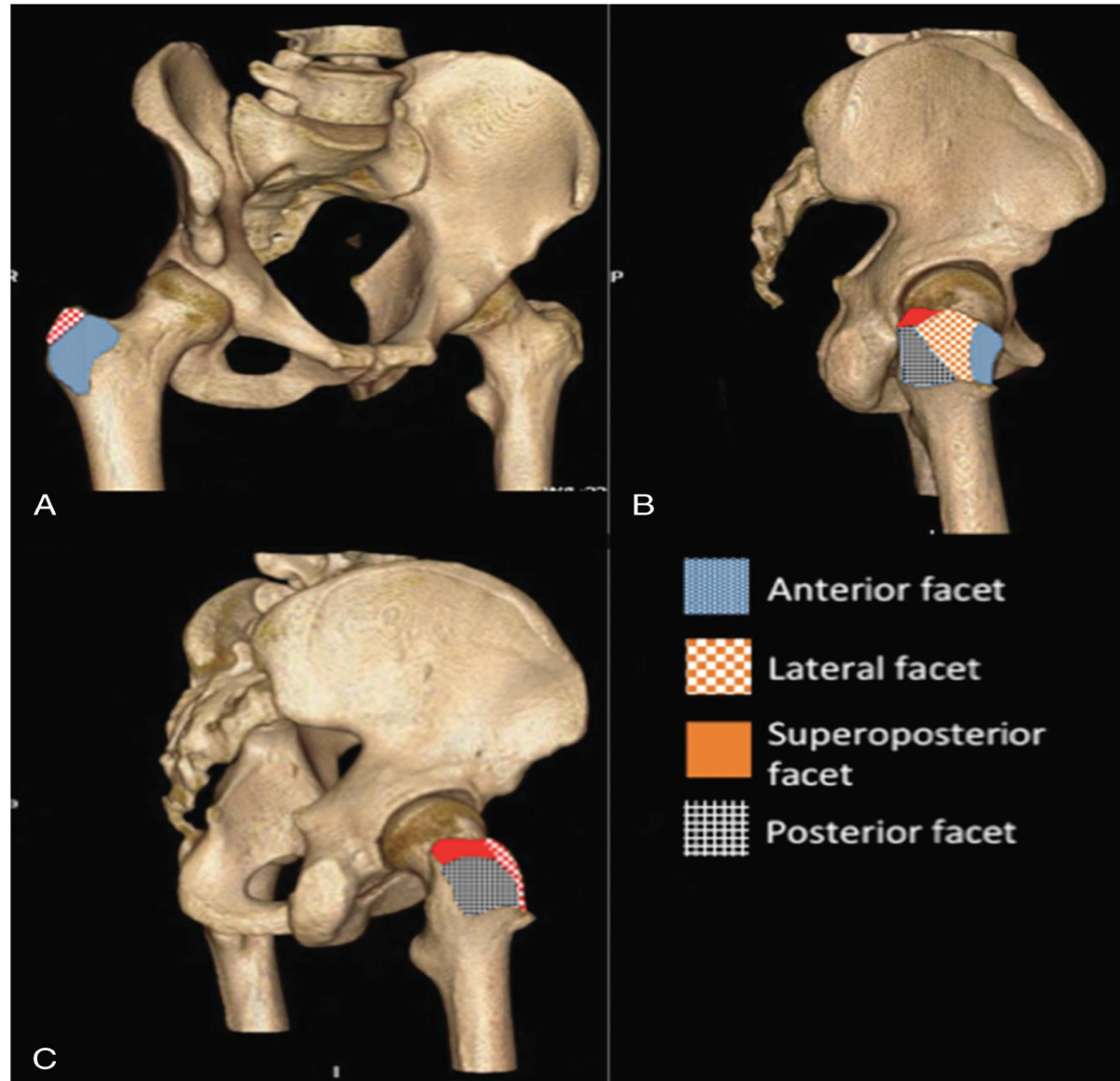


FIGURE 4. Figure shows the 4 facets of great trochanter. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.



TABLE 1. Origin and Insertion of the Muscles in the Lateral Hip Region

Muscle	Origin	Insertion
Gluteus maximus	Outer surface of ilium behind the posterior gluteal line, adjacent posterior surface of the sacrum and coccyx and sacrotuberous ligament	Majority inserted into the IT band, some to the gluteal tuberosity of the femur
Tensor fascia lata	Outer edge of the iliac crest between ASIS and the iliac tubercle	IT band
Gluteus medius	Outer surface of ilium, between iliac crest and posterior and middle gluteal line	Anterior tendon to lateral facet and posterior tendon to superoposterior facet of GT
Gluteus minimus	Outer surface of ilium between middle and inferior gluteal line	Anterior facet of GT

ASIS indicates anterior superior iliac spine.

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Fascia over
gluteus medius

Gluteus maximus

Tensor fascia
latae

Iliotiibial tract

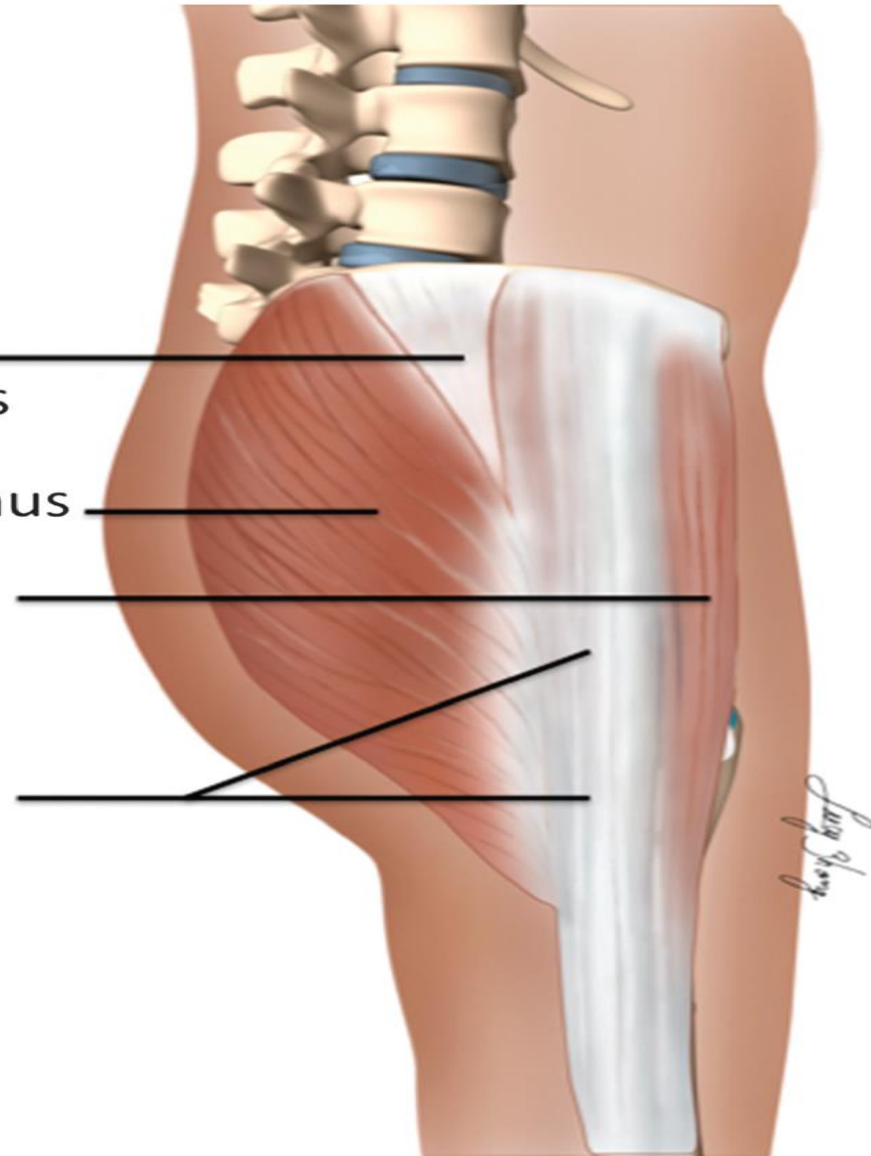


FIGURE 5. Figure shows the muscles and fascia in the lateral hip region. Reproduced with permission from USRA.



TABLE 2. GTPS: A Bursitis or Rotator Cuff Disease

	Shoulder	Hip
Similarity between shoulder and hip anatomy		
Tendons	Supraspinatus	Gluteus medius, gluteus minimus
Bone attachment	Greater tuberosity	Greater trochanter
Impingement	Coracoacromial arch	Fascia lata, IT tract
Bursa	Subdeltoid, subacromial bursa	Subgluteus maximus bursa
Evidence supporting cuff disease as etiology		
Bursitis is secondary to initial pathology at tendinous attachments	Rationale behind rotator cuff tendonitis, ^{12,13} supported by radiological evidence ¹⁴	
Evidence of bursitis in GTPS	Uncommon ¹⁵⁻¹⁷	
Presence of tendinopathy or tendon tears in GTPS	Very common ¹⁷	

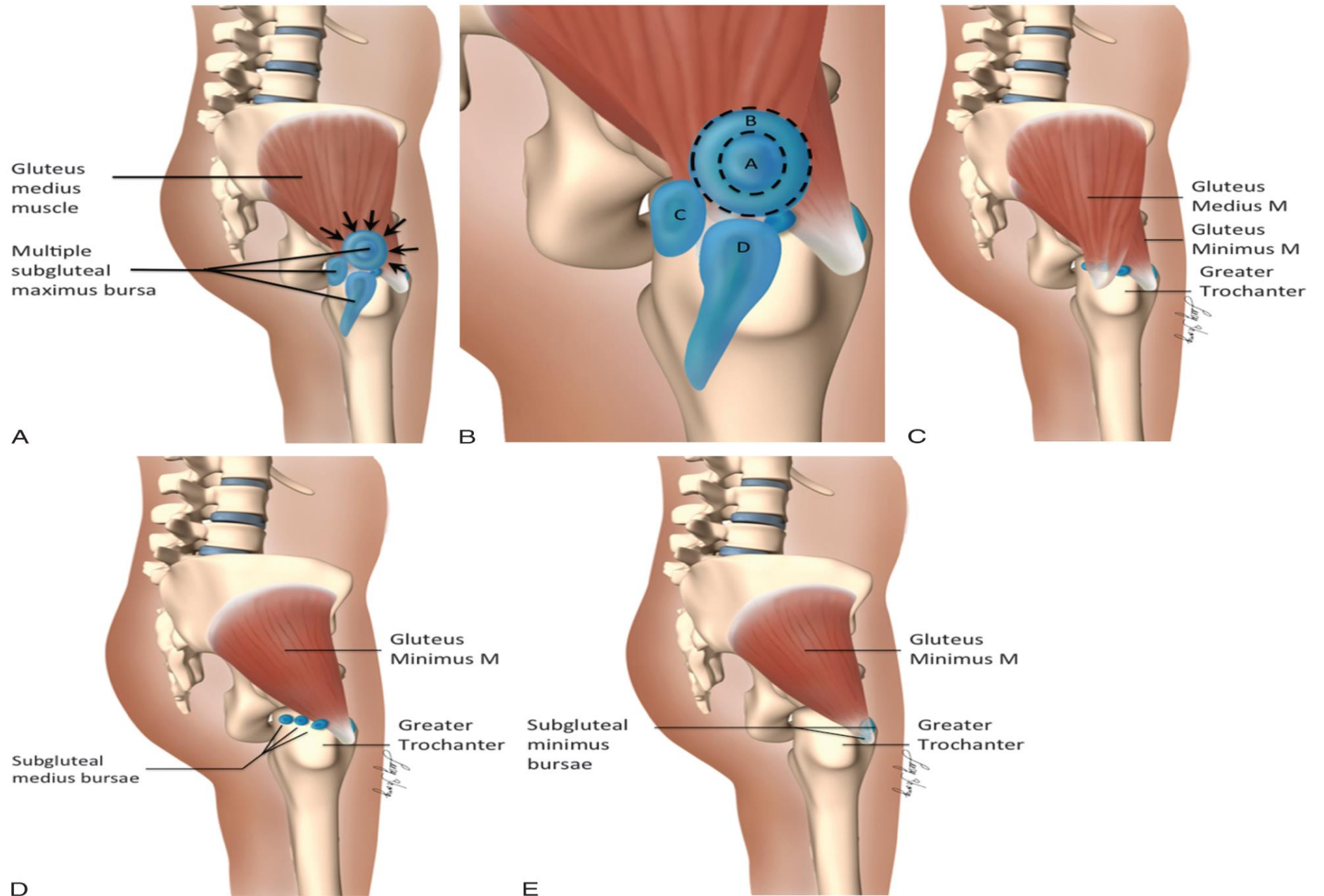


FIGURE 6. Figures show the bursae in the lateral hip region layer by layer. Panel B is a close up of panel A. A indicates superficial SMaB; B, deep SMaB; C, secondary deep SMaB; D, gluteofemoral bursa; M, muscle. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.

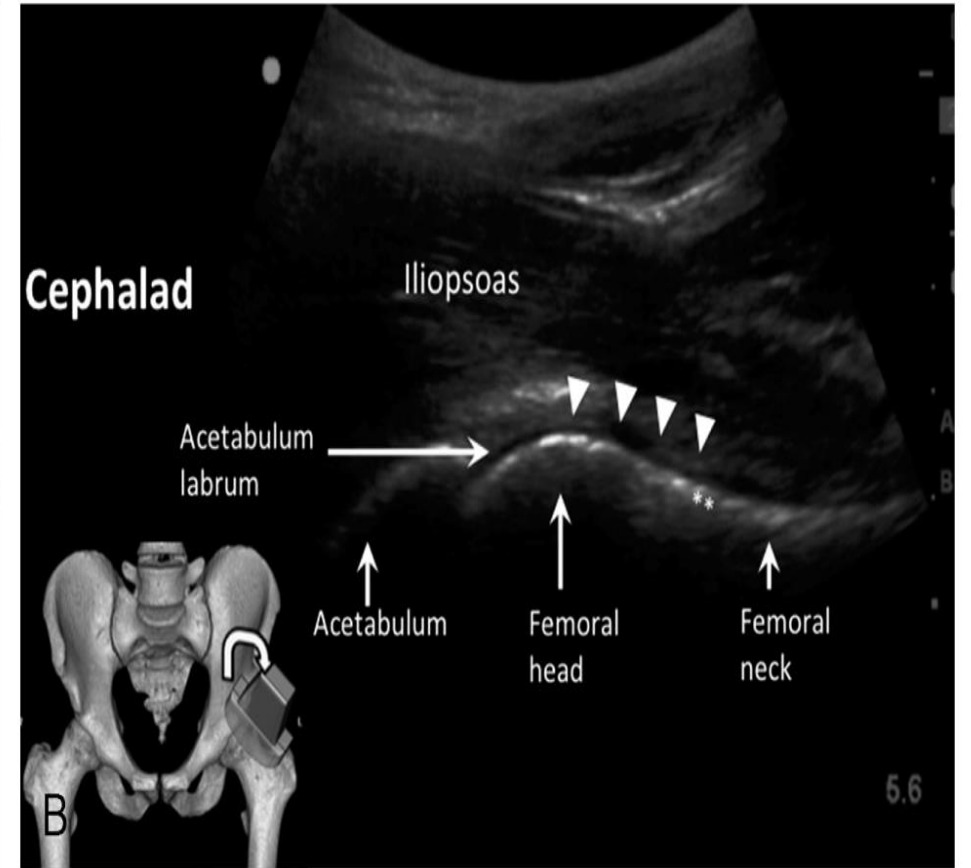
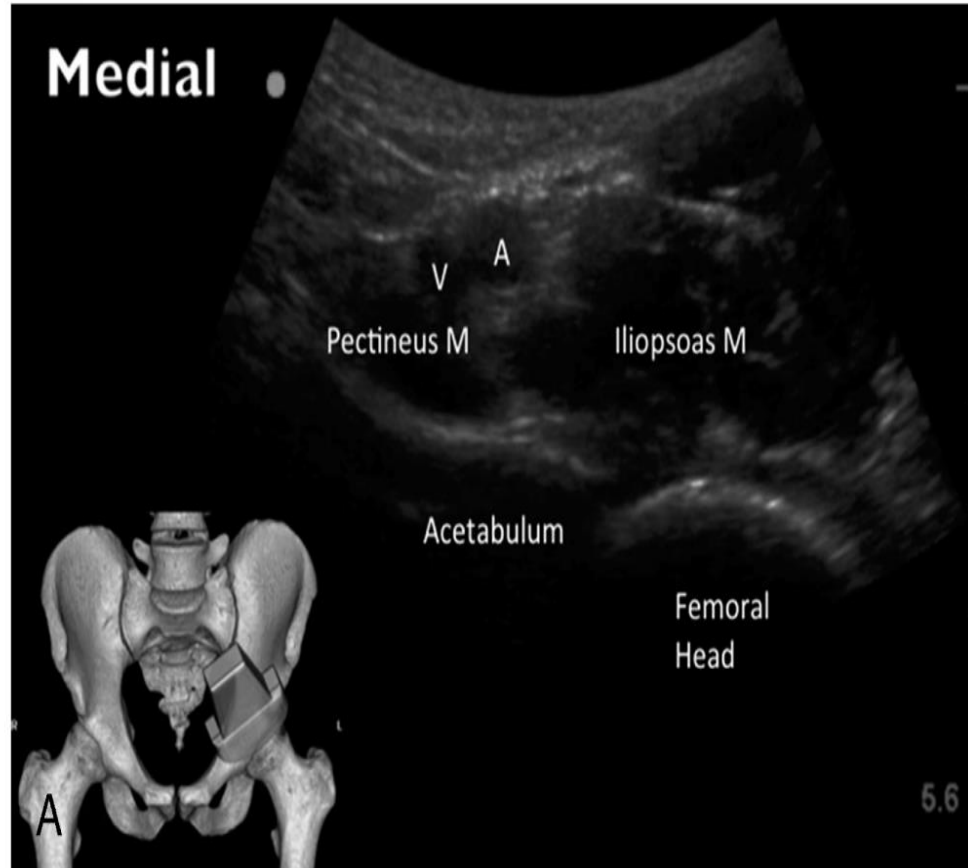


FIGURE 7. A, Sonoanatomy of the infrainguinal hip region. The position of the transducer is shown in the insert. A indicates femoral artery; V, femoral vein. B, Sonoanatomy of the anterior hip region when the transducer is placed in the long axis of the femoral neck. The arrowheads indicate the anterior recess. The position of the transducer is shown in the insert. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.

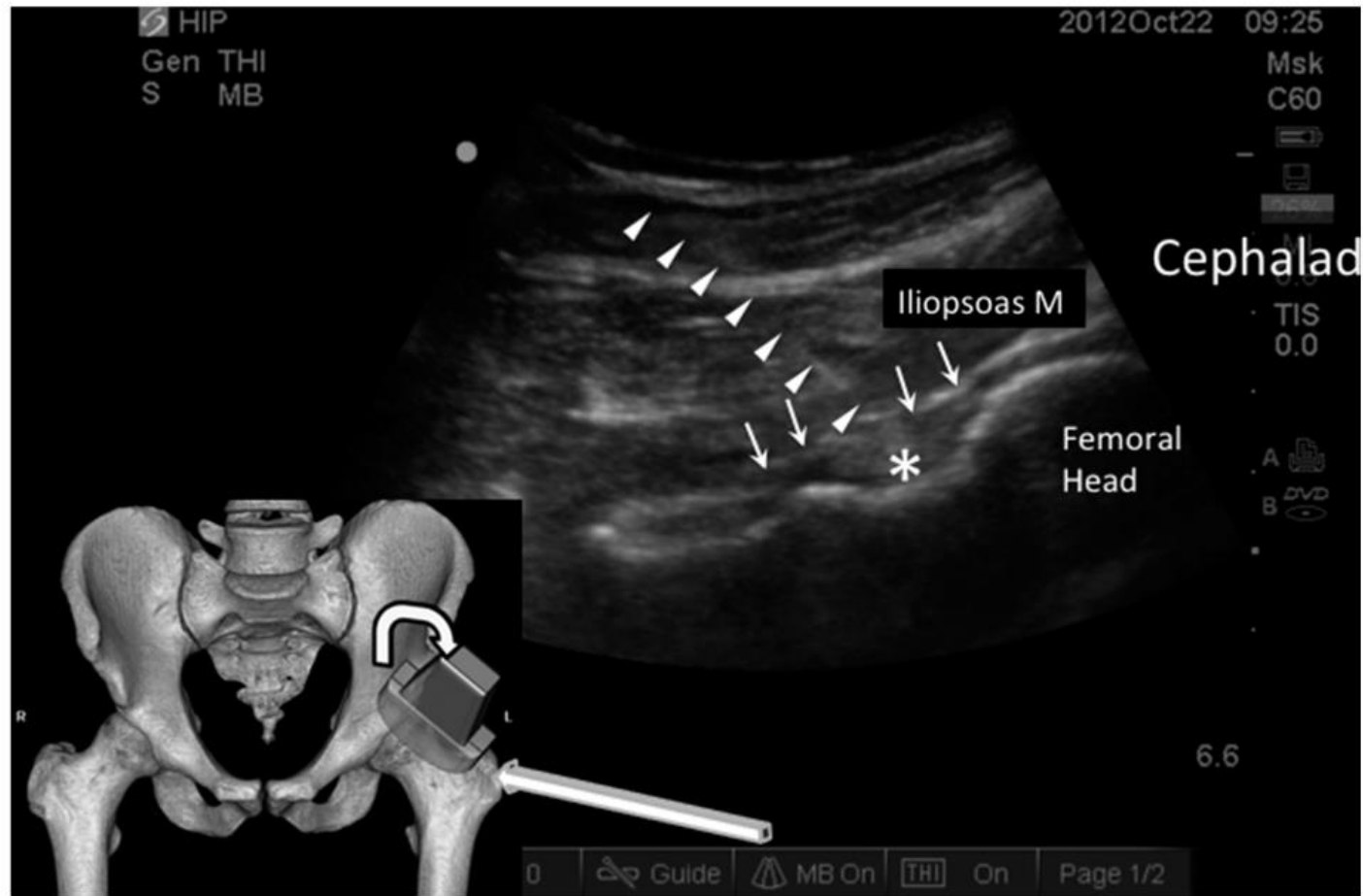


FIGURE 8. Ultrasonography shows the anterior recess (*) as the target. Small arrows outline the joint capsule, and arrowheads indicate the needle. The insert shows the position of the transducer and the needle. Reproduced with permission from *Ultrasound for Regional Anesthesia*, www.usra.ca.



TABLE 3. Risk of Injection Following Hip Arthroplasty With Previous Intra-articular Steroid Injection

Authors	Study Period	Matching Cohort	THR With Previous Injection	Location of Procedure	Infection
Kaspar and de V de Beer ⁴¹	1995–1998	Yes	40	XR	Overall: 30 vs. 7.5% Deep: 10 vs. 0%
Sreekumar et al ⁴²	1997–2004	Yes	66	XR	NS
McIntosh et al ⁴³	1998–2002	Yes	217	XR	NS superficial and deep
Chitre et al ⁴⁴	1996–2000	No	36	OR	Superficial-1
Sankar et al ⁴⁵	2002–2009	No	40	OR	Superficial-1

THR indicates total hip arthroplasty; XR, radiological suite; OR, operating room; NS, no significant difference.

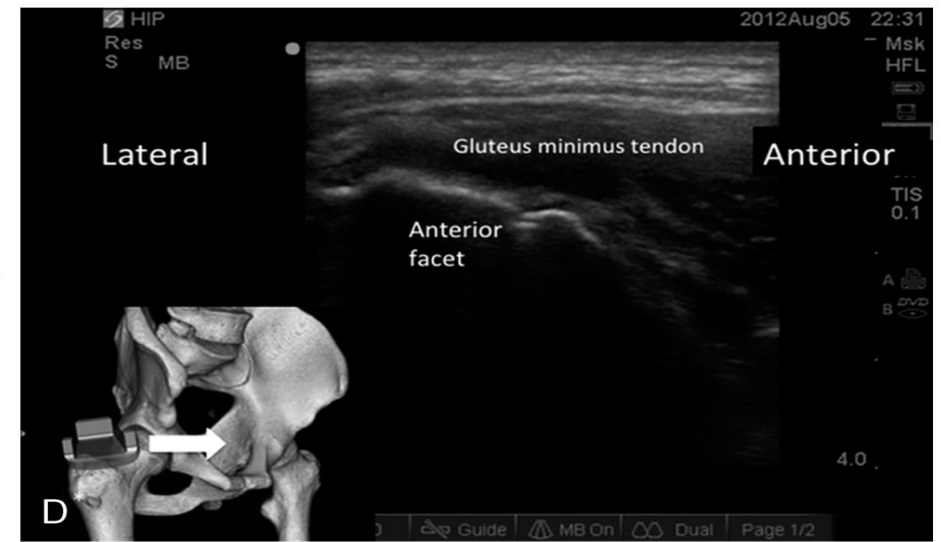
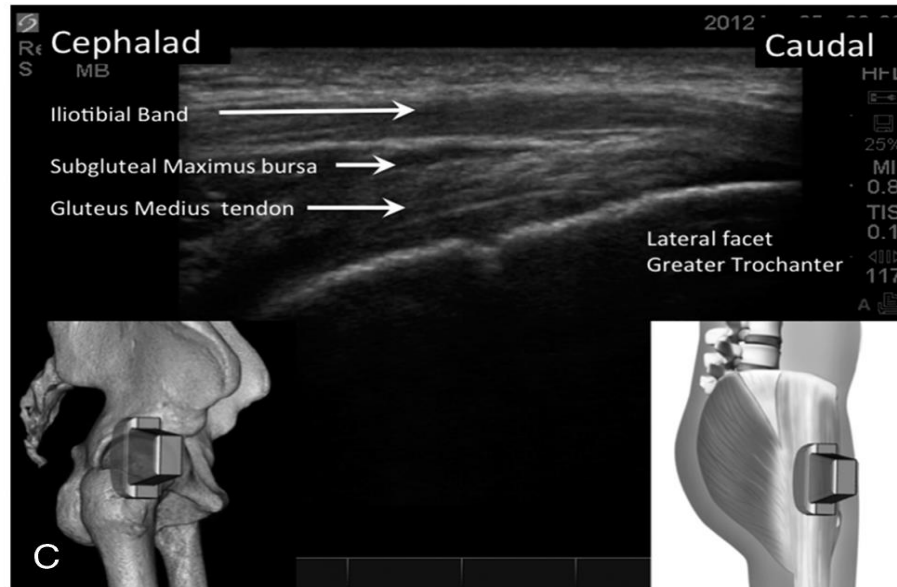
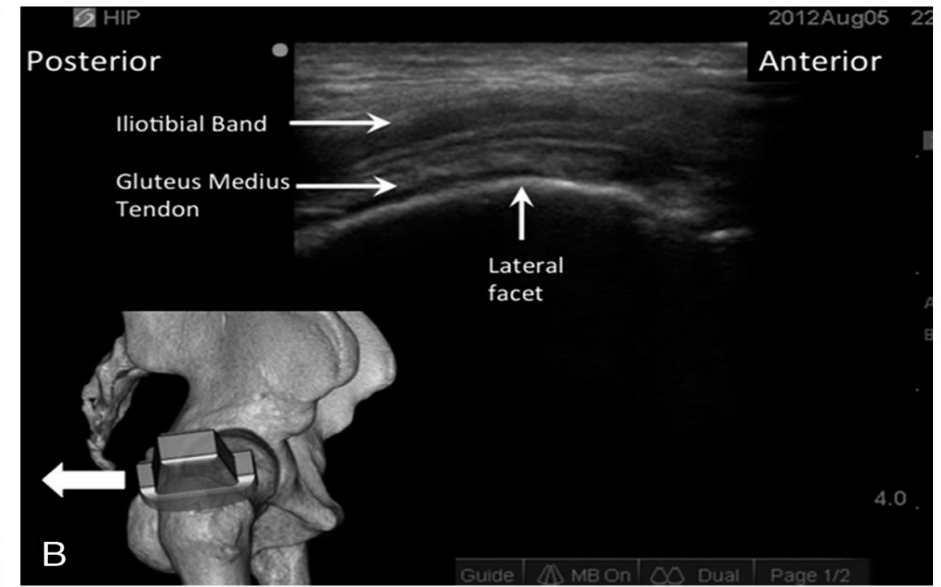
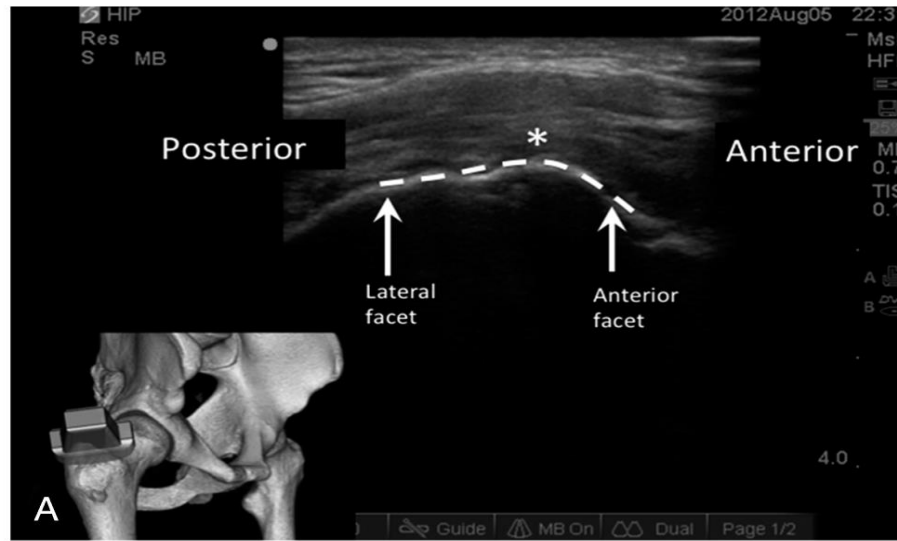


FIGURE 9. A, Ultrasonography shows the junction (*) between the anterior and lateral facets of the GT (dotted line). The position of the transducer is shown in the insert. B, Ultrasonography shows the gluteus medius tendon in short axis. The position of the transducer shown in the insert is posterior to that shown in A. C, Ultrasonography shows the SMAb. Note that the axis of the transducer is aligned with the long axis of the IT band as shown in the insert. D, Ultrasonography shows the gluteus minimus tendon. Note that the position of the transducer is anterior to that shown in A. Reproduced with permission from Ultrasound for Regional Anesthesia, www.usra.ca.



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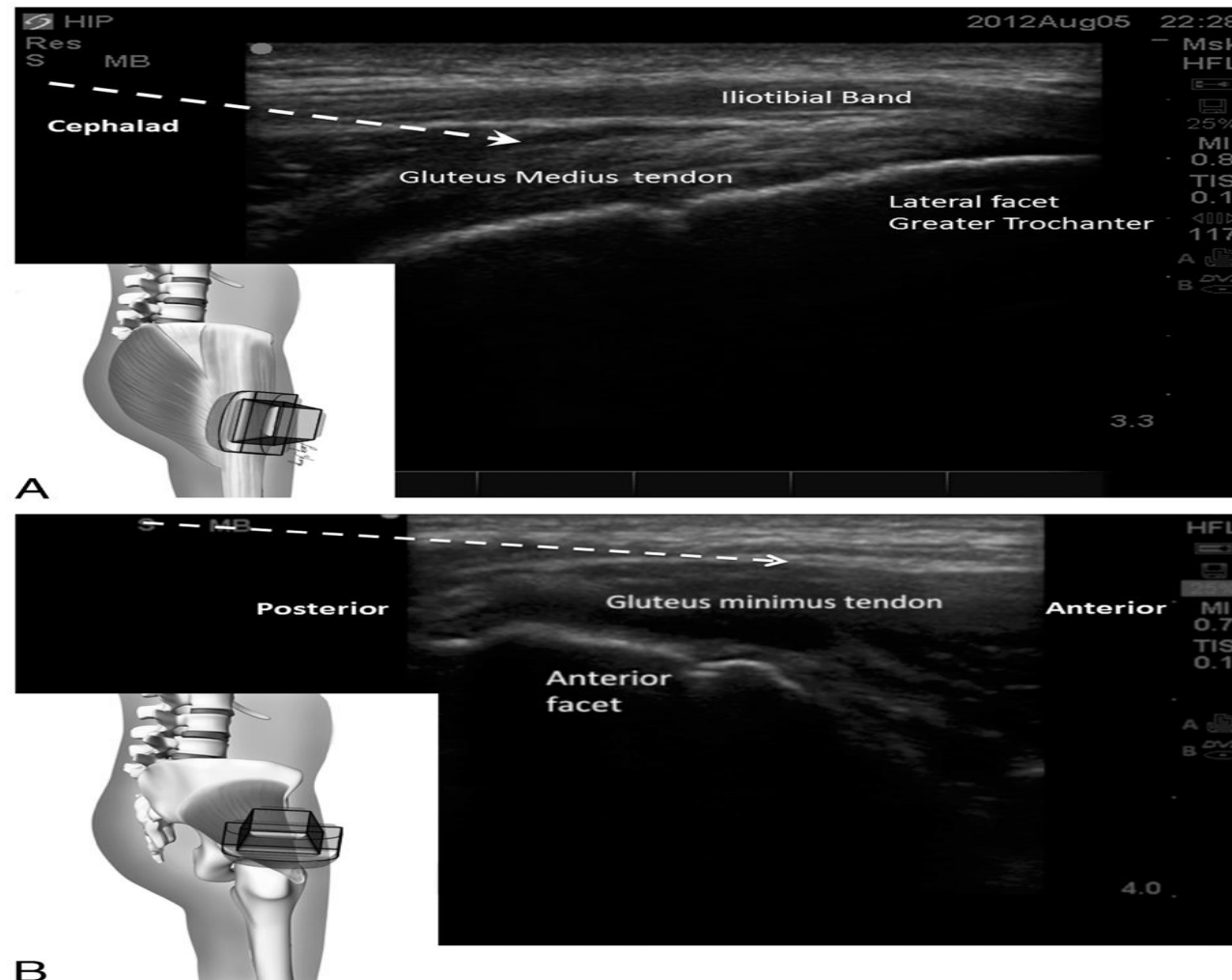


FIGURE 10. A, Ultrasonography shows the target for the peritendinous injection for gluteus medius. The dashed arrow shows the path of the needle inserted in-plane from cephalad to caudal direction. The insert shows the ultrasound probe position. B, Ultrasonography shows the target for the peritendinous injection for gluteus minimus. The dashed arrow shows the path of the needle in plane from posterior to anterior direction. The insert shows the ultrasound probe position. Reproduced with permission from *Ultrasound for Regional Anesthesia*, www.usra.ca.

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