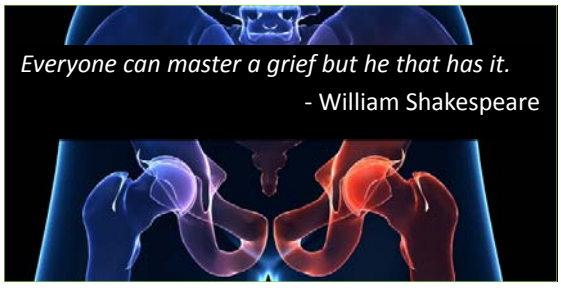
Anatomy

Timothy Ganey
Atlanta Medical Center **April 23, 2016**
Timothy.ganey@tenethealth.com

Disclosure and Interests

- Vivex BioMedical, Inc.
- 4WEB Medical, Inc.
- Amendia, Inc.
- E-Fellow

SI – A patient perspective

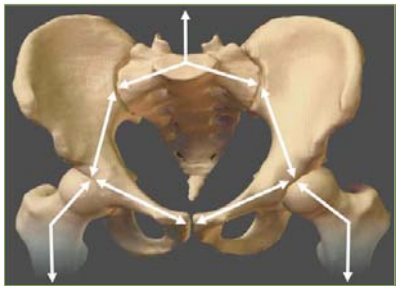


SI – A patient perspective

SI Sculpture

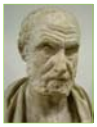
SI Joint Function

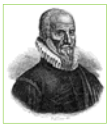
Transfer Load between the spine and legs



Historical Overview

- Hippocrates 460-377BC
- Vaesalius 1514-1564
- Pare 1634

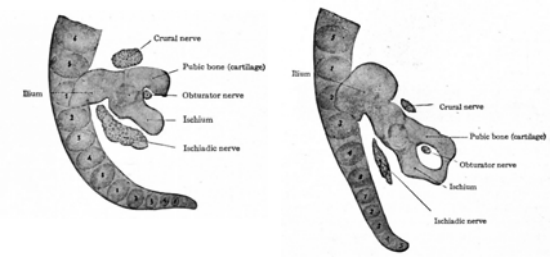




"SI Joint only mobile during pregnancy"

Sacrolliac Articulation

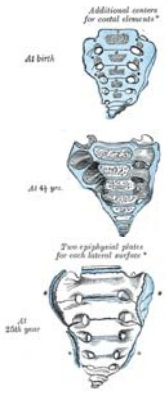
- Sacroiliac joints are true synovial joints
- Subject to various forms of arthritis and degenerative processes.
- Rotate 3–5° in the younger subject – they may be susceptible to mechanical trauma.
- Fibrosis takes place between the cartilage surfaces after the fifth decade of life
- Range of movement decreases as fibrous ankylosis increases by the seventh decade



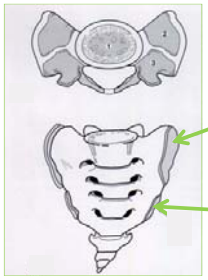
PETERSEN, H.: Untersuchungen zur Entwickelung des menschlichen Beckens. Arch, f. Anat. u. PhysioL, Anat. Abth., 1893.

Embryology

- 35 centers of ossification.
- Each sacral segment is formed by five ossification centers
  - one primary center that forms the body
  - four secondary centers that form the superior and inferior epiphyseal plates and the two halves of the vertebral (neural) arch.
- The first 3 sacral segments have a pair of costal elements that project anterolaterally to form the alae. Two epiphyseal plates on each side of the sacrum form the lateral aspect of the bone, including the auricular surface that articulates with the ilium.
- The fusion of the costal elements and auricular surfaces of the sacral alae does not begin until puberty and fusion of the vertebral bodies does not commence until near the end of the second decade.

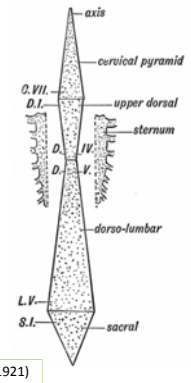


Lateral Epiphyseal Consolidation



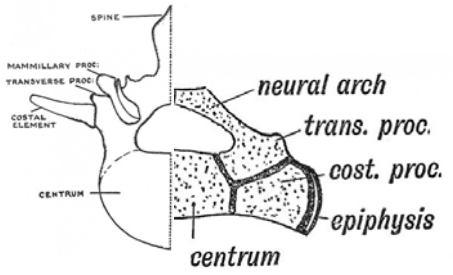
The lateral epiphyses and costal elements fuse completely by age 22, the S3-S4 and S4-S5 segments fuse by age 22, the S2-S3 segment fuses by age 23, and the S1-S2 segment may not fuse until the fourth decade of life or later .

Pyramids of the spine



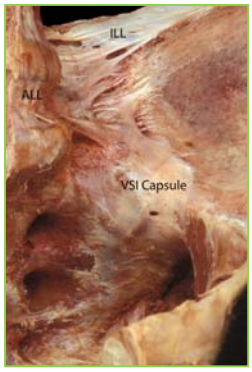
Keith, A. Human Embryology And Morphology (1921) Longmans, Green & Co.:New York.

Homologous Attributes

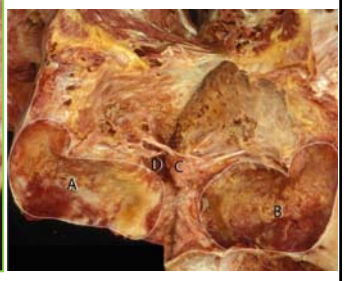


Lumbar Vertebra

Sacral Vertebra

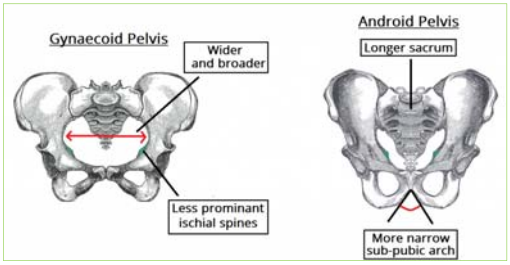


Ligamentous Investment



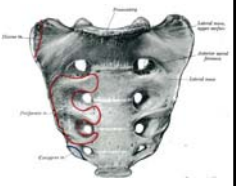
J Anat. 2012 Dec; 221(6): 537–567.

Gender Variation



Muscular Attachments

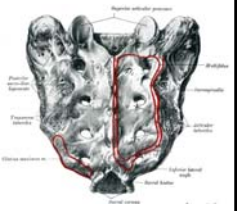
Anterior Surface



- **Piriformis**: Originates from S2 – S4 level of the pelvic surface. Due to its attachment at the trochanter of the femur, it is able to externally rotate, abduct, extend and stabilize the hip joint.
- **Coccygeus** muscle inserts on the lower sacrum. It gives support to the contents of the pelvic cavity and due to its attachment to the coccyx, is able to flex the bone.
- **Iliacus** – although it primarily arises from the iliac fossa, it also has fibers originating at the ala of the sacrum. Its distal attachment to the lesser trochanter of the femur allows it to flex the thigh at the hips and stabilize the hip joint.

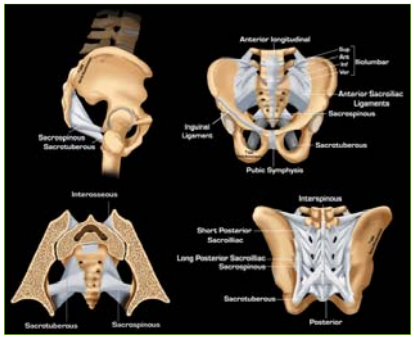
Muscular Attachments

Posterior Surface

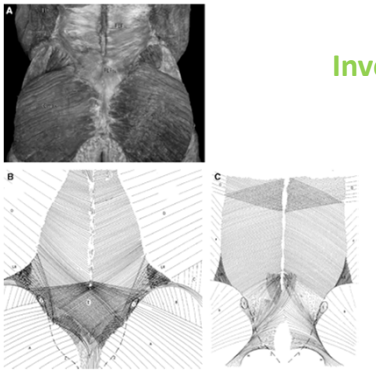


- **Gluteus Maximus**
- **Multifidus lumborum** – the deepest muscle arising from the sacrum. Some of its fibers cover the upper two sacral foramina. This muscle attaches to the transverse processes of the superior vertebrae and is therefore able to help stabilize the spine.
- **SacroSpinalis** – partly arises from the posterior sacrum and the sacrospinous ligament. It is essential in achieving extension and lateral bending of the head and vertebral column.

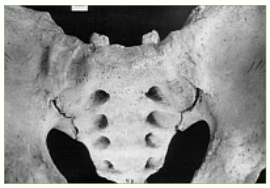
Sacral Ligaments

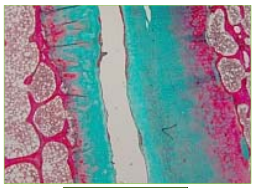


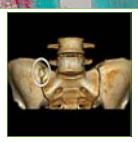
Fascial Investment

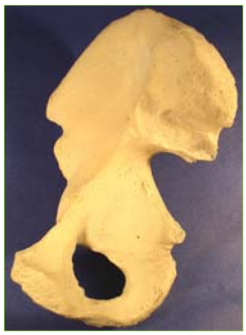


Sacrum – Iliac Articulation





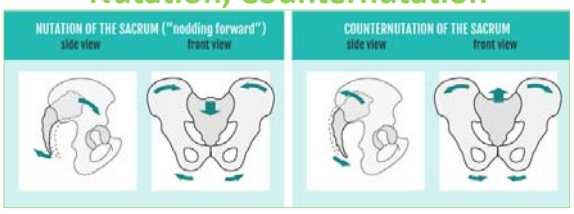


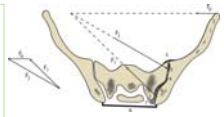
Pathology

- Nutation/counternutation – rotation-translation displacement
- Proprioceptive, Nocioceptive, Mechanoreceptive
- Inflammation, Irritation
- Anatomical evolution

Nutation, Counternutation



Bi-Pedal Posture
Adapting Lumbar Lordosis
Form and Force Closure – strain generation
Shear Mechanical Reaction
Force Closure trumps Form Closure

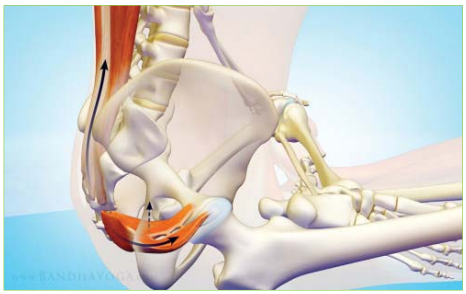


Adapted from Snijders, 1995

Nutation – "nodding"

Nutation – "nodding"

Interaction between erector spinae and pelvic floor muscles – stabilizing SI joint.



Illustrator – **Chris Macivor**

Proprioceptive, Nocioceptive

SIJ receives myelinated and unmyelinated fibers from the dorsal rami of the first four sacral nerves (Grob 1995)

Fibers have been shown to demonstrate electrical responses in group 3 fibers that were mechanical and electrical (Sakamoto N, et al.

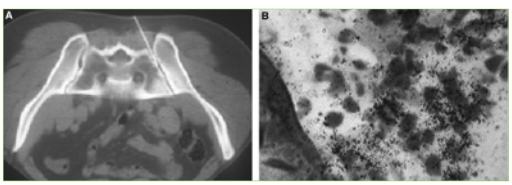
- Pacinian corpuscles
- Substance P
- Calcitonin gene-related Peptide
- Protein Gene Product 9.5

Sakamoto N, et al. Mechanoreceptors in the Sacro-iliac Joint. Trans Orthop Res Soc 199; 24:988
Grob KR, et al., Die innervation des sacroiliacalgelenkes beim menschen. Z. Rheumatol 1995; 54:117-22

Inflammation – Arthritic Change

- Vast proportion of local or global osteophyte
- Osteophyte more rare in women than in men
- Extra-articular in males, intra-articular in females – useful in paleo-osteology
- Enthesopathic calcification of ligaments and tendons follow tensional stresses
- Most important age-related changes occur at the ilium

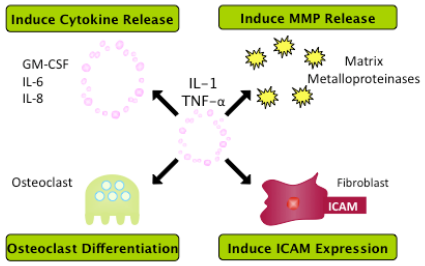
TNF-α Cytokines



(A) Computed tomography (CT) guided sacroiliac biopsy specimens from patients with active AS; (B) provided specimens with TNFα mRNA (black spots).5 Adapted and reprinted, with permission from the authors and Wiley-Liss, Inc, a subsidiary of John Wiley and Sons, Inc, from reference 5.

J Braun et al. Ann Rheum Dis 2002;61:iii51-iii60

Pro-Inflammatory Cytokines



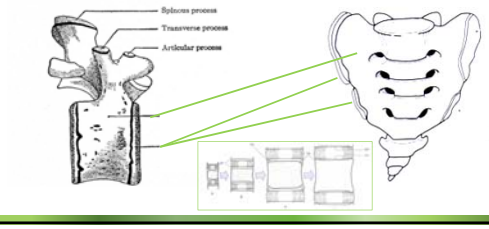
Choy EH, et al. *N Engl J Med.* 2001;344:907-916; Doan T, et al. *J Clin Pharmacol.* 2005;45:751-762; McInnes IB, et al. *Nat Clin Pract Rheumatol.* 2005;1:31-39.

Summary

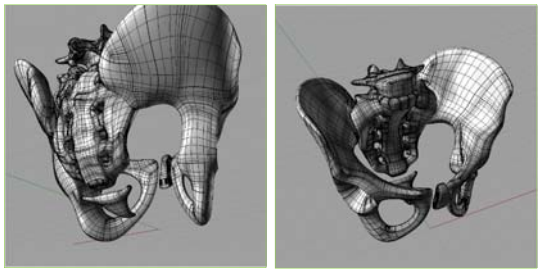
Anatomical –Diminution of secondary centers

Inflammation – Response

Nocioception – Pain



Defining Trajectory



Thank you for your attention

Men of few words are the best men.

King Henry the Fifth - (Act III, Scene II).

Born April 23, 1564
Died April 23, 1616