Developmental Hip Dysplasia: What Can We Do Now

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DDH

Radiographic
• Dysplastic
Clinical or radiographic
• Subluxable
• Dislocatable
• Dislocated
Developmental Dysplasia

• Neonatal period
• Early Childhood
• Late Dysplasia

• What Can We Do Now?
  – Screening
  – Surveillance
  – Intervention
Epidemiology

• 1 in 100 born with dysplasia or subluxatuion
• 1 in 1000 with dislocated hip
  - Wide ethnic variation
• Female gender 70%
• Breech 30-70%
• Left hip 60%
• Bilateral 20%
• Torticollis 20%
• Metatarsus adductus 5%
Etiology

- Mechanical
  - Breech
  - Multiple gestation
  - LGA/oligohydramnios
  - Tight hamstring and psoas

- Genetic
  - 6% if sibling affected
  - 12% if parent affected
  - 36% if parent and sibling affected
    (Wynne-Davies)

- Hormonal
  - Maternal relaxins circulate in the child and cause temporary ligamentous laxity
Risk Factors

- Female 70%
- Breech 30%
- Family history
Newborn Evaluation

• Every newborn should have Barlow, Ortolani maneuver performed

• Reassess at each infant visit up to walking age
  – Skin creases
  – Galeazzi sign
  – Asymmetric abduction

BEWARE THE BILATERAL DISLOCATION

Not reliable, especially before three months
Barlow and Ortolani
Ultrasound Findings
Femoral head coverage

a) femoral head coverage = \( \frac{d}{D} \times 100 \)

b) bony rim percentage = \( \frac{a}{b} \times 100 \)
Ultrasound Anatomy of the Infant Hip

- Alpha angle: the angle between the vertical iliac line and the acetabular line
Radiographic landmarks

Become useful after 6 months of age
Natural history

• Bialik
  – 8600 hips with sonogram at birth
    • 344 (4%) had sonographic evidence of dysplasia or instability
    • 90% resolved spontaneously at 6 week follow-up ultrasound.
      – Only 17% of dislocated hips failed to normalize at 6 weeks
Natural History

• Hip that remains dislocated will not spontaneously reduce
  – Abnormal articulation
    • Pseudoacetabulum
    • Arthrosis/Arthritis
  – Leg length discrepancy
  – Abductor weakness and limp

No good natural history study demonstrating this
• What about the dysplastic hip?
  – May be Barlow positive or clinically undetectable
  – Reality is 90-95% percent resolve without any intervention at all by 6 weeks
  – How do we know who may have residual dysplasia?
  – Is it important?
  – Who should be worked up?
Natural History of Subluxed or Dysplastic Hip

- Residual or recurrent dysplasia can lead to altered biomechanics of the hip joint
  - Edge loading of the acetabulum
  - Abnormal growth of lateral acetabular cartilage
  - Can lead to progressive subluxation and/or cartilage degradation
  - Believed to be more painful than frank dislocations

Center edge angle < 17º predictive of osteoarthritis in 100% of hips by age 60.

Murphy et al, 1995
Natural history of the dysplastic hip

Dysplasia 43%
Perthes Disease 22%
Slipped Epiphysis 11%
Other 12%
“Idiopathic”/“Primary” 12%

Aronson, AAOS ICL Lec. 35:119-128, 1986
Treatment

• Pavlik harness 0-6 months
• Abduction orthosis may be trialed later
• Closed Reduction w/ or w/o adductor release 6-12 months
• Open reduction 12 months or greater
  – w/ or w/o pelvic osteotomy (age 3 cutoff)
  – w/ or w/o femoral osteotomy (shortening of the femur)
Pavlik Harness

• Used almost exclusively as first-line “brace” of choice in the US
• Designed to hold legs flexed and to prevent adduction, not to force abduction
• Recommended to wear full time. Remove one leg at a time for bathing and hold leg in abduction
• ? Duration of use – follow ultrasonography
  – Rapid improvement in coverage
Pavlik Harness

Flexion $\leq 100^\circ$
Abduction $\leq 55^\circ$ should be able to adduct to the midline
Results of Pavlik Harness Treatment

- **Dysplasia**
  - 90-95% treated successfully in Pavlik harness
  - 10% recurrence rate—must be followed to maturity

- **Dislocatable hips**
  - 85% success rate in achieving stable reduction
  - AVN rate less 5% (but reported up to 60%)
  - 2 to 3% may go on to have severe late dysplasia
Risks with Pavlik harness

- Femoral nerve palsy
- AVN
- Pavlik disease
  - remodeling of posterior wall of acetabulum

Expected sequelae
  - external rotation and flexion contractures
  - resolve 1-2 months
AVN and Pavlik harness

- Related to compression of vessels feeding the femoral epiphysis
- AVN rate increases significantly in patients over 6 months old. Pavlik should not be used
## Treatment with Pavlik Harness

<table>
<thead>
<tr>
<th>Severity</th>
<th>Full Success</th>
<th>Early Success with late failure</th>
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</thead>
<tbody>
<tr>
<td>Moderate Subluxation</td>
<td>34/34 100%</td>
<td>0/0 0%</td>
</tr>
<tr>
<td>Severe Subluxation</td>
<td>36/38 95%</td>
<td>2/38 5%</td>
</tr>
<tr>
<td>Dislocatable/Partially Reducible</td>
<td>12/14 86%</td>
<td>2/14 14%</td>
</tr>
<tr>
<td>Dislocated/Irreducible</td>
<td>0/1</td>
<td>1/1 100%</td>
</tr>
</tbody>
</table>

2/87 had AVN

Venelin et al JPO 26(1) 16-27.
Closed Reduction

• Useful in children 6-12 months
• An Ortolani maneuver under general anesthesia with radioopaque dye in the joint to confirm the reduction
Offending Structures

- Ligamentum teres elongated and hypertrophied
- Inverted limbus
- Capsule
- Transverse acetabular ligament hypertrophied
Open Reduction

• Grants access to obstructing structures for release
• Permits a controlled, gentle reduction to place the femoral head into the true acetabulum
• Permits capsular plication to tighten the capsule and prevent redislocation
Open Reduction

A. Skin incision

B. Fascia lata incised with care to preserve lateral femoral cutaneous nerve

C. Plane between tensor fasciae latae, rectus femoris, and sartorius opened by blunt dissection starting distally and working proximally. Corticocutaneous emphysema of iliac crest instead deeply

D. Iliac apophysis drawn aside, sartorius separated from its origin at anterior superior iliac spine; gluteus medius and minimus elevated subperiosteally from the iliac crest, exposing hip capsule. Capsule is mobilized if it is adherent to pelvis.

E. Both heads of rectus femoris detached from their origins and turned down. Iliopsoas muscle retracted away from hip fossa, and tendon transected on undersurface of muscle to achieve intramuscular lengthening.

F. T-shaped incision in capsule of hip joint

G. Joint opened, ligamentum teres divided, and any impediment to reduction removed (though it is seldom necessary to excise an inverted limbus). After reduction, capsule is closed by overlapping or excising redundant portions to decrease chance of redislocation; muscles reattached

H. Reduction maintained by moderate internal rotation, abduction and slight hip flexion (no traction). Wound closed and cast applied with hip in this position. Cast well molded about hip to maintain reduction
Timing of Surgery

• Debate in the orthopaedic literature regarding safety and rate of redislocation as a function of age.
• AVN rate not higher at younger age
• Luhmann *et al* Repeat surgery rate doubles if surgery waits until femoral head ossific nucleus appears.
• Trend towards open reduction at younger ages.
Early treatment leads to more remodelling

Lindstorm, Ponseti, Wenger JBJS-A 61(1) 112-118.
• Acetabulum remodelling potential decreases with time.
  – Pelvic osteotomy used to address residual dysplasia after open reduction
  – Typically done in patients older than 3 or anyone with a non-spherical acetabulum
Femoral anteversion and coxa valga are often contributors to pathoanatomy and can be addressed by a femoral osteotomy.

Femoral shortening may also be performed to decrease stress on reduction. Shown to decrease rate of AVN.
Results

- 93% good to excellent results at 20 years with Salter osteotomy
- Long term follow-up shows we have more to learn about osteotomies of the pelvis
Complications

- Failed reduction or recurrent dislocation
- Avascular necrosis
  - 10-40%
  - Trend towards less AVN with open reduction
  - Younger age no better or worse with regard to AVN
Intervention

- **Why?**
  - It works
  - The acetabulum can remodel achieving physiologic joint motion and long-term viability of the joint

- **When?**
  - When the problem is identified
  - The earlier the better!
This may have been avoidable
Evaluation

- “Screening” does not end at walking age
- Dysplasia can occur late
- Hip, knee, and gait complaints may all be caused by hip dysplasia
Neonatal Screening

- The effectiveness of screening has been questioned
- No good natural history studies link neonatal and early natural history and intervention with outcomes in adulthood.
USPSTF

- Systematically evaluate literature regarding screening and treatment of DDH
- Develop guidelines for pediatricians
- Conclusion
  – Routine screening not effective at improving long-term outcomes
  – Evidence insufficient
Arrow 1: Does screening for DDH lead to improved outcomes (including reduced need for surgery and improved functional outcomes such as gait, physical functioning, activity level, peer relations, family relations, school and occupational performance)?

Arrow 2: Can infants at high risk for DDH be identified, and does this group warrant a different approach to screening than children at average risk?

Arrow 3: Does screening for DDH lead to early identification of children with DDH?
   (a) What is the accuracy of clinical examination and ultrasound?
   (b) How does the age of the child affect screening parameters?
   (c) How does the educational level and training of the screener impact screening?

Arrow 4: What are the adverse effects of screening?

Arrow 5: Does early diagnosis of DDH lead to early intervention, and does early intervention reduce the need for surgery or improve functional outcomes?
   (a) Is the likelihood of surgical intervention reduced in children diagnosed at an earlier age?

Arrow 6: What are the adverse effects of early diagnosis and/or intervention?

Key question 7 (no arrow): What cost-effectiveness issues apply to screening for DDH?
<table>
<thead>
<tr>
<th>Arrow</th>
<th>Key Question</th>
<th>Level and Type of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Does screening for DDH lead to reduced need for surgery or improved functional outcomes?</td>
<td>Poor: No controlled studies have compared screening with no screening to determine whether there is an impact on functional outcomes. There is conflicting evidence from ecologic studies that screening reduces the rates of surgery.</td>
</tr>
<tr>
<td>2</td>
<td>Can infants at high risk for DDH be identified, and does this group warrant a different approach to screening than children at average risk?</td>
<td>Fair: In case-control and cohort studies, family history, breech presentation, and clinical instability are consistently associated with an increased risk of DDH, but most infants with DDH do not have risk factors. No practice-based, prospective studies on the performance of risk-assessment instruments are available.</td>
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<td>3</td>
<td>Does screening for DDH lead to early identification of children with DDH?</td>
<td>See questions 3a, 3b, and 3c below.</td>
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<tr>
<td>3a</td>
<td>What is the sensitivity, specificity, and predictive value of screening exams? (eg, Barlow/Ortolani, other exam findings, ultrasonography, and radiographs).</td>
<td>Poor: Ascertainment of test characteristics is unreliable, because definitions of a positive test vary, and most studies did not use an independent standard to determine disease status. Low-risk/screen-negative patients are followed with intensity of high-risk/screen-positive patients. High rates of spontaneous resolution have been reported.</td>
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<tr>
<td>3b</td>
<td>How does the age of the child affect screening parameters?</td>
<td>Fair: Limited hip abduction becomes a more sensitive sign of DDH over the first several months of life.</td>
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<tr>
<td>3c</td>
<td>How does the educational level and training of the screener impact screening?</td>
<td>Fair: Experience with the clinical examination of the hip in infants predicts screen-positive rates and accuracy of exam, but few head-to-head comparisons without biases have been conducted. A consistent but limited amount of evidence indicates that well-trained nonphysicians can interpret clinical examination findings as well as pediatricians and better than physicians-in-training.</td>
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<tr>
<td>4</td>
<td>What are the adverse effects of screening?</td>
<td>Poor: In theory, forceful exam of already-lax newborn hips might cause injury or dislocation, but there is limited and conflicting evidence regarding this hypothesis.</td>
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<tr>
<td>5</td>
<td>Does early diagnosis of DDH lead to early intervention, and does early intervention lead to improved functional outcomes? Is the likelihood of surgical intervention reduced in children diagnosed at an earlier age?</td>
<td>Fair: Early diagnosis leads to early intervention. Evidence of the effectiveness of intervention is inconclusive because of (1) high rate of spontaneous resolution, (2) absence of comparative studies of intervention versus no intervention, and (3) variation in surgical indications and protocols. Few studies examine functional outcomes in a valid and reliable fashion.</td>
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<tr>
<td>6</td>
<td>What are the adverse effects of early diagnosis and/or surgical and nonsurgical interventions?</td>
<td>Fair-poor: Evidence is limited and mixed on the effect of earlier diagnosis on likelihood of surgery. Fair: All nonsurgical and surgical interventions are associated with a risk of AVN. Many nonsurgical interventions are in use, but data are insufficient to determine whether there are differences among them. This is also true of surgical interventions.</td>
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Screening Strategies

• Clinical screening only

• Sonographic screening
  – Universal
  – Selective

• Decision Analysis forthcoming
  – Selective ultrasonographic screening of infants at risk factors probably the most effective
    • Female, breech, family history
Treatment Decisions

• Dislocated or dislocatable hip
  – Referred to orthopedist
  – Treatment instituted immediately
  – Trial Pavlik harness

• Subluxable or dysplastic hip
  – The hip may “tighten up” as maternal hormone levels fall.
  – Up to 95% may spontaneously resolve
  – Decision to treat versus rescreen at 3-6 weeks with ultrasound. Evidence to treat not clear. Follow-up is critical!
Decision Making

Clinical exam
Barlow positive, Ortolani negative hip – observe
reexamine at 3 weeks
Ortolani positive hip = Pavlik harness with ultrasound in 3 weeks. Some advocates for observation with ultrasound and repeat exam in 3-6 weeks
The frankly dislocated, irreducible hip gets a manipulation under ultrasound and possibly a trial Pavlik harness for 3-4 days
   If no progress, plan for early open reduction
Adolescent and Young Adult Dysplasia

• The late dysplastic hip presents when the child develops symptoms that interfere with activity.

• Once symptoms develop, the time course for deterioration of the joint leading to progressively worsening pain and function can be rapid.
dGEMRIC

• Delayed Gadolinium Enhanced MRI of Cartilage
• IV gadolinium taken up by glycosaminoglycan component of cartilage. Imaging then maps GAG content.
• Areas of decreased GAG content consistent with osteoarthritic change.

Outcomes in Bern/Boston

- Hip still preserved in 90+% at 10+ yrs
- Pain relief excellent in most
- Mild loss of flexion in most (~8°)
- CE angles improved from ~5 to ~27 degrees
- Best results if OA 0 or grade 1 preop and no labral tear
- If preop OA gr 2-3: ~50% reoperation rate at 5 y
- Conversion to THR straightforward if needed
Conclusions

• Examine newborn and at well child visits until walking age
• Ultrasound most effective way to evaluate if any suspicion or hip pathology
  – In absence of Ortolani positive hip, ultrasound can wait 4-6 weeks
• At well child visits, observe the child walking for any evidence of limp, check physical exam – Trendelneburg sign
• In adolescent athletes, do not underestimate the value of plain film imaging in working up hip pain, specifically groin pain. Evaluate for Trendelenburg sign.
• Early intervention for dysplasia is effective at all age levels, get your favorite orthopaedist involved early