Developmental Dysplasia of the Hips

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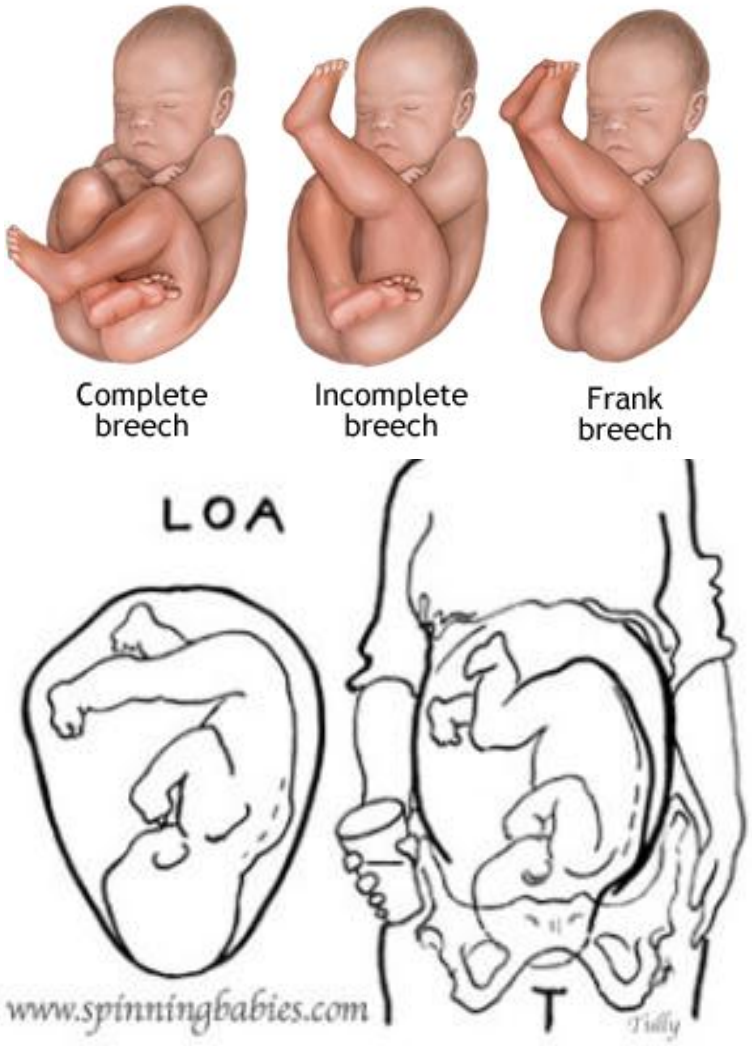
Outline of Presentation

- **Clinical Background**
- Imaging Anatomy
- Ultrasound Techniques
- Imaging Guidelines and non-US Imaging
- Screening Recommendations

Incidence

- 1.5-20/1000 births
- F:M 6:1
- Breech presentation
- Oligohydramnios
- Large infants
- L:R 3:1



Natural History

- Most DDH identified during newborn period is hip laxity and immaturity
- Spontaneous resolution of abnormalities:
  - 60-80% found on physical exam
  - 90% found on US
- Untreated subluxed and dislocated hips can lead to early degenerative disease

Barlow and Ortolani Tests

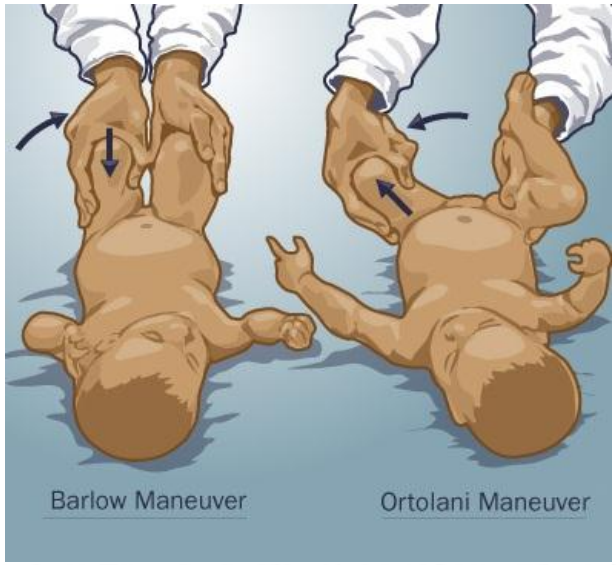
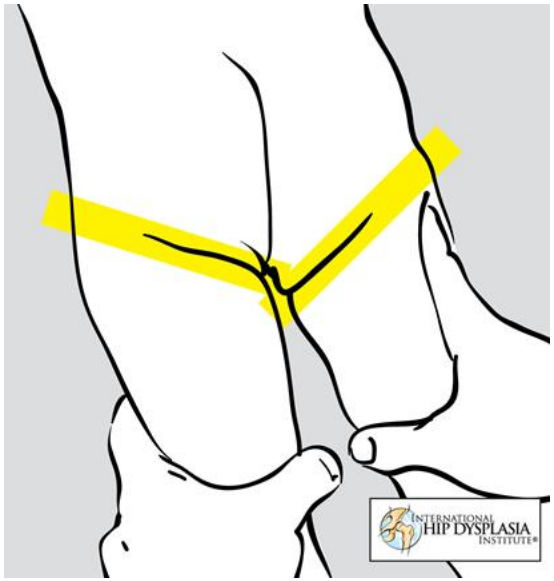


FIG. 1
The new-born child is laid on its back with the hips and knees flexed and the middle finger of each hand is placed over each greater trochanter.

Barlow TG. J Bone and Joint Surgery 1962

- "B" comes before "O"
- To go to the Bar you have to go out
- Once you're Out, you have to go home
- "Click" ≠ "Clunk"

Clinical Evaluation



Asymmetric gluteal creases may be sign of hip dysplasia

Asymmetric thigh folds rarely indicated hip dysplasia

Leg appears shorter because hip has moved upward

Clinical Exam & US

- 41-58% of abnormal physical exams were negative on US
- US screening reduced abduction splinting in clinically detected hip instability with no increase in abnormal hip development
- Optimum strategy to reduce risk of having an arthritic hip at 60 is physical exam screening and selective US

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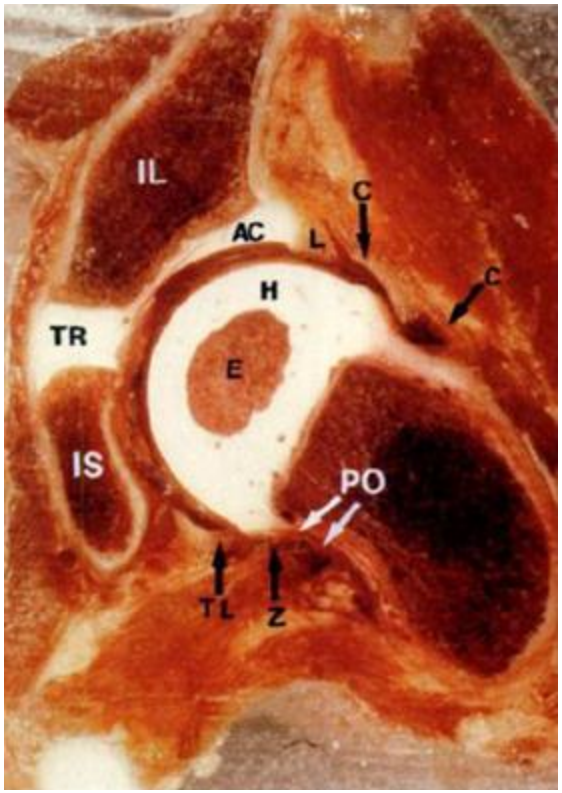
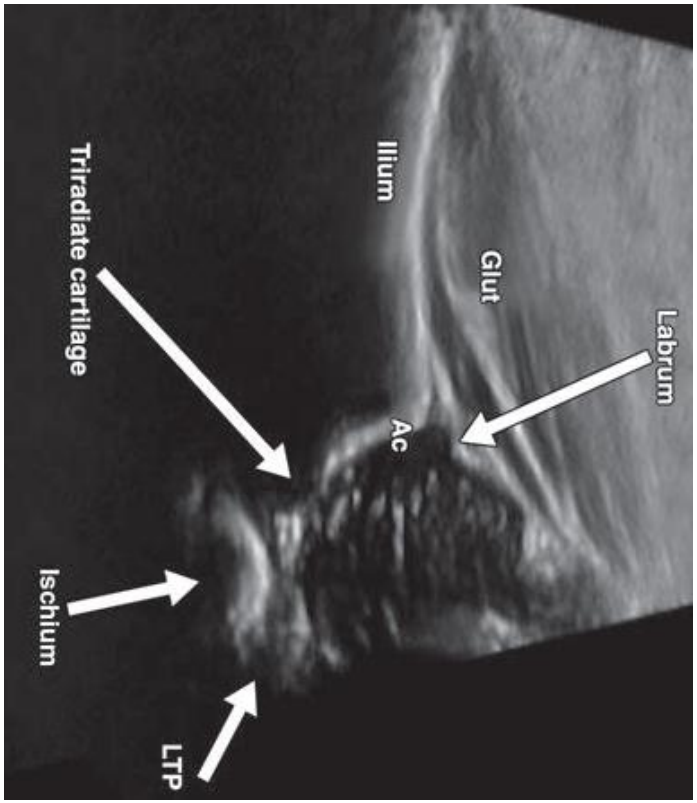
Coronal Anatomy

IL=ilium
TR=triradiate cartilage
IS=ischium
AC=acetabular cartilage
L=labrum
C=joint capule
PO=periosteum
TL=transverse ligament
Z=zona orbicularis



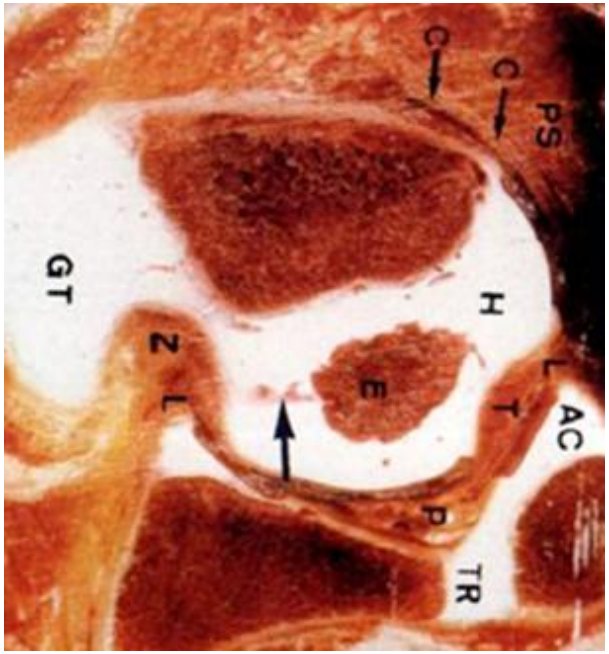
Johnson ND. AJR 1989



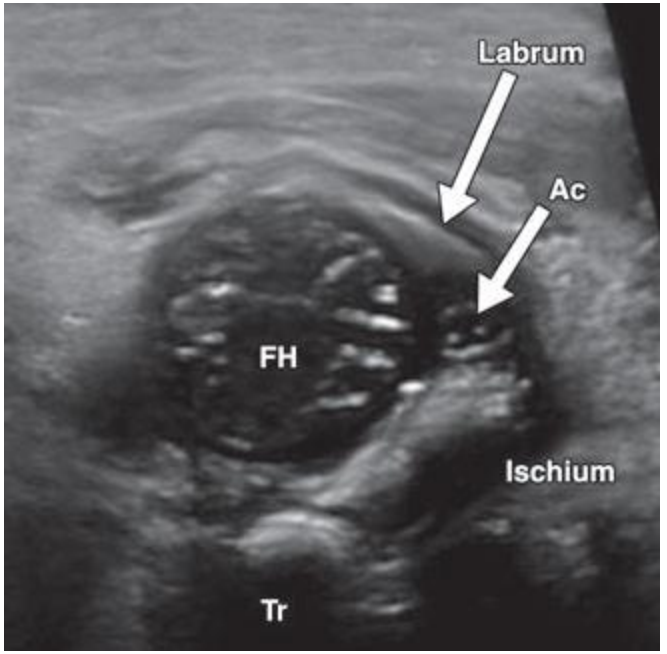
Starr V. AJR 2014

Transverse Anatomy

AC=acetabular cartilage
TR=triradiate cartilage
L=labrum
T=ligamentum teres
P=pulvinar
C=joint capsule
H=femoral head
GT=greater trochanter

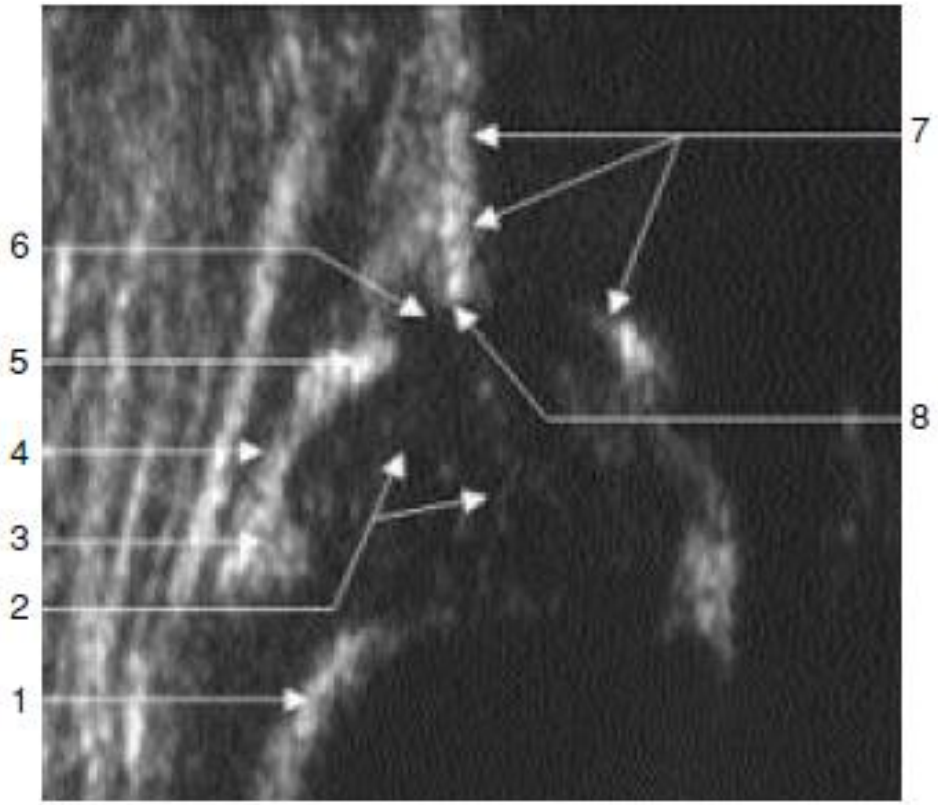


Johnson ND. AJR 1989



Starr V. AJR 2014

“Correct order of anatomical identification”



Graf R. Acta Orthop Tramatol Ture 2007

1. Chondro-osseous junction
2. Femoral head
3. Synovial fold
4. Joint capsule
5. Acetabular labrum
6. Hyaline cartilaginous preformed acetabular roof
7. Bony part of acetabular roof
8. Bony rim: turning point

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Graf vs Harcke

- **Graf method –** Static,single coronal plane
- **Harcke method-** Dynamic, coronal and transverse real-time assessment of hip stability (and static anatomy)
- With both techniques, considerable interobserver variability, especially during the first 3 weeks of age
- Increase reliability by performing at 4-6 weeks of age

Graf Static Method

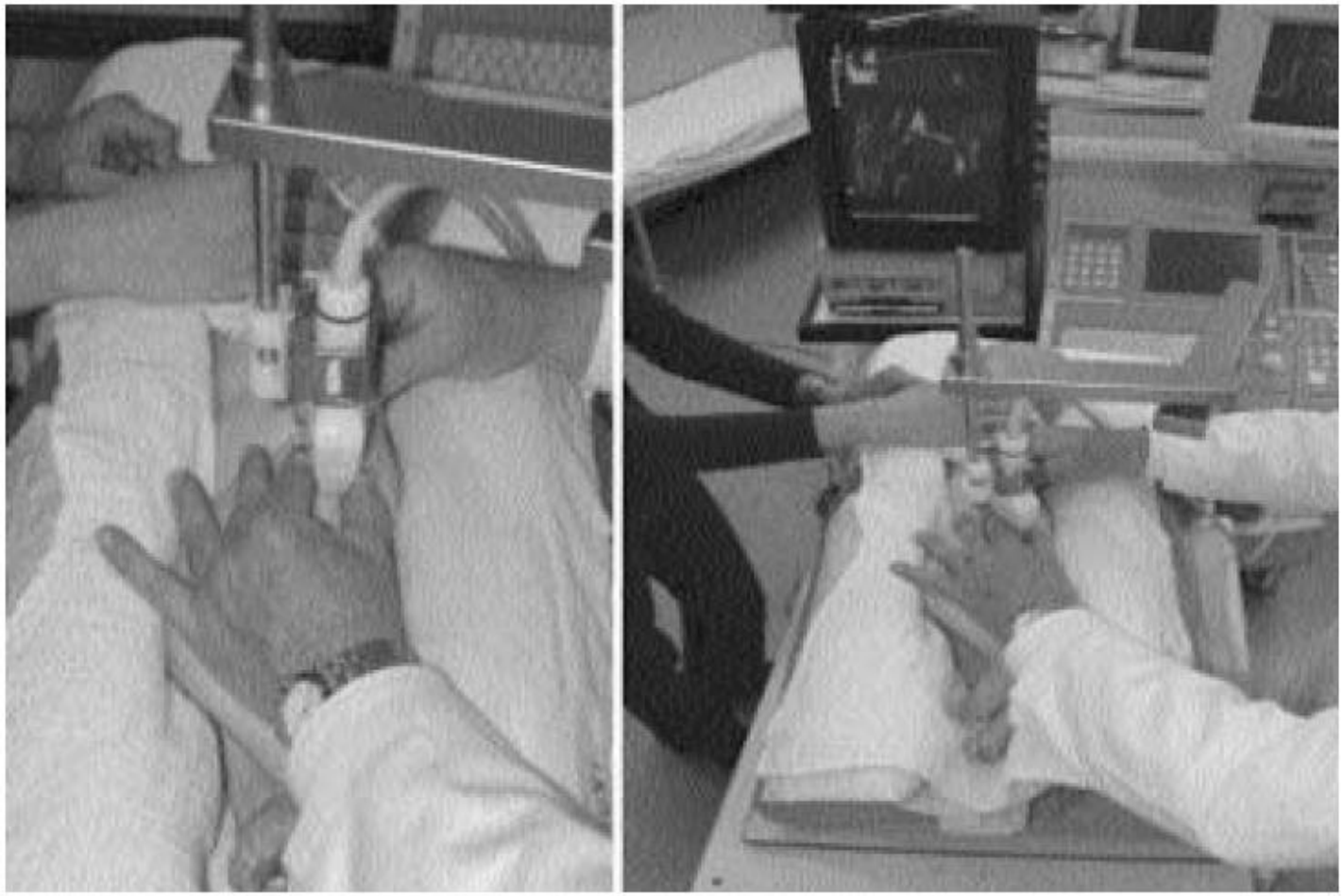
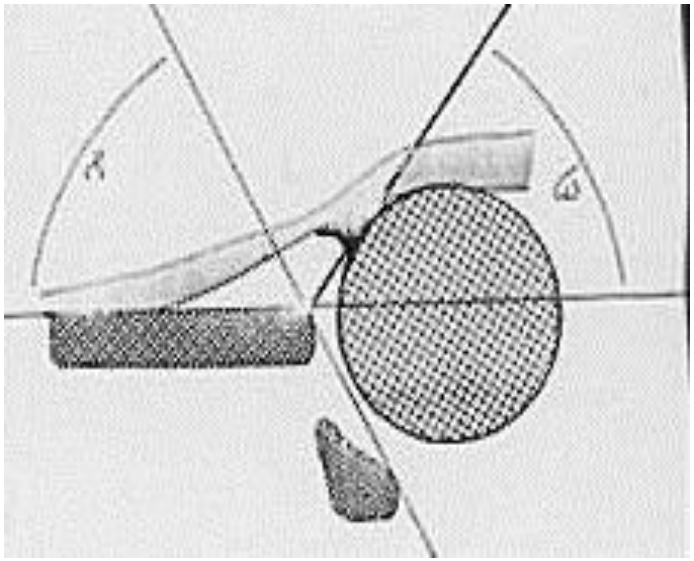
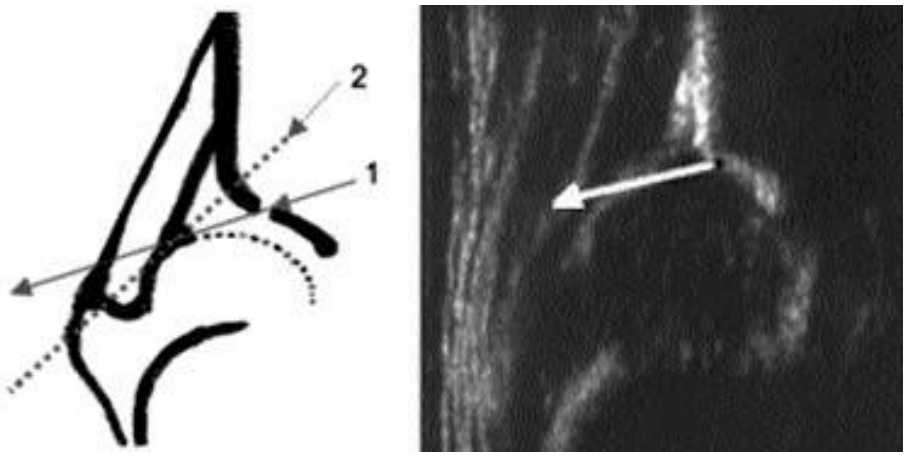


Figure 7. Correct scanning technique with cradle and probe guiding system (sonoguide)

Graf R. Acta Orthop Tramatol Ture 2007

Graf α and ß angles

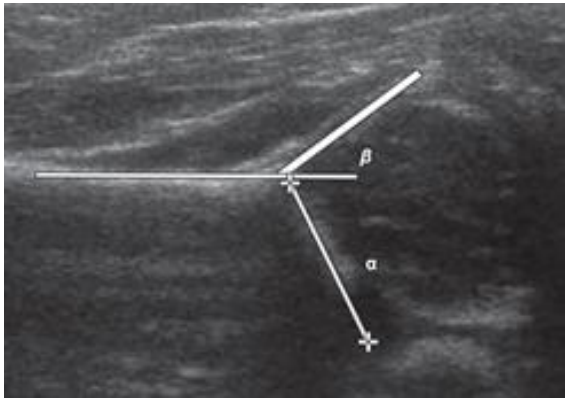




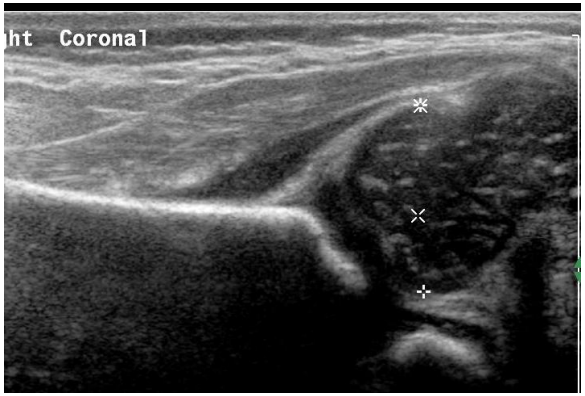
- α angle formed between vertical cortex of ilium and acetabular roof
- ß angle formed by line through vertical ilium and cartilaginous acetabular labrum

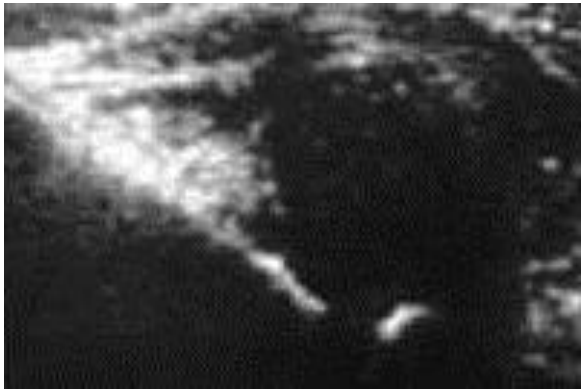
Graf R. Acta Orthop Tramatol Ture 2007

Graf α and ß angles

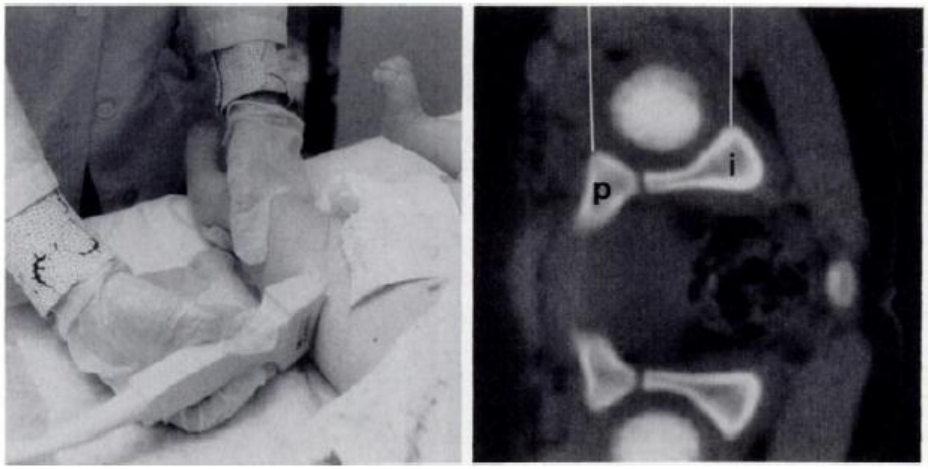


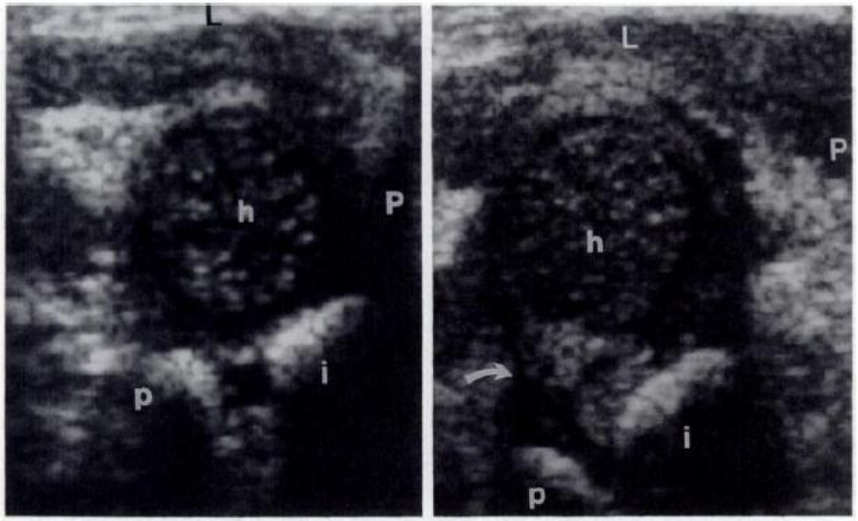
- Normal α angle **≥ 60°**
  - α angle < 60° = shallow acetabulum
- Normal ß angle **< 55°**
  - ß angle ≥ 55° = elevated labrum from femoral head displacement





Harcke Dynamic Method



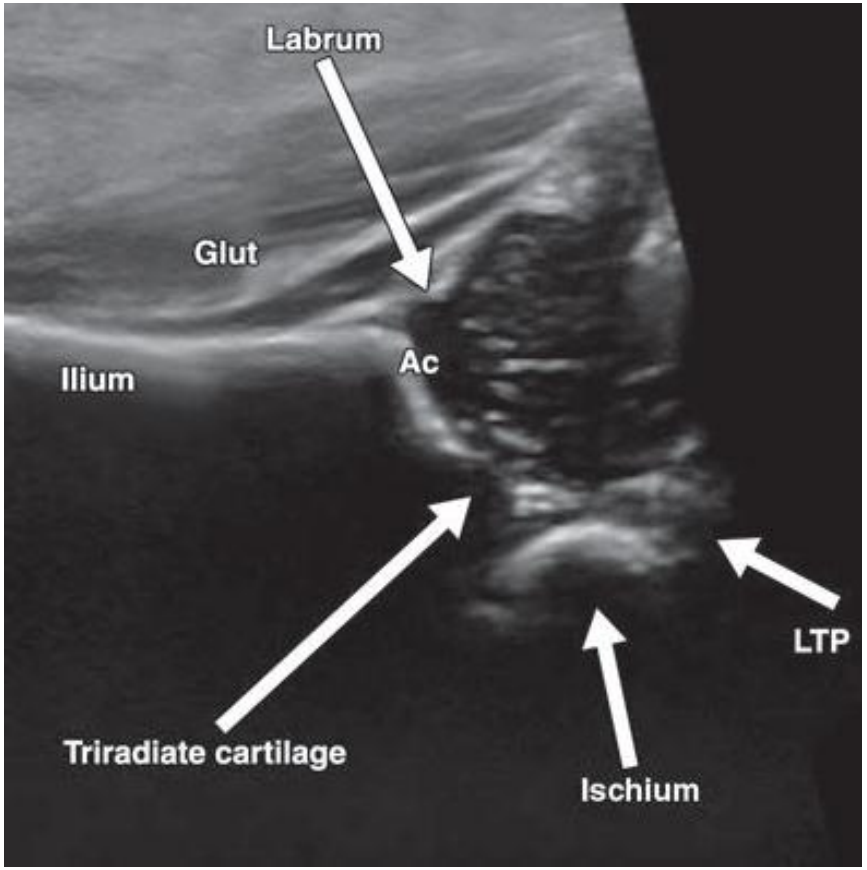


Harcke HT. AJR 1990

- Coronal and Axial images obtained in neutral and hip flexion
- Stress maneuver similar to Barlow maneuver
  - Hip adducted posterior pressure

American College of Radiology

- Coronal view standard plane at rest
- Transverse view flexed hip without and with stress
- Standard plane:
  - Straight iliac line
  - Femoral head max diameter
  - Tip of echogenic acetabular labrum
  - Triradiate cartilage
- Report largest α angle, not average



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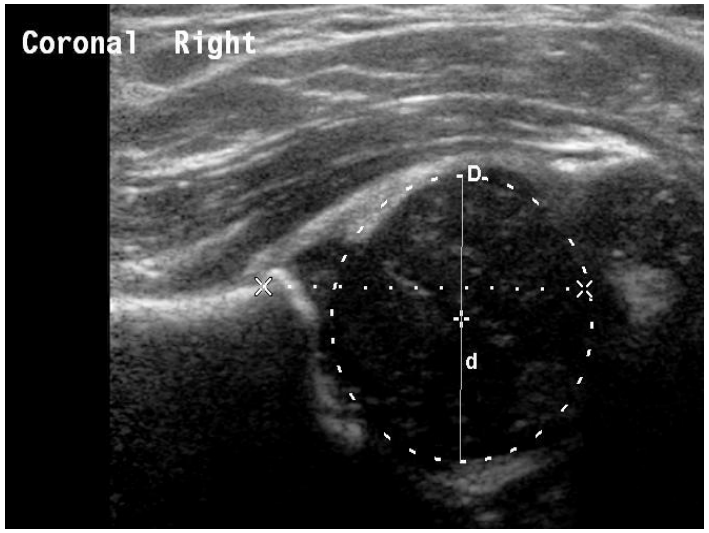
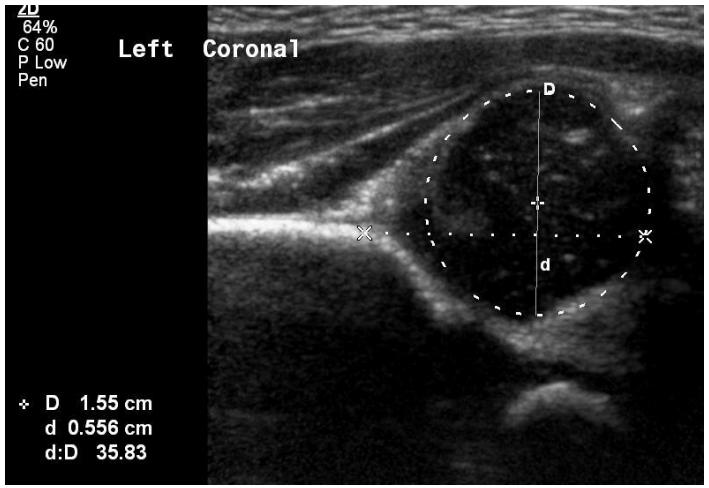
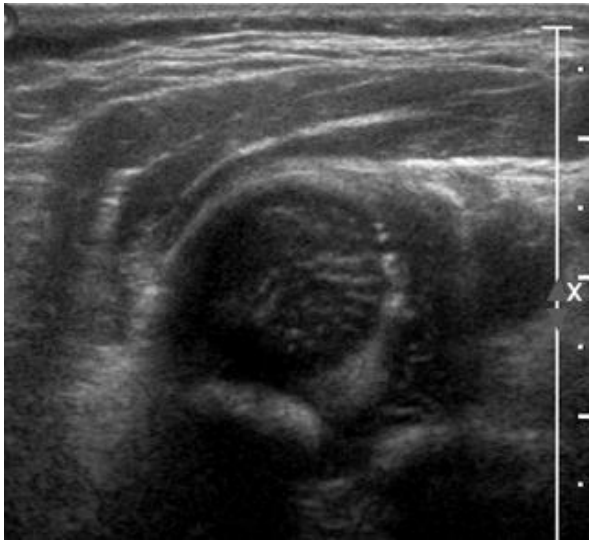
Femoral head position

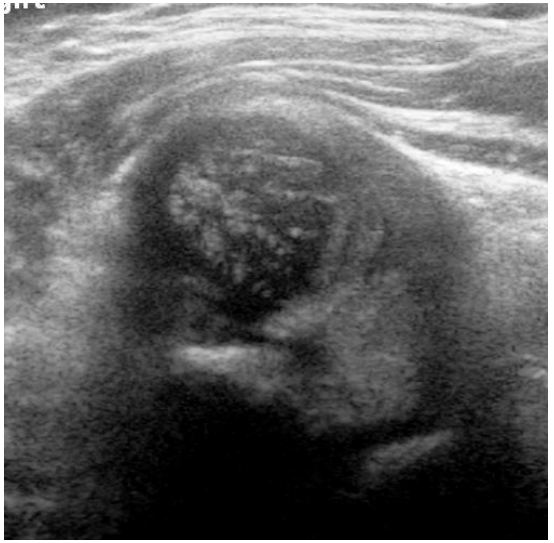


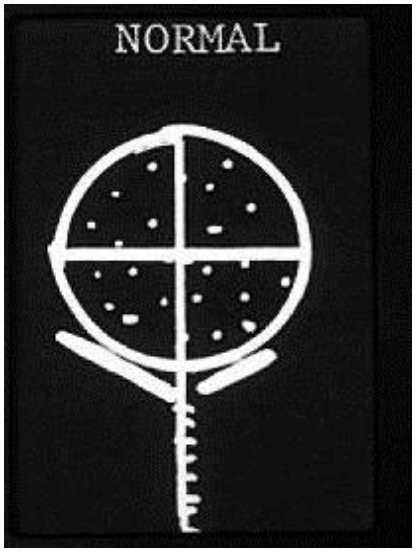


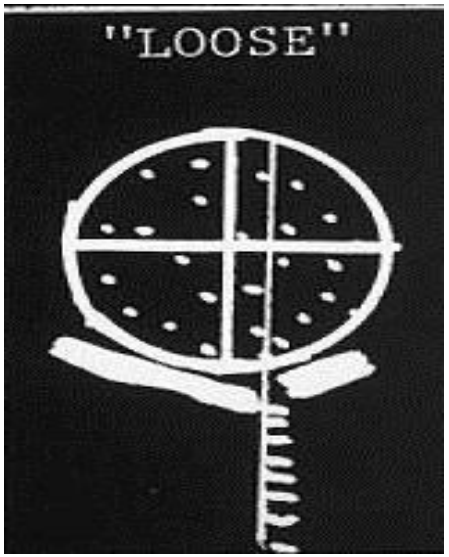
- Normally positioned femoral head >50% covered by acetabulum
- DDH results in shallow acetabulum and decreased coverage

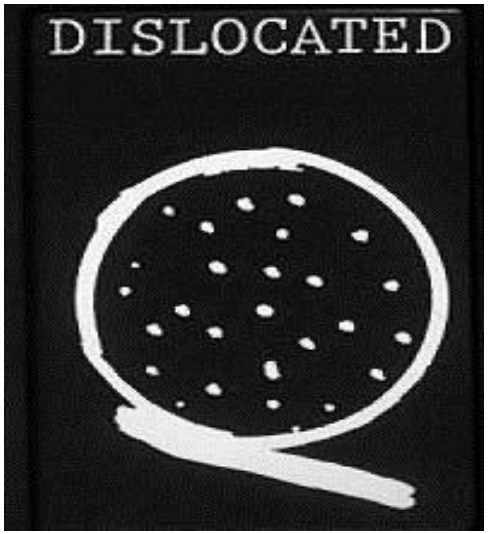
Transverse Stress



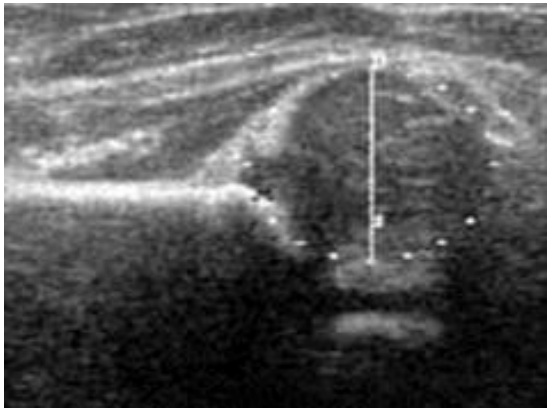




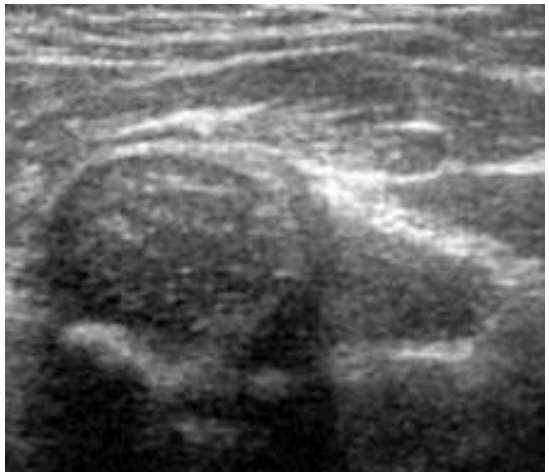




Physiological Immaturity



- Initial study
  1 month old



- Three week
  follow up

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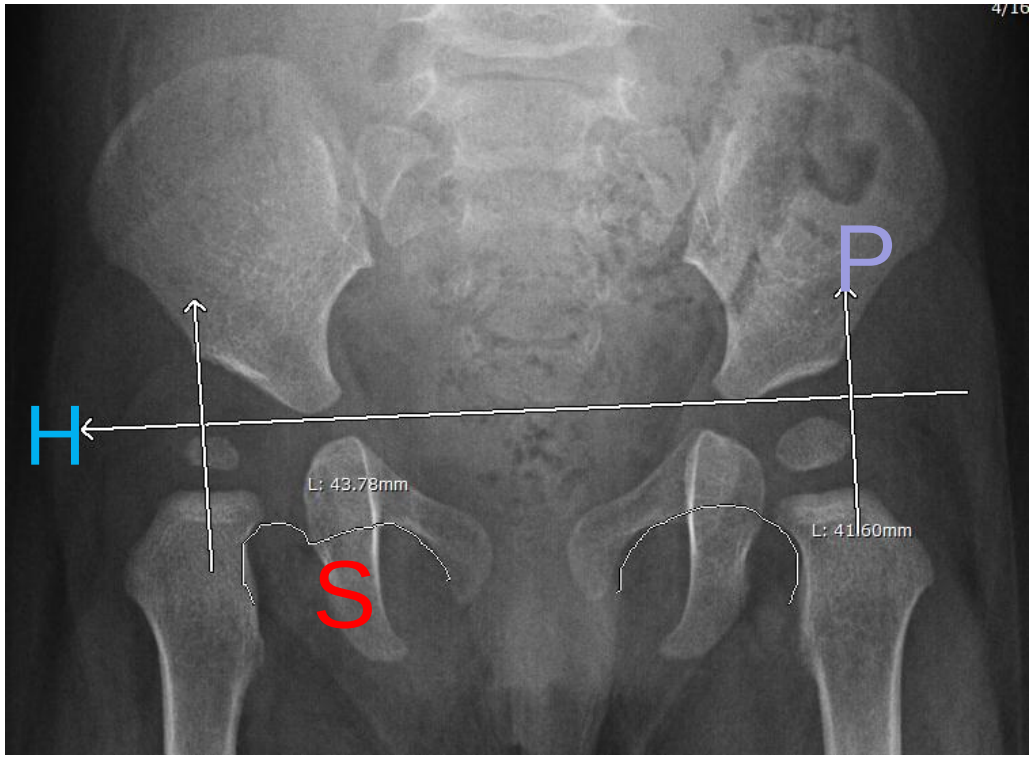
Age and Screening

Modality	Age or Indication	Advantages and Disadvantages
Ultrasound	Up to 4–5 mo	Unossified femoral head, bony, and nonbony landmarks well evaluated
Radiography	After 5–6 mo	Once femoral head ossifies, bony landmarks evaluated
CT	Problem solving, mostly postoperative evaluation	Used for problem solving in past; however, has disadvantage of unnecessary ionizing radiation
MRI	Treatment planning and monitoring, including postoperative evaluation	Treatment planning and monitoring, including postoperative evaluation

Starr V. AJR 2014

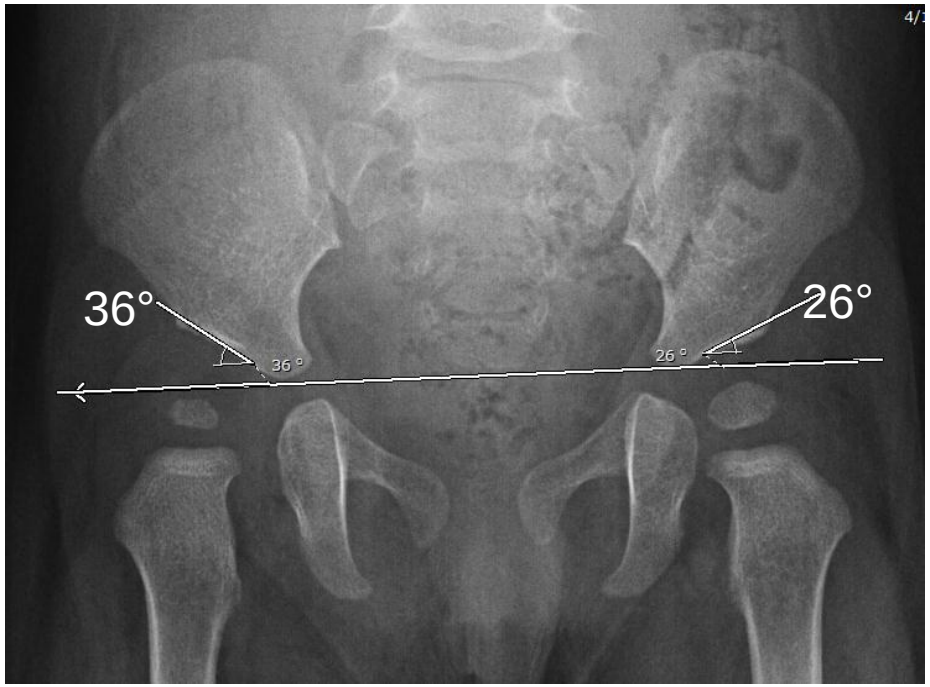
Ultrasound is preferable in patients **4-6 weeks** of age, but we will *attempt* up to 9 months of age

Conventional Radiography



- >4-6 months old after femoral head ossification
- Hilgenreiner = Horizontal
- Perkins = Perpendicular
- Shenton's line

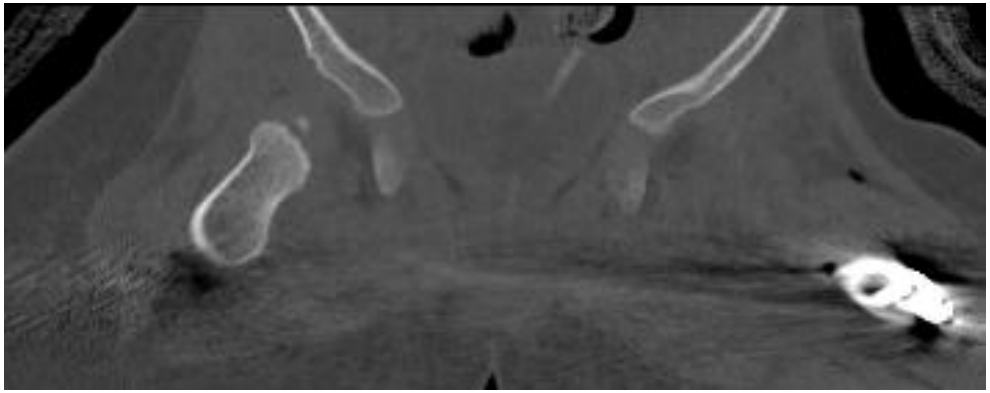
DDH Criteria



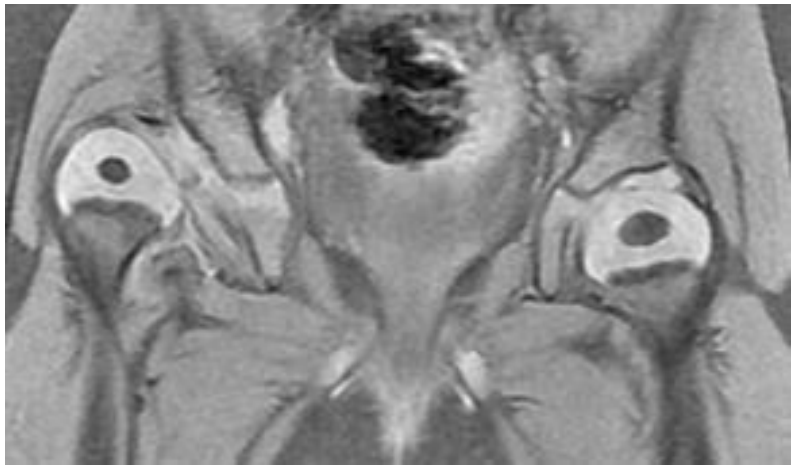
- Shallow acetabulum
  - Acetabular angle <29°at birth
  - Acetabular angle <22°at 1 year
- <80% femoral head coverage
- Femoral head not in inferomedial quadrant
- Delayed ossification of femoral head

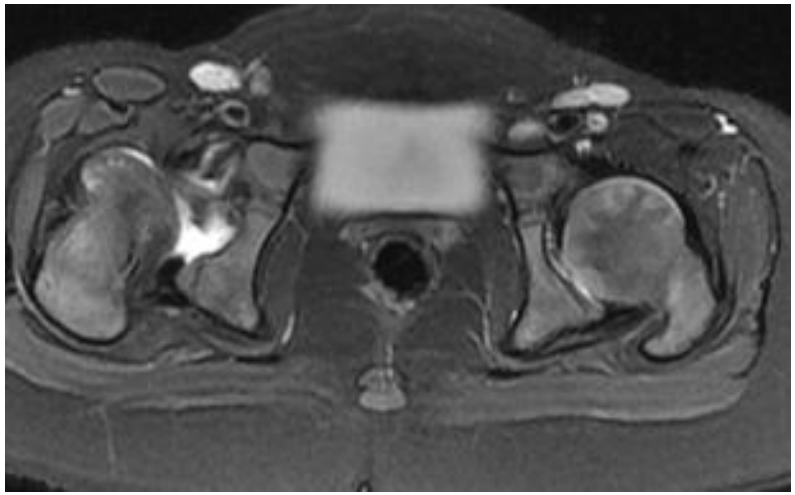
CT

- Problem solving in difficult cases
- Patients with casts after surgery to confirm reduction
- Evaluate complex hip dislocations
- Avascular necrosis



MRI





- Treatment planning and monitoring
- Postoperative evaluation
- Particularly useful for determining ligamentous and soft tissue abnormalities that prevent reduction

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Universal vs Selective Screening

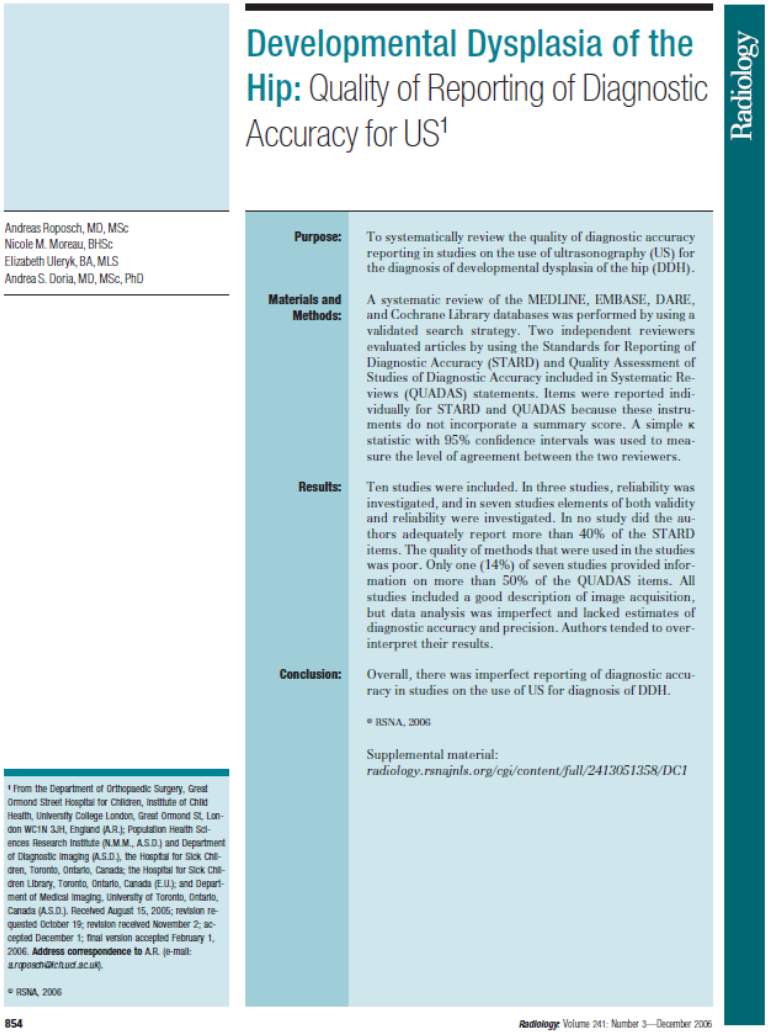
Universal

- Some European countries
- Increase DDH detection and treatment
- May increase unnecessary treatment, expense, and post-treatment AVN

Selective

- Breech, family history, females
- Primaparity, oligohydraminios, congenital anomalies
- AAP recommend: female infants born in breech position
- Optional: males born breech or female with family history

What is the Quality of our data?



Developmental Dysplasia of the Hip: Quality of Reporting of Diagnostic Accuracy for US[1]

Radiology

Andreas Roposch, MD, MSc
Nicole M. Moreau, BHSc
Elizabeth Uleryk, BA, MLS
Andrea S. Doria, MD, MSc, PhD

Purpose: To systematically review the quality of diagnostic accuracy reporting in studies on the use of ultrasonography (US) for the diagnosis of developmental dysplasia of the hip (DDH).

Materials and Methods: A systematic review of the MEDLINE, EMBASE, DARE, and Cochrane Library databases was performed by using a validated search strategy. Two independent reviewers evaluated articles by using the Standards for Reporting of Diagnostic Accuracy (STARD) and Quality Assessment of Studies of Diagnostic Accuracy included in Systematic Reviews (QUADAS) statements. Items were reported individually for STARD and QUADAS because these instruments do not incorporate a summary score. A simple κ statistic with 95% confidence intervals was used to measure the level of agreement between the two reviewers.

Results: Ten studies were included. In three studies, reliability was investigated, and in seven studies elements of both validity and reliability were investigated. In no study did the authors adequately report more than 40% of the STARD items. The quality of methods that were used in the studies was poor. Only one (14%) of seven studies provided information on more than 50% of the QUADAS items. All studies included a good description of image acquisition, but data analysis was imperfect and lacked estimates of diagnostic accuracy and precision. Authors tended to overinterpret their results.

Conclusion: Overall, there was imperfect reporting of diagnostic accuracy in studies on the use of US for diagnosis of DDH.

Supplemental material:
radiology.rsnajnls.org/cgi/content/full/2413051358/DC1

[1] From the Department of Orthopaedic Surgery, Great Ormond Street Hospital for Children, Institute of Child Health, University College London, Great Ormond St, London WC1N 3JH, England (A.R.); Population Health Sciences Research Institute (N.M.M., A.S.D.) and Department of Diagnostic Imaging (A.S.D.), the Hospital for Sick Children, Toronto, Ontario, Canada; the Hospital for Sick Children Library, Toronto, Ontario, Canada (E.U.); and Department of Medical Imaging, University of Toronto, Ontario, Canada (A.S.D.). Received August 15, 2005; revision requested October 19; revision received November 2; accepted December 1; final version accepted February 1, 2006. **Address correspondence to** A.R. (e-mail: *a.roposch@ich.ucl.ac.uk*).

- **Accuracy:** no study report more than 40% of STARD
- **Quality:** only 14% of studies provide more than 50% of QUADAS
- **Conclusion:** “Imperfect” reporting of diagnostic accuracy of US for DDH

Roposch A. Radiology 2006

Summary

- Modern US approach to diagnosis of DDH combines **Static Graf** & **Dynamic Harcke**
- US requires knowledge of **anatomy** and correct **technique**
- Different countries adopt Universal vs Selective **Screening**
- Quality of methodology in papers reporting Diagnostic Accuracy is poor