



# A normal screening ultrasound does not provide complete reassurance in infants at risk of hip dysplasia; further follow-up is required

Jill Mulrain<sup>1</sup>  • Jennifer Hennebry<sup>2</sup> • Patrick Dicker<sup>3</sup> • James Condren<sup>1</sup> • Donal O'Driscoll<sup>2</sup> • Joseph O'Beirne<sup>1</sup>

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Jean-Luc Banks, MS3

Journal Club

# Learning Objectives

By the end of this journal club, participants will be able to:

- Understand the epidemiology and etiology of developmental dysplasia of the hip (DDH)
- Recognize the presentation of DDH in infants and children
- Understand the importance of the physical exam combined with imaging in the diagnosis of DDH
- Understand the significance of the alpha angle and acetabular angle in the diagnosis of DDH
- Be familiar with the Graf classification system in the diagnosis of DDH
- Understand the limitations of a single modality of imaging and the importance of follow-up in the diagnosis of DDH

# Module Outline

- I. Case
- II. Background
- III. Article Overview
- IV. Clinical Questions
- V. Key Points

# Case Presentation

7 week-old female referred to radiology for “instability of the hips”

**PMHx:** Born to G1P1 mother at 39 weeks via uncomplicated C-section due to breach positioning. One- and five-minute APGAR scores were 8 and 9 respectively. Mother reports no complications during delivery. Baby girl is breastfed and gaining weight with no other reported health concerns. Mother states that they were referred for “instability in the hips” that was mentioned when the baby was born.

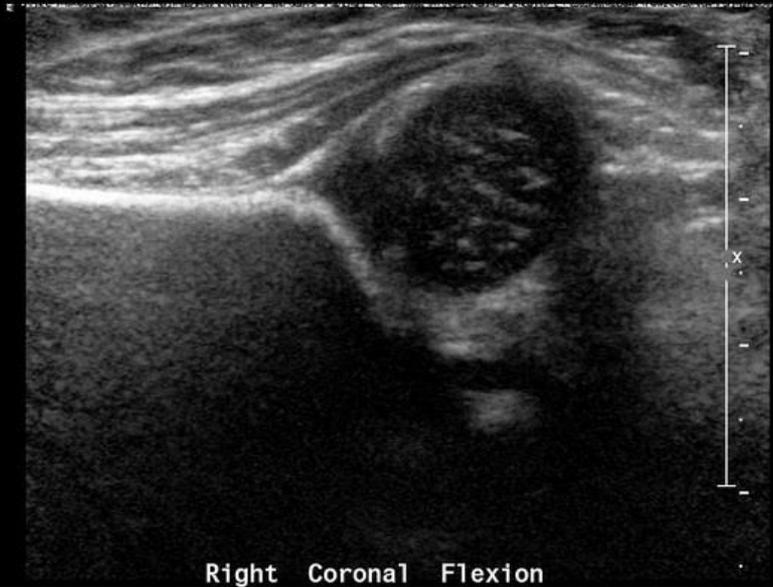
**Fam Hx:** Mother reports that maternal grandfather, great uncle, and a cousin were braced as children for “congenital hip problems.”

# Case Questions

- What physical exam maneuvers do you think were performed to diagnose this “instability in the hip?”
- What imaging studies would you perform for the patient at this time?

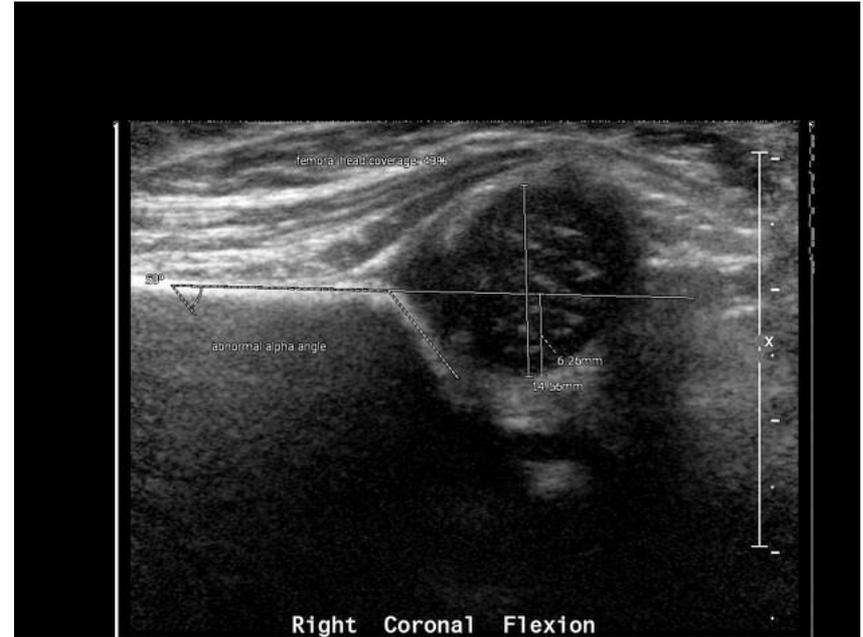
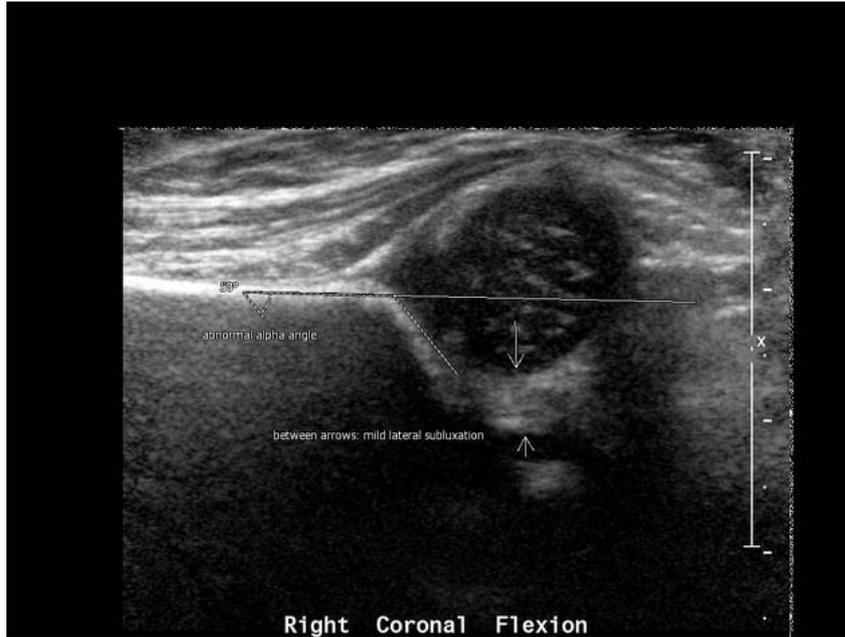
# Case Imaging - Bilateral

*Radiopedia*



# Case Imaging – Right Hip

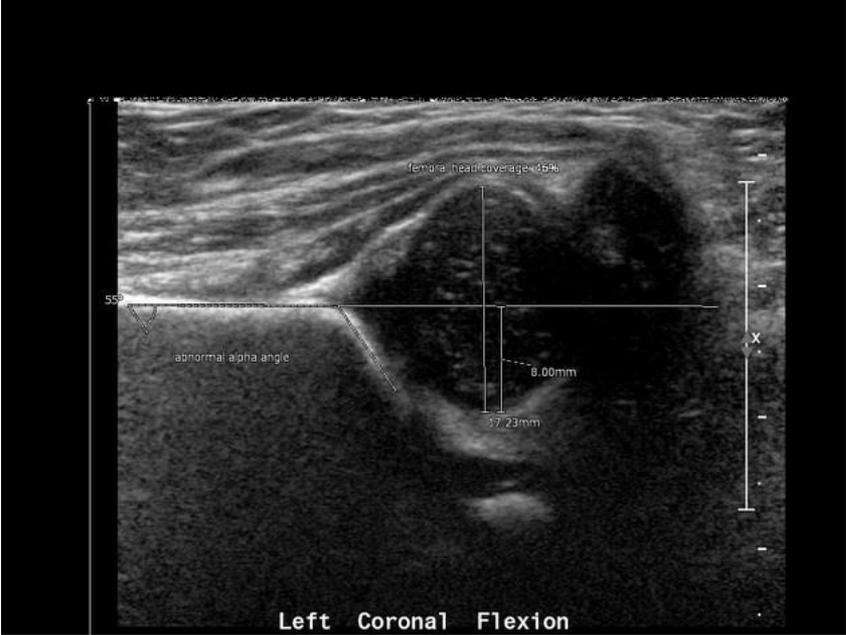
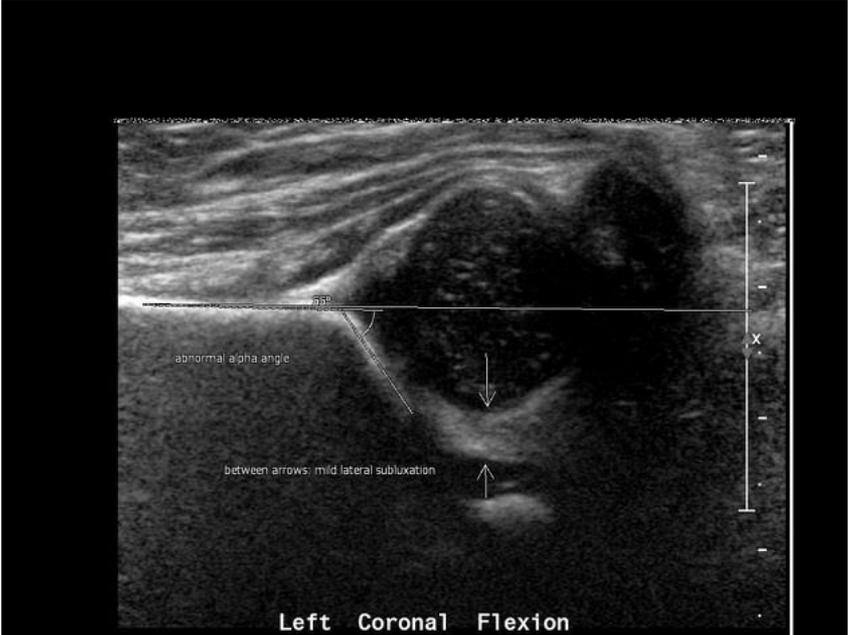
Radiopedia



right alpha angle measures: 50 degrees

# Case Imaging – Left Hip

Radiopedia



left alpha angle measures: 55 degrees

# Case Questions

- What do these ultrasound findings tell us about the diagnosis of the child?
- What are the imaging study recommendations for a patient with a normal hip ultrasound at 7 weeks? Should they be re-evaluated?
- If we find that a patient has DDH at 7-week ultrasound, what are the next steps in management?

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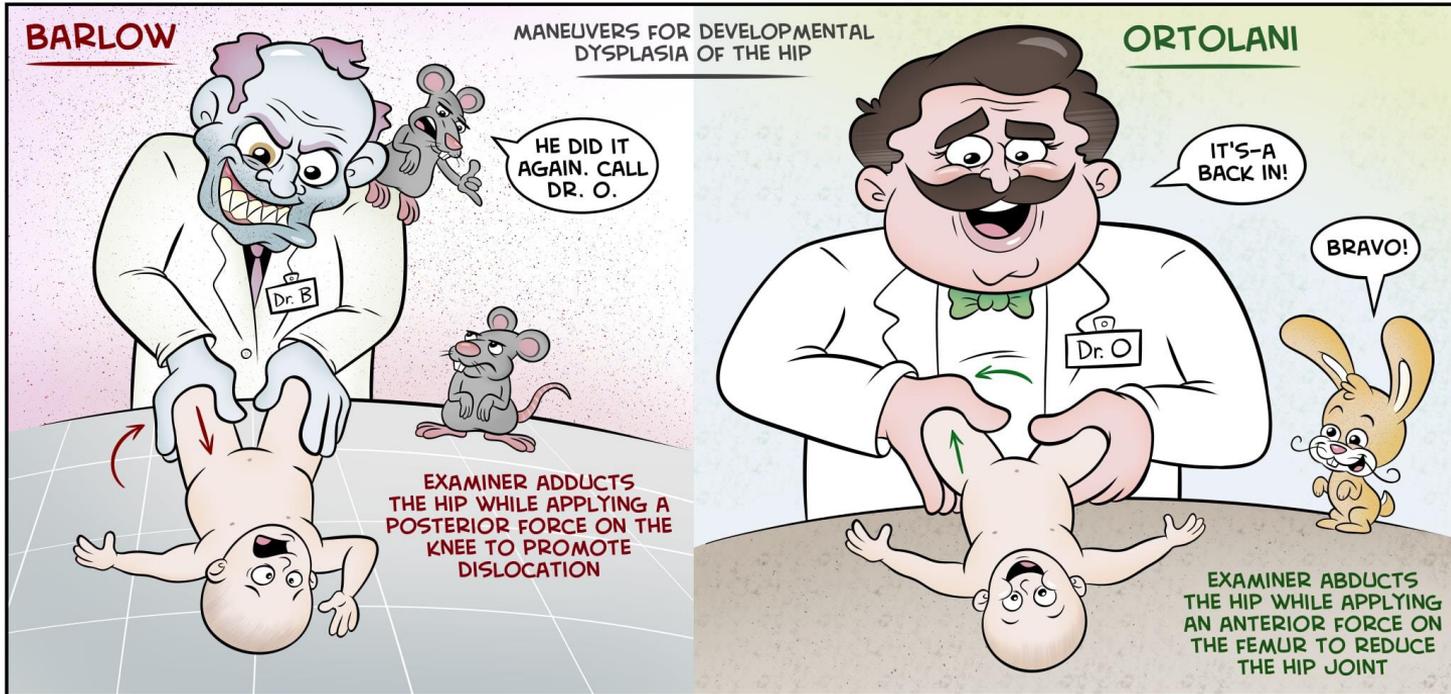
# Developmental Dysplasia of the Hip DDH

- Abnormal development of the acetabulum and proximal femur along with mechanical instability of the hip joint
- May affect 1 or both hips, but is more common in the left hip
- Affects 1-34:1000 depending on diagnostic evaluation<sup>2</sup>
- Risk factors
  - First born status
  - Female sex
  - Breech positioning at > 34 weeks gestation
  - Family history of DDH
  - Oligohydramnios

# Developmental Dysplasia of the Hip DDH

- **Presentation:** Clinical features depend upon age of the child and severity of the abnormality – from instability in newborn exam, to limited abduction in infant, to asymmetric gait in toddler, to activity related pain in adolescent, to osteoarthritis in adult<sup>1</sup>
- **Etiology:** multifactorial condition with several predisposing factors including ligament laxity, breech presentation, postnatal positioning, and primary acetabular dysplasia
- **Diagnostic Evaluation:**
  - **Physical Exam**
    - **< 3 months** – Ortolani, Barlow, and Galeazzi tests
    - **> 3 months** – limited abduction, thigh-length discrepancy (in unilateral cases) and Galeazzi and Klisic tests
    - **Walking age children** – positive Trendelenburg pelvic tilt test (in unilateral cases)
  - **Imaging**
    - **< 4 months** – ultrasound
    - **> 6 months** – radiograph

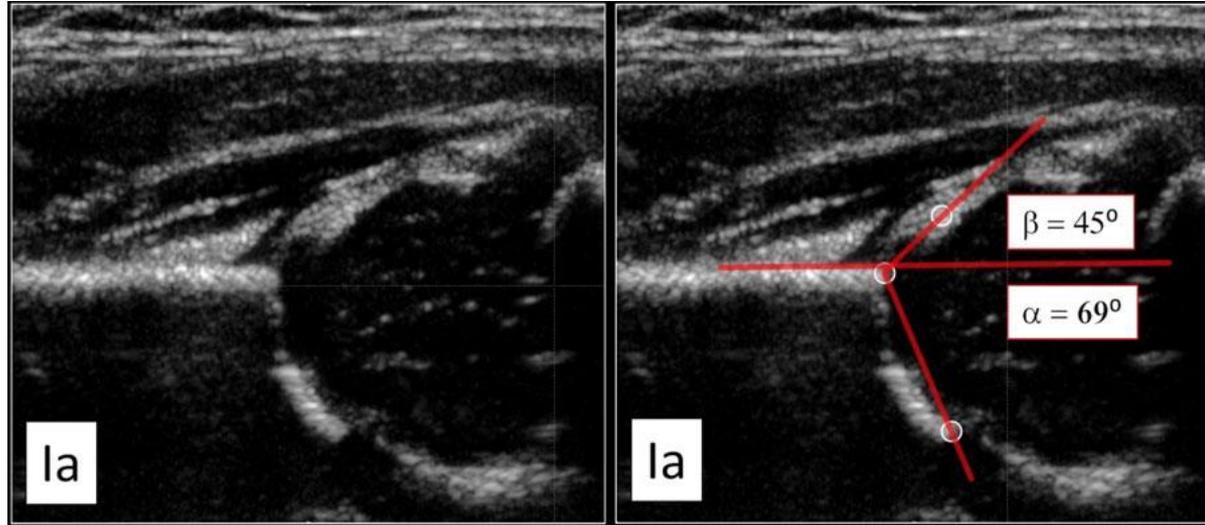
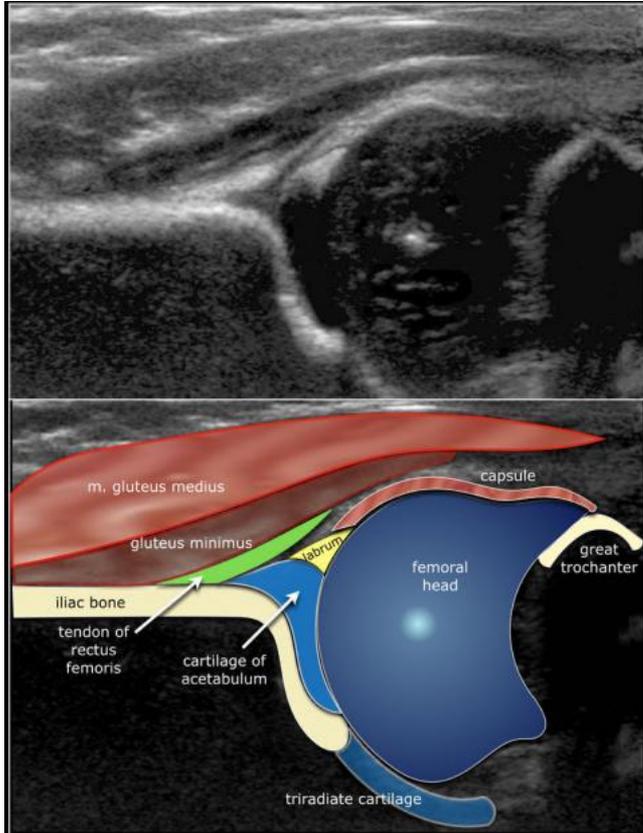
# Ortolani and Barlow Maneuvers



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# Ultrasound Findings and the Alpha Angle



The normal value is greater than or equal to 60 degrees. Less than 60 degrees suggests dysplasia of the acetabulum.

# Graf Classification System

## Developmental Dysplasia of the Hip

$\alpha$  - angle

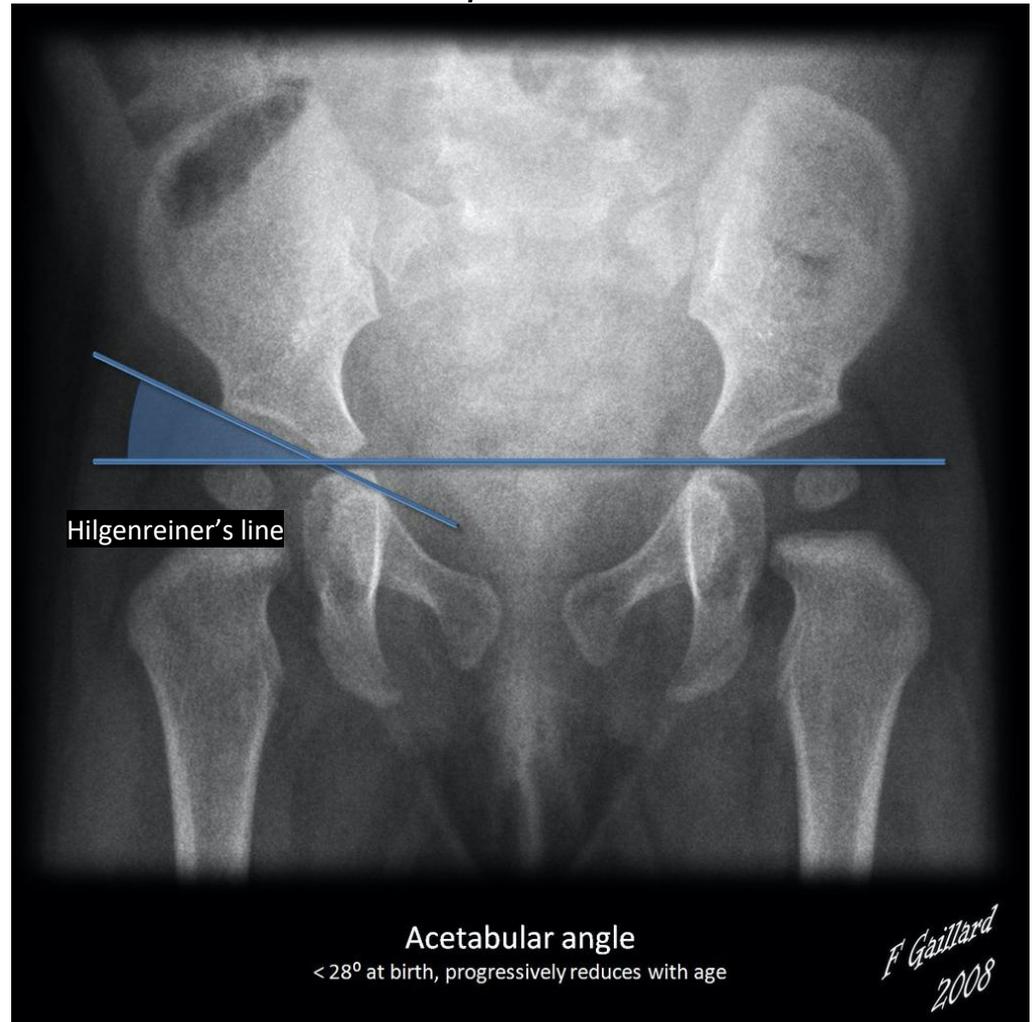
★ Type I	$\alpha > 60^\circ$	
IIa	$\alpha 50 - 59^\circ$	appropriate for age
Type IIb	$\alpha 50 - 59^\circ$	inappropriate for age
IIc	$\alpha 43 - 49^\circ$	
Type D	$\alpha 43 - 49^\circ$	decentring hip
Type III	$\alpha < 43^\circ$	eccentric hip
Type IV	$\alpha < 43^\circ$	inverted labrum

Type	Maturity	Bony roof	Bony angle	Bony rim	Cartilage roof	$\beta$ -angle	Age
Type I	mature	good	$\alpha \geq 60^\circ$	sharp	good coverage femoral head	la = $\beta < 55^\circ$ lb = $\beta > 55^\circ$	All
Type II a+	immature but appropriate for age	adequate	50-59°	blunt	coverage femoral head		< 3 mo
Type II a-	immature and inappropriate for age	deficient	50-59°	rounded	coverage femoral head		< 3 mo
Type II b	delay in development	deficient	50-59°	rounded	coverage femoral head		> 3 mo
Type II c	stable or unstable	severely deficient	43-49°	rounded / flat	still coverage femoral head	$\beta < 77^\circ$	All
Type D	decentring hip	severely deficient	43-49°	rounded / flat	displaced	$\beta > 77^\circ$	All
Type III	eccentric hip	poor	< 43°	flat	labrum pressed upwards		All
Type IV	eccentric hip	poor	< 43°	flat	labrum pressed downwards		All

*Radiology Assistant*

# Radiographic Findings and The Acetabular Angle

- At birth the acetabular angle should be less than 28 degrees and should progressively reduce with maturation of the hip.
- should measure less than 22° at and beyond 1 year of age.



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# Article Specifics

**Purpose:** To evaluate the number of patients in their hospital network with a normal screening ultrasound at 6 weeks with evidence of DDH at the time of radiographic review at 6 months. Secondary aim: to determine the outcomes for these patients.

**Journal:** Irish Journal of Medical Science, July 2020

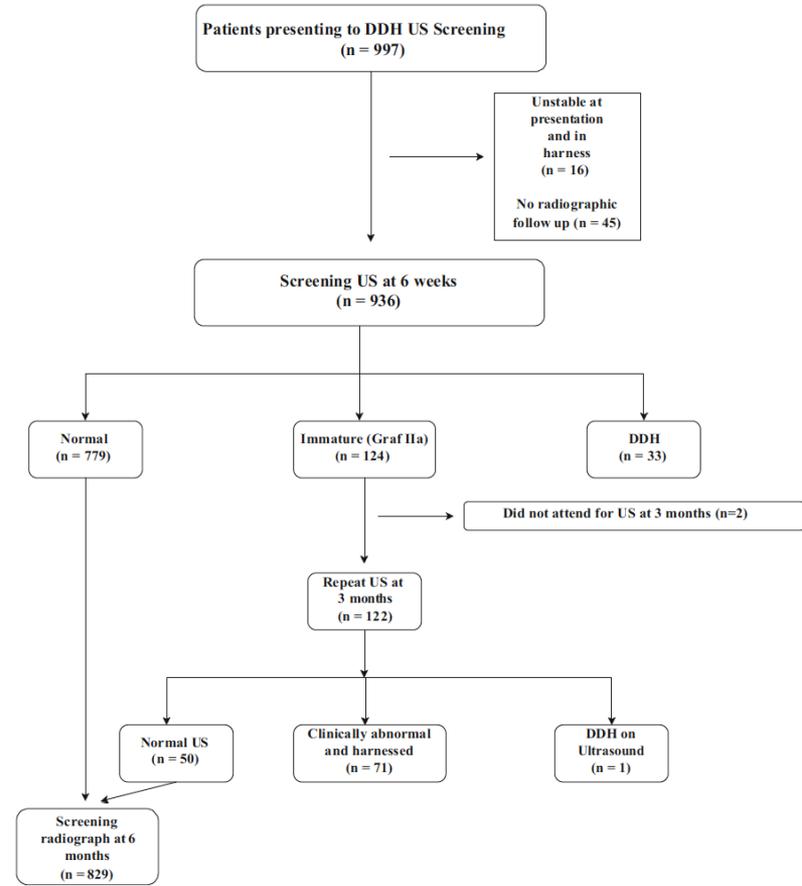
**Study Type:** Retrospective study done to infants undergoing DDH ultrasound screening between January and December 2015.

**Number of Cases:** 829 patients included for analysis

**Data:** ultrasound and radiographic reports

# Study Cohort

- 779 patients presenting after normal US screening at 6 weeks + 50 patients presenting after normal US screening at 3 months due to initial immature(Graf IIa) hip = 829 patients



**Table 1** Demographics and risk factors of screening population (*N* = 829)

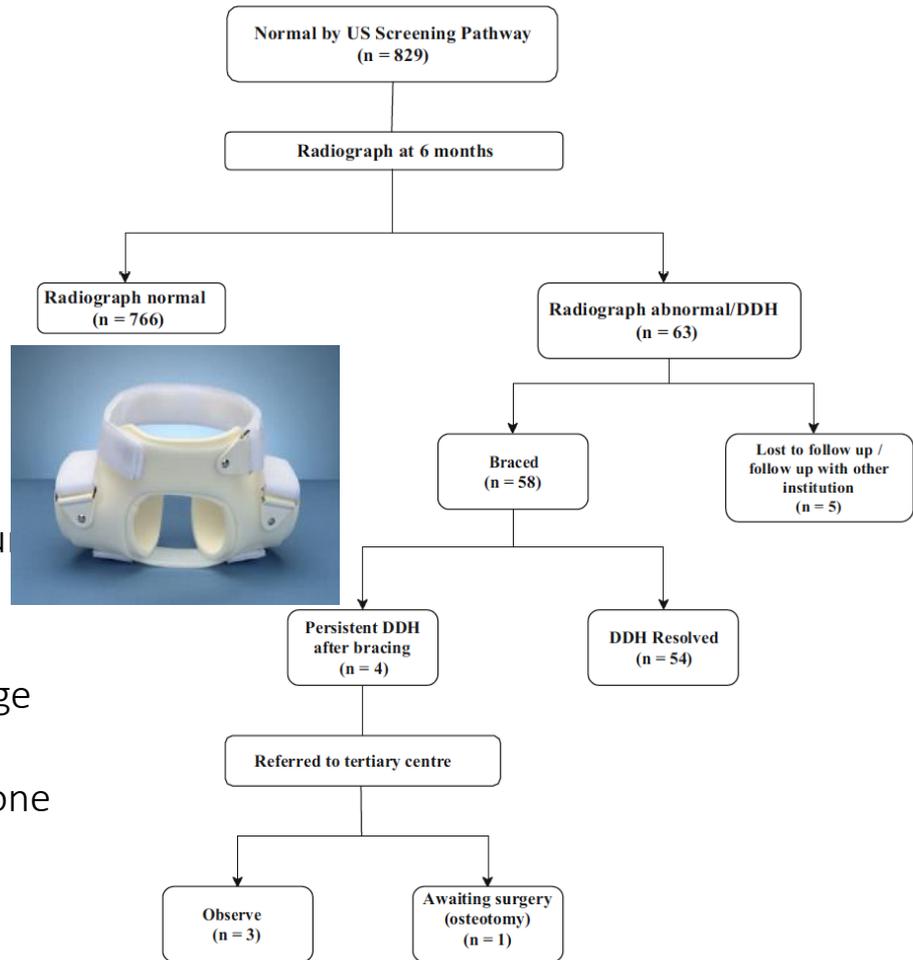
Characteristic		<i>n</i> (%)
Gender	Female	429 (52%)
	Male	400 (48%)
Indication	Breech presentation	245 (29%)
	First degree family history of DDH	320 (38%)
	Breech and first degree family history of DDH	6 (1%)
Other referral	‘Clicky hip’	141 (17%)
	Asymmetric skin creases	11 (1%)
	Abnormal examination	41 (5%)
	Other non-first degree family history	21 (3%)
	Unknown	4 (1%)
	Other	41 (5%)

# Material and Methods

- Retrospective review of patients presenting for DDH ultrasound screening in the study hospital between January-December 2015
- Medical charts and radiographic databases were searched for data including sex, risk factors, and other indications for referral
- Ultrasound and radiograph reports reviewed for findings consistent with DDH
  - Non-specific reports measurements taken from radiographs, using the PACS software
  - An acetabular angle of more than than  $27^\circ$  was considered abnormal
- Radiographic diagnostic cases of DDH underwent logistic regression to determine risk of DDH for gender, presentation at birth, and family history of DDH

# Results

- 63 patients with abnormal radiographs at 6 months,
  - overall radiographic pick up rate of 8%
- 5/63 patients lost to follow-up. The rest diagnosed at 6 months were treated in Boston brace with regular follow-up until examination and radiographic parameters normalized and up walking age
- 4 infants had persistent dysplasia by walking age and were referred for tertiary pediatric orthopedic review. Surgery was performed in one patient in the radiograph diagnosed group



# Results Continued

- 16 infants had unstable hips at birth, and a further 168 infants were diagnosed as a result of screening
  - 105 via US (33 at 6 weeks, 72 at 3 months)
  - 63 via radiograph at 6 months
- Of the 184 DDH diagnoses for the year, 63 (34%) were diagnosed on radiograph at 6 months.

# Results Continued

**Table 3** Demographics of babies with radiographic-diagnosed DDH ( $N = 63$ )

Characteristic		<i>n</i> (%)
Gender	Female	50 (79%)
	Male	13 (21%)
Indication	Breech presentation	15 (24%)
	First degree family history of DDH	27 (43%)
	Breech and first-degree family history of DDH	1 (2%)
	Clicky hip(s)	9 (14%)
	Abnormal examination	6 (9%)
	Other	5 (8%)
Side of DDH	Left	19 (30%)
	Right	23 (37%)
	Bilateral	21 (33%)

**Table 4** Characteristics of X-ray diagnosed patients with persistent DDH|

Gender	Side	Risk factor/indication	First ultrasound	Outcome
Female	Bilateral	Family history	Normal	Observe
Female	Bilateral	Breech	Normal	For osteotomy
Female	Left	Clicky hip	Normal	Observe
Female	Left	Other	Normal	Observe

# Results Continued

- Female gender was a strong risk factor for DDH in those with normal ultrasound examinations
- Family history of DDH showed an increased risk for DDH but this was not statistically significant

**Table 2** Risk of late diagnosed DDH in those with a normal ultrasound examination

Risk factor	OR (95% CI)	<i>P</i> value
Female gender	3.9 (2.1–7.4)	<0.001
Family history of DDH	1.3 (0.7–2.1)	0.390
Breech presentation at birth	0.8 (0.4–1.4)	0.389
Family history + breech	2.5 (0.3–21.4)	0.414

# Discussion

- DDH screening continues to evolve
- Ultrasound techniques and population selection for screening may vary
- Follow up after initial normal ultrasound is not agreed upon internationally
- Patients diagnosed on radiograph at 6 months had milder pathological disease
- In comparison to other studies conducted, these findings reported higher pickup rates on radiograph than others
- Concern for radiation dosages in infants

# Study Limitations

- Variability due to multiple reporters of radiographs from different institutions within the hospital network
- Learning curve associated with Graf ultrasonic method
- Retrospective design
- Natural history of DDH still not fully understood making it difficult to develop a universal screening program
- Spectrum of pathology in those with DDH limits generalizability
- No control group for treatment of radiograph-diagnosed group since all patient underwent bracing

# ACR Appropriateness Criteria

**Variant 1:** Child, younger than 4 weeks of age. Equivocal physical examination or risk factors for DDH. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US hips	Usually Not Appropriate	○
Radiography pelvis	Usually Not Appropriate	⊕⊕

**Variant 2:** Child, between 4 weeks to 4 months of age. Equivocal physical examination or risk factors for DDH. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US hips	Usually Appropriate	○
Radiography pelvis	Usually Not Appropriate	⊕⊕

**Variant 3:** Child, younger than 4 months of age. Physical findings of DDH. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US hips	Usually Appropriate	○
Radiography pelvis	Usually Not Appropriate	⊕⊕

# ACR Appropriateness Criteria Continued

**Variant 4:** Child, between 4 to 6 months of age. Concern for DDH. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography pelvis	Usually Appropriate	☼☼
US hips	May Be Appropriate	○

**Variant 5:** Child, older than 6 months of age. Concern for DDH. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography pelvis	Usually Appropriate	☼☼
US hips	Usually Not Appropriate	○

**Variant 6:** Child, younger than 6 months of age. Known diagnosis of DDH, nonoperative surveillance imaging in harness.

Procedure	Appropriateness Category	Relative Radiation Level
US hips	Usually Appropriate	○
Radiography pelvis	Usually Not Appropriate	☼☼
CT pelvis with IV contrast	Usually Not Appropriate	☼☼☼☼
CT pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼
CT pelvis without IV contrast	Usually Not Appropriate	☼☼☼☼
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○

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# Clinical Questions

- What explains the DDH recognized on pelvic radiograph at 6 months that was not identified on US at 6 weeks?
- Should all infants with normal ultrasound images at 6 weeks be re-evaluated at 6 months of age for DDH?
- How do we adjust these criteria for:
  - Older children and adults?
  - Children born in another country?
  - Children who are unable to afford medical care?
- Do we follow ACR criteria at UNC? How might this change as we learn more about this condition?

# Key Points

- The alpha angle is an important diagnostic criterion for the evaluation of DDH on ultrasound
- The acetabular angle is an important diagnostic criterion for the evaluation of DDH on radiograph
- Despite initial negative evaluation on ultrasound, DDH can present on 6-month radiograph
- Children who present later with DDH often have a less severe condition
- Current ACR guidelines exist for screening for hip dysplasia in children, but guidelines are not consistent internationally

# Guess Who?



It's Me!

2 months post bilateral  
femoral osteotomy for  
bilateral DDH

# References

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