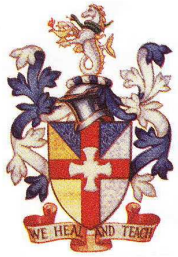


THE great north CHILDREN'S HOSPITAL

Leg Length Discrepancy

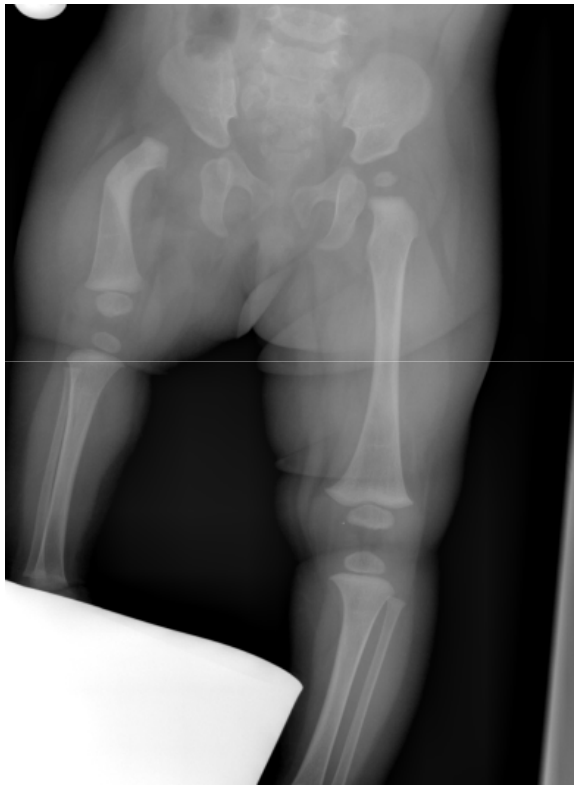
Antoine de Gheldere, MD
Consultant in Children's Orthopaedics and Trauma

GNCH – Royal Victoria Infirmary
Newcastle upon Tyne, UK

Paediatric Orthopaedics Teaching, 16th April 2012

What age?

- Non walking child
  - CSF (PFFD)
  - DDH



- Walking child
  - Late DDH (CDH)
  - Others…

Does Our Lower Limbs Are the Same Length?

- 600 military recruits
  - Between 0.5 and 1.5 cm : 32%
  - Over 1.5 cm : 4%

Hellsing AL, Ups J Med Sci, 1988

Long Term Effect of LLD?

- Eyes act like an “artificial horizon”

- Hip problem (remember Pauwel)?
- Back problems?

- Gait analysis for children with LLD <3%
  - No compensatory strategies

Song KM, JBJS-Am, 1997

Stay out of Trouble!

- 3% of LLD = 1 inch or 2.54 cm (adult)
- Predicting LLD at maturity:
  - If LLD < 1 inch = acceptable
  - If LLD > 1 inch = need correction

Which Leg Is Abnormal?

- One leg is too short?

  … or the other one is too long?
- Rule out serious underlying causes
  - Neurofibromatosis
  - Bone or soft-tissue tumors
  - Neurologic disorders
  - …

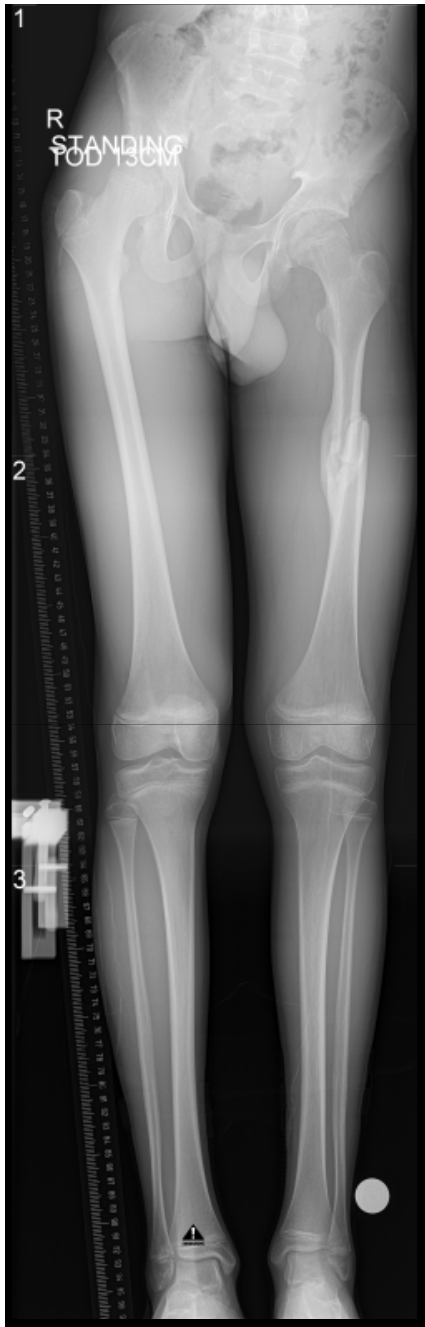
Pathologic Long Limbs

- Proteus syndrome
- Klippel-Trenaunay syndrome
- Neurofibromatosis
- Beckwith-Wiedemann syndrome (BWS)
  - Abdomen US: Wilms/other tumor
  - 7.5% (96% before 8yo)
- …

Debaun MR et al. Am J Hum Genet, 2002

Pathologic Short Limbs

- Hemiplegia
- CTEV
- Coxa vara
- Bowing
- Absence of ACL
- Lateral femoral hypoplasia
- Fibular hemimelia
- Tumorous condition: fibrous dysplasia, …
- Following DDH, Perthes, Infection, Trauma, SUFE, …
- …

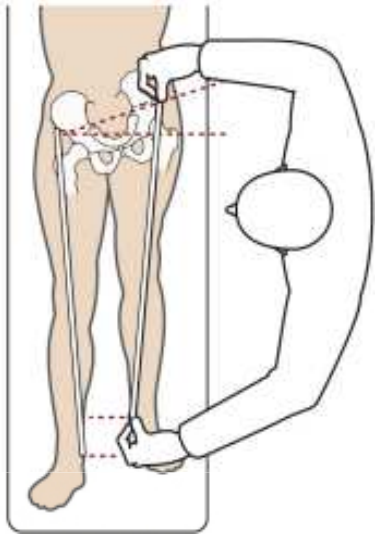


Fracture

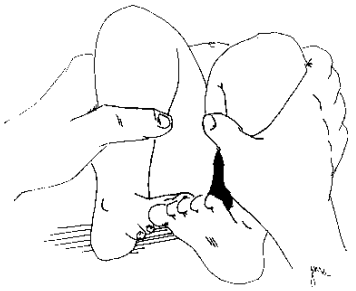
Neonate Infection

Physical Examination Pitfalls

Supine



- Hip position
  - Adducted hip: leg appear shorter
  - Abducted hip: leg appear longer
  - 3 cm of LLD for each 10 degrees
  - Position of feet of a supine patient (?)
- ASIS to medial malleolus mesure (?)
- Galeazzi test for nonambulators or uncooperative children



Ireland J et al. Clin Orthop Relat Res, 1980

Physical Examination Pitfalls
Standing

- Hands on iliac wings
- Wooden blocks
  - Knee straight (?)
  - Equines (?)
  - Obese child (?)
  - Previous pelvic surgery (?)
  - Fixed pelvis (spine?)

Tethered cord, scoliosis, left foot deformity

Referred for LLD 2cm (physical examination)

LLF shows LLD = 0.5 cm

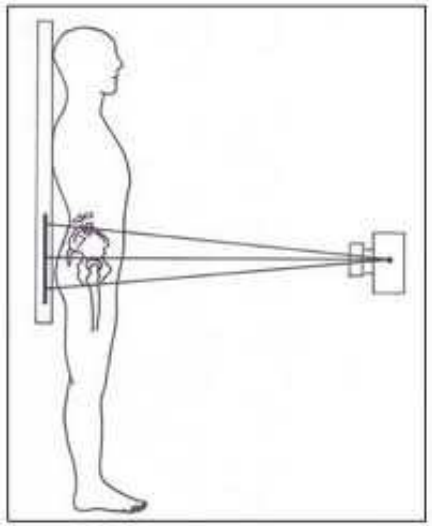
Fixed pelvis with fixed scoliosis

Radiographic Assessment

- Teleoroentgenogram (long leg film)
- Scanogram
- Computer axial tomography (CT)

Teleoroentgenogram pitfalls

- Parallax effect (?)
- Hip/knee contractures



Scanogram pitfalls

- Foot not included (foot deformity?)
- Movement between the three images
- Diaphysis of femur/tibia not imaged
- Hip/knee contractures

CT Advantages

- More accurate if hip/knee contractures
- Lower radiation exposure?
- Can assess rotational deformity

Fixed foot deformity

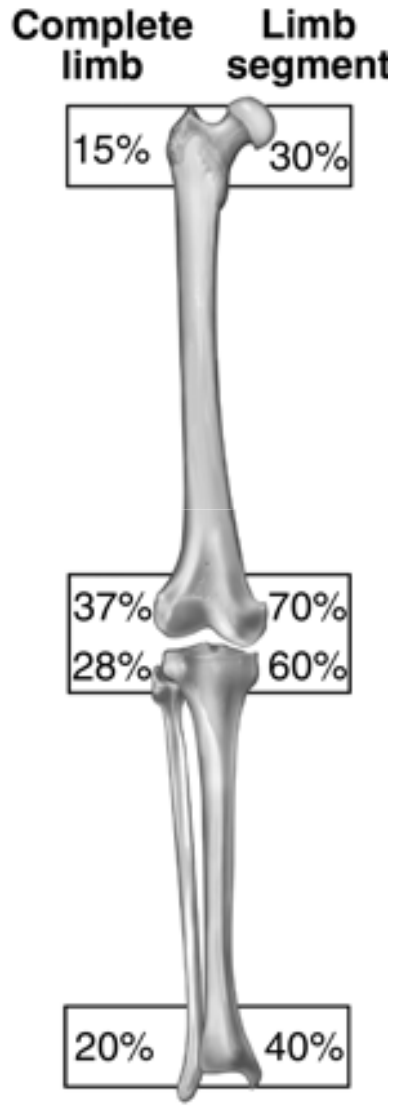
Apparent LLD

Right Femur: 42.6 cm
Right Tibia: 34.1 cm
Left Femur: 43.0 cm
Left Tibia: 33.2 cm

Normal Growth

- PF GP: 4mm/yr
- DF GP: 10mm/yr
- PT GP: 6mm/yr
- DT GP: 5mm/yr

- Average total length in adult *female*: 78cm
- Average total length in adult *male*: 85cm



Before Predicting LLD…

- Treating the LLD predicted at maturity
  - Progressive
  - Not progressive
- Measures of maturity are inaccurate:
  - Chronologic age (?)
  - Radiologic appearance of the physis (?)
  - Comparison child/parents height (?)
  - Bone age (?)
- Underlying disorders may affect maturation

Predicting LLD

- Bone age
- Anderson and Green database:
  - Arithmetic method
  - Growth-remaining method
  - Straight-line method (Moseley)
- Multiplier method (Paley)
  - For congenital discrepancy
  - For achondroplasia

Paley D et al. JBJS-Am, 2000

Predicting LLD Pitfalls

- Error in bone age:
  - 50% children: bone age differed >1 year
  - 10% children: bone age differed >2years

- Error in growth charts:
  - Epiphysiodesis “wrong timing”:
    - 71% children: residual LLD >1.5cm
    - 51% children: residual LLD >1.0cm

Kemnitz et al. JPO-B, 2003 – Blair et al. JPO, 1982 – Cundy et al. JPO, 1988

How To Stay Out Of Trouble?

- Multiple measurements/clinics
- Multiple maturity assessment:
  - Bone age
    - Hand, elbow, others radiographic signs…
  - Tanner (?)
- Aim "undercorrection" rather than "overcorrection"

Traditional Guidelines for Treatment of LLD*

- *LLD <2 cm*: **no** treatment (or shoe lift)
- *LLD 2 to 6 cm*: **epiphysiodesis** (or shoe lift)
- *LLD 6 to 20 cm*: **lengthening**
- *LLD >20 cm*: **amputation** (or lengthening)

**must be modified and discussed to individual patient's condition and goals*

General Principles

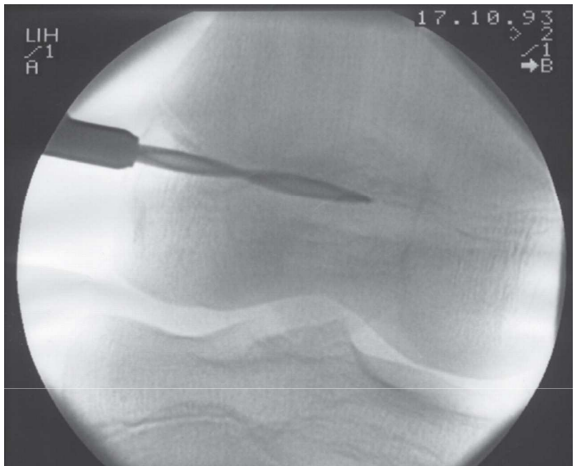
- Shoe lift or orthotic:
  - Walking on the toes
  - Prevent equines deformity
- Correction of significant angular deformity will modified the LLD prediction
- Epiphisiodesis:
  - Aim “undercorrection” (0.5 – 1.0cm)
  - Never shortened too much!

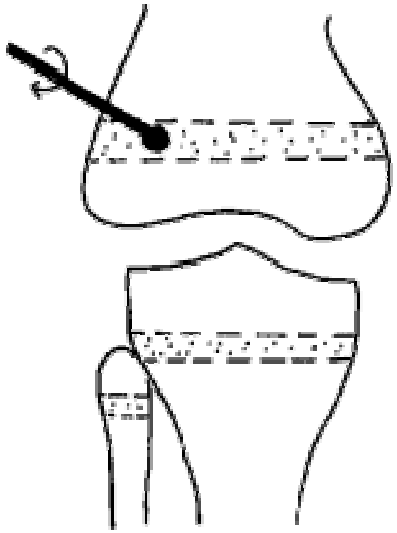
1. Epiphysiodesis

- Technically not difficult
- Timing is the key point
- Permanent vs. reversible
- DF/PT (rarely proximal fibula)
- Complications:
  - Stiffness
  - Fractures?
  - Incomplete/deformity (before 6 months)

Permanent Epiphysiodesis

- Percutaneous
- Double approach
- Physis ablation
- Drill/curettes
- No hardware
- Radiations ++
  - Soft bone
  - DF GP not flat!



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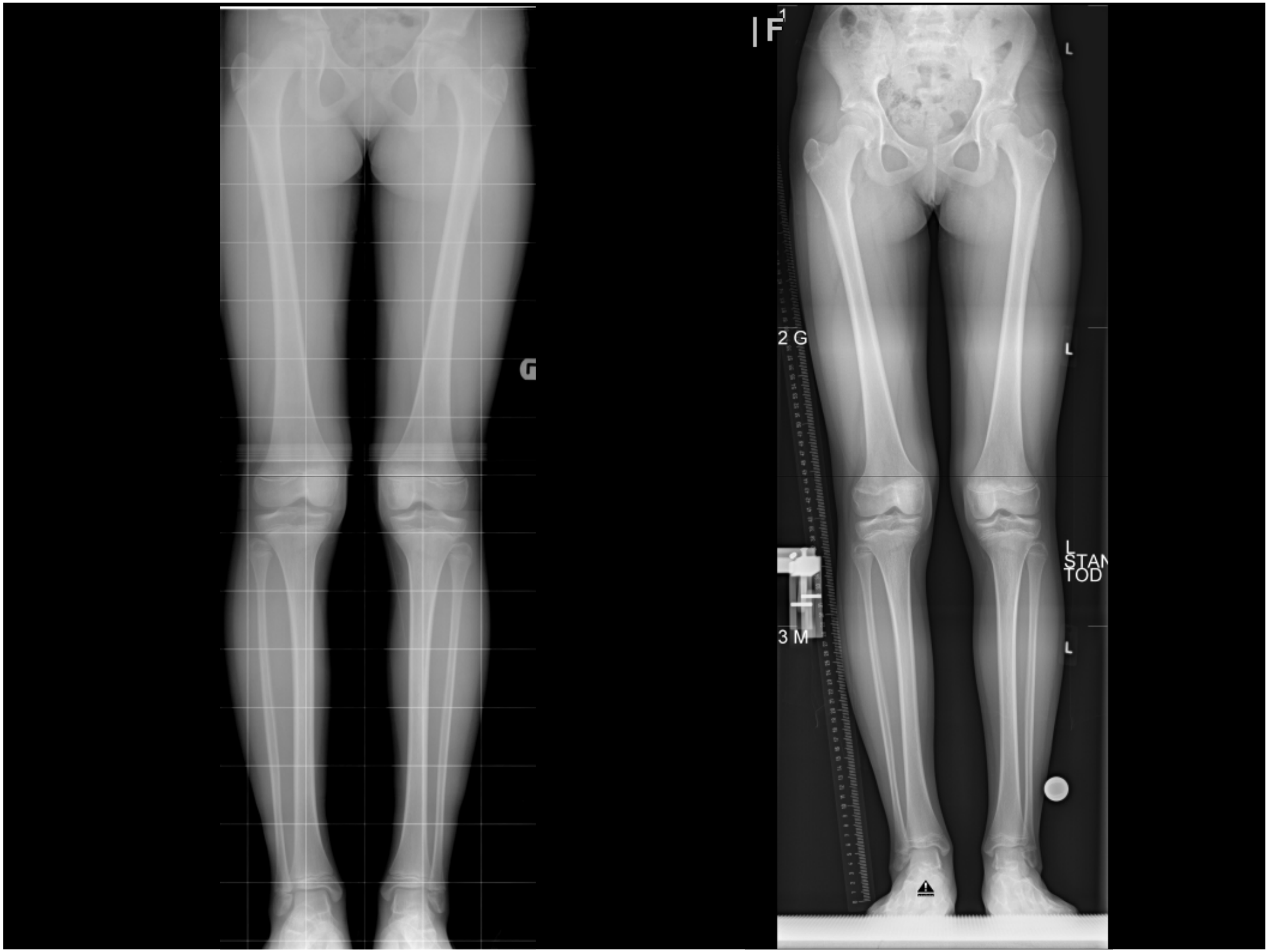
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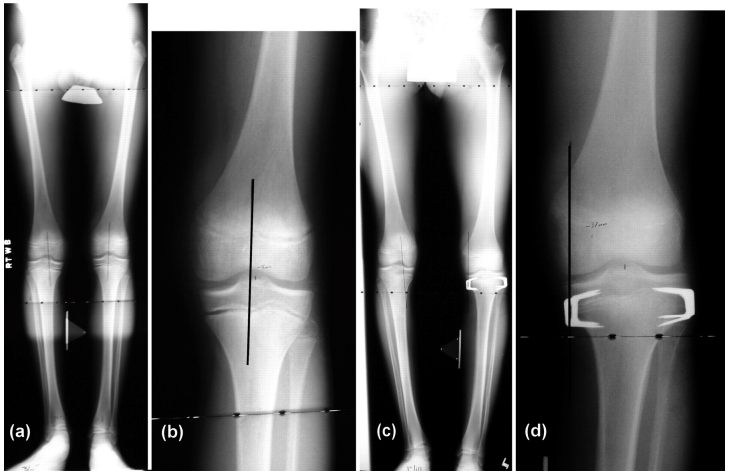
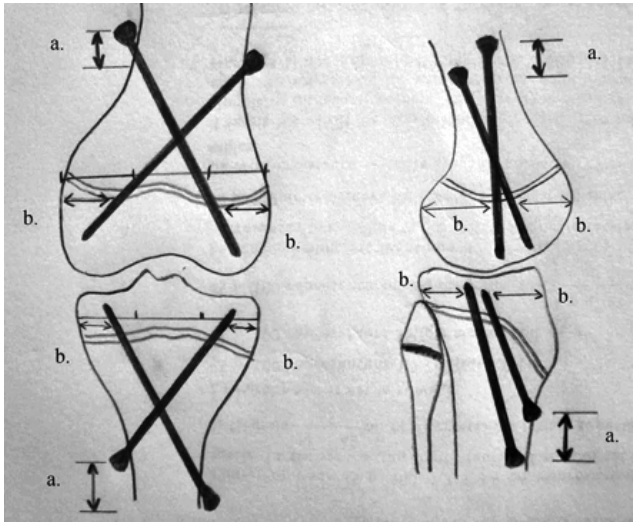
“Reversible” Epiphysiodesis

- Extra periosteal stapling
- Hardware prominence
- Rebound phenomenon?
- 8-plate alternative?



“Reversible” Epiphysiodesis

- Extra periosteal screw
- Technical
- 6.5 screws
- No hardware prominence
- Immediate effect!
- Rebound phenomenon?



2. Femoral Shortening

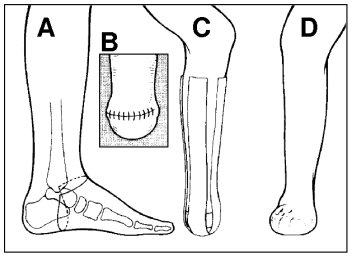
- When insufficient growth for epiphysiodesis
- More complications then epiphysiodesis
- Max: 5cm (muscle weakness)
- Open vs. closed technique?
- Proximal vs. diaphysis?

3. Lengthening

- What the family can/should expect:
  - 100% complication!
  - Multiple complications
  - Result:
    - Thinner leg
    - Ugly scars
    - Decreased mobility and weakness
    - unlikely to be exactly the same length as the other leg
- Patient/family selection

4. Amputation

- Amputation vs. Heroic Lengthening procedure
- Symes amputation in childhood:
  - No difference from normal adult (psycho, QoL, self esteem, walking/running)
- Before amputation:
  - Second opinion
  - Study group/conference
- When indicate; amputate early



Take Home Message

- Most errors in LD surgery are from miscalculations!
    - Limb length verified by imaging AND physical exam
    - Double-check calculation of final LLD
- Correction of angular deformity will lengthen the leg
- Adequate explanation/patient expectation
- Function is more important than length!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Thank You…