Hip Dysplasia: A Review of Early Management and Salient Points on Hip Preservation in the Adolescent

Pediatric Grand Rounds
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GDH, MD

Introduction: A little about me
- UTHSCSA c/o 2009
- UTSW Orthopaedics c/o 2014
- Pediatric Ortho training at TSRH and CMC Dallas
- Harvard-Boston Childrens c/o 2015

Intro: Clinical Interests
- Dysplasia and hip preservation
- Spinal deformity
- Trauma

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Disclosures
- Grant Hogue, MD, has no relationships with commercial companies to disclose
Learning Objectives

- What is hip dysplasia?
- History of hip dysplasia
- Review of current diagnostic and treatment regimens for developmental/congenital hip dysplasia in the newborn and younger child
- What happens to untreated/subclinical mild dysplastic patients?
- What is hip preservation and why haven’t I heard more about this?!?

Aristotle 384 – 322 BC

- Well known as a philosopher, teacher, and academic
- “Repetition is the key to adult learning”
- We will repeat concepts today

What is developmental dysplasia of the hip?

- “DDH is a spectrum of disorders of development of the hip that present in different forms at different ages. The common etiology is excessive laxity of the hip capsule with failure to maintain the femoral head within the acetabulum.”
- Commonly presents at birth with a dislocated or dislocatable hip
- Presentation in walking age children with limb length discrepancy of gait abnormality

History of CDH/DDH

- Probably described by Hippocrates?
- Descriptions and understanding really began to take off once radiographs introduced
- Rontgen’s first Xray 1895
- First used in surgery in 1896 in England (removal of needle in a hand)

Incidence

- Dislocation: 1-1.5/1000 (Northern Europe)
- >75/1000 in Yugoslavia; ~188/1000 in Native Americans in Manitoba
- Common in Japan
- Very rare in sub-Saharan Africa
- Dislocatable: ? Differences in groups?
- Subluxatable: ?
- Dysplasia: ~1%+ in U.S. Caucasians ???; wide ethnic variation

Risk Factors for DDH

- Breech presentation
- Family history
- Torticollis, lower ext deformity, metatarsus adductus
- Oligohydranmios
Epidemiology of Infant DDH

- Female gender 70+%  
- Breech ~70%  
- L hip ~60%; R hip ~20%; Bilateral ~20%  
- Torticollis/calcaneovalgus foot  
- * First-born female breech: DDH till proven otherwise!

Prevention of DDH?

- Is primary prevention of DDH possible?  
  - Yamamuro feels that maternal swimming in the third trimester has a preventive affect  
- Triple Prevention Program of Klisic (Yugoslavia)  
  - Universal neonatal hip exams  
  - Universal abduction diapers  
  - Universal followup clinical checks till walking age

Screening for DDH

- Universal ultrasounds in infancy  
  - Austrian model; followed in Germany  
  - + Israel  
- Selective ultrasounds if risk factors or clinical suspicion (U.S.)  
- Clinical exam alone: other countries

U.S. Screening

- All infants get physical exam screening  
- Higher risk infants get ultrasound screening  
  - Breech presentation  
  - Family history (sibling or parent)  
- Ultrasound screening should be done around 6 weeks of life  
  - u/s done before 4 weeks is VERY unpredictable  
  - Often causes over-treatment

Diagnosing DDH in Infancy

- Clinical/physical exam  
  - Evocative tests  
    - Ortolani-test of reducibility “OKAY!”  
    - Barlow-test of dislocatability “BAD!”  
- Ultrasound  
  - More sensitive than PE or XR till ~6 mo of age  
- Radiography  
  - More sensitive than US after ~6 mo of age

Ortolani Test

- A test of reducibility  
- Is positive only if a dislocated hip is reduced  
- Is negative if: a hip lies reduced  
- * Or: if a hip is dislocated and irreducible !!!
Ortolani

- **Ortolani hip is Out**

Marino Ortolani

- 1904-1983
- Eventual Chief at Ferrara Childrens
- PEDIATRICIAN
- (so thanks)

Barlow Test

- Is a test of dislocatability
- ?May increase instability of the tested hip?
- May not be a good idea in treated hips
  - Barlow reported rates as high as 20% (much higher than most populations)
  - How many hips was he forcefully shoving out?

Barlow

- Barlow is in but can be pushed out---dislocated
TG Barlow

- 1915-1975
- British physician at Hope Hospital in Salford
- Unclear to me if he was a pediatrician or a non-operative orthopaedist
- Call it a tie?

Galeazzi

Klisic’s Test
DDH Exam Pearls

• The neonatal period in the human infant is a time of physiological hip instability!
  – (i.e., Borderline dysplasia/instability is the norm!)
• The neonatal acetabulum is normally shallow
• The neonatal femoral head is relatively large
• The neonatal hip capsule is normally lax
  A very small push in the wrong direction can set the infant hip on a course to DDH

• The natural history of a persisting congenital hip dislocation is for signs of instability to decrease with time.
  – (The Ortolani sign tends to disappear) – can’t be relocated
• Conversely, signs of deformity and contracture increase with time.
  – (Apparent shortening/adductor tightness) – galeazzi, klisic, asymmetric abduction

DDH Exam Pearls

• The newborn with a dislocated hip usually has:
  – NO ADDUCTOR TIGHTNESS
  – and a positive Ortolani test.
• The 6 month old with a long-standing dislocation usually has:
  – NEGATIVE ORTOLANI TEST → cannot be reduced
  – marked adductor tightness → asymmetric abduction

Ultrasound in Infant DDH

• Baseline assessment
  – Static
    • qualitative assessment of joint development
    • quantitative measurements
  – Dynamic
    • qualitative assessment of joint stability
  • * Excellent visualization of radiolucent cartilage and soft tissues

Sono In Infant DDH

• Able to perform serial examinations without risk of radiation

Anatomy of an U/S

• Femoral Head
• Acetabulum
• Labrum
• Alpha Angle
• Head “coverage”
**Anatomy of an U/S**

- **Alpha angle**: the angle between the vertical iliac line and the acetabular line
  - Bigger angle, less dysplasia
  - Smaller angle, more dysplasia

- **Femoral Head Coverage**
  - >50% normal till 3 mo

- **What’s normal?**
  - Alpha angle: >50° normal till 3 mo; 60° later

- **Beta angle?**
  - Not useful.

**Plain Radiography in Infant DDH**

- Rarely useful before 6 mo of age
- Complementary with US:
  - as femoral head’s secondary ossification center begins to ossify:
    - 1) US becomes less accurate
    - 2) plain x-ray becomes more accurate
Femoral head should be in inferomedial quadrant
AI < 30 in newborn and ~20 deg by 2yo

Treatment Modalities for Developmental Hip Dislocation
- Gradual reduction
  - Pavlik harness or traction
- Closed reduction with spica
- Open reduction with spica

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**Arnold Pavlik**

- Born 1902 in Czechoslovakia
- MD in 1930 and his practice consisted of general pediatrics and otolaryngology
- DDH → high rate of AVN → presented his “functional treatment” in Prague in 1946

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**Early Pavlik Harness**

- Dr. Pavlik Died in 1962 at the age of 60
- His treatment strategy has endured through technological advances and the scrutiny of evidence based medicine

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**Pavlik Harness**

- Less useful in large infants (>6mos old) and walking age toddlers
- Reinforces importance of early diagnosis

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**CASE JC**

- 6 week old female referred for possible DDH
- Full term, vertex, normal delivery
- Hip click at newborn exam
- No family history of DDH
- Pediatrician ordered ultrasound at 6 weeks due to hip click
- Alpha 44 deg
Case JC

- Risk factors
  - Breech: no
  - Oligo: no
  - Family Hx: no
- Barlow and Ortolani: negative
- Only diagnosed because pediatrician felt subtle “click”
  - That’s the feeling of the head rubbing on the posterior labrum/acetabulum

What if Pavlik doesn’t work or patient has late presentation?

- Newborn:
  - Primary pathology: Capsular laxity
  - Secondary deformity: none
  - Treatment principle: protective splinting to allow capsular tightening

- Older infant/toddler:
  - Primary pathology: Capsular laxity
  - Secondary deformity: soft tissue contract
  - Treatment principle:
    - Reduction
    - Stabilization

Closed Reduction with Spica Casting

- Preceded by relief of contractures
  - traction/Pavlik harness/adductor tenotomy
- General anesthesia mandatory
- Maneuver is a simple gentle Ortolani test
- * Position hip in the “safe zone” (not too much abduction)
- Imaging to confirm reduction
- Splinting to maintain the reduction (spica)

Case KS

- 6 month old female
- Full term, vertex but breech until 8 months, c-section due to failure to progress in labor
- No screening done
- u/s hard to read at 6 mos
- Exam
  - Negative Ortolani, negative Barlow
  - Positive Galeazzi
  - Limited right hip abduction
Risk Factors

• Breech: Yes
• First female: Yes
• Barlow and Ortolani negative (6 mos old!)
• Galeazzi positive
• Once we get to 6 mos (maybe 3 mos in some children) we have missed the boat for Barlow and Ortolani
• This patient was a home delivery in western Massachusetts

Risk Factors

• 1st female: Nope...7th!
• Breech: No
• Nursery Exam: unknown
• Family Hx: Mother treated for DDH
• Now with LLD and strange gait
  – Maybe walks with one foot in equinus (single leg toe walkers are NOTORIOUS for DDH)

Case AC

• 2 yr 8 month old female with gait disturbance
• 7th child, vertex, full term, normal delivery
• Mother treated with harness for DDH
• Walked at 18 months
• Physical exam:
  – Lordotic spine
  – Trendelenburg gait
  – Full abduction

OR for adductor tenotomy, closed reduction with arthrogram, and spica cast

OR for bilateral open reduction, pelvic osteotomy, and spica cast
DDH Summary

- Most common cause of hip OA in N. America
- Early dx helps to optimize result
- US screening useful in at-risk populations
- FU through maturity is prudent
- Secondary treatment often needed

17yo M with L side LBP/Glut pain

- Seen in my clinic on Tuesday
- Anything interesting about his left hip?

What if we compare to “normal”?

- Untreated/undiagnosed mild hip dysplasia
- Femoral head coverage should be ~60%
  - His is <50%
- Lateral Center Edge Angle should be 30-34 degrees
  - His is 17 deg

Now to change speeds a bit and jump into the future... hip preservation in the adolescent
Three Rules of Adolescent DDH

1. **EVERY** hip with a center edge angle <17 deg will develop OA by age 60. (Murphy et al, 1995)
2. Successful treatment requires treatment in the coronal and sagittal plane.
   - (multidirectional or rotational osteotomy)
3. No amount of femoral osteotomy (varus) can correct the instability created by an oblique acetabulum.

***Rule #1 is really the only one that pertains to you***

Mechanical Characteristics of Adolescent DDH

- Static overload of rim: local stress concentration
- Dynamic instability: shear forces

Adolescent DDH Pathomorphology

- Rim pathology: labrum; rim fractures
- Femoral head pathology: chondromalacia
- Cartilage-biochemical: Early GAG loss

Clinical Evaluation/History

- Vague pain: has usually seen primary care doctor and at least one specialist before eventual diagnosis. **Most go undiagnosed.**
  - Hence the high rate of THA
- Pain can be non-specific
  - Lateral (greater trochanter pain)
  - Anterior groin (intra-articular pain)
  - Posterior (back/gluteal pain from hyperextension/lordosis)
- Most dysplastic hips will hurt worst when extended and/or externally rotated

Indications for Joint-Preserving Therapy in the Adolescent

- Symptoms likely to be relieved
  - Pain matches up with symptoms of dysplasia
- Prognosis likely to be improved
  - Hip has not already been irrevocably damaged
- Joint preservation preferred over THR
  - Some patients would rather have a THR at 40-60yo than take a year out of sporting activities

What is Hip Preservation?

- Surgical techniques to treat instability (DDH) or impingement (FAI) that aim to restore normal pathomechanics to the hip joint in an effort to maintain native anatomy and reduce osteoarthritis and the need for arthroplasty
- Manipulation of native anatomy to avoid eventual hip replacement
**Treatment of Choice in Adolescent DDH**

- Ganz Periacetabular Osteotomy (PAO)
- Developed by Professor Reinhold Ganz in Bern, Switzerland
- An osteotomy that reorients the acetabulum and predictably preserves hip function and motion

**Technique**

- The acetabulum is separate from the rest of the pelvis using 4 “cuts”
  - Ischium
  - Sup Ramus
  - Ilium
  - Posterior Column
- The socket can then be rotated into the anatomic position and fixed in place with screws

**The Bottom Line**

- Most OA in the hip has a mechanical etiology, and it often starts BEFORE skeletal maturity
- Impingement (FAI) and instability (DDH) are the bad actors
  - Different presentations
- Developmental deformity patterns are common causes of pathomechanics
- Early surgery limits cartilage damage

**Thank You**