ddh

October 13, 2023

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26th Annual Pediatric Orthopaedic Surgery Symposium

will cover

- Description
- Risk factors
- Diagnosis
- Non-operative treatment
- Operative treatment

embryology

- Femur and acetabulum form from the same mesenchyme
- 7-8 weeks cleft develops
- 11 weeks hip joint is complete
  - at this point it can become dislocated.
- By 20 weeks the femur is ossified up to the lessor trochanter
- All further development occurs after birth.

postnatal hip development

- Boney acetabulum has three primary ossification centers
  - Illium, ischium, and pubis
  - Unite to form the triradiate cartilage
    - Closes at about 14.5 years in males and females

postnatal hip development

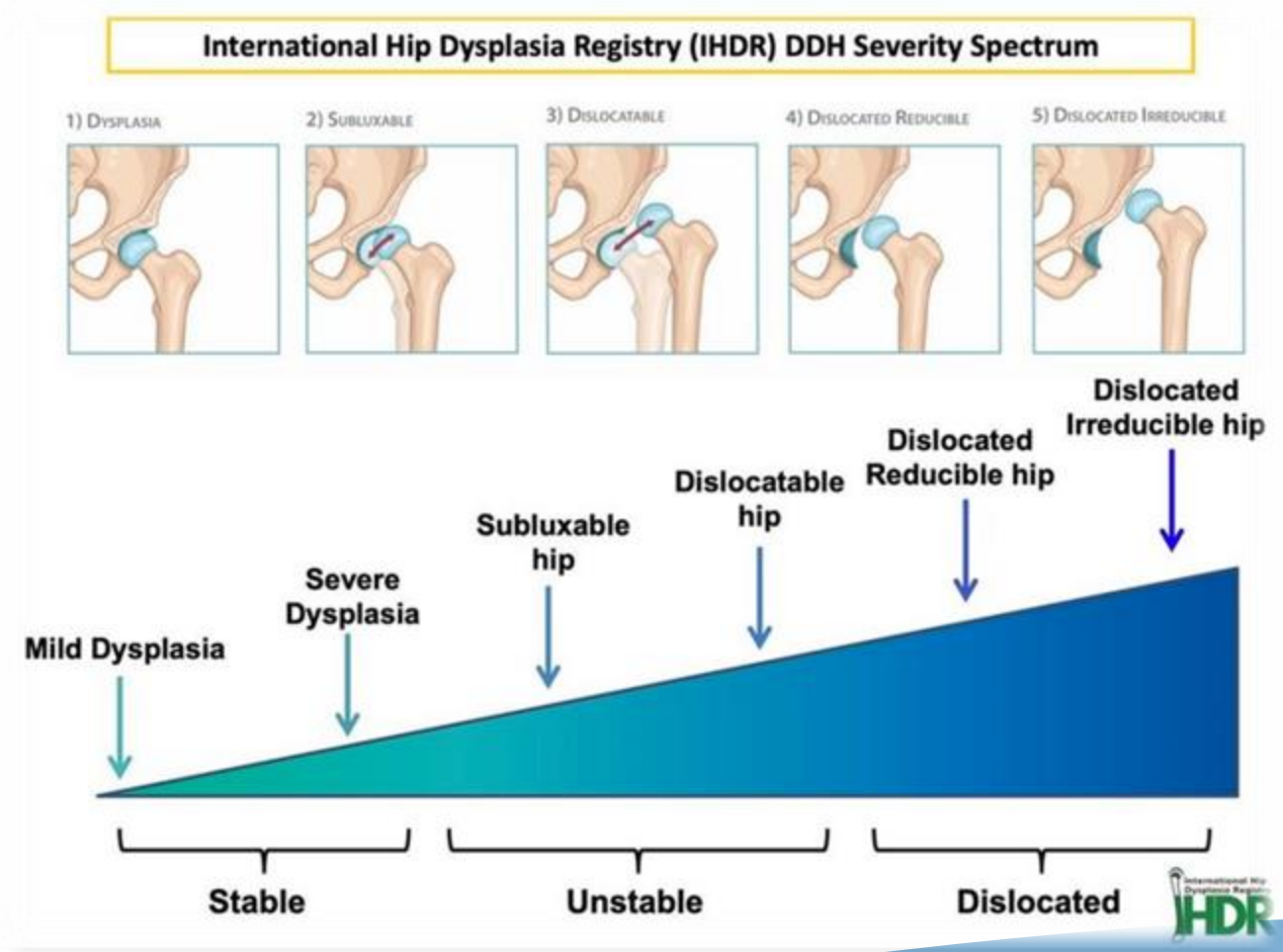
- Proximal femur has three secondary ossification centers
  - Proximal femoral epiphysis, greater trochanter, and lesser trochanter
    - Proximal femoral epiphysis starts to ossify at 3-7 months
      - Important when considering imaging choice

dayton children's

ddh

- Most common orthopaedic disorder in newborns
  - Dysplasia 1:100
  - Dislocation 1:1000
- Demographics
  - Greater in females 6:1
  - Native Americans – cultural swaddling traditions
- Left hip 60%
  - Common position is left hip adducted against mom's lumbosacral spine
- Bilateral 20%

ddh –spectrum of disease



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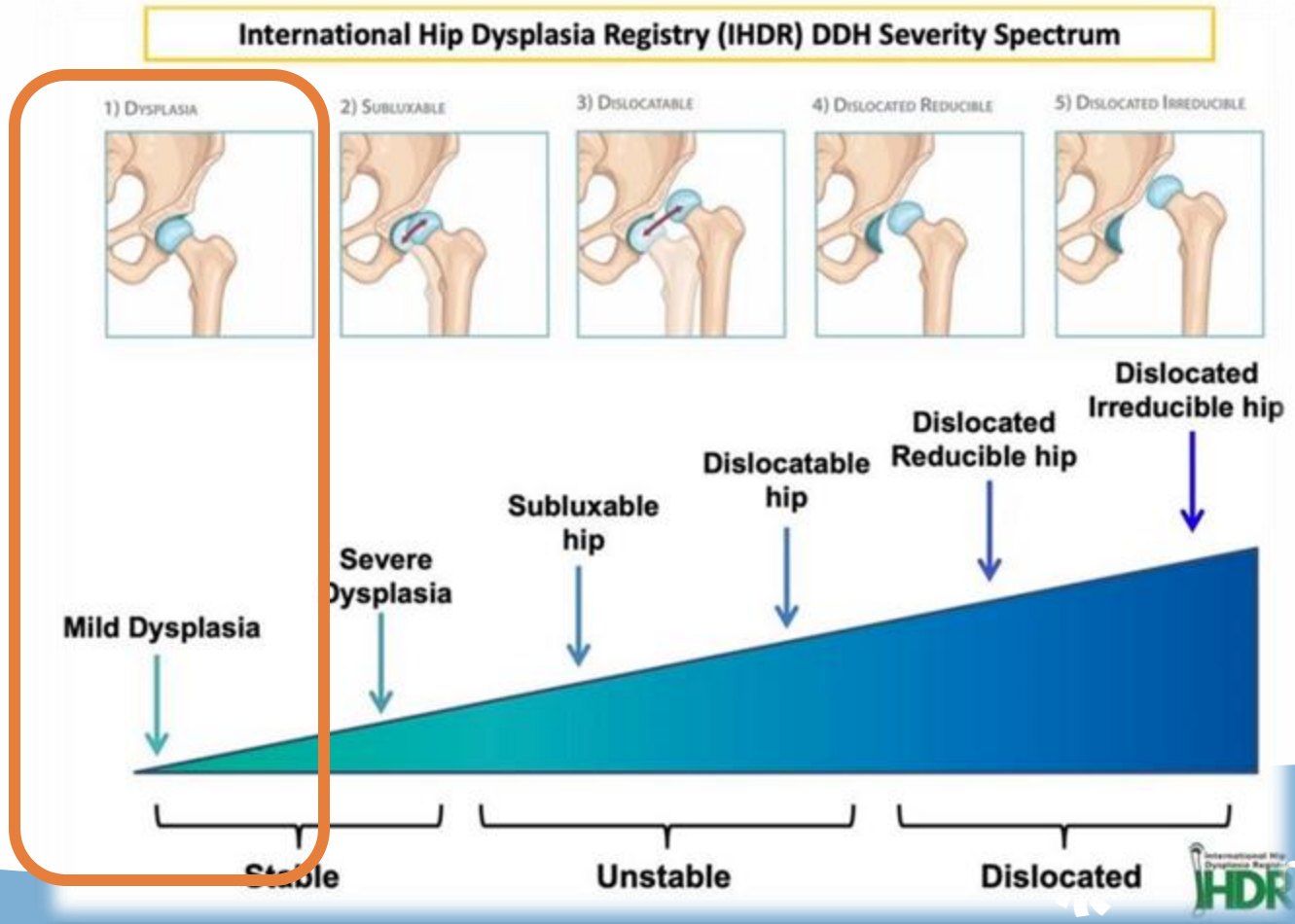
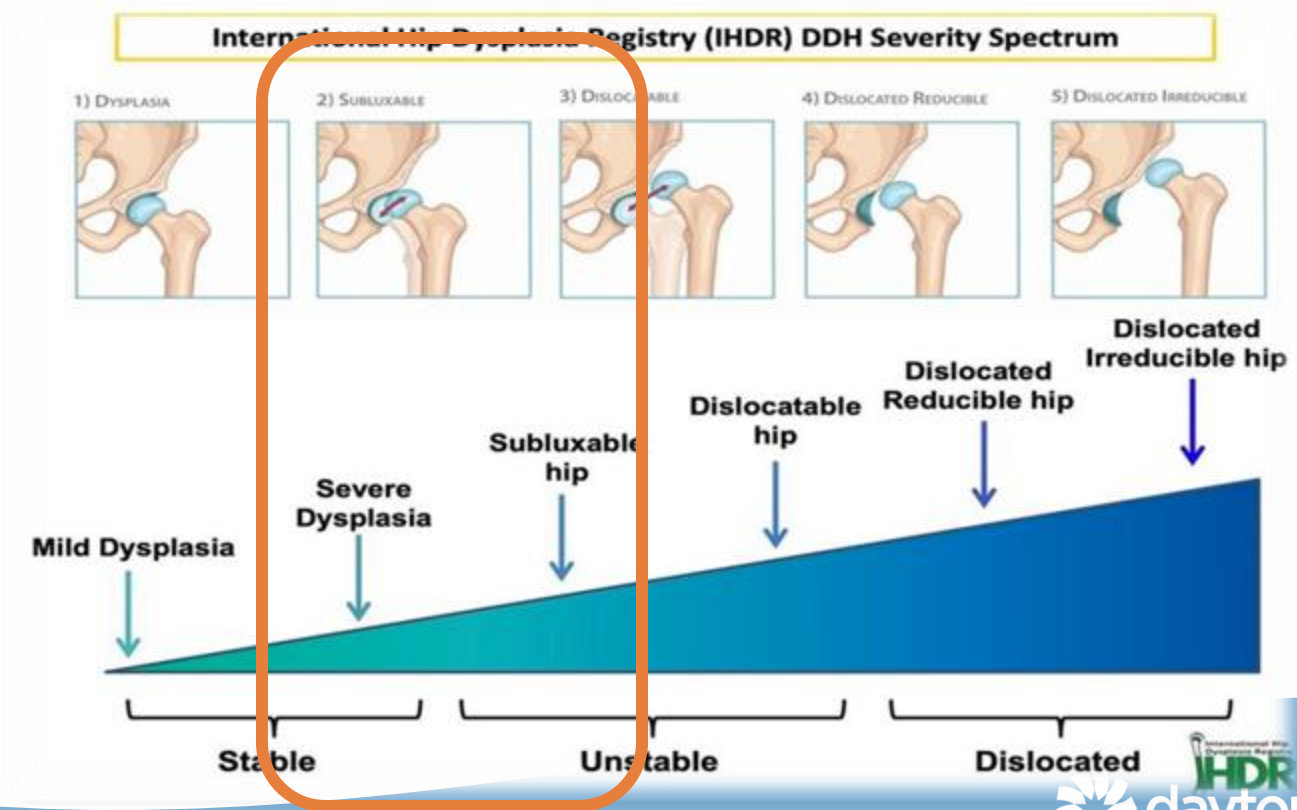
dysplasia

- Shallow or underdeveloped acetabulum



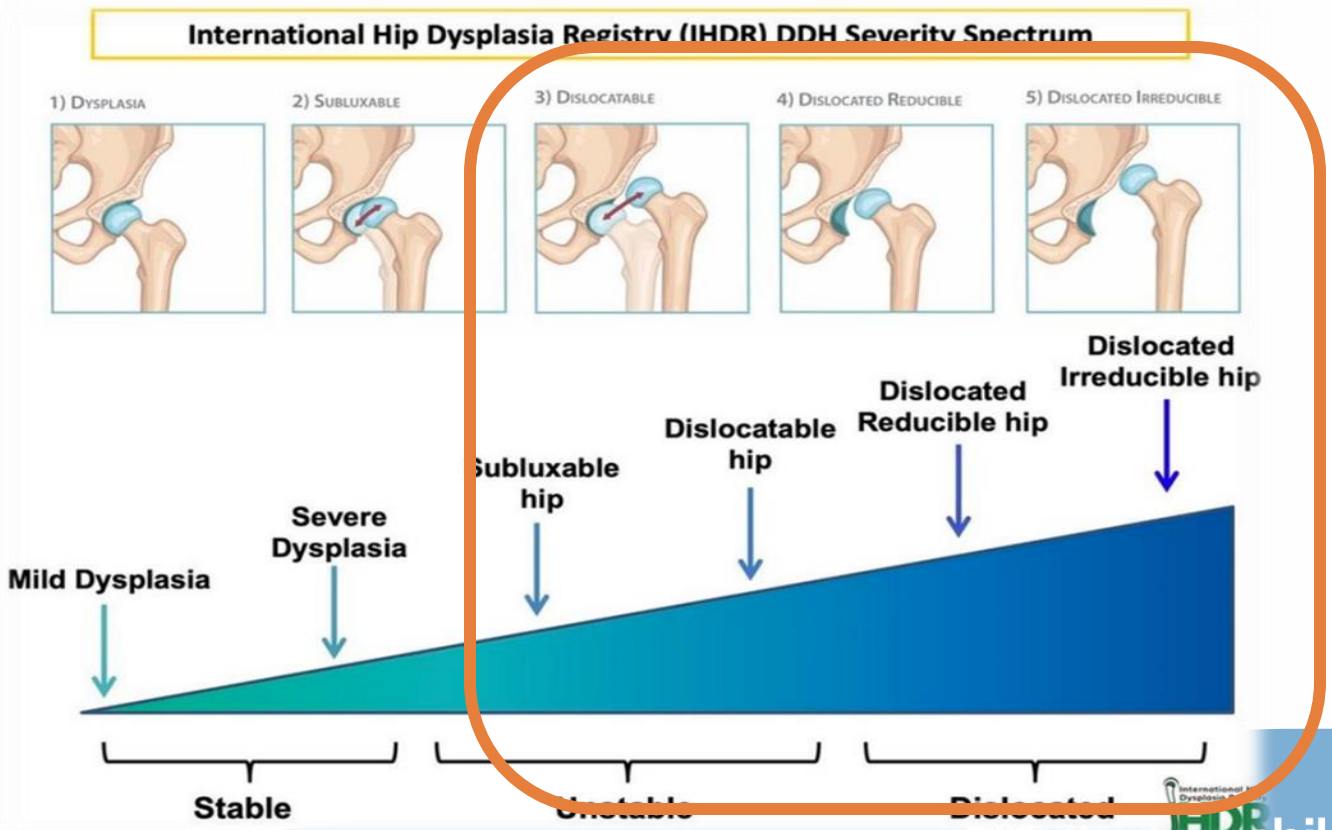
subluxation

- Displacement of the joint with some contact remaining between articular surfaces



dislocation

- Complete displacement of the joint with no contact between the original articular surfaces



teratologic hip

- Hip was dislocated in utero
- Irreducible on exam
- Associated with neuromuscular conditions/genetic disorders
  - Arthrogryposis
  - Myelomeningocele
  - Larsen's
  - Ehlers-Danlos

late dysplasia

- Mechanically stable and reduced
- Acetabulum is dysplastic

dayton children's

etiology

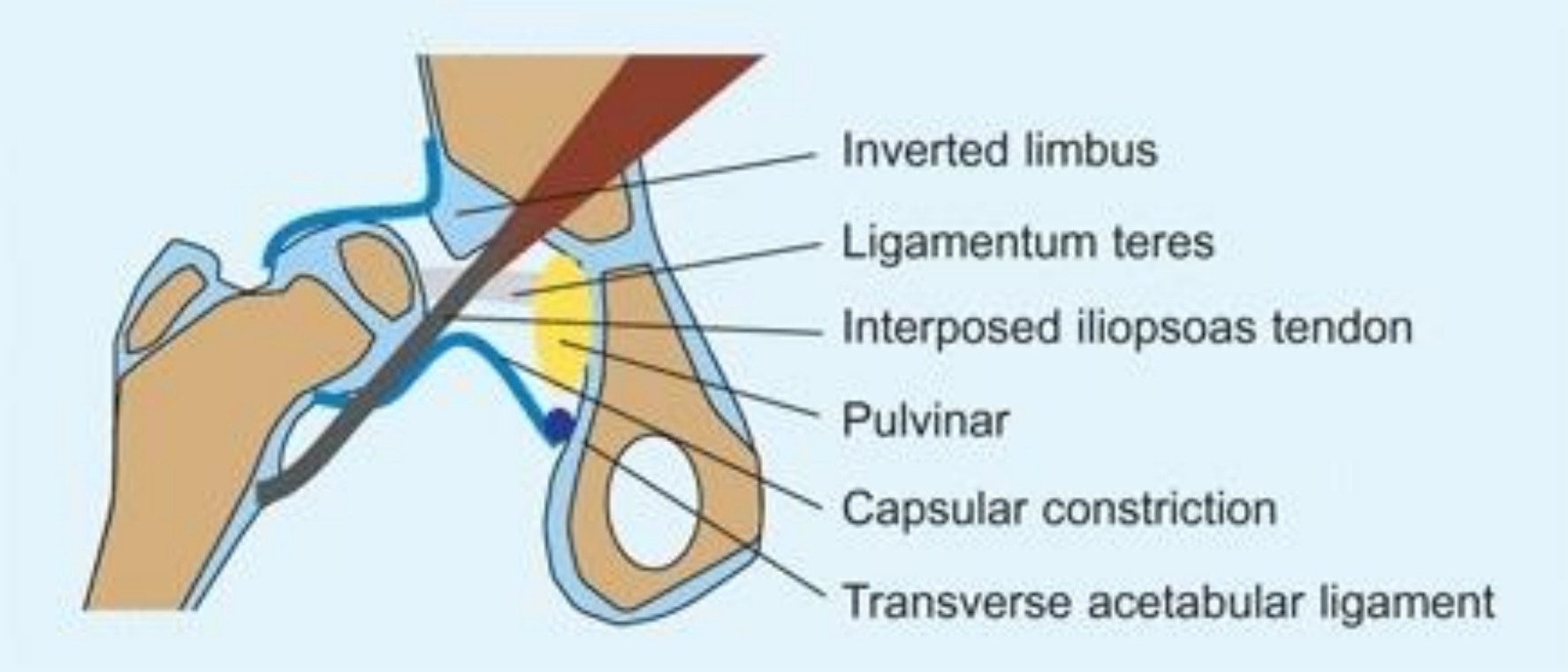
- Likely multifactorial
  - Genetic
  - Environmental intrauterine factors
- Most significant risk factors
  - Firstborn
    - Limited space
  - Female
    - Increased hyperlaxity with estrogens
  - Breech
    - Higher with frank/single breech position
  - 1st degree relative affected by DDH

associated conditions

- Congenital muscular torticollis
  - 20%
- Metatarsus adductus
  - 10%
- Congenital knee dislocation

physiologic changes

- Pulvinar thickens
- Ligamentum teres thickens and elongates
- Transverse acetabular ligament hypertophic
- Hip capsule and iliopsoas create an hourglass
- Increased femoral anteversion
- Increased acetabular version/decreased concavity of the roof
- Flattening of the femoral head


Inverted limbus
Ligamentum teres
Interposed iliopsoas tendon
Pulvinar
Capsular constriction
Transverse acetabular ligament

AAP Screening

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

- 2006 – US Preventive Services Task Force
  - Insufficient evidence to support routine screening for DDH in infants to prevent future adverse outcomes
- Controversy on “what is screening”
  - Physical exam
  - Selective use of ultrasonography
    - Not associated with significant increase in late diagnosis
  - Universal ultrasonography
    - Over treatment
- AAP recommends continuing periodic newborn physical examination surveillance throughout infancy.
- Targeted US 6 weeks to 6 months

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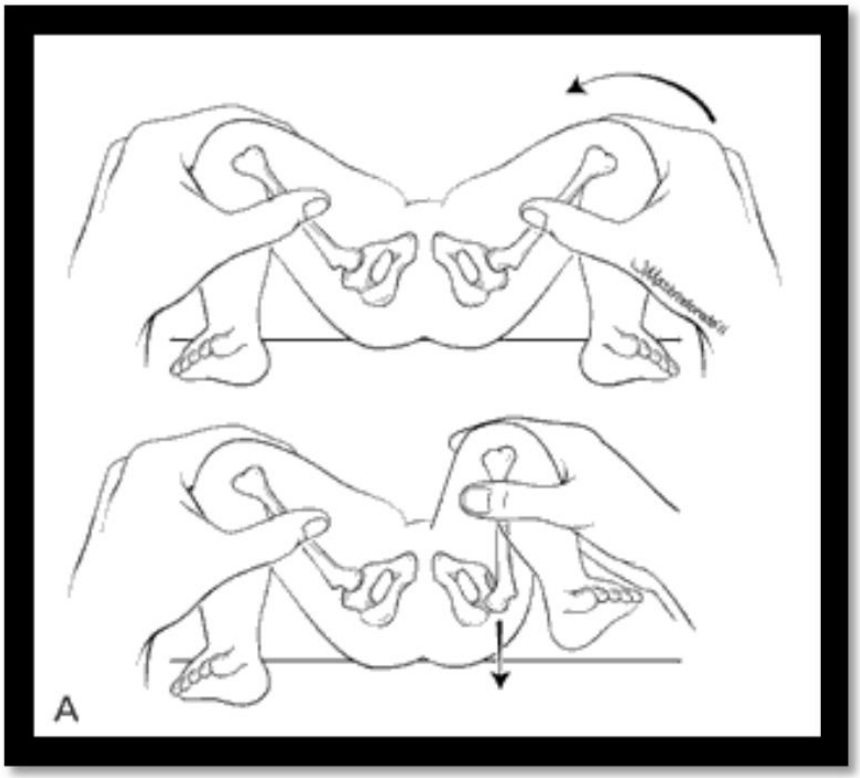
AAOS Screening

- Screen study < 6 months with more than 1 significant risk factors
  - Breech position
  - History of clinical instability
  - Positive family history

- Both AAP and AAOS
  - Avoid tight swaddling
  - Infants hips should have freedom of flexion and abduction

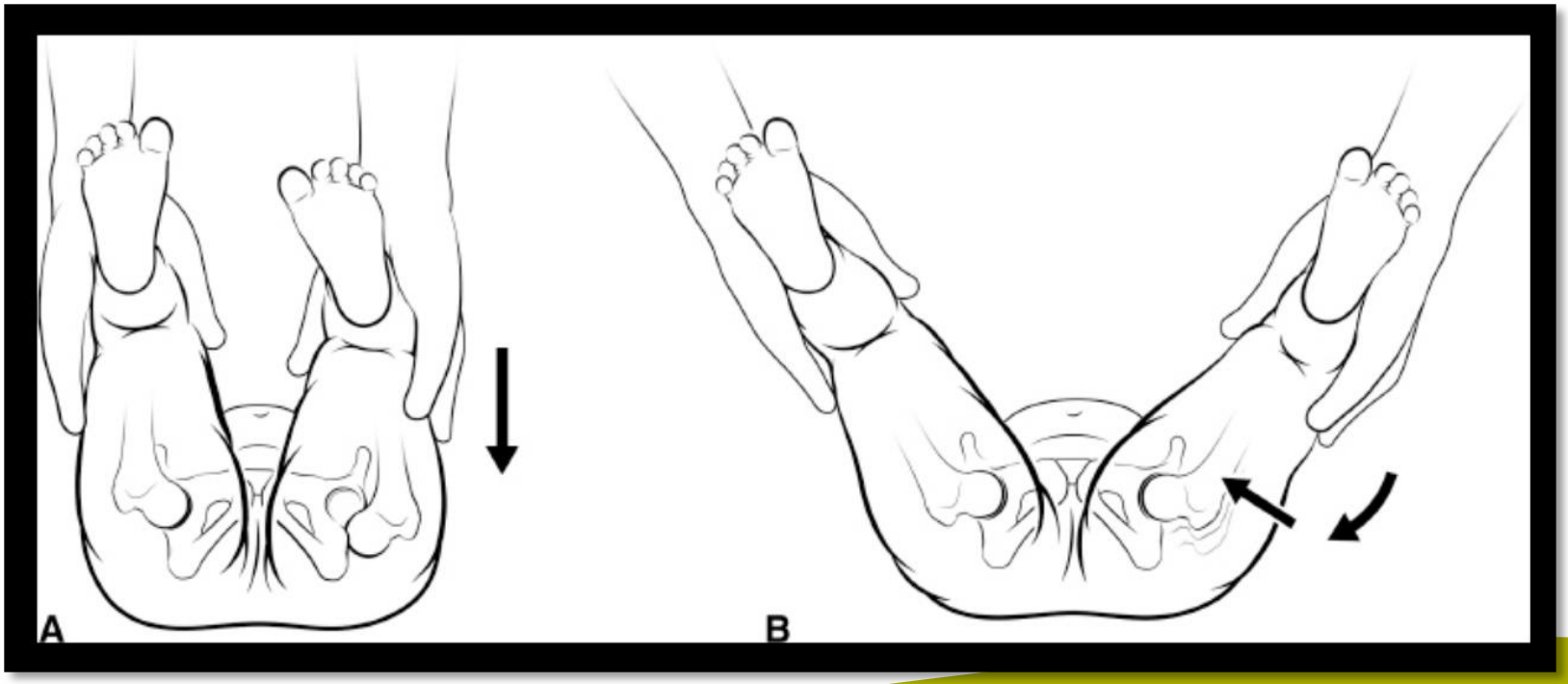
physical exam

- Barlow test
  - Provocative maneuver to test for hip instability
  - Gentle-
    - Adduction and depression of flexed femur
  - Hip is reduced but dislocatable



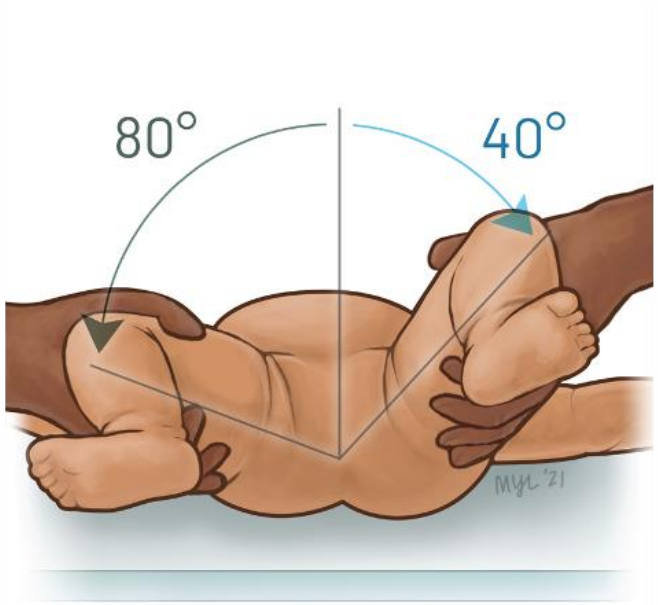
physical exam

- Whether a dislocated hip can be reduced
  - Reduces hip by elevation and abduction of flexed femur
  - Negative Ortolani test does not guarantee a normal hip



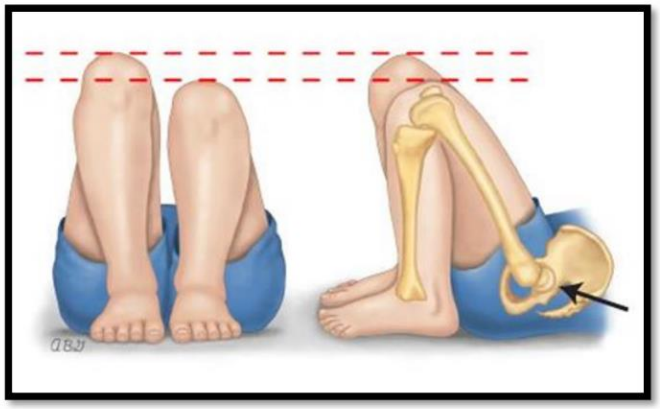
physical exam

- Limited abduction
  - More reliable after 3-4 months

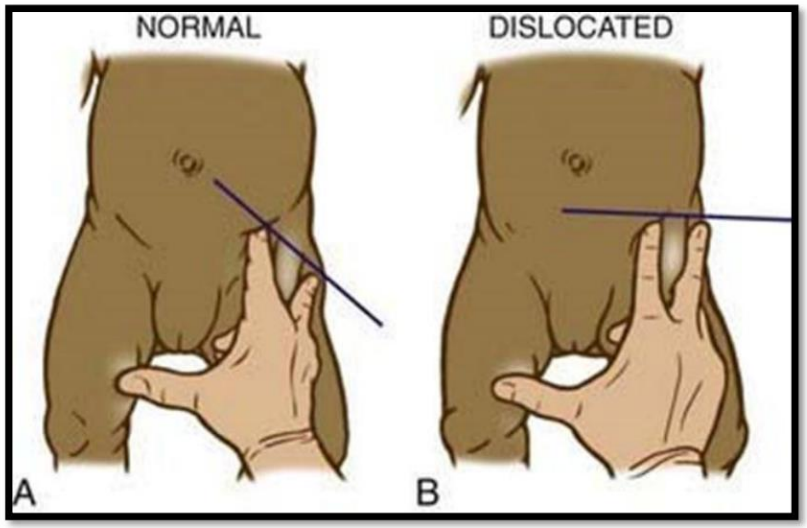


physical exam

- Galeazzi sign
  - Unilateral hip dislocations
  - Affected side is shorter
  - Pelvis must be level

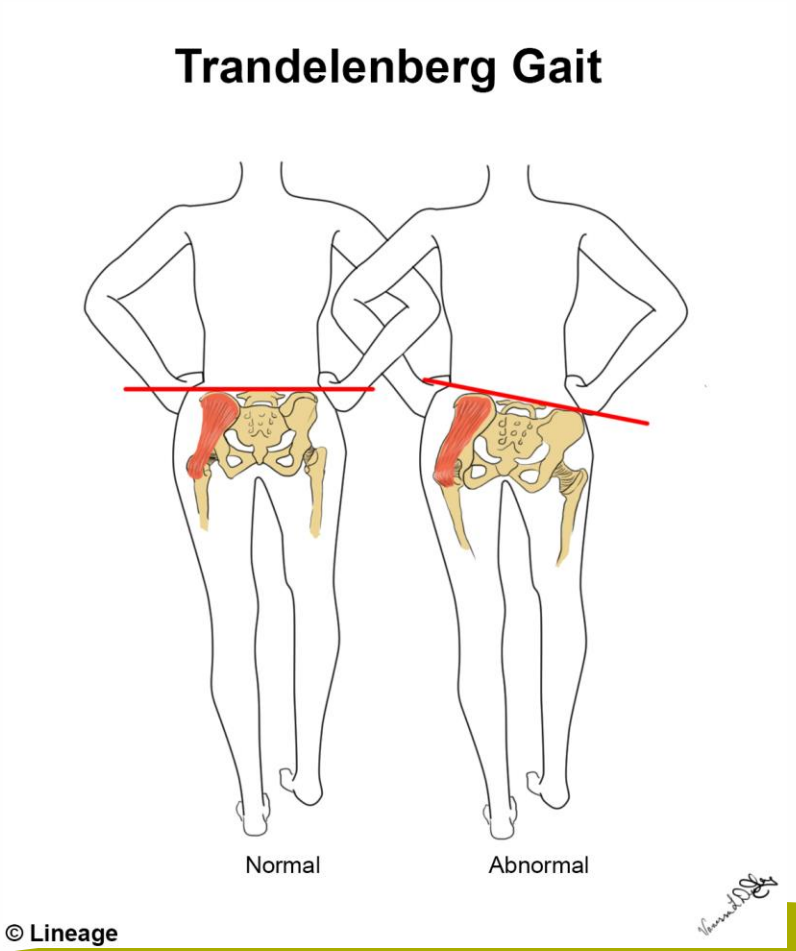


- Klisic test
  - Bilateral dislocations
  - Finger on the ASIS and greater trochanter
    - A line draw between them should intersect the umbilicus



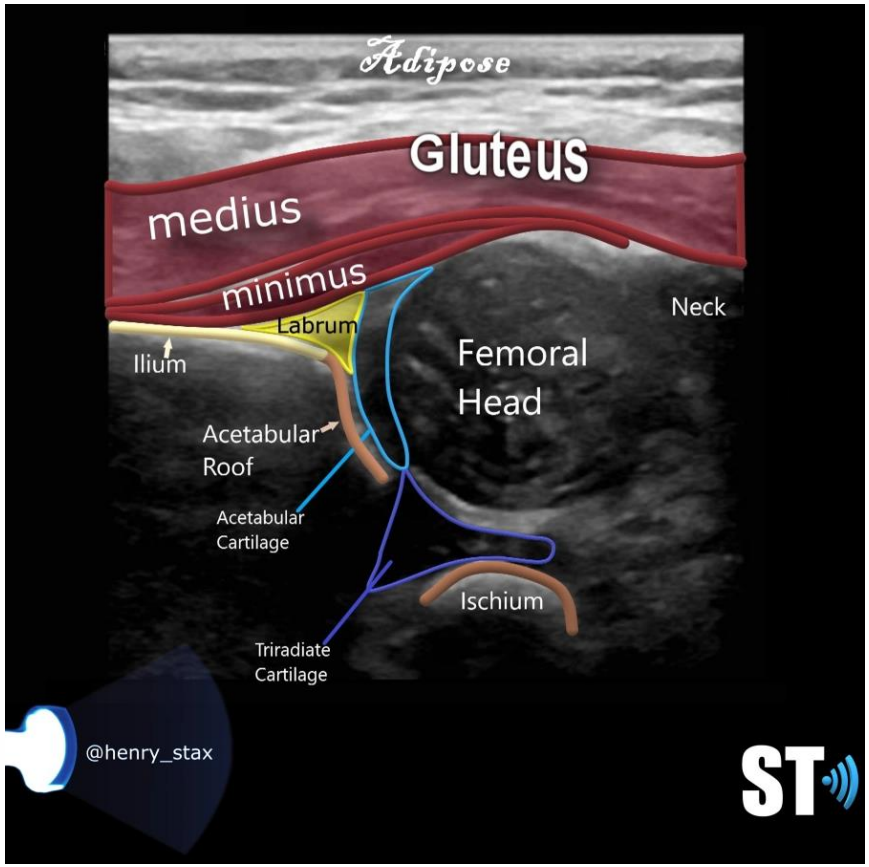
physical exam > 1 year

- Pelvic obliquity
- Lumbar lordosis
  - Result from hip contracture from bilateral dislocations
- Trendelenburg gait
  - Result from abductor insufficiency
- Toe-walking
  - An attempt to compensate for the shortened side (dislocated side)

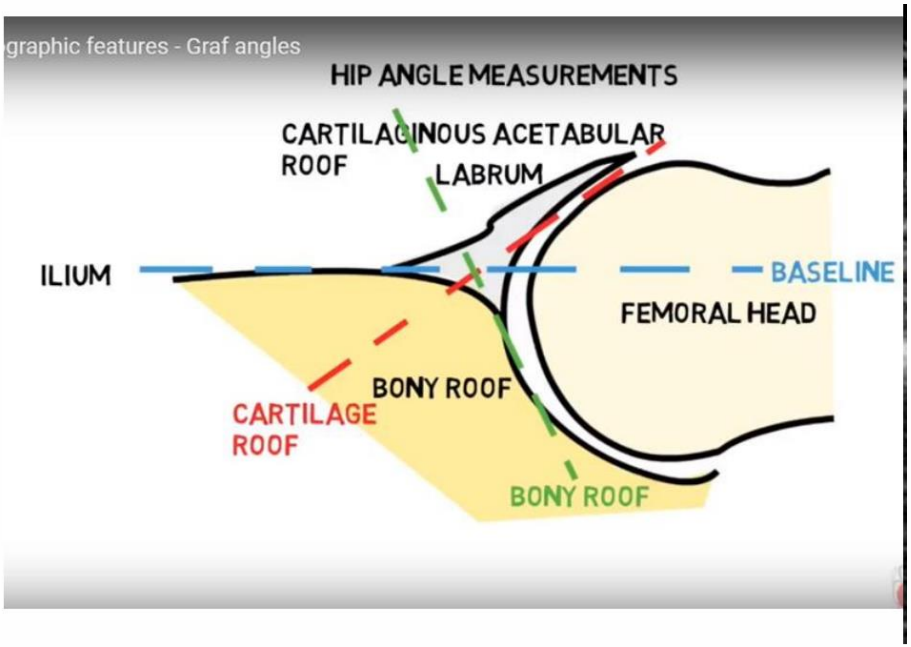


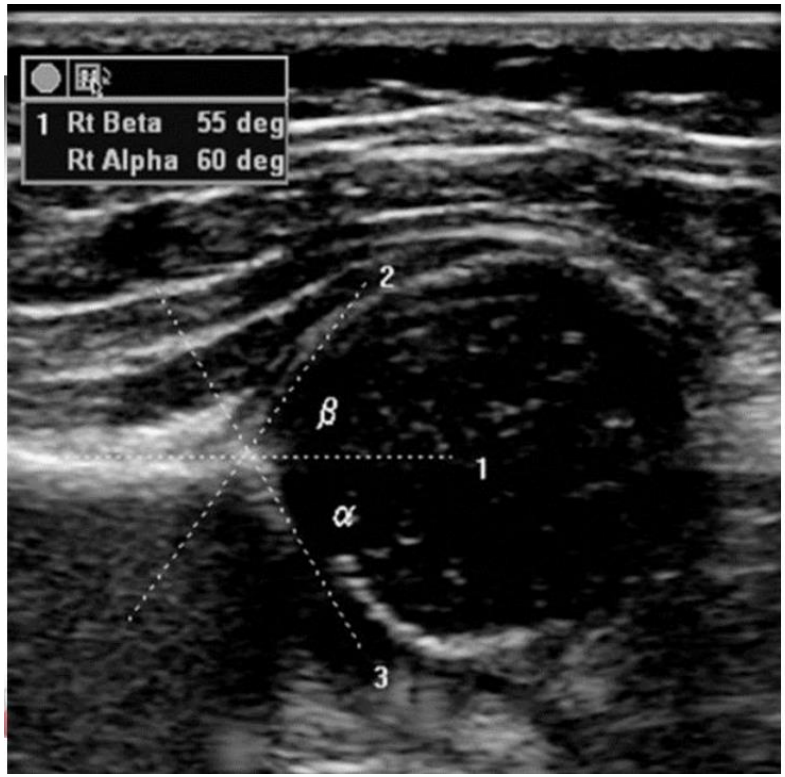
imaging studies

- Hip ultrasounds
  - Newborn – 6 months
  - If stable exam want to wait until 6 weeks of life prior to obtaining
  - Reason to get ultrasound prior to 6 weeks.
    - Unstable exam
    - Follow position in Pavlik harness



normal ultrasound





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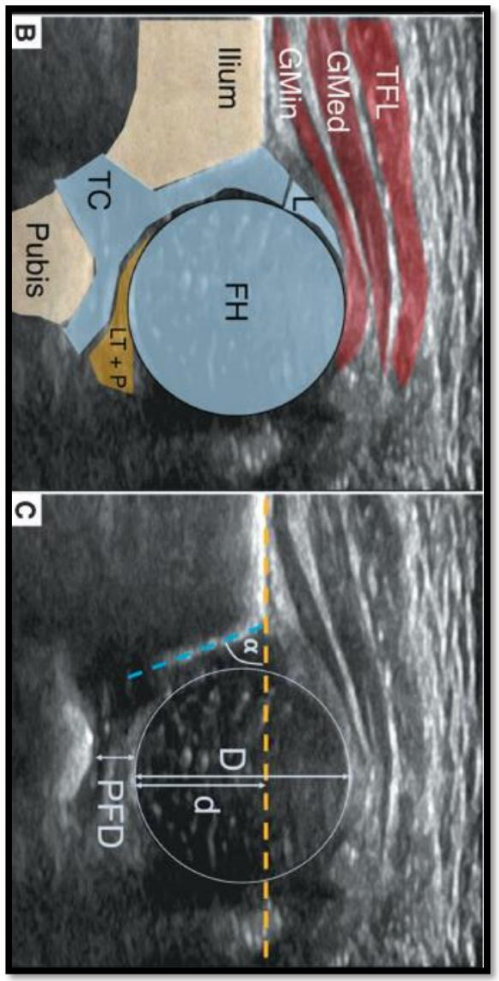
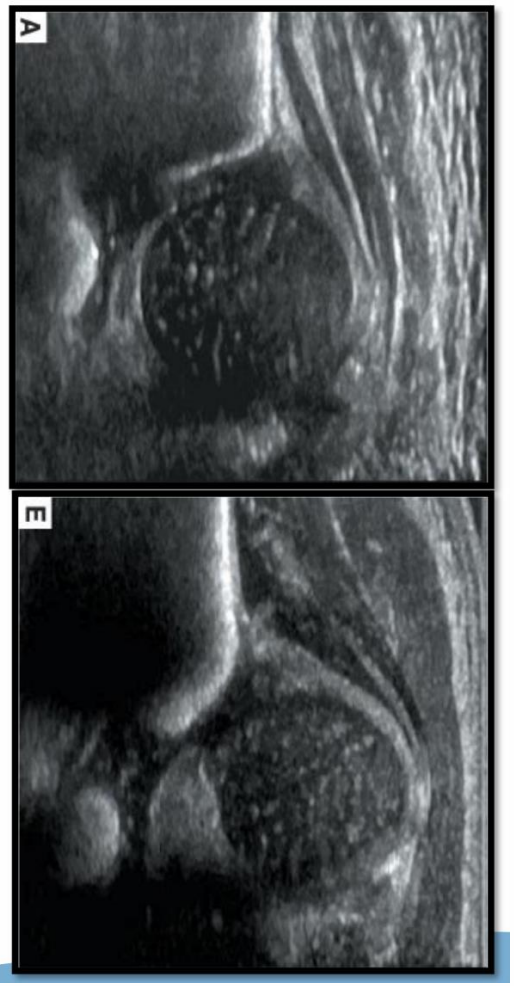
imaging





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radiographs

- 4-6 months
- AP pelvis with neutral rotation
  - Supine patient
  - Legs internally rotated 15 degrees

Shenton Line

- A curved line that follows the inferior border of the superior pubic ramus
- To the arch of the medial femoral metaphysis
- Disruption of the line is abnormal
- Raise concern for a subluxed or dislocated hip
- Validated in kids over 2 years of age

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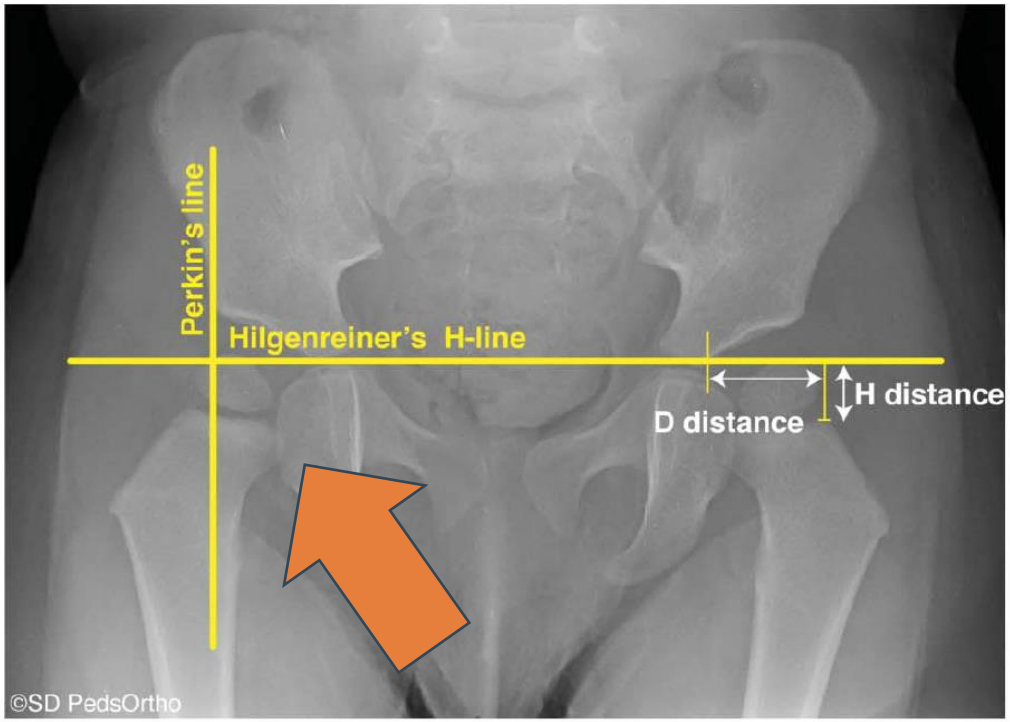
Hilgenreiner and Perkins Lines

- H-Line
  - Transverse line through the triradiate cartilage
- Perkins Line
  - A vertical line along the lateral border of the acetabulum
- Medial metaphysis in the lower inner quadrant



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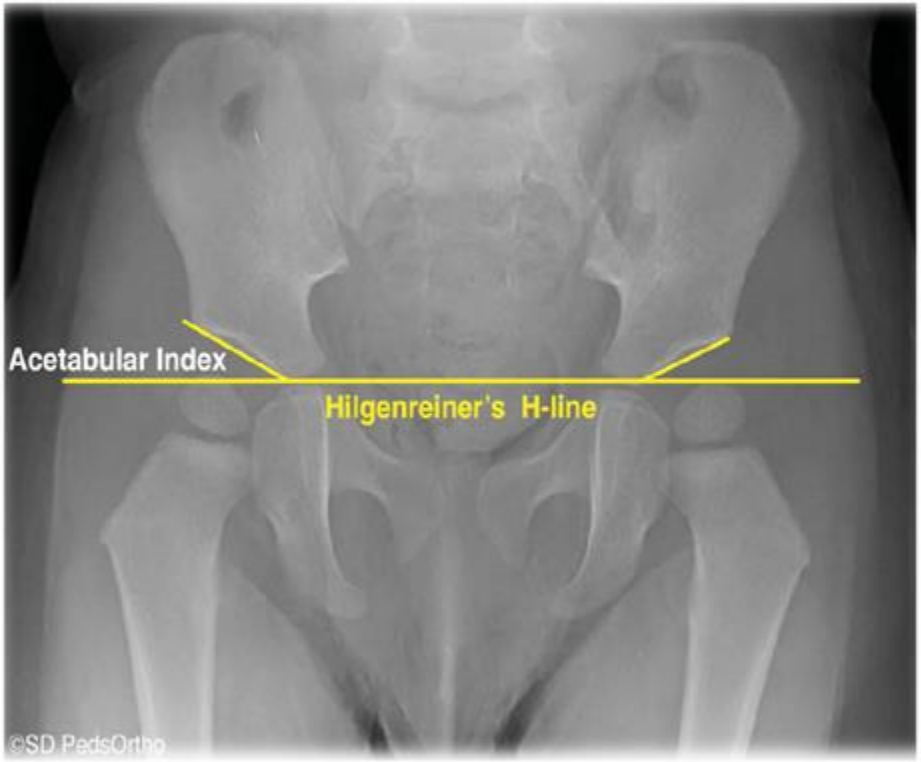
acetabular angle (AI)

- Measures the obliquity of the acetabulum
- As much remains cartilaginous
- H-line and 2nd line extending from the bony margin of the sourcil
- Neutral pelvic positioning is key



AI

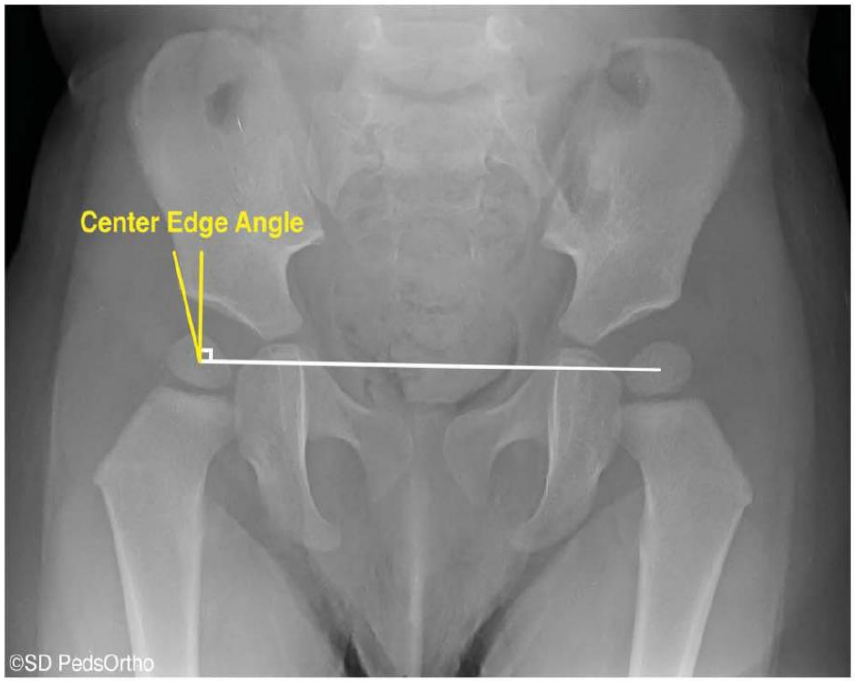
- Less than 22 degrees by the age of 2 years

Table 2. Normal Values for the Acetabular Angle

	Age	Female	Male
Caffey acetabular angle	Newborn	28.8° ± 4.8°	26.4° ± 4.4°
	3 mo	25° ± 3.5°	22° ± 4°
	6 mo	23.2° ± 4°	20.3° ± 3.7°
	1 yr	21.2° ± 3.8°	19.8° ± 3.6°
	2 yr	18° ± 4°	19° ± 3.6°
	5 yr	13° ± 4.3°	13° ± 4.3°
	10 yr	10° ± 4.6°	10° ± 4.6°
		Both	Sexes

center edge angle (CEA)

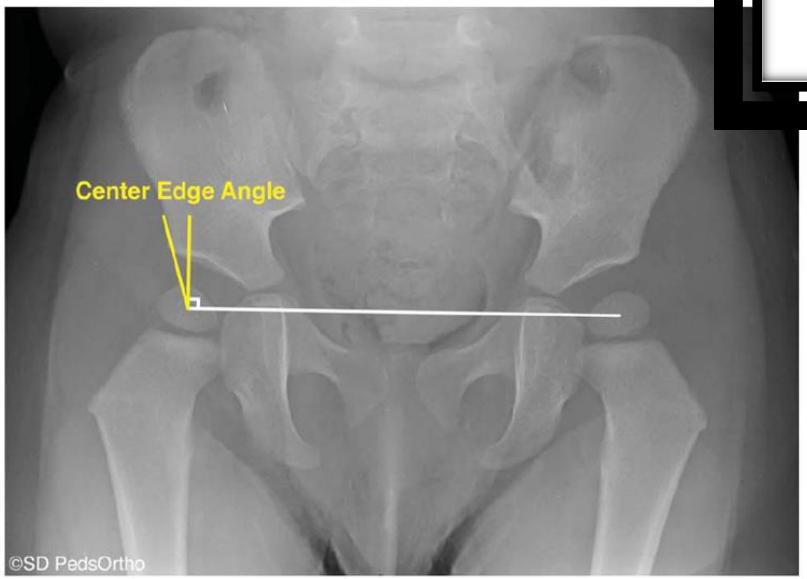
- Evaluates the relationship between the femoral head and acetabulum
- The angle formed from the line at the center of the femoral head to the edge of the acetabulum
- Better used in older children



CEA

Table 3. **Normal Values for the Center Edge Angle of Wiberg**

	Age	Angle
Center edge angle	Newborn	21° ± 5°
	2 yr	24° ± 6°
	5 yr	27° ± 5°
	10 yr	33° ± 6°
	15 yr	37° ± 5°



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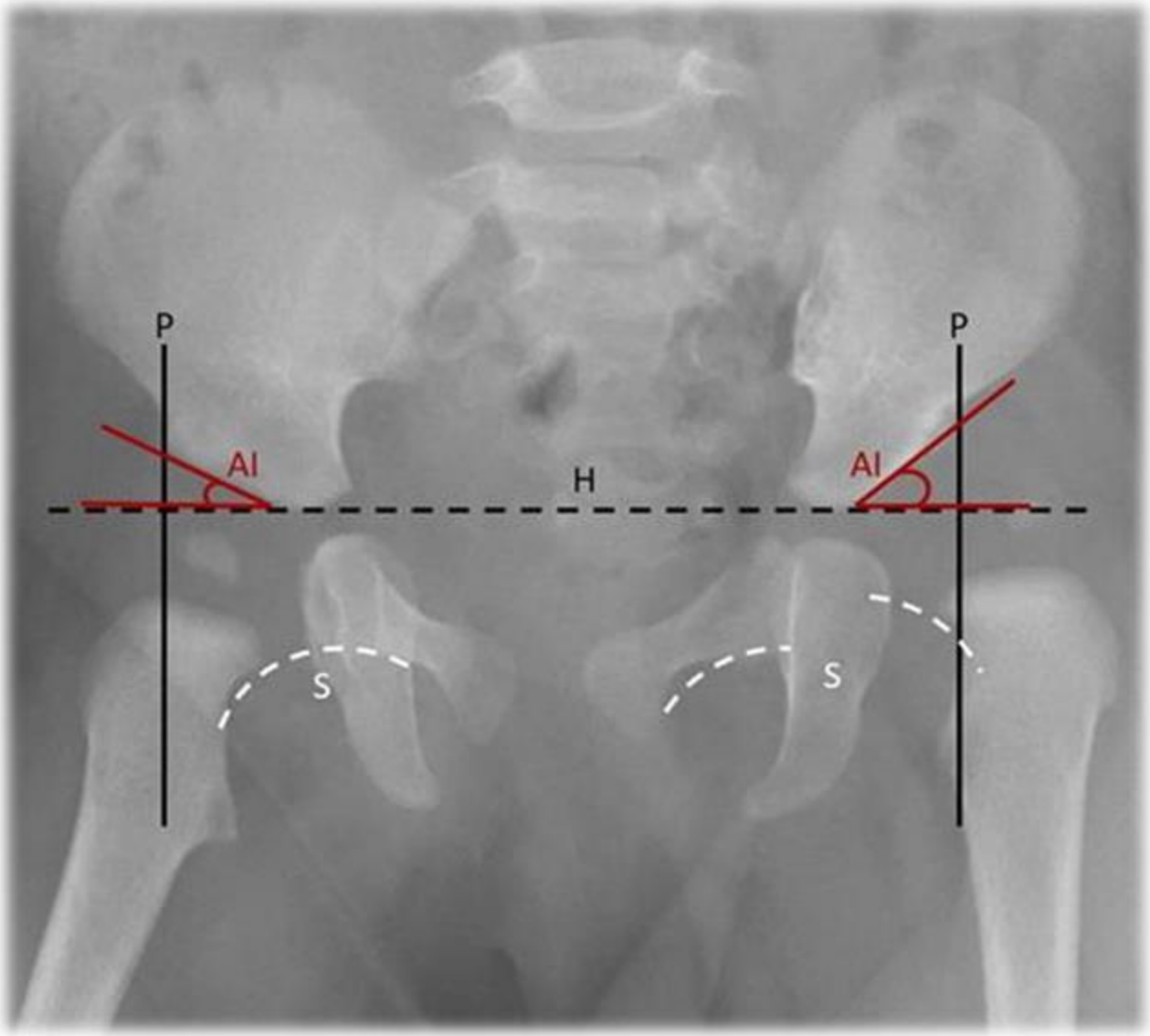

P
P
AI
AI
H
S
S

treatment

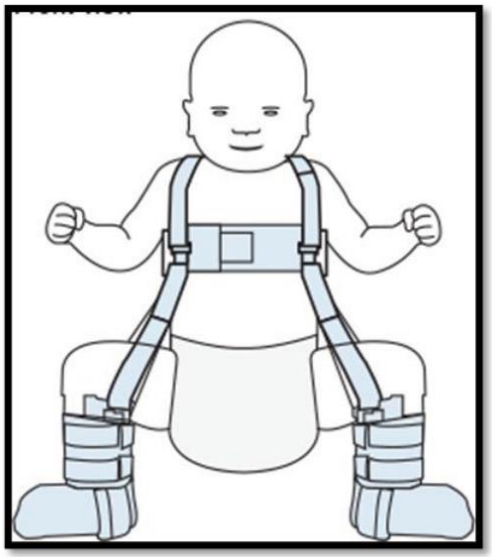
- Pavlik Treatment
- Other brace treatment
- Closed reduction and Spica cast
- Open reduction and Spica cast
  - + Femoral shortening
  - Acetabular Osteotomy

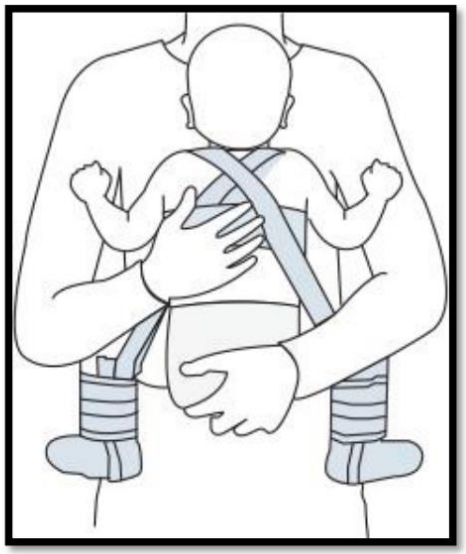
Pavlik

- Abduction bracing
- Pavlik – most used brace in North America
  - < 6 months of age
  - Discontinue if not reduced by 3-4 weeks
  - Recheck with US
  - Contraindicated in teratologic hip dislocations
    - Requires normal muscle function
- Success rates
  - 100% for dysplasia
  - 70-90% for dislocation

Pavlik style

- Anterior leg straps flex hips 90-100 degrees
  - Prevent extension
- Posterior straps prevent adduction
- Recheck with US



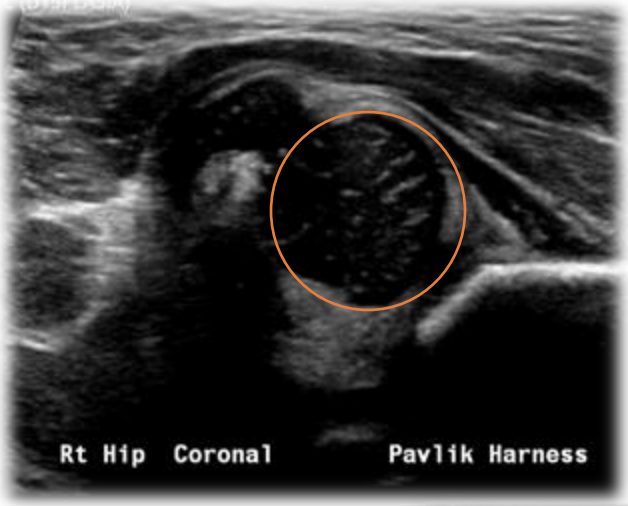


- Abandon harness after 3-4 weeks if not reduced
  - Critically question the fit and compliance
- If progressive improvement seen can continue
- Risks
  - Pavlik harness disease
    - Erosion of posterior wall of the acetabulum
  - Femoral nerve palsy
    - Too much hip flexion
    - Resolved with removal
- Options for “failed” Pavlik
  - Abduction orthoses
  - Closed reduction spica casting
    - Increased risk of AVN compared to bracing

Pavlik harness treatment

- 8 day old, female
- First child
- History of breech positioning

- Right hip increased laxity
- Left hip positive Ortolani
- Was placed into harness and ultrasound in harness ordered.



Right
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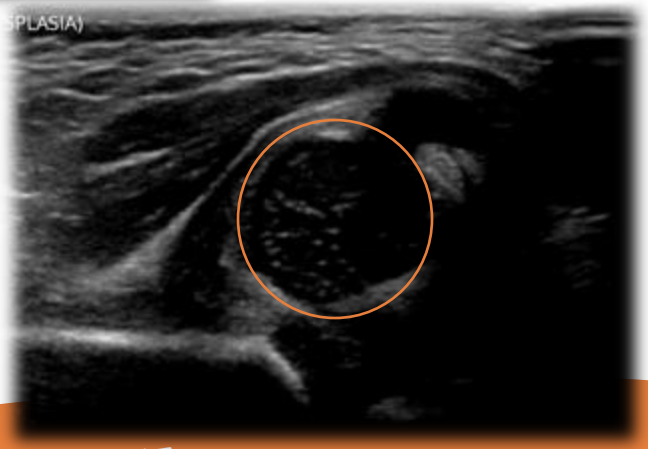

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α= 42
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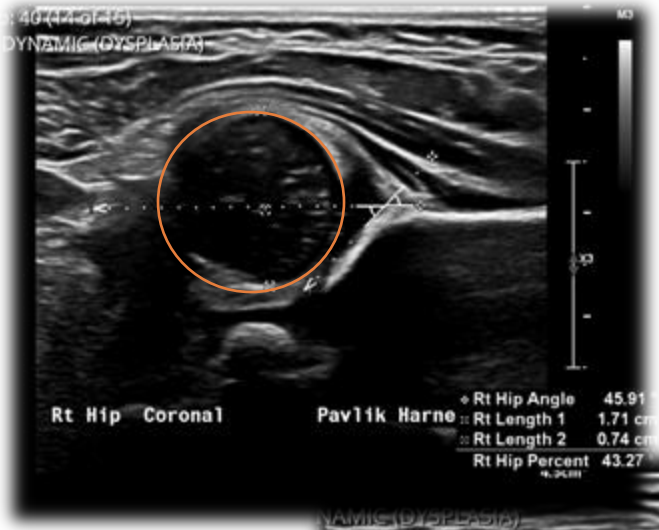
Pavlik harness treatment

- 2 -3 weeks into Pavlik repeat ultrasound in brace.



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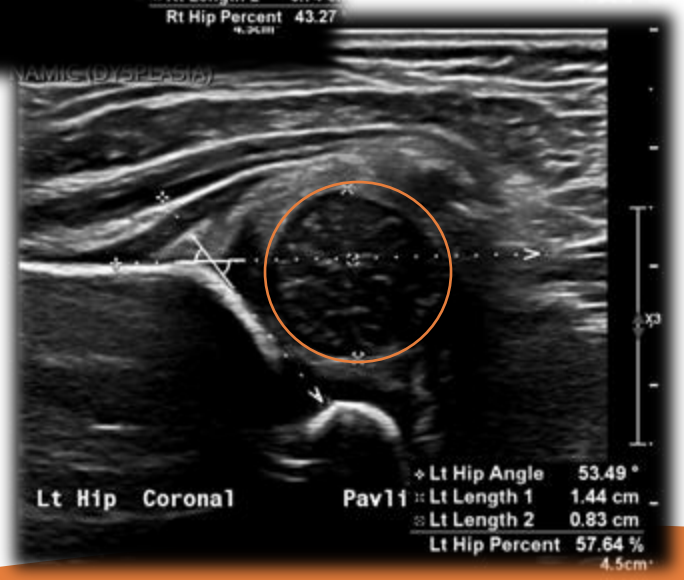

Left
α=53
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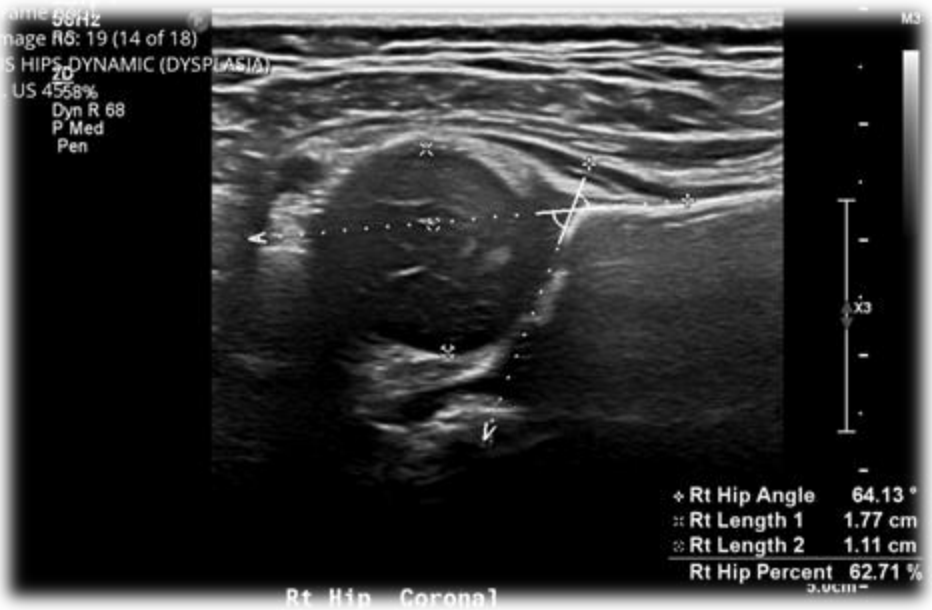
Pavlik harness treatment

- At final ultrasound

Right
α=64
%=63%



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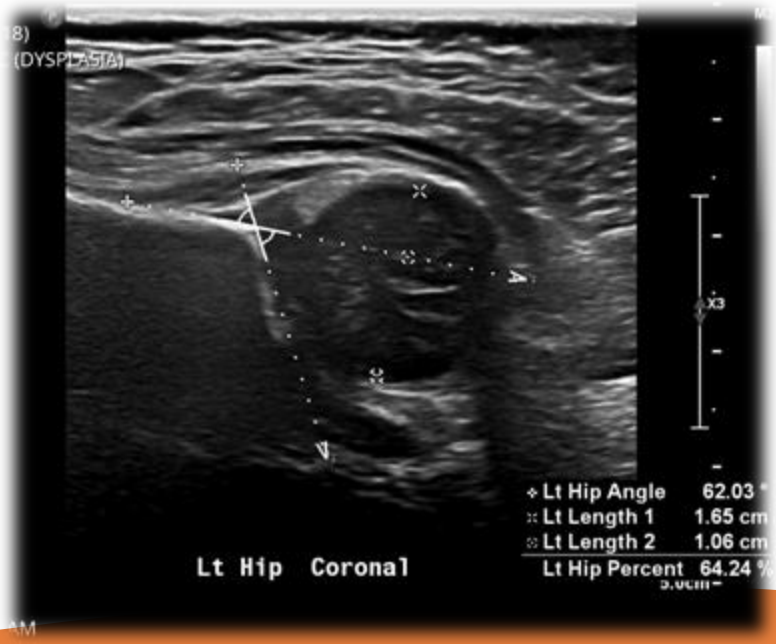

successful Pavlik treatment

- Continue for 4-8 weeks after stabilization
- Potential wean out prior to discontinuing
- Follow periodically with radiographs until skeletally mature

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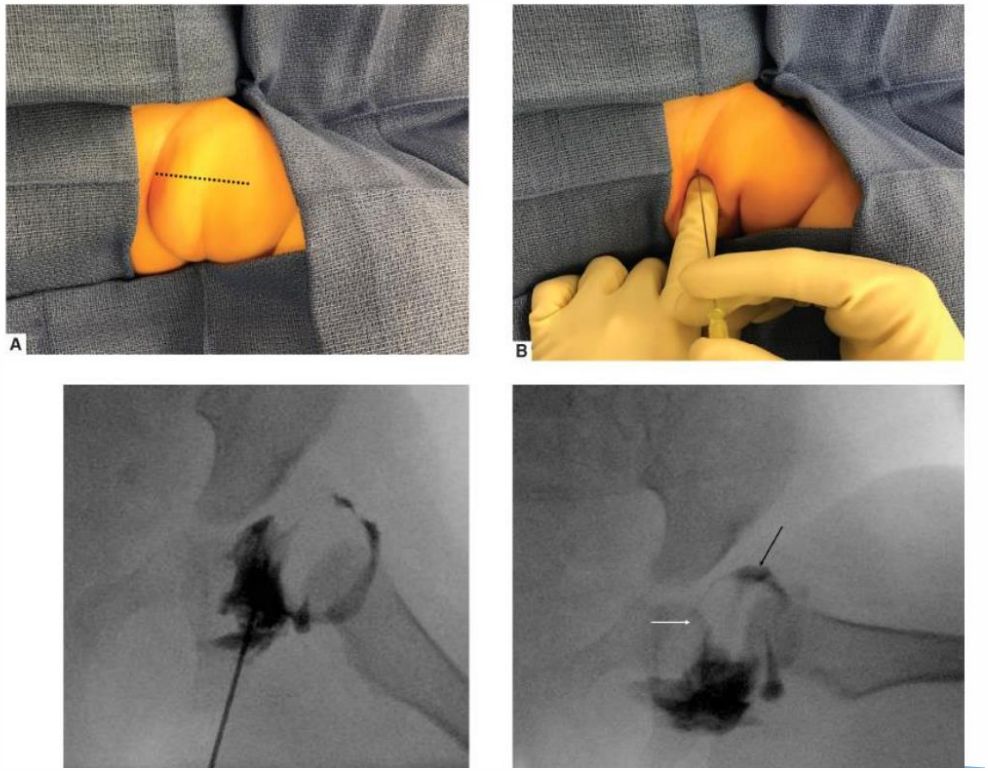
closed reduction and casting

- If failed Pavlik/bracing
  - May need to overcome tissue contracture
  - Mostly adductors
- Ability to reduce hip is confirmed with arthrogram



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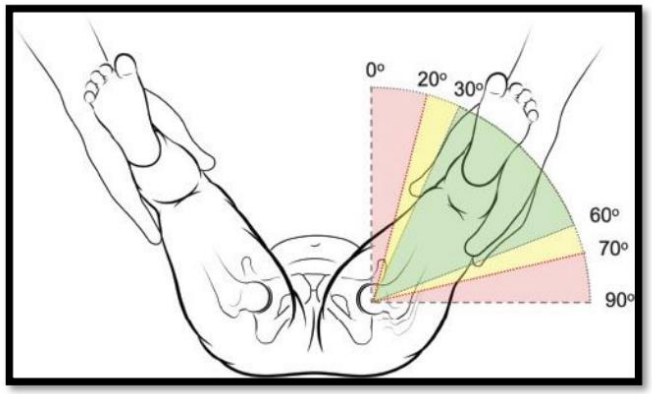
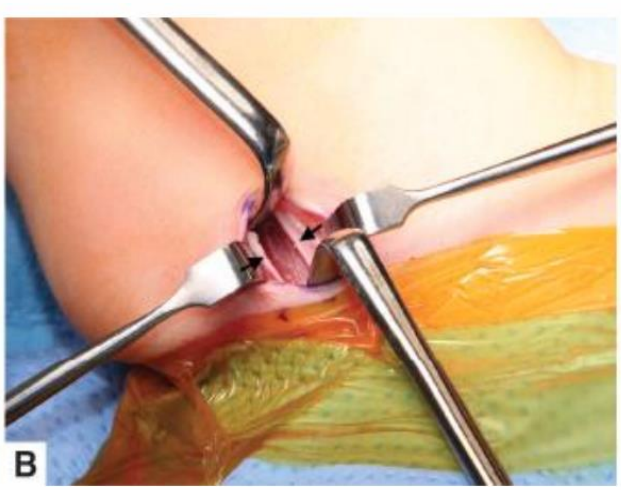
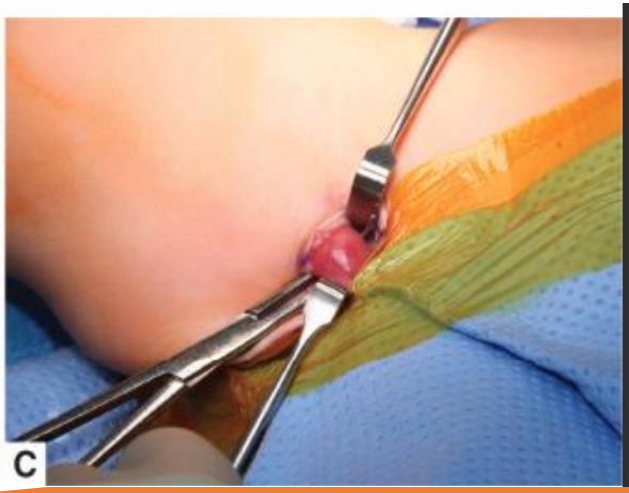
CR + adductor tenotomy

- Increases the safe zone in a closed reduction







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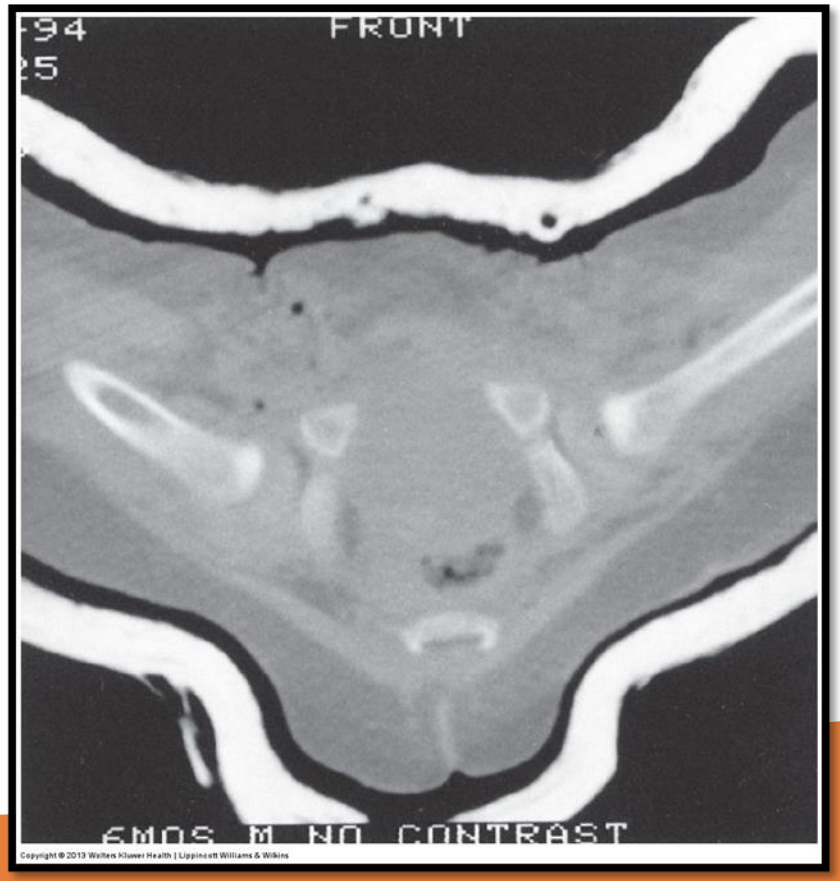
spica cast

- Cast position
  - 90-100 degree hip flexion
  - 45 degree abduction
  - Neutral rotation
- Change cast/ check hip at 6 weeks
  - Ideally 12 weeks in cast
- Spica cast care
- Car seat

post reduction imaging

- In OR
  - Arthrogram to evaluate/ confirm reduction
- After OR
  - CT
  - MRI



hip spica cast care: a guide for parents

Your child will be going home in a spica cast. A spica cast prevents leg movement after injury or surgery so that bones can heal. Taking care of a child in a spica cast can feel challenging and confusing. Our staff is here to make the experience easier for you and your child. This information will help you take care of the cast and avoid common problems.

cast care

- Keep the cast **dry**.
  - If the cast gets damp, use a hair dryer on the cool setting to blow air on the edges of the cast.
  - Always make sure the air is cool, because warm and hot air can accidentally cause burns.
- Check the cast daily for dents or cracks.
- Do not let your child put any objects in the cast. It could hurt their skin.
- Put a bib or a t-shirt on your child when eating. This will keep food out of the cast.
- If something falls into the cast, you should:
  - Use your hand to remove the object if you can see it.
  - Call your doctor if you cannot see or reach the object.

skin care

- Check the following at least **once per day:**
  - Are your child's toes pink and warm?
  - Can your child feel all of their toes when touched?
  - Can your child wiggle all of their toes?
  - Do you see any redness, blisters, or sores around the edges of the cast? You may want to use a flashlight when you check.
- Do not use lotions, oils or powder on the skin under the cast.
- If your child gets itchy **do not place anything into the cast**. Try these tips instead:
  - Tap the outside of the cast.
  - Use a hair dryer on the cool setting to soothe the skin.
  - Change your child's position.
  - Try to distract your child.
- Turn your child from front to back or side to side **every 2 hours**. Changing position helps prevent sores on their skin.

when to call the doctor

Call the orthopaedic surgeon at 937-641-3010 for any of the following

- Temperature of 101 or higher
- Numbness, tingling or worsening of swelling
- Foul or rotten smell from cast
- Skin color changes – becomes red or bluish
- Redness or drainage from any surgery site
- Pain not relieved by the pain medication, ice, and elevation
- Burning feeling under the cast
- The cast breaks

If you have any physical therapy concerns, please call our rehabilitation department at **937-641-3070** and ask for a PT.

practical tips and tricks

lifting and moving

- Try not to lift your child by the arms or under their armpits.
- Do not pull your child by the bar between their legs.
- When you lift your child try to:
  - Support their back and below their buttocks.
  - Give your child a "bear hug" around their trunk.
  - Bend your legs and do not lift with just your back.
- When your child is awake, try to support them using:
  - Beanbag chairs (like 'Big Joe' chair) or child recliners
  - A bed reading pillow (with a backrest and two small armrests)

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transportation

- Smaller children may fit in a stroller or wagon using pillows and a seatbelt.
- Older children may use a rental wheelchair. Talk to your therapist if you need help with this.
- Your child may not fit in their car seat. Talk to hospital staff about different car seat options to keep your child safe.

diet

- Prevent constipation by offering more fluids, fruits, vegetables, whole grain cereals, and other high fiber foods.
- Prevent large bowel movements by feeding frequent, smaller meals.
- Do not put your child to bed with a bottle or cup. This will help keep the cast dry.

toileting

Diapers and "double diapering" to keep the cast dry.

- Always use two sizes of diapers.
- The first diaper should be one size too small. Tuck this small diaper into the cast.
- A sanitary napkin or maxi pad may be placed inside the first diaper to absorb more urine, especially at night.
- The second diaper will cover the first diaper and will be outside of the cast.
- Check the diaper hourly during the day and at least once during the night.

Bedpan

- For older children, feel free to ask for a urinal or bedpan before you are discharged.
- Make sure to dry the buttocks well after using the bedpan to prevent rashes.
- Change any wet bed linens to prevent the cast from becoming wet or soiled.

activities

- Plan quiet activities for your child when they are in the cast.
- Crafts, movies, and board games can be fun things for your family to do with your child!
- Keep an eye on playing with small toys to avoid them falling or being put in the cast.

when the cast comes off

- The skin will look different and may have dark patches or unusual hair growth. This is temporary and should go away in a matter of days.
- Do not peel the skin off. Allow it to shed naturally.
- Wash with a gentle soap and apply fragrance-free lotion.

parent recommendations:

Here are some tips from parents whose child had a spica cast

- Use sections of pool noodles, rolled up blankets or towels, or pillows to support the cast or to position the cast at different angles.
- Create "breakaway" pants:
  - Cut the seams of oversized sweat pants
  - Install Velcro to close the seams
- Use adhesive moleskin to wrap around the cast edges if skin irritation occurs.
- Check your home for obstacles. Narrow hallways and tight corners can mean accidental jarring of the cast. A clear path is easiest to navigate.
- Keep waterproof pads, such as puppy training pads, over your child's cast to keep them clean and dry during meals, playtime, teeth brushing or washing up.
- Car seat transfer preparation: Testing the car seat for a good fit in the hospital room while front facing your child isn't the same as placing them in the seat once installed in your car. Make sure to measure the cast length and allow for the transition path into the seat from the side of the vehicle, including room for yourself to assist with positioning. Once the child is safely in the seat, use large pillows to support the cast.

online resources

- https://kidshealth.org/Demo29/en/parents/casts.html
- www.hipdysplasia.org under "Infant and Child"
- EZ On Pro installation (only needed if EZ On Vest is issued for transport home in your car): https://ezonpro.com/our-products/transportation-vests/modified-laydown-vest/, click "Video Instruction"
- Hip Dysplasia Institute - Although your child may have a hip spica cast for another reason, this website goes through tips and tricks that can be helpful: https://hipdysplasia.org/developmental-dysplasia-of-the-hip/child-treatment-methods/hip-spica-cast/

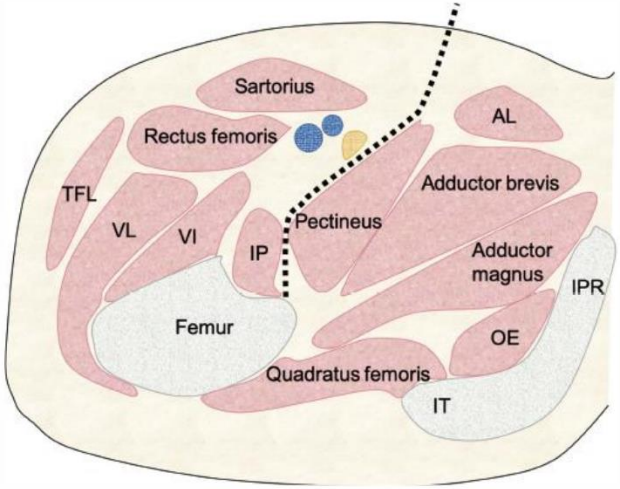
dayton children's

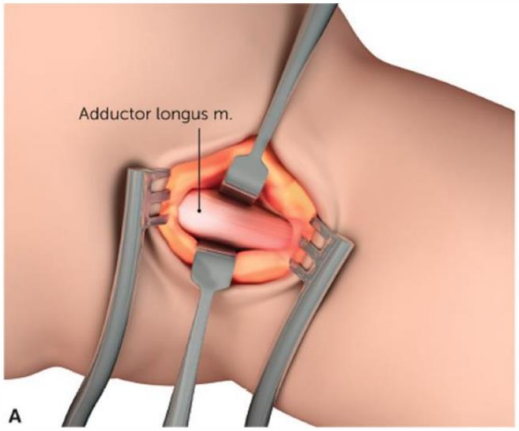
open reduction

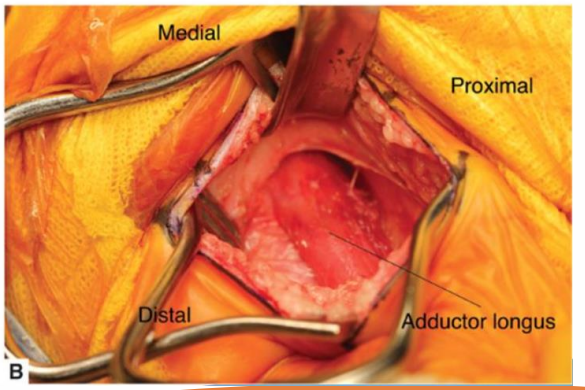
- Inadequate / Unstable closed reduction
- What approach?

medial approach

- Medial approach if < 12 months old
  - Decreased blood loss
  - Direct access to blocks to reduction
  - CANNOT perform capsulorrhaphy
  - Higher risk of AVN

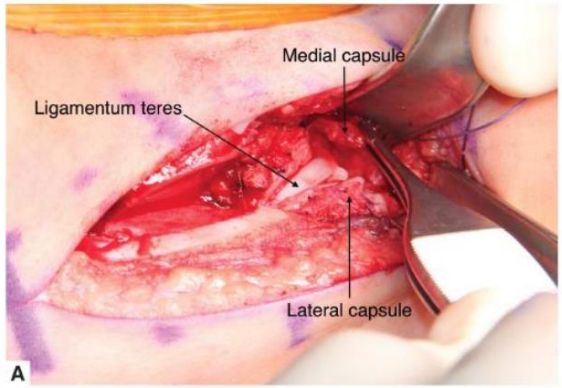


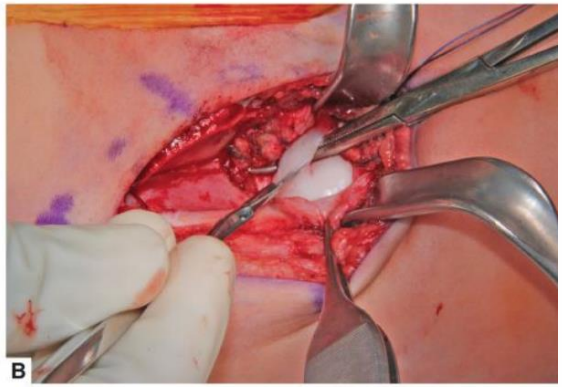


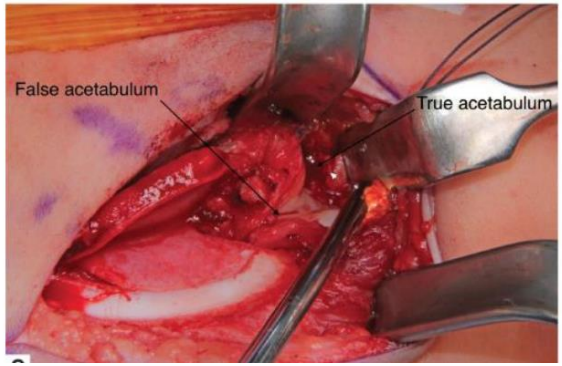


anterior approach

- > 12 months of age
- Decrease risk of injury to medial femoral circumflex artery
- Can do capsulorrhaphy
- Pelvic osteotomies can be done in same incision

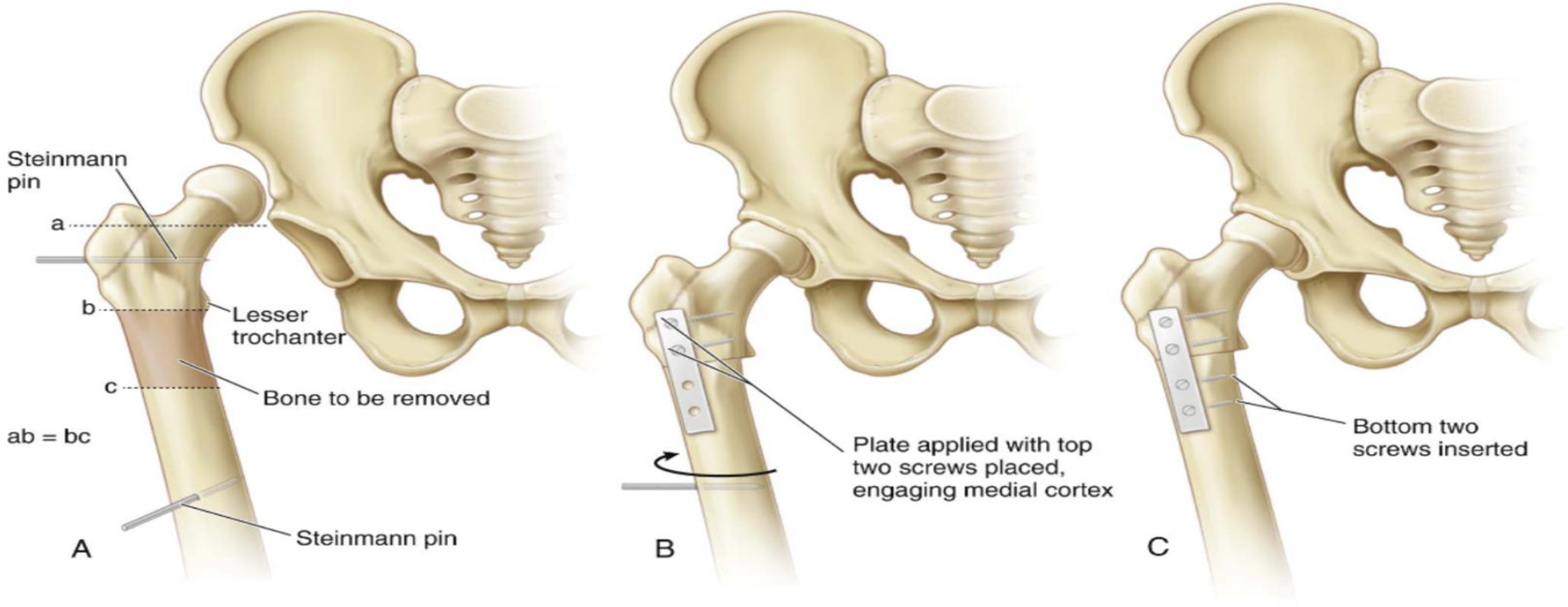






open reduction + +

- + femoral osteotomy
  - >18 months
  - If significant force to hold reduction
    - Shorten the femur
  - A varus derotational osteotomy
    - Excessive femoral anteversion/valgus



open reduction ++

- + pelvic osteotomy
  - > 2 years
  - Typically to increase anterior/anterolateral coverage to increase AI
  - Re-directional vs. Salvage

dayton children's

post-op

- Confirm reduction
  - CT or MRI in cast
- Spica Cast
  - 6 weeks change in OR with exam
- Continue to periodically follow with radiographs until skeletally mature

take away

- Early diagnosis and treatment is KEY
- Pavlik harness has a great success rate
- Follow until Skeletal Maturity
  - With incremental imaging.

dayton children's

references

- Edmonds, Eric W. MD; Hollnagel, Katharine F. MD; Bomar, James D. MPH; Frick, Steven L. MD. AP Radiographic Assessment of the Pediatric Pelvis for Developmental Dysplasia of the Hip. Journal of the American Academy of Orthopaedic Surgeons 31(14):p 717-726, July 15, 2023. | DOI: 10.5435/JAAOS-D-22-01218
- Fourth International NYU Langone Hip Dysplasia Symposium: Experience, Judgement and Wisdom September 10, 2021.
- Hip Preservation Surgery in Children and Adolescents Chapter 1. Infant hip dysplasia: diagnosis and brace treatment. Philadelphia. 2021. 1-8.

- Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants up to Six Months of Age. AAOS. 2014.
- Herring, JA. Developmental Dysplasia of the Hip. *Tachdjian's Pediatric Orthopaedics. 5th ed.* 2014.
- Shaw BA, Segal LS, AAP SECTION ON ORTHOPAEDICS. Evaluation and Referral for Developmental Dysplasia of the Hip in Infants. *Pediatrics*. 2016;138(6):e20163107
- Weinstein, SL. Developmental Hip Dysplasia and Dislocation. *Lovell and Winter's Pediatric Orthopaedics.* 7th ed. 2014.