Most common abnormality in newborn infants
Clinical hip instability 1-3% of neonates
Ultrasound hip dysplasia 5-15% of neonates
~80% mild cases resolve spontaneously
Neonatal hip instability accounts for <10% of hip dysplasia cases
>90% of hip dysplasia presents in adolescents or adults

5-10% of all total hip replacements are due to hip dysplasia

• Genetics - familial and ethnic factors
• Hormonal
  Ligament laxity for delivery
  Ratio of Girls to Boys is 6 to 1
• Mechanical risk factors
  First Born
  Prolonged labor
  Left hip due to fetal position
  Torticollis
  Breech babies (25% hip instability)
  Swaddling to extend hips and knees

• More common in winter births except for breech infants
• More common in Northern climates
  This suggests environmental factors such as wrapping or nutritional insufficiencies

Chinese, Bantu, Nigerian
Rare hip dysplasia, rare hip arthritis in adults. Infants in these cultures are carried with hips abducted.

Navajo Indians
Before 1940 - Cradle board
  without diapers: 2.7% had hip dislocations
After 1960 - diapers introduced:
  0.7% had hip dislocations

Japan
1965: 3% incidence of hip dislocation
  In spite of screening
1975: National program eliminated swaddling
1984: 0.2% incidence of hip dislocation
Yamamuro, Ishida CORR 1984;184:34-40

Australia
2003: Increasing popularity of baby wrapping (Swaddling)
After 2003:
  • National increase in DDH
  • Increase by three fold in one region
N Williams, et al, MJA 2012;197(5):272
Infantile DDH
HS Hosalkar, SJ Mubarak, EL Sink, K Mulpuri, CT Price

PREVENTION

Robert Salter, 1968

“It is quite possible that if infants’ hip joints were never suddenly passively extended either at birth or shortly after birth and if infants’ hips were never maintained in extension and adduction for long periods during the early months of postnatal life, the initial dislocation in congenitally unstable or dislocatable hips might never occur”.

Canadian Med Assoc J 1968;98(20):933-45

Newborn infants have hip and knee flexion contractures

Klisic Method of Prevention

- Use of bulky diaper “Hip Package” for all “normal” infants eliminated missed DDH
- Seven fold decrease in surgery for DDH


Similar results: Judet, 1959; Mittlemeier, 1998; Tredwell 1989

Use of bulky diaper “Hip Package” for all “normal” infants eliminated missed DDH

Seven fold decrease in surgery for DDH


Healthy Hip Swaddling

Screening – Early Detection

- Neonate exam is essential for early detection
- Validated teaching module available online at no cost: http://www.hipdysplasialorg/for-physicians/pediatrician-and-primary-care-providers/lectures-and-video/

DeRosa GP, Feller N, CORR1987;(225):77-85

- US Preventive Services Task Force and Canadian Task Force on Preventive Health Care recommend against routine screening of infants that do not have a dislocated hip detected at birth
- POSNA and the American Academy of Pediatrics recommend selective screening for infants with a normal neonatal hip examination
- Ultrasound screening at 4-6 weeks may be recommended for infants with normal exam who have risk factors for hip dysplasia:
  - breech presentation
  - positive family history
  - parental concern
  - suspicious exam
  - history of tight lower extremity swaddling

- H Panel, CMAJ 2001;164(12):1669-77
Infantile DDH
HS Hosalkar, SJ Mubarak, EL Sink, K Mulpuri, CT Price

Diagnosis Pitfalls

Torticollis and foot deformities

Hip Abduction Contracture

• Asymmetrical gluteal creases with abducted thigh at rest
• Adduction of both hips pulls opposite thigh into excessive adduction with pelvic obliquity
• Apparent limb length discrepancy due to pelvic obliquity
• Opposite hip at risk for dysplasia
• Treat with abduction splinting combined with stretching exercises

Green NE, Griffin PP. JBJS-Am. 1982;64(9):1273-81

Slightly increased risk of DDH
Questionable value of routine ultrasound screening
DDH easily overlooked while treating these conditions

KP Minihane, Am J Orthop 2008;37(9):E15508
von Heideken, JPO 2006;26(6):805-8
RW Paton, JBJS-Ir. 2009;91(5):655-8

Ultrasound Diagnosis

Graf Static Method ------ Larger $\alpha$-angle is better

Coronal View - Hip flexed

Simplified Graf Classification of DDH

<table>
<thead>
<tr>
<th>Class</th>
<th>$\alpha$-angle</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ila</td>
<td>50°-60°</td>
<td>&lt; 3 mo old</td>
<td>Observe</td>
</tr>
<tr>
<td>Ilib</td>
<td>50°-60°</td>
<td>&gt; 3 mo old</td>
<td>Pavlik</td>
</tr>
<tr>
<td>IIc-d</td>
<td>43°-59°</td>
<td>Acetabular deficiency</td>
<td>Pavlik</td>
</tr>
<tr>
<td>III</td>
<td>&lt; 43°</td>
<td>Everted labrum</td>
<td>Pavlik</td>
</tr>
<tr>
<td>IV</td>
<td>Dislocated</td>
<td>Attempt Pavlik, Expect Closed Reduction</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Tachdjian’s Pediatric Orthopedics, 3rd Edition p.529

Harcke Dynamic Method ------ Stability is tested

Evaluation of DDH – Harcke Method

• Subluxation - normal hip has more than 50% containment
• Instability - Newborn may have 4-6 mm instability that resolves

Advantages
• Measurements not required
• Rapid examination
• Easily performed in Pavlik Harness

Treatment indications
• Treat at birth for dislocated hips
• Treat at 3 weeks if subluxation present
• Treat at 6 weeks if instability present

Mean $\alpha$-angle = 70° at 6 weeks of age

Pressure similar to Barlow test in coronal and transverse view

Transverse View - Hip flexed

α-angle = 70°
Normal hip

α-angle = 51°
Dysplastic hip

α-angle = 38°
Dislocated hip


Infantile DDH
HS Hosalkar, SJ Mubarak, EL Sink, K Mulpuri, CT Price
**Pavlik Harness**
- Allows diaper change without removal
- Useful for all classes of DDH
- Permits ultrasound imaging in the harness

**Abduction Pillows and Braces**
- Intuitive for parents to use
- Useful for hips that are reduced and stable in abduction
- Limited usefulness of ultrasound in the pillow or brace

**Treatment Protocol**
- Full-time wear with hip ultrasound in harness every 7-14 days
- 90% of successful cases are reduced by two weeks
- May require up to four weeks to reduce or stabilize
- Abandon harness if not reduced by 4 weeks in child < 6 months old
- May attempt Pavlik for subluxated hips between 6-12 months old
- Up to six weeks may be needed in this age group

**Pavlik Harness – Tips**
- Chest halter positioned at nipple line.
- Leg should be supported to popliteal crease
- Anterior straps attached at anterior axillary line
- Posterior straps attached over scapula
- Adjust anterior straps so hips are flexed 100°-110°
- Adjust posterior straps to allow the hips to adduct to within 5 cm between the knees

**Pavlik Harness – Pitfalls**
- Leg supports too short
- Incorrect forces on hip
- Femoral nerve palsy – quadriiceps paralysis
- More common in higher grade dislocations
- Discontinue Harness until recovers
- 70% success if recovers in ≤ 3 days
- Avascular necrosis
- Absent ossification one year after treatment, broadening of femoral neck, or fragmentation
- Decrease risk of AVN by avoiding forced or prolonged abduction

**Infantile DDH**
HS Hosalkar, SJ Mubarak, EL Sink, K Mulpuri, CT Price
Success Rates with Pavlik Harness

- High success rates for unstable and subluxated hips
- 65-85% success rates for dislocated hips treated before 6 weeks of age

Harding, Harcke, Bowen JPO 17:189, 1997
Cashman, Clarke JBJS 84B:418, 2002
Peled, Blaiik, et.al. CORR 466:825, 2008
Swaroop and Mubarak JPO 29:224, 2009

- 20-60% success rates for dislocated hips treated between 6 weeks and 6 months of age

Lerman, Kasser, et.al. JPO 21:348, 2001
Viere, Herring, Johnston, et.al. JBJS 72A:238, 1990
Harding, Harcke, Bowen, et.al. JPO 17:189, 1997

Typical Treatment Plan

- Follow with hip ultrasound until reduced and stable
- Infants ≤ 6 months at start of treatment
- Abandon Pavlik harness if unsuccessful in 4 weeks
- Continue full time bracing 6 weeks after stable for slightly longer after 3 months of age
- Part-time harness or abduction brace for 6 more weeks
- Infants 6-12 months with subluxated hip
- Follow with ultrasound or radiographs
- Abandon harness if unsuccessful in 6 weeks
- Longer duration of full time and part time treatment for these older infants
- Total time approximately equal duration to age at time of reduction; example, 6 months of treatment for a 6 month old infant

Options when Pavlik Harness fails?

Closed reduction and hip spica cast
- Most frequent option after Pavlik harness or abduction brace failure
- Infants ≤ 18 months of age
- ? Greater risk of AVN before ossific nucleus appears?
- ? Preliminary traction or no preliminary traction?

Surgical reduction

Medial Open Reduction
- Best results prior to one year of age
- Hip is reduced at a younger age for better development
- Relatively uncommon procedure requires proper training and experience
- High rate of growth disturbances when patients are followed to maturity

Anterior open reduction ± femoral shortening ± pelvic osteotomy after ossific nucleus appears
- Time interval provides a break for mother to nurture her child
- Allows posterior acetabulum to recover
- May decrease risk of AVN
- Later surgery means shorter time in cast, and may have social advantages.
- Disadvantage of more invasive surgery performed later in development of joint

Follow-up until maturity is recommended for more severe degrees of dysplasia

➢ 3% adolescent dysplasia after successful treatment without AVN using Pavlik Harness prior to age 6 months

K Modarresi, J Child Orthop (2011) 5:261–266
Considerations for AVN

Vascularity

Newborn
Compressible cartilage and vessels with poor collateral circulation

7 months
Ossific nucleus resists compression, provides collateral circulation

Does ossific nucleus protect against AVN?

- Evidence is inconclusive
- Approximately equal risk with or without ossific nucleus
- Severity may be greater in absence of ossific nucleus

A. Roposch (Meta-analysis) JBJS-Am 2009;91(4):911-8

- Avoid compression of femoral head during reduction


Closed Reduction

Adductor tenotomy – increases safe zone and decreases forces on femoral head in abduction

Arthrogram

- Limbus type and soft tissue depth influence outcome

< 3.5 mm
- A. <3.5mm initial reduction
- 38% secondary surgery

> 3.5 mm
- B. >3.5mm initial, but <3.5mm at second arthrogram
- 79% secondary surgery

Guided overhead traction gradually abducts the hips over 5-7 days

Preliminary Traction

- Unlikely to decrease risk of AVN
- May improve rate of successful closed reduction, especially for high dislocations
  - 60% success without traction
  - 70-90% success with guided overhead traction


Vessels

Compressible cartilage and vessels with poor collateral circulation

Ossific nucleus resists compression, provides collateral circulation

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New methods for intra-operative imaging include ultrasound, color Doppler ultrasound, MRI, 3-D fluoroscopy, arthroscopy


MRI at time of initial reduction shows reduced hip but poor congruency

Arthrogram 6 weeks later shows improved congruency

Post-op MRI is often used to confirm reduction in the cast. Limited CT scan, and ultrasound have also been used

Gadolinium MRI and Color Doppler Ultrasound may assess vascularity

Conroy E, J Child Orthop. 2009;3(3):223-7
Tiderius C, J Pediatr Orthop. 2009 Jan-Feb;29(1):14-20

Typical Treatment Plan

Change cast after 6 weeks
Repeat arthrogram
Do not test hip mobility or stability
Full-time immobilization period 4½ to 6 months with cast plus abduction brace
Part Time bracing for 6 weeks after full time period
Allow contractures to resolve spontaneously

Management after closed reduction

- Hip flexion decreases forces of iliopsoas
- Knee flexion decreases forces of hamstrings
- Limit abduction to safe zone

Post-op MRI is often used to confirm reduction in the cast. Limited CT scan, and ultrasound have also been used

Gadolinium MRI and Color Doppler Ultrasound may assess vascularity

Conroy E, J Child Orthop. 2009;3(3):223-7
Tiderius C, J Pediatr Orthop. 2009 Jan-Feb;29(1):14-20
Follow-up after closed reduction

Long-term results may be disappointing
- 30-50% of patients require secondary surgery when followed more than 10 years after successful closed reduction
- Results are better when reduction is performed before age 18 months

Arthrogram at time of cast removal 4.5 months after successful closed reduction

Age 16 months - six months after cast removal

Closed reduction at 6 months of age

Residual Dysplasia

Follow acetabular index if hip remains reduced
- Consider surgical intervention if Acetabular Index remains abnormal without gradual improvement over 12 months of observation

MRI may be useful
- High signal intensity area in acetabular cartilage on T2-weighted image predicts poor outcome with observation

Age 3 years

Average Acetabular Index for girls age 2 years is 19°

Also - CORR 1976:119:39-47

Additional Resources

For patients and families:
- www.hipdysplasia.org
- International Hip Dysplasia Institute

For physicians: