Hip Evolution to Degeneration

“The Adult with a Limp”

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Hip Evolution to Degeneration

I have no disclosures

Dr Kieran Frawley
Hip Evolution to Degeneration

• Normal hip evolution over 360 mya
  – Bipedal gate
  – Brain development

• Normal development
  – Anatomy
  – Growth

• Degeneration
Hip Evolution to Degeneration
Evolution - 360 mya Lobe finned fish

Ray fish
- Broader base
- Separate rays

Lobe finned fish (Sarcopterygian)
- Endochondral bone
- Narrower base allows rotation
- One proximal and two distal bones
  eg lung fish

Tom Hogervorst et al. Evolution of the hip and pelvis.
ACTA ORTHOPAEDICA SUPPLEMENTUM NO. 336, VOL. 80, 2009
Evolution - 360 million years ago

Lobe (fleshy) finned fish

Eusthenopteron

Evolution - 360 million years ago

Flattened humerus

Panderichthys

Evolution - 360 million years ago

Wrist like function of fin

Tiktaalik

Evolution - 360 million years ago

Origin of digits
hind limb and pelvic girdle

Evolution - 360 million years ago

Ichthyostega

Elongation of limb long bones

Evolution - 360 million years ago

Terrestrial locomotion
?gill breathing lost

Evolution – hip joint and femur

Trough and cam

Tom Hogervorst et al. Evolution of the hip and pelvis. ACTA ORTHOPAEDICA SUPPLEMENTUM NO. 336, VOL. 80, 2009
Today  360 million years ago

Femur
Postminimus
Intermedium
Prehallux
Tibia
Fibula
Fibulare

Femur
Fibula
Postminimus
Fibulare (mesomere 3)

I
II
III
IV
V

Homo. Embryo 15.5 mm.
Ichthyostega. Devon

Evolution – Development
5 week human embryo – 10 mm

Evolution – Primitive reptiles

- Horizontal femurs and humeri – limited size
Evolution – walking upright
Dinosaurs 230 mya

• Legs below body – heavier load
Evolution - Mammals

- Evolved 300 mya
  - mammal like reptiles
- 200 mya
  - "true" mammals, small mammals
- 65 mya
  - large mammals
  - primates
- 25 mya
  - apes
- 6 mya
  - early humans
- 0.2
  - Homo Sapiens
Evolution - Mammals

- 2 types
- Coxa recta
  - *Sturdy hip*
  - Head neck junction straight and no offset (thickness of neck to the head)
- Coxa rotunda
  - *Mobile hip*
  - Head neck junction rounded and offset
Evolution Mammals - Coxa recta

<table>
<thead>
<tr>
<th></th>
<th>Horse</th>
<th>Wolf</th>
<th>Mandrill</th>
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<tbody>
<tr>
<td>Reduced offset</td>
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<td>Straight head neck junction</td>
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ACTA ORTHOPAEDICA SUPPLEMENTUM NO. 336, VOL. 80, 2009
Evolution Man – Bipedal Gait
Anterosuperior Coxa Recta - CAM

• 14 yo male
Evolution Man
Bipedal / erect posture

Double extension: Lumbar lordosis and hip extension

Macaque  Gibbon  Chimpanzee  Man

Tom Hogervorst et al. Evolution of the hip and pelvis.
ACTA ORTHOPAEDICA SUPPLEMENTUM NO. 336, VOL. 80, 2009
Evolution Man
Bipedal / erect posture

Hip extension

Anteversion
Evolution Man - Childbirth

3.2 mya
Evolution Man – Bipedal Gait
Childbirth – Coxa profunda
Pelvic evolution summary
Evolution
Developmental Anatomy (for radiologists)

5 week embryo

38 year old female
Development - Anatomy
Development - Anatomy

Development - Anatomy

Development – Anatomy of Labrum

Photomicrograph of Fetal hip at term

Photomicrograph of Fetal hip at 20 weeks

Development – Anatomy of Labrum

Bone
Blood vessels
Calcified cartilage layer
Labrum
Transition zone
Hyaline cartilage
Femoral head

Richard E. Field, PhD, FRCS, FRCS(Orth), and Karthig Rajakulendran, MSc, MRCS
Development – Anatomy Summary

- Bone
- Blood vessels
- Calcified cartilage layer
- Labrum
- Transition zone
- Hyaline cartilage
- Femoral head

Images showing anatomical structures and labels.
Development - Growth

• Acetabular growth
  – Triradiate cartilage
  – Iliac, ischial and pubic cartilage
  – Secondary ossification centres appear approximately age 8-9 yrs
  – Shape determined by approx. 8 yrs

• Femoral growth
  – 3 growth plates (GP)
    • Longitudinal GP
    • Trochanteric GP
    • Femoral neck isthmus

Abnormal Growth – Hip dysplasia

- 27 months femoral bilateral DDH
Abnormal Growth – Hip dysplasia

- 15 yo cerebral palsy - Acetabular Rim Syndrome
Abnormal Growth – 16 yo Septic hip as neonate
Abnormal Growth - Perthes

- Perthes – 8 yo Male
Abnormal Growth - Perthes

- Perthes – 3 years later at 11 yo
Abnormal Growth - Perthes

• Perthes – 5 years later at 13 yo
Abnormal Growth - Perthes

• 18 yo F – left Perthes
Abnormal Growth - Perthes

- 18 yo F – left Perthes
Abnormal Growth - Perthes

- 18 yo F – left Perthes
Abnormal Growth - SCFE
Abnormal Growth - SCFE

- 19 yo M – acetabular rim syndrome post SCFE
“Abnormal growth” – CAM FAI

• 15 yo male
“Abnormal growth” – CAM FAI

- 16 yo male
“Abnormal growth” – CAM FAI

- 17 yo male
“Abnormal growth” – CAM FAI

- 20 yo M – basketballer with left hip pain
“Abnormal growth” – CAM FAI

• Evo-Devo response
  – Genetic regulatory process during development and growth eg. like coxa recta.

• Wolff’s law
  – Mechanical response to loading/ stress
  – Increased incidence CAM deformity in athletes, >50 % and up to 90 % in studies

• CAM bump develops in adolescents at the final stage of growth
  – Up to 25 % males and 10% females
Development summary
Degeneration – hip joint

Mobility ↔ Stability
Degeneration - Premature

Arthroplasty less than 50 yo (640 patients, 710 hips)

- Osteoarthritis – 48 %
  - DDH 48 %
  - Perthes 10 %
  - SCFE 6 %
  - Unknown 36 %
    - 63 % CAM feature
    - 6 % Pincer
    - 30 % combined

- Osteonecrosis – 29 %
- Post traumatic – 9 %
- Inflammation – 8 %
- Nonspecified/ others – 6 %
Degeneration – Premature OA

Approx 50 % acetabular dysplasia

Approx 50 % impingement

• Perthes, SCFE, CAM FAI, pincer FAI, combination
Degeneration - longevity
Degeneration – Longevity

- Female prototype is coxa profunda
  - Pincer type FAI usually 6\textsuperscript{th} decade
- Male prototype is coxa recta
  - CAM type FAI usually in 4\textsuperscript{th} and 5\textsuperscript{th}
- Evolution
  - no disadvantage
  - Grandparents/ deceased by 4\textsuperscript{th} decade
U.S. Life Expectancy at Birth
1900 to 2009

Influenza Epidemic, 1918

Years

1900 1925 1950 1975 2000

47.3 78.2
Early OA – 38 yo female
Summary – evolution to degeneration
Thank You