Imaging Pediatric Joints

CRYSTAL L. PARENTI, RDMS

ANN & ROBERT H. LURIE CHILDREN'S HOSPITAL OF CHICAGO

What joints can be imaged and evaluated?

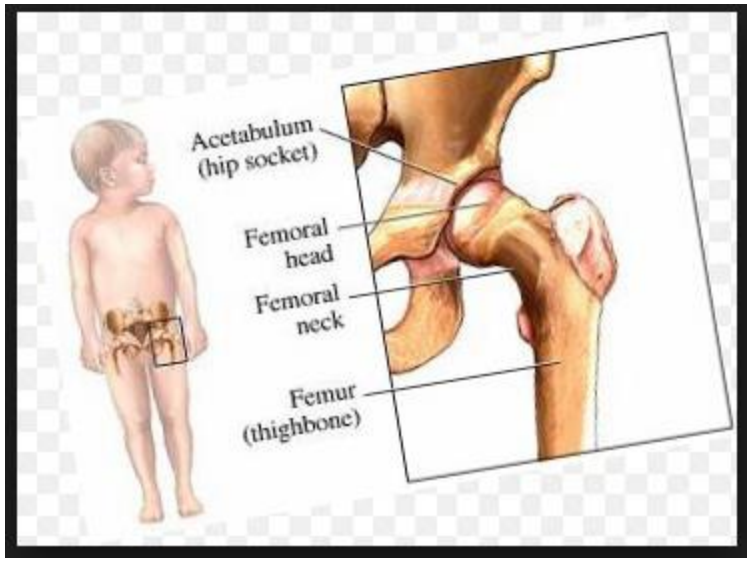
- Evaluate infant hips for DDH
- Evaluate dysplastic hips in a Pavlik Harness
- Evaluate for joint effusion
- MSK indications (synovitis, tennosynovitis, injury, tendon tears, etc)

Hip Ultrasounds

DDH

PAVLIK HARNESS

JOINT EFFUSION



DDH Indications

-breech

-hip click/clunk

-asymmetric gluteal or thigh folds

-family history

-prior positive finding

-oligiohydramnious

-neuromuscular conditions

DDH Indications

- The two strongest risk factors for DDH are:

Female with a frank breech presentation at birth

Family history of a parent and/or sibling

Limitations of Exam

- Operator dependent
- Study becomes less reliable as the ossification of the femoral head progresses
- Should not be preformed before the age of 4 weeks due to the presence of physiologic laxity of the hip

  *exception…. Unless there are clinical findings that suggest dislocation or significant instability

Required Images

- Both hips should always be examined, even during a follow up scan.

- Two planes need to be imaged:
  - coronal images at rest to assess morphology and anatomy
  - transverse views flexed with and without stress to evaluate for instability

Coronal View

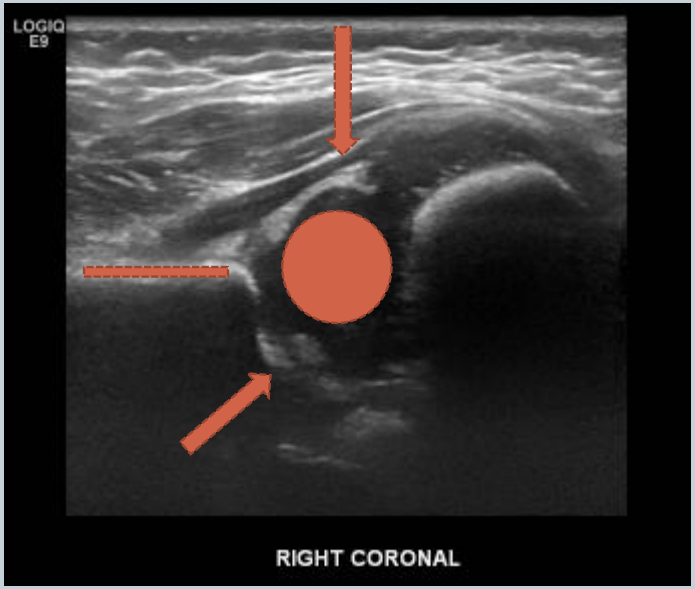
Remove the patient's pants and one side of the diaper.
Oblique the patient with the assistance of the parent.
Place the transducer (rotated 10-15 degrees) parallel to the lateral aspect of the infant's hip.
Use your left hand to hold the infant's knee in proper position and to reduce the amount of movement/kicking.

How do I work the machine?????

- Foot pedal

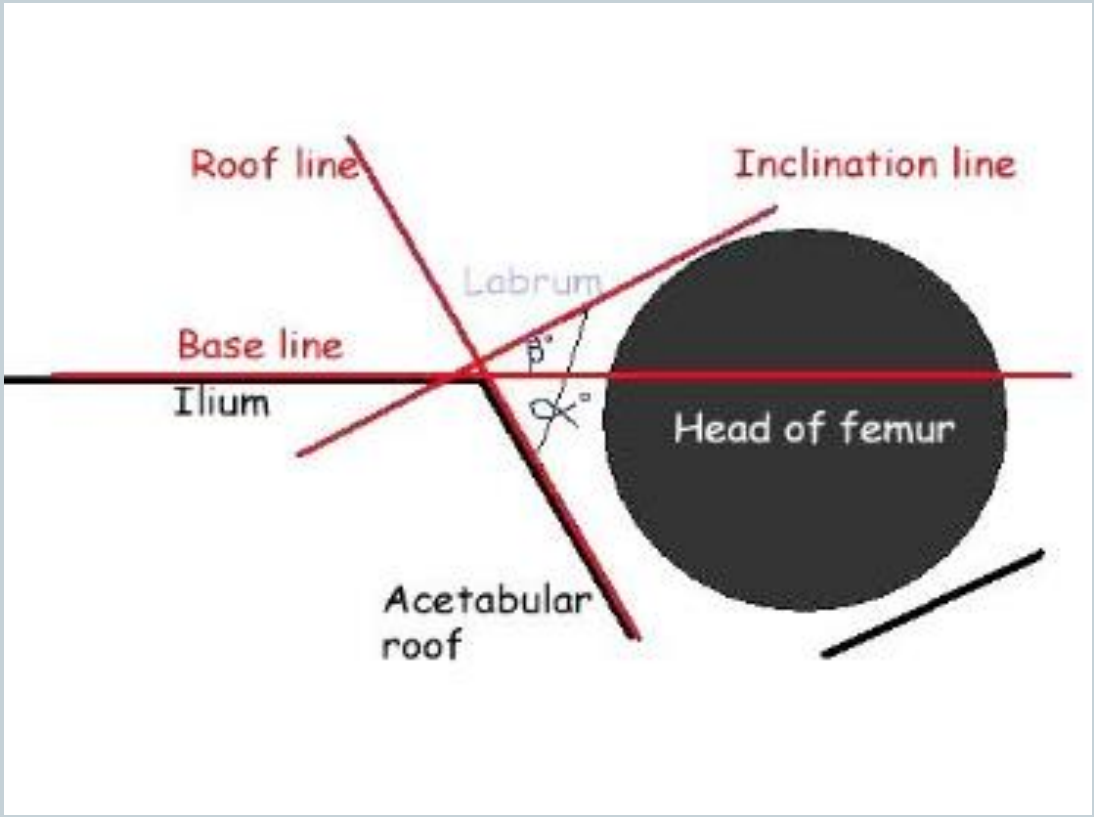
- Adjust your gain, TCG, depth, etc first.
- Get a great image, freeze and cine.
- Repeat!

Coronal View

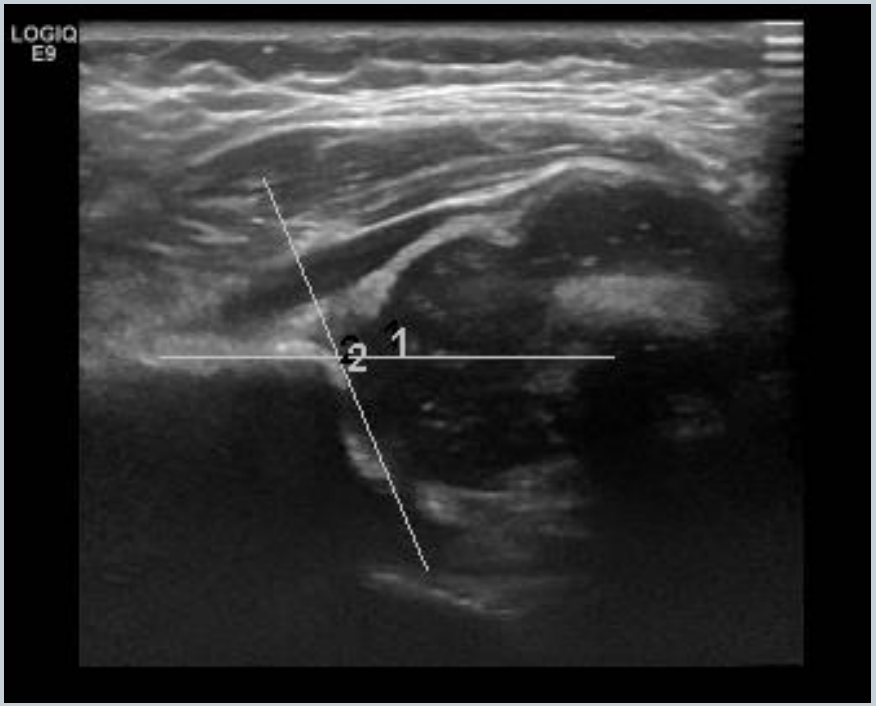


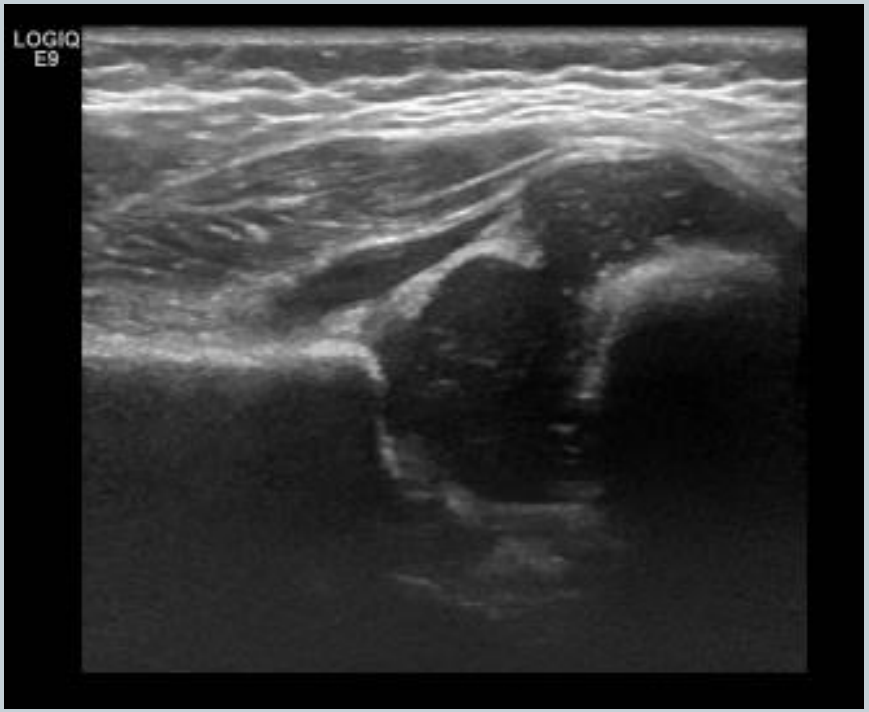
- Ilium will appear straight
- Adjust depth to visualize the deepest part of the acetabulum and cartilage
- Ensure you can see the tip of the acetabular labrum
- Note the position of the femoral head

How to Measure Hips



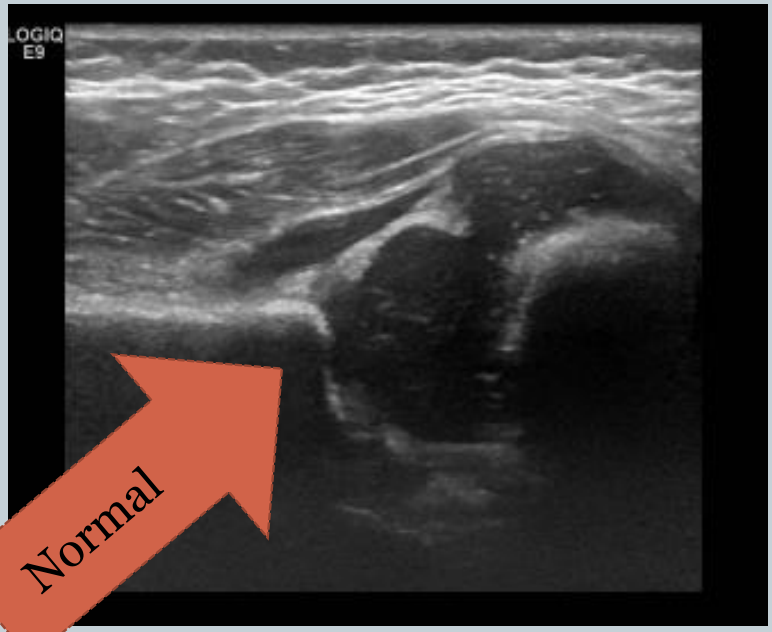
Normal Hip Anatomy

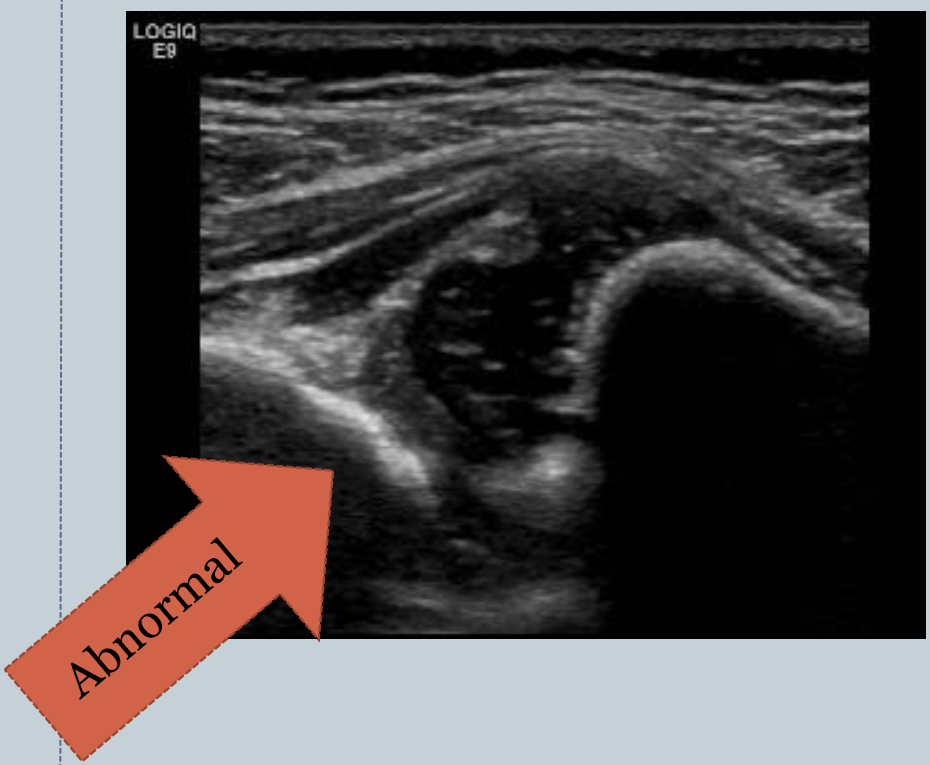




Validate by ensuring the acetabular angle is greater than 60 degrees.

Developmental Dysplasia of Hips

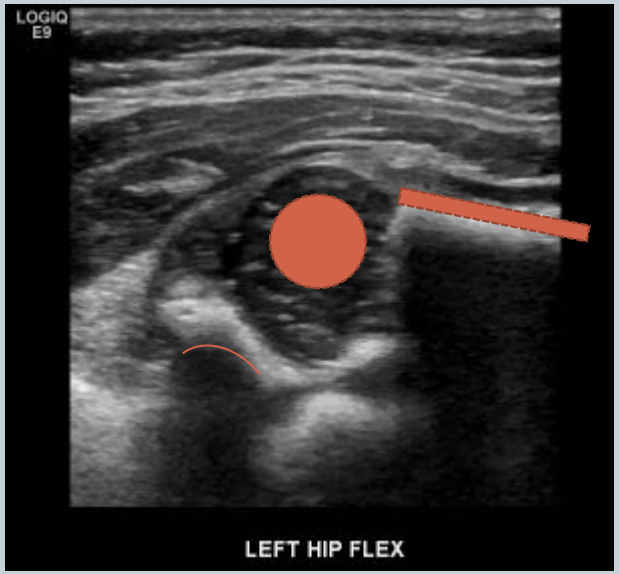




Transverse View

Lay patient supine and flex the hip and knee to 90 degrees
Place the probe (notch to the bed) perpendicular to the lateral aspect of the infant's hip.

Transverse View



- Femoral shaft terminating at the femoral head
- Femoral head will rest on the ischium
- Gently apply stress by adducting and abducting to assess for stability

Transverse Flex and Stress

The femoral head should maintain it's relationship with the posterior acetabulum during the flex and stress maneuvers.

Ultrasound of an Abnormal Hip

Rounded bony rim, poor relationship between the femoral head and acetabular roof and an alpha angle of 43 degrees.

Abnormal Transverse View

Normal

Abnormal

Graf Classification for DDH

Sonographic Anatomic Classification of Infant Hip Dysplasia

Classification	*α Angle*	*Superior Bony Rim*	*% Coverage*
Type I (mature)	>60°	Sharp	>50%
Type IIA (immature) (<3 months old)	50°–59°	Rounded	40–50%
Type II (mild–moderate) (>3 months old)	50°–59°	Rounded	40–50%
Type IIC (critical zone dysplasia)	43°–49°	Rounded	40–50%
Type III (severe dysplasia: subluxation)	<43°	Rounded	<40%
Type IV (dislocation)	<43°	Rounded	0%

References

Harcke, H.T., Hip in Infants and Children, Clinics in Diagnostic Ultrasound, 1995, No.30, pp 179 -199.

Millis, M.B., et al, Use of Ultrasonography in Dysplasia of the Immature Hip, Clinical Orthopaedics and Related Research, 1992, No. 274, pp 160 - 171.

Graf, R., Guide to Sonography of the Infant Hip, Thieme, 1987, pp 31 - 78.

Harcke, H.T., et al, Infant Hip Sonography: Current Concepts, Seminars in Ultrasound, CT and MRI, Vol. 15, No. 4, Aug. 1994, pp 256 - 263.

CLOSE ✕

DDH at Lurie Children's

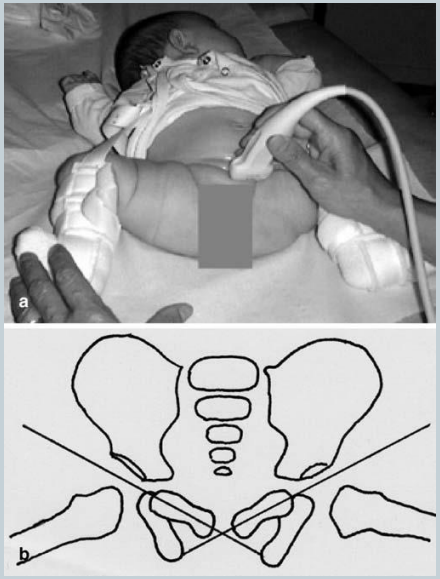
- In 2015 we at Lurie Children's Hospital and our off sites scanned a combined total of 935 patients to evaluate for DDH.
- Of those patients, 73 had positive findings that either required further repeat imaging or were referred to Ortho for treatment.
- Additionally, we performed 42 ultrasounds of the hips in a Pavlik Harness to evaluate for progress in treatment.

Ultrasound and The Pavlik Harness

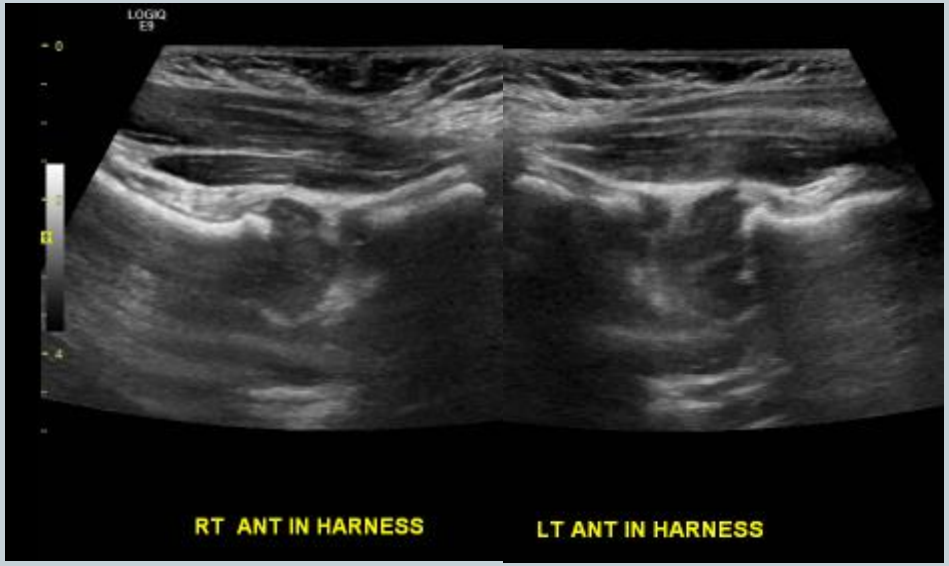
- Ultrasound is very effective in increasing the accuracy of clinical exams by controlling the treatment of abnormal hips.
- It is likely to decrease the duration of treatment, the number of x-rays and is able to ensure a quick detection of persistent dislocations.
- The ultrasound is easily performed with proper training.
- Additionally this approach does not apply any strain to the hip and is extremely well tolerated.
- A normal anterior scan will show the femoral head, the femoral metaphysis and the pubic symphysis horizontally aligned.
- If the hips are dislocated, the femoral head will be posteriorly displaced.

Evaluating Hips in a Pavlik Harness

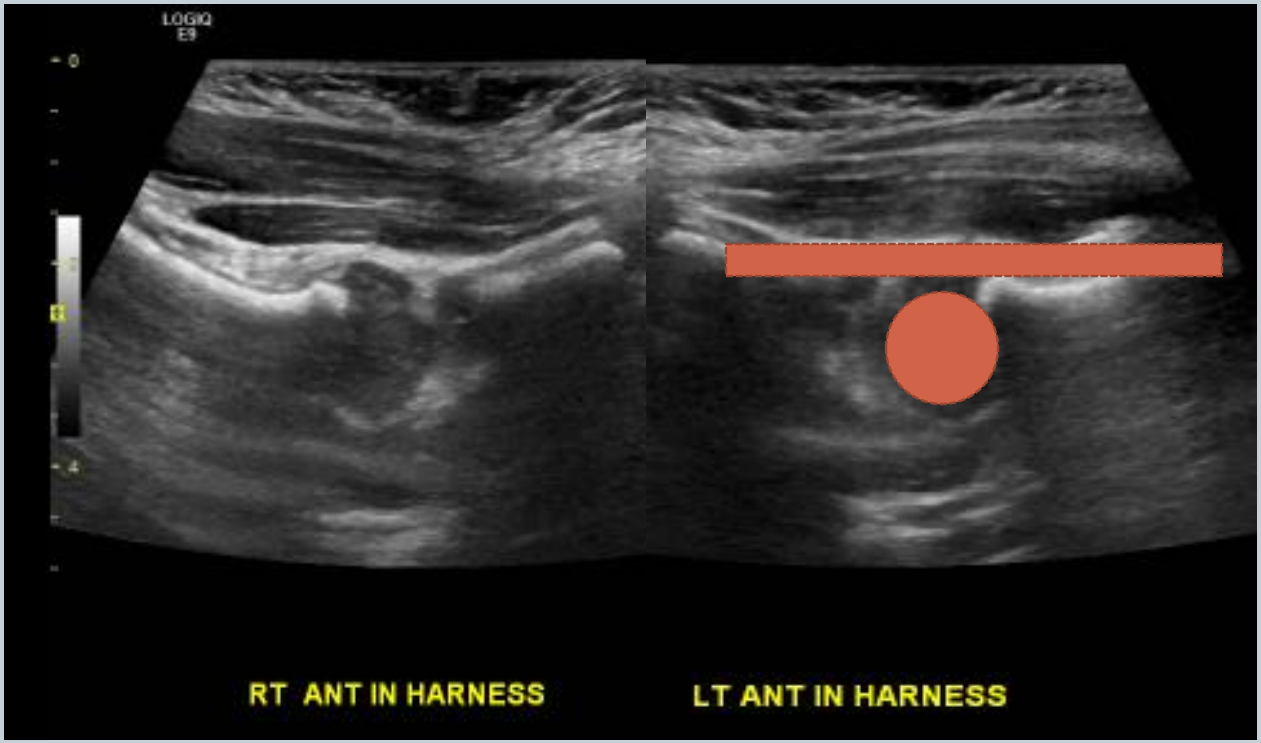
The anterior scan should show proper alignment of the pubic bone and femoral metaphysis.



Dual image in harness

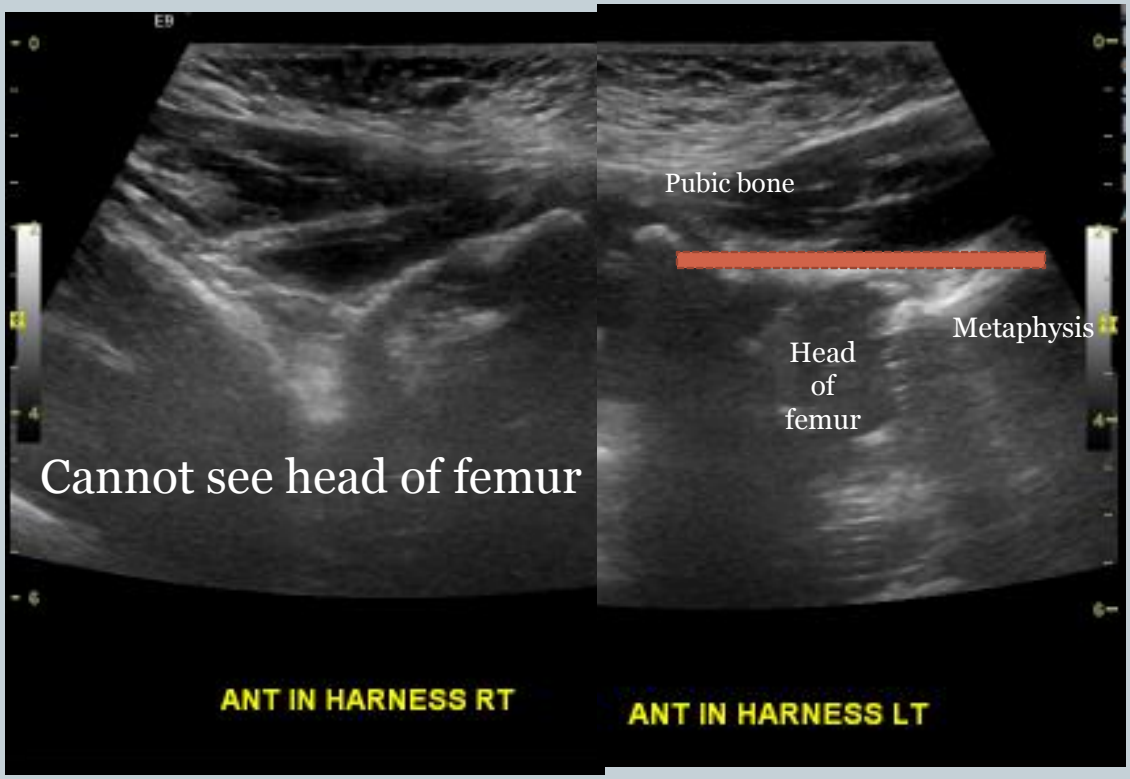


Evaluating hips in harness



1.) Alignment of pubic bone with femoral metaphysis
2.) Femoral head

Dislocated hip in harness



Confirmed with a coronal view

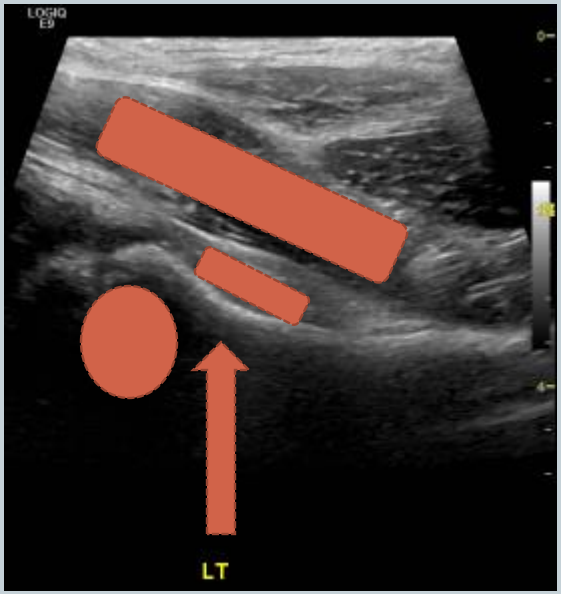
Hip Effusions

- Transient Synovitis is the most common cause of acute hip pain in children ages 3-10 years old.
- It affects boys twice as often as girls.
- Symptoms include limp, refusal to bear weight and pain.
- Patients may also have a recent history of an upper respiratory or ear infection .
- Ultrasound is especially useful to identify an effusion that causes bulging of the anterior joint capsule.

Scanning for a hip effusion

- Patient lying in a supine position with legs extended
- Use a high frequency linear transducer
- Place the transducer in a sagittal oblique plane, parallel to the long axis of the femoral neck.

Scanning for a hip effusion



- In this view, the femoral head, femoral neck, capsule, and iliopsoas muscle are visualized
- Always evaluate both hips and use the split screen function.

Why do you always scan the other side???

- Capsular thickening may be present secondary to an inflammatory process on the affected side.
- The presence of an anechoic effusion may be difficult to distinguish from the joint capsule.

- Basically, you want to be able to correctly determine the normal anatomy and tissue architecture

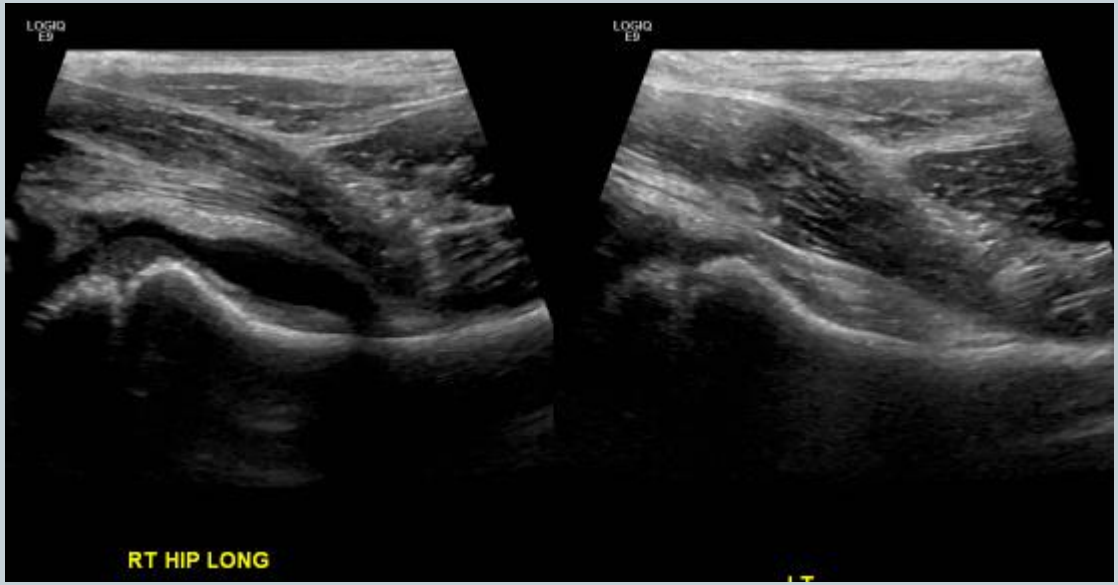
Positive hip effusion

- The effusion fluid may have variable echogenicity, appearing either hypoechoic, anechoic, or hyperechoic, which distends the joint capsule.
- The presence of a hip effusion is defined as an anterior synovial space thickness greater than 5 mm, measured from the concavity of the femoral neck to the posterior surface of the iliopsoas muscle, or greater than 2 mm difference when compared to the asymptomatic contralateral hip.

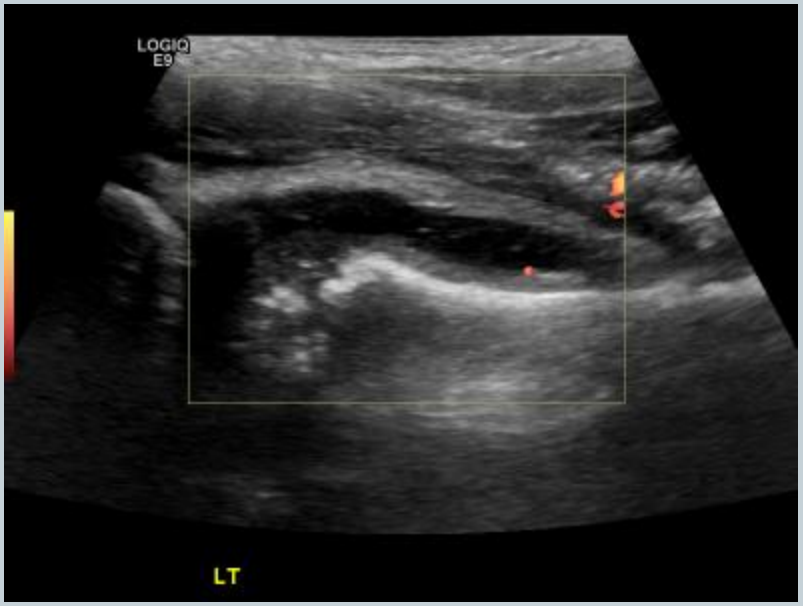
Hip Effusion Case Study

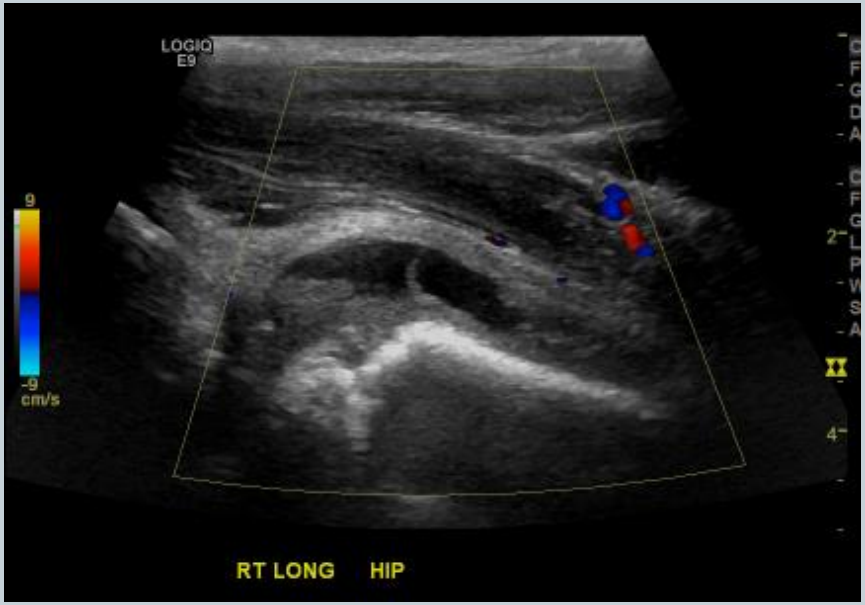
- A 7 year old male presents to the Emergency Department with a 3 day history of worsening right hip pain while walking.
- After physical examination, a portable ultrasound was ordered to evaluate for a hip effusion.
- The patient was scanned in his room in the Emergency Department and the family was able to receive results quickly and with almost no discomfort to the patient.

Positive hip effusion



Complex Hip Effusions





Knee Ultrasounds

KNEE EFFUSIONS, ANATOMY AND PATHOLOGY

SCANNING TECHNIQUE

Knee Effusion Anatomy and Scanning

You will want to evaluate the knee from all sides:

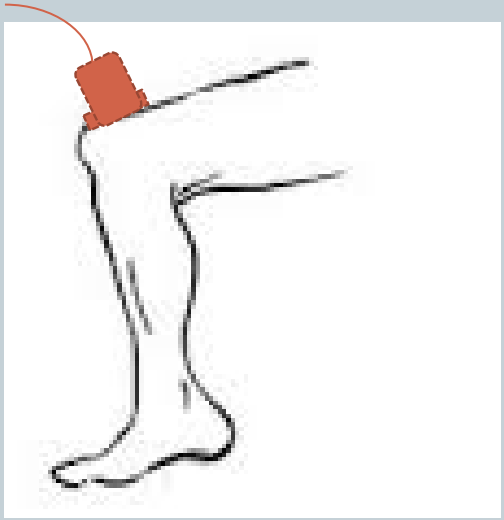
- Anterior
- Medial
- Lateral
- Posterior

Choose a high frequency linear transducer.

Have the patient lay supine with their head slightly elevated for comfort.

Knee Effusion Anatomy and Scanning

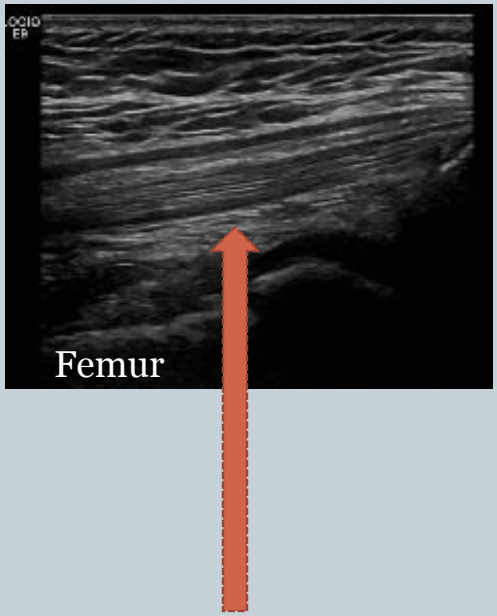
Anterior Knee



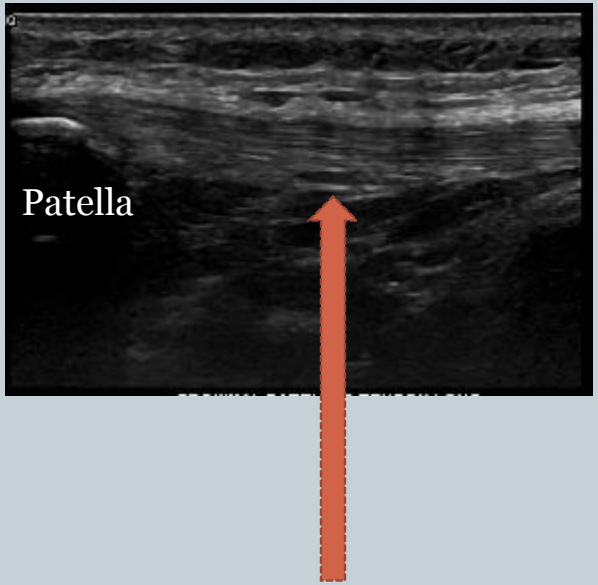
Most common location for an effusion is between the distal femur and quadriceps tendon.
You will want to scan in a sagittal orientation over the suprapatellar region of the patients knee with the knee slightly bent.

Knee Anatomy and Scanning

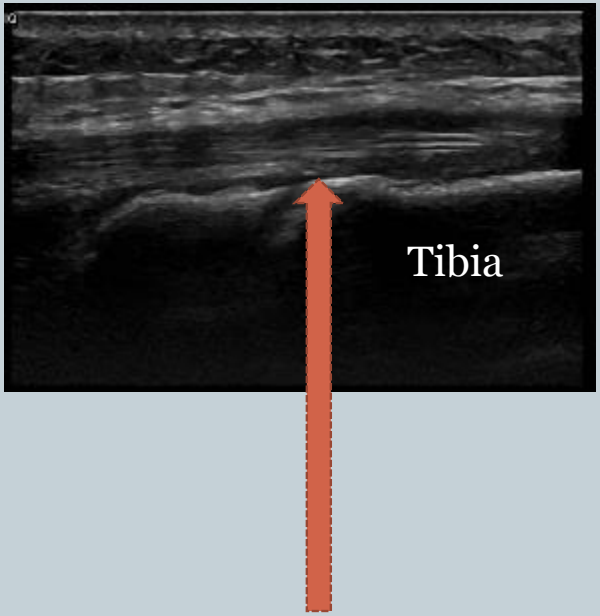
Anterior Knee Anatomy
3 Images



Quadriceps Tendon



Proximal Patellar Tendon



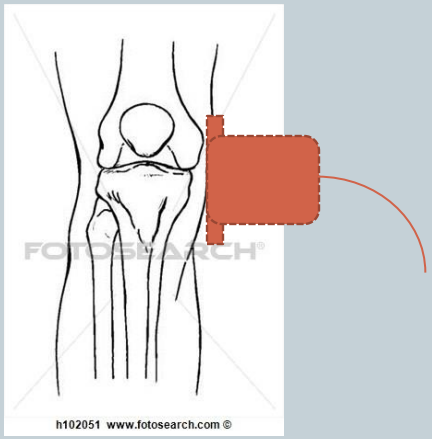
Distal Patellar Tendon

Knee Anatomy and Scanning

Medial Knee

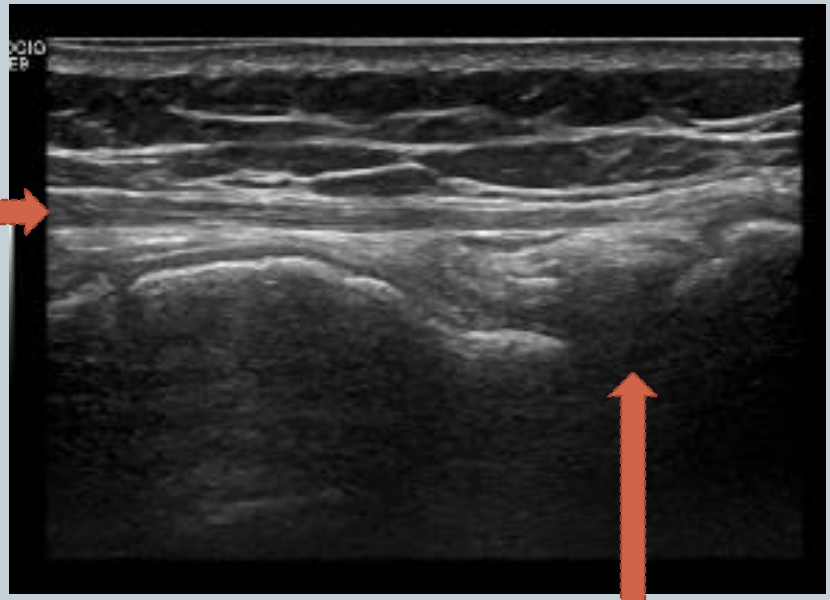
Medial Collateral Ligament

Medial Meniscus



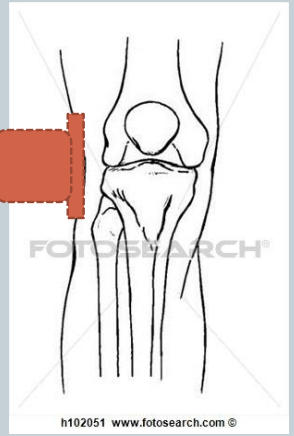
Knee Anatomy and Scanning

Lateral Knee



Lateral Collateral Ligament

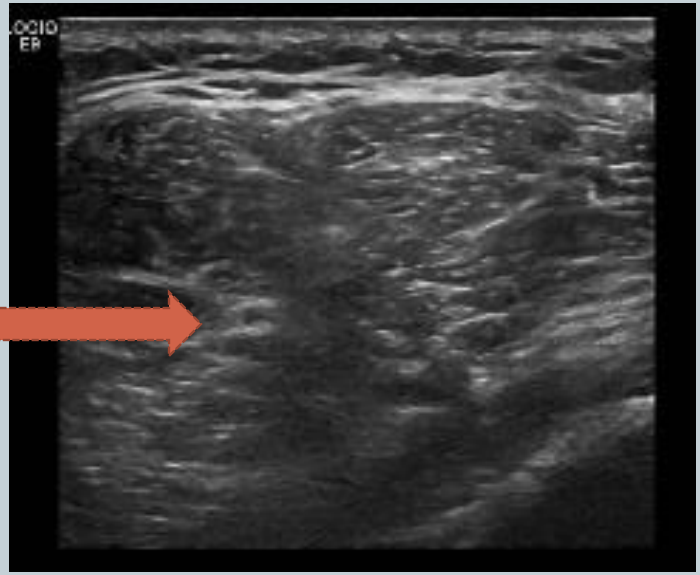
Lateral Meniscus

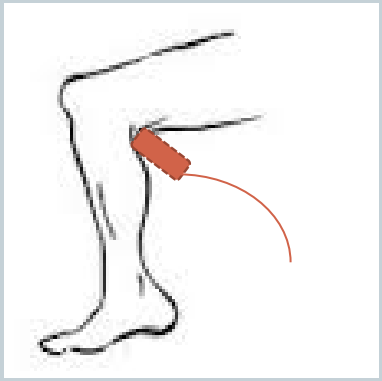


Knee Anatomy and Scanning

Posterior Knee

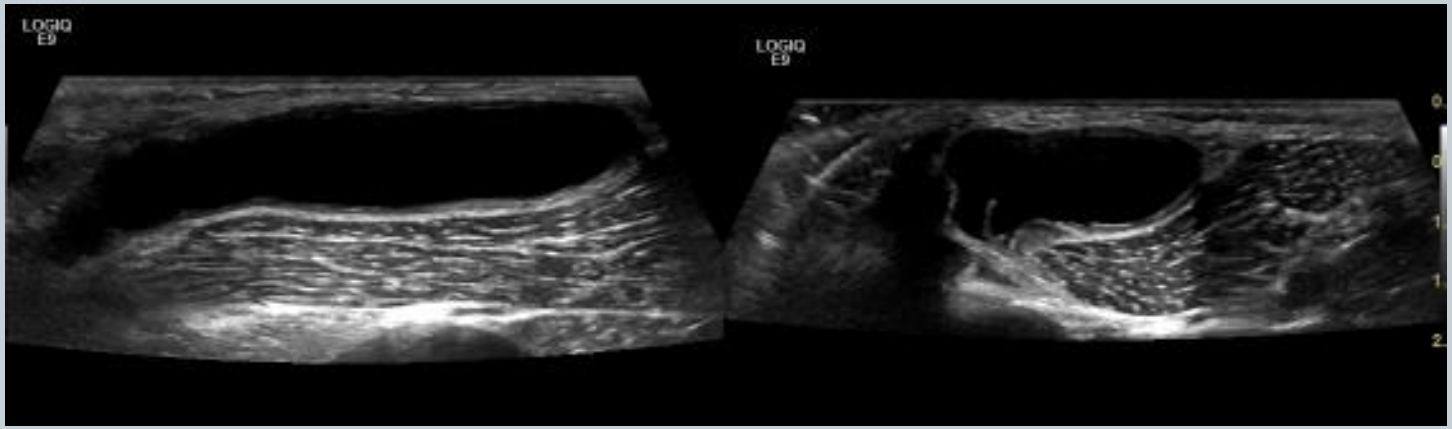
Vessels





Evaluate for a Baker's Cyst

Baker's Cyst



Important Anatomy Information

- Must know your normal anatomy for the age group you are imaging.
- Cartilage in children can appear to be fluid.
- Very important to image both the symptomatic and asymptomatic sides.

Effusion vs. Normal Cartilage

Right Knee

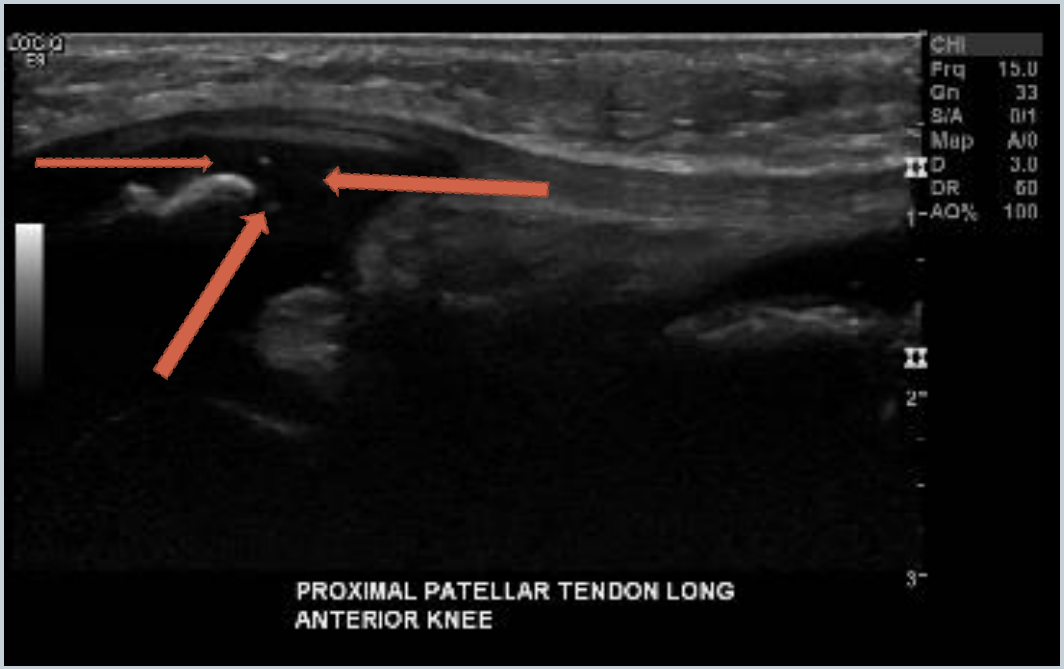
Left Knee

Effusion vs. Normal Cartilage

Left

Right

How else can you tell???



Echogenic walls of blood vessels
Capsular appearance

Knee Effusion Case Study

- Patient with a complex past medical history presents to the Emergency Department with pain and tenderness while moving right leg, mostly located over the distal portion of the femur.
- Upon physical examination it was noted that the knee appeared to be warm and swollen.
- An X-ray was ordered to rule out a fracture and came back negative.
- An ultrasound was then ordered to evaluate for a joint effusion.

Knee Effusion

Pediatric Musculoskeletal Ultrasounds

BENEFITS
COMMON USES
JIA AND SYNOVITIS
JOINT FLUID

Pediatric Musculoskeletal Ultrasounds

- Over the last two decades, physicians have relied on ultrasound to evaluate for musculoskeletal conditions in the adult population.
- Only recently has it become more utilized and attractive to pediatric rheumatologists.
- Compared to physical exam and other imaging modalities, ultrasound seems to be the superior choice.

Benefits of Ultrasound vs. MRI

- Can be preformed rapidly.
- Young patients cannot tolerate laying still for an MRI.
- During an ultrasound, the patient can move other extremities.
- No sedation needed.
- Lower cost.
- Ultrasound's real time imaging allows for dynamic assessment of the joint and tendon.

Disadvantage

- Inability to visualize pathology inside the bone or at sites where it is not possible to position the probe.
- User dependent!!
- In order to master this skill, there needs to be proper education and ample practice.

Common Uses for MSK Ultrasound

- Assess soft tissue
- Detection of fluid collections
- Visualize muscle and fascia
- Evaluate tendons, ligaments, synovium, costal cartilage and bone surface
- Assist in guidance of aspiration, biopsy and injection treatment

Transducer Selection

- High frequency linear transducer
- Ideally want a variety of small, medium and large footprints

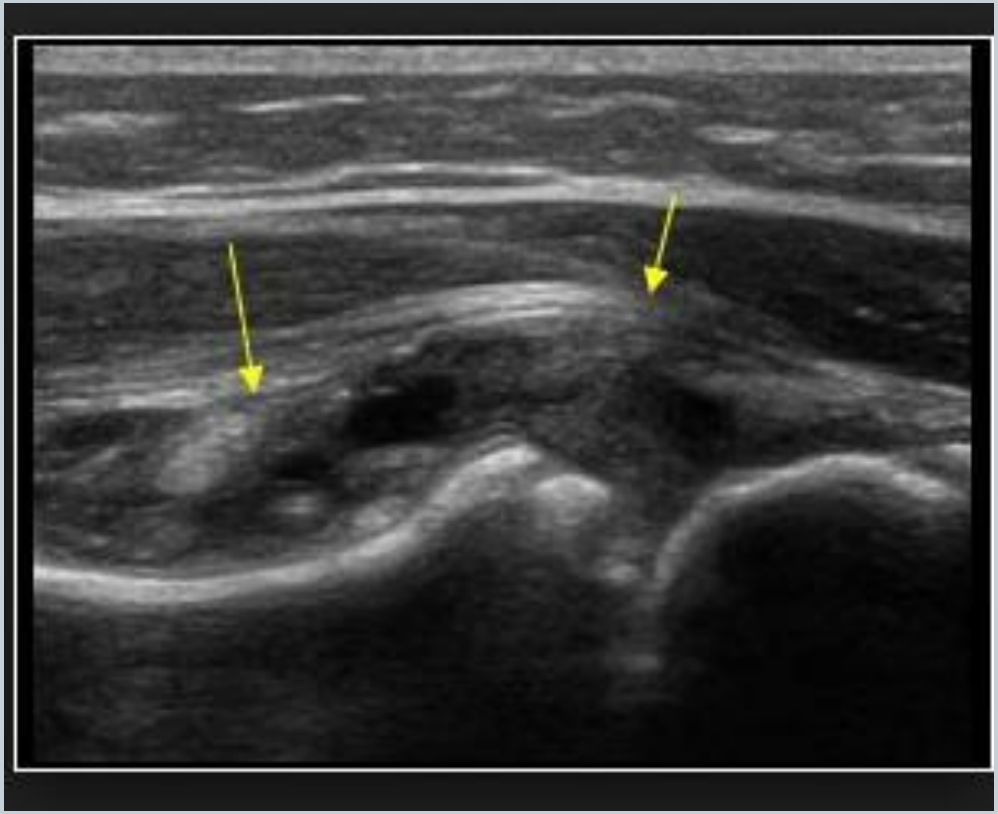
Juvenile Idiopathic Arthritis (JIA)

- Most common chronic inflammatory arthropathy in childhood
- Characterized by arthritis that persists for a minimum of 6 consecutive weeks in one or more joints, beginning before the age of 16
- Ultrasound has proven to be valuable in the early diagnosis of JIA, to follow up disease activity and for the assessment of treatment response.
- Sensitive in detecting synovitis, intra-articular effusion, cartilage edema/thinning and bony erosions

Synovitis

- The synovial membrane is an important connective tissue lining the inner surface of the joint capsule, tendon sheath and bursa
- In JIA the synovium undergoes significant changes leading to the formation of a mass of synovial tissue
- Presence of an accompanying effusion will confirm the finding and enables better visualization of the synovial thickening.

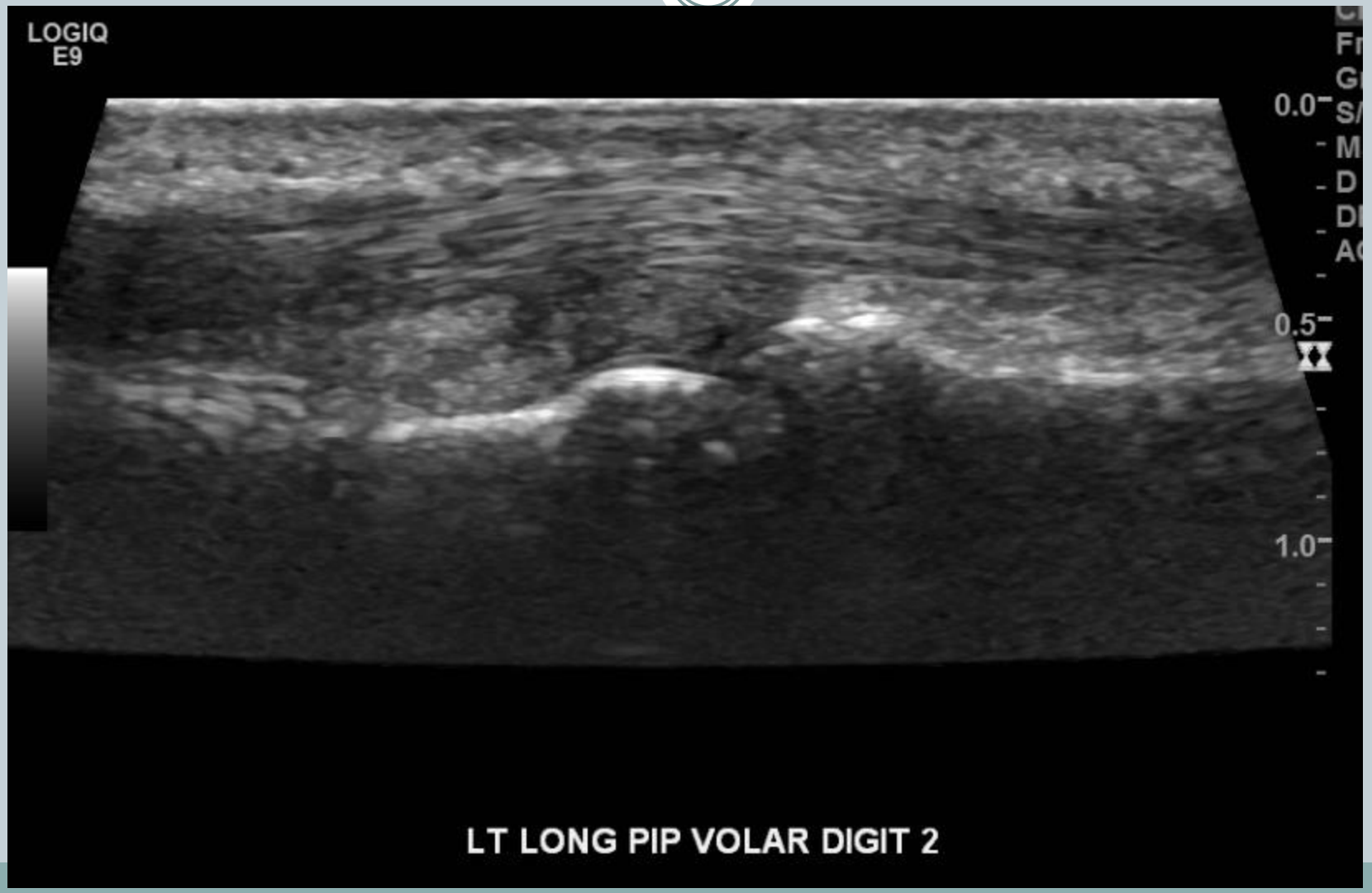
Synovial thickening and effusion of the elbow



What if there isn't an effusion???

- Presence of an abnormally thickened hypoechoic region
- Measure in a standard plane with reference to an established normal range or to the contralateral normal joint
- Use power and/or color Doppler to assess for active vs inactive synovitis

Synovial thickening without an effusion



Intra-articular Fluid

- Joint effusion is a valuable indicator of active joint disease
- Ultrasound is one of the best methods for detection of fluid
- Effusions as small as 1mL can be detected on ultrasound in hand and foot joints

Clinical use of ultrasound

- Ultrasound has greatly improved accurate needle placement from 59% by palpation guidance to 96% by MSK ultrasound guidance
- Additionally, it can give a basic estimate of fluid viscosity which in turn aides in the selection of the appropriate gauge size of the needle for fluid aspiration

THANK YOU!!