Hip Biomechanics and Osteotomies

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Organization

- Introduction
- Hip Biomechanics
- Principles of Osteotomy
- Femoral Osteotomies
- Pelvic Osteotomies
- Summary



Inroduction

- Osteoarthritis is very prevalent
- Primary OA most common
- Secondary OA not insignificant
- Three main pediatric hip pathologies
 - Hip Dysplasia
 - Legg-Calve-Perthes Disease
 - Slipped Capital Femoral Epiphysis

Hip Mechanics

- Hip designed to support BW permit mobility
- Max ROM 140 flex/ext, 75 add/abd
- Functional ROM 50-60 flex/ext
- 1.8-4.3 x BW through hip
- Highest ascending stairs

Hip Biomechanics

- Forces acting across a hip joint can be measured either
 - Directly with implanted straingauged endoprosthesis
 - Mathematical model calculations 2D static analysis

2D Static Analysis



- One legged stance 5/6 BW on femoral head
- Ratio of lever arms to BW 3:1

Biomechanics of Cane



- Cane in
 Contralateral
 hand decreases
 JRF
- Long moment arm makes so effective
- 15% BW to cane reduces joint contact forces by 50%

Biomechanics



- Dynamic analysis much more complex
- Forces across hip joint combination of:
 - Body weight
 - Ground reaction forces
 - Abductor muscle forces



Biomechanics

 Improving abductor function will decrease joint reactive forces





Secondary Osteoarthritis

- Prevalence of OA by age 50
 - DDH 40-50%
 - LCP 50%
 - SCFE 20%
- Despite many recent advances arthroplasty has many limitations in younger patients

Avoiding Revision Arthroplasty





Why does Osteotomy work?

- Osteotomies improve hip function
 - Increasing contact area / congruency
 - Improve coverage of head
 - Moving normal articular cartilage into weight bearing zone
 - Restore biomechanical advantage / Decreasing joint reactive forces
 - ?? Stimulating cartilage repair

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Principles of Osteotom

- Ostoeotomy can be viewed as either
 - Reconstructive
 - Salvage

 Femoral osteotomy to correct proximal femoral abnormalities and vice versa

Pre-op Evaluation

- Physical exam to ensure ROM
- Plain films
 - Standing AP
 - Frog leg lateral
 - False profile (anterior lip cover.)
 - Full abduction/adduction
- CT scan +/- 3D reconstruction

Contraindications to Osteotomy

- Neuropathic arthropathy
- Inflammatory arthropathy
- Active infections
- Severe osteopenia
- Advanced arthritis/ankylosis
- Advanced age
- *smoking, obesity

Varus Femoral Osteotomy

- Intact lateral portion of femoral head is prerequisite
- Can be combined with either flexion or extension component





Varus Osteotomy

- Indications: hip joint instability b/c' femoral deformity which corrects with internal rotation & abduction view
- Pelvic osteotomy should be performed in pts with CEA < 15 degrees
- Useful some DDH, SCFE, LCP, AVN and femoral neck nonunion/malunion

Disadvantages of varus femoral osteotomy

- Potential to shorten limb
- Weaken abductors
- Trendelenburg gait
- Potential difficulty with stem insertion in future arthroplasty

Valgus Femoral Osteotomy



 Coxa vara
 Performed if adduction film reveals concentric reduction

Valgus Femoral Osteotomy

- Moves noninervated inferior cervical osteophytes into contact with flooer of acetabulum
- Lateral traction on superior capsule may stimulate fibrocartilage transformation





Pelvic Osteotomies

- Reconstructive
 - Salter 18m 6y
 - Pemberton 18m 10y
 - Steel
- Salvage Chiari

skeletal maturity PAO (Ganz) skeletal maturity

skeletal maturity

Overview of Pelvic Osteotomies





Pelvic Osteotomies

Review of Pelvic Osteotomies			
Procedure	Osteotomy Description	Requirements	Comments
Salter	Innominate (open wedge)	 Congruous acetabular dysplasia CE angle >12-15 degrees Anterior and lateral redirection of acetabulum 	 Does not always provide good lateral coverage Used primarily in early youth
Double or triple innominate	Innominate and pubis or innominate and both rami	 CE angle 0–15 degrees Congruous acetabular dysplasia 	 For more advanced dysplasia Preserves triradiate cartilage Used primarily in youth
Spherical acetabular osteotomy	Acetabular Subchondral	 Almost any CE angle Must have closed triradiate cartilage (compromises vascular supply to area) Congruous acetabular dysplasia 	 Medialization of acetabular segment complex and difficult Capsulotomy contraindicated Complications of osteonecrosis and intra-articular penetration frequent
Periacetabular osteotomy (Ganz et al.)	Periacetabular	 Almost any CE angle Congruous acetabular dysplasia 	 Capsulotomy is safe (allows look for labral tears) Medialization of acetabulum is easy Minimal fixation required; only 2-4 screws Preferred osteotomy in adult
Chiari's osteotomy	Curved innominate slides iliac shelf over uncovered femoral head and capsule; interposed capsule undergoes metaplasia into cartilage material	• Unstable aspherical joint	 Salvage osteoromy in adult Salvage osteoromy only Leaves anterior acetabulum uncovered Abductor lurch common after Chiari's unless trochanteric advancement is performed

Salter Osteotomy

- Single Innominate osteotomy
- Acetabulum together with ilium and pubis rotated
- Held by wedge of bone
- Illiopsoas & adductor tenotomies common
- 18 mon to 6 years

Pemberton Osteotomy

- Pericapsular osteotomy for residual dysplasia
- Hinges through the triradiate cartilage – must be open!!
- Changes the volume & orientation of acetabulum
- Although good results up to 10 most recommend 6 to 8 years

Steel Triple Innominate Osteotomy

- Indication : DDH
 in older child
- Need good ROM
- Secure with bone graft & AO screw fixation



Steel Osteotomy



Contraindications

- Limited ROM
- Incongrous reduction
- Significant joint space narrowing / degenerative arthritis
- Two incision approach

Periacetabular Osteotomy



- Devised by Ganz
- Indication DDH in adolescents & adults
- Achieves

 correction of
 containment &
 congruency

Periacetabular Osteotomy - Advantages

- Permits extensive reorientation
- Preserves blood supply
- Posterior column remains intact – true pelvis unchanged
- Single incision
- Preferred reconstructive osteotomy for acetabular dysplasia

Periacetabular & Femoral Osteotomy



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Chiari Osteotomy





Chiari Osteotomy

- Devised by Chiari 1950's
- Salvage procedure
- Relief of pain in incongrous hip
- Increases coverage by medializing hip centre
- Fibrocartilage transformation of superior capsule

Chiari Osteotomy Results

- Chiari reported 200 procedures
 - 2/3 good to excellent outcome
 - 1/3 improved
- Similar results by others
- While pain relief is predictable, trendelenburg gait remains
- Trochanteric advancement may alleviate trendelenburg gait