

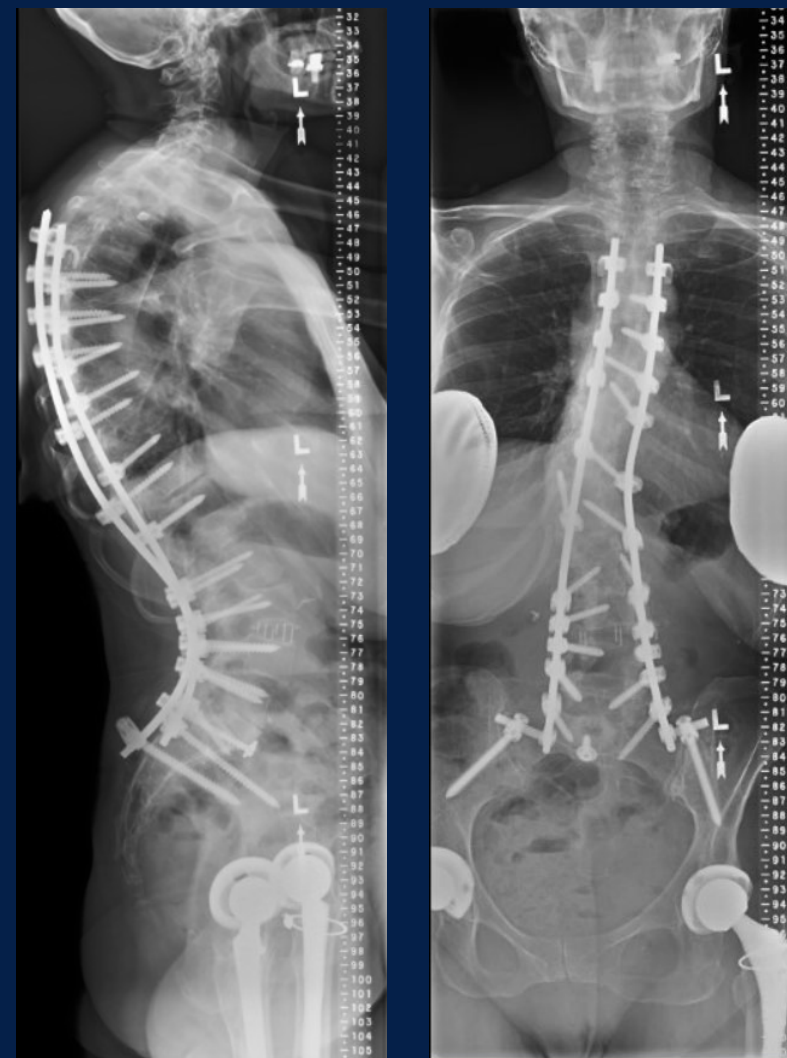


University of California
San Francisco

Hip-Spine

Back to ignoring it all over again

Jeff Barry, MD
Associate Clinical Professor of Orthopaedics
Arthroplasty Fellowship Director
UCSF Department of Orthopaedic Surgery



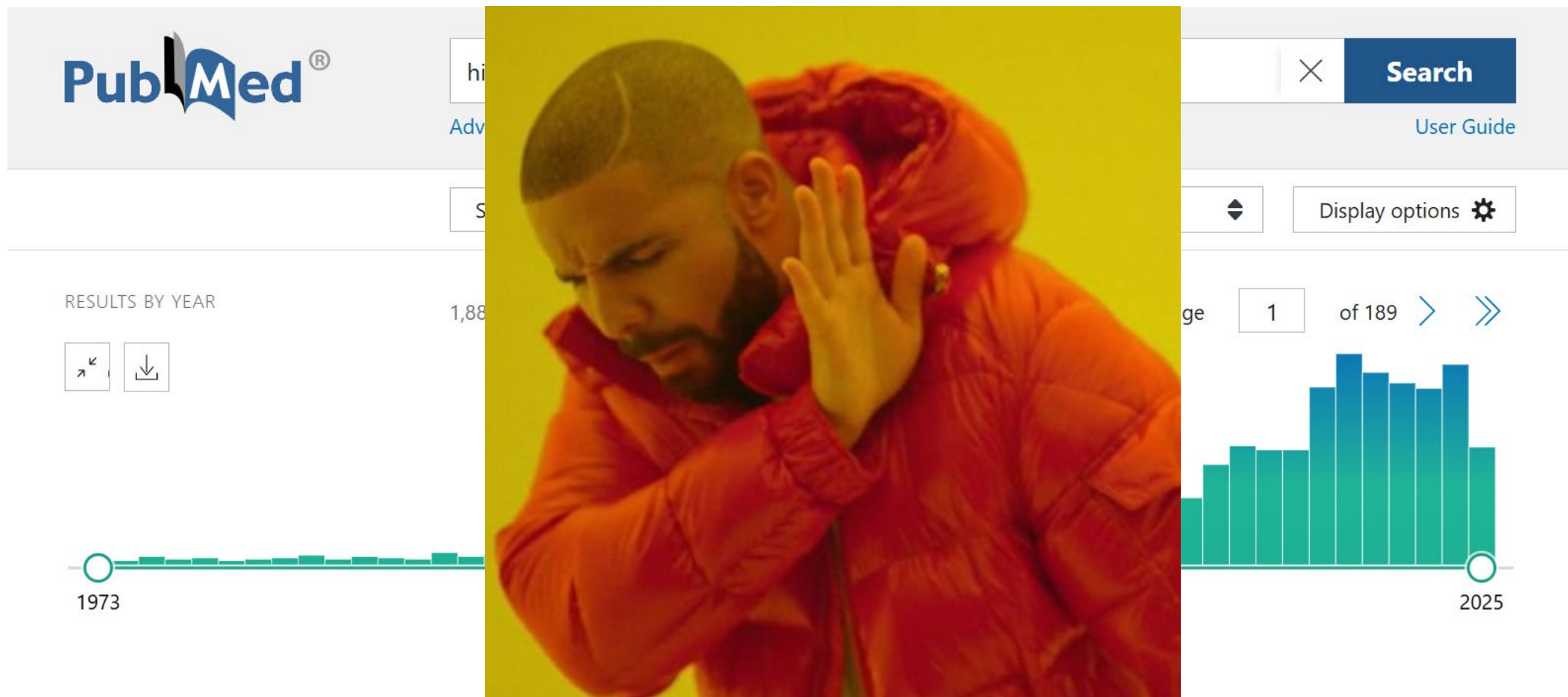
Disclosures

- Consulting:
 - Smith & Nephew
 - Onkos
 - J&J MedTech
 - Lineage Medical
- Institutional Fellowship grants: S&N, AAHKS

Outline

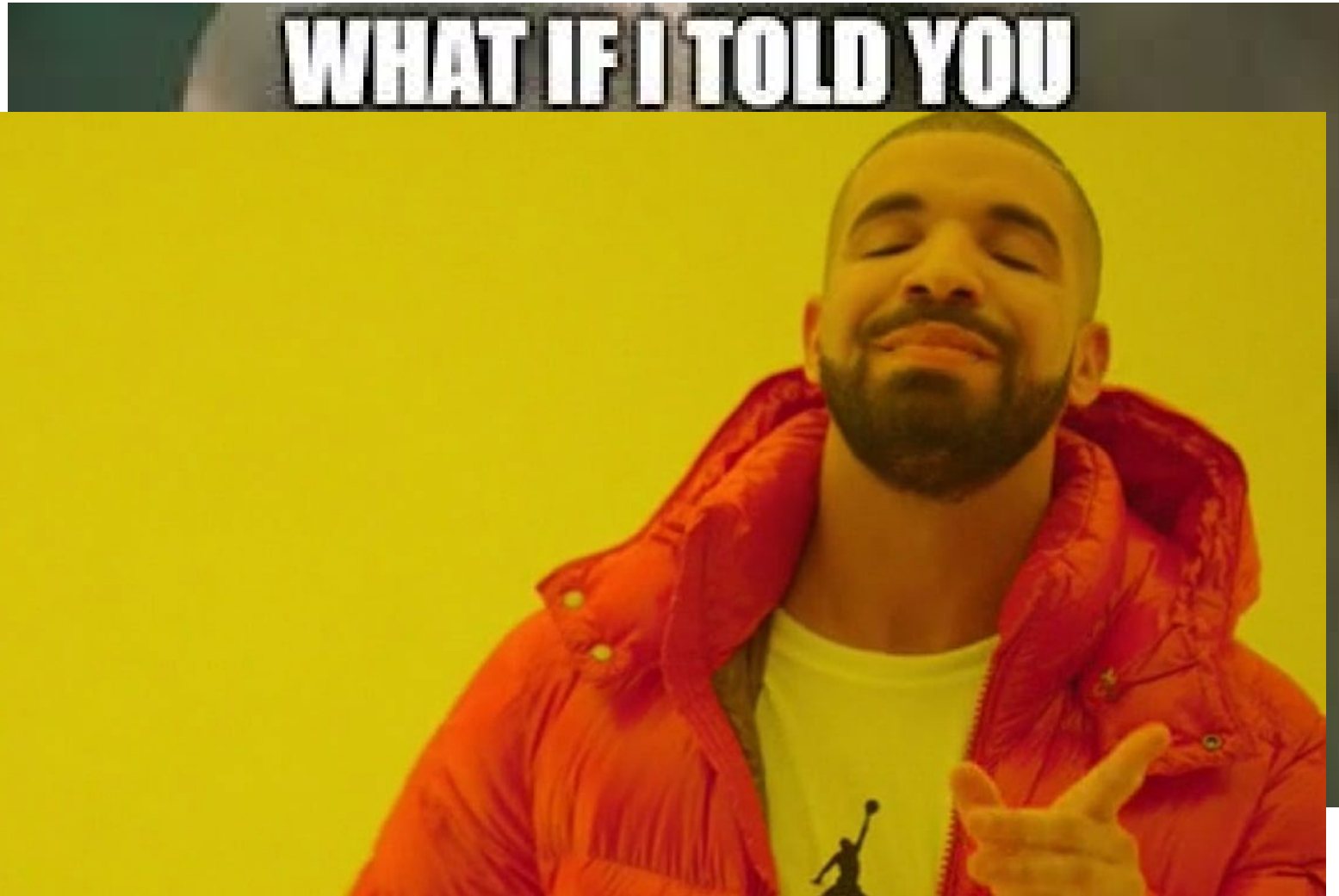
- Understand Pelvic Position and the relationship to Acetabular Position
- Barry Algorithm for Cup Positioning

Hip-Spine Recently

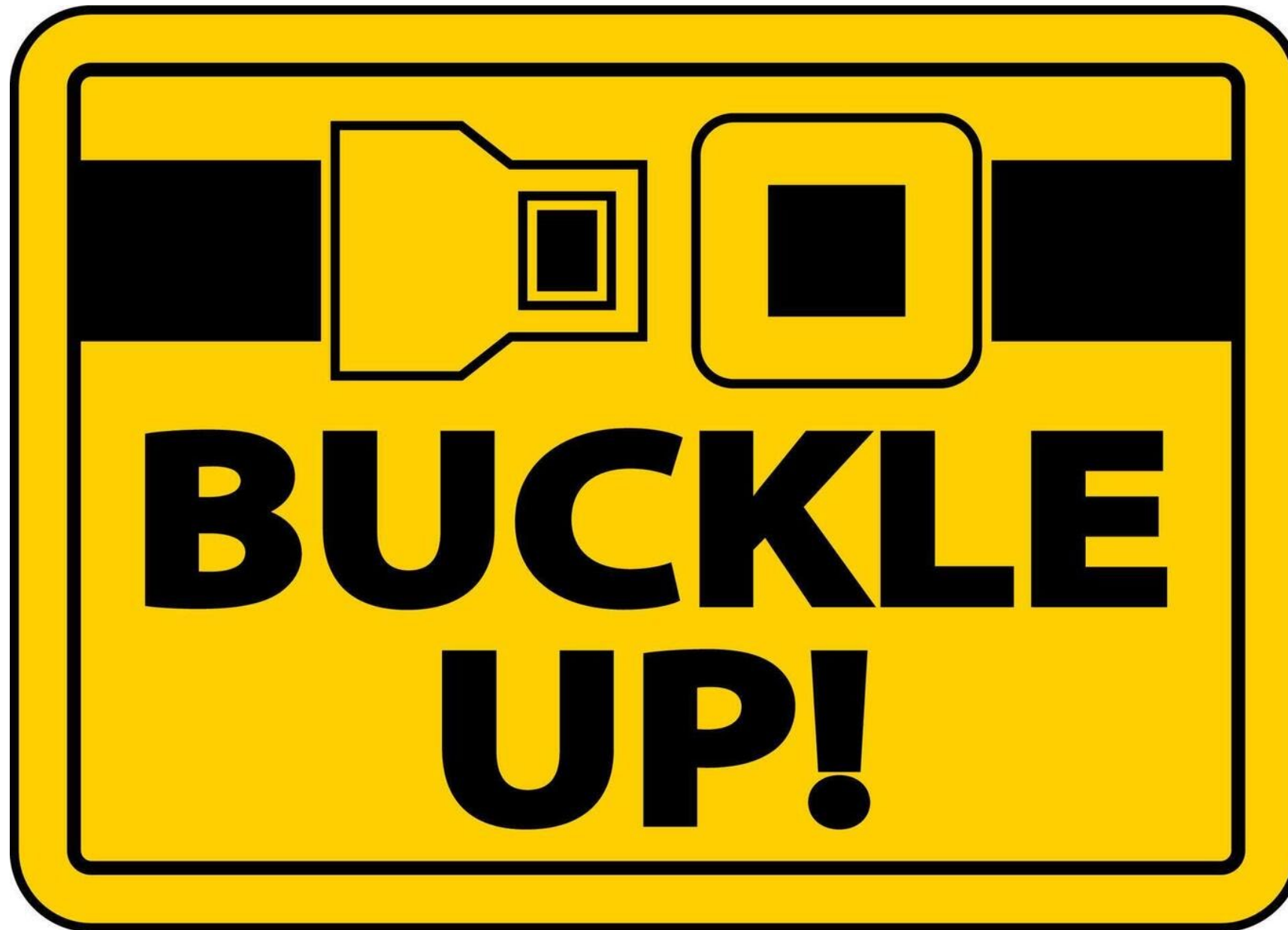


Don't Be This Guy Today





**A Way Without Classifications or Measurements
or Robots or Sit to Stand Spine Films**

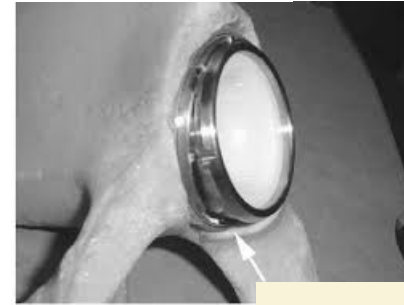


Why is Spine a Topic of Every Meeting



▪ Alternative Topics

- Poly wear (solved)
- CoCr issues (solved)
- Anterior vs Posterior hips (solved)
- Infection (never gonna solve)



Posterior hips do just as well!!!



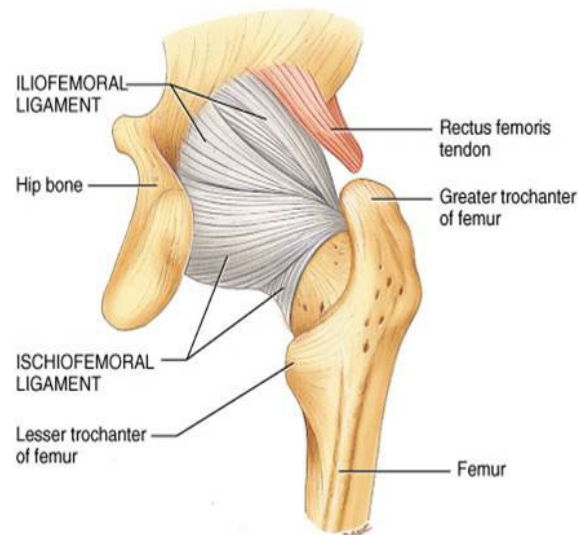
Anterior
surgeons

▪ Let's talk about the spine!!

- Admittedly has led to improved biomechanical understanding

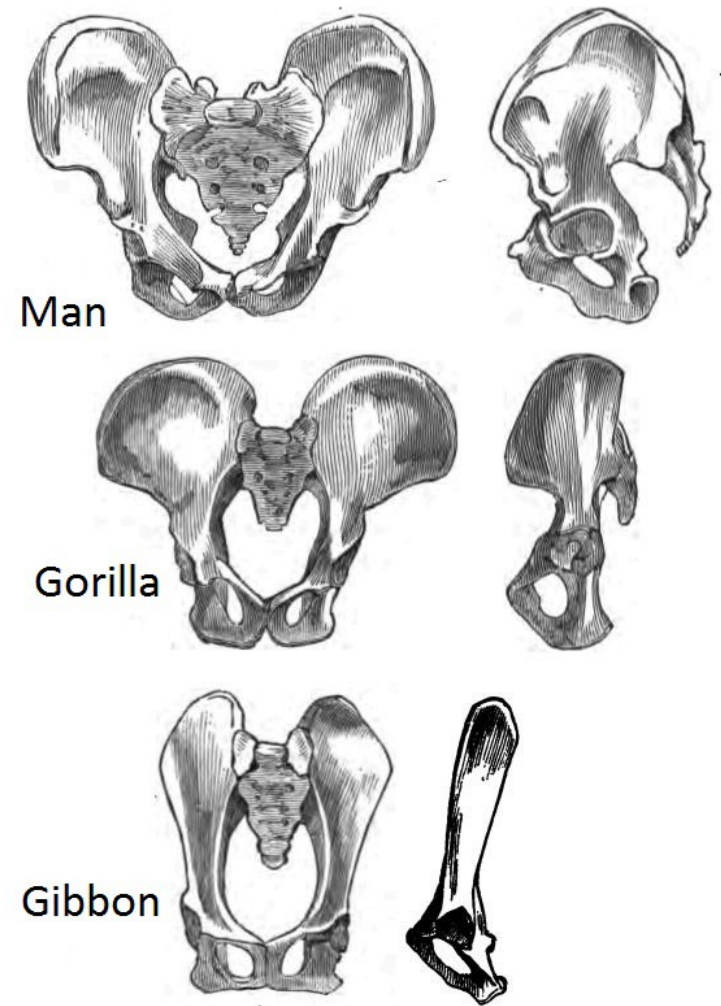
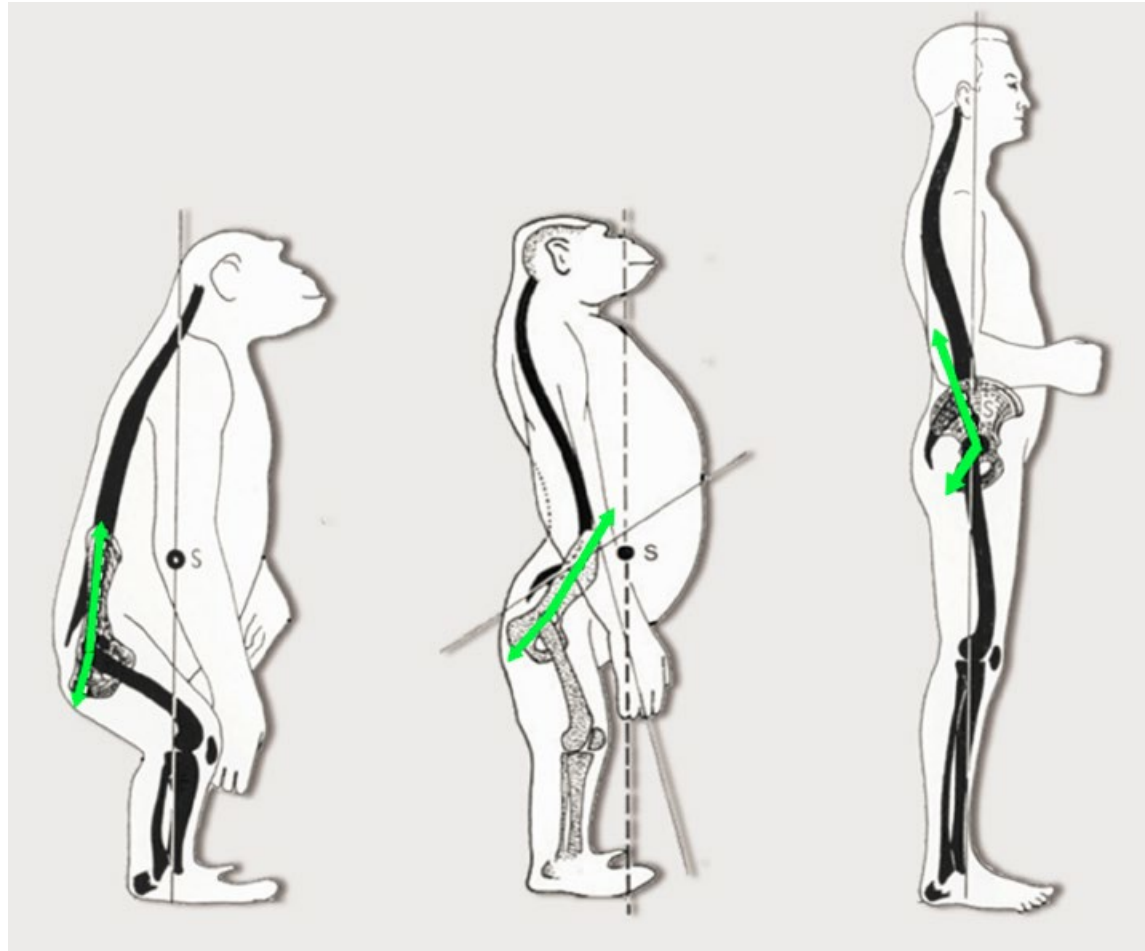
The Stable (Native) Hip Joint

- Enarthrodial ball and socket joint
- Inherently stable
 - Bony congruity
 - Labrum
 - Capsulo-ligamentous complex



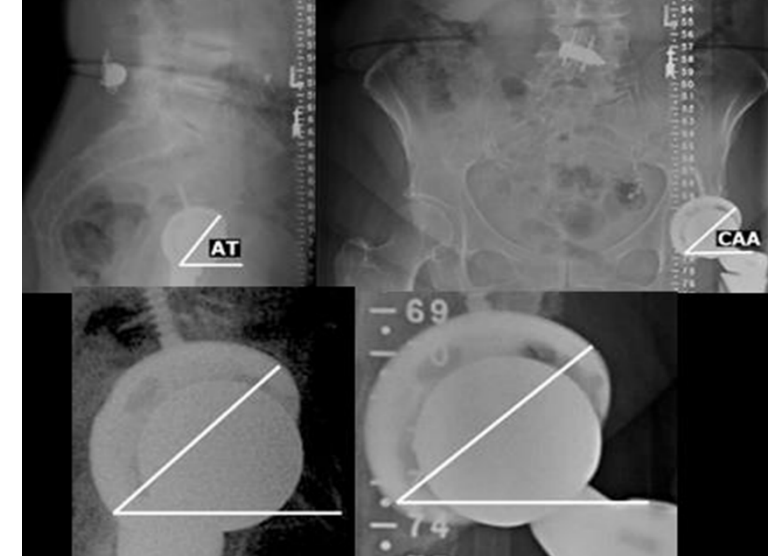
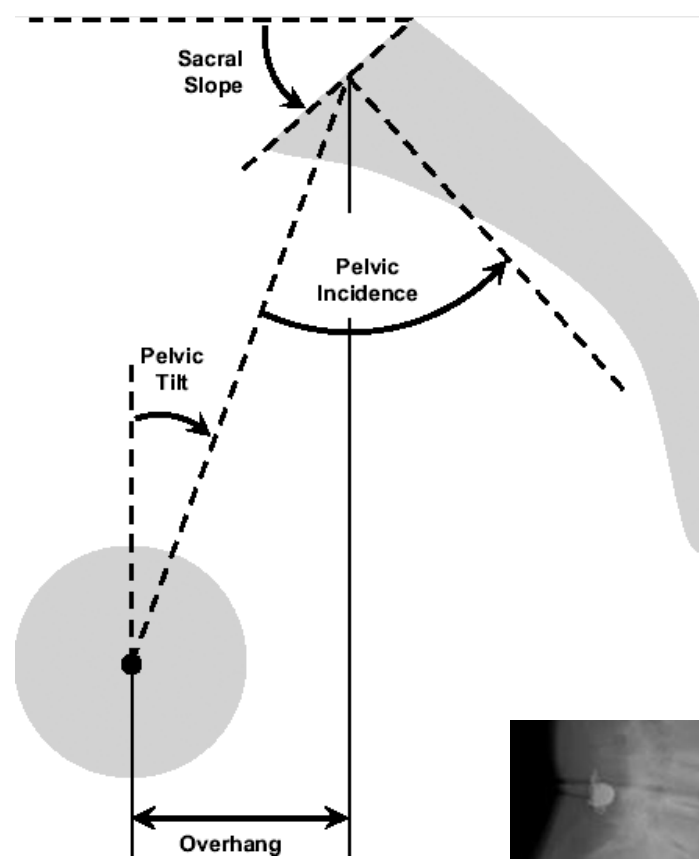
Human Pelvis and Hip Joint

- Evolved to allow upright bipedal ambulation and still be able to birth large brains



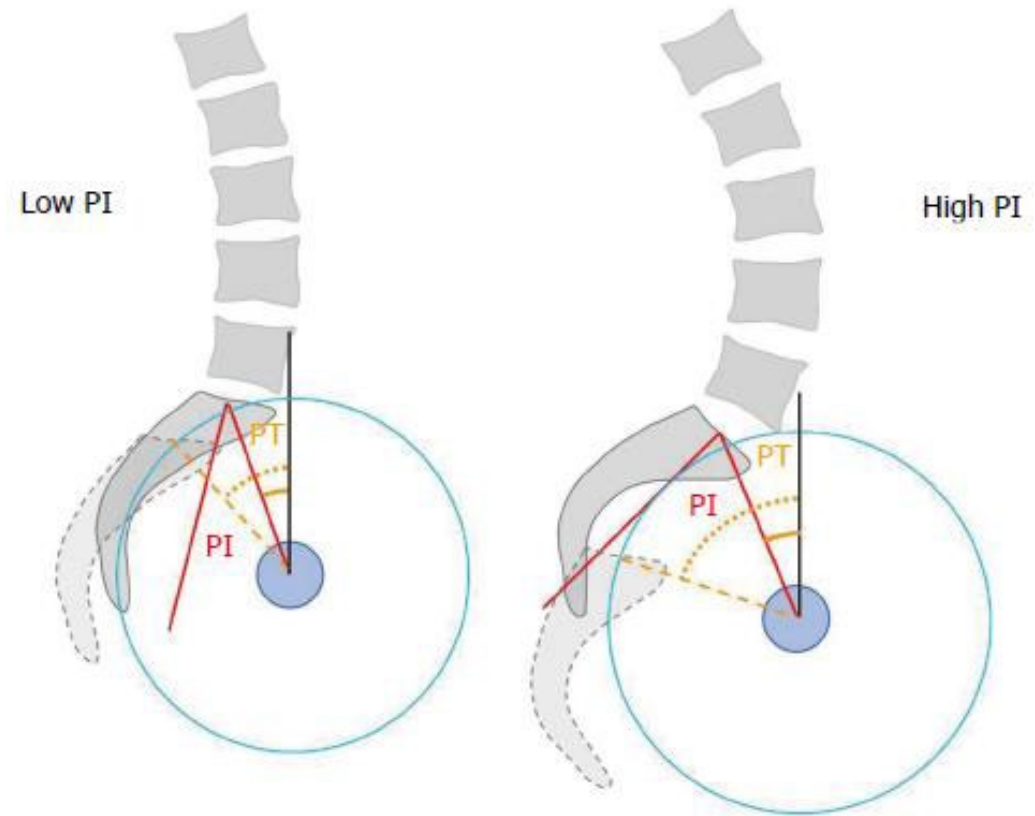
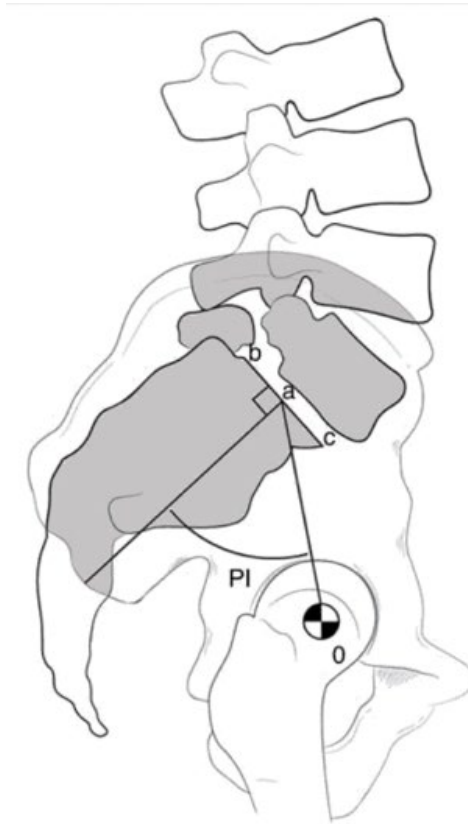
Pelvic Terms

- Measurements inherent to pelvic anatomy
 - **Pelvic incidence**
- Dynamic / positional / functional measures
 - **Pelvic tilt**, sacral slope, lumbar lordosis
 - **Acetabular anteversion and inclination**



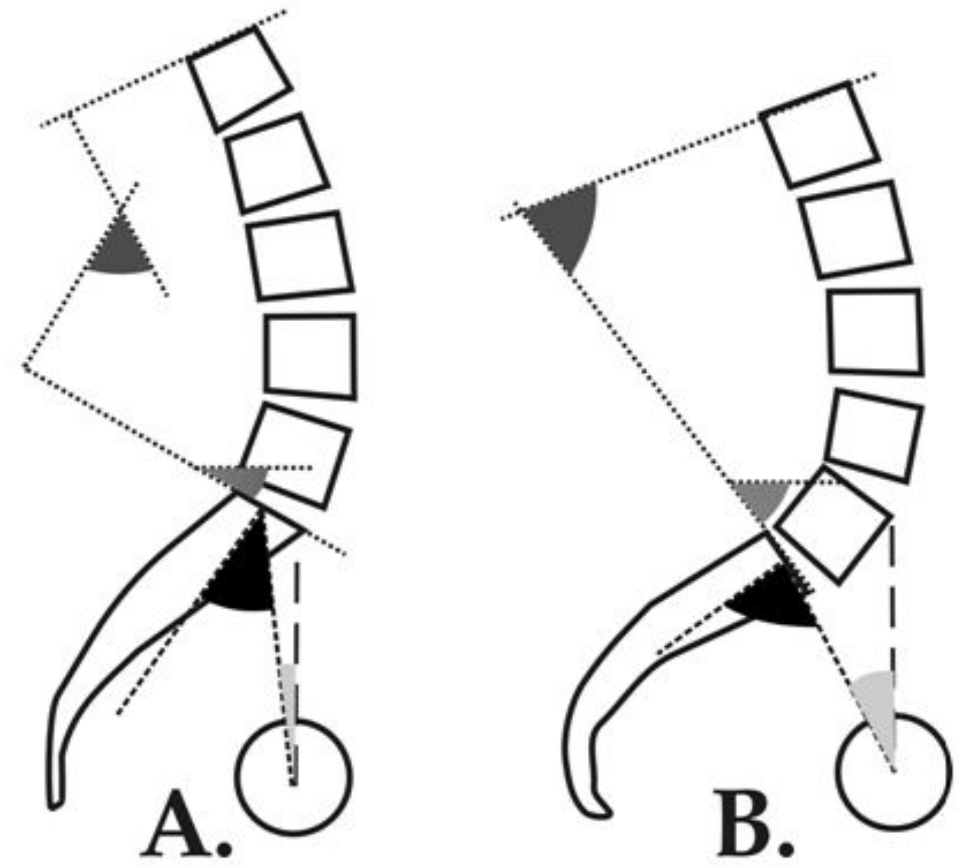
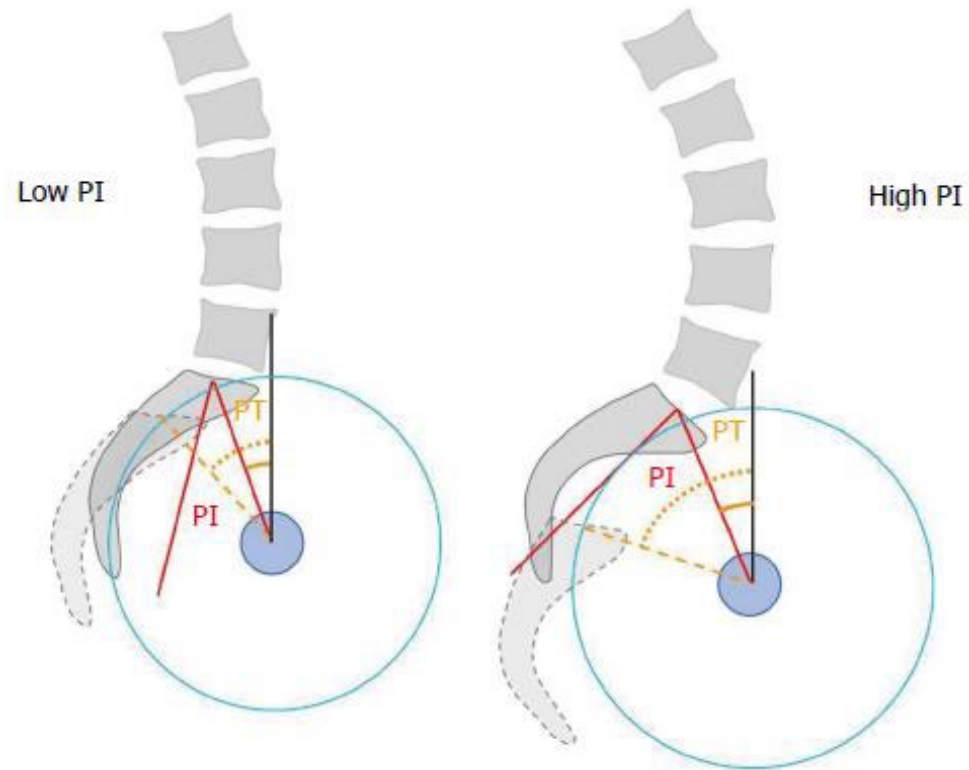
Pelvic Incidence

- Fixed in maturity - Increases during development
- Measure of *individual* pelvic anatomy

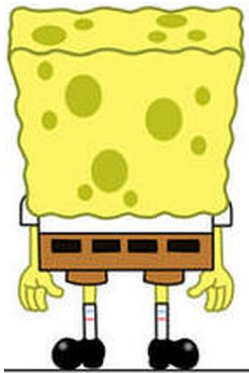


Pelvic Incidence (fixed) Sets Lordosis

- Sets the base of the spine

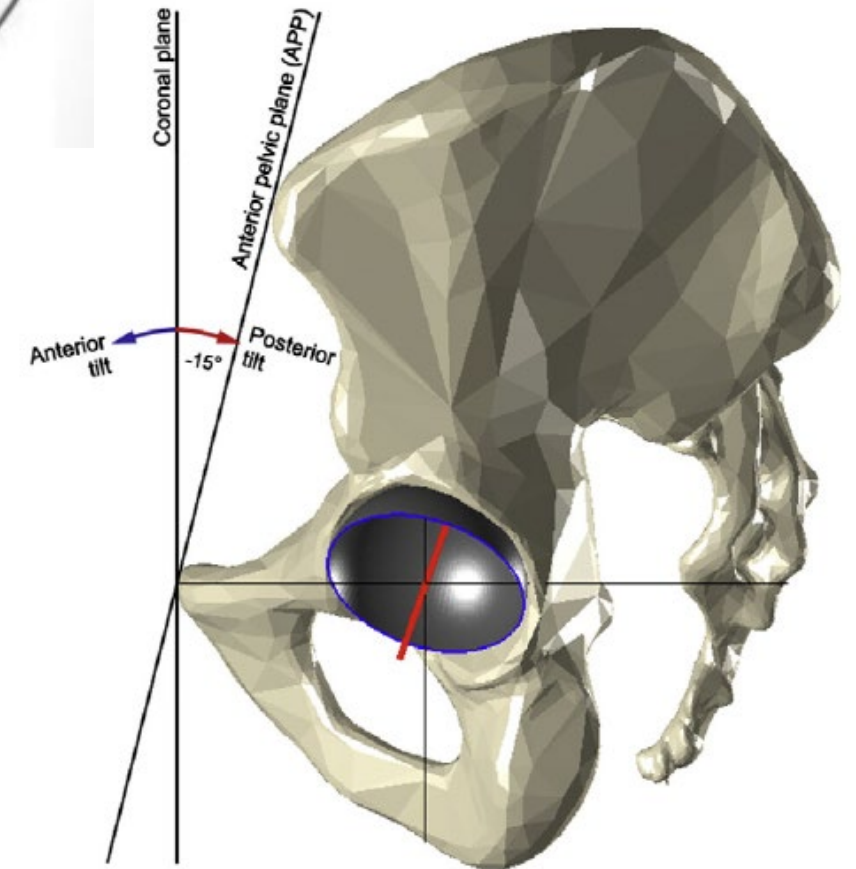
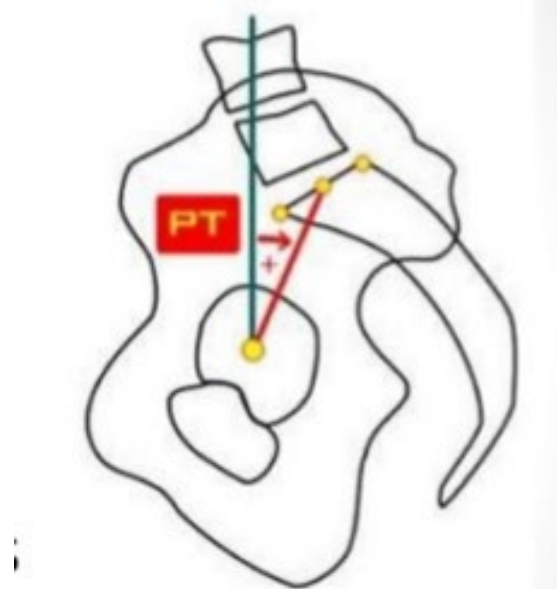


Work What Your Momma Gave You



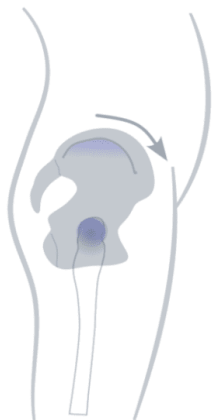
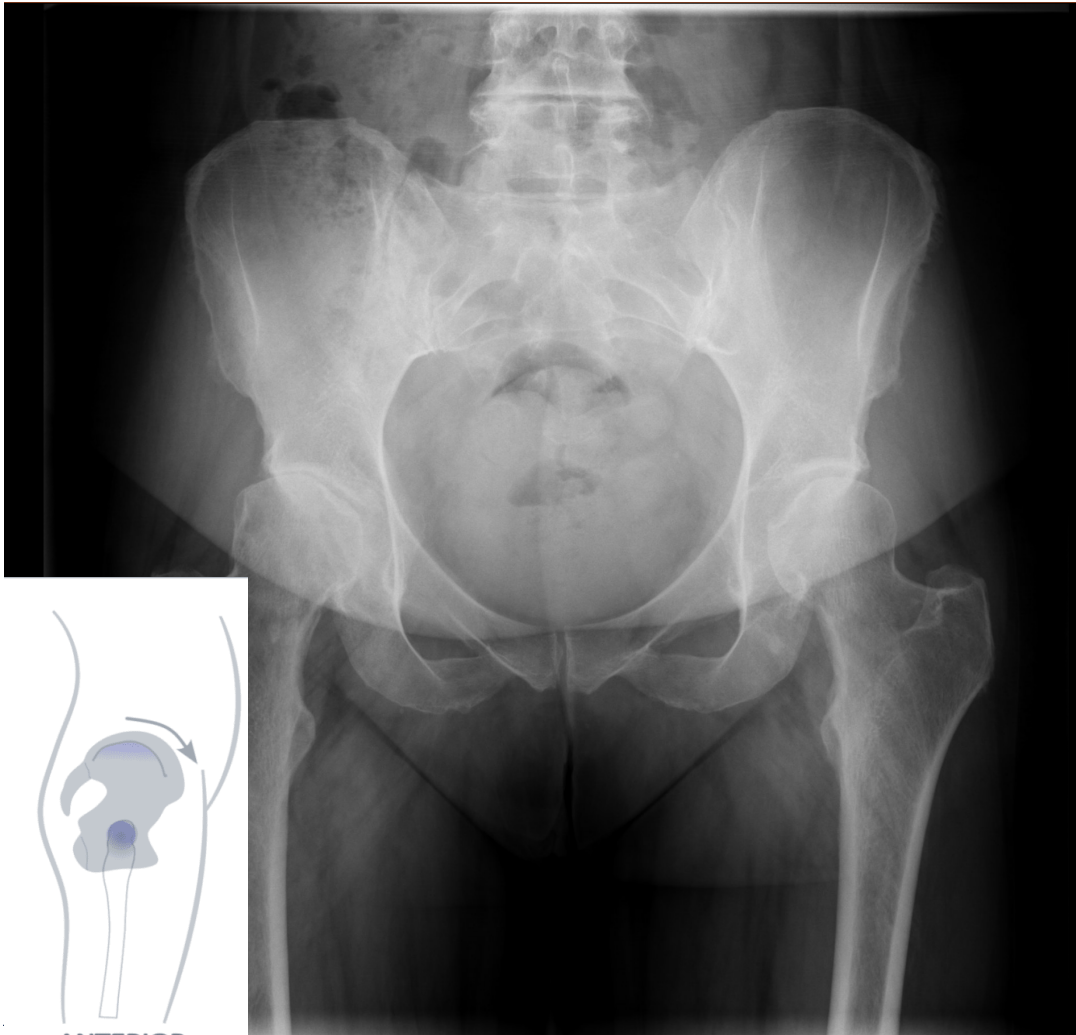
Pelvic Tilt – Positional Parameter

- Spine measurement
 - Normal ~13deg
- Arthroplasty measurement – ASIS to symphysis
 - Look at anterior pelvic plane
 - ~zero normal



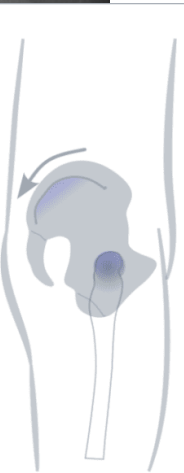
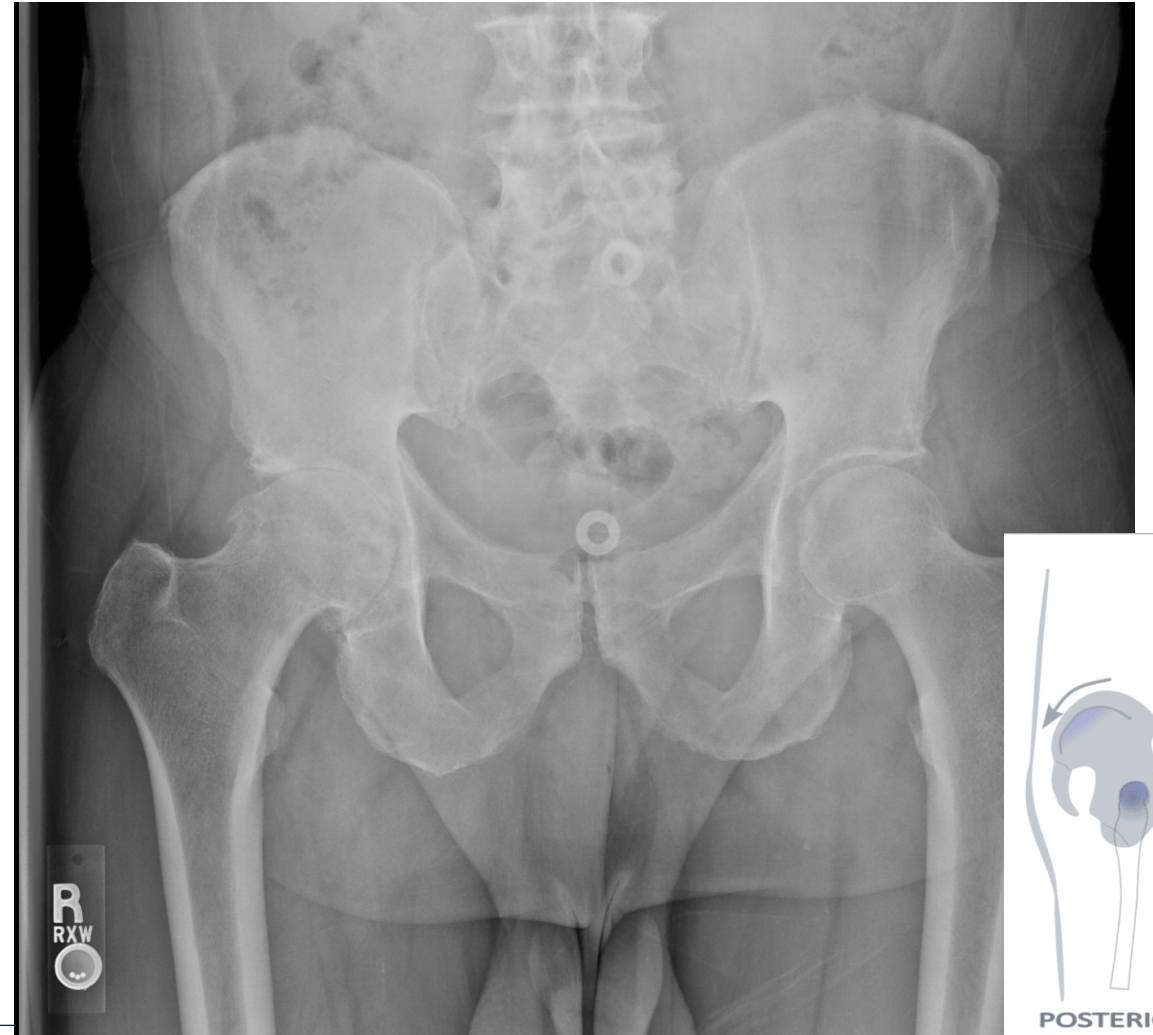
****PELVIC TILT CAN BE APPROXIMATED ON AP IMAGE****

MORE INLET = ANTERIOR TILT



**ANTERIOR
TILTED
PELVIS**

MORE OUTLET = POSTERIOR TILT



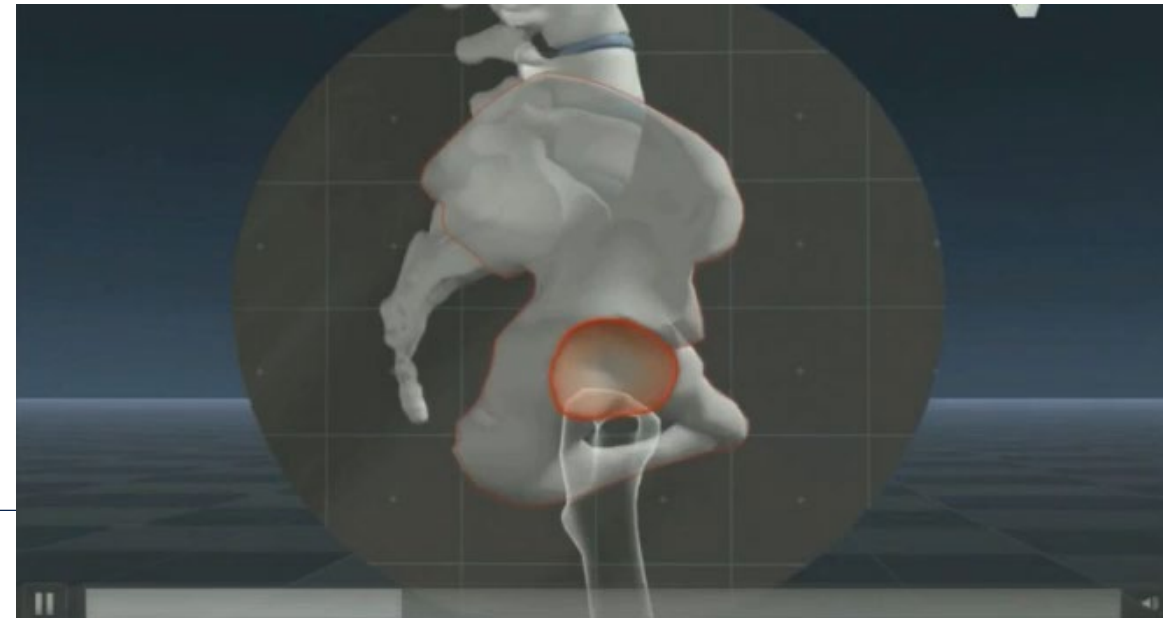
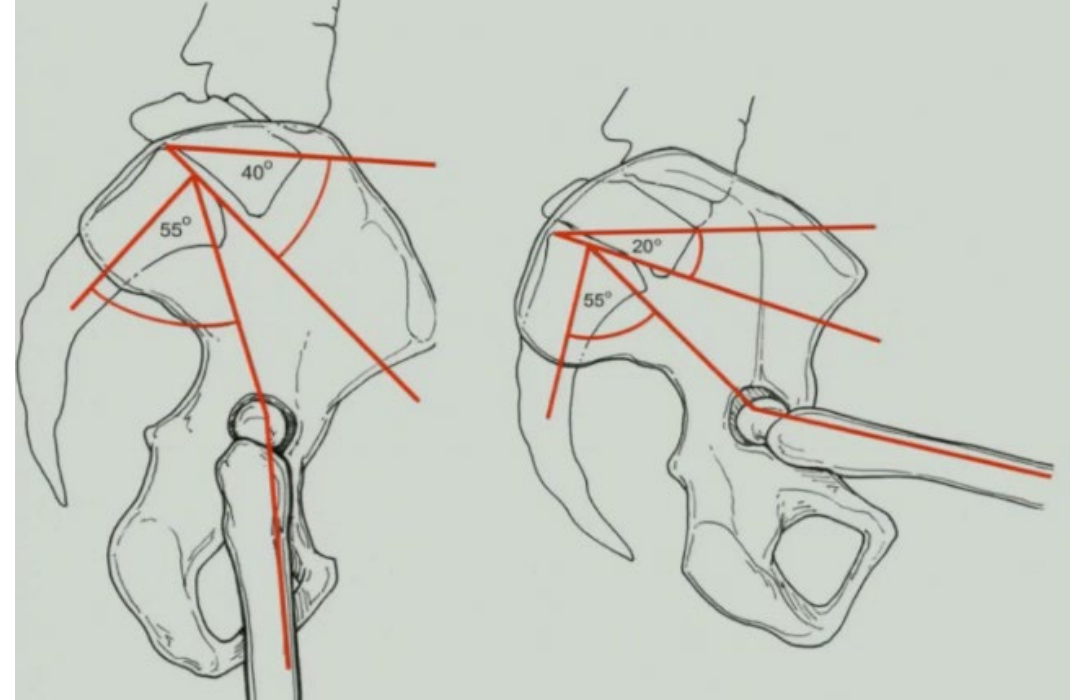
**POSTERIOR
TILTED
PELVIS**

The pelvis was meant to tilt



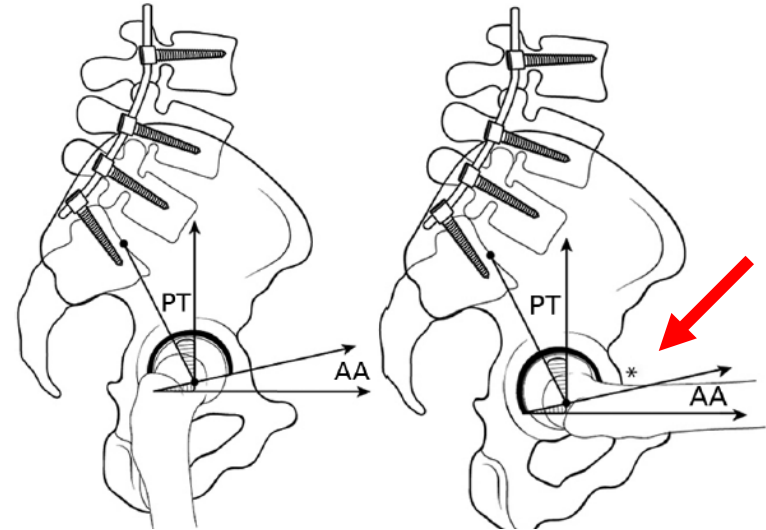
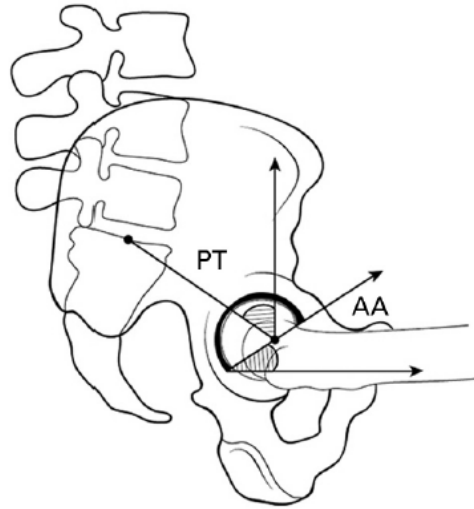
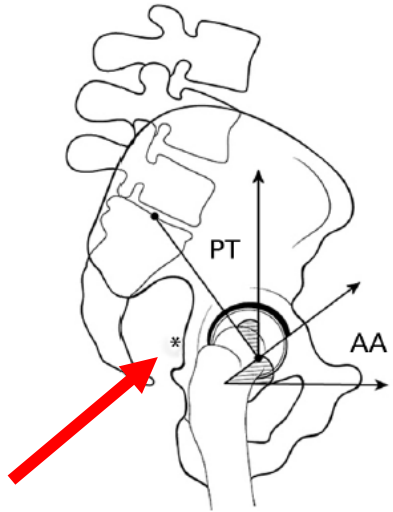
The pelvis was meant to tilt

- **Standing to sitting: PT increases (roll back)**
 - Opens up cup to allow legs to flex up without impingement
- **Lying down PT decreases (roll forward)**
 - Coverage against anterior instability
 - Important in DA surgery positioning!
- **Changes in PT increase safe functional range of motion without impingement in native hip**



Effect of Stiff Spine

- Stuck Sitting – pelvis already retroverted – can't roll forward when standing and can get impingement in extension (anterior instability)
- Stuck Standing – pelvis neutral and can't roll on sitting – risk anterior impingement (posterior instability)

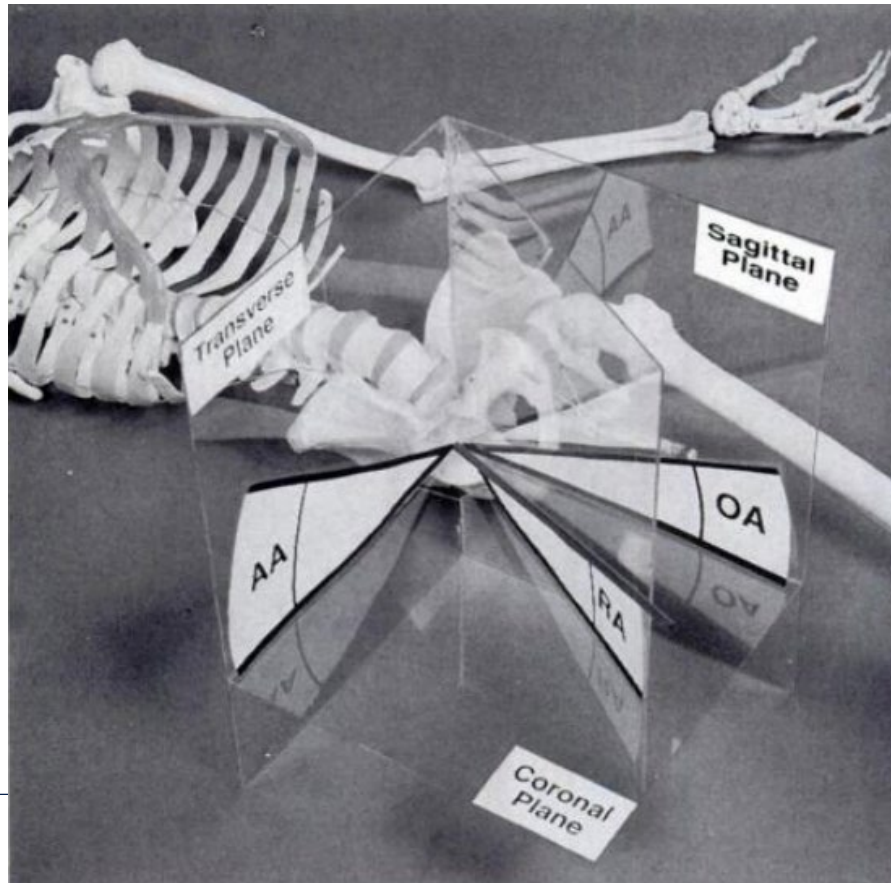


Connection of Tilt and Acetabular Position

THE DEFINITION AND MEASUREMENT OF ACETABULAR ORIENTATION

D. W. MURRAY

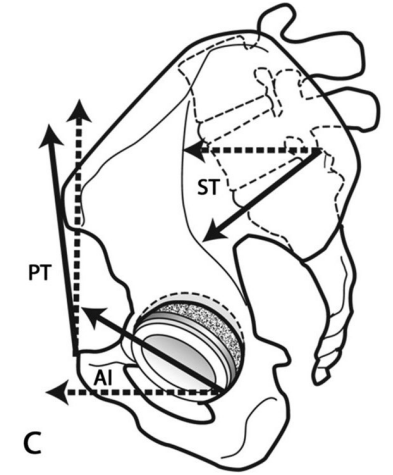
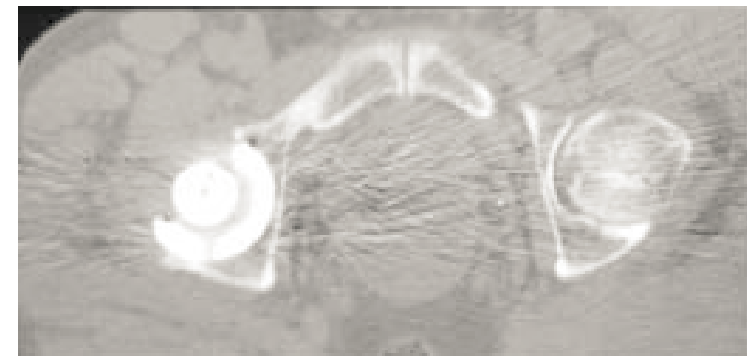
- Typically anteversion refers to “operative” anteversion
- How much you raise your hand from longitudinal axis



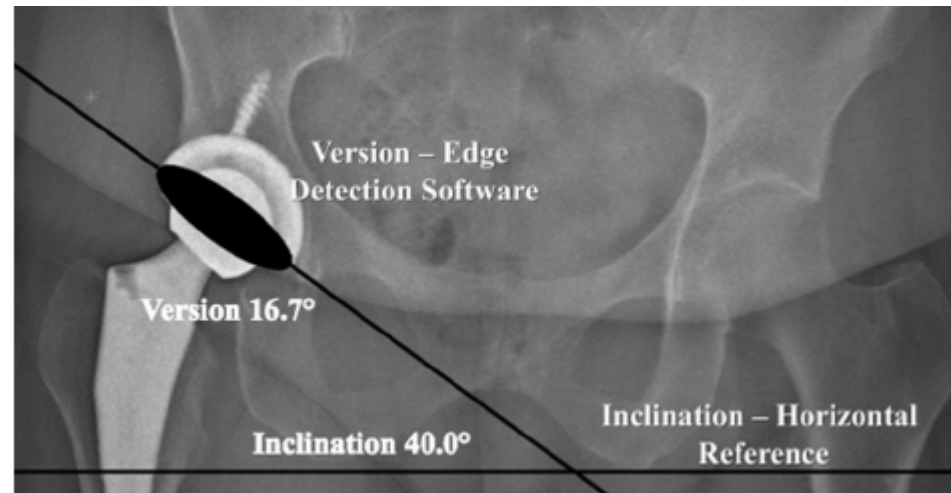


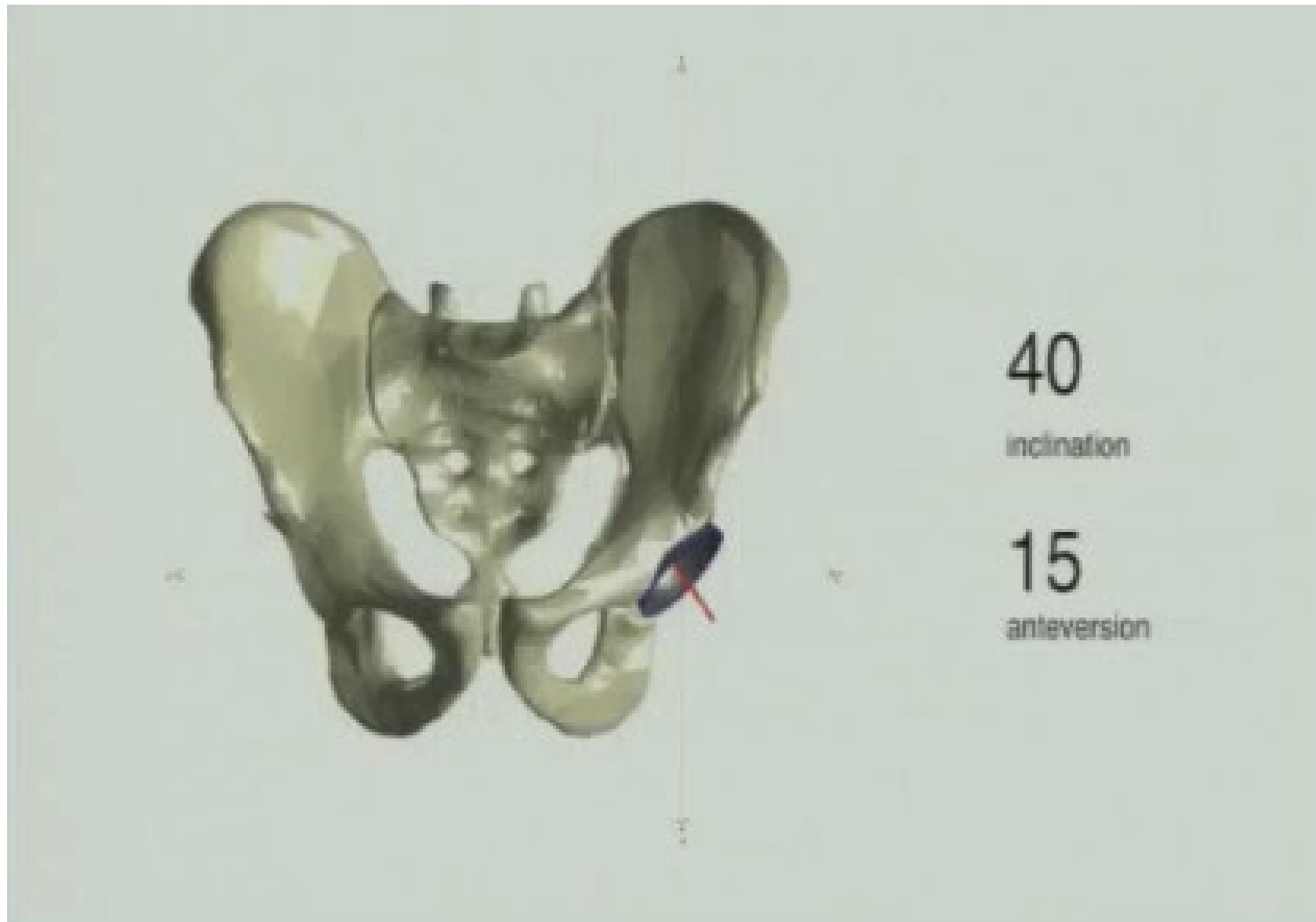
Operative Anteversion

- Hard to measure radiographically so surrogates are used (and abused...)
 - Anteinclination
 - Estimates based on major and minor diameters on an AP – Ackland
 - Projection anteversion
 - Anatomic anteversion (CT)
 - Lateral anteversion
 - Acetabular tilt

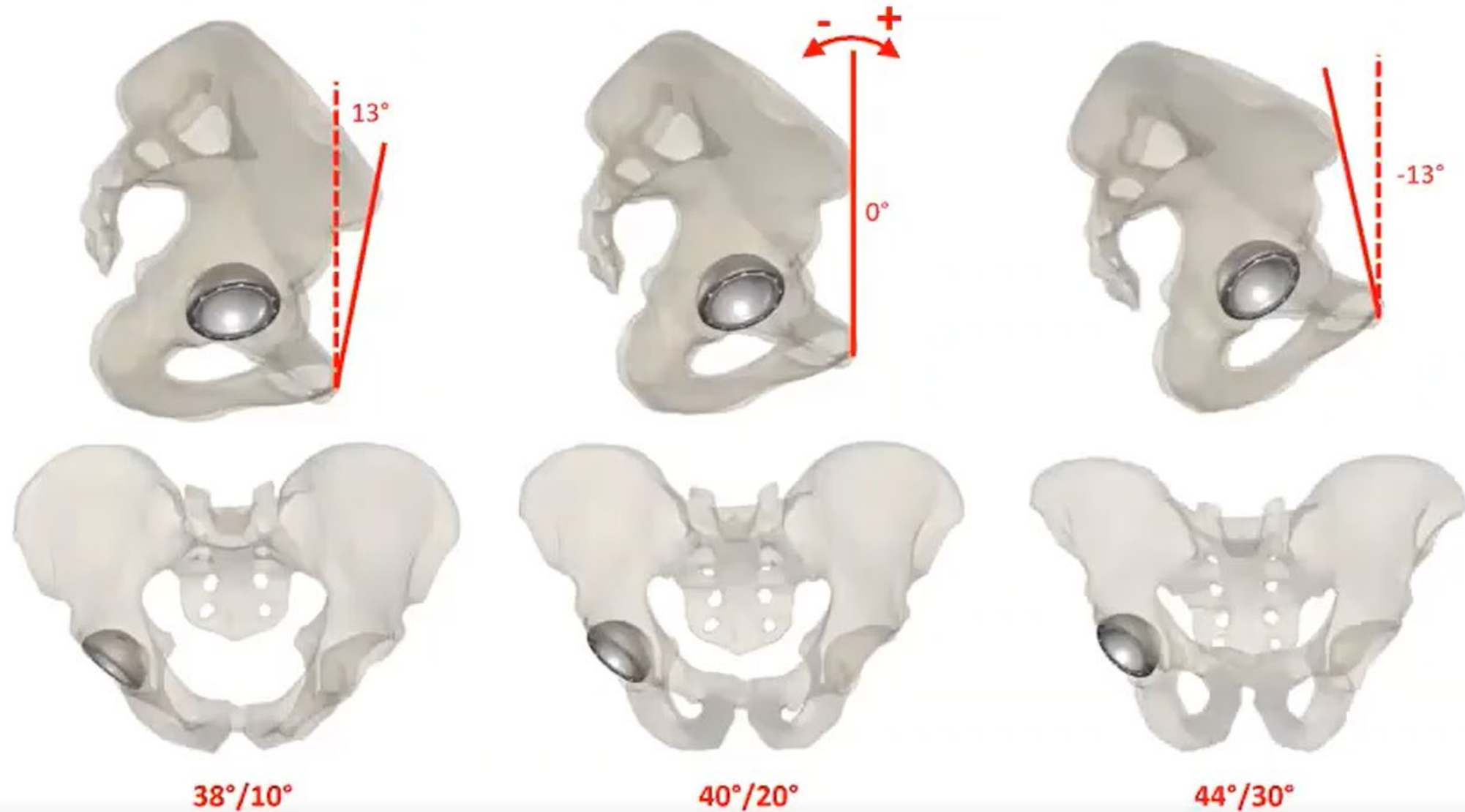


▪ All are positional!



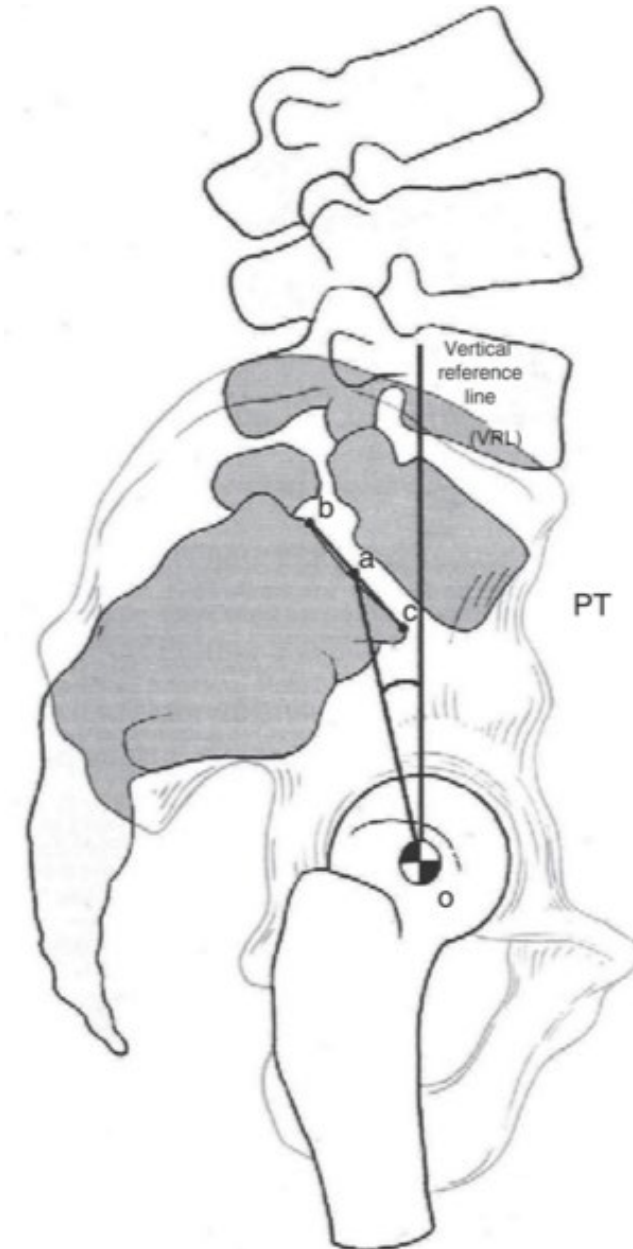


Acetabular Position Changes with Pelvic Tilt



Pelvic/Spine Summary

- Pelvis and spine moves depending on functional position
- Stiff spines can be stuck in various tilted positions
- Acetabular position is a function of pelvic position and tilt
- What isn't here... clinical implications!!!!

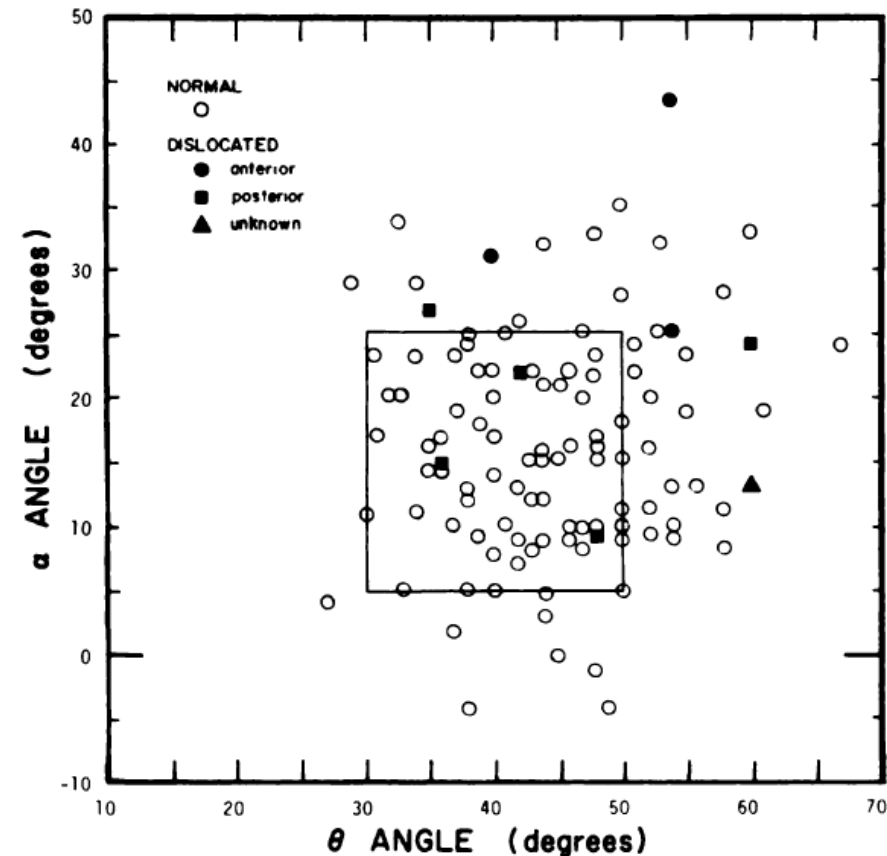


Dislocations after Total Hip-Replacement Arthroplasties*

BY GEORGE E. LEWINNEK, M.D.[†], JACK L. LEWIS, PH.D.[‡], RICHARD TARR, M.S.[‡], CLINTON L. COMPERE, M.D.[†],
AND JERALD R. ZIMMERMAN, B.S.[‡], CHICAGO, ILLINOIS

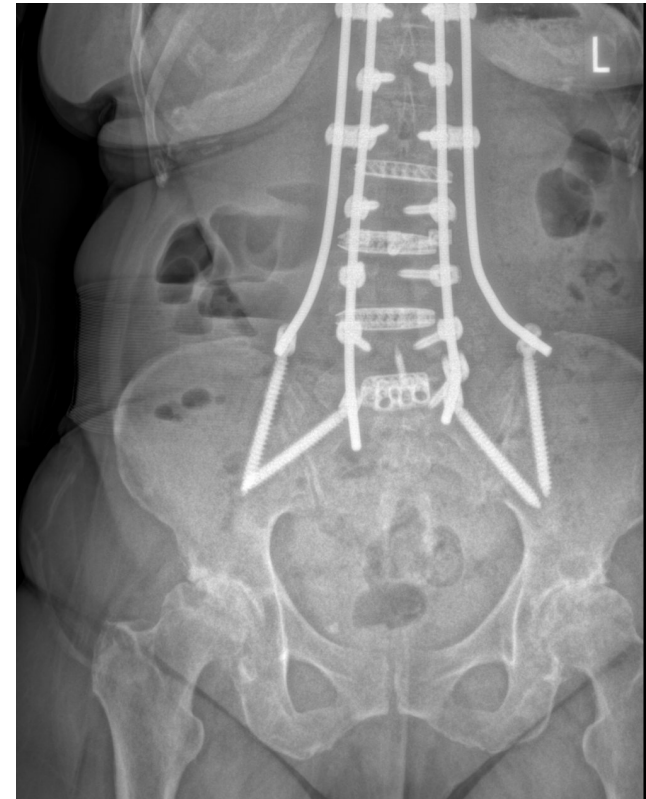
From the Northwestern Memorial Hospital, Chicago

- 9 dislocations
- Defined a safe zone
 - 40 +/- 10° inclination
 - 15 +/- 10° anteversion
- 1.5% dislocation rate in safe zone
- 6% dislocation rate out of safe zone
- Orthopaedic gospel set by 3 cases you should ignore and 6 cases you should listen to
- NO CONCEPT OF PELVIC POSITIONING OR STANDARDIZATION ON RADIOGRAPHS!!!!

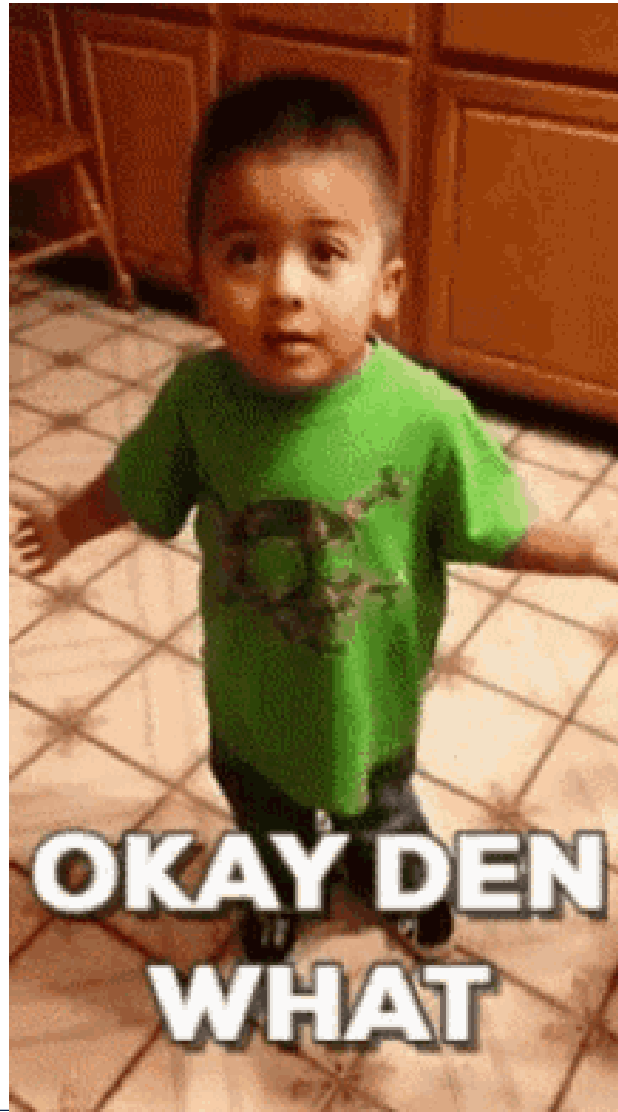


Summary of 1882 Papers on Spine and Hip Clinical Outcomes

- Bad spine = more risk for problems after THA



How does this impact what I should do?



Who's At Risk.... (taken from AAHKS FOCAL lecture)

MORE LIKE WHO'S CONFUSED!!



J. Langston,
J. Pierrepont,
Y. Gu,
A. Shimmis

From Melbourne
Orthopaedic Group,
Windsor, Australia

■ PAPERS FROM THE INTERNATIONAL Hip Society Risk factors for increased sagittal pelvic motion causing unfavourable orientation of the acetabular component in patients undergoing total hip arthroplasty

Aims
It is important to consider sagittal pelvic rotation when introducing the acetabular component at total hip arthroplasty (THA). The purpose of this study was to identify patients who are at risk of unfavourable pelvic mobility, which could result in poor outcomes after THA.

Patients and Methods
A consecutive series of 4042 patients undergoing THA had lateral functional radiographs and a low-dose CT scan to measure supine pelvic tilt, pelvic incidence, standing pelvic tilt, flexed-seated pelvic tilt, standing lumbar lordotic angle, flexed-seated lumbar lordotic angle, and lumbar flexion. Changes in pelvic tilt from supine-to-standing positions and supine-to-flexed-seated positions were determined. A change in pelvic tilt of 13° between positions was deemed unfavourable.

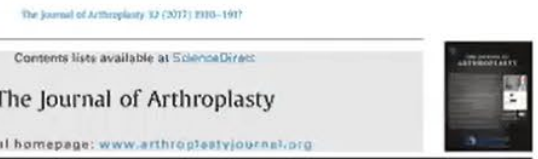
1. Standing Posterior PT $\geq 10^\circ$
2. PT Change Supine $\rightarrow$ Standing $\leq -13^\circ$
3. PT Change Stand $\rightarrow$ Seated $\geq 20^\circ$

established that a change in sagittal pelvic tilt of 10° will change the version of the acetabulum by approximately 7° and its inclination by approximately 3° . If the pelvis tilts posteriorly, there is increased a "safe zone" for inclination of $40^\circ \pm 10^\circ$ and for anteversion of $15^\circ \pm 10^\circ$. Despite placing components in these positions, however, dislocations continued.^{3,6}

4. Lumbar Flexion $\leq 20^\circ$
5. Advanced Age >75 Yrs – Especially In Females

proper tilt, which would be a post-operative pre-emptive strategy, which aid in predicting an ideal, patient-specific THA component position that would improve stability and limit-bearing surface wear. How patients achieve sitting position through the lumbar-pelvic-femoral complex continues to be an area of interest given the impact on functional acetabular component position following THA [3,3,7], and arthroplasty surgeons are becoming increasingly aware that previous spine surgery may be associated with poor outcomes after THA [5,8].

Sitting position can be achieved through a combination of lumbar spine segmental motions and hip motion. Patients with stiff spines have a limited change in pelvic tilt from standing to sitting.



Primary Arthroplasty Total Hip Arthroplasty in the Spinal Deformity Population: Does Degree of Sagittal Deformity Affect Rates of Safe Zone Placement, Instability, or Revision?

Edward M. DelSole, MD*, Jonathan M. Vigdorchik, MD, Ran Schwarzkopf, MD, MSc, Thomas J. Errico, MD, Aaron J. Buckland, MBBS, FRACS

Department of Orthopaedic Surgery, The Hospital for Joint Diseases, NYU Langone Medical Center, New York, New York

ARTICLE INFO ABSTRACT

6. Severe Sagittal Spinal Deformity (Pelvic Incidence – Standing LL Mismatch $\geq 20^\circ$) Have Dislocation Rate Of 8%

pelvic tilt (SPT) and, as a consequence, changes the functional position of the acetabulum. This has a direct impact on the

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to <http://dx.doi.org/10.1016/j.arth.2016.12.039>.

Investigation was performed at NYU Hospital for Joint Diseases, New York, NY.
* Reprint requests: Edward M. DelSole, MD, Department of Orthopaedic Surgery, The Hospital for Joint Diseases, NYU Langone Medical Center, 301 East 17th Street, Suite 1402, New York, NY 10003.

<http://dx.doi.org/10.1016/j.arth.2016.12.039>
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and kyphotic curvature of the spinal column, resulting in abnormal pelvic or lower extremity posturing in an attempt to regain balance [10]. The role of the pelvis in compensating for SSD is essential; as a patient's overall sagittal balance tends toward kyphosis, patients increase pelvic tilt in an effort to maintain upright posture and forward gaze [11,12]. This pelvic compensation may cause unexpected changes in cup position during transition to a standing position, leading to instability of the hip prosthesis [13].

In this study, we sought to investigate the acetabular cup position, dynamic changes in cup position, and rate of instability episodes in patients with SSD who have undergone THA. We evaluated the relationships between cup position in both the

SUMMARY: RISK FACTORS

- Stiff Lumbar Spine ($\leq 20^\circ$ Lumbar Flexion)
- Increased Age (> 75)
- Increased Standing
 - $< -10^\circ$
- Supine $\rightarrow$ Standing $> 13^\circ$
 - $\geq 10^\circ$ Functional A
- Sagittal Spine Imbal
 - Risk Increases If
- Consider Dual Mo

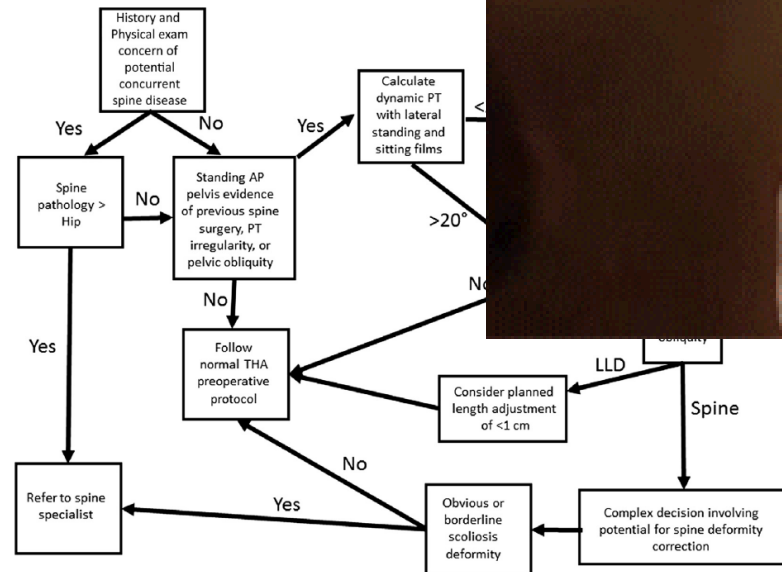


Figure 1. Recommendation of cup placement algorithm, based on Steff et al. [56].

Fig. 1. Explanation of Hip-Spine Classification and corresponding treatment recommendations. FPP, functional pelvic plane; APP, anatomic pelvic plane.

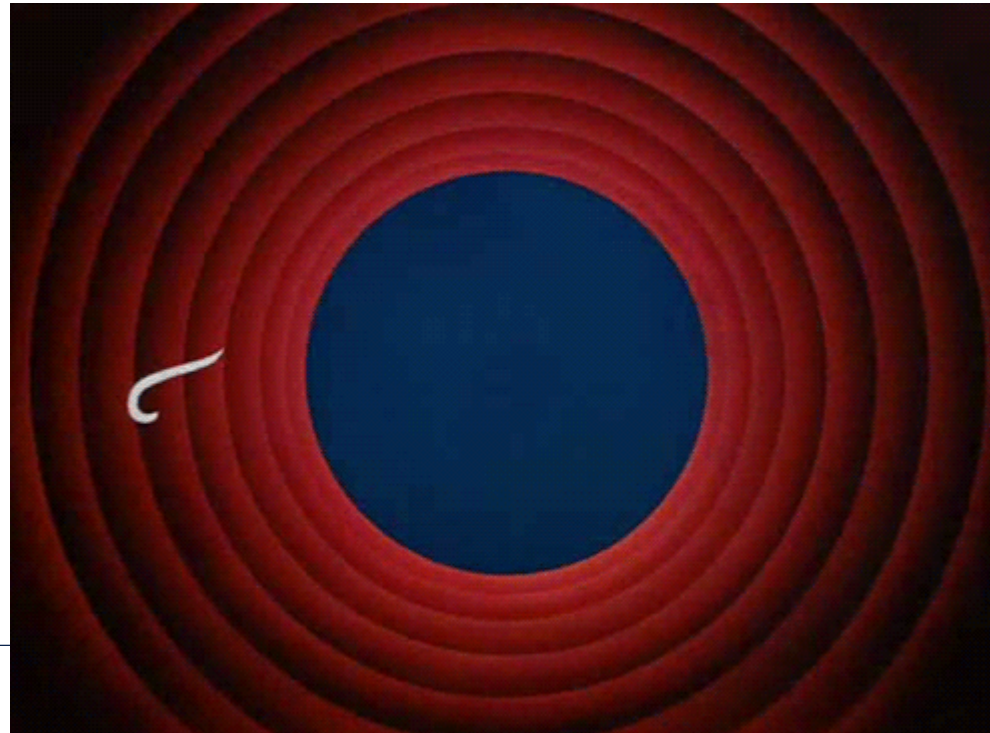
Journal of Arthroplasty 37 (2022) S540–S545

Explanation of Pathology	Treatment Recommendation
Normal Anatomy and Normal Mobility (APP similar to FPP)	Target 20°-25° anteversion from normal anatomy (to the APP)
Stiff spine, needs more anteversion relative to the APP which is similar to the FPP	Target 30° anteversion on the standing AP Pelvis (to the FPP). Note the higher target due to the stiff spine to protect from a posterior dislocation.
Be aware the FPP is different than the APP (posterior pelvic tilt from the spinal deformity causes more functional cup anteversion)	Target 25°-30° anteversion on the standing AP Pelvis (to the FPP)
2B* Flatback deformity (PI-LL>10°) Stiff Spine (<10° change in Sacral Slope from stand to sit)	FPP is different than the APP and a stiff spine, so you need more anteversion, but be aware of the reference because the spinal deformity will cause more functional cup anteversion Target 30° anteversion on the standing AP Pelvis (to the FPP). Note the higher target due to the stiff spine to protect from a posterior dislocation.



Barry “Algorithmic” Approach to Spine Patient

1. Preop standing AP pelvis (define functional plane)
2. Antevert cup from the functional plane (match the tilt)
 - 20-25 deg for anterior approach
 - 25-35 deg for posterior approach



Barry “Algorithmic” Approach to Spine Patient

*** Exception in primary posterior hips:

- Long segment fusion to pelvis (>3 levels) consider DM
- Uncoordinated frail grandma scares me way more than yoga instructor





I'm going to say the same thing
but make it more confusing

C.S. Sicat et al. / The Journal of Arthroplasty 37 (2022) S540–S545

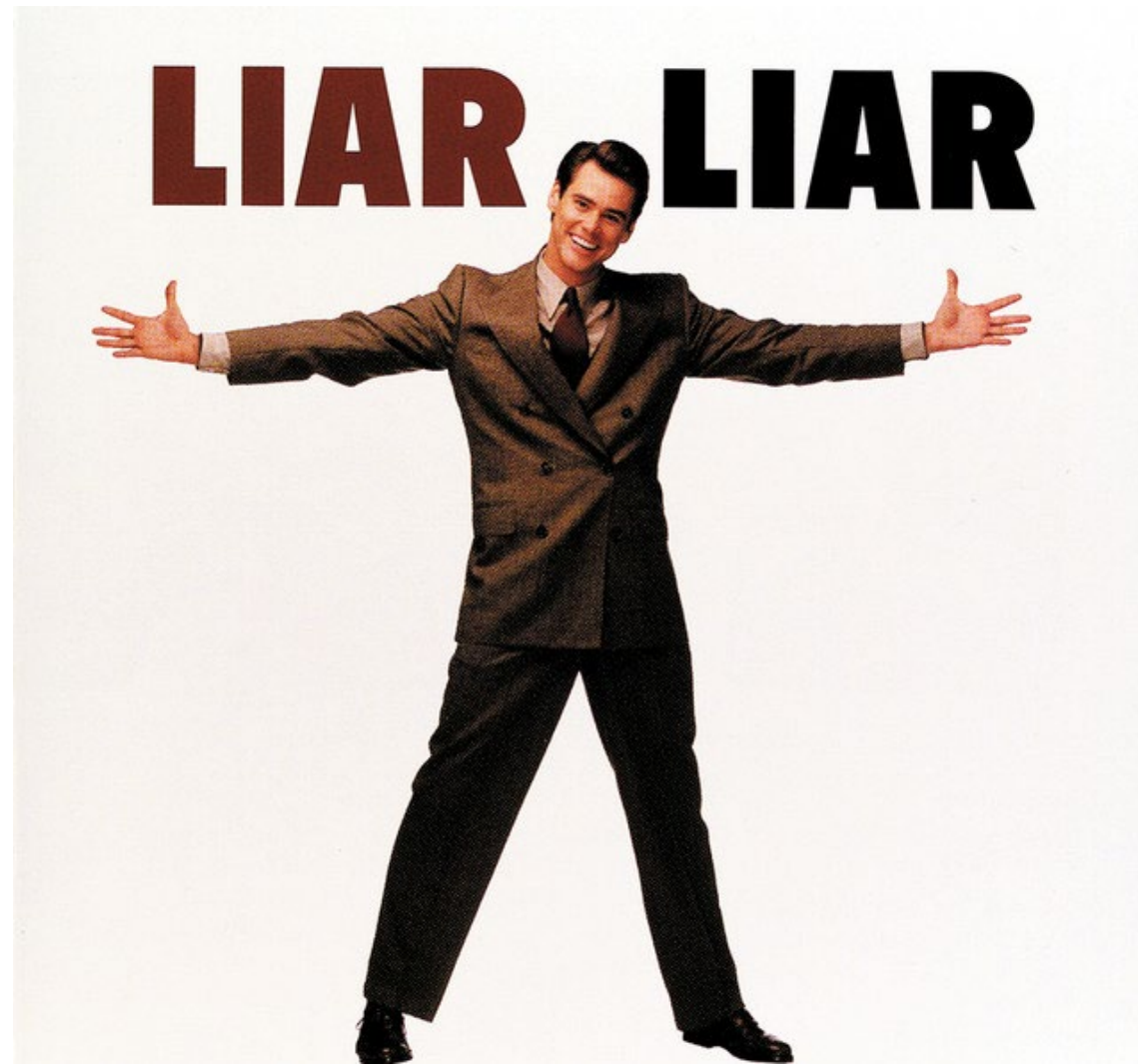
Group	Classification	Explanation of Pathology	Treatment Recommendation
1A	Normal Alignment Normal Mobility	Normal Anatomy and Normal Mobility (APP similar to FPP)	Target 20°-25° anteversion from normal anatomy (to the APP)
1B	Normal Alignment Stiff Spine ($<10^\circ$ change in Sacral Slope from stand to sit)	Stiff spine, needs more anteversion relative to the APP which is similar to the FPP	Target 30° anteversion on the standing AP Pelvis (to the FPP). Note the higher target due to the stiff spine to protect from a posterior dislocation.
2A	Flatback deformity (PI-LL $>10^\circ$) Normal Mobility	Be aware the FPP is different than the APP (posterior pelvic tilt from the spinal deformity causes more functional cup anteversion)	Target 25°-30° anteversion on the standing AP Pelvis (to the FPP)
2B*	Flatback deformity (PI-LL $>10^\circ$) Stiff Spine ($<10^\circ$ change in Sacral Slope from stand to sit)	FPP is different than the APP and a stiff spine, so you need more anteversion, but be aware of the reference because the spinal deformity will cause more functional cup anteversion	Target 30° anteversion on the standing AP Pelvis (to the FPP). Note the higher target due to the stiff spine to protect from a posterior dislocation.

1. Preop standing AP pelvis (Functional position)
2. Antevert from the functional position
 - 20-25deg for DA;
 - 25-35deg for posterior

Classification made for posterior approach

Barry Algorithm fits into every category!
(25-35deg anteversion for posterior hips to standing AP Pelvis)

Fig. 1. Explanation of Hip-Spine Classification and corresponding treatment recommendations. FPP, functional pelvic plane; APP, anatomic pelvic plane.



Jeff, you said there was no measurements. 20-25 or 25-35 how do I calculate or get there? What gives?

Math to Ignore

The Journal of Arthroplasty Vol. 19 No. 3 2004

A Simplified Method to Determine Acetabular Cup Anteversion From Plain Radiographs

Karl-Heinz Widmer, MD, Dipl Ing (TU)

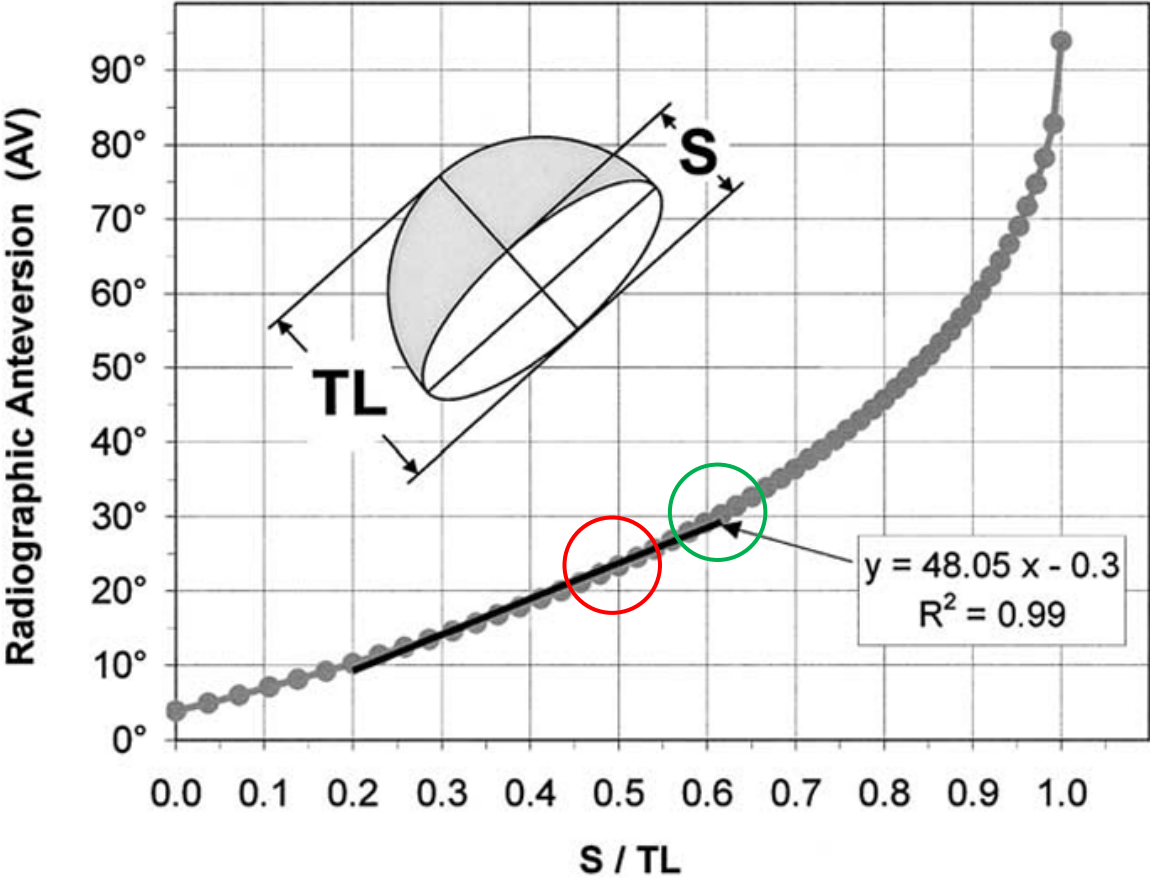


Table 1. S/TL-Ratio Versus Radiographic Cup Anteversion on a Plain Radiograph Centered on the Symphysis for 40°, 45°, 50°, and 55° Cup Inclination*

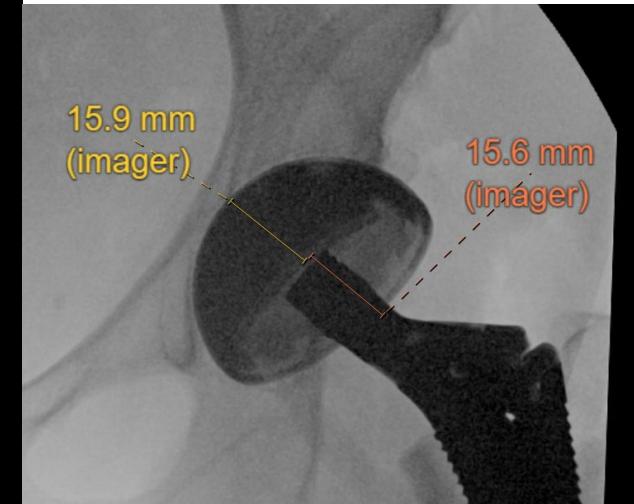
S/TL	Radiographic Cup Anteversion			
	Cup Inclination			
	40°	45°	50°	55°
0.00	3.5°	3.9°	4.2°	4.5°
0.04	4.6°	5.0°	5.2°	5.5°
0.07	5.6°	6.0°	6.3°	6.6°
0.11	6.7°	7.1°	7.4°	7.7°
0.14	7.8°	8.1°	8.4°	8.7°
0.17	8.8°	9.2°	9.5°	9.8°
0.20	9.9°	10.3°	10.6°	10.8°
0.23	11.0°	11.3°	11.6°	11.9°
0.26	12.0°	12.4°	12.7°	13.0°
0.29	13.1°	13.5°	13.8°	14.1°
0.31	14.2°	14.6°	14.9°	15.1°
0.34	15.3°	15.7°	15.9°	16.2°
0.36	16.3°	16.7°	17.0°	17.3°
0.39	17.4°	17.8°	18.1°	18.4°
0.41	18.5°	18.9°	19.2°	19.5°
0.43	19.6°	20.0°	20.3°	20.6°
0.46	20.7°	21.1°	21.4°	21.7°
0.48	21.9°	22.2°	22.5°	22.8°
0.50	23.0°	23.4°	23.7°	23.9°
0.52	24.1°	24.5°	24.8°	25.1°
0.54	25.2°	25.6°	25.9°	26.2°
0.56	26.4°	26.8°	27.1°	27.4°
0.58	27.6°	27.9°	28.2°	28.5°
0.60	28.7°	29.1°	29.4°	29.7°
0.62	29.9°	30.3°	30.6°	30.9°
0.63	31.1°	31.5°	31.8°	32.0°
0.65	32.3°	32.7°	33.0°	33.3°
0.67	33.5°	33.9°	34.2°	34.5°
0.68	34.7°	35.1°	35.4°	35.7°
0.70	36.0°	36.4°	36.7°	37.0°
0.71	37.3°	37.6°	37.9°	38.2°
0.73	38.5°	38.9°	39.2°	39.5°
0.74	39.9°	40.2°	40.5°	40.8°

Anteversion from Projection

SET FUNCTIONAL PELVIC PLANE
(MATCH STANDING AP INLET/OUTLET APPEARANCE)

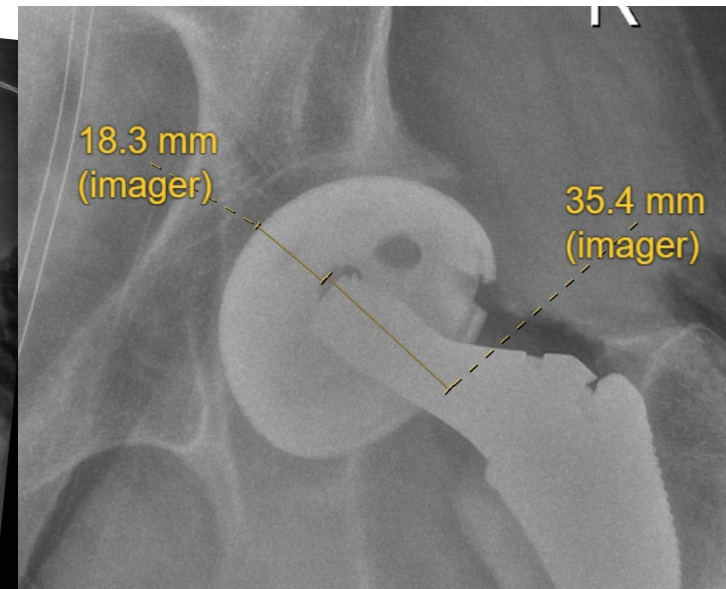
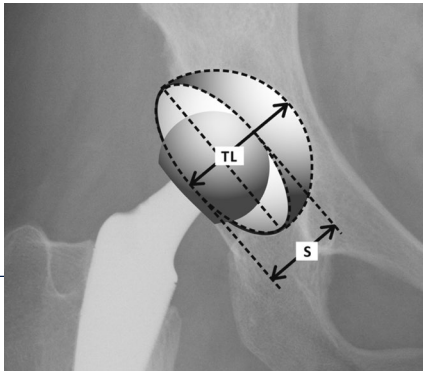
Anterior Approach

Solid to Open 50/50 – 1:1
= ~23deg anteversion

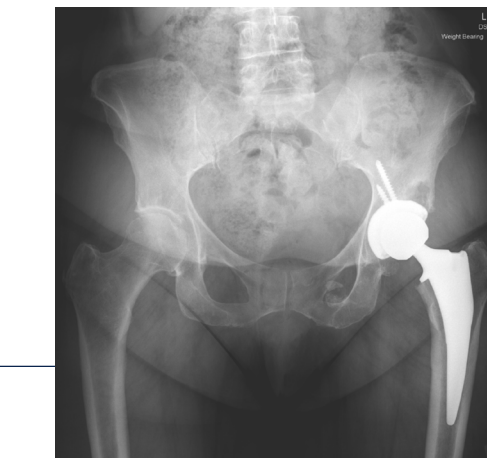
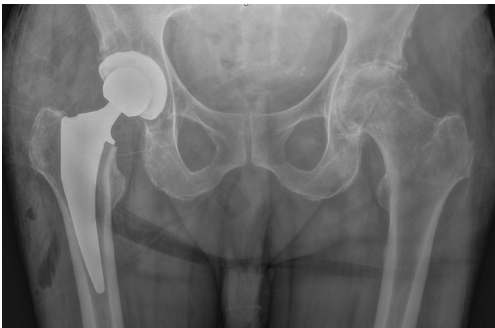
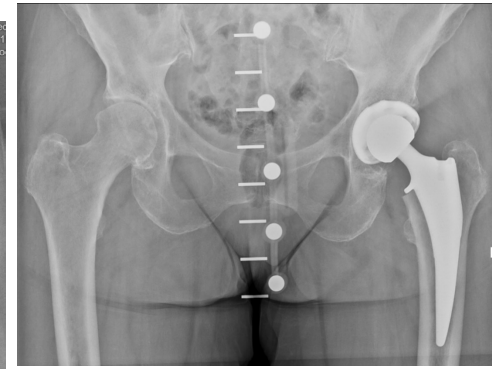
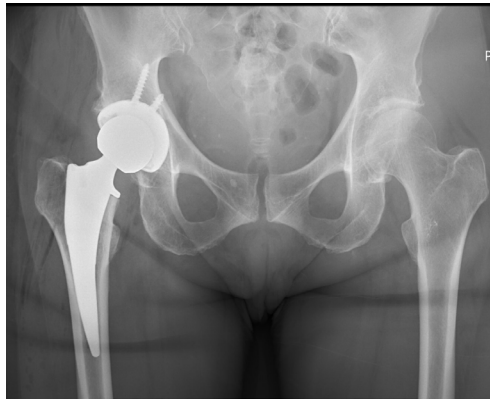


Posterior Approach

Solid to Open 33/66 or 1:2
= ~32deg anteversion



Reproducible



Why This Works!!!!

Instability is not JUST cup position

- Component(S) position – femoral version matters as much as cup
- Impingement source
 - USUALLY SOFT TISSUE OR TROCH ON PELVIS
NOT NECK ON CUP!!!
- Anatomy restoration
- Other (spine, muscle quality, abductor insufficiency, FNF or AVN, dementia)
- Approach



Approach and Instability

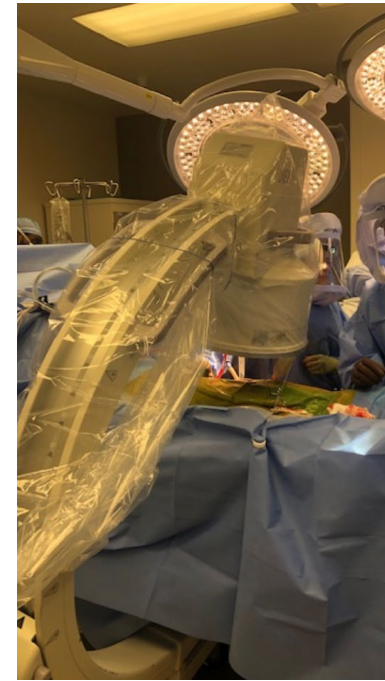
- DA is not DA is not DA....
 - PRESERVE THE POSTERIOR CAPSULE AND ITS HARD TO COME OUT THE BACK!!!
 - DON'T do inferior episiotomy
 - Repair anterior capsule
 - Minimize femoral releases (table is your best instrument)
 - Recreate native offset
 - Anterior positions of instability are unnatural

Approach and Instability

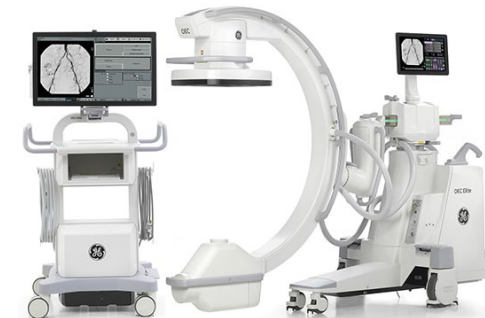
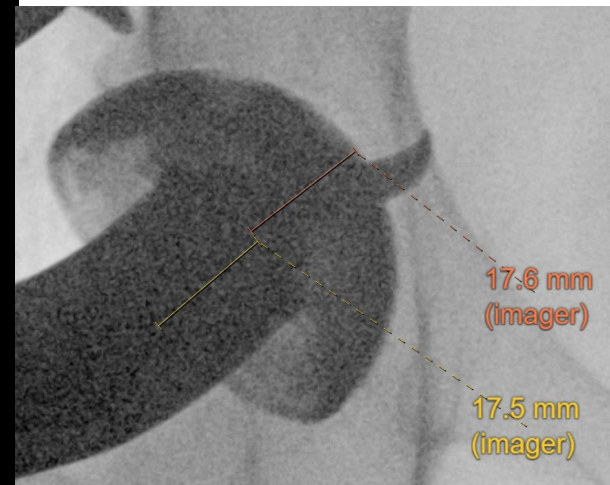
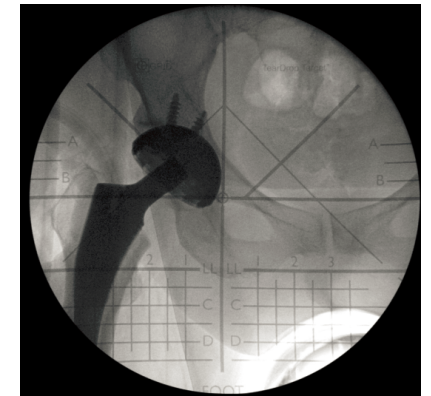
- Posterior approach
 - Template to restore anatomy
 - can augment with robot or navigation if not confident
 - Trial to determine instability sources
 - Troch vs hypertrophic capsule vs thigh on belly vs implant impingement (RARE)
 - Repair posterior capsule when able
 - Intraoperative xray MATCHING STADNING before finalizing cup

DA Advantage = Fluoro Advantage!!!

- Match fluoro plane to standing view (add ~10deg outlet) (Roettes JoA 2018)
- Center over the cup to avoid parallax in old c-arm
 - Square intensifier = vascular = no parallax
 - Round intensifier = parallax susceptible
 - (test with metal rod if not sure)
- 50/50 Open/Closed in the functional positional

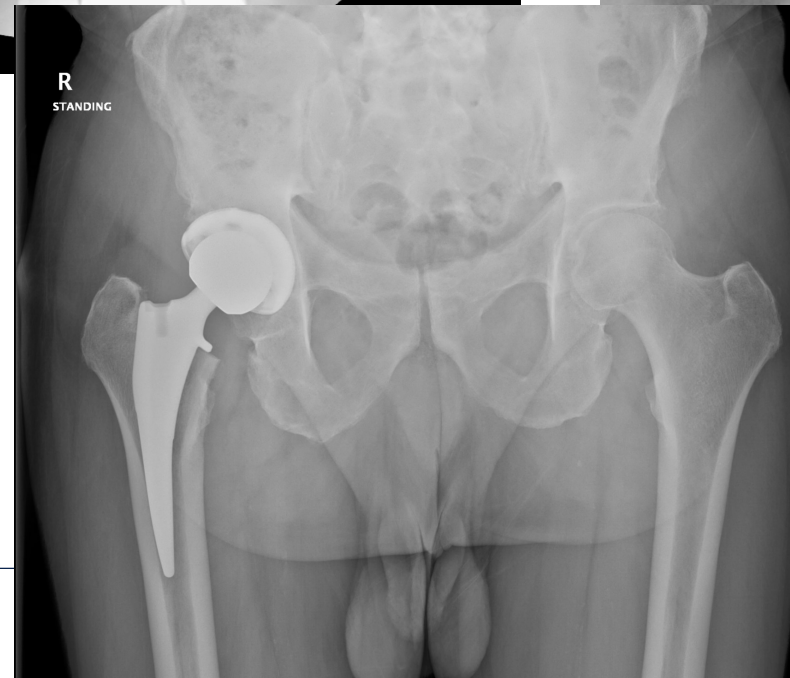
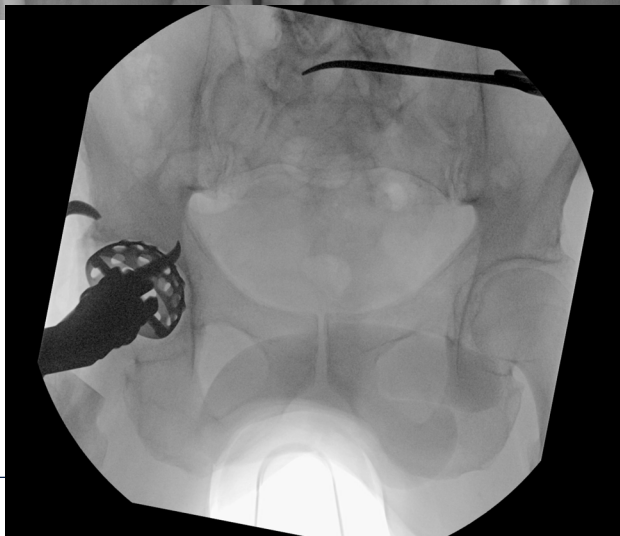
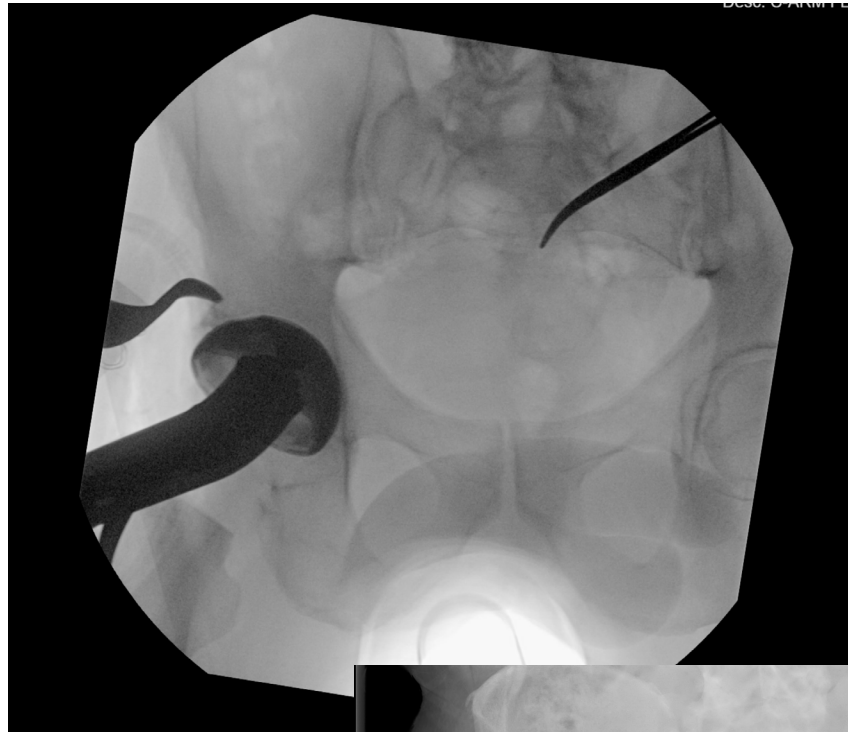


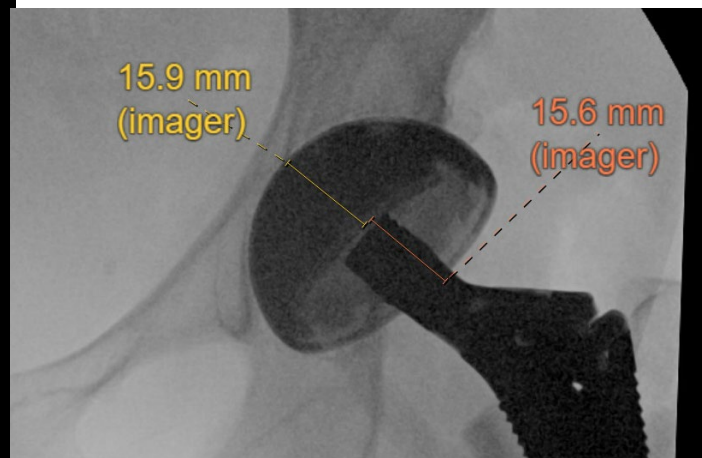
NOTE** if not a vascular style digital c-arm center your arm over the area of interest (ie cup during insertion)



Conclusions

- Acetabular position is a dynamic measure based on pelvic position
- Standing AP Pelvis tells you all you need to know about the spine
 - FUNCTIONAL PELVIC CUP POSITIONING (and anterior approach) will keep you safe
- Intraop Targets based on the FUNCTIONAL POSITION (Standing AP Pelvis Match)
 - Anterior – 50/50 cup
 - Posterior – 66/33 cup
- Anterior surgeons – go back to ignoring spine
- Posterior surgeons – go back to ignoring spine (except when you see lots of hardware)
 - DM judiciously



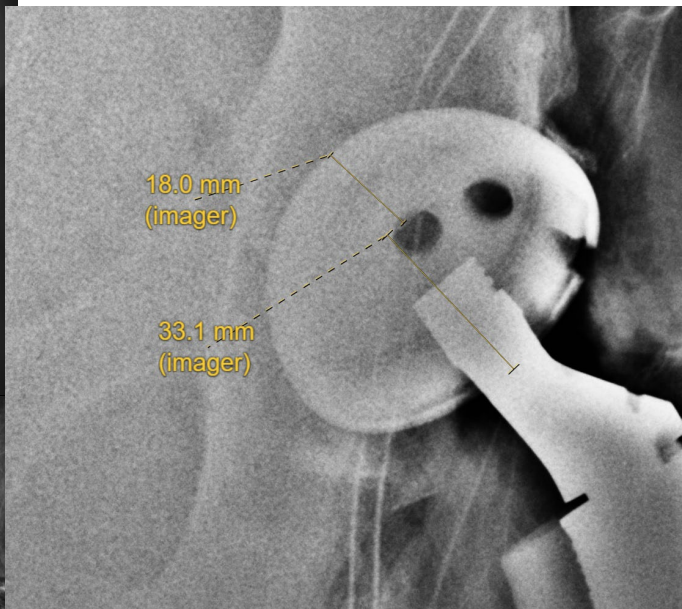




ms/dr



LT
AP WB



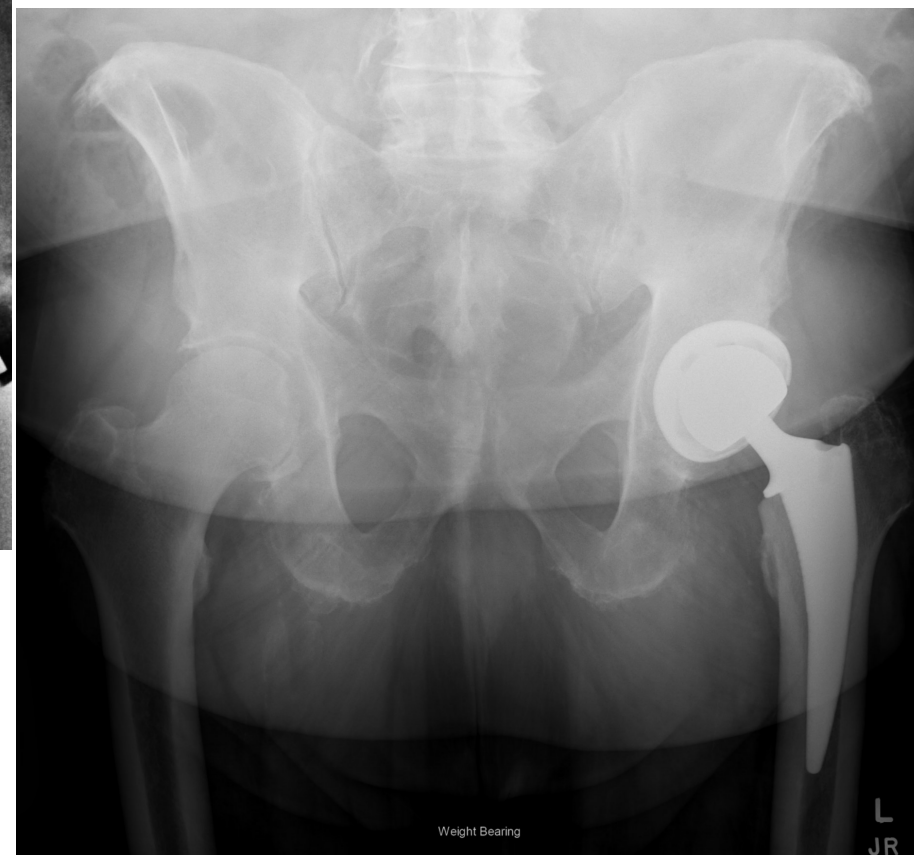
18.0 mm
(imager)

33.1 mm
(imager)



R

CROSS-TABLE



Weight Bearing

L
JR



UCSF

University of California
San Francisco

