

Imaging DDH

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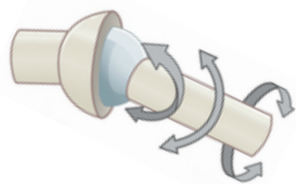
Secret Paediatric Radiologist Business



- Diagnosis & Management of DDH is a mess



Just a ball & socket joint



Secret Paediatric Business

- The Mess of DDH
 - Definition
 - Diagnosis
 - Incidence
 - Treatment



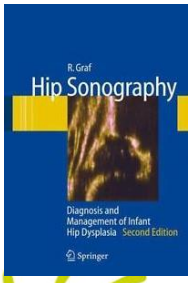
DDH: "Definition"

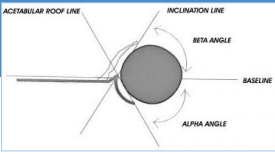
- "Abnormal relp of femoral head & acetabulum"
- 3 major characteristics:
 - Alignment - concentric anatomical relationship
 - Growth abnormality
 - Clinical instability
- Dysplasia overlaps with normal maturation

How do we translate this vague definition to imaging criteria?



DDH: "Science"


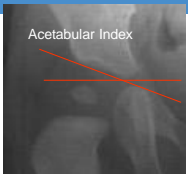





Hip type	Osteous roof- α angle	Cartilaginous roof- β angle	Cartilaginous rim
Type I Mature hip	≥ 60	<55 - type Ia >55 - type Ib	a - narrow b - wide based
Type Ia (I) Physiological immaturity - appropriate for age (within age of 3 months)	50 - 59	>55	Wide covers femoral head
Type Ib (I) Physiological immaturity - transitional (within 3 months age of 3 months)	50 - 59	>55	Wide covers femoral head
Type IIa Degree of ossification after age of 3 months	50 - 59	>55	Wide - still covers femoral head
Type IIb Littoral range (late age)	43 - 49	70 - 77	Wide - still covers femoral head
Type III Discontinuing (late age)	43 - 49	>77	Displaced
Type IVa	<43	>77	Displaced, without structural alteration
Type IVb	<43	>77	Displaced, with structural alteration
Type IVc	<43	>77	Displaced intrafemorally

DDH: Diagnosis

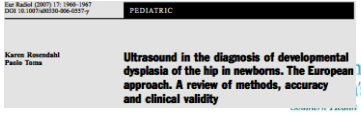
- Clinically
 - Instability (Barlow Test)
 - Reduced abduction....
- Imaging
 - X-Ray
 - Blunting outer acetabular margin
 - Femoral Head Coverage (?50, 55, 57, 58, 60%)
 - Acetabular Index (absolute & asymmetrical)
 - Ultrasound
 - Morphology (as per X-Ray, quantified by Graf)
 - Dynamic "Sonographic Barlow" (Harke)




DDH: "Incidence"

- Incidence - 25 fold variation
 - Immaturity 2-56%
 - Dysplasia 0.2-5%
- Increased since screening (esp. ultrasound)




DDH: Screening

- Objective: diagnose & treat DDH early
 - ➔ reduce intensity of treatment
 - ➔ improve outcome
- Subjective & operator dependent
- Not change surgical rate of treatment ??
 - Maybe ↓ severity of surgery required




US Screening around World

- Germany & Austria – all neonates
- United States - "ultrasound screening for DDH cannot be considered more reliable than physical examination"



- Australia – screen at risk groups




Indications: Risk Factors for DDH (Why?)

- History (40%)
 - Family Hx of DDH
 - Intrauterine "Packaging"
 - Breech
 - Oligohydramnios
 - Torticollis
 - Foot deformity

- Physical Examination
 - Click or Clunk
 - Limited range of motion
 - Asymmetrical skin folds
 - Asymmetrical leg length

10% of all newborns



DDH: Treatment

- Poor evidence of effectiveness
 - Good to treat a condition that often gets better by itself
- Variably treated
 - Conservative
 - Broad Nappies
 - Harness or Brace
 - Surgery
- Management varies between
 - Countries
 - Institutions
 - Medical practitioners
 - Patients of same clinician



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DDH is a bit of a mess

- Ultrasound accepted tool for DDH
 - Diagnosis
 - Monitoring development & treatment
- Experience is that treatment is effective
- Common paediatric medico-legal condition



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How to do it



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Pitfalls of Hip Sonography

- Graf angles
- Femoral head coverage
- Correlation with radiography
- "Immaturity" retrospective diagnosis
- Older infant



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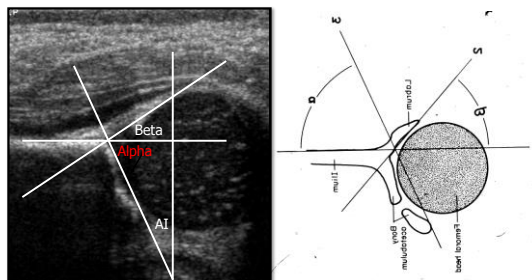
Pitfalls of Hip Sonography

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Graf Angles



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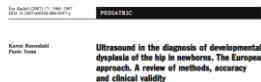
Objective US Assessment: Graf

Graf Type	Bony Roof (α angle)	Bony Rim	Cartilage Roof (β angle)	Age
I Mature hip	Good α ≥ 60°	Ia Sharp Ib Round	Ia β < 55° Ib β > 55°	Any age
IIa Physiologically Immature	Adequate α = 50-59°	Rounded	Covers femoral head	0-12 weeks
IIb Delayed Ossification	Deficient α = 50-59°	Rounded	Covers femoral head	>12 weeks
IIc	Severely deficient α = 43-49°	Rounded to flattened	Covers femoral head	Any age
III Dislocated	Poor α < 43°	Flattened	Pressed upwards	Any age
IV Dislocated	Poor α < 43°	Flattened	Pressed downwards	Any age



DDH: Graf Reproducibility

- Intra/inter-observer reliability
 - esp. outside dedicated paediatric centres
- Graf Reproducibility
 - Normal Hips
 - Intra observer 98%
 - Inter observer 98%
 - Abnormal Hips
 - Intra observer 41%
 - Inter observer 28%

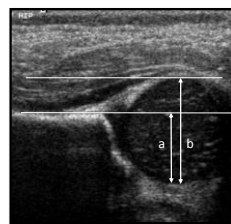


Pitfalls of Hip Sonography

- Graf angles
- **Femoral head coverage**
- Correlation with radiography
- "Immaturity" retrospective diagnosis
- Older infant



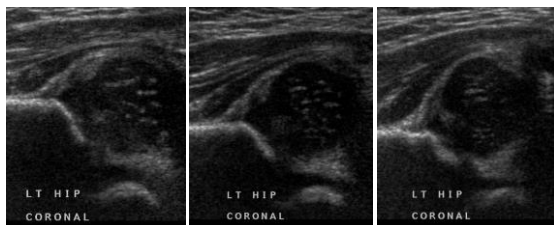
Objective US Assessment: Femoral Head Coverage



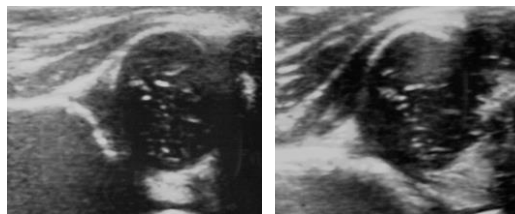
- Femoral Head Coverage = $a/b \times 100$
- Normal ?50, 55, 57, 58, 60%
- Reproducibility?



Femoral Head Coverage

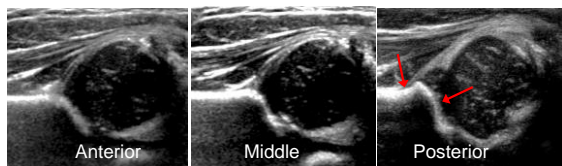


Femoral Head Coverage



Why the inconsistency?

- Attempt to get “best” image
 - Scanning posteriorly
 - Maximise coverage & Sharpen margin
 - But **not** representative image



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Pitfalls of Hip Sonography

- Graf angles
- Femoral head coverage
- **Correlation with radiography**
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Normal US & “Abnormal” X-Ray



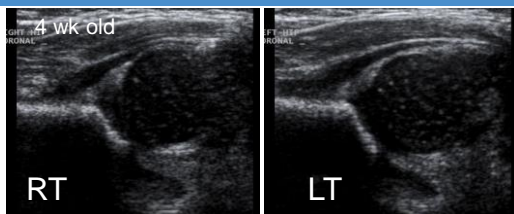
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Pitfalls of Hip Sonography

- Graf angles
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- **“Immaturity” retrospective diagnosis**
- Older infant

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Diagnosis?



“Immature hips, suggest follow up if clinically concerned”

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“Immaturity” Retrospective Diagnosis



No follow up: X-ray 3 years later

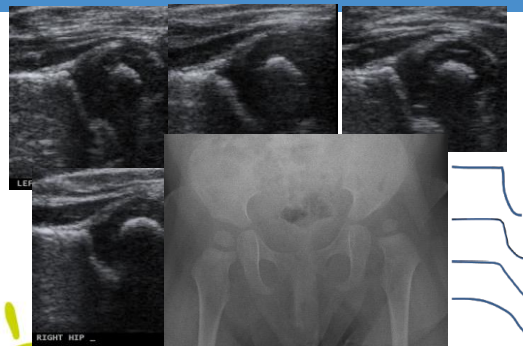
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Pitfalls of Hip Sonography

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When do we need an X-Ray?



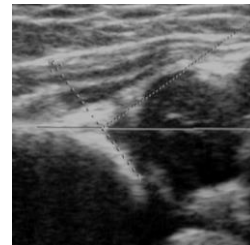
Alarm Bells: When should you hear them?



Alarm Bells: When should you hear them?



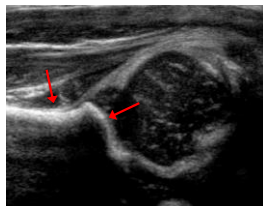
- Acetabular shape & coverage don't match



Alarm Bells: When should you hear them?



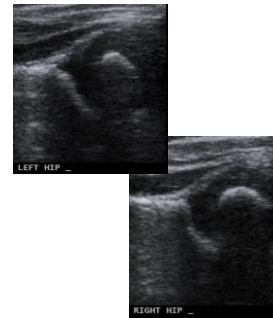
- Acetabular shape & coverage don't match
- Concave/Convex



Alarm Bells: When should you hear them?



- Acetabular shape & coverage don't match
- Concave/Convex
- Asymmetry



Alarm Bells: When should you hear them?



- Acetabular shape & coverage don't match
- Concave/Convex
- Asymmetry
- Difficult to get "nice" view



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DDH: Conclusion

- Diagnostic criteria limited by DDH Definition
- More than just Graf & Coverage
- Shape (& alpha angle)



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