Advancing the Anatomical, Biomechanical and Clinical Understandings of the Hip Spine Si Pelvic Core

PAOs

Phoenix Arizona

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Disclosure Slide

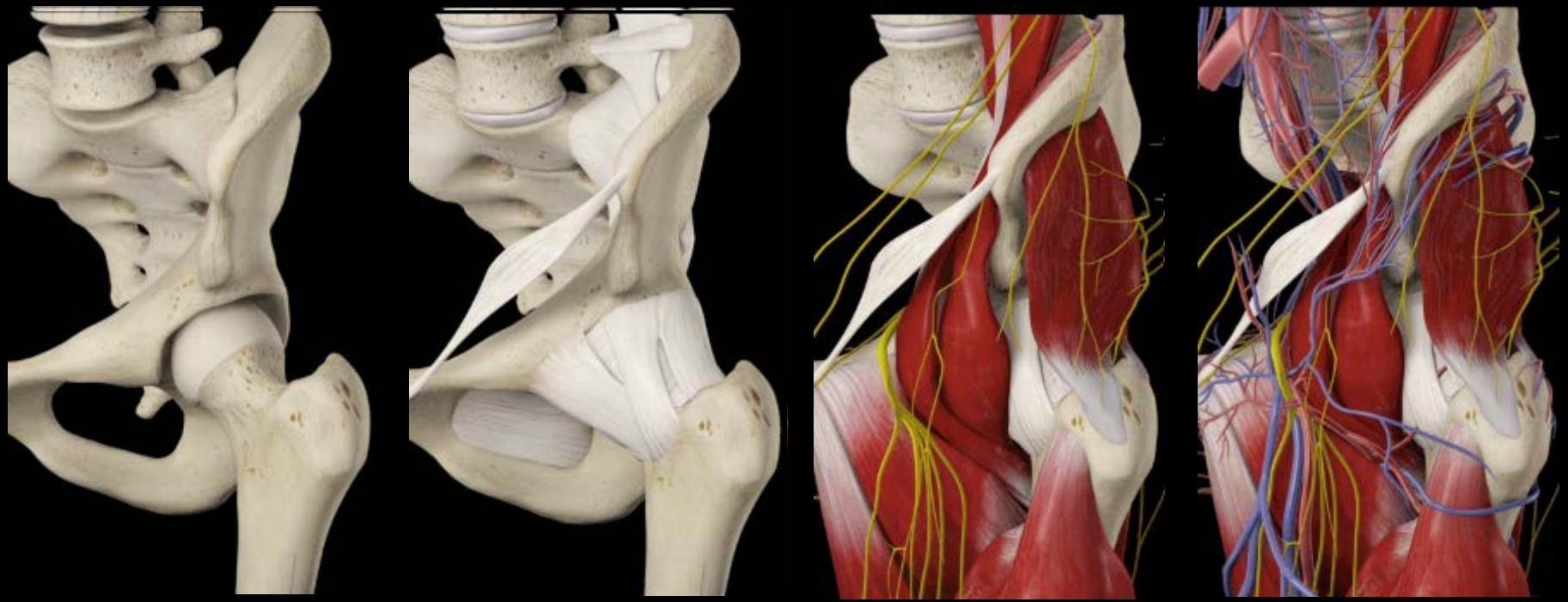
Consultant SI Bone

Presentation does not reflect policies of
Baylor University Medical Center

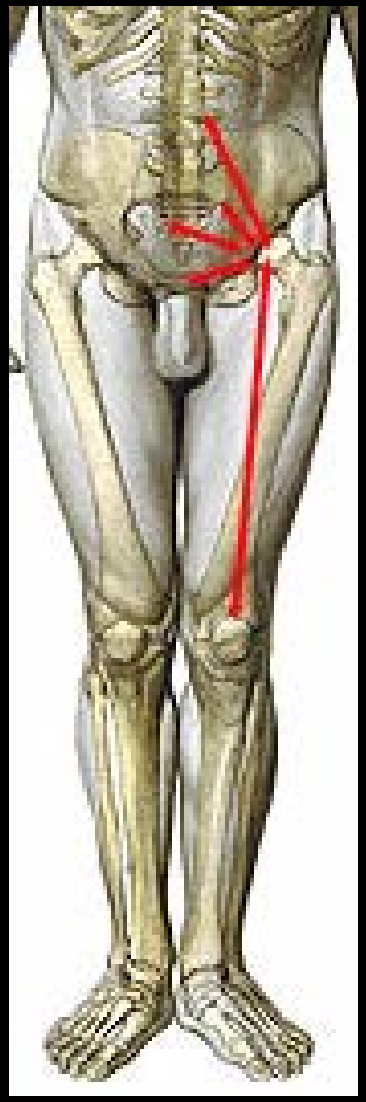
Introduction

- Low back pain is a significant societal problem
  - More than 80% of the population will complain of lower back pain
  - Low back pain symptoms are 2nd leading cause of primary physician consultations
  - Most frequently evaluated by Orthopaedic Surgeons and Neurosurgeons
  - 485 new patient for hip preservation issue ---→ 64% w back pain marked on intake form
- Estimate of 1,500,000 lumbar spine MRI's performed annually in USA
  - 87% are negative for spine pathology
    - Where does the pain originate?

A complete hip evaluation ???



Not really…….



Osseous Layer and Kinematic Chain

Cascade of pathology

Osseous pain with PROM

at end range motion

abnormal ROM

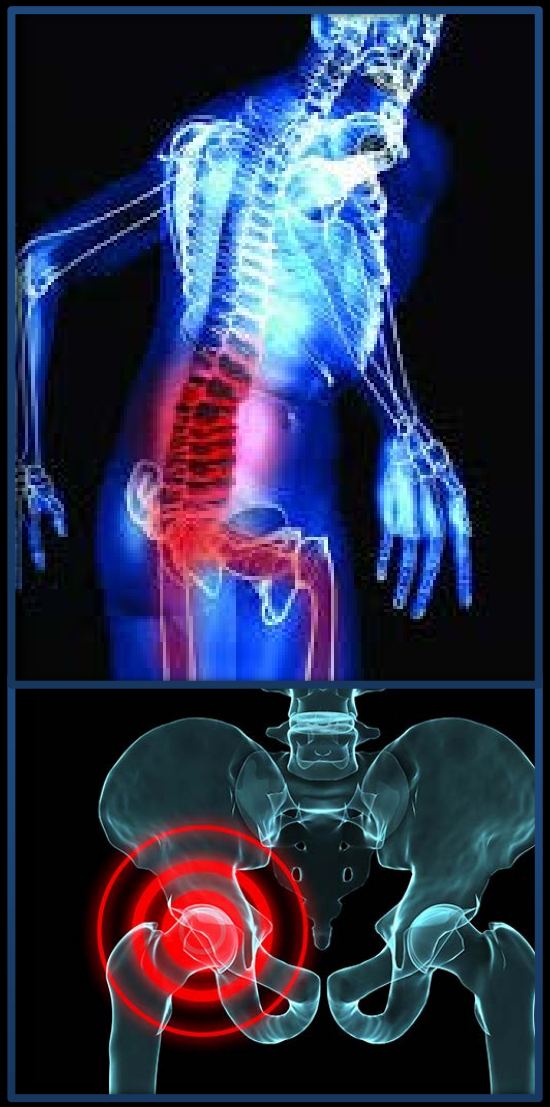
IN THREE PLANES!

Capsulolabral Laxity / Impingement

Musculotendinous Weakness Contractures

Neuro-Vascular

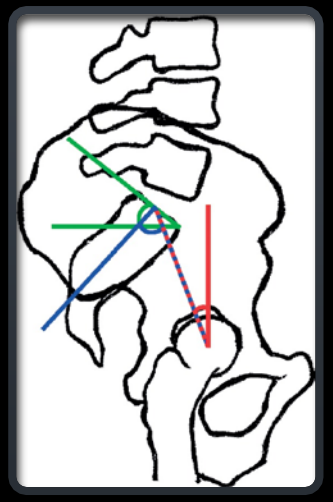
Kinematic Chain (spine/SI) Effects



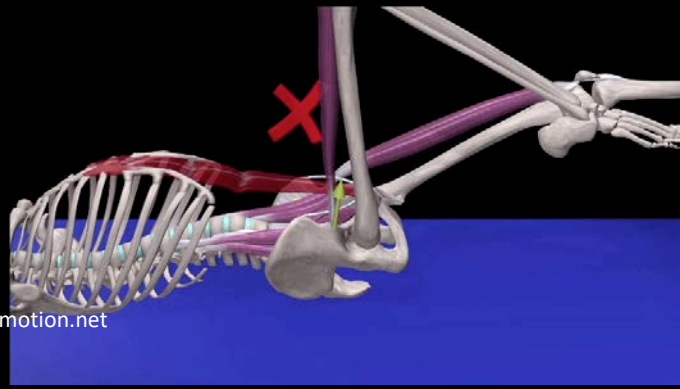
Spine-Hip Relation

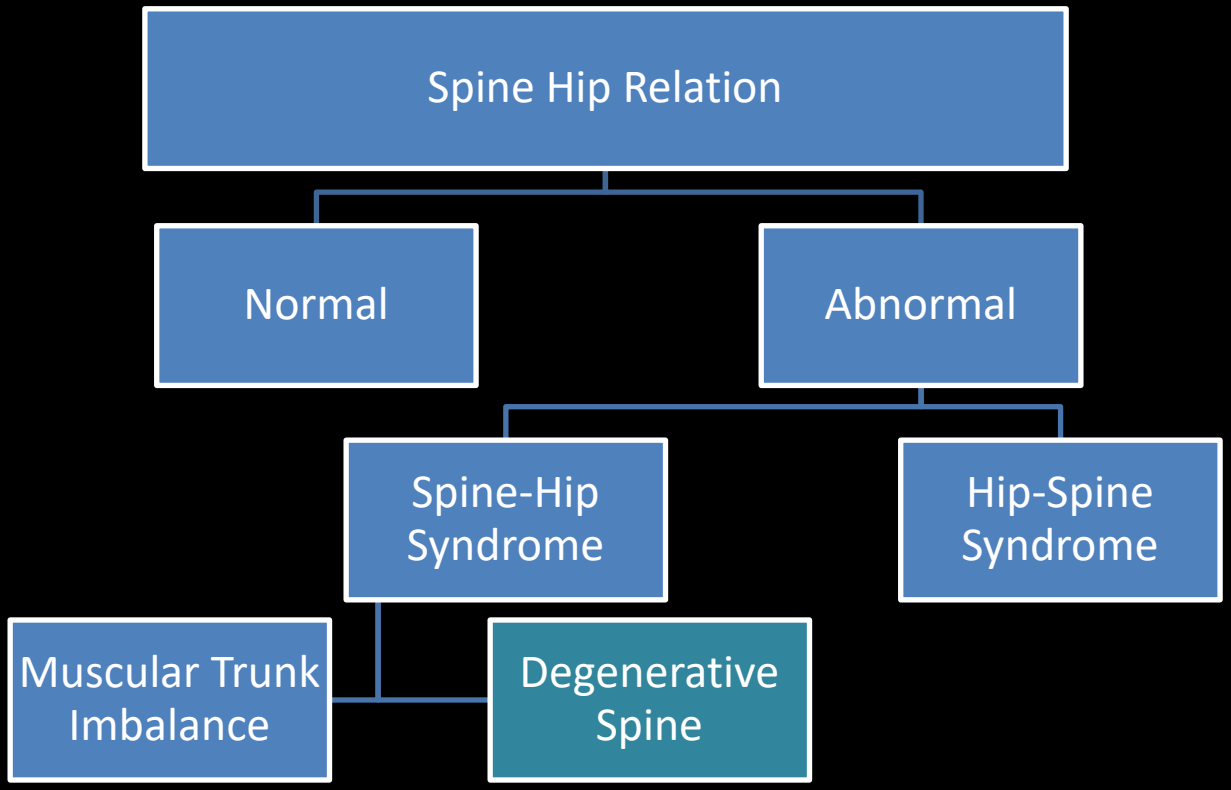
- Pathology of the hip Joint Can Clinically Impact the Lumbosacral Spine and Vice Versa (Reviere, 2018)

Abnormal Spine-Hip Relation

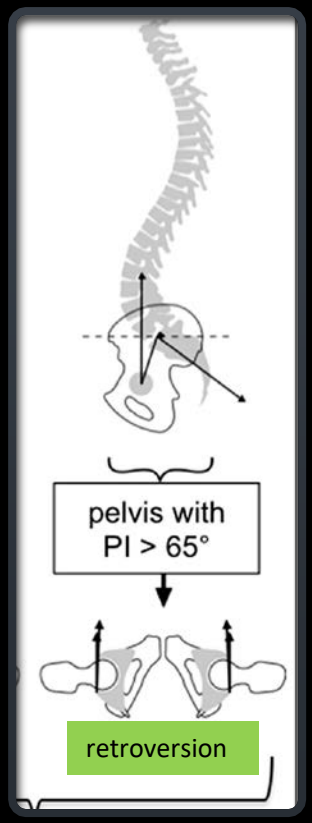


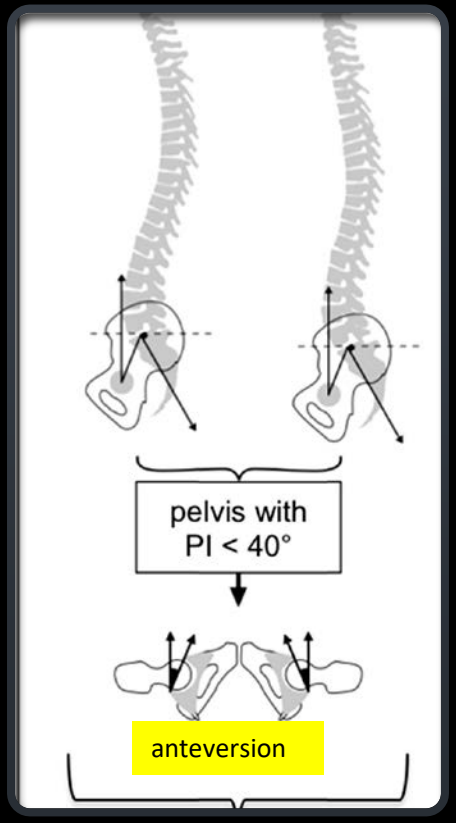
- When one of these anatomical structures becomes dysfunctional, a clinically deleterious compensatory mechanism is often initiated by the other
- Two Types
  - Hip-Spine Syndrome: Dysfunction of the hip Joint leads to Lumbosacral Pathology
  - Spine-Hip Syndrome: Dysfunction of the Lumbosacral Spine that leads to Hip Joint Pathology





- Older
- **Loss of Lordosis**
- **Rigid Posterior Pelvic Tilt**
- Forward head
- Hypomobile Pelvic Tilt ROM
- + FABER
- Global strength deficits
- Poor balance



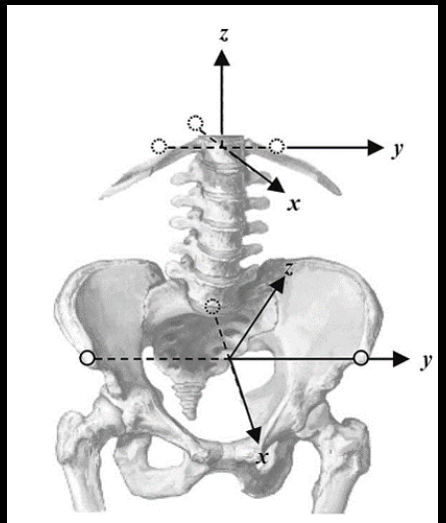


Spine-Hip Syndrome

- The Lumbopelvic Complex won't move
  - Poor Active movement patterns
- The Lumbopelvic Complex can't move
  - Hypomobility

Lumbo-pelvic Interactions

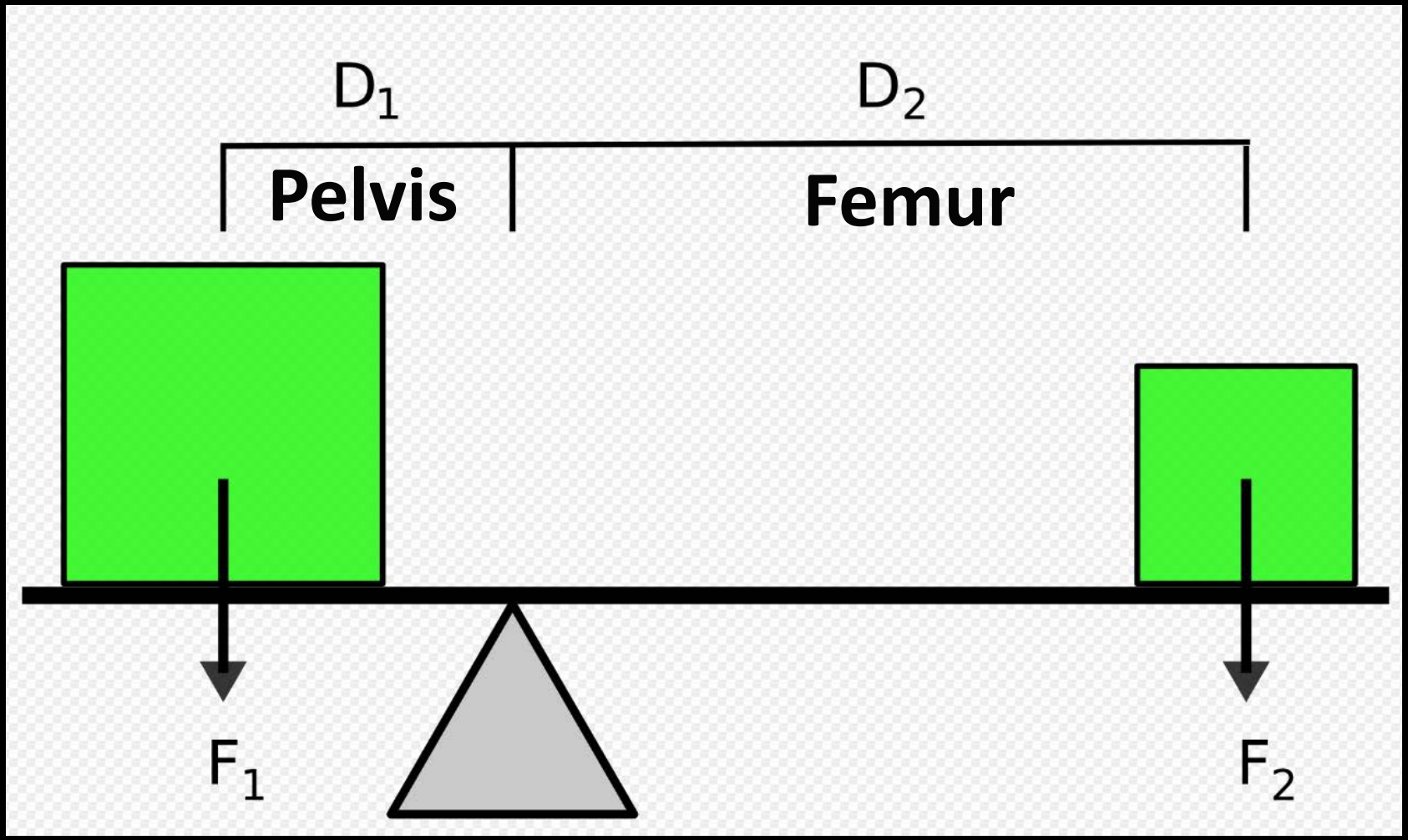
- Intricated nature of the lumbo-pelvic complex
- How does abnormal hip anatomy affect this?
  - Extension
    - Ischiofemoral Impingement
    - Increased / Decreased femoral version
    - Posterior impingement i.e Coxa Profunda, Acetabular Version
  - Flexion
    - Cam-type FAI
    - Pincer anterior



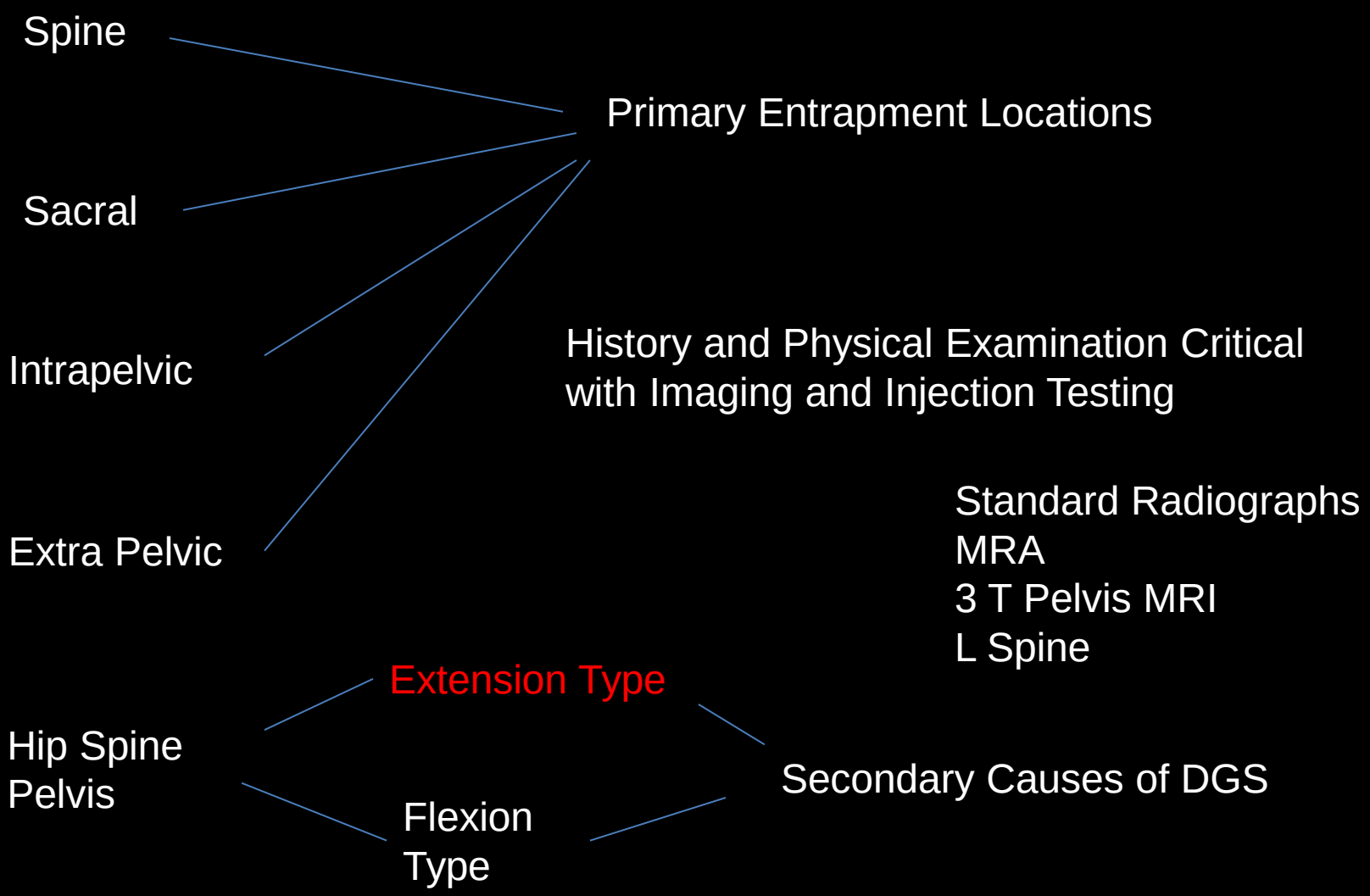
Hip-Spine Syndrome

1. *Limited hip motion in extension*
1.1 Ischiofemoral impingement
1.2 Anterior capsular hip contracture
1.3 Quadricep contracture
2. *Limited hip motion in flexion*
2.1. Anterior hip impingement
2.1.a. Pincer-type
2.1.b. Cam-type
2.1.c. Mixed-type
2.1.d. Subspinous
2.2 Posterior hip capsular contracture
2.3 Hamstring contracture
3. *Flexion and extension hip-spine*
3.1 Abnormal femoral neck version
3.2 Abnormal pelvic tilt
3.3 Hip osteoarthritis

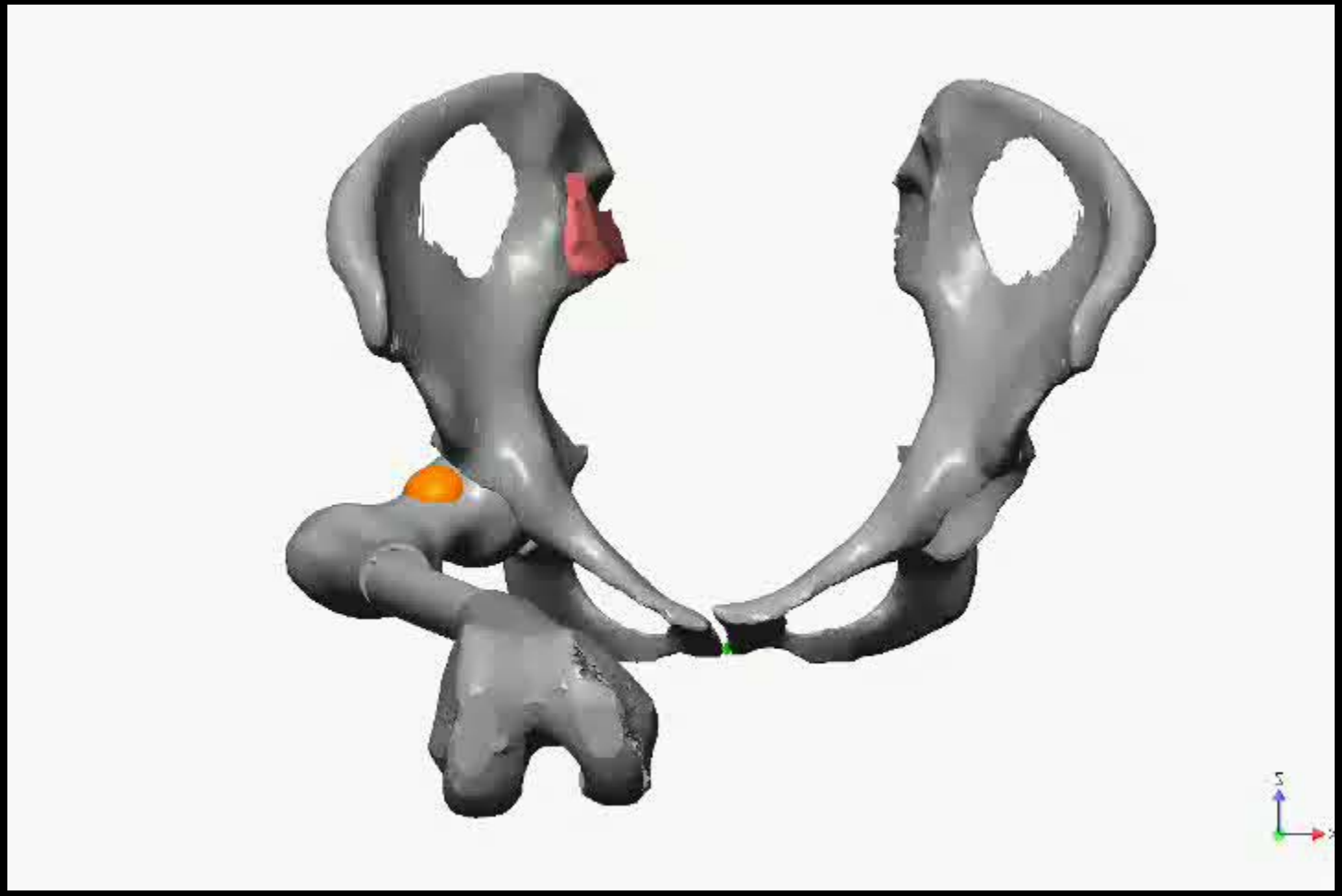
Hip-spine-pelvis-CORE



Sorting Posterior Hip Pathologies



From Marc Safran MD



Hip Spine Connection

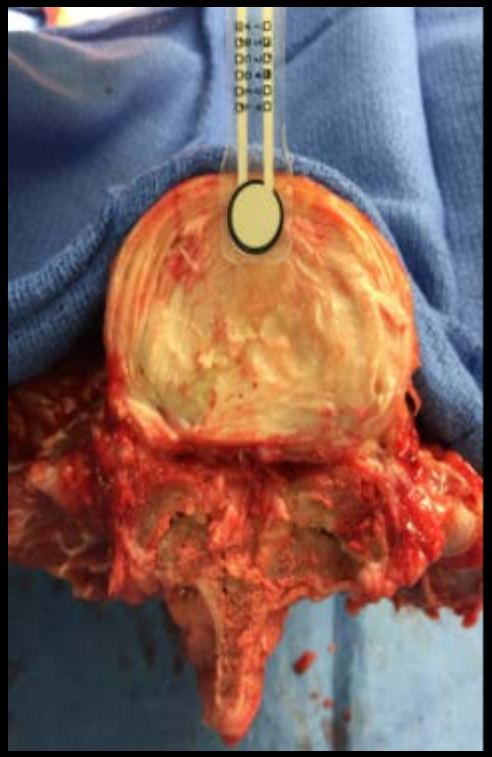
- Significant correlation between Cam type impingement (Alpha angle and Anterior femoral neck Offset) and Spinal Osteoarthritis (Gebhart, 2016)
- Patients with Low Back Pain and positive exam findings for hip pathology have greater pain and impaired function (Prather, 2017)
- Patients that receive Spinal Surgery first have poor outcomes following total hip arthroplasty (Eneqvist, 2017)
- Addressing the hip pathology first may be associated with improved functional outcome(Grammatopoulos, 2018)
- After THR, a relief of both hip and low back pain and a change in spinopelvic parameters is observed. (Piazzolla, 2018)
- Both LBP and spinal function were improved following Total Hip arthroplasty (Ben-Galim 2007)

Simulated Cam - Spine

Simulated Cam - Spine

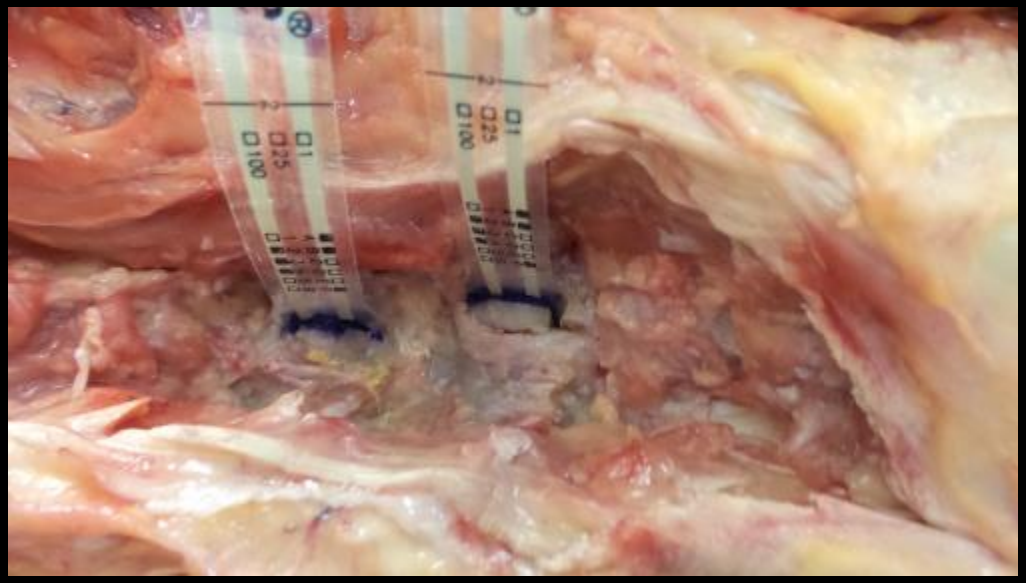
Limited motion in Flexion - Spine

Khoury A, Gomez-Hoyos J, Yeramaneni S, Martin HD. Biomechanical effect of anterior hip impingement on lumbar intradiscal pressure. Santiago: International Society for Hip Arthroscopy; 2017.

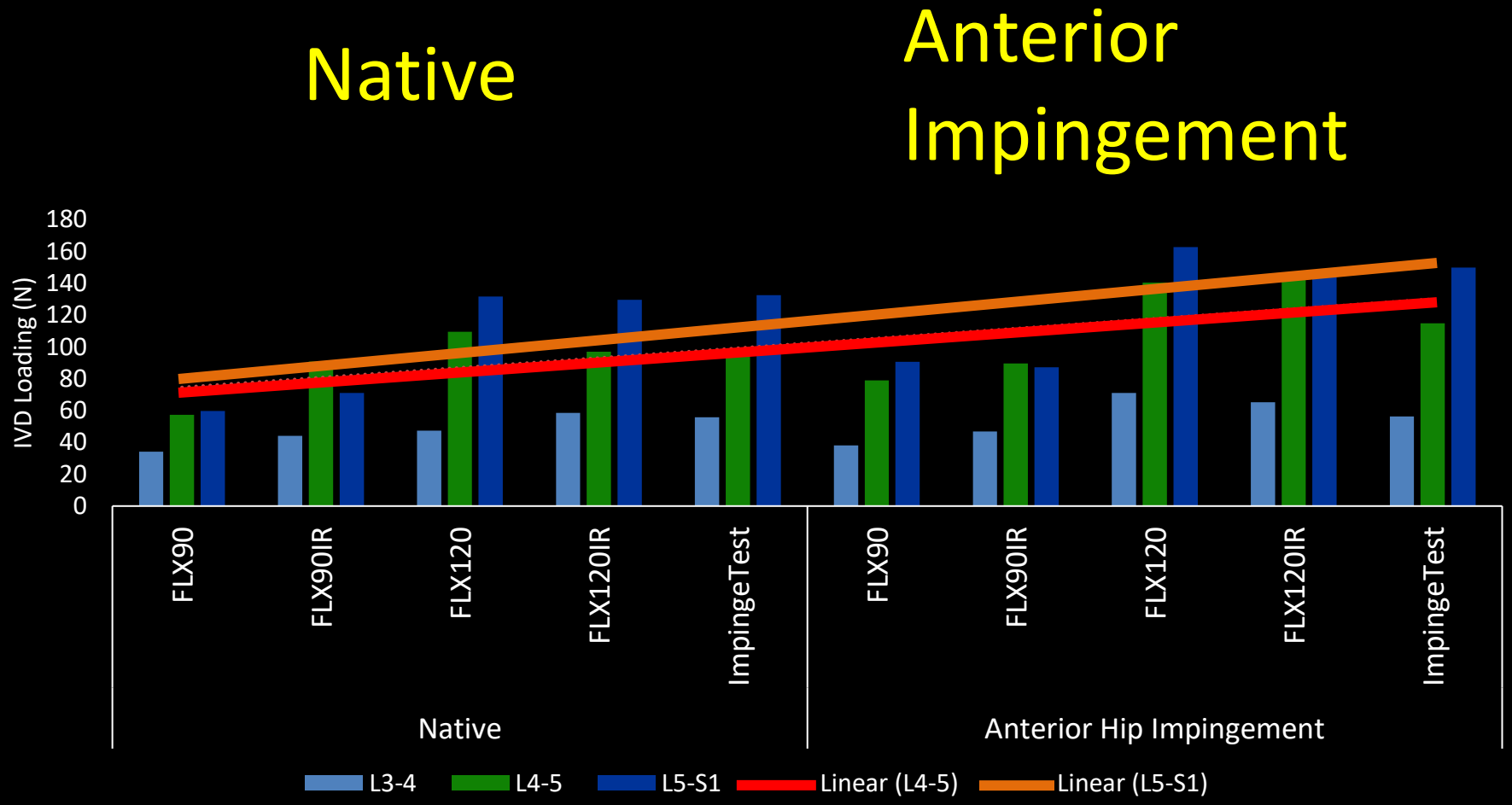


The Hip Spine Effect

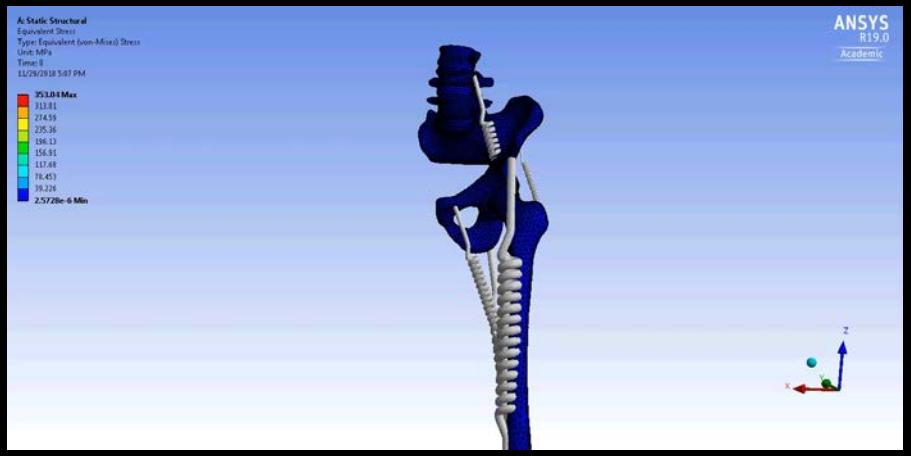
Abnormal excessive and decreased femoral version affecting intra-facets joint pressure

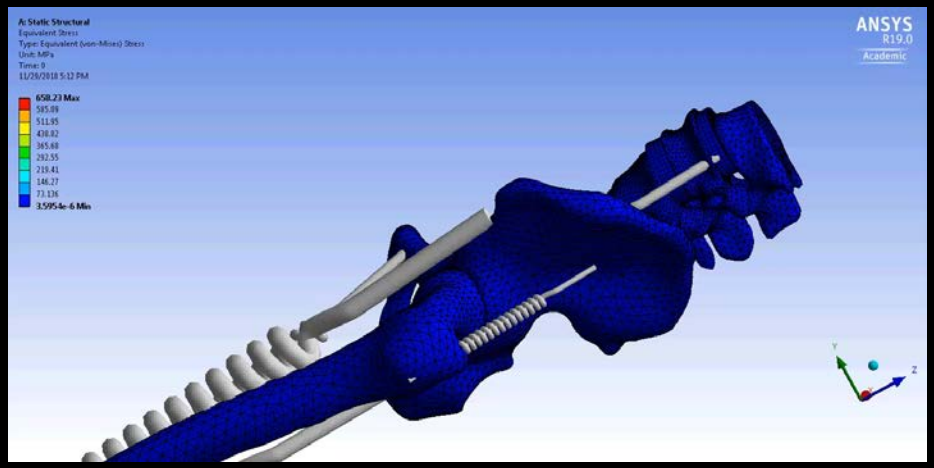


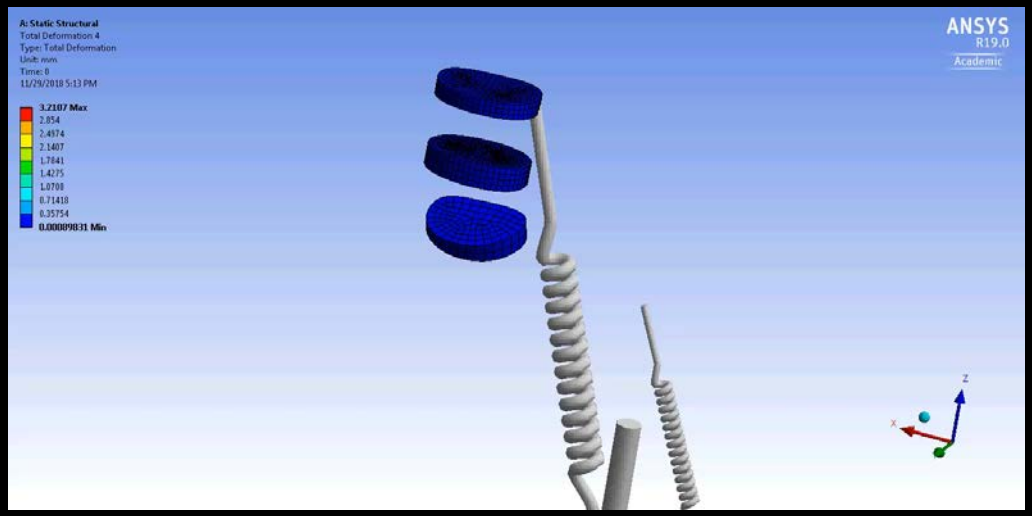
Khoury A, Gomez-Hoyos J, Yeramaneni S, Martin HD. Biomechanical effect of anterior hip impingement on lumbar intradiscal pressure. Santiago: International Society for Hip Arthroscopy; 2017.



Cam-FAI Hip-Spine Effect (finite element)







Hip extension X low back function

- 476 individuals with low back pain
- Hip extension influences more low back function than flexion and rotation

Mellin G. Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients. *Spine (Phila Pa 1976)*. 1988;13(6):668-70.

Femoral torsion abnormalities

Limited Hip IR ----- Low back pain

Spine (Phila Pa 1976). 1988 Jun;13(6):668-70.

Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients.

Mellin G[1].

Hum Mov Sci. 2002 Oct;21(4):481-94.

Relationship between the movements of the lumbar spine and hip.

Lee RY[1], Wong TK.

Int J Sports Phys Ther. 2015 Feb;10(1):13-20.

Passive hip range of motion is reduced in active subjects with chronic low back pain compared to controls.

Roach SM[1], San Juan JG[2], Suprak DN[3], Lyda M[1], Bies AJ[4], Boydston CR.

J Orthop Sports Phys Ther. 2017 Mar;47(3):163-172. doi: 10.2519/jospt.2017.6567. Epub 2017 Feb 3.

Hip and Lumbar Spine Physical Examination Findings in People Presenting With Low Back Pain, With or Without Lower Extremity Pain.

Prather H, Cheng A, Steger-May K, Maheshwari V, Van Dillen L.

Limited flexo-extension - Low back pain

Spine (Phila Pa 1976). 1983 Apr;8(3):316-21.

Hip-spine syndrome.

Offierski CM, MacNab I.

Spine (Phila Pa 1976). 1988 Jun;13(6):668-70.

Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients.

Mellin G[1].

Eur J Orthop Surg Traumatol. 2015 Aug;25(6):1061-8. doi: 10.1007/s00590-015-1603-8. Epub 2015 Feb 12.

Measuring extension of the lumbar-pelvic-femoral complex with the EOS® system.

Lazennec JY[1], Brusson A, Folinais D, Zhang A, Pour AE, Rousseau MA.

Orthop Traumatol Surg Res. 2017 Jun;103(4):559-568. doi: 10.1016/j.otsr.2017.02.014. Epub 2017 Apr 1.

The influence of spine-hip relations on total hip replacement: A systematic review.

Rivière C[1], Lazennec JY[2], Van Der Straeten C[3], Auvinet E[3], Cobb J[3], Muirhead-Allwood S[4].

Limited Hip IR ----- CORE injury

J Sci Med Sport. 2007 Dec;10(6):463-6. Epub 2007 Mar 1.

Hip joint range of motion restriction precedes athletic chronic groin injury.

Verrall GM[1], Slavotinek JP, Barnes PG, Esterman A, Oakeshott RD, Spriggins AJ.

Am J Sports Med. 2012 May;40(5):1113-8. doi: 10.1177/0363546512437723. Epub 2012 Mar 5.

The effect of dynamic femoroacetabular impingement on pubic symphysis motion: a cadaveric study.

Birmingham PM[1], Kelly BT, Jacobs R, McGrady L, Wang M.

Arthroscopy. 2012 Oct;28(10):1388-95. doi: 10.1016/j.arthro.2012.02.024. Epub 2012 May 19.

High incidence of athletic pubalgia symptoms in professional athletes with symptomatic femoroacetabular impingement.

Hammoud S[1], Bedi A, Magennis E, Meyers WC, Kelly BT.

Limited Hip IR ----- ACL tear

Arthroscopy. 2008 Sep;24(9):1034-7. doi: 10.1016/j.arthro.2008.05.012.

Decreased hip range of motion and noncontact injuries of the anterior cruciate ligament.

Gomes JL[1], de Castro JV, Becker R.

Knee Surg Sports Traumatol Arthrosc. 2010 Nov;18(11):1562-7. doi: 10.1007/s00167-010-1175-4. Epub 2010 Jun 19.

Radiographic findings in restrained hip joints associated with ACL rupture.

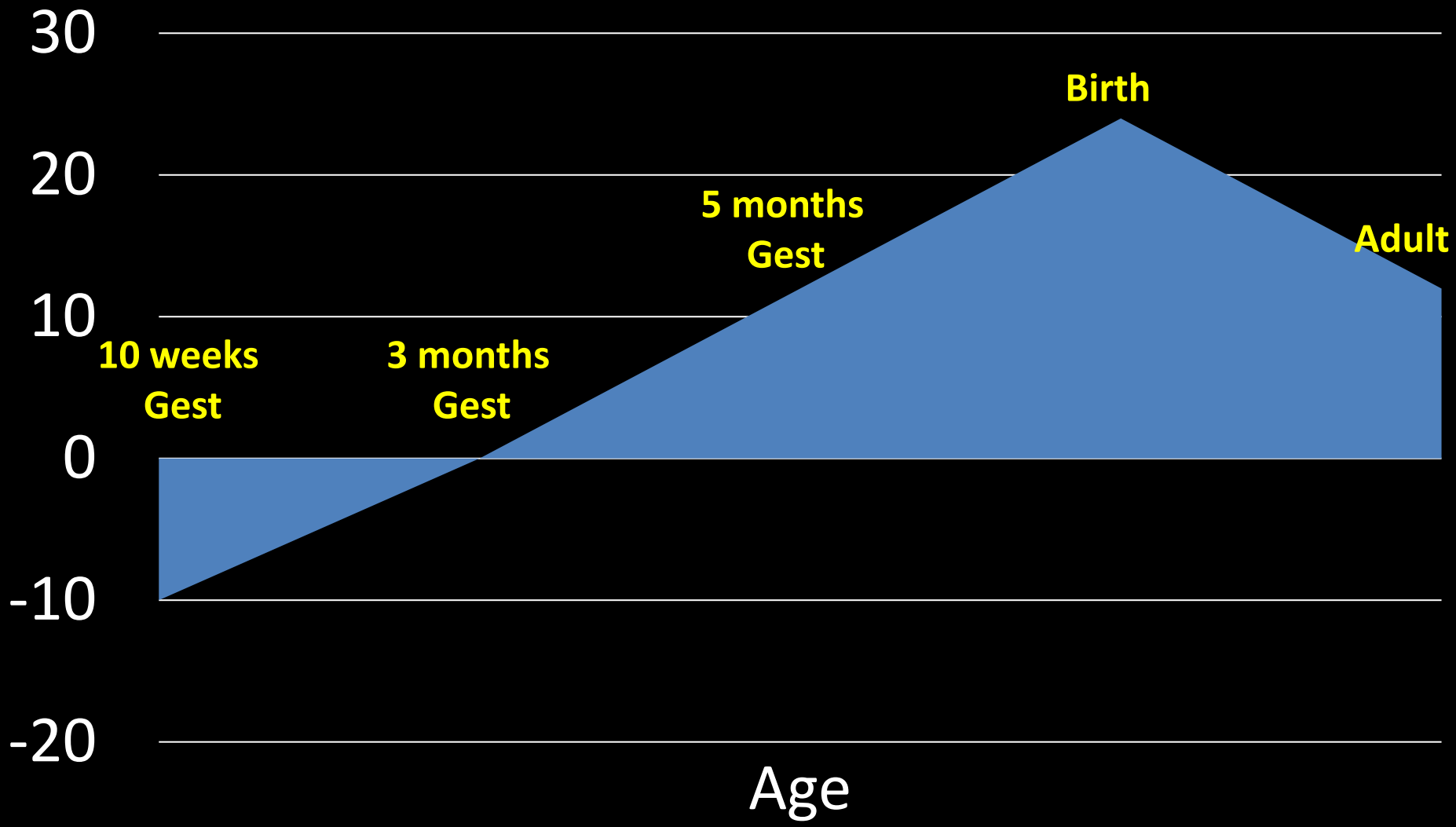
Ellera Gomes JL[1], Palma HM, Becker R.

Knee Surg Sports Traumatol Arthrosc. 2016 Jun;24(6):2024-31. doi: 10.1007/s00167-014-3299-4. Epub 2014 Sep 11.

Restriction in hip internal rotation is associated with an increased risk of ACL injury.

Bedi A[1], Warren RF[2], Wojtys EM[3], Oh YK[4], Ashton-Miller JA[4], Oltean H[3], Kelly BT[2].

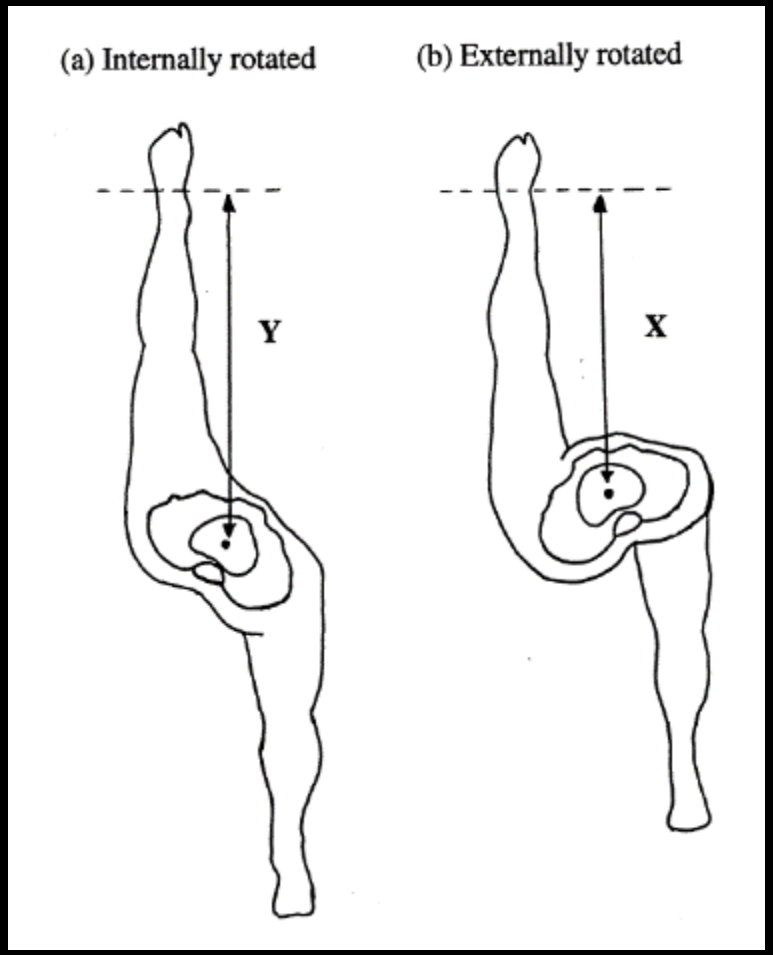
Proximal femoral version

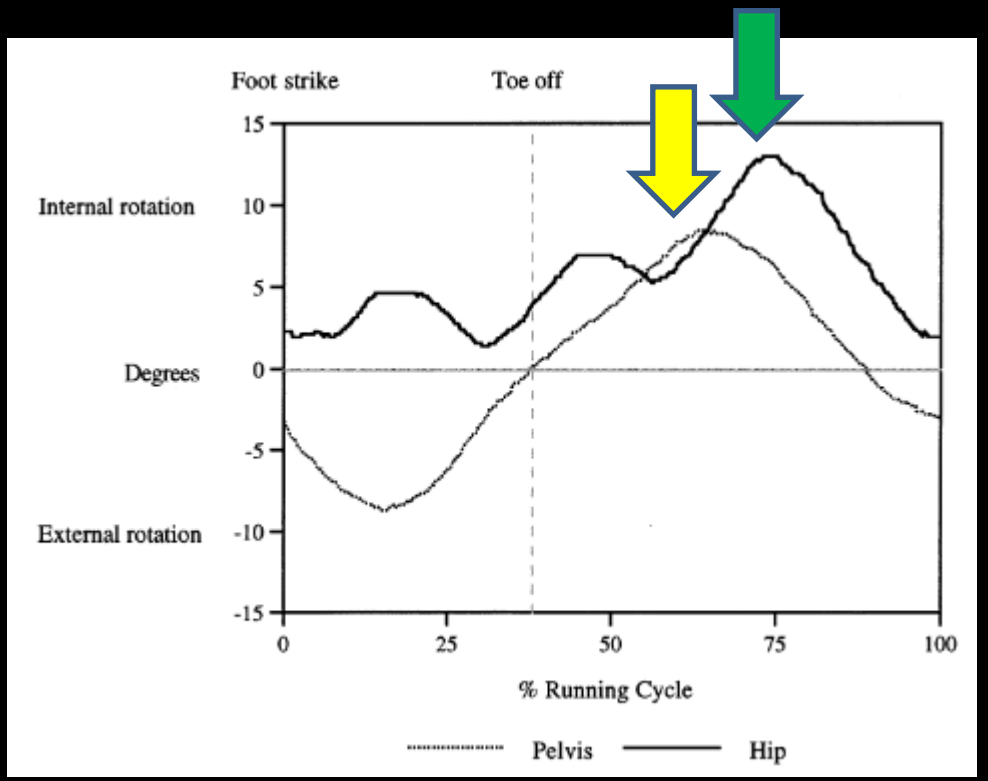


Increased anteversion with tibial torsion

Retroversion

Internal rotation and Running





Schade, GA et al J. Gait and posture, 1999.

Thigh internal rotation at walking: 15 degrees

- 8 degrees at the hip
- 7 degrees at the pelvis

Perry J. Gait analysis: normal and pathological function. 1992

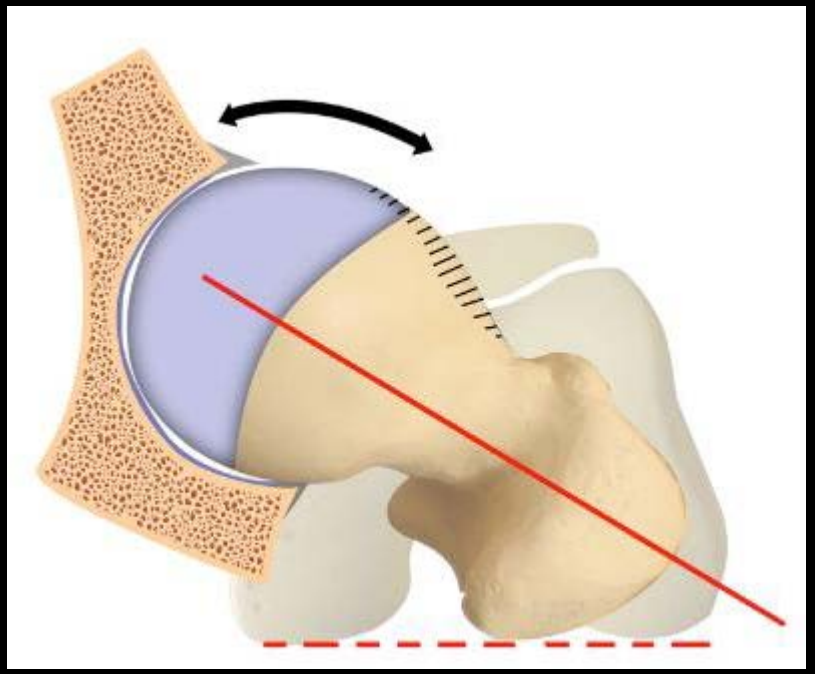
Femoral version is the main determinant

of hip rotation ROM

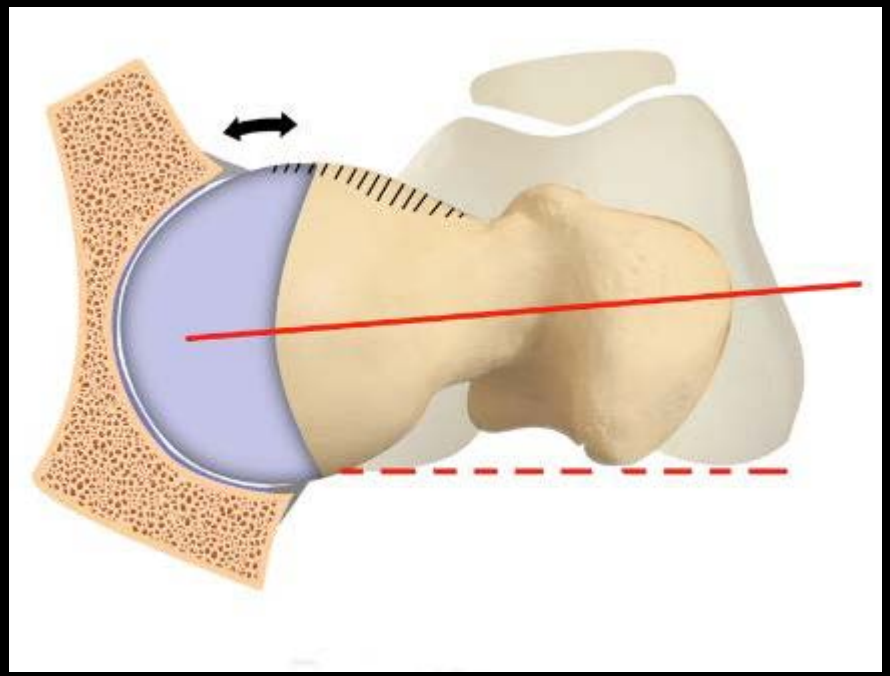
Kraeutler et al, JBJS 2018.

Femoral Version and FAI

Increased femoral version

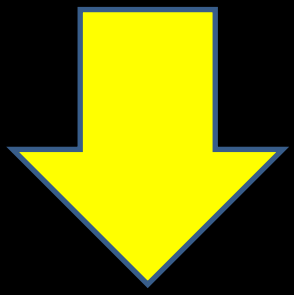


Retroversion



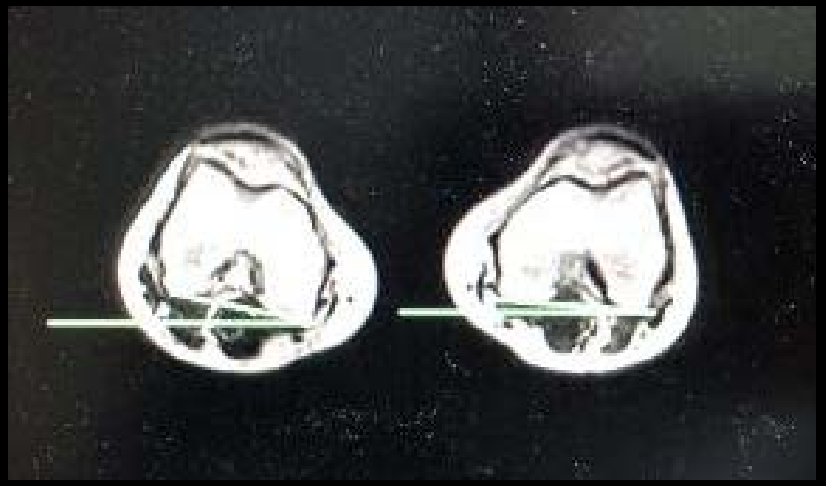
Decreased femoral version limiting hip flexion and extension

Premature coupling

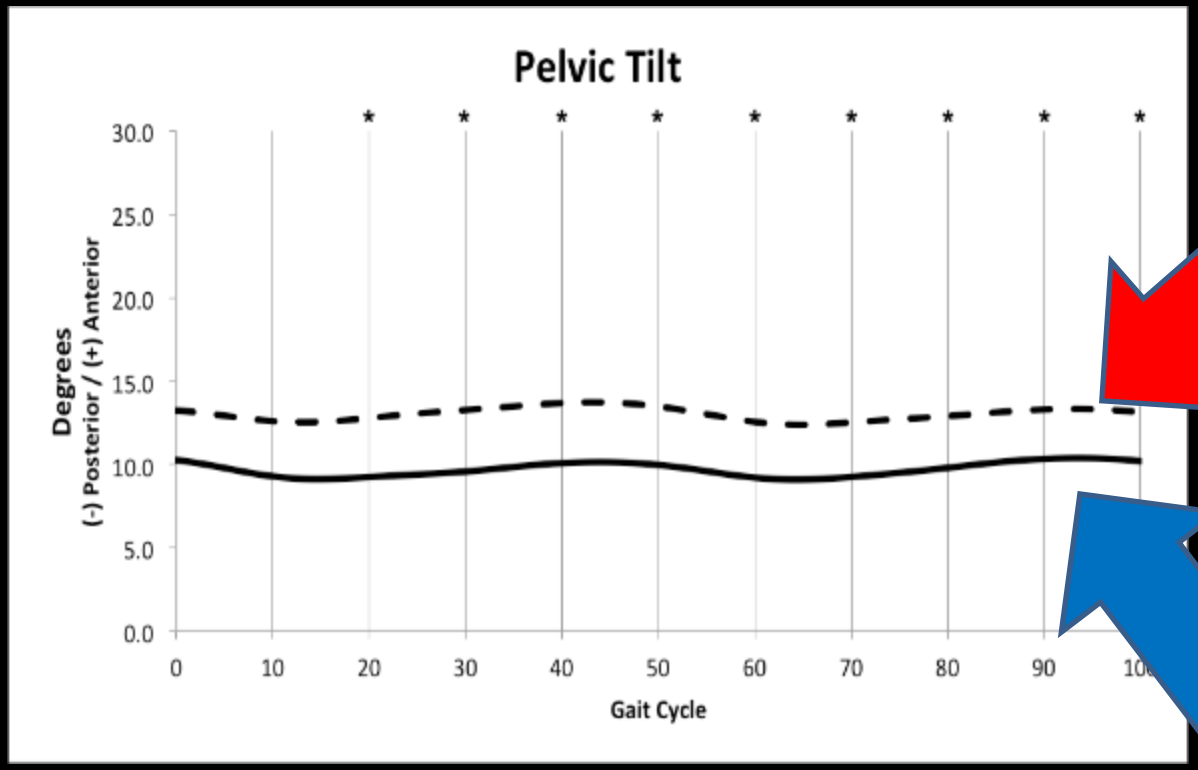


Compensation up and downstream

Increased femoral version effect on hip extension



Gait Analysis
Decreased femoral version associated with increased pelvic tilt

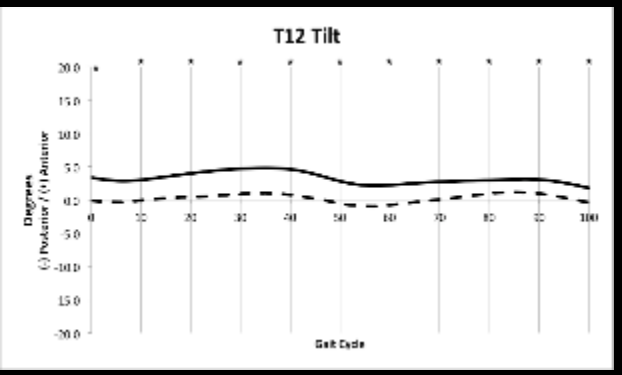


DFV

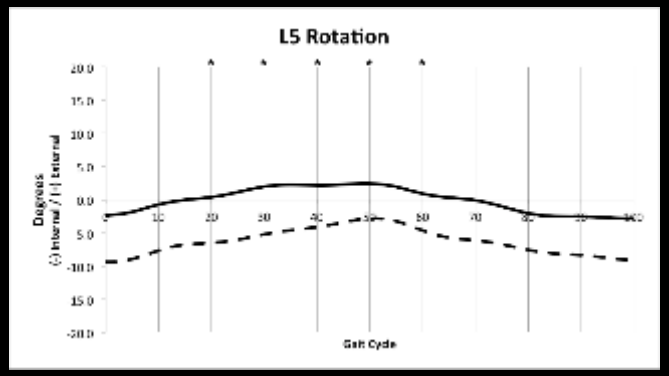
Normal version

Gait Analysis
Decreased femoral version and spine

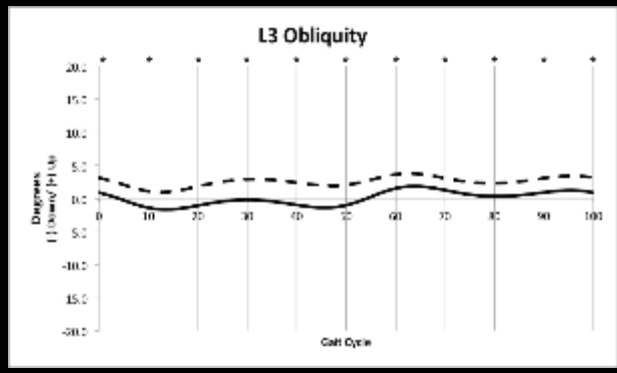
T12 tilt



L5 rotation



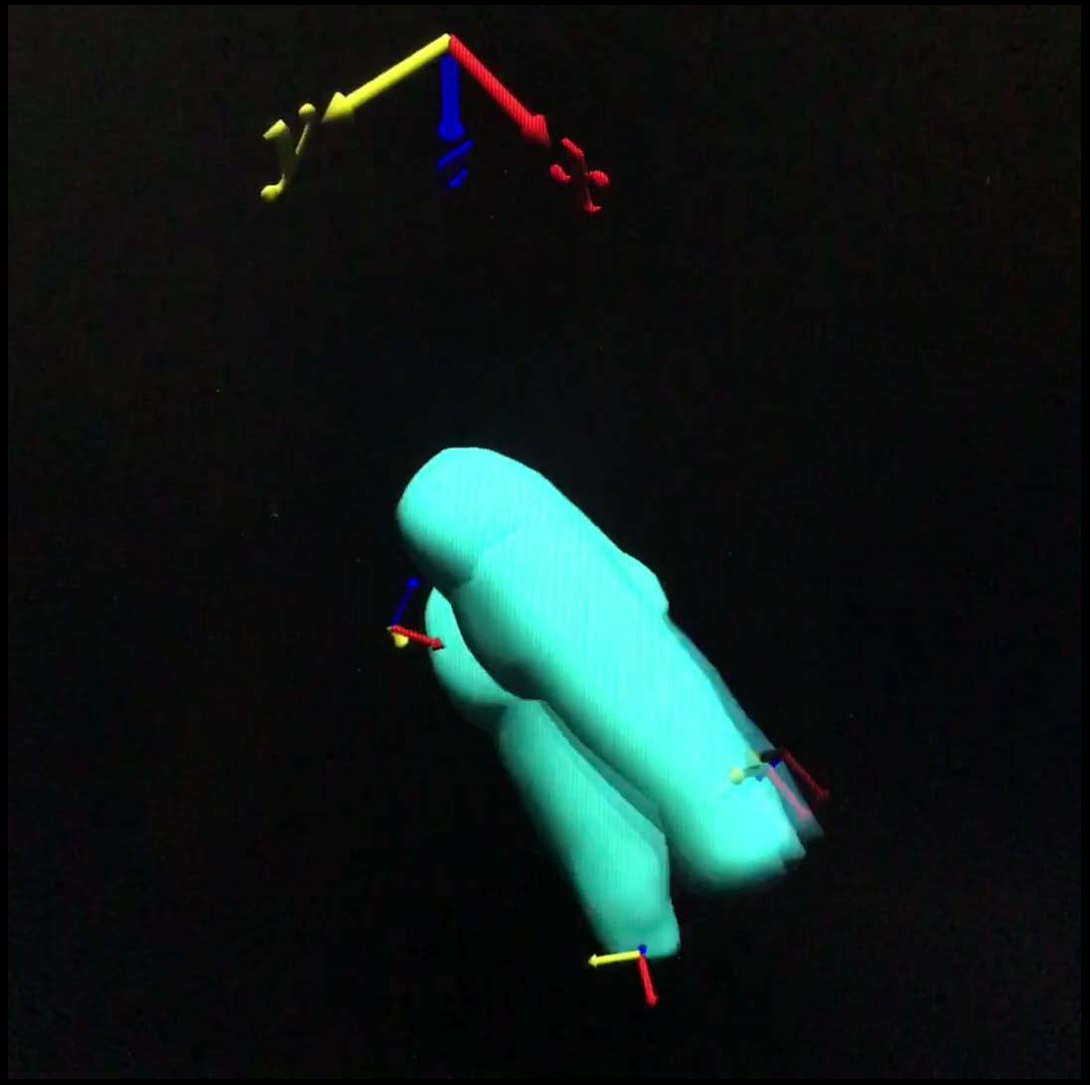
L3 obliquity



- - - - - **DFV**

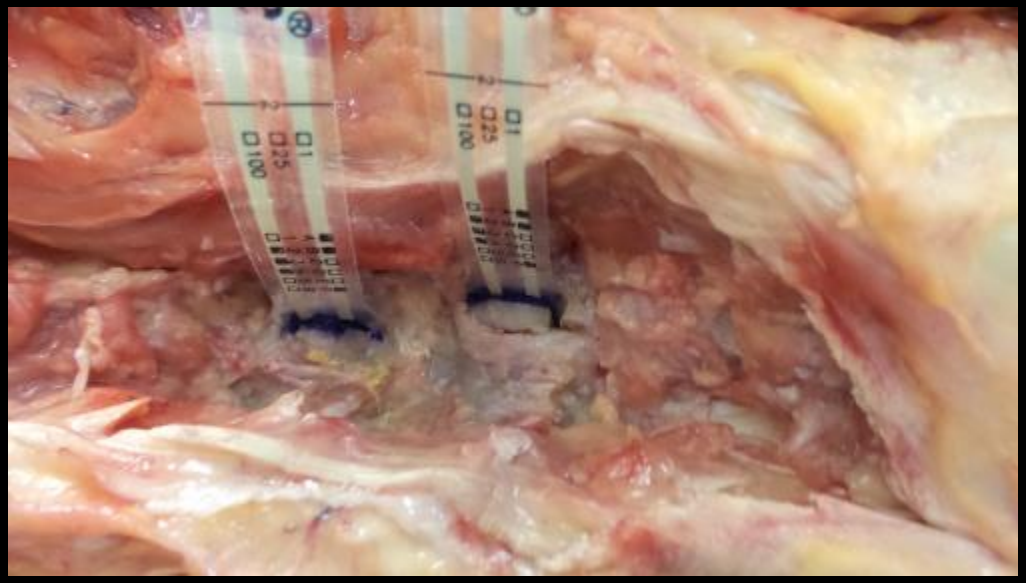
_____ **Control**

Femoral version – Lumbar spine

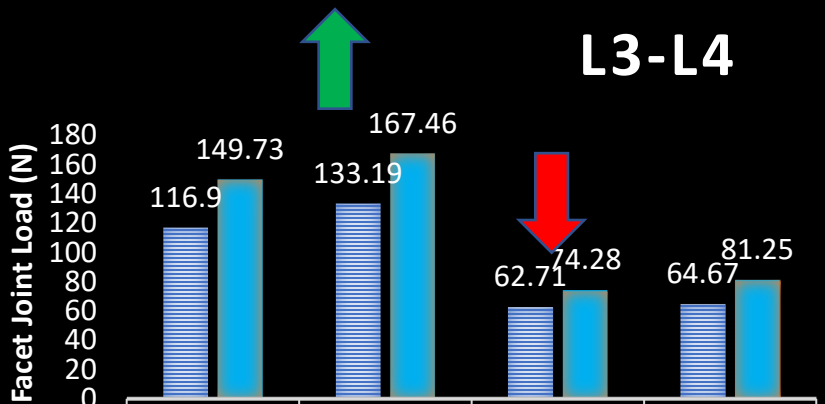


The Hip Spine Effect

Abnormal excessive and decreased femoral version affecting facets joint pressure

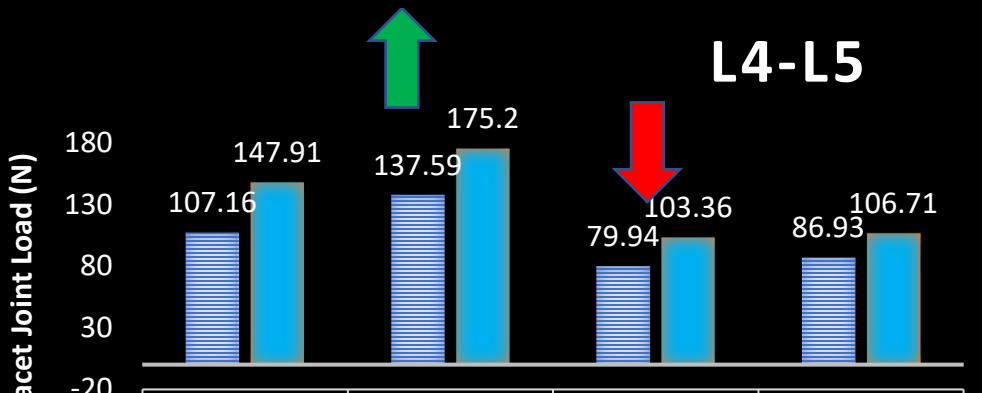


Femoral Version Hip-Spine Effect (cadaveric)



	Native (N)	+30° FV (N)	-10° FV (N)	-ILFL (N)
10°	116.9	133.19	62.71	64.67
20°	149.73	167.46	74.28	81.25

	L3-L4	L4-L5
	p-value	p-value
Effect: Femoral version		
-10°FV vs Native	0.04	0.07
-10°FV+ILF vs Native	0.06	0.04
+30°FV vs Native	0.18	0.04
Effect: Hip extension		
20° Hip EXT vs 10° Hip EXT	0.03	0.001

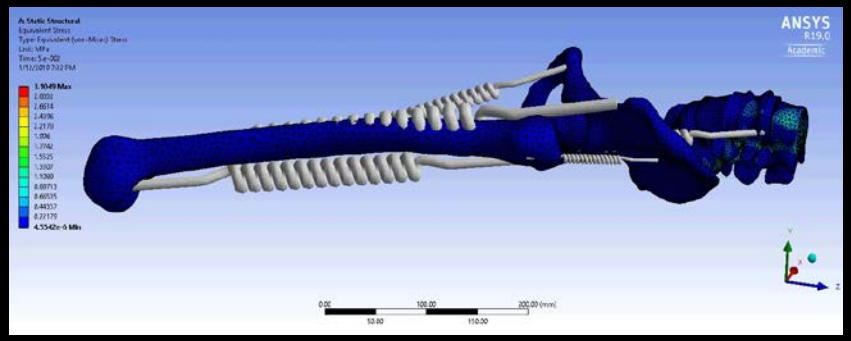


	Native (N)	+30° FV (N)	-10° FV (N)	-ILFL (N)
10°	107.16	137.59	79.94	86.93
20°	147.91	175.2	103.36	106.71

Finite element - Femoral Version Hip-Spine Effect

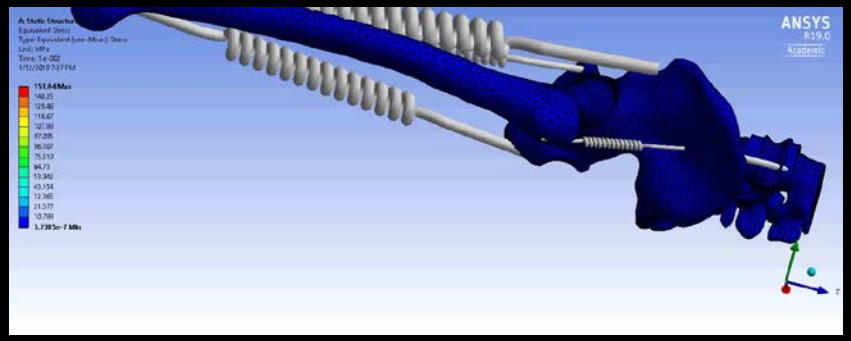
✓ Confirms cadaver experiments ✓

-10° FV
lumbar loading



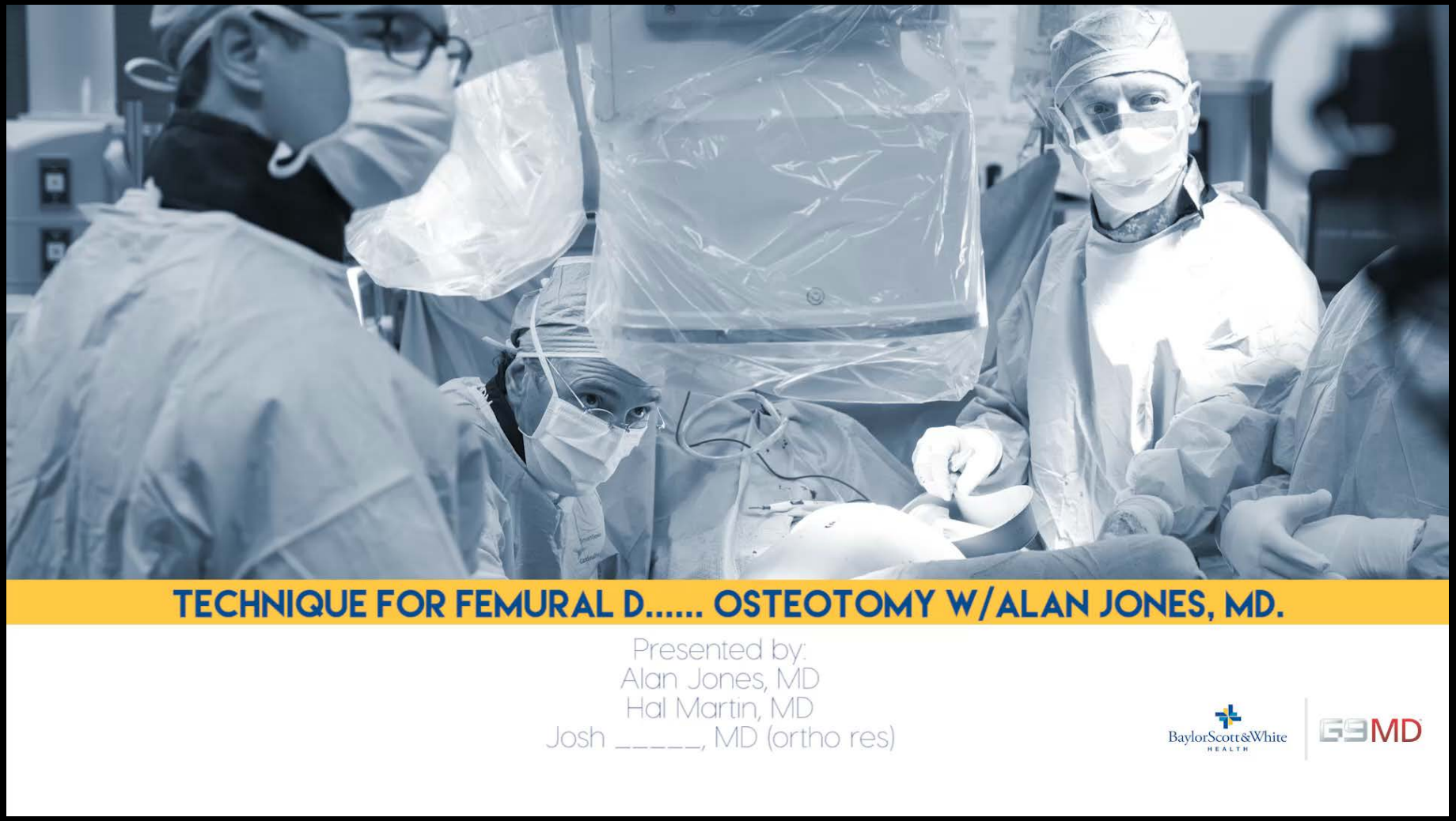
	Native Sum of Forces (N)	20° Hip EXT Sum of Forces (N)
L3-L4	0.603	0.47
L4-L5	7.68	5.53
L5-S1	5.07	0.21

+30° FV
lumbar loading



	Native Sum of Forces (N)	20° Hip EXT Sum of Forces (N)
L3-L4	0.603	1.77
L4-L5	7.68	23.50
L5-S1	5.07	9.68

Before Derotation Osteotomy



Derotation Osteotomy

After Derotation Osteotomy

Results

> Arthroscopy. 2020 Aug 21;S0749-8063(20)30686-1. doi: 10.1016/j.arthro.2020.08.008. Online ahead of print.

Femoral Derotation Osteotomy Improves Hip and Spine Function in Patients With Increased or Decreased Femoral Torsion

Munif Hatem [1], Anthony Nicholas Khoury [2], Lane Richard Erickson [2], Alan Leslie Jones [2], Hal David Martin [2]

- At 24 months (12-65 months)
  - mHHS : from 58 to 82
  - Oswestry: from 45% to 22%

Spine (Phila Pa 1976). 2000 Nov 15;25(22):2940-52; discussion 2952.

The Oswestry Disability Index.

Fairbank JC[1], Pynsent PB.

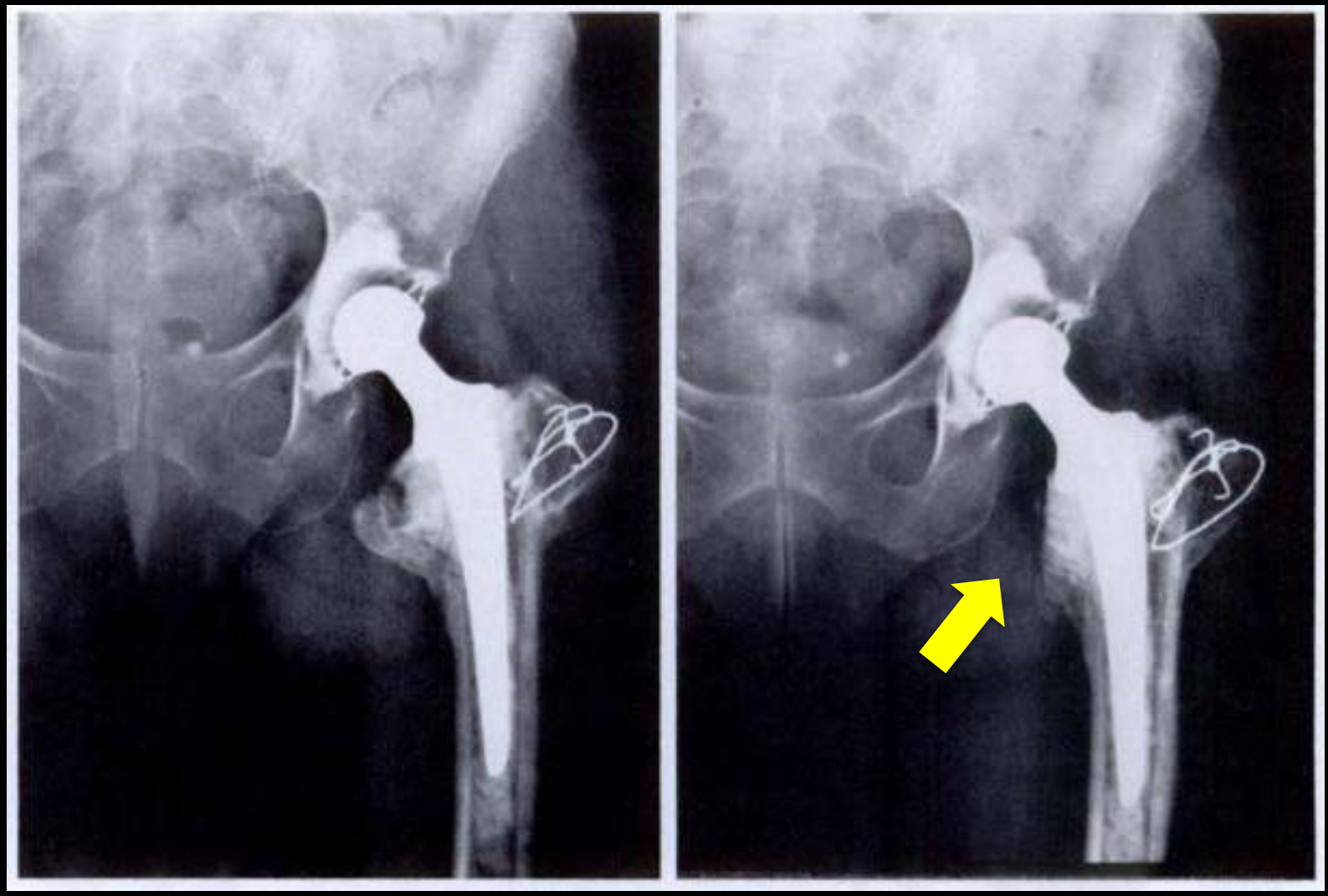
- 0% –20%: Minimal disability
- 21%–40%: Moderate Disability
- 41%–60%: Severe Disability
- 61%–80%: Crippling back pain
- 81%–100%: Bed-bound or exaggeration of symptoms

Ischiofemoral Impingement

Osseous causes of limitation in hip extension

- Posterior acetabular over coverage or cam
- Decreased ischiofemoral space
- Increased femoral torsion (>30°)
- Decreased femoral torsion (<5°)

2008
Case 1
55 yr old Professor



Johnson KA. JBJS,1977.

- Torriani, 2009, AJR

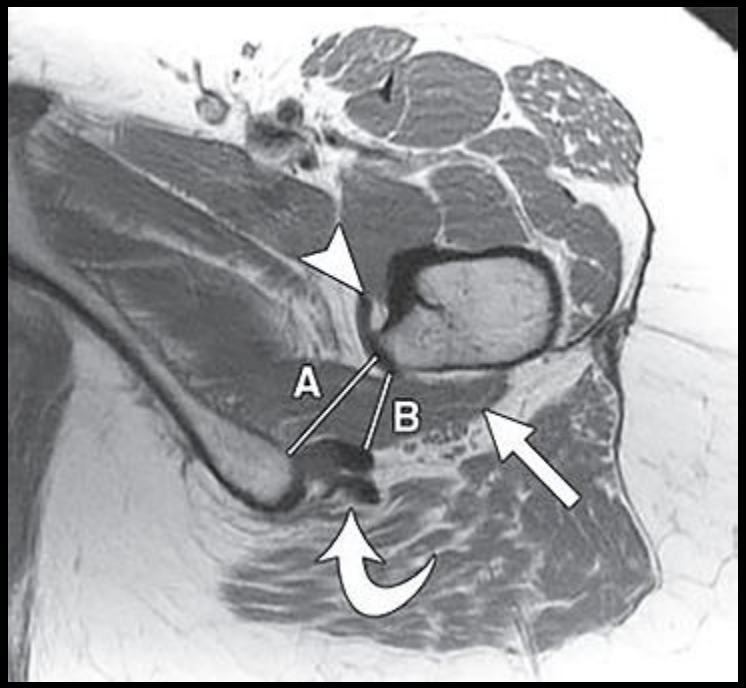
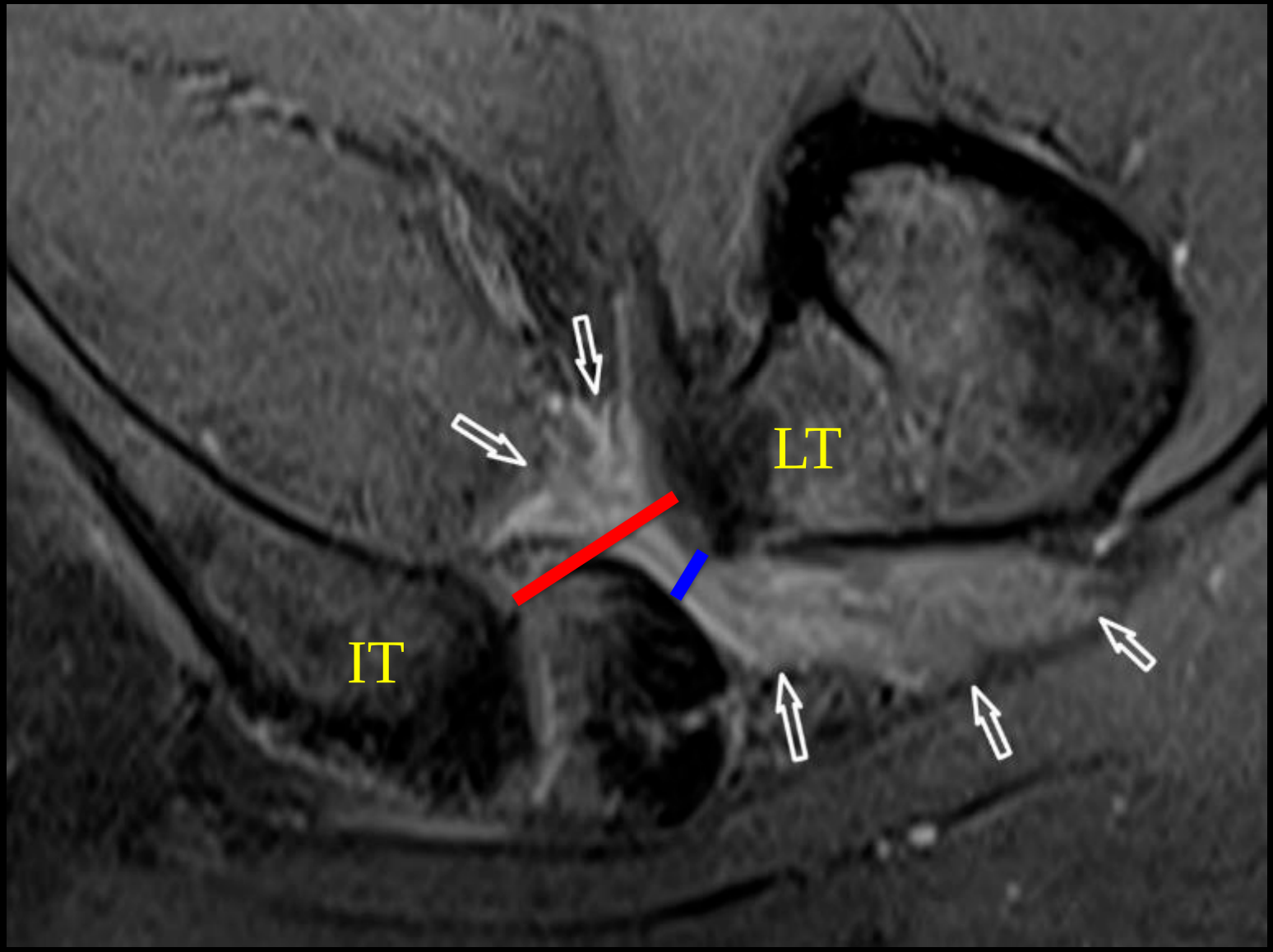


TABLE 1: Results of Statistical Analyses of Nine Affected Subjects (12 Hips) and 10 Control Subjects (11 Hips)

Measurement[a]	Affected Subjects (mm)	Control Subjects (mm)	*p*	Cutoff (mm)[b]	Sensitivity (%)	Specificity (%)
Ischiofemoral space	13 ± 5	23 ± 8	0.002	≤ 17	83	82
Quadratus femoris space	7 ± 3	12 ± 4	0.002	≤ 8	83	82

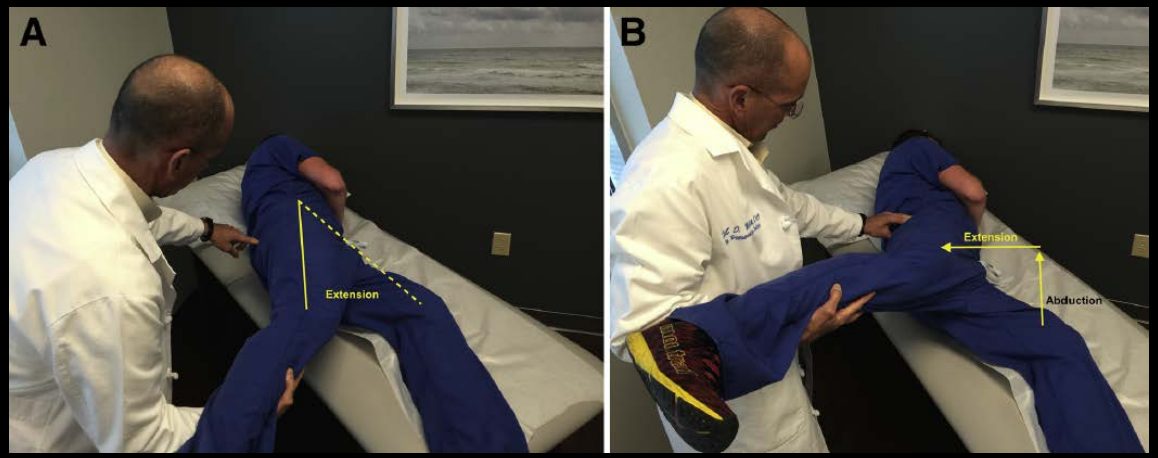

LT
IT

Positive Hip-Spine Test due to Ischiofemoral Impingement

2016, Arthroscopy

Accuracy of 2 Clinical Tests for Ischiofemoral Impingement in Patients With Posterior Hip Pain and Endoscopically Confirmed Diagnosis

Juan Gómez-Hoyos, M.D., RobRoy L. Martin, P.T., Ph.D., Ricardo Schröder, P.T., Ian James Palmer, Ph.D., and Hal David Martin, D.O.



Long Stride Walk Test

Sensitivity 0.94

Specificity 0.85

IFI TEST

Sensitivity 0.82

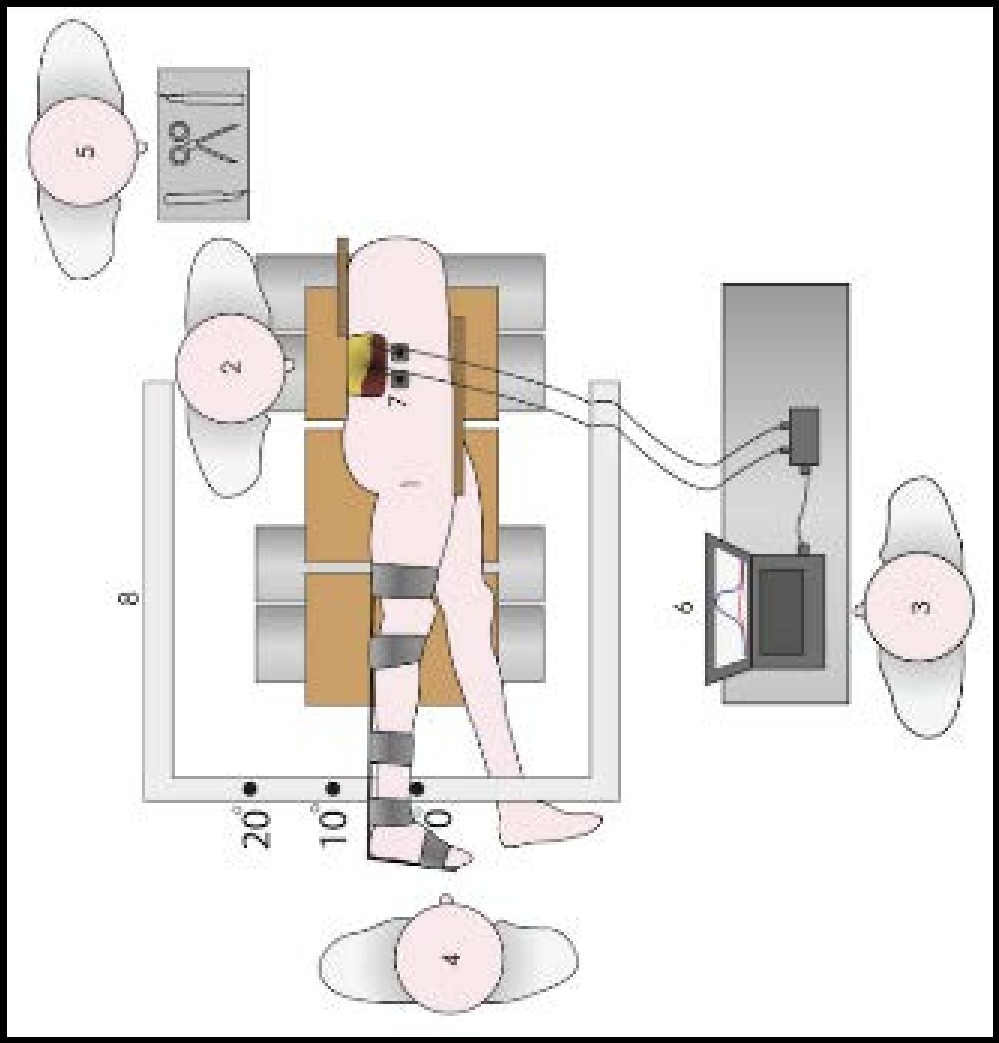
Specificity 0.85

2017, Arthroscopy

The Hip-Spine Effect: A Biomechanical Study of Ischiofemoral Impingement Effect on Lumbar Facet Joints

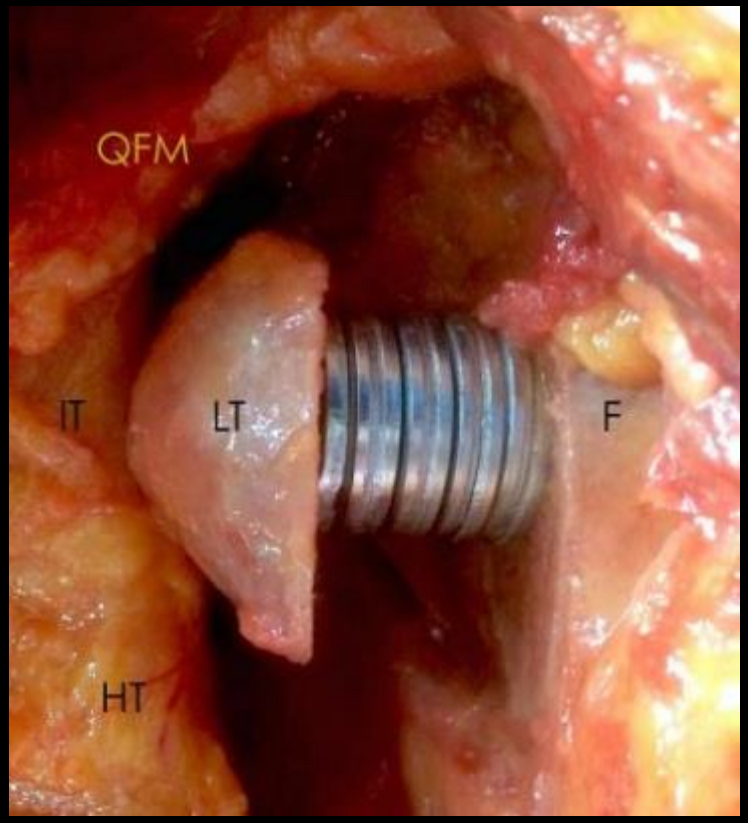
Juan Gómez-Hoyos, M.D., Anthony Khoury, M.S., Ricardo Schröder, P.T., Eric Johnson, B.S., Ian J. Palmer, Ph.D., and Hal D. Martin, D.O.

IFI - Lumbar Facet load

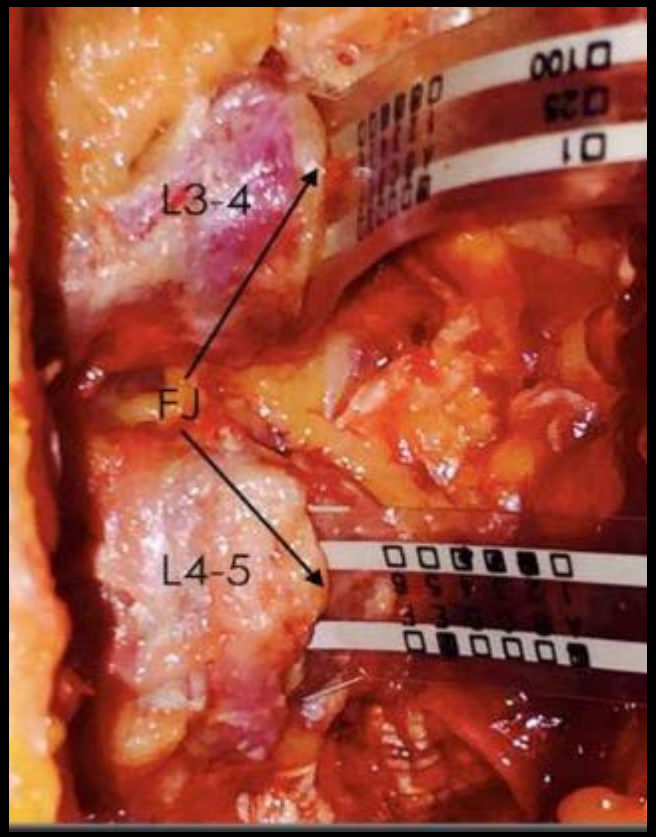


IFI - Lumbar Facet load

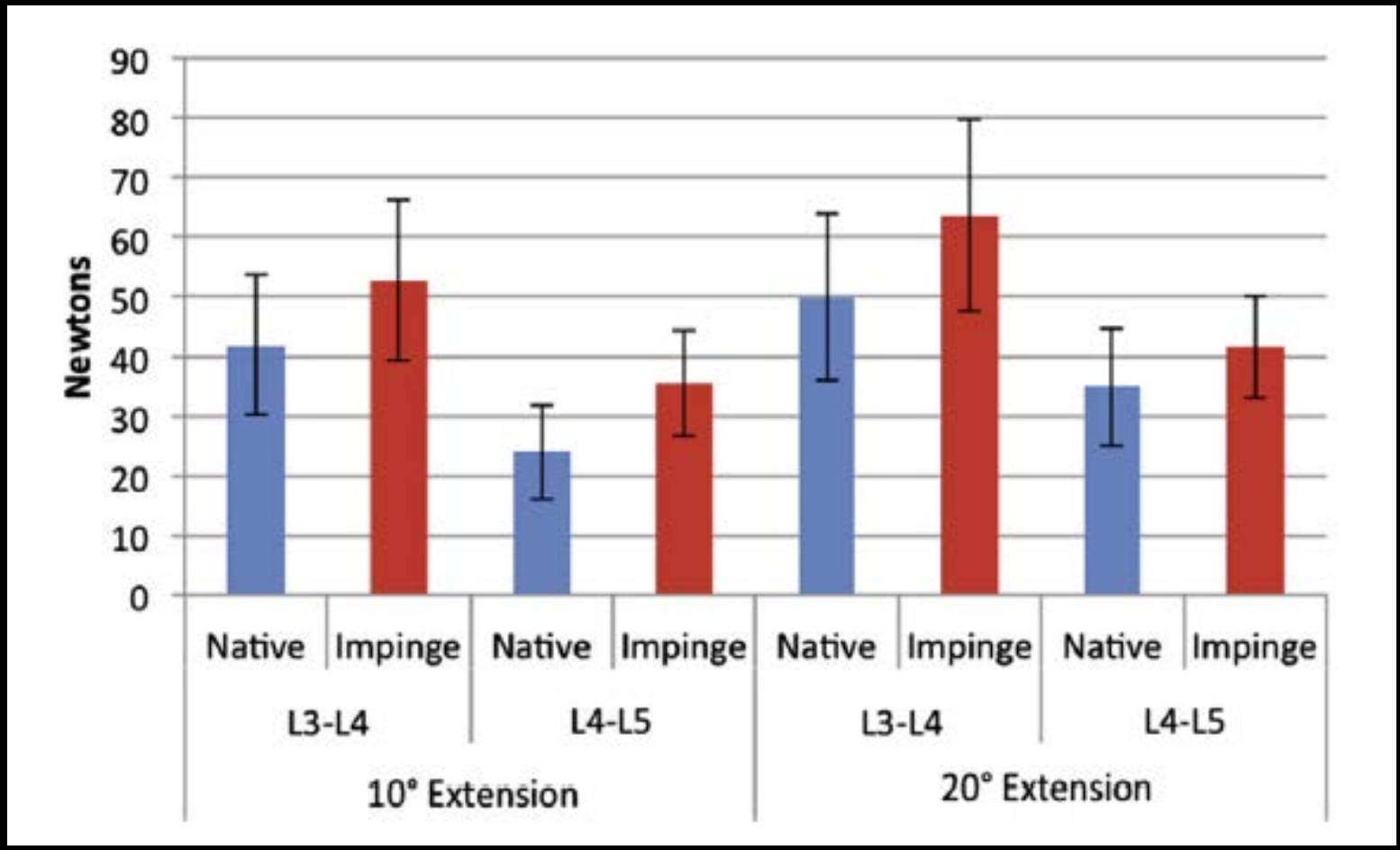
Simulated Ischiofemoral Impingement



Facet joint measurement with load sensors



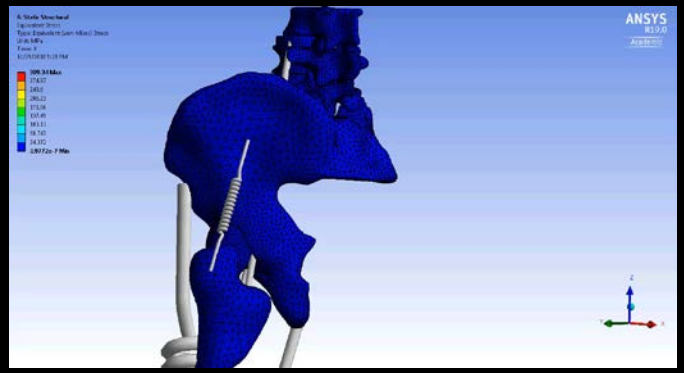
IFI – Peak Lumbar Facet load

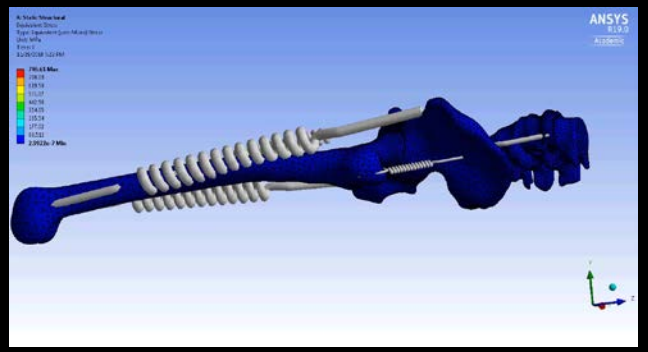


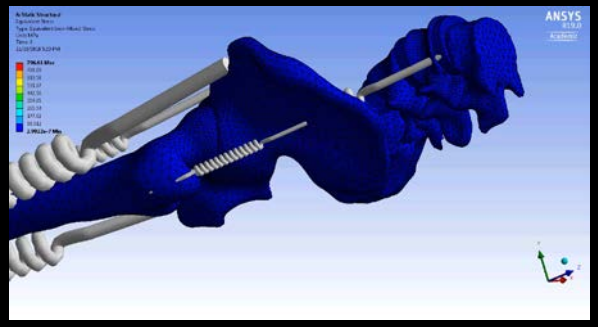
IFI Hip-Spine Effect (finite element)

- Cadaver experiments verified with finite element analysis

- IFI ⬆ lumbar spine loading



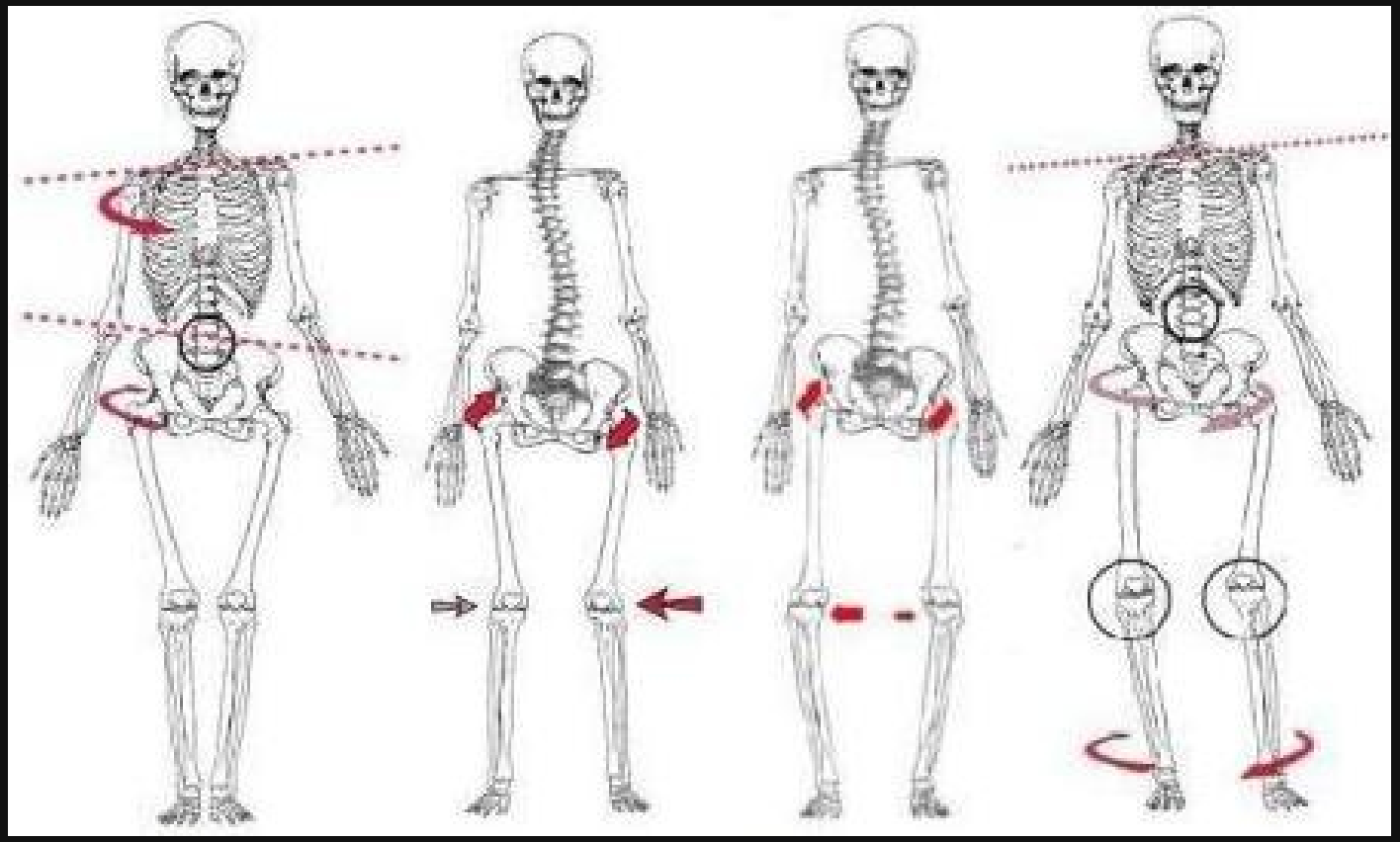




Contributing factors to IFI

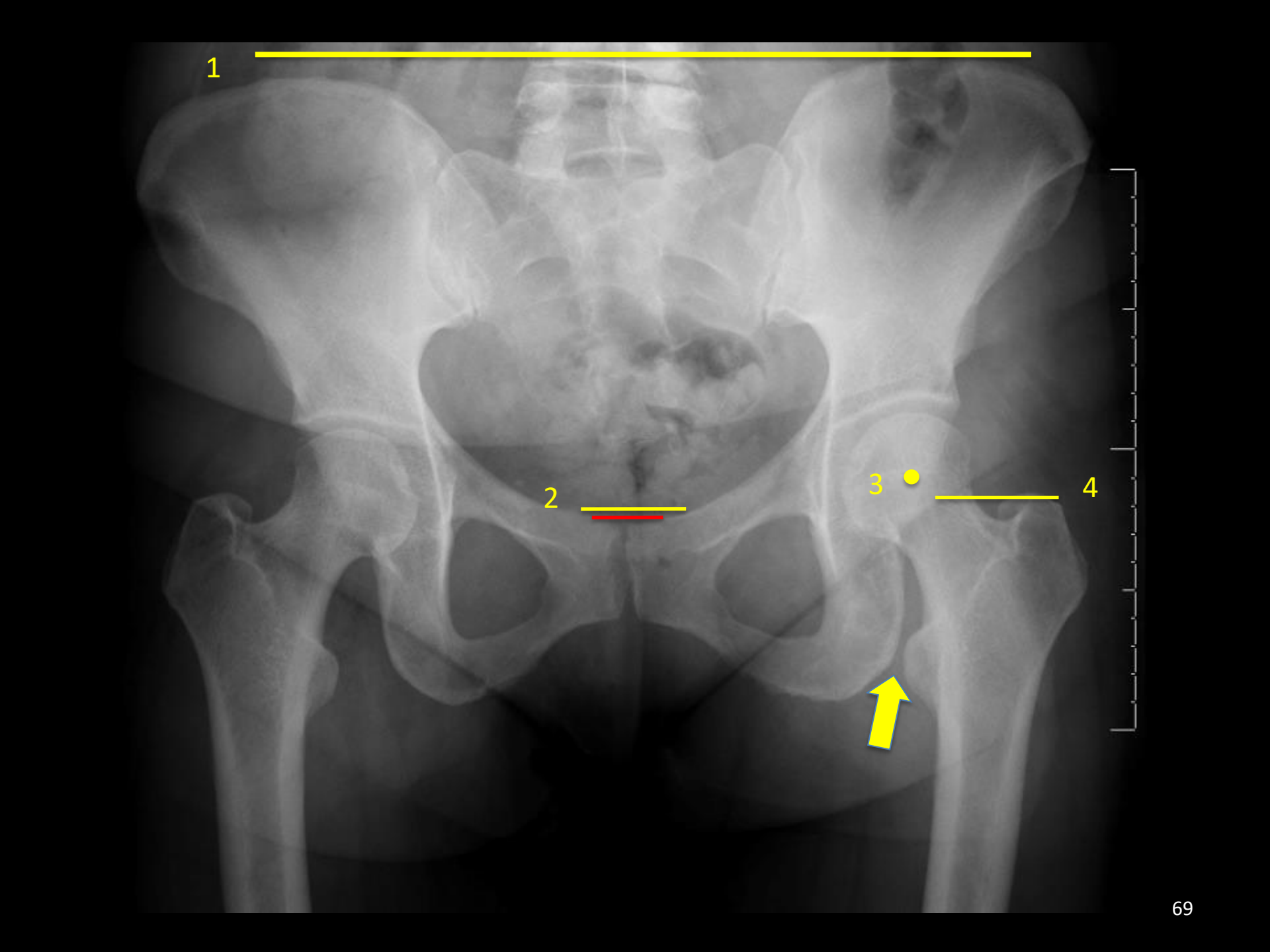
- Hip
- Above
- Below

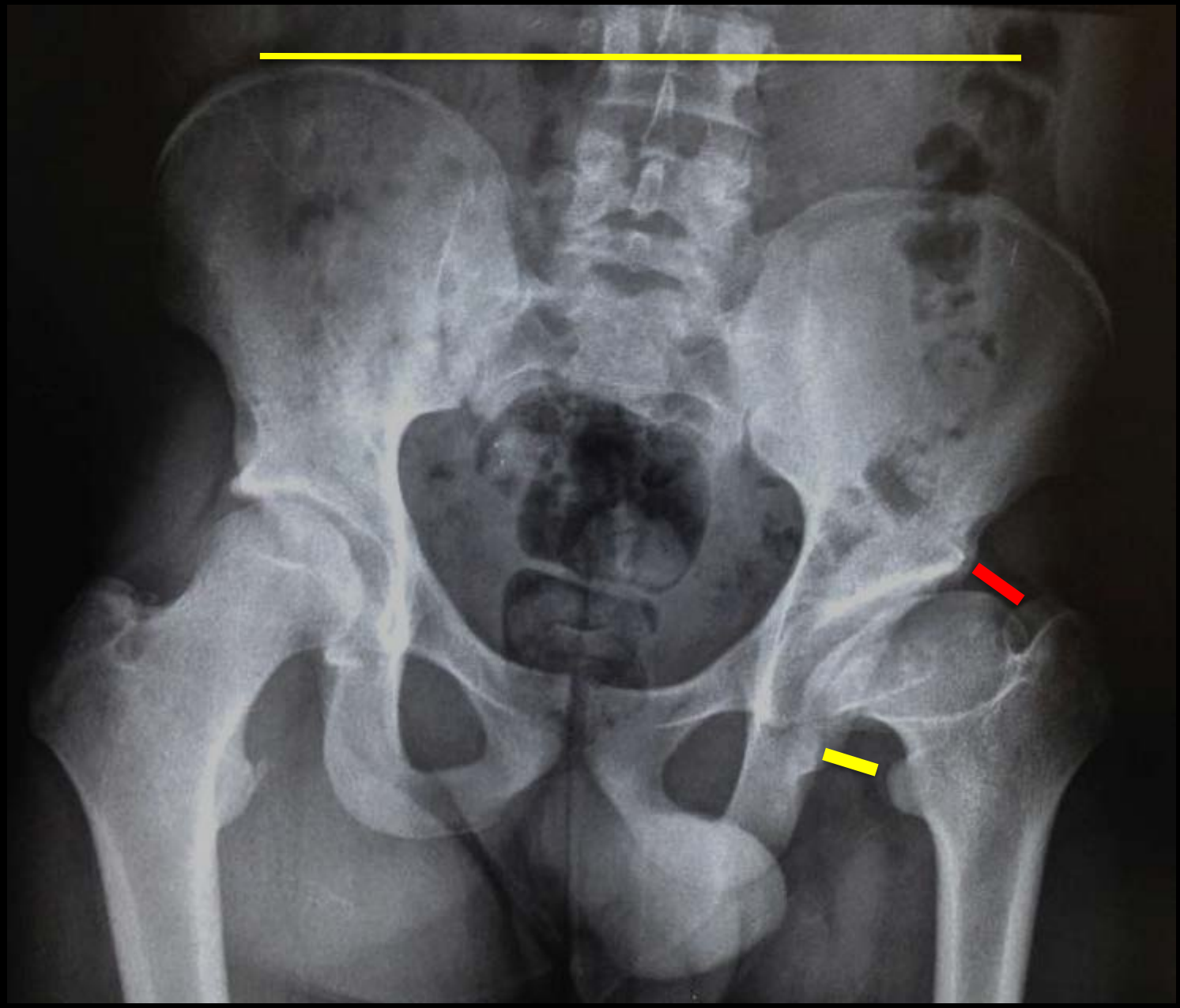
DOES DECREASED FEMORAL VERSION INFLUENCE PELVIS AND LUMBAR KINEMATICS DURING GAIT?

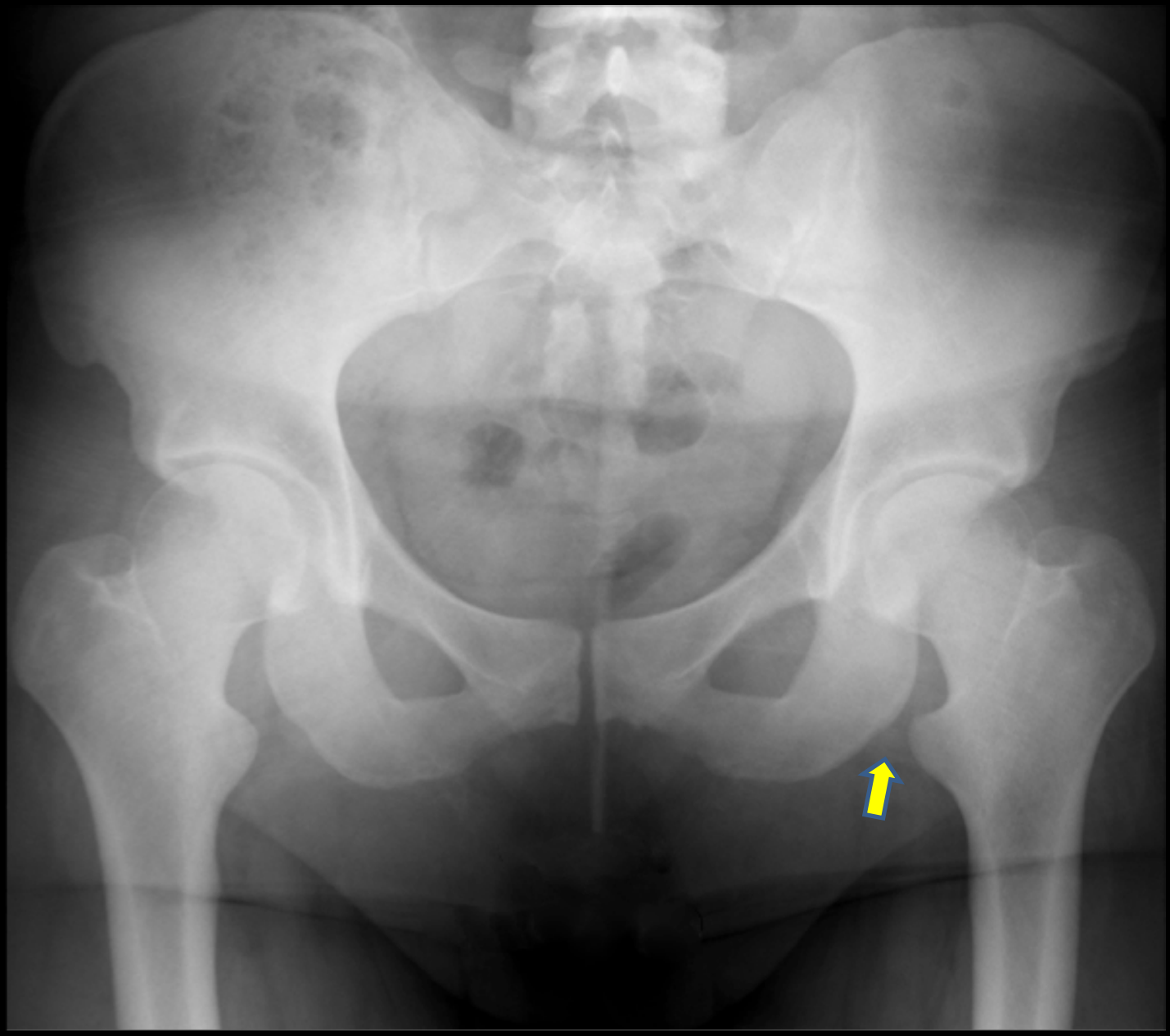


HD Martin, RG Schroder, IJ Palmer, M Hatem

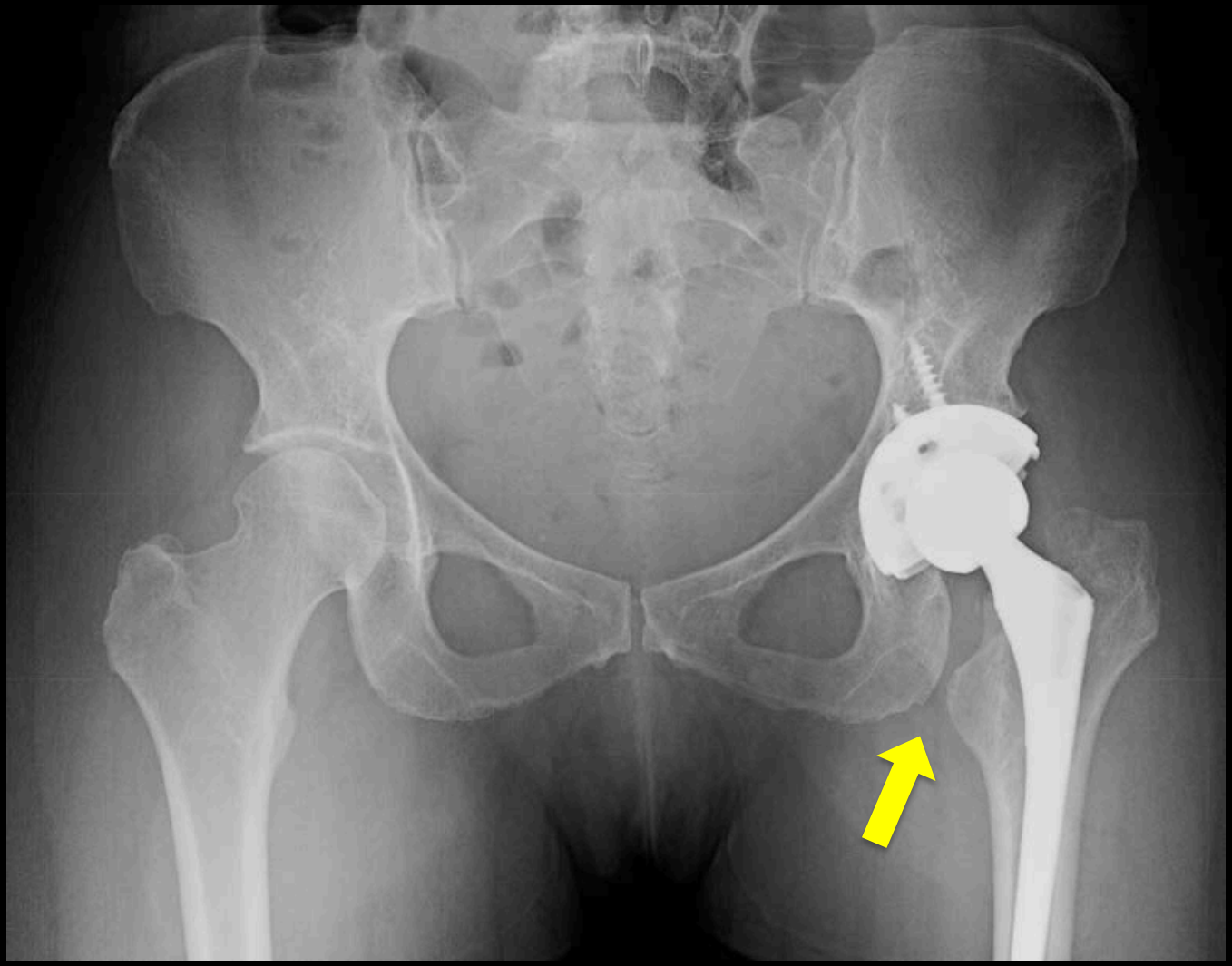
HIP PRESERVATION CENTER
AT BAYLOR UNIVERSITY MEDICAL CENTER DALLAS
Baylor Scott & White
RESEARCH INSTITUTE


1
2
3
4

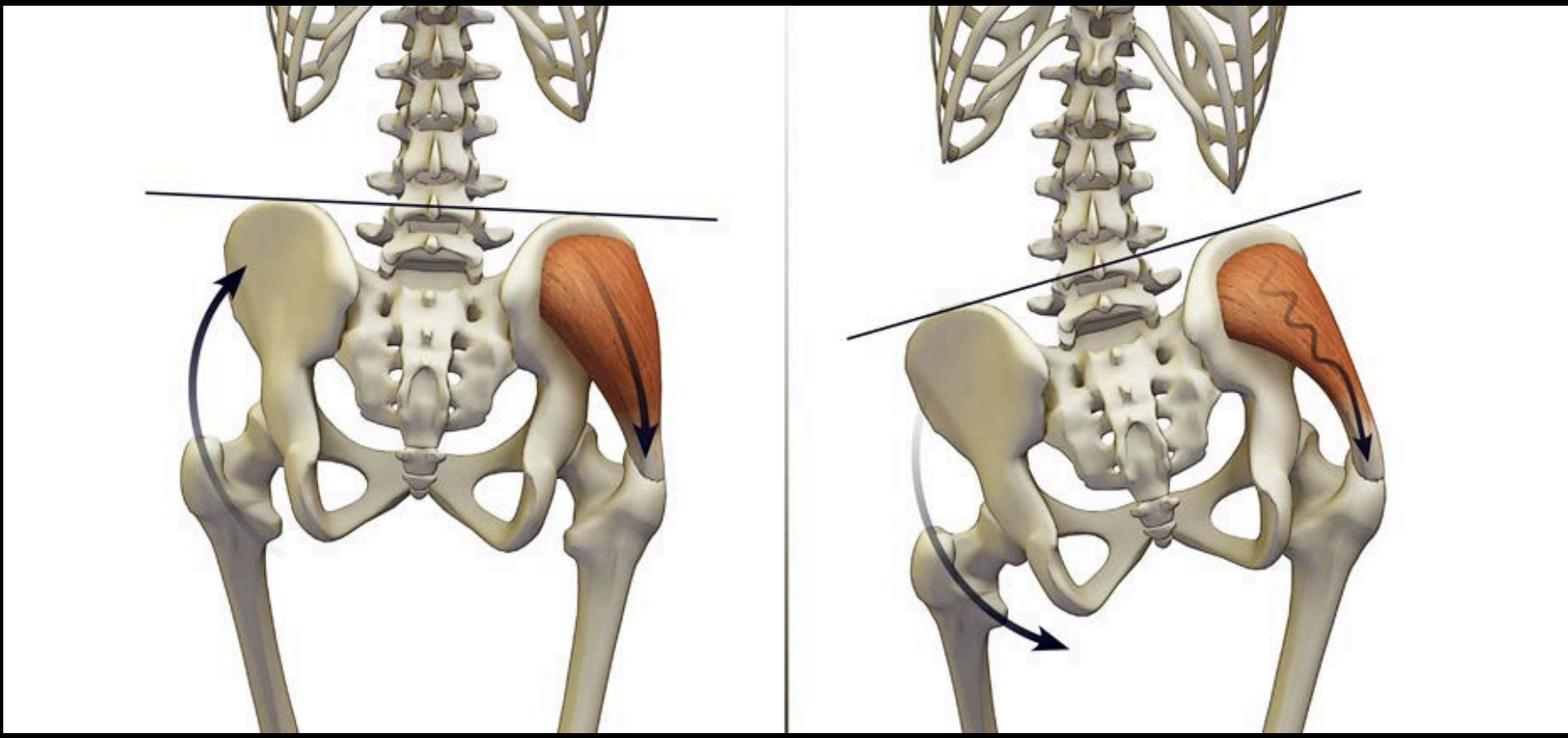




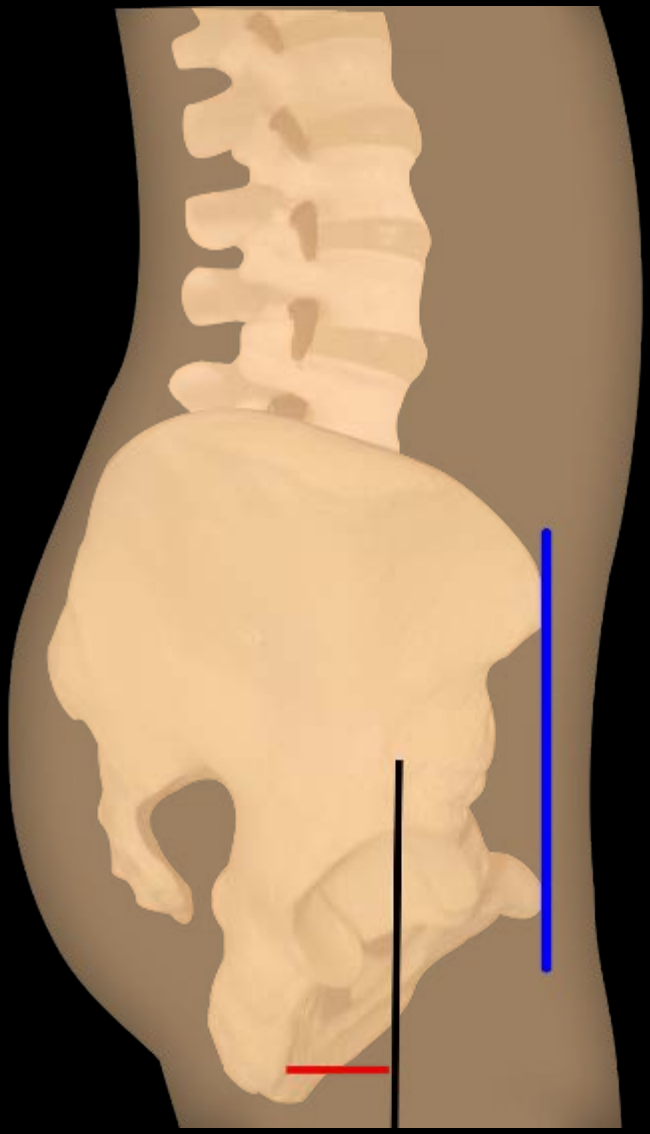
IFI secondary to excessive anteversion

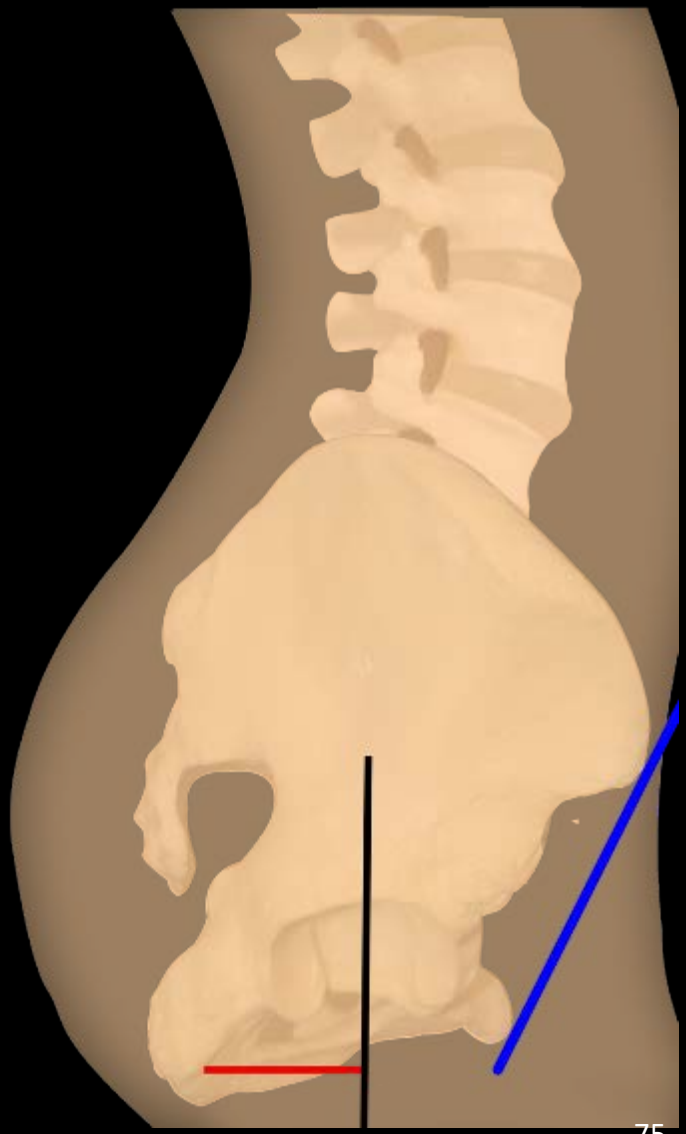


Muscular imbalance



Lumbar lordosis – Pelvic Tilt





Other biomechanical factors

- Ischium morphology
- Ligament Laxity
- Stride length / Physical activities

Ischial Femoral Impingement
Static vs Dynamic

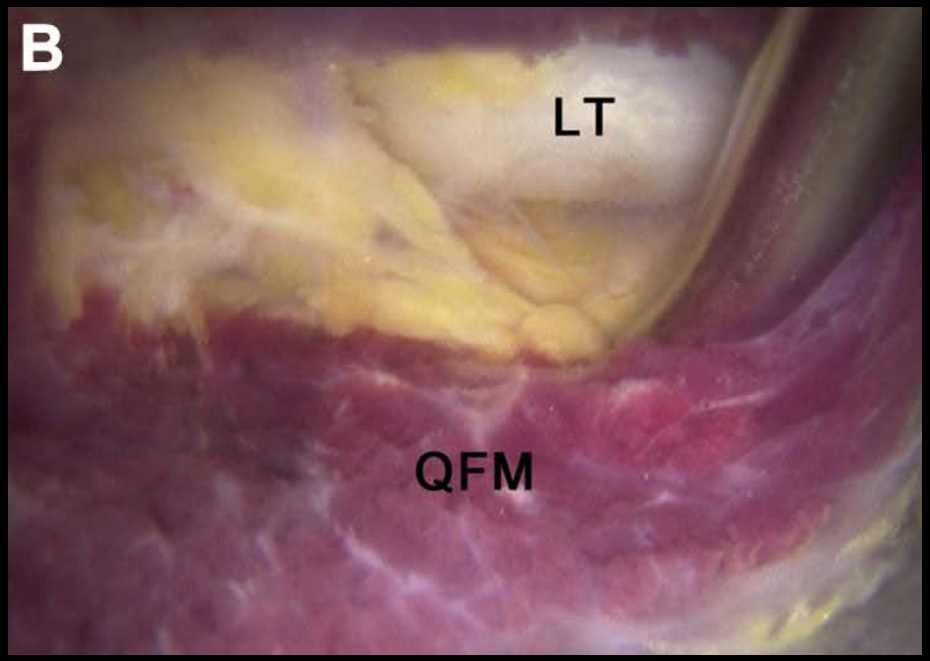
- Check the entire biomechanical axis in 3 planes
- Physical Examination is best comprehensive to assess each layer which can contribute to the etiology
- Treatment is based on etiology
- All treatment begins with education

2015

Diagnosis and 2-Year Outcomes of Endoscopic Treatment for Ischiofemoral Impingement

Munif Ahmad Hatem, M.D., Ian James Palmer, Ph.D., and Hal David Martin, D.O.

Arthroscopy 2015; 31(2):239-46



25% improvement

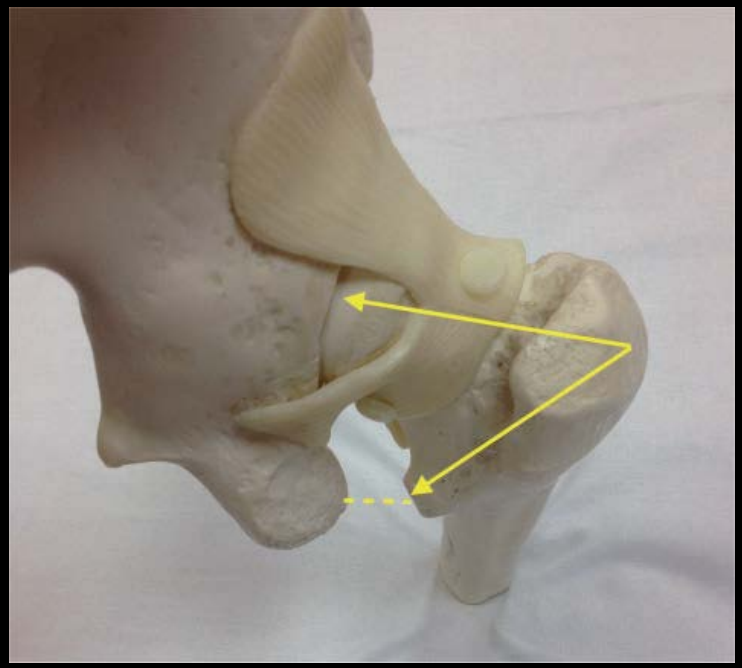
- Spine fusion minimum clinically important difference in the ODI = 12.8%.
- FDA: 15%

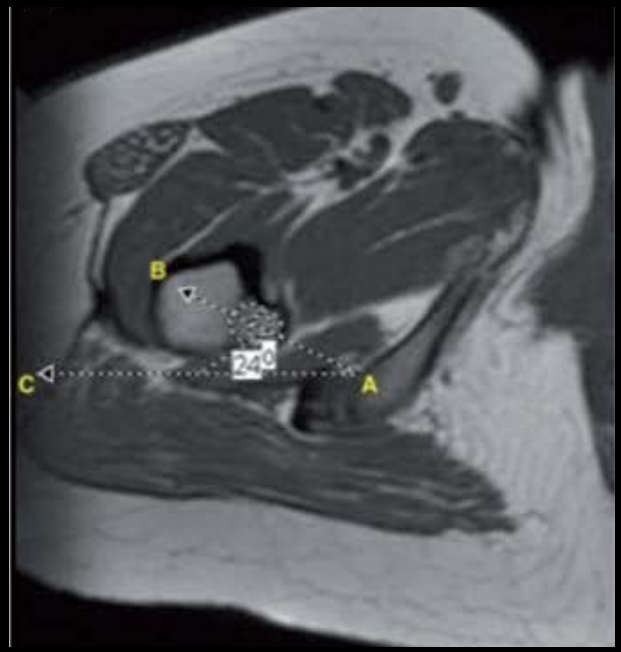
1. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976). 2000 Nov 15;25(22):2940-52; discussion 2952. Review.
2. Copay AG, Glassman SD, Subach BR, Berven S, Schuler TC, Carreon LY. Minimum clinically important difference in lumbar spine surgery patients: a choice of methods using the Oswestry Disability Index, Medical Outcomes Study questionnaire Short Form 36, and Pain Scales. *Spine J*. 2008;8(6):968-974.

2015, Journal of Hip Preserv. Surg.

A MRI study of the lesser trochanteric version and its relationship to proximal femoral osseous anatomy

Ricardo Gonçalves Schröder[1,*], Manoj Reddy[1,2], Munif Ahamad Hatem[1,3], Juan Gómez-Hoyos[1], Leon Toye[4], Anthony Khoury[1,5] and Hal David Martin[1]

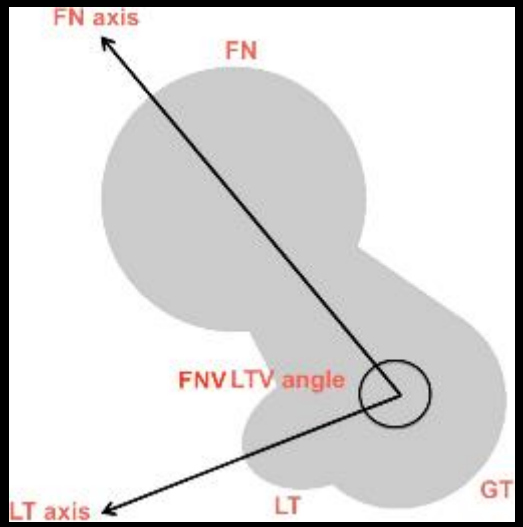


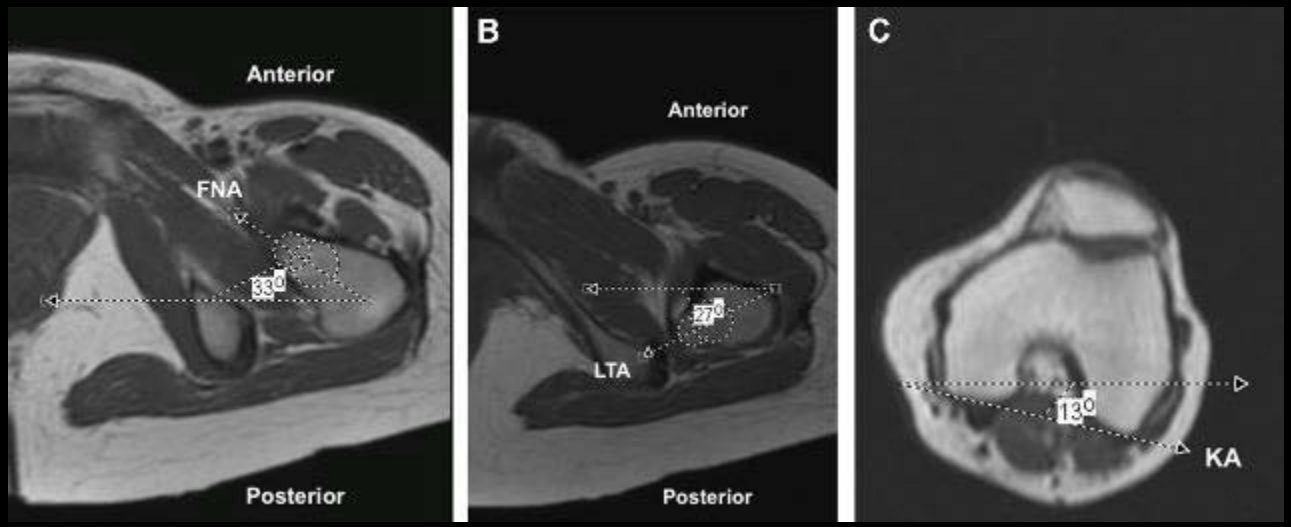


2015, Journal of Hip Preserv. Surg.

Femoral Neck Anteversion and Lesser Trochanteric Retroversion in Patients With Ischiofemoral Impingement: A Case-Control Magnetic Resonance Imaging Study

Juan Gómez-Hoyos, M.D., Ricardo Schröder, P.T., Manoj Reddy, B.S., Ian James Palmer, Ph.D., and Hal David Martin, D.O.

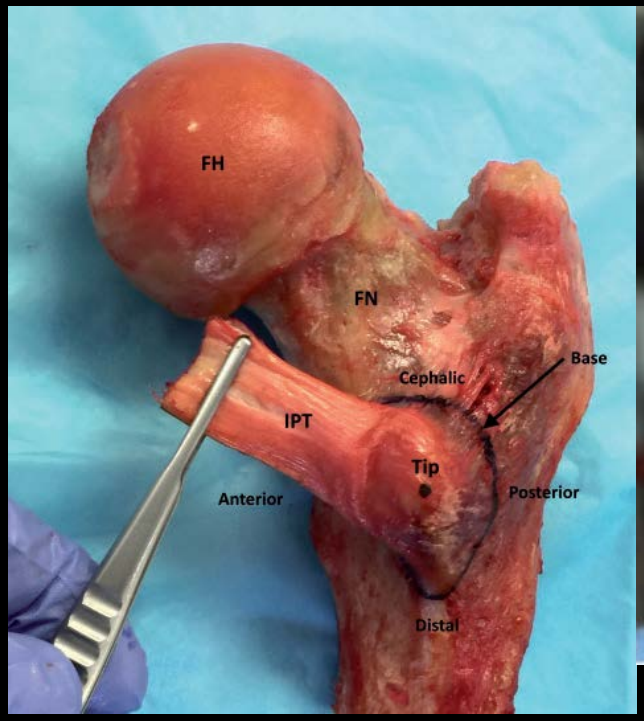


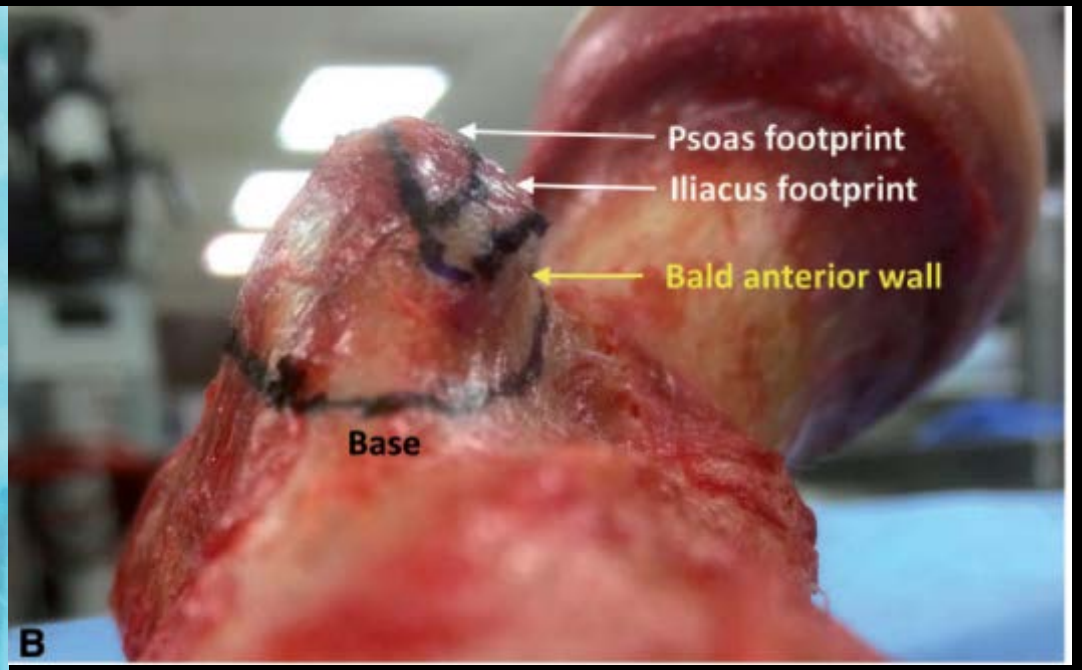


2015, Journal of Hip Preserv. Surg.

Iliopsoas tendon insertion footprint with surgical implications in lesser trochanterplasty for treating ischiofemoral impingement: an anatomic study

Juan Gómez-Hoyos[1,2*], Ricardo Schröder[1], Ian J. Palmer[1], Manoj Reddy[3], Anthony Khoury[1,4] and Hal David Martin[1]





2017, KSSTA

Ischiofemoral impingement: defining the lesser trochanter–ischial space

Benjamin R. Kivlan[1,2] · RobRoy L. Martin[1,2] · Hal D. Martin[3]

Motion	Mean (cm)	Range (cm)	Standard deviation (cm)
Position 1 (0° medial/lateral rotation)	2.8	0.9–5.0	1.1
Position 2 (40° medial rotation)	4.3	2.0–6.7	1.2
Position 3 (60° lateral rotation)	1.4	0.0–3.0	0.7

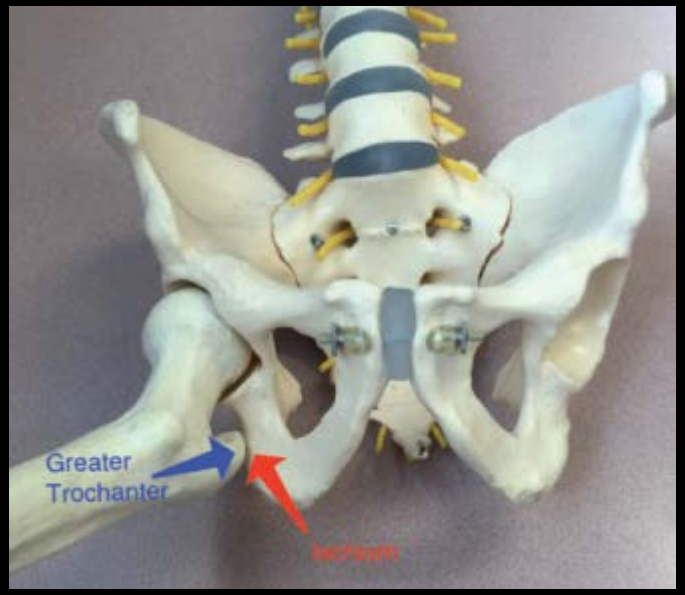
2016, Journal of Hip Preserv. Surg.

Defining the greater trochanter-ischial space: a potential source of extra-articular impingement in the posterior hip region

Benjamin R. Kivlan[1,2,*], RobRoy L. Martin[1,2] and Hal D. Martin[3]

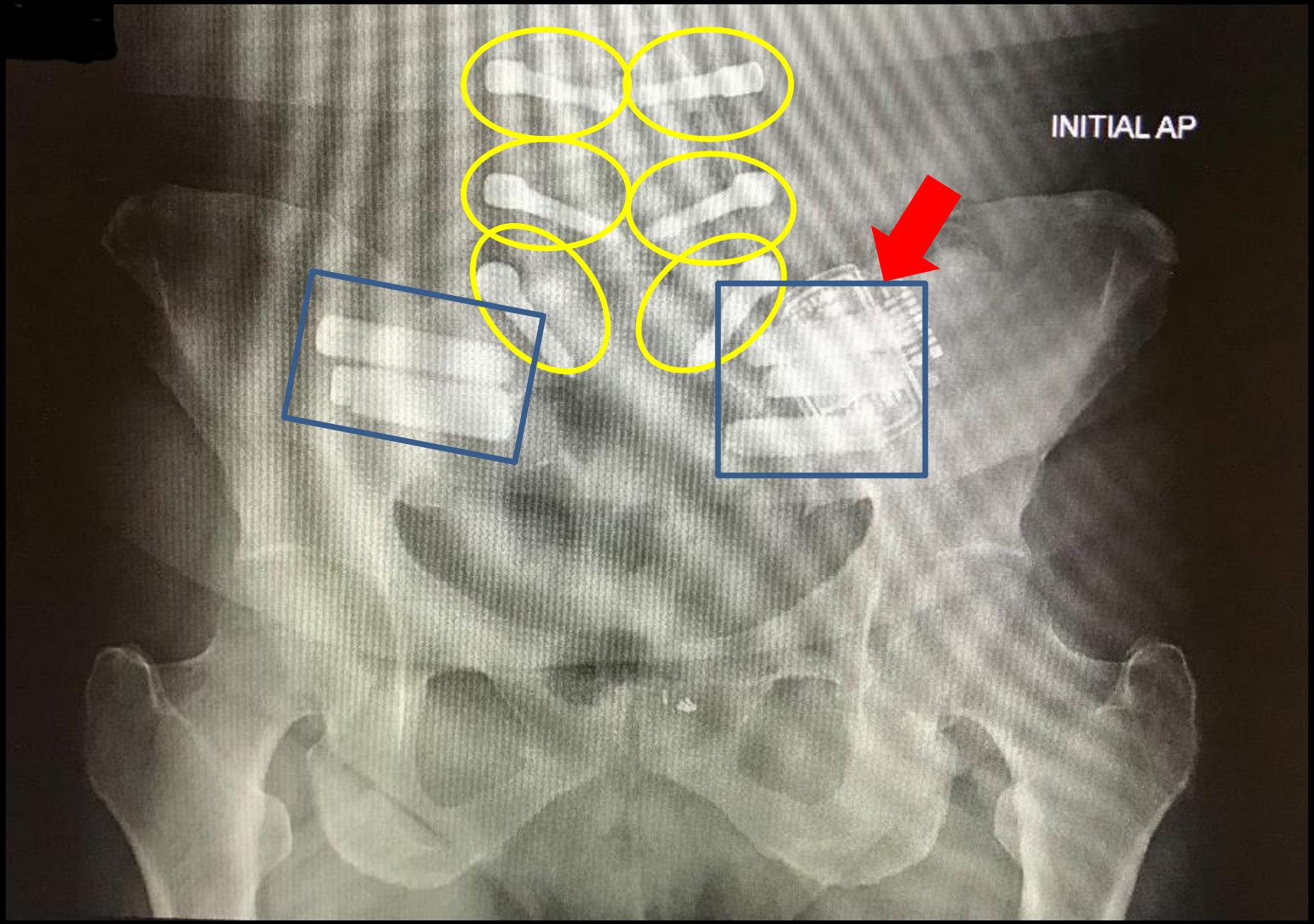
FABER: 22 out of 23 cadavers

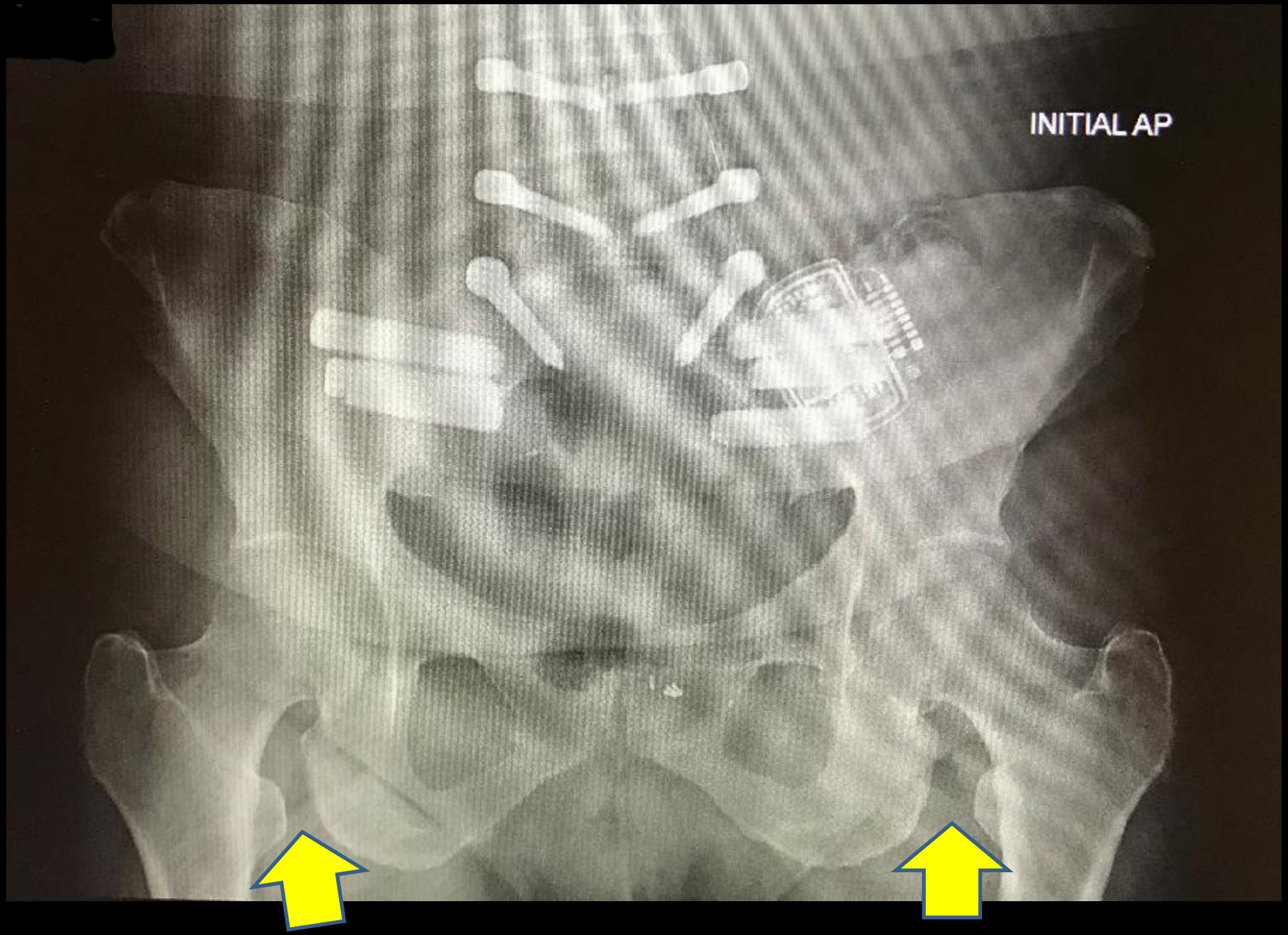
Extension with 60° ER and 30° abduction



Clinical observation in IFI patients

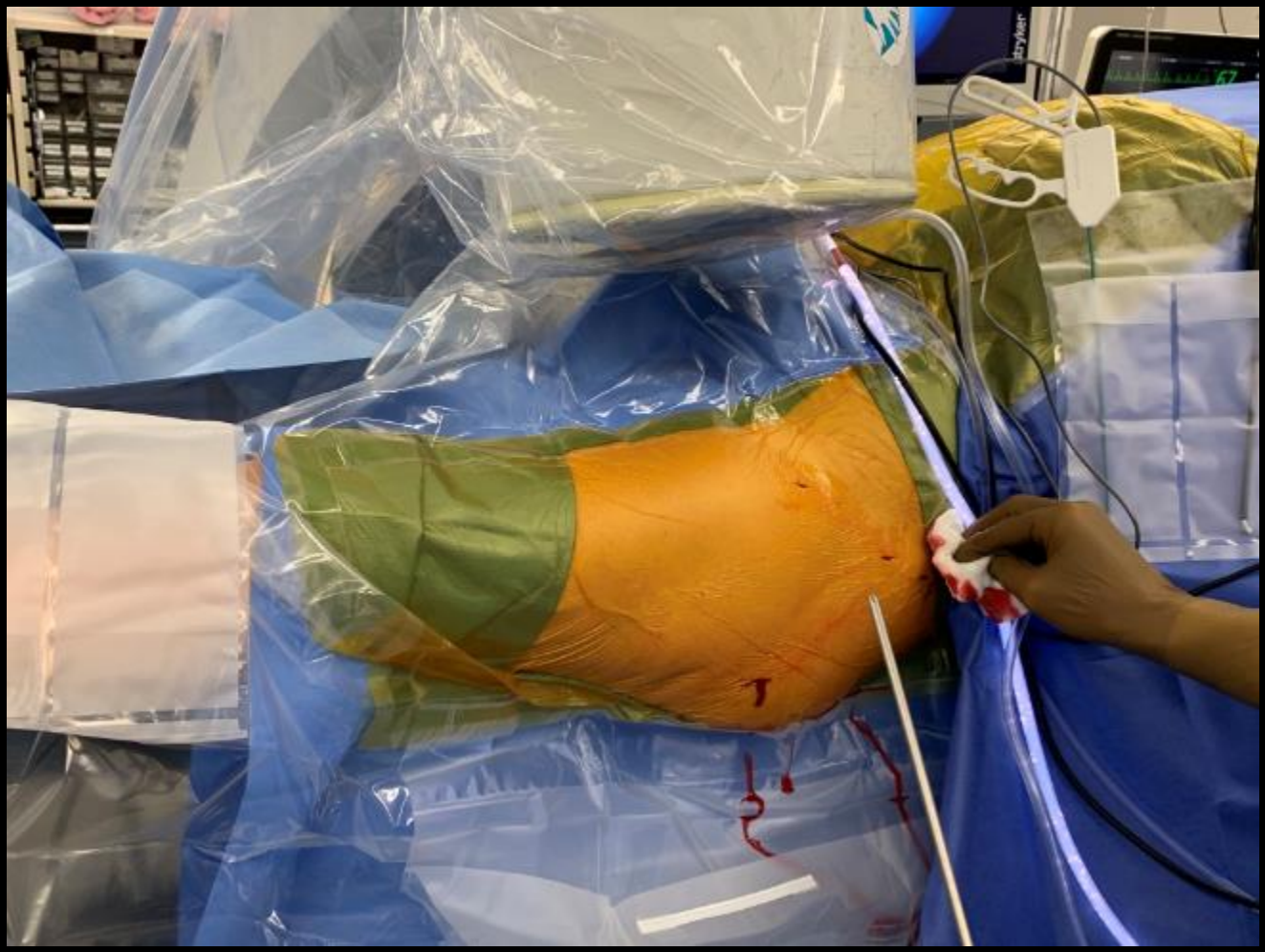
- Sacrum stress fracture
- SI joint pain
- Low back Pain
- Pelvic complaints


INITIAL AP


INITIAL AP

IFI - Surgical Treatment

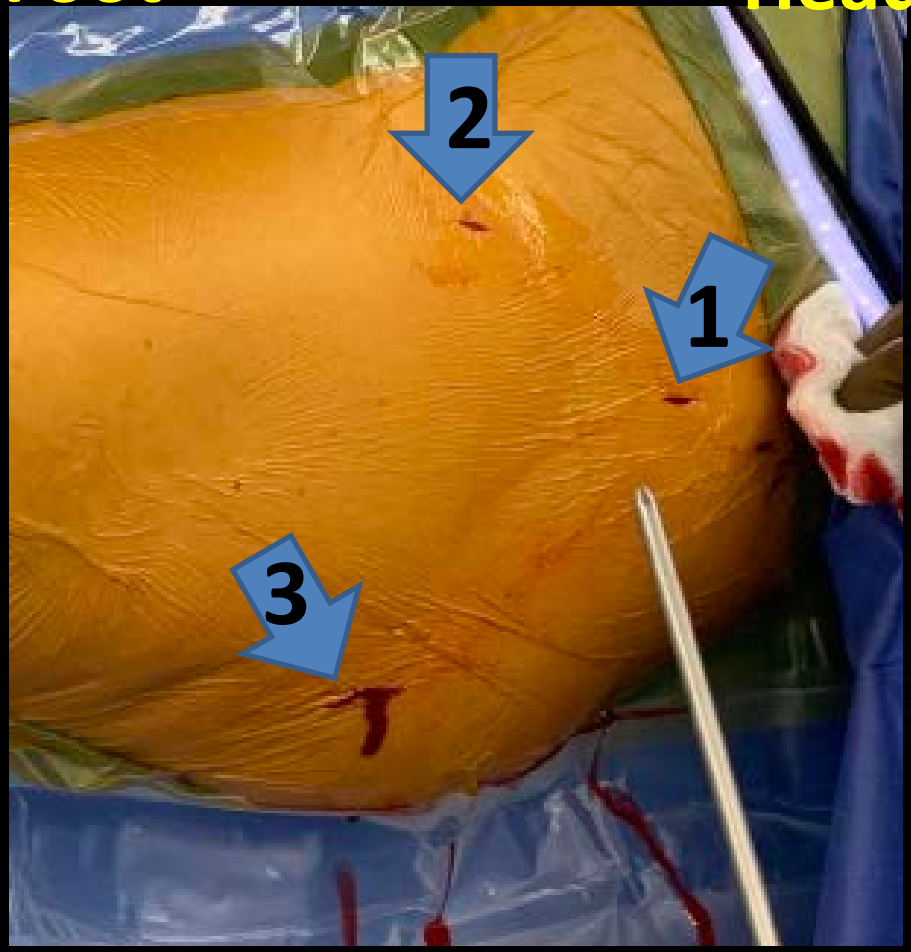
Foot



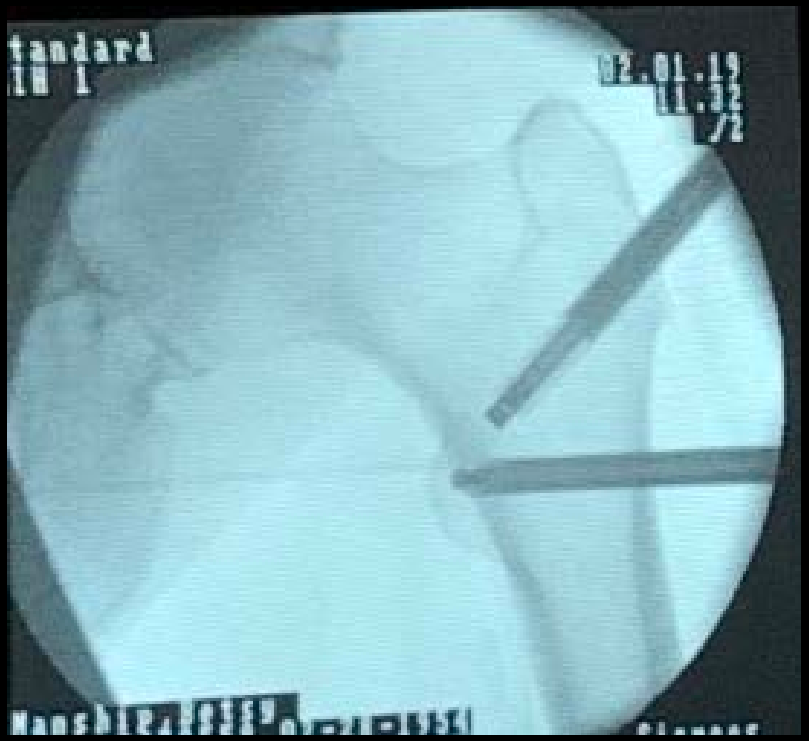
Head

IFI - Surgical Treatment

Foot **Head**




stryker
51
100
29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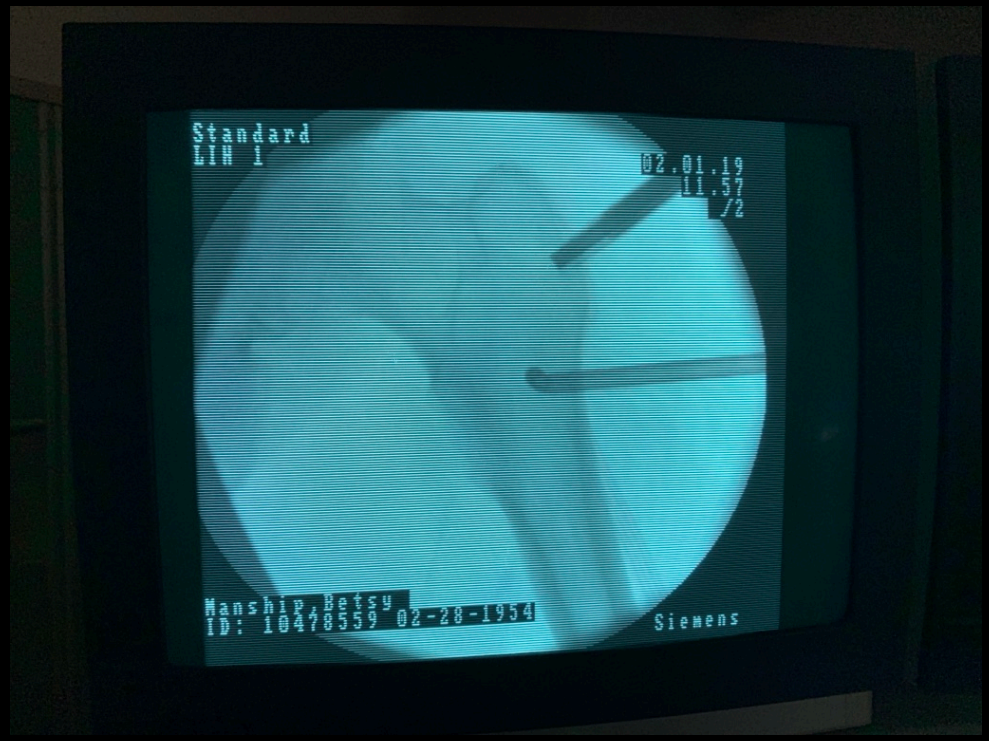
Standard
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Siemens


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73
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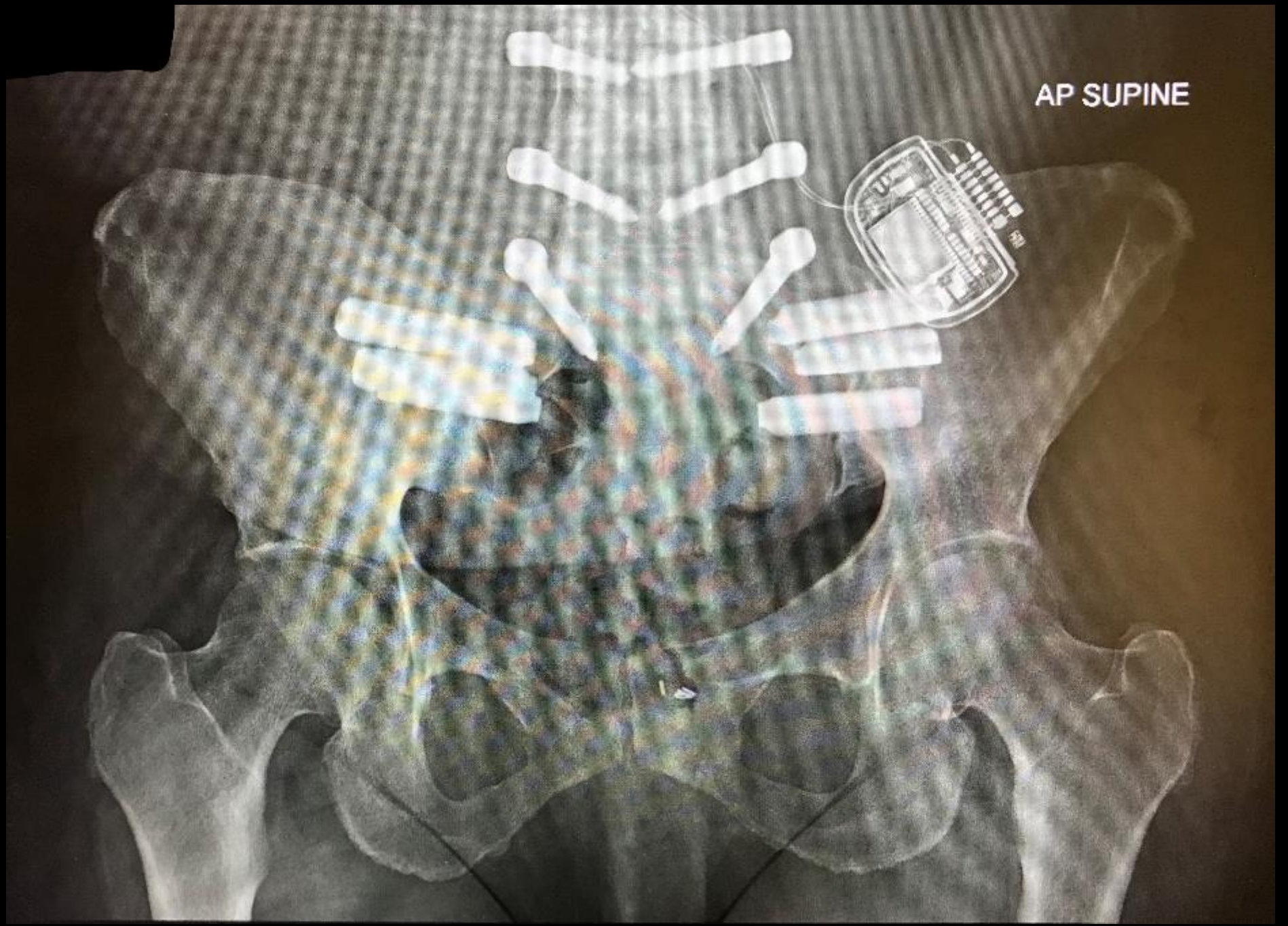
35.8
99
35
109/66 (76)
10
7:40
PHILIPS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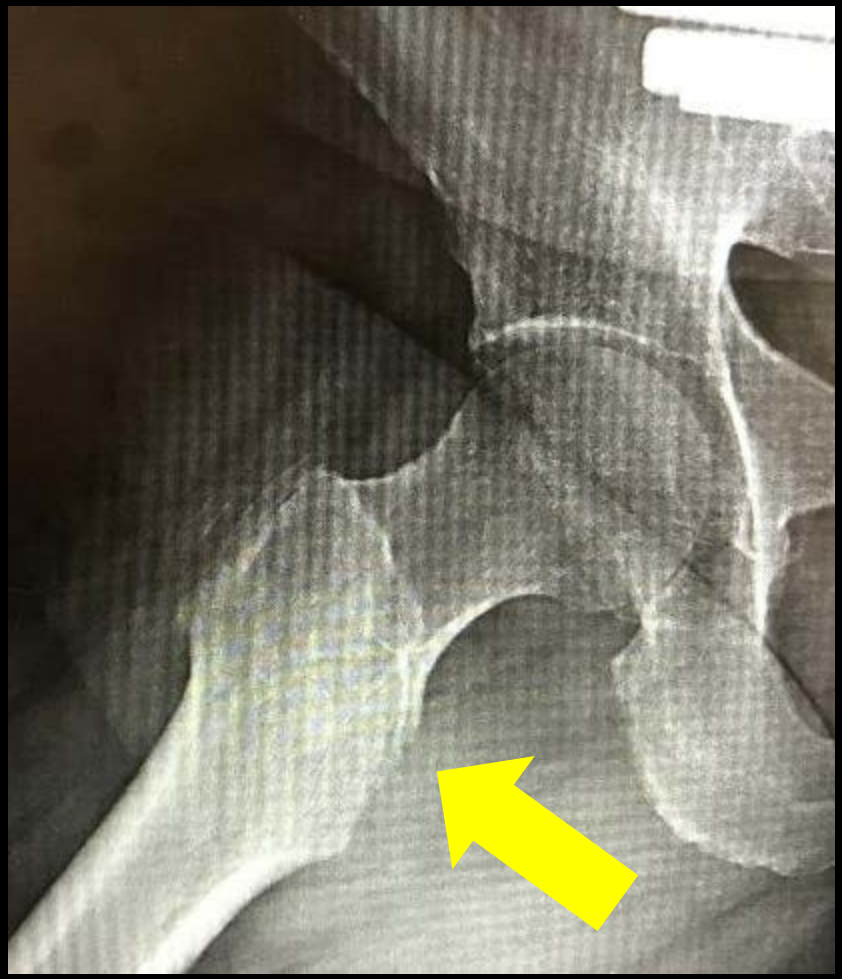
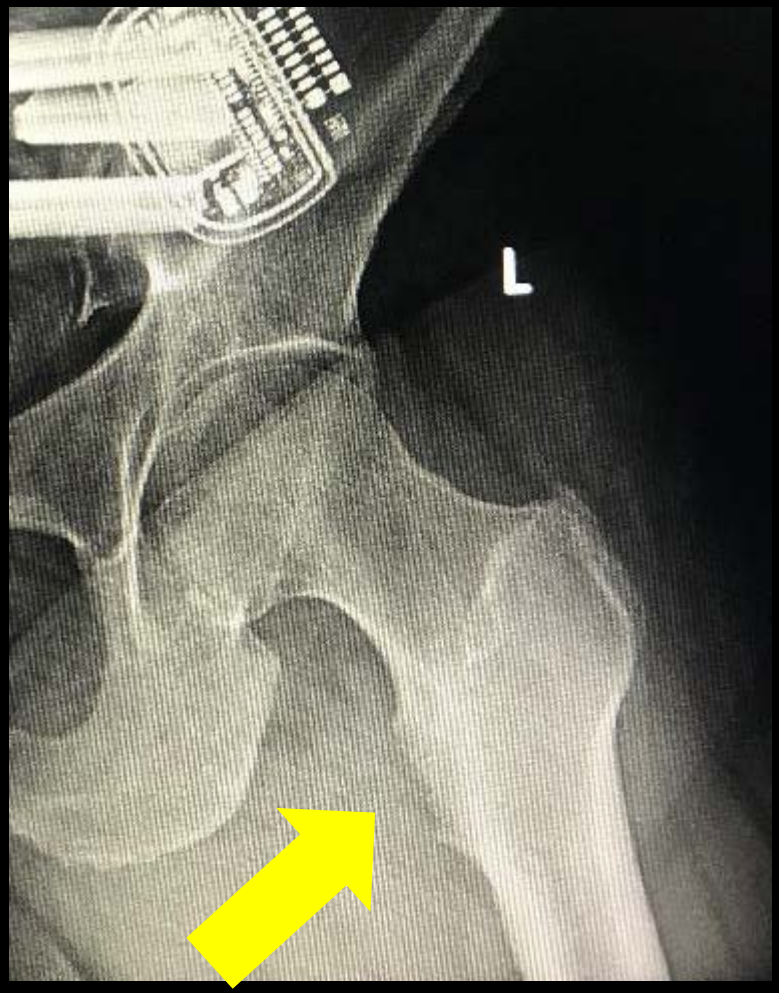



L

LT plasty in 41 hips

- Oswestry Disability Index
  - Before surgery: 47% (severe disability)
  - Last Follow-up(3 months to 2 y): 22%

› Arthroscopy. 2021 May;37(5):1503-1509. doi: 10.1016/j.arthro.2021.01.006. Epub 2021 Jan 15.

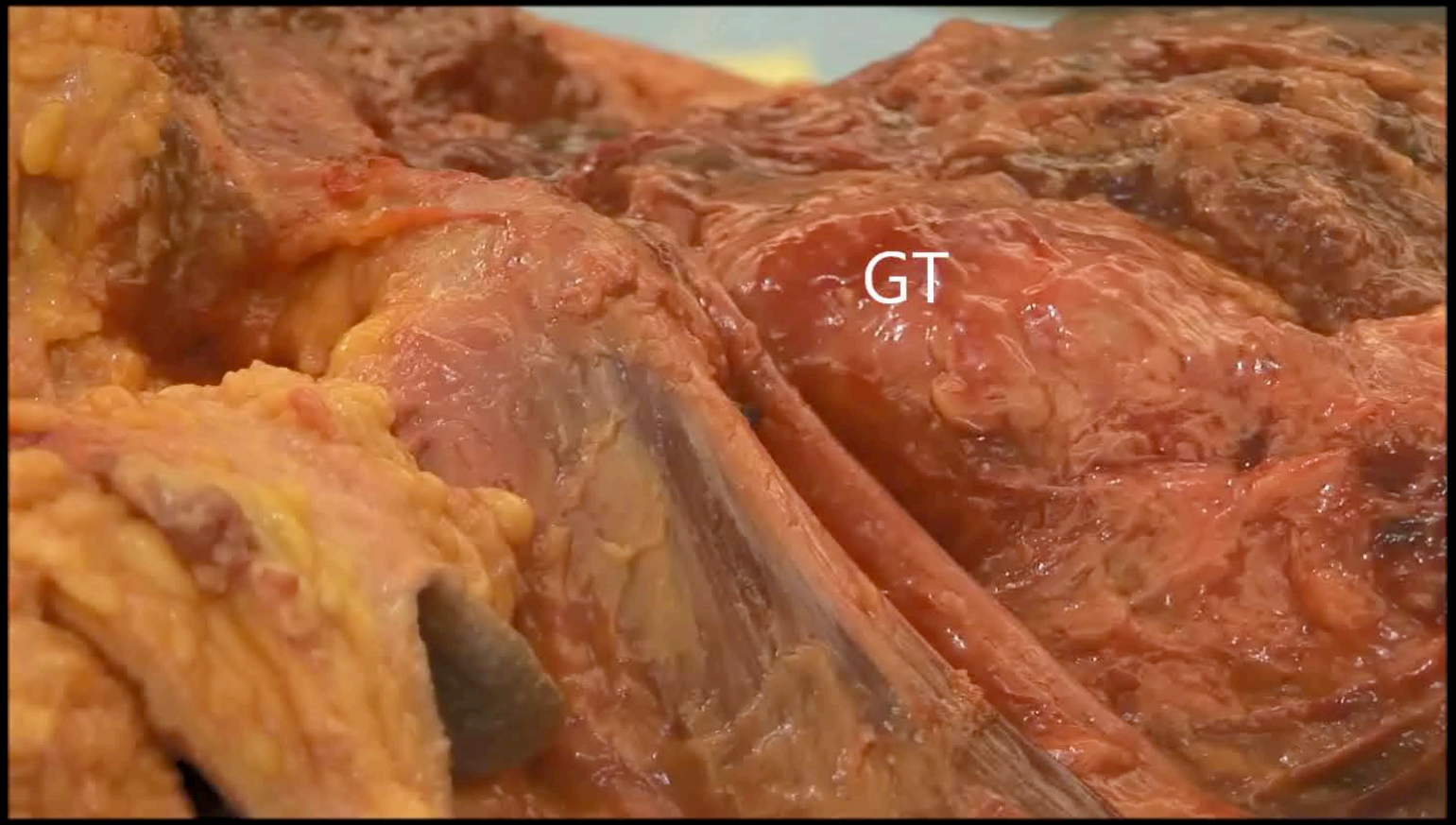
Low Back Pain Improves After Surgery for Lesser Trochanteric–Ischial Impingement

Munif Hatem [1], Hal David Martin [2]

LT plasty at 1.5 years

- mHHS : from 56 to 81
- Oswestry: from 48% to 21%

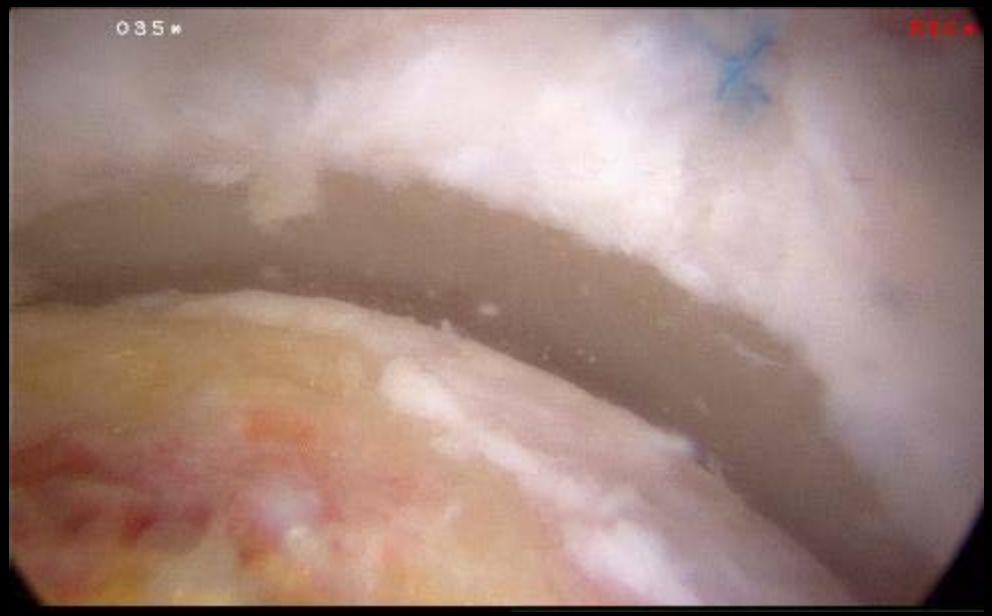
Kinematics of Sciatic Nerve
Sciatic moves lateral at ischial tunnel with knee flexion hip flexion abduction

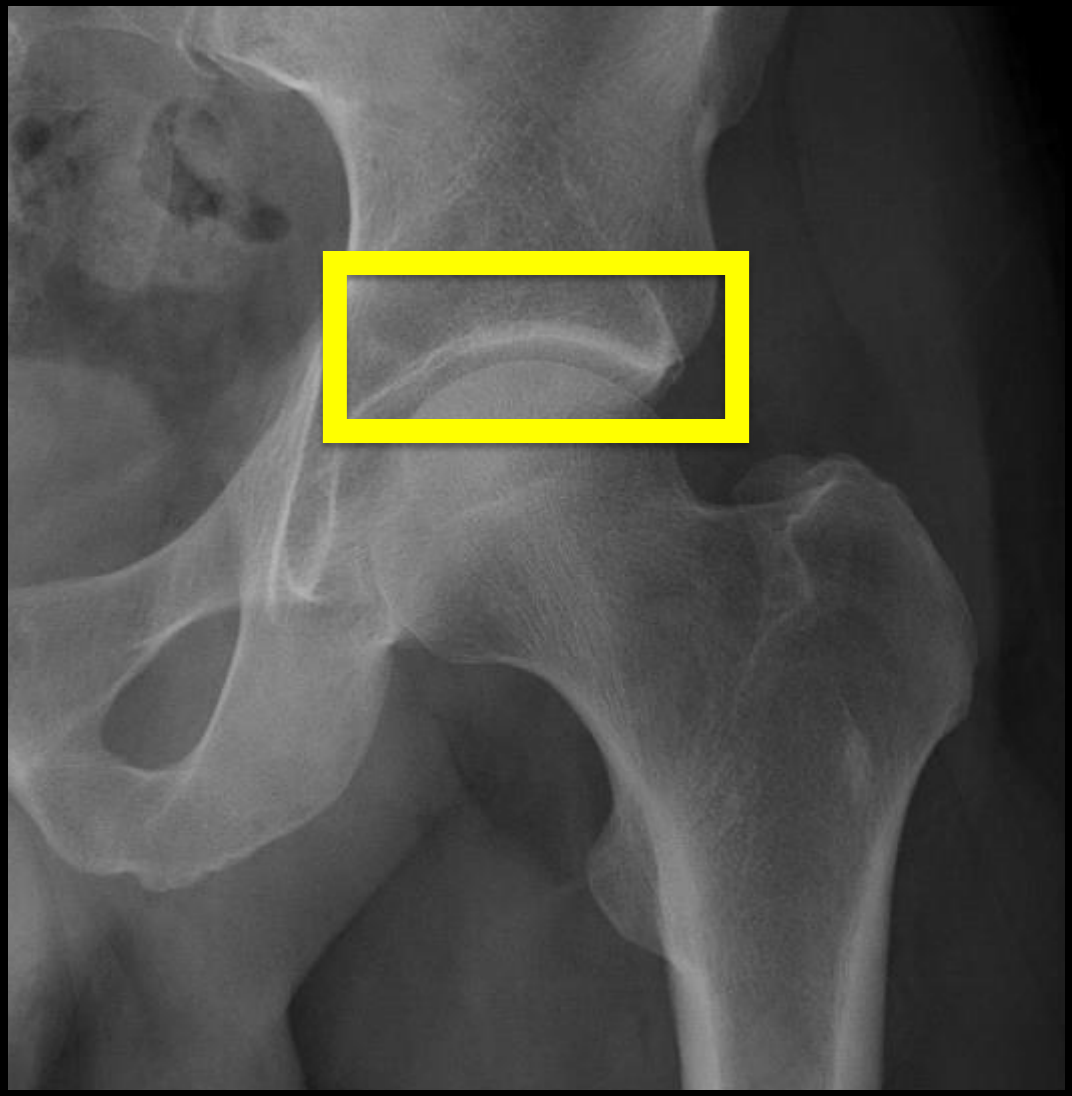


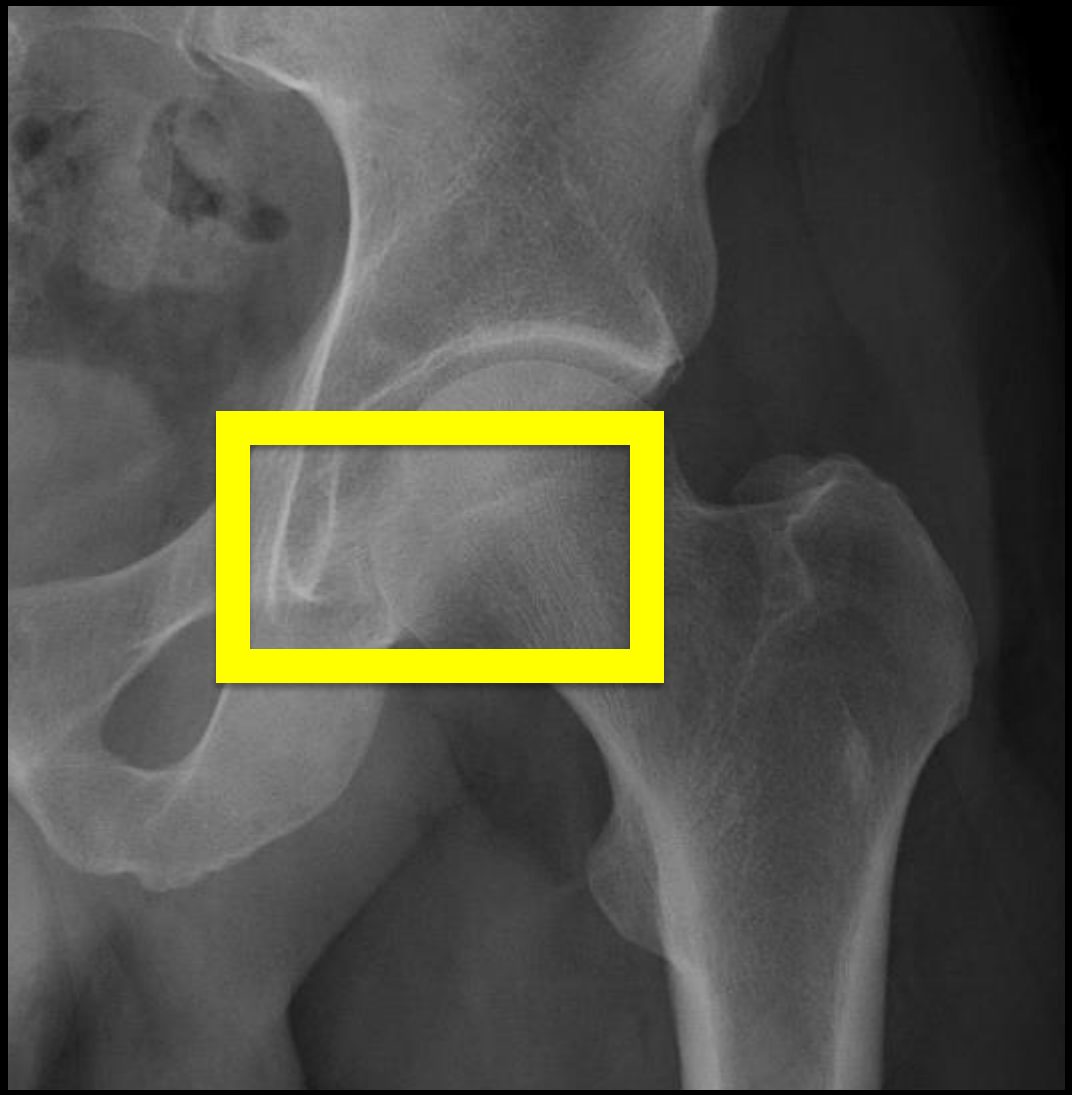
Antero-Inferior Instability

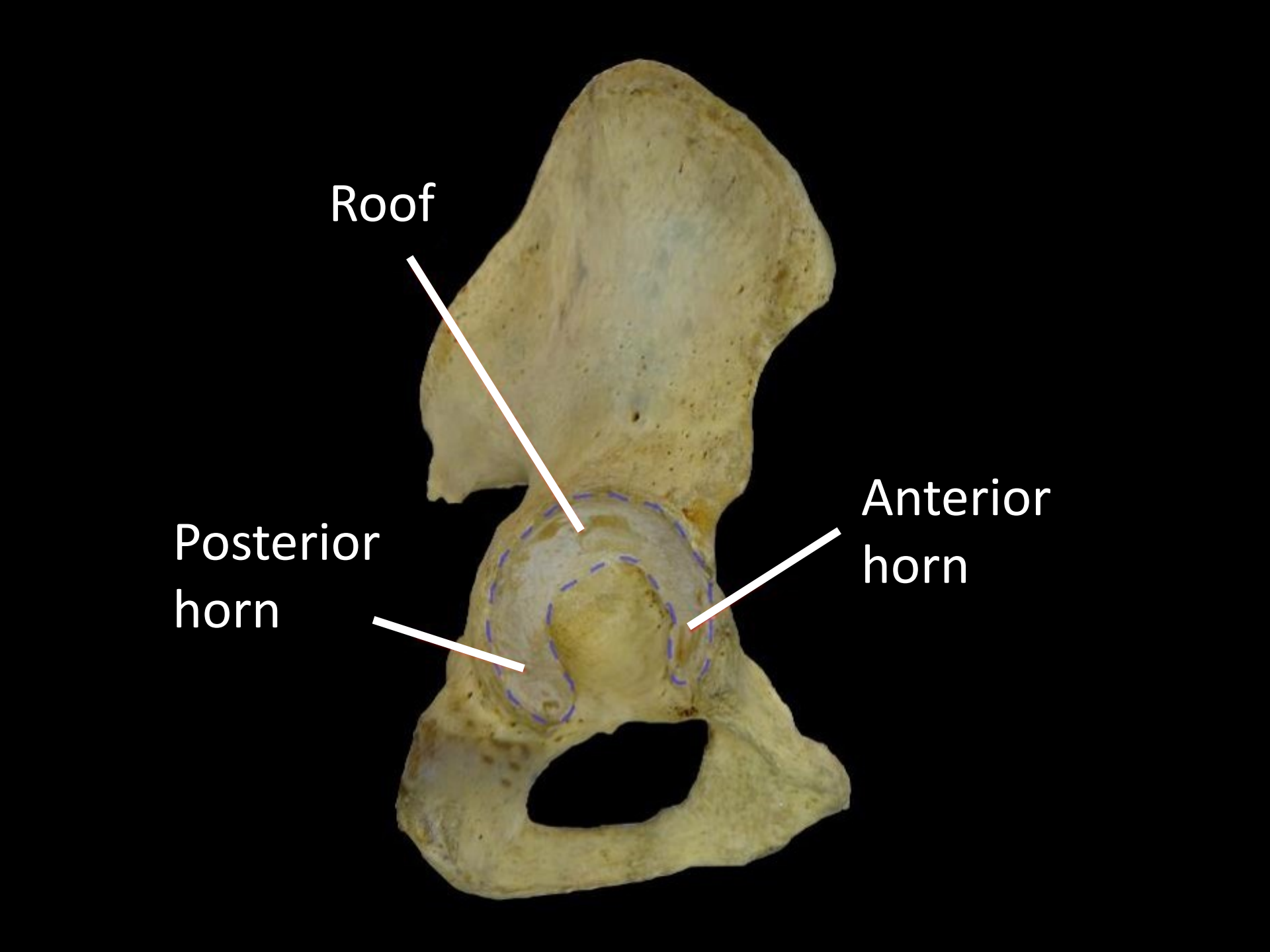
Dynamic testing

Dynamic assessment – Subluxation with > 60-90º of hip flexion








Roof
Posterior horn
Anterior horn

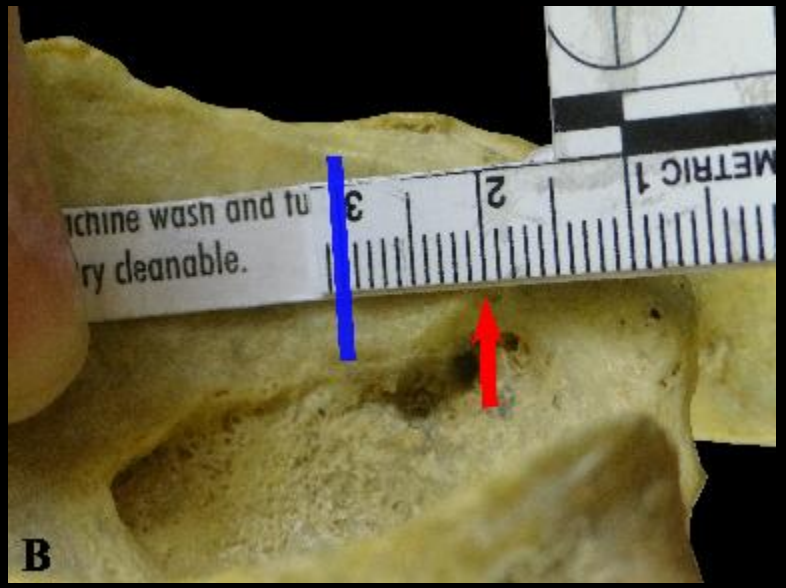
2016, Journal of Hip Preserv. Surg.

Parameters for assessment of the inferior acetabulum morphology in 300 adult hips

Munif A. Hatem[1,2,*], Luiz A. M. da Cunha[2], João C. M. Abdo[2] and Hal David Martin[1]

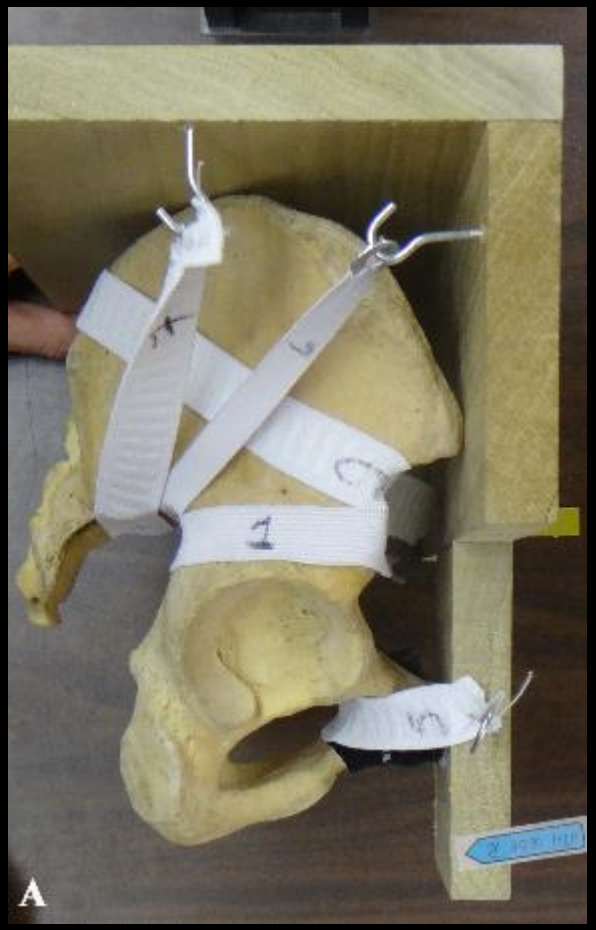
- Hamann-Todd Collection – Cleveland Museum of Natural History
- 300 acetabula (150 pelvises)


A

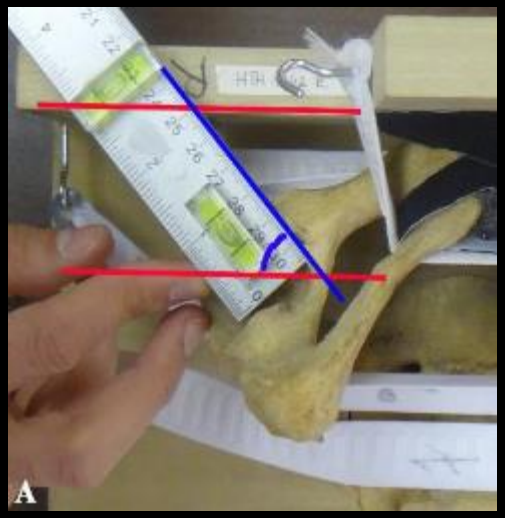

B

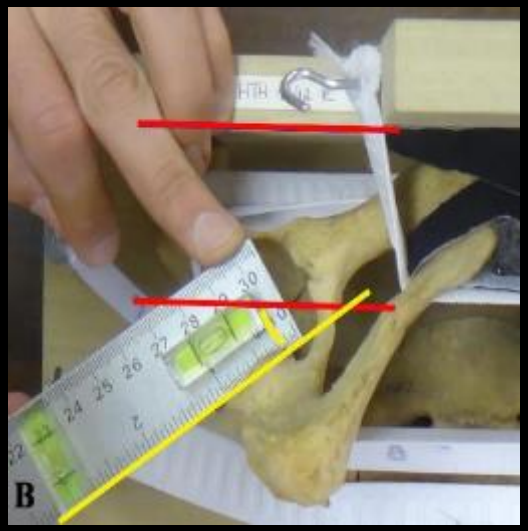

C

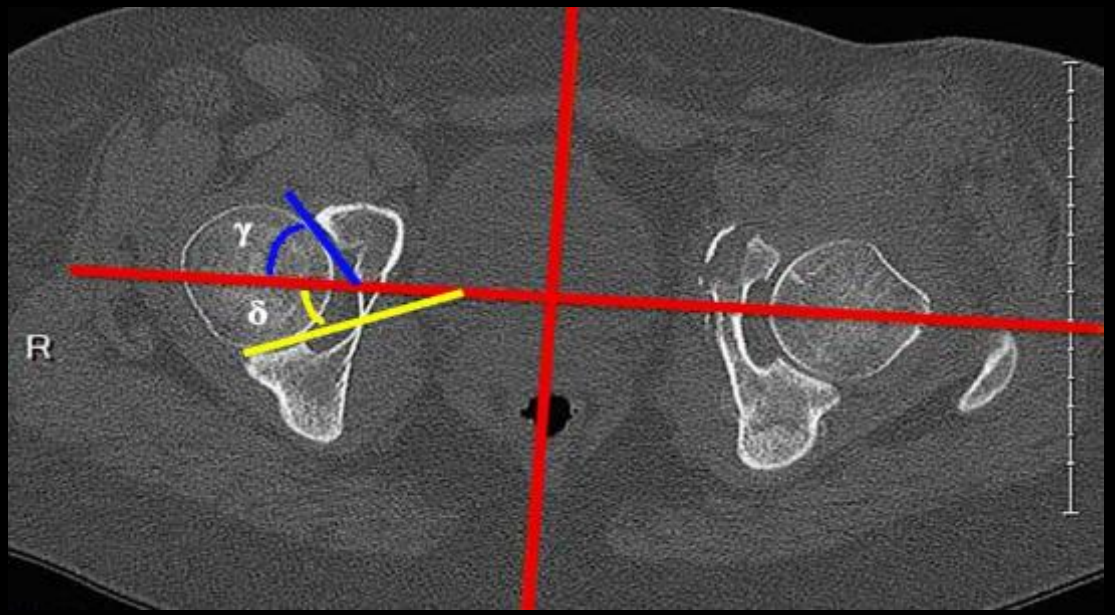

A


A

Anterior and posterior horn angle



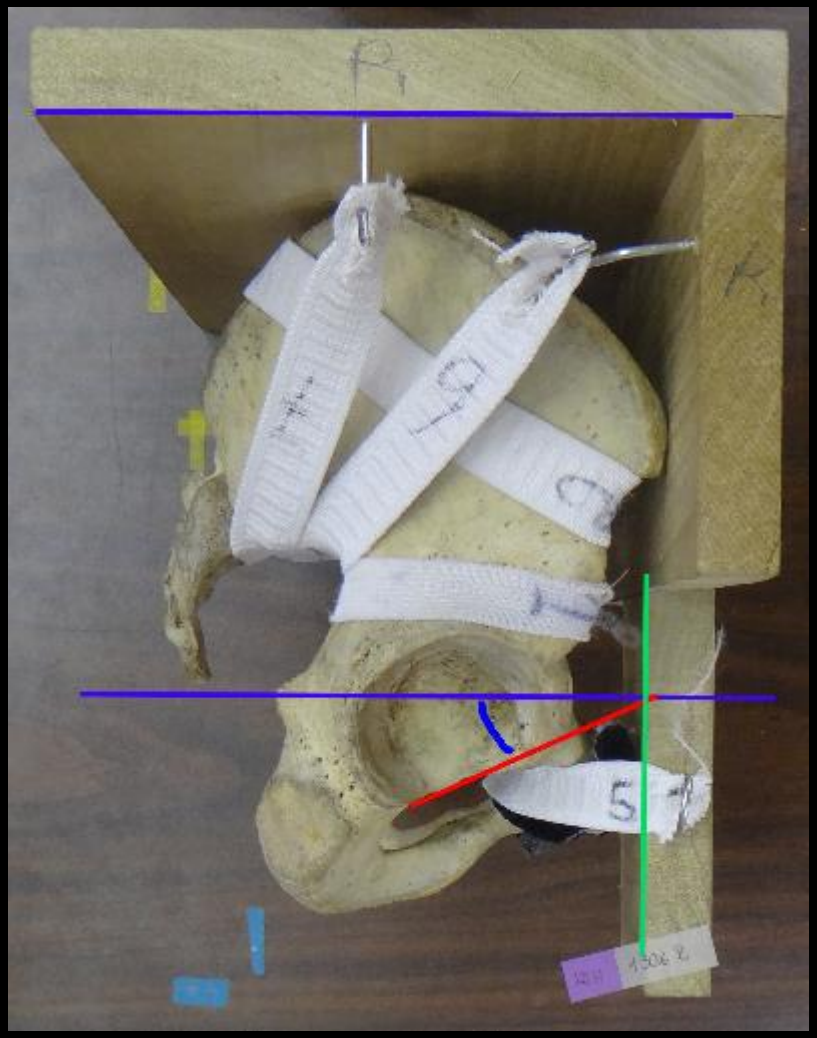




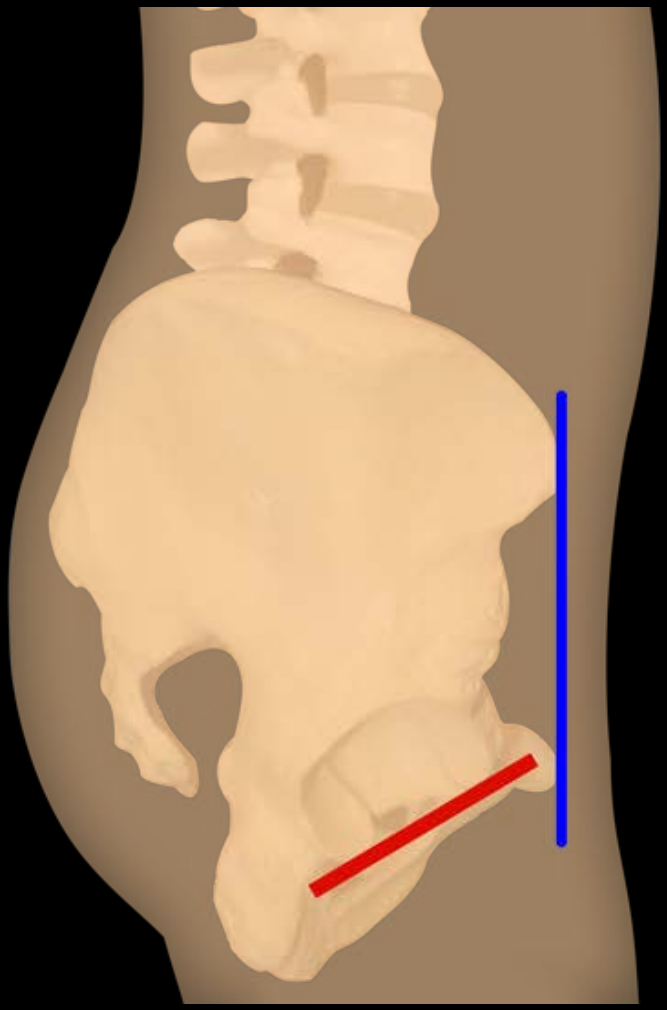
Slope

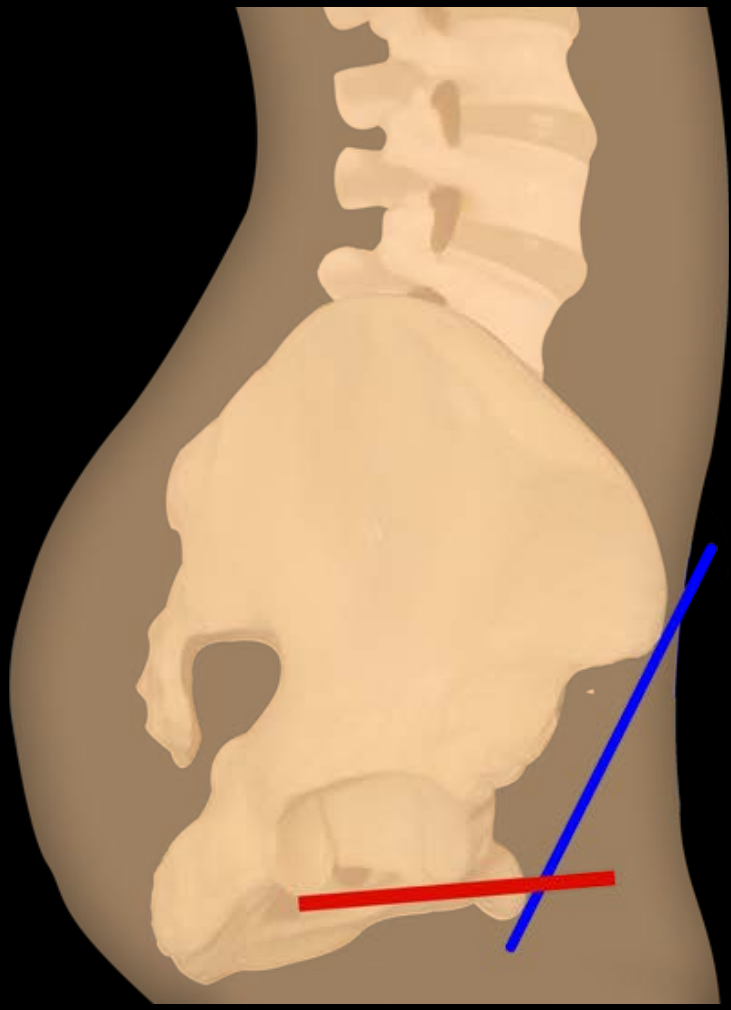
Mean:
25.33° (± 5.4°)

Range:
10.9° to 43.1°




HTH
1343 C





Anterior Inferior Acetabular Horn Morphology: A Factor In Hip Instability

Asadullah Helal[1], Anthony Khoury[1], Ricardo G. Schroder[1], Shahnawaz Yousaf[2], Ian J. Palmer[1], Hal D. Martin[1]

Inferior Stability

- Bone morphology
- Femoral version
- Pelvic tilt
- Teres ligament
- Ischiofemoral and pubofemoral ligament
- Muscle strength

Capsulolabral Layer

2012, Arthroscopy

Physiological Changes as a Result of Hip Arthroscopy Performed With Traction

Hal D. Martin, D.O., Ian J. Palmer, Ph.D., Keith Champlin, B.S., Bill Kaiser, Bryan Kelly, M.D., and Michael Leunig, M.D.

Physiologic Changes as a Result of Hip Arthroscopy Performed with Traction. *Arthroscopy,* Martin et al.

- Blood Flow:
  - Intra-operative popliteal vein: (13/15 patients) complete occlusion
  - Intra-operative femoral vein: (5/15 patients) demonstrated flow decreased of >50%

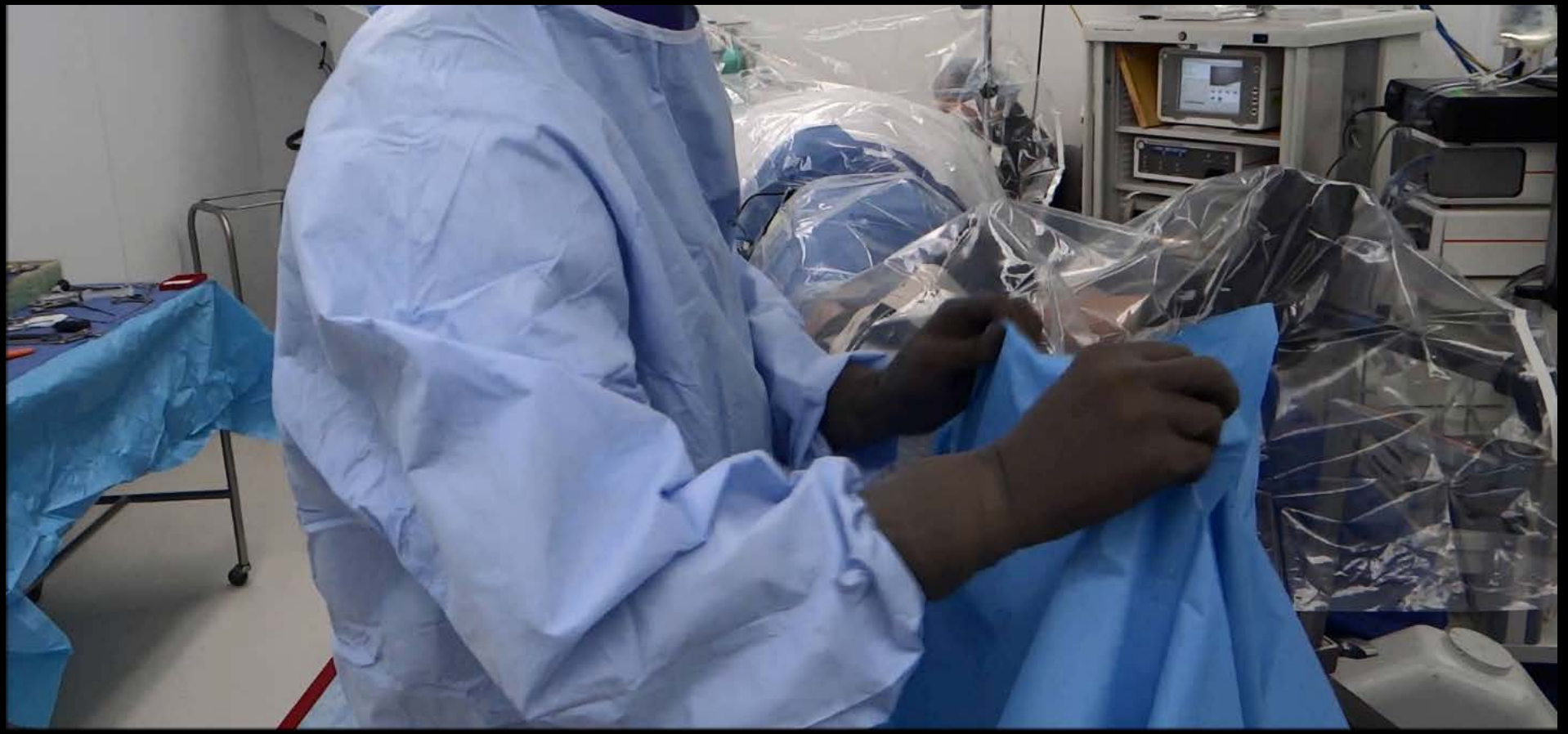
Martin HD. et al. 2012.

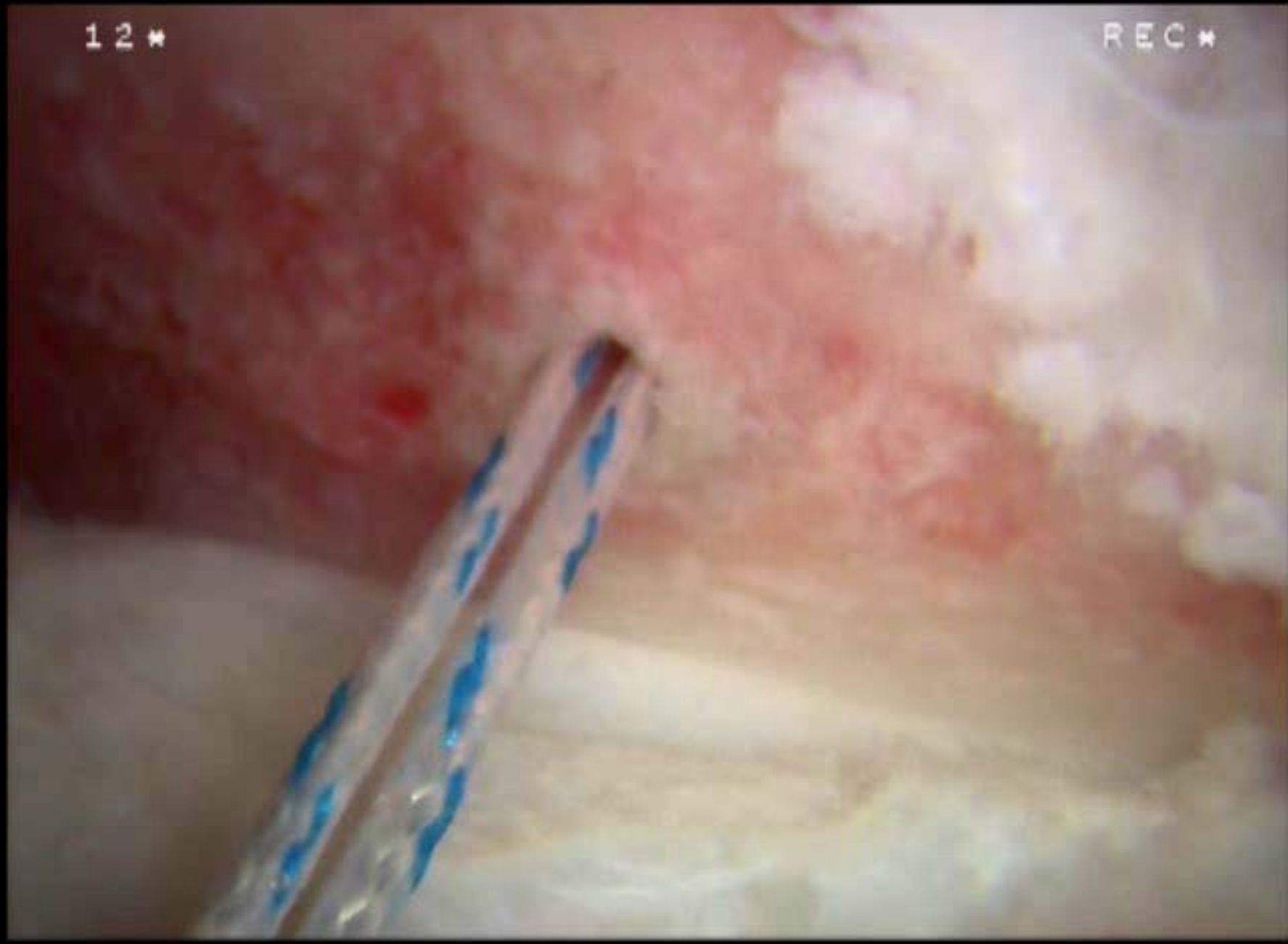
Physiologic Changes as a Result of Hip Arthroscopy Performed with Traction.

- SSEP
  - Operative limb, 8 of 15 patients had significant response:
    - 5 PTN only, 1SPN only, and 2 PTN/SPN
  - Non-operative limb, 9 of 15 patients had significant response:
    - 5 PTN only, 2 SPN only, and 3 PTN/SPN

Martin HD. et al. 2012.

Release traction




12
REC

Outcomes

- 2013-2019 (No significant change in technique since 2008)
- 658 hips
- Post-Op Follow-up > 1 year
- HHS: Pre-Op Post-Op

  59.7 83.7

2008

The Function of the Hip Capsular Ligaments: A Quantitative Report

Hal D. Martin, D.O., Adam Savage, B.S., Brett A. Braly, B.S., Ian J. Palmer, Ph.D., Douglas P. Beall, M.D., and Bryan Kelly, M.D.

Capsular ligaments and Rotation

- Ischiofemoral → IR in flexion and extension
- Lateral arm of the iliofemoral ligament → ER in flexion
  ER and IR in extension
- Pubofemoral ligament → ER in extension/Flexion?

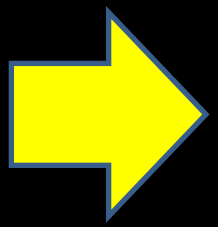
2017, Arthroscopy

Contribution of the Pubofemoral Ligament to Hip Stability: A Biomechanical Study

Hal D. Martin, D.O., Anthony N. Khoury, M.S., Ricardo Schröder, P.T., Eric Johnson, B.S., Juan Gómez-Hoyos, M.D., Salvador Campos, M.D., and Ian J. Palmer, Ph.D.

Pubofemoral ligament function

Pubofemoral ligament

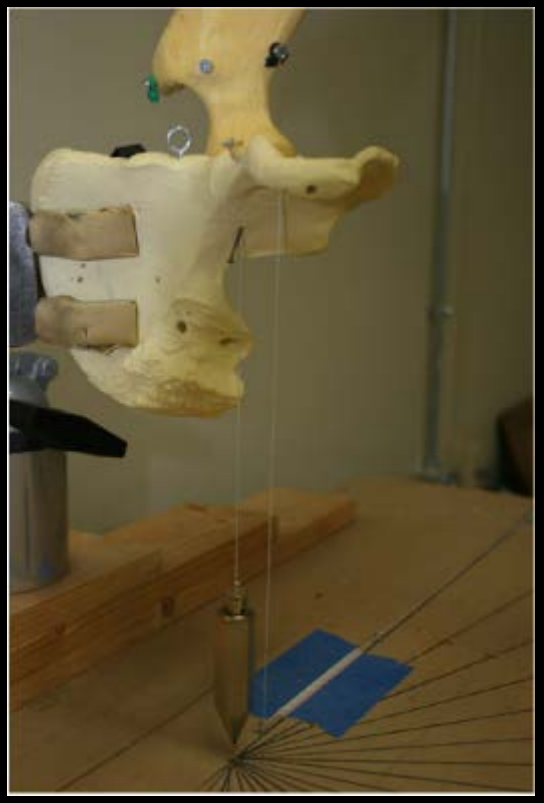


Limits IR in flexion + abduction

2012, KSSTA

Ligamentum teres: a functional description and potential clinical relevance

RobRoy L. Martin · Ian Palmer · Hal D. Martin



2013, KSSTA

Function of the ligamentum teres during multi-planar movement of the hip joint

Benjamin R. Kivlan · F. Richard Clemente · RobRoy L. Martin · Hal D. Martin

2014, Arthroscopy

Function of the Ligamentum Teres in Limiting Hip Rotation: A Cadaveric Study

Hal D. Martin, D.O., Munif A. Hatem, M.D., Benjamin R. Kivlan, M.S., P.T., and RobRoy L. Martin, Ph.D., P.T., C.S.C.S.

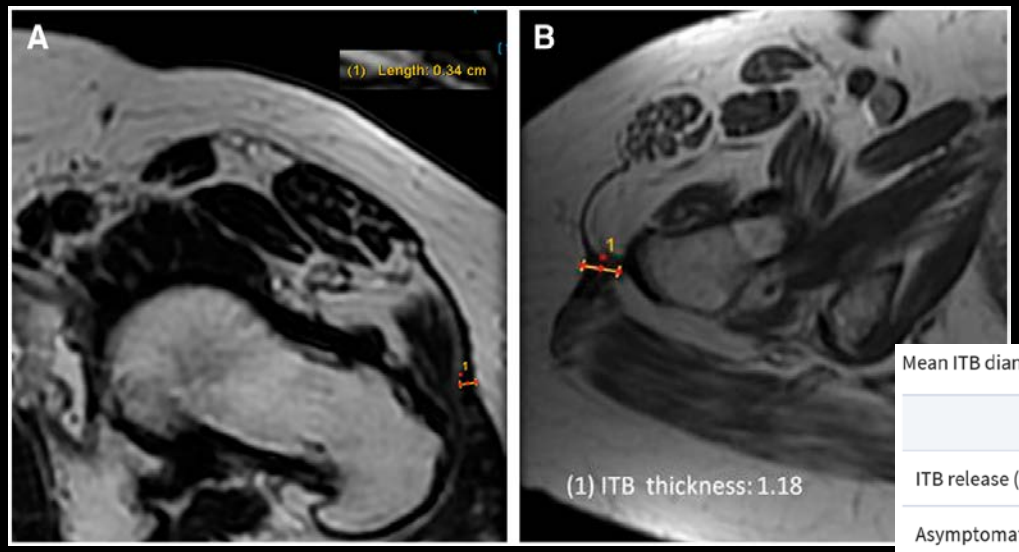
The LT functions as an end-range stabilizer to hip rotation dominantly at 90° or greater of hip flexion

Musculotendinous Layer

2018, Journal of Hip Preserv Surg

Proximal iliotibial band thickness as a cause for recalcitrant greater trochanteric pain syndrome

Anthony N. Khoury[1,2*], Karina Brooke[1], Asad Helal[1], Benton Bishop[1], Lane Erickson[1], Ian James Palmer[1] and Hal David Martin[1]



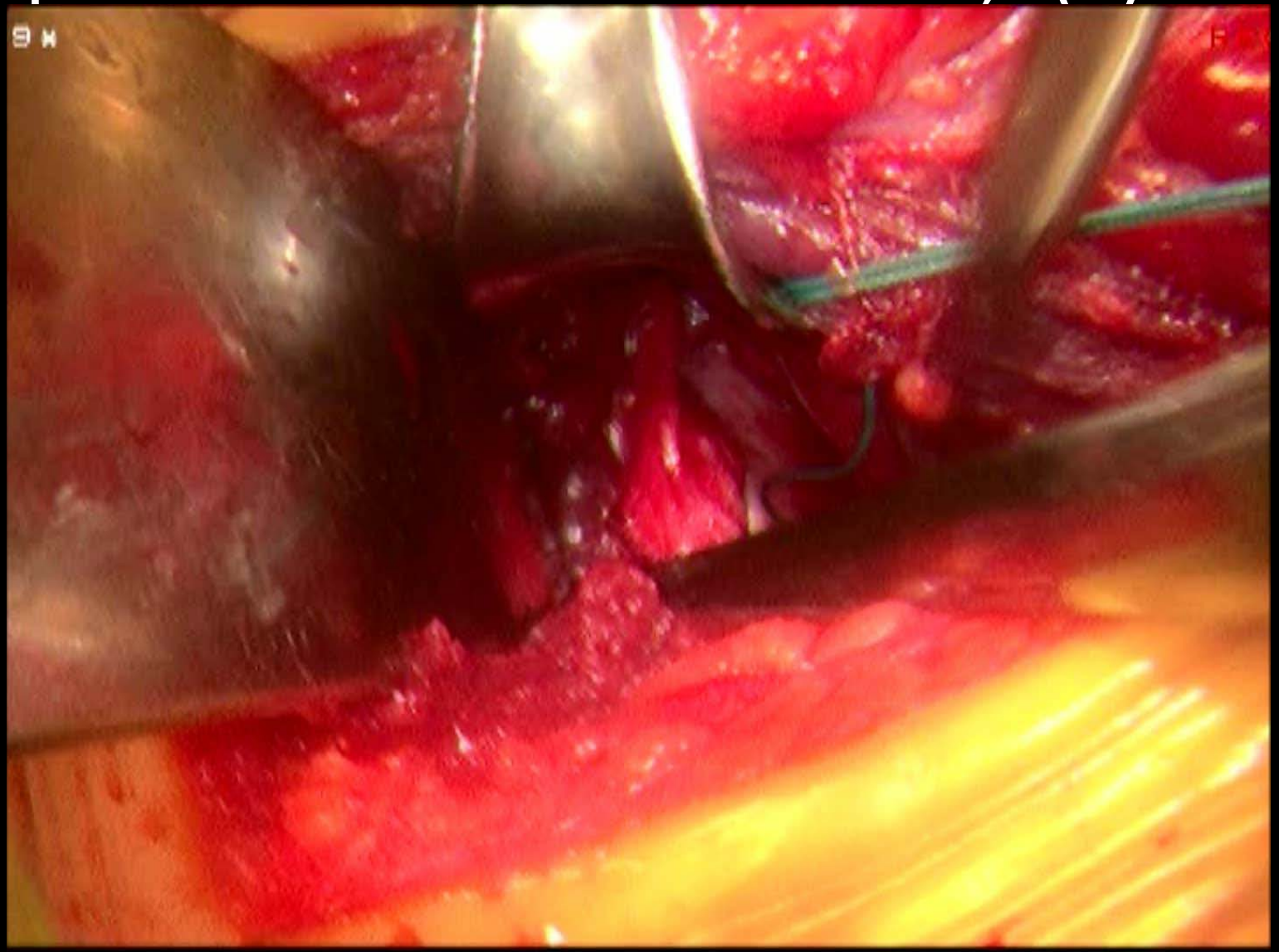
Mean ITB diameter thickness

	Average thickness (mm)	Standard deviation	*t*-test
ITB release (*n* = 34)	5.61	±2.10	*P* < 0.001
Asymptomatic (*n* = 20)	3.77	±0.79	

Assess muscle strength in all patients, every appointment

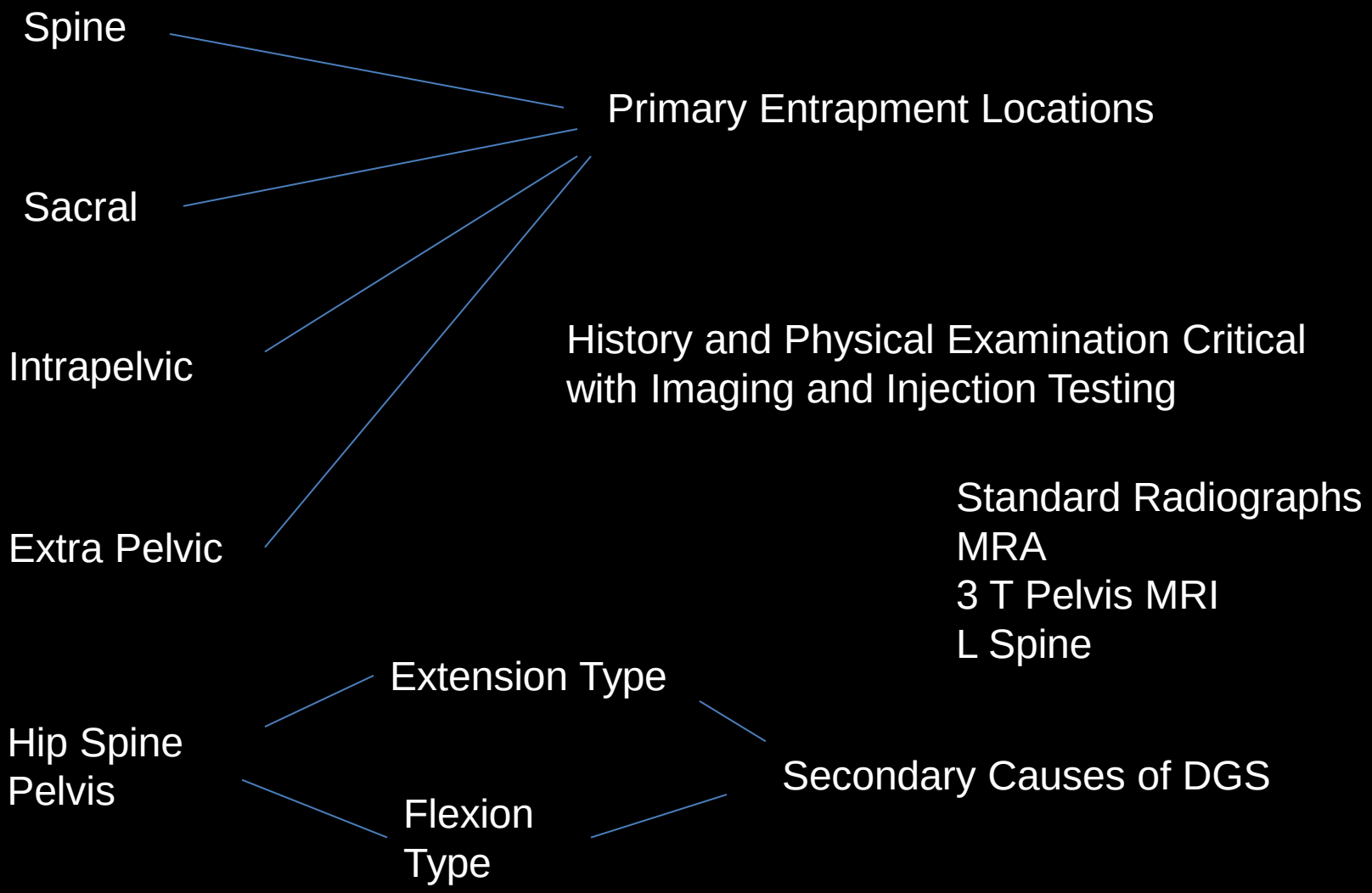
Arthroscopic Anatomy and Surgical Techniques for Peritrochanteric Space Disorders in the Hip
James E. Voos, M.D., Jonas R. Rudzki, M.D., Michael K. Shindle, M.D., Hal Martin, D.O., and Bryan T. Kelly, M.D.

Endoscopic assisted open hamstring repair . *Arthrosc Techn.* 2015;4(3):193-9



Neurovascular Layer

Sorting Posterior Hip Pathologies



Primary DGS

VS

Secondary DGS

Primary DGS

Intra pelvic

X

Extra pelvic

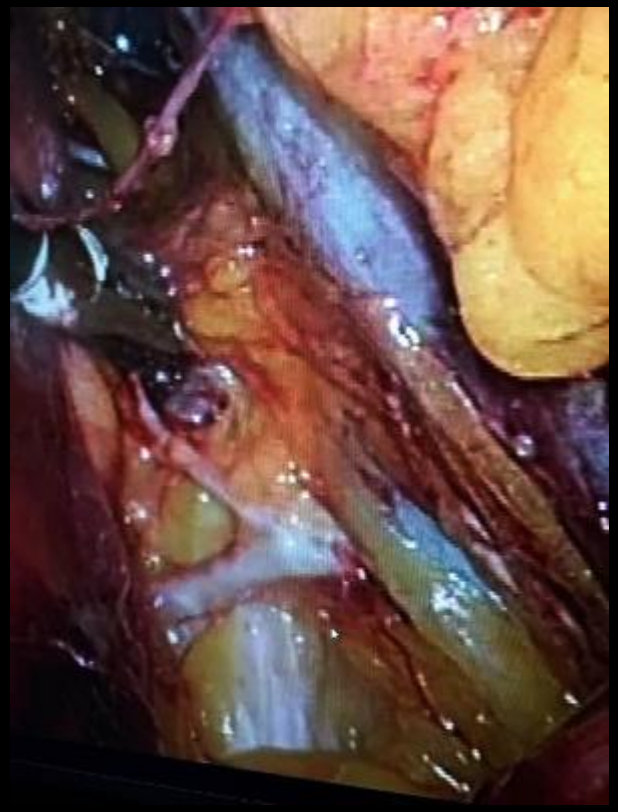
Intrapelvic Etiology

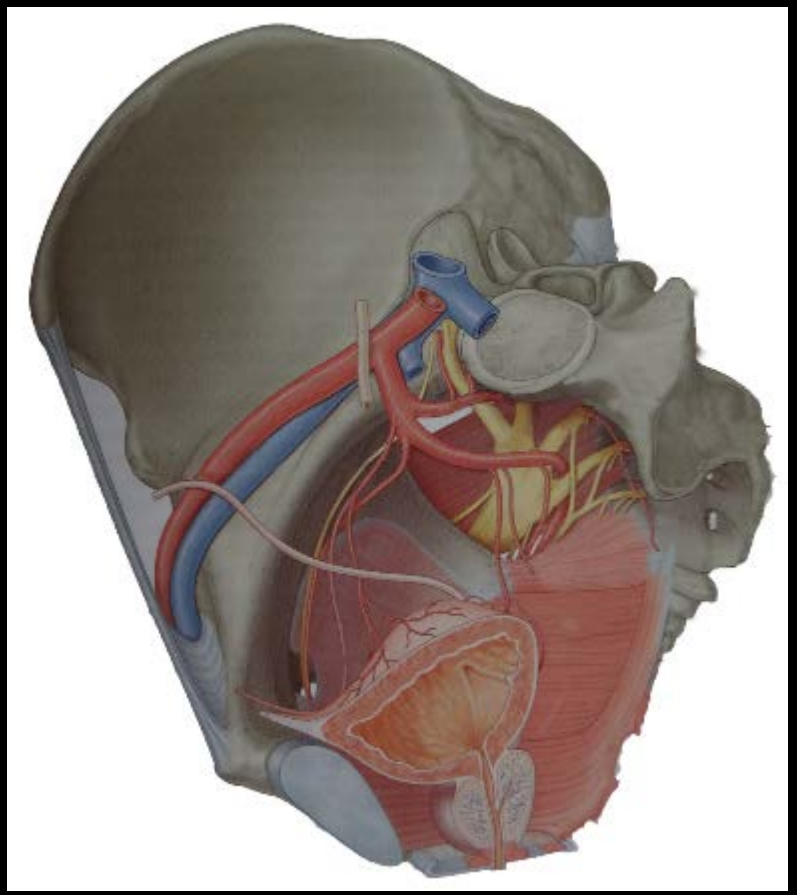
- Cyclic Pain or Post surgical Gyn pain
- Lying down 0/10…. Sitting Sever throb
- Physical selective dermatome sensory change
- Provocative P Piriformis Stretch
- MRI 3 T intra pelvic findings
- Selective Nerve Root Block as test and treatment
- Failed Conservative care >>> Intrapelvic Referral

Intrapelvic Nerve Entrapments

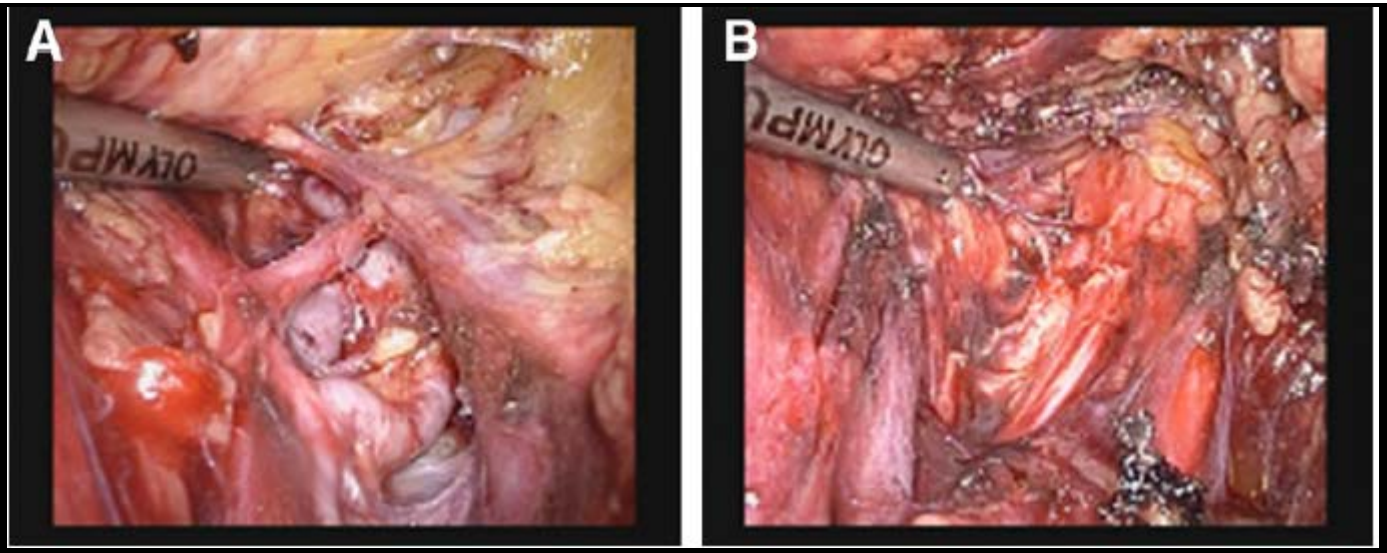
7

Nucelio L. B. M. Lemos





Laparoscopic therapy for endometriosis and vascular entrapment of sacral plexus



Comparison in VAS score before and after surgery at 6-month follow-up according to the causes.

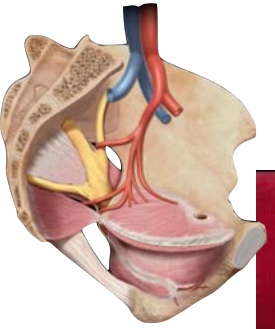
VAS score	Endometriosis (n = 175)	Vascular entrapment (n = 37)	Pyriformis muscle syndrome (n = 1)
Preoperative	7.7 (± 1.16; 6–10)	6.6 (± 1.43; 5–9)	7
6-mo follow-up	2.6 (± 1.77; 0–6)	1.5 (± 1.27; 0–4)	1

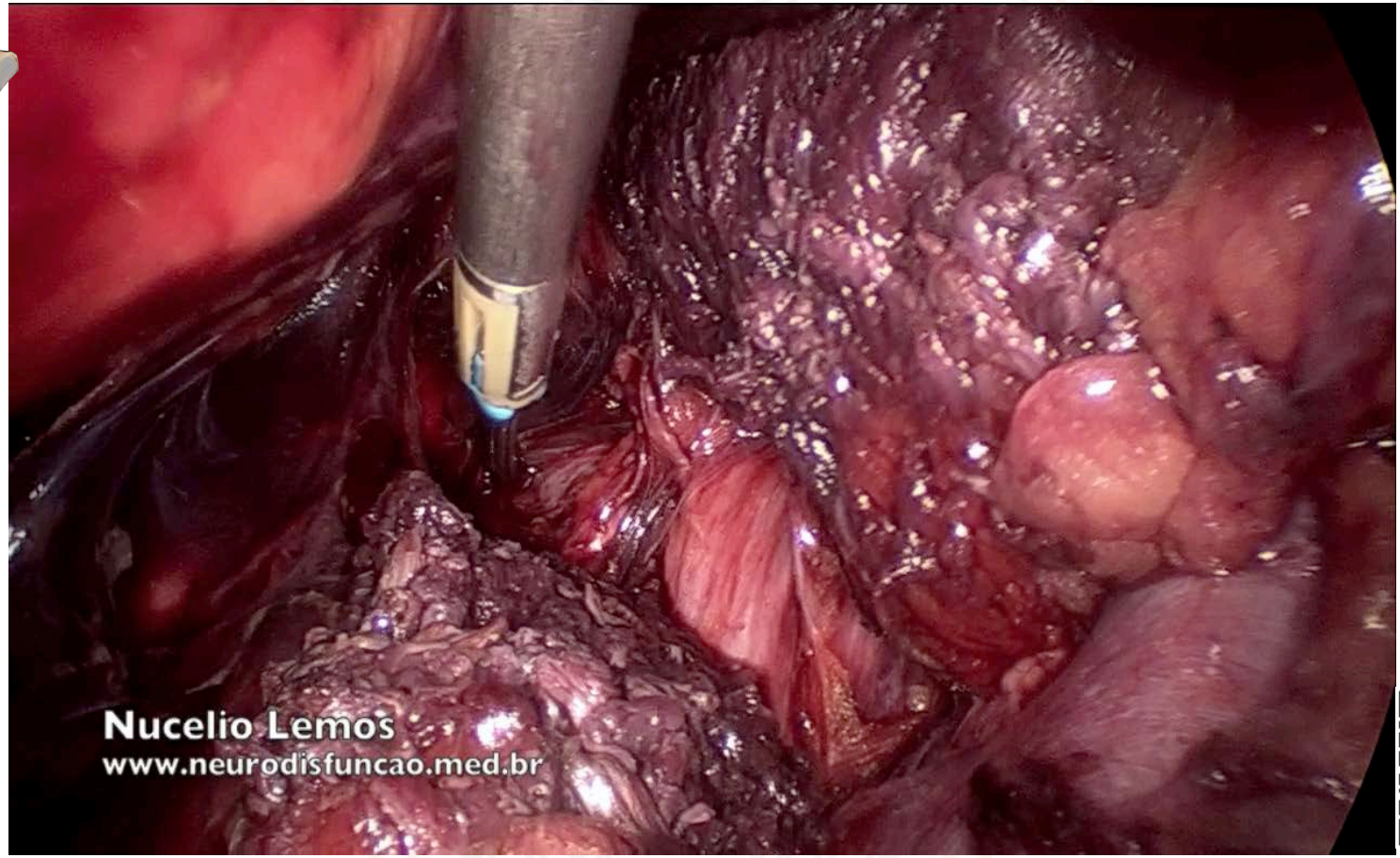
Note: Values are expressed as mean (± SEM; range). For all comparisons, $P < .001$ by *t*-test.

Possover. Techniques and instrumentation. Fertil Steril 2011.

Possover, M Fertil Steril. 2011 Feb

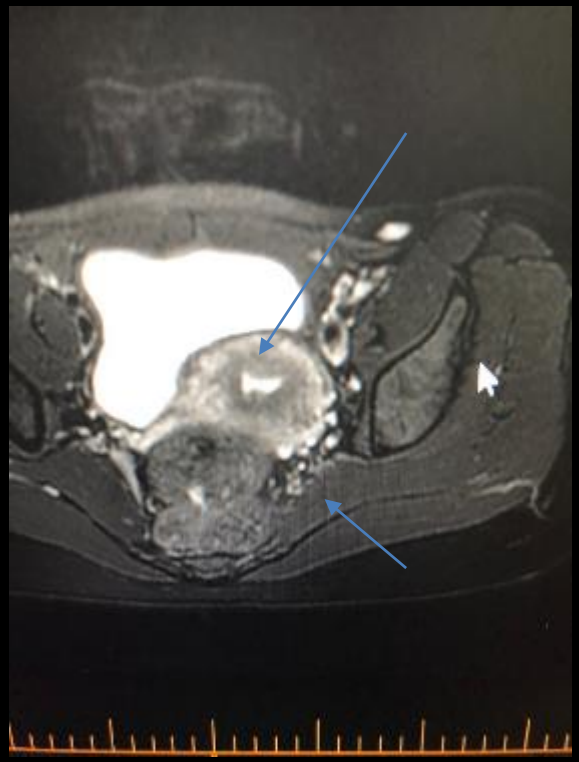
Muscular Entrapment

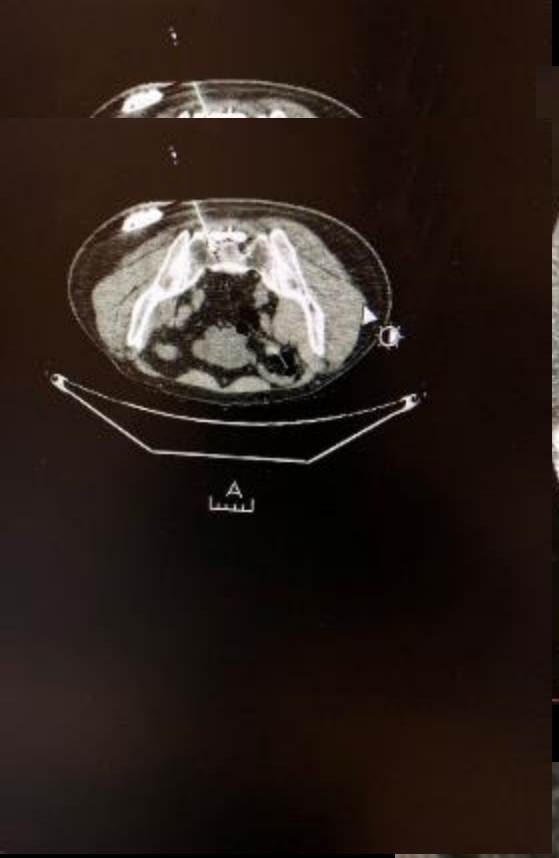


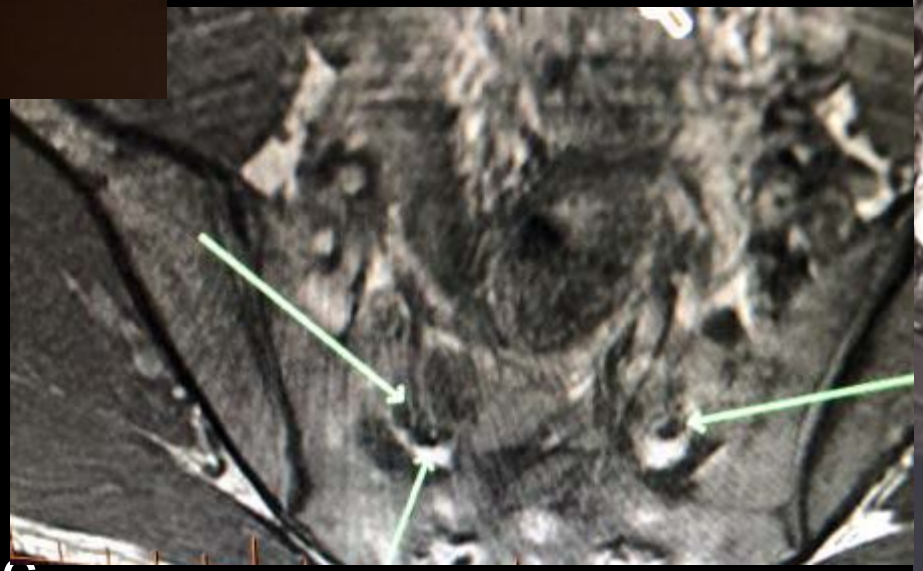


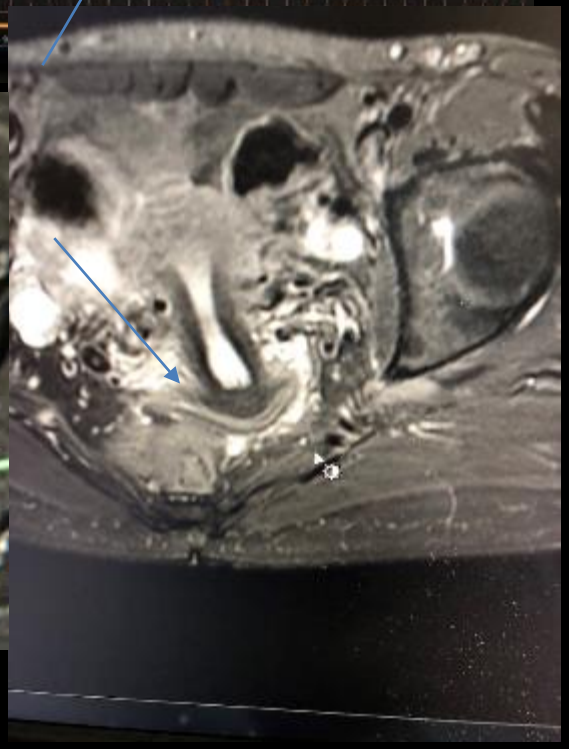
Sacral Tarlov/ Osseous R/ L Spine

Piriformis Effect
Intra pelvic and Extra Pelvic!



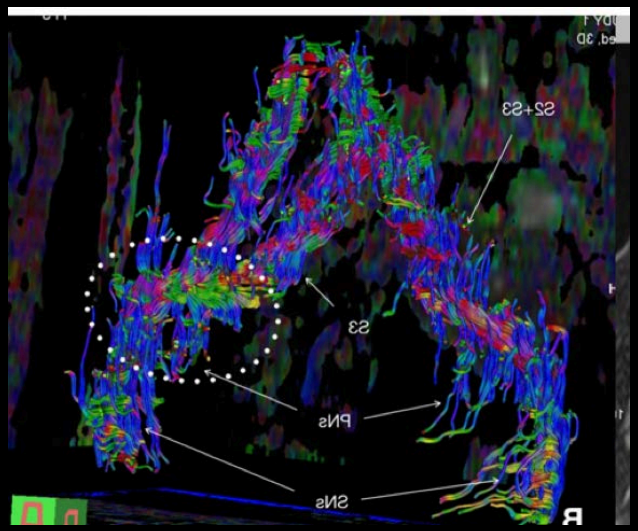




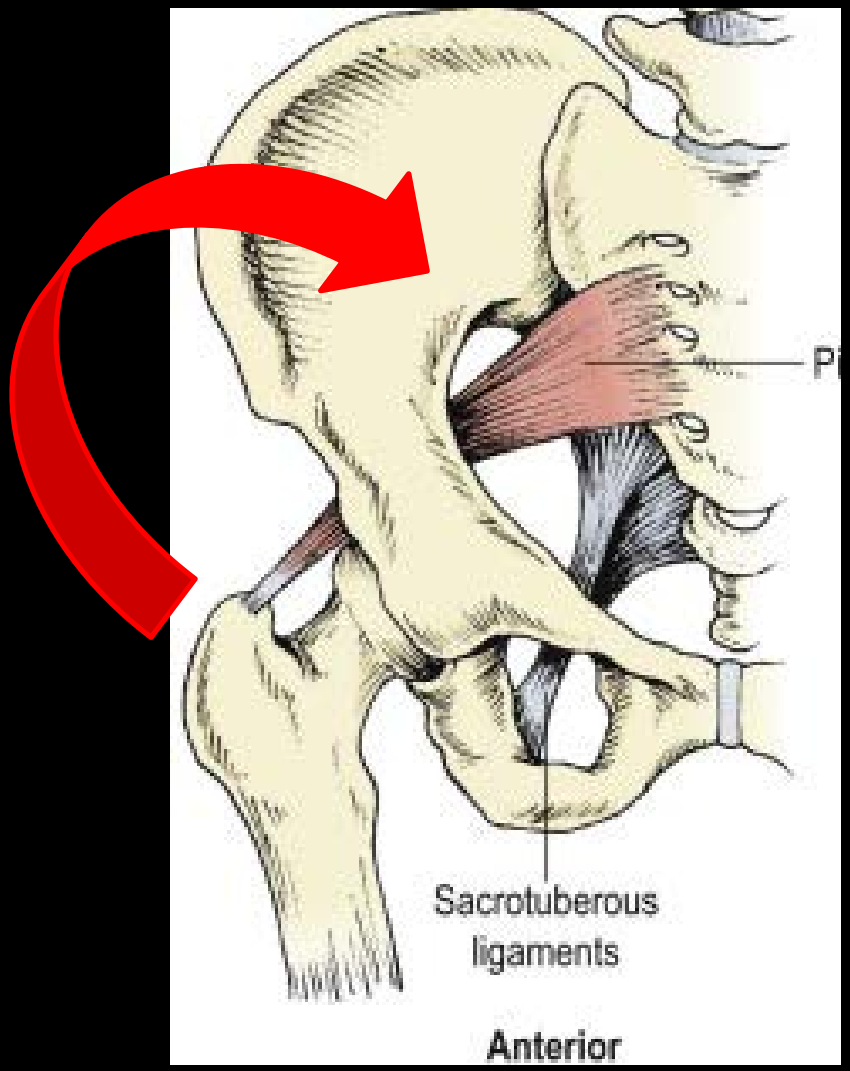


PT and
Injections
Laproscopic

Tractography positive intra pelvic

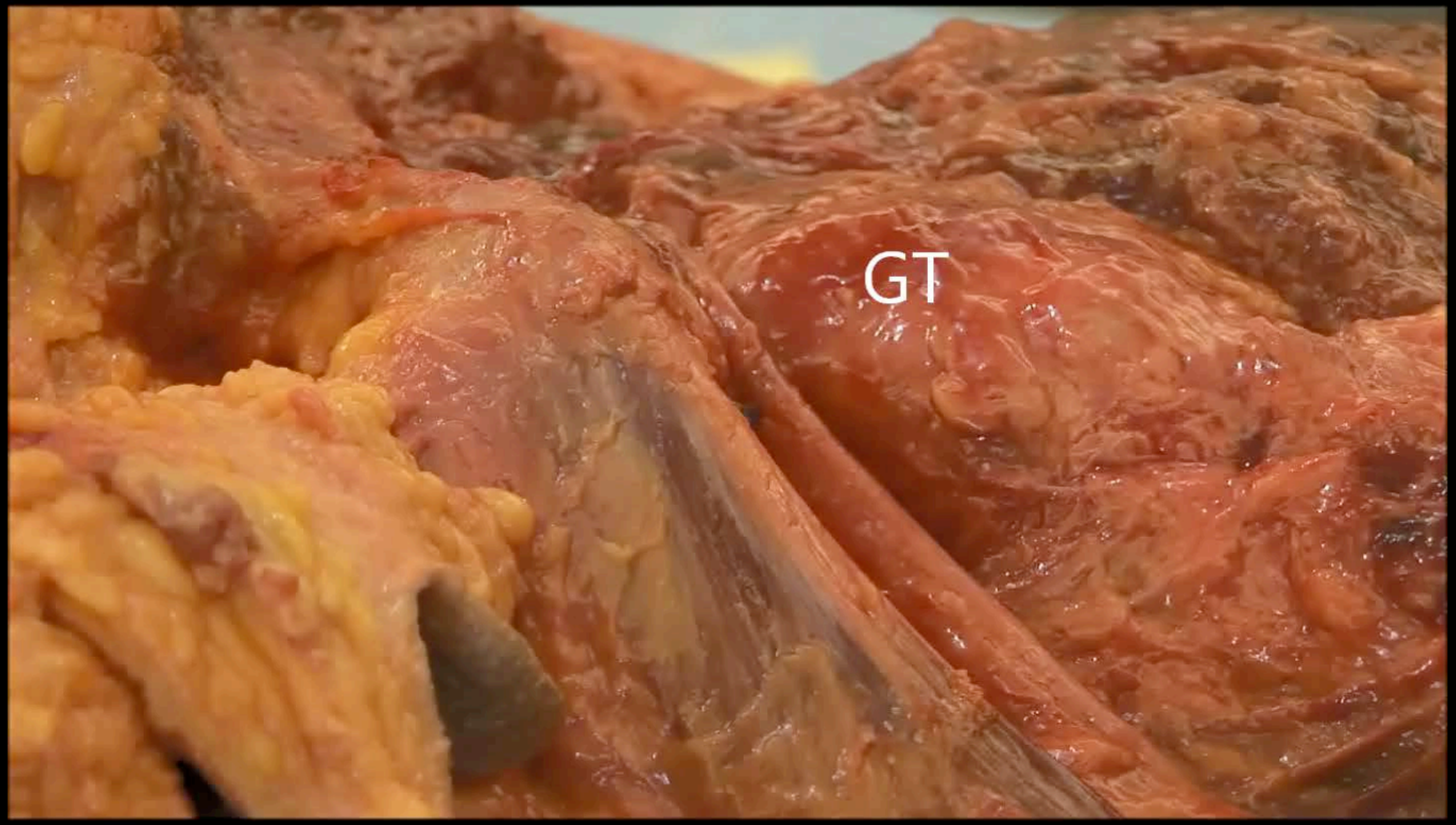


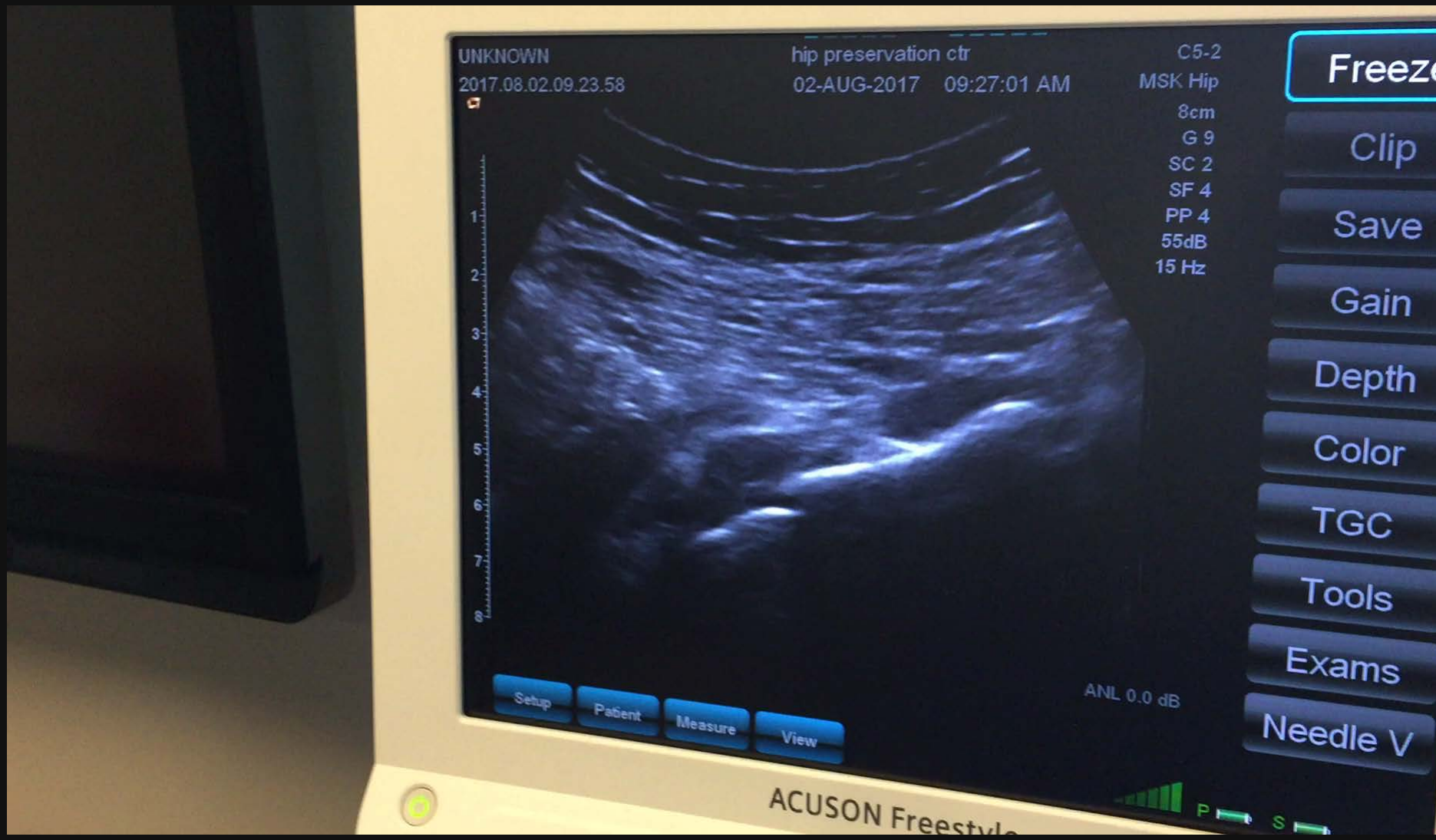
CT S 2 Block based on History and PE Dermatome Pattern



PE Test
MRI T3 Functional
Injections

Kinematics of Sciatic Nerve
Sciatic moves lateral at ischial tunnel with knee flexion hip flexion abduction




UNKNOWN
2017.08.02.09.23.58
hip preservation ctr
02-AUG-2017 09:27:01 AM
C5-2
MSK Hip
8cm
G 9
SC 2
SF 4
PP 4
55dB
15 Hz
Freeze
Clip
Save
Gain
Depth
Color
TGC
Tools
Exams
Needle V
Setup
Patient
Measure
View
ANL 0.0 dB
ACUSON Freestyle

Extension Block 2ND to decreased femoral version can cause SI & 2nd PIRIFORMIS PAIN

Three Causes of Ext Block

1. IFI
2. Decreased FV (Iliofem)
3. Posterior Wall FAI
4. Coxa Profunda

Spine and Pelvis!!!!!

Hip extension test
Primary vs Secondary Piriformis?

Positive recreation of Pain in
Extension neutral rotation

relieved in Abduction

Osseous Causes

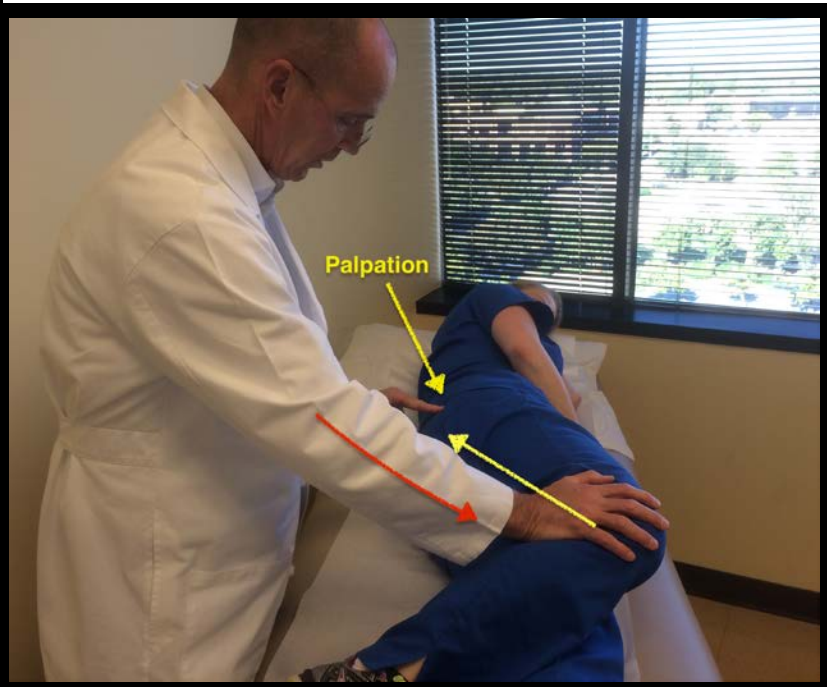
IFI
Decreased Femoral Version
Posterior Impingement

Sciatic Involvement ?

2014, KSSTA

Diagnostic accuracy of clinical tests for sciatic nerve entrapment in the gluteal region

Hal D. Martin · Benjamin R. Kivlan · Ian J. Palmer · RobRoy L. Martin



Active Piriformis Test

Sensitivity 0.78

Specificity 0.80

Passive Piriformis Stretch Test

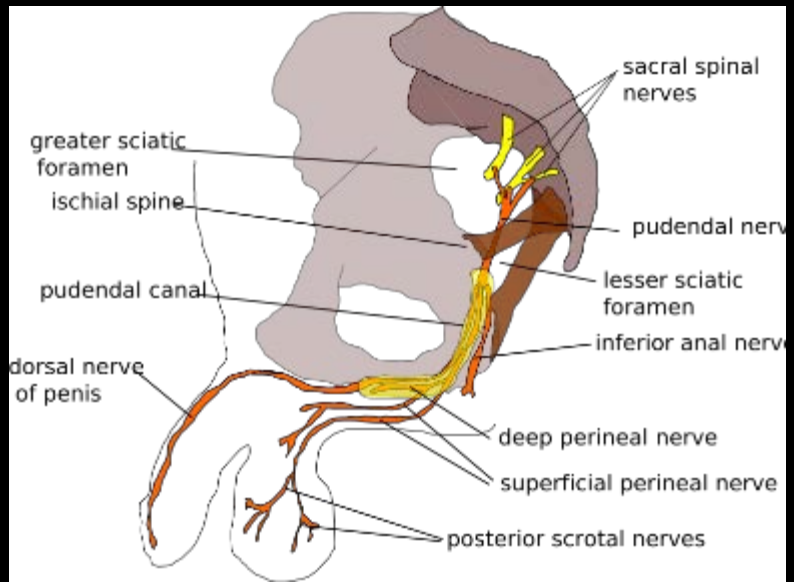
Sensitivity 0.52

Specificity 0.90

Secondary Pudendal Neuralgia
Pain Medial to Ischium

- Posterior Hip Pain
- Inability To sit < 30 min , Toilett OK
- Positive Intrapelvic examination by Physical Tx
- Positive Injection at one or more entrapement sites

Piriformis
Sacrospinous ligament
Falciform Ligament
Obturator Internus



2011, Arthroscopy

The Endoscopic Treatment of Sciatic Nerve Entrapment/ Deep Gluteal Syndrome

Hal D. Martin, D.O., Shea A. Shears, B.S.N., R.N., J. Calvin Johnson, M.D., Aaron M. Smathers, M.S., and Ian J. Palmer, Ph.D.

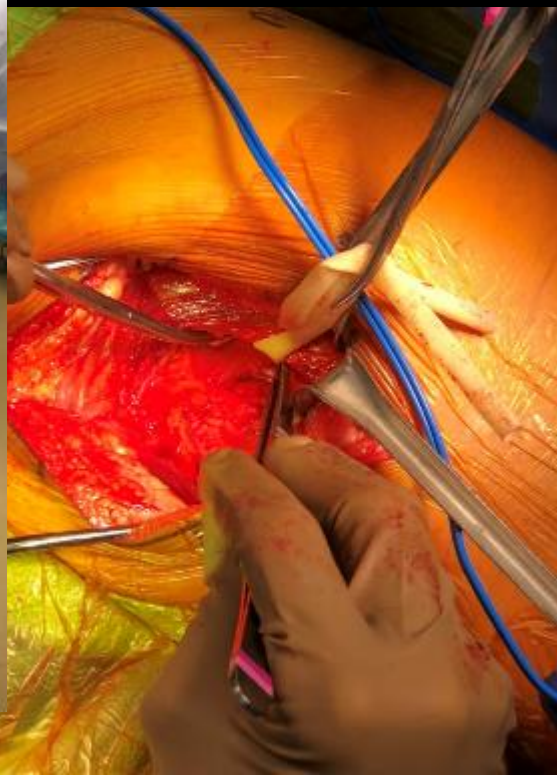
Clinical and rehab applications

Joint Mobilization

Piriformis Stretch (hold for 20 sec)

Neural Glides (in abduction)

Open Release Posterior Lateral with Complex Pathology

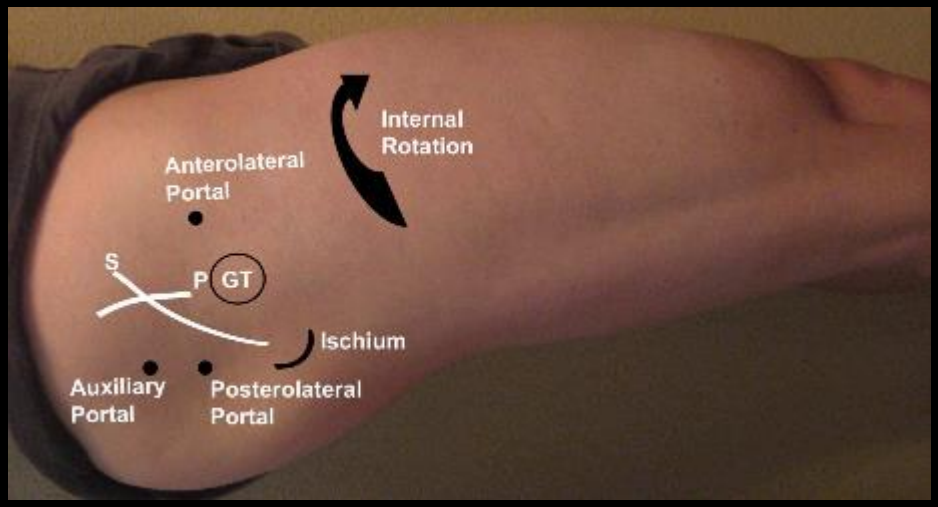


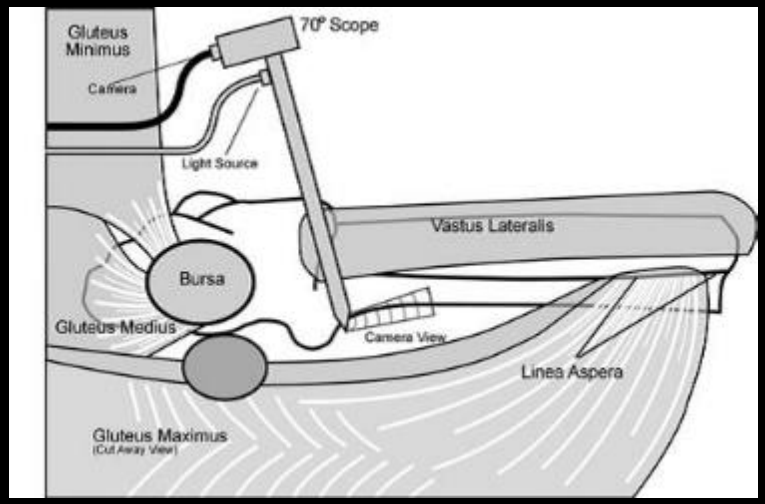
Open SN Decompression

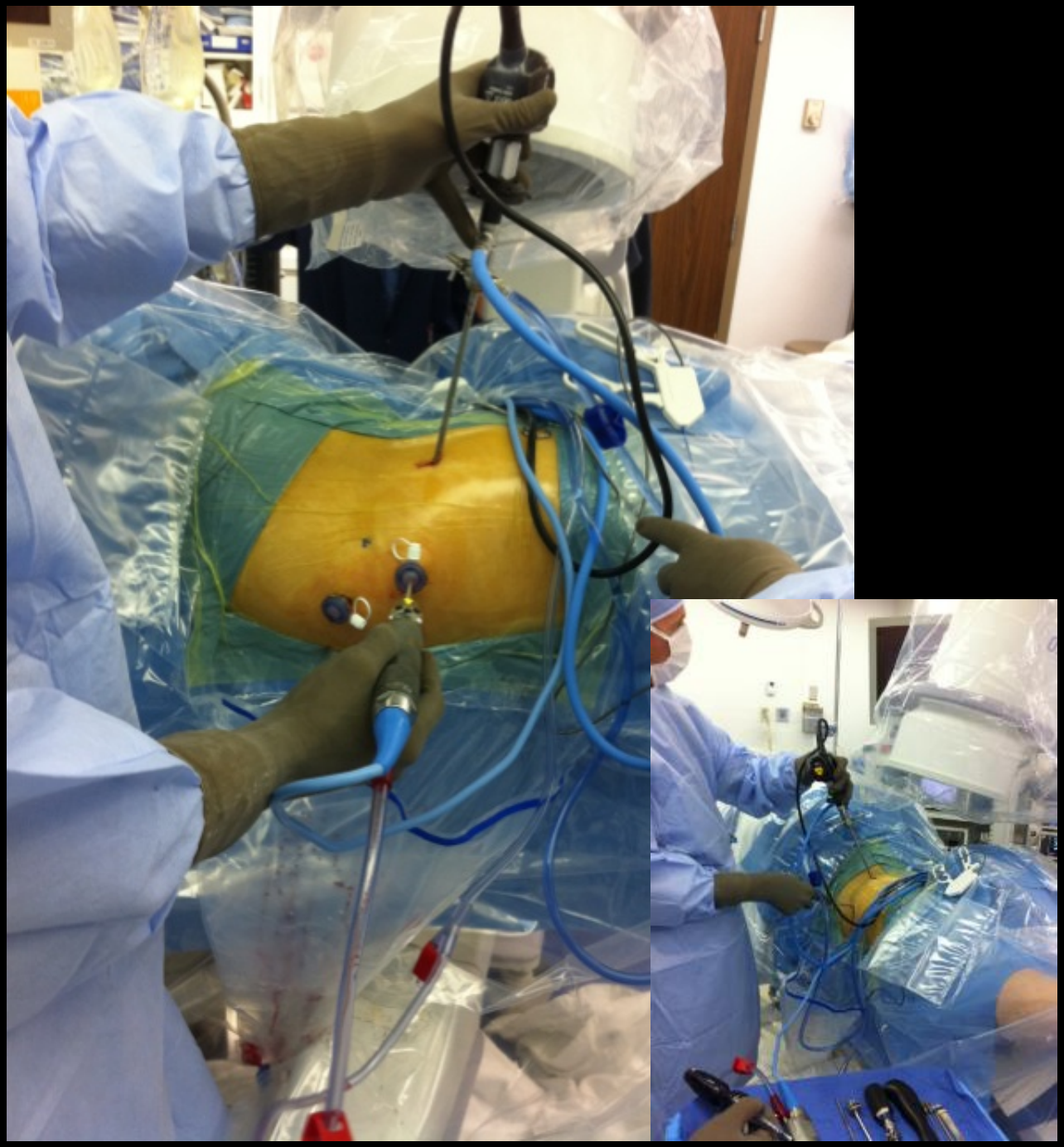
Author	Number of Procedures	Results
Miller A, et al.	1	Immediate pain relief, 2.5 years post-op no pain yet decreased sensation over the posterolateral aspect of thigh
Vandertop & Bosma	1	4 years post-op, doing well
Chen, WS	1	pain resolved in one week. Motor weakness of the ankle extensors and toes for 3 months. 4 years post-op asymptomatic
Hughes SS, et al.	5	At 1 year: 1)No pain, slight residual tenderness in buttock, 2) asymptomatic, 3) No pain, slight residual tenderness in buttock, 4) No pain, 5) Excellent
Sayson, et al.	1	6 months post-op: No pain
Benson & Schutzer	15	2 years post-op: 11 Excellent, 4 Good
Meknas K, et al.	12	No pain decrease at 6 months. 8 years post-op: significant decrease in pain
Filler AG et al.	64	2 years post-op: Excellent: 59%, Good: 23% , No Benefit: 17%, Worse: 2%
Lewis AM, et al.	4	2 months post-op: 3 excellent, 1 still experiencing pain
Issack P, et al.	10	1 year post-op: Partial to complete relief of radicular pain, of diminished sensation, and of paresthesias.
Young IJ, et al.	44 Hamstring	53 months post-op: 33 satisfied, 5 somewhat satisfied, 6 not satisfied.
Beauchesne & Schutzer	1	Immediate pain relief, residual numbness and limp resolved in 4 weeks.
Jones HG, et al.	1	Immediate pain relief, 6 weeks post-op: complete resolution of symptoms

Endoscopy of the Deep Gluteal Space

- Supine position
- 70° standard and long arthroscopes

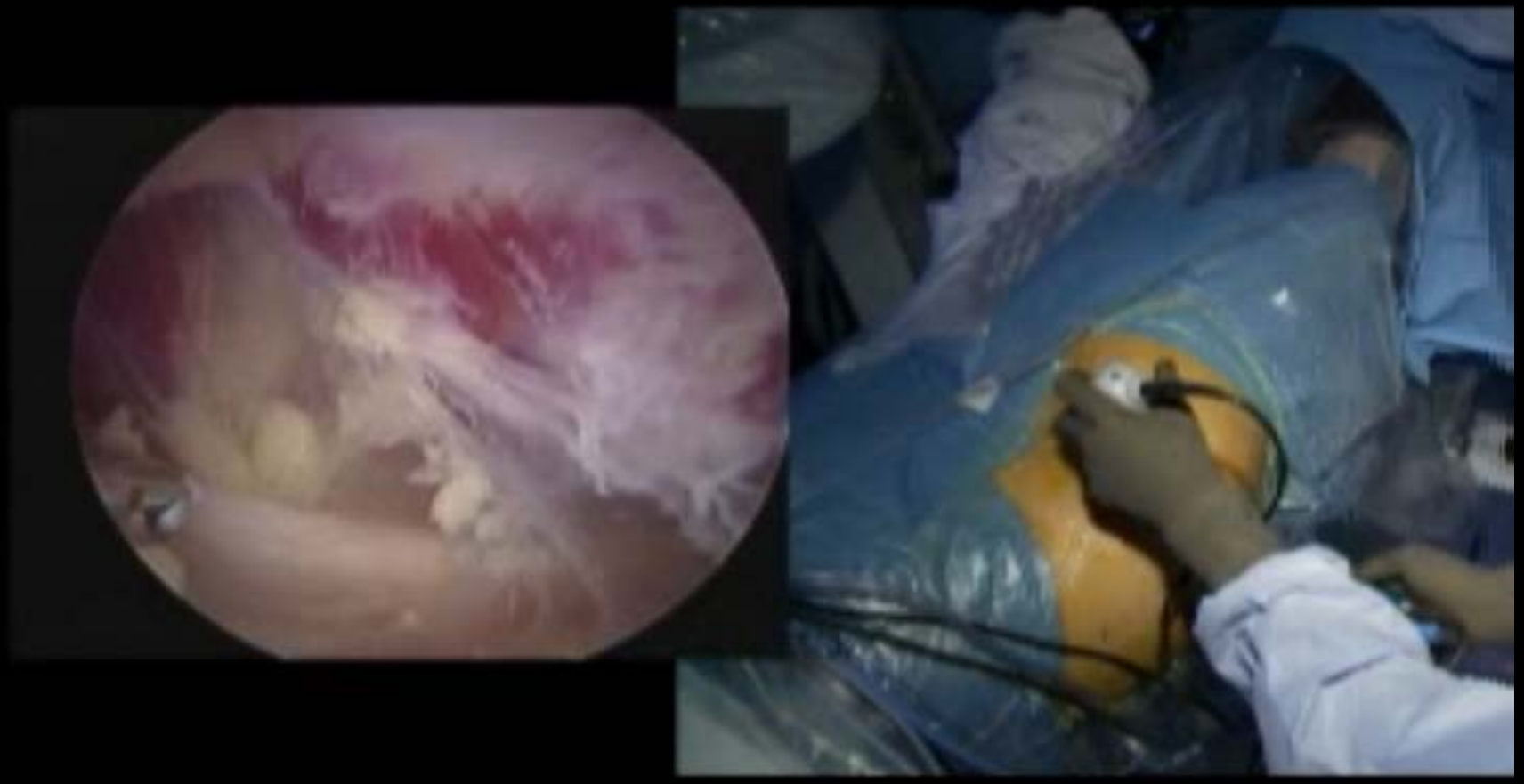




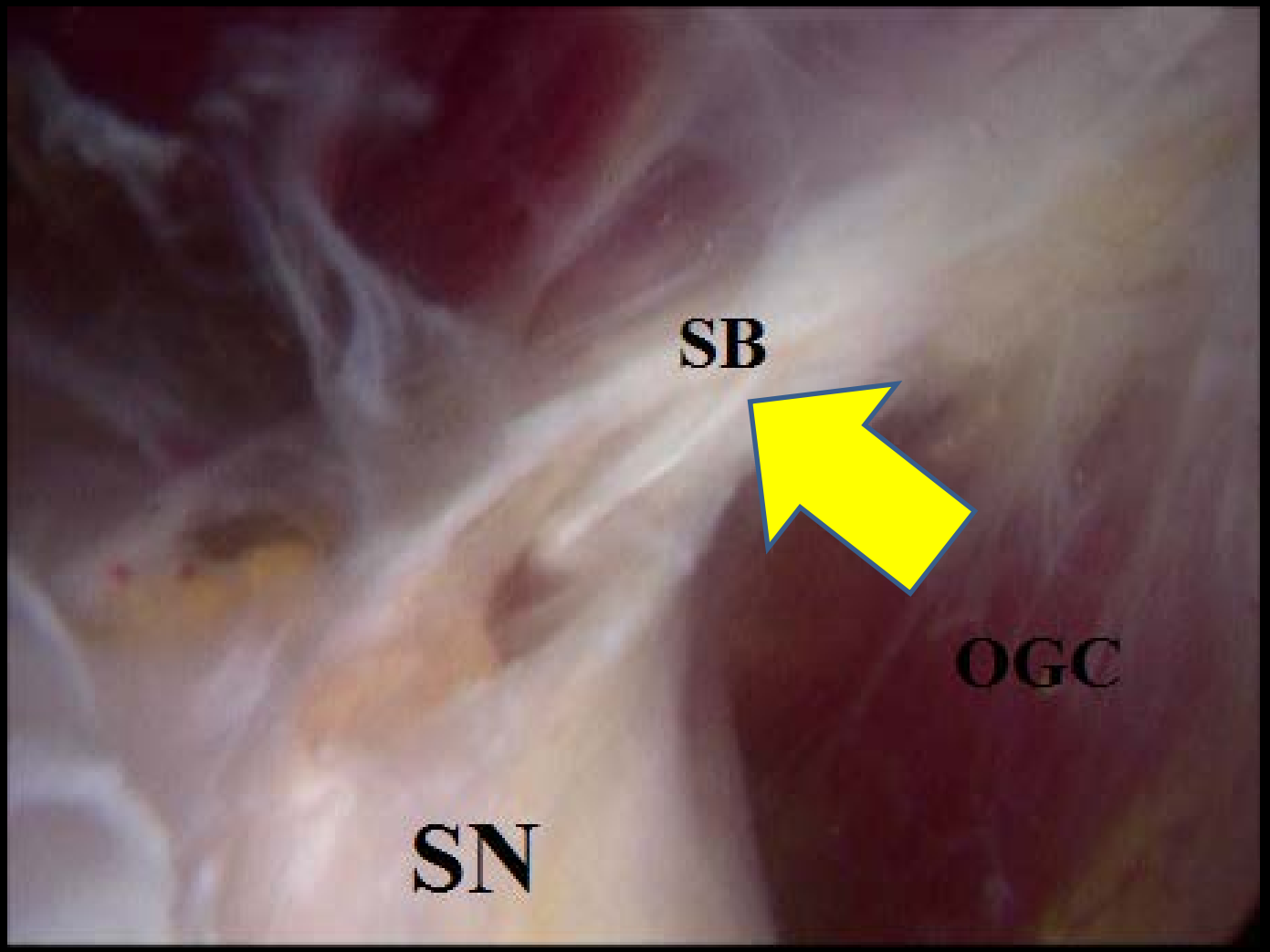


Normal Sciatic Nerve Motion

Endoscopic Inspection of the Sciatic Nerve Motion



Extra Pelvic Sciatic nerve scar from Trauma



Endoscopic SN Decompression Results

Martin et al 2011 35 patients 54.4->78.0 m HHS

Agulira et al 2018 41 patients 48.4->63 WOMAC

Perez-Carro 2012 52 patients 56.0->79.0 mHHS

Park et al 2016 60 patients 81.7->91.8 mHHS

Ham et al 2018 24 patients 59.4 ->85.0

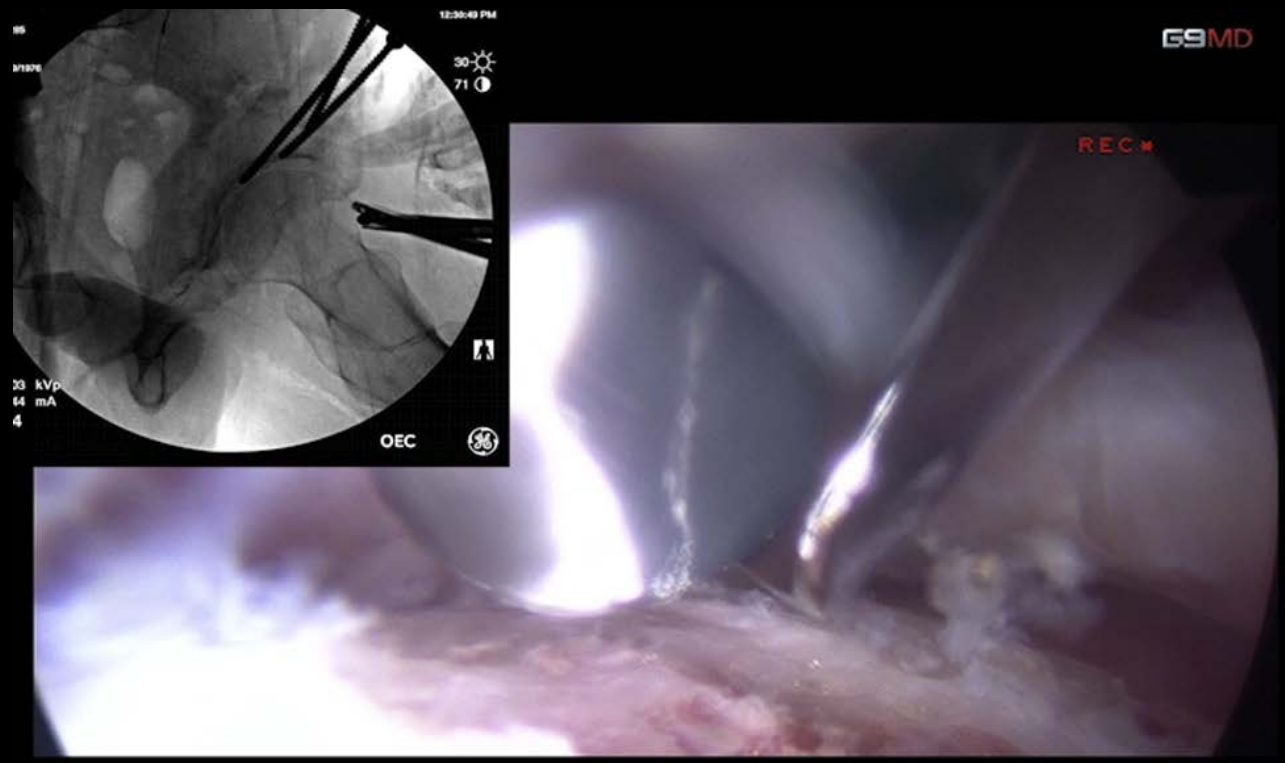
Ilizaliturri 2018 15 hips 46.8-> 84.9 mHHS

Park et al 2019 85 hips 65.8-> 91.4 mHHS

2016, Arthroscopy Techniques

Endoscopy-Assisted Periacetabular Osteotomy

Dean K. Matsuda, M.D., Hal D. Martin, D.O., and Javad Parvizi, M.D.



The uniqueness of the sciatic nerve

- There is no nerve in human body crossing as many bone structures as the SN

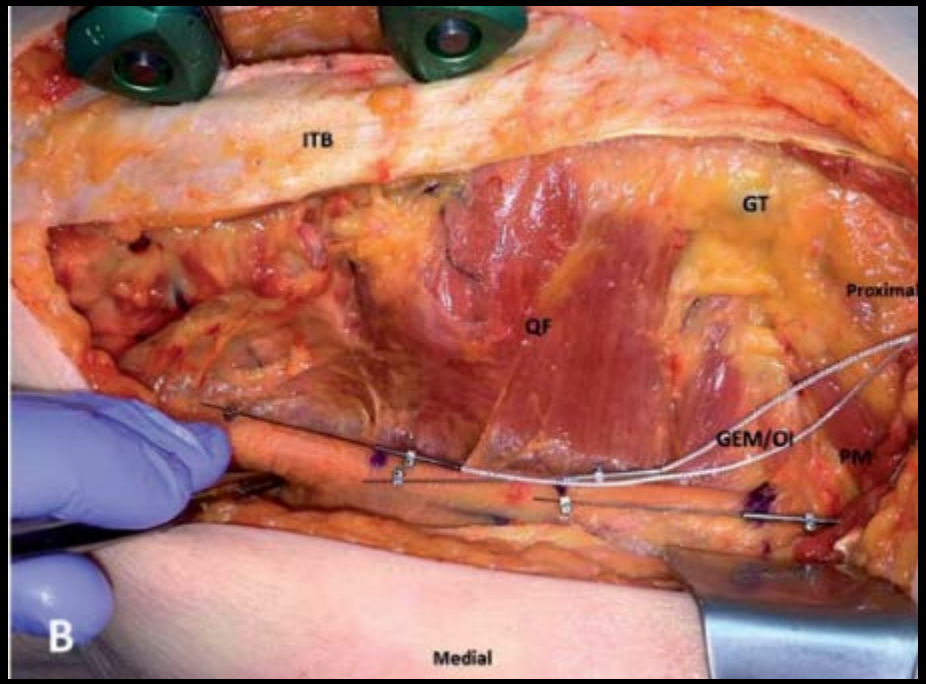
- It needs to accommodate to the hip joint

2017, Journal of Hip Preserv. Surg.

The effects of hip abduction on sciatic nerve biomechanics during terminal hip flexion

Hal David Martin[1], Anthony N. Khoury[1,2*], Ricardo Schroder[1], Juan Gomez-Hoyos[1], Samrat Yeramaneni[1], Manoj Reddy[1,3] and Ian James Palmer[1]

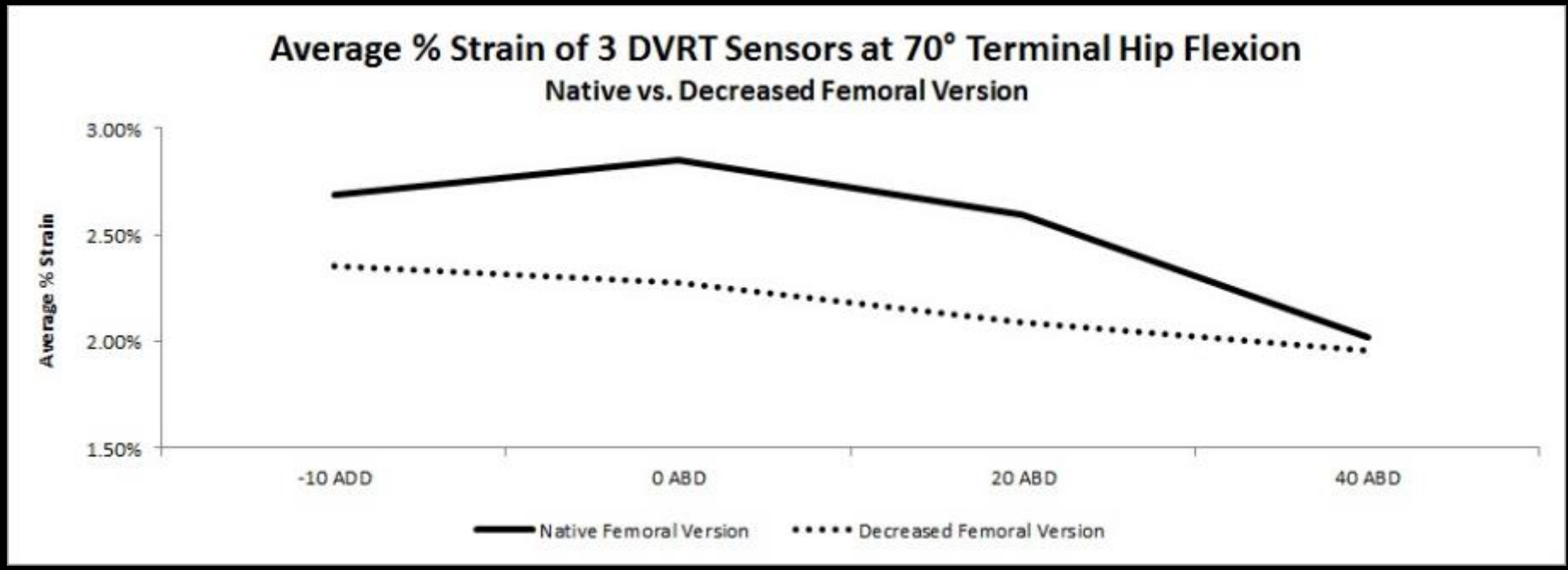
- 12 fresh-frozen human cadaver hips
- Custom-built PVC frame for accurate positions
- 3 DVRT Sensors
- Strain measurement in different hip positions



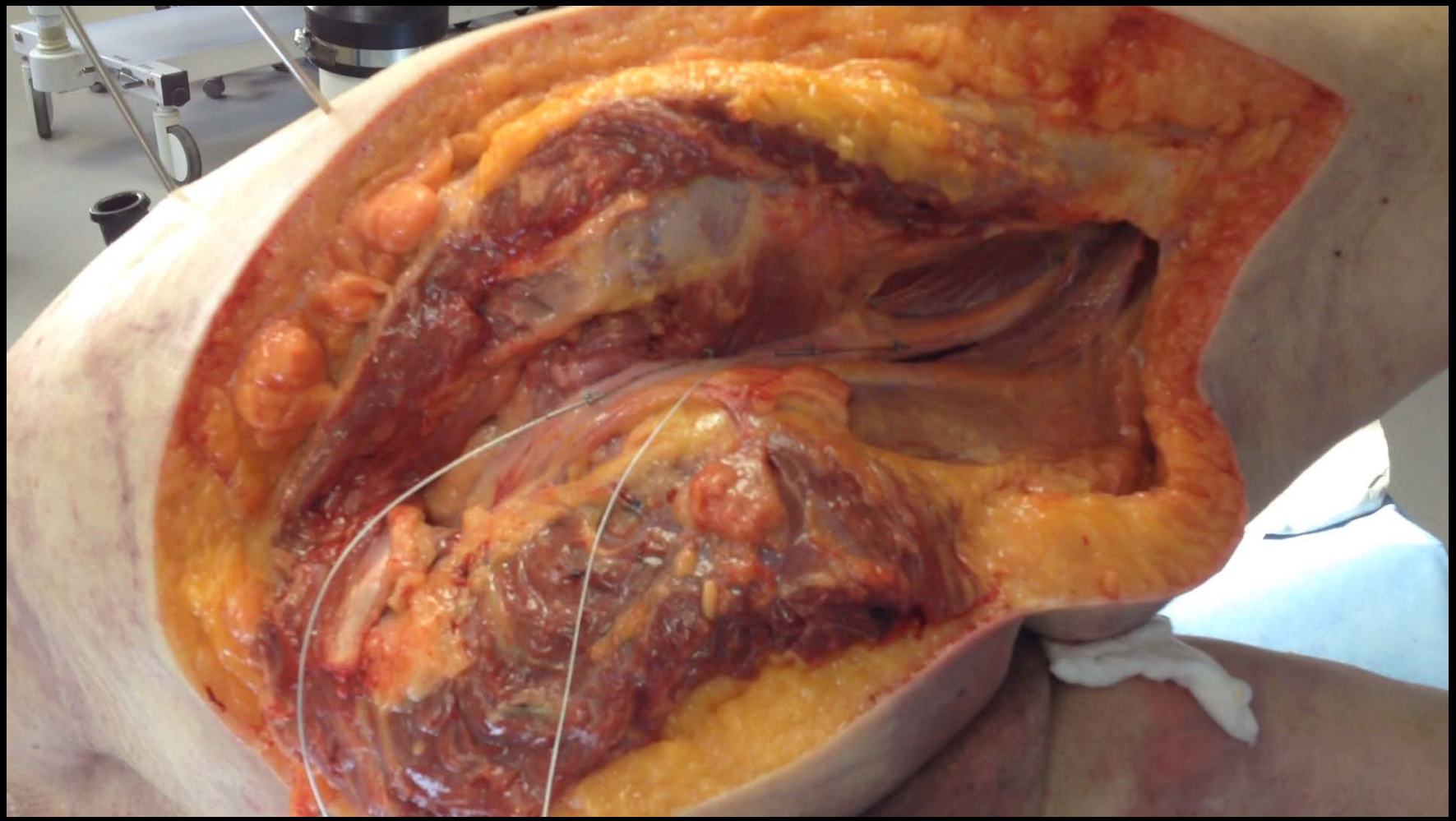
- Subtrochanteric osteotomy – simulated version
- Remeasurement of SN strain

Moving the hip from 0 ° → 40° of abduction

84.23% decrease in SN strain ($p<.05$)



”Spiraling Effect”



Posterior Hip Disorders

Clinical Evaluation and Management

Hal D. Martin
Juan Gómez-Hoyos
Editors

Springer

Measuring the Accuracy of Diagnostic Systems

Swets, Science, Vol 240

- “A common set of problems in testing is faced in all fields. How well these problems are handled, or can be handled in a given field, determines the degree of confidence that can be placed in a measured value of accuracy. Some fields fare much better than others”

Can we automatize the hip history/ examination to AI or +- mid level provider to increase accuracy of diagnosis

- History alone is insufficient do to the complexity of pelvic, abdominal, Spine, SI and hip co morbidity the exist as a primary or secondary presentation
- Physical Examination is not standardized between specialties(spine, uro-pelvic-gyn, hip preservation, reconstruction, pain specialist, and spine surgeons
- What specialty has the training to assess the entire biomechanical and anatomical axis from the superior to inferior and converse
- Injections alone lack standardization of positive vs negative tests 85% vs 50 percent, post exercise or ADL?
- Imaging: high false positive with observable potential pathologies

History

What is your goal in treatment?

Feel better, have a better solution for walking and to be able to squat.

My goal is to have my pain levels reduced and being able to enjoy living an active lifestyle.

To be pain free

Get back to normal.

Associated Symptoms

- 190 New Patient visits - last 6 months

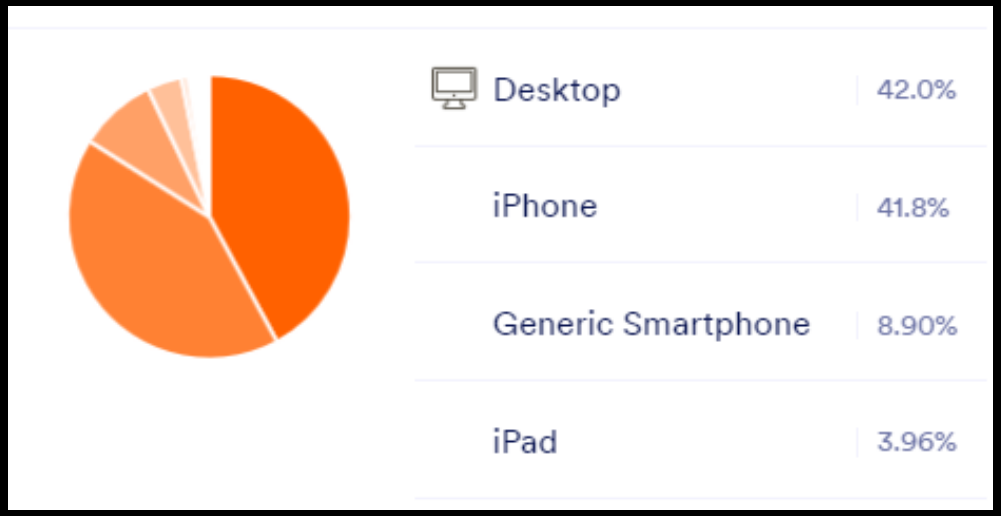
  64% answered as having low back pain: average Oswestry disability index of 31% (moderate disability)

Before visit

- HSPC patients demand more time and energy
- Covid – related changes
  - Patient stay in the office
  - Staff

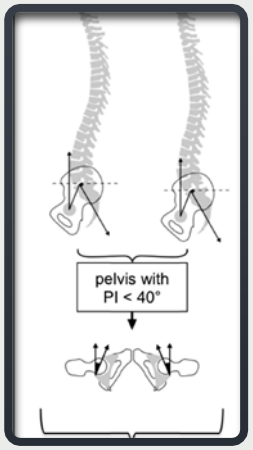
Electronic form

446 New Patient Forms: 30 minutes average time



The Development and Validation of a Self-Administered Quality-of-Life Outcome Measure for Young, Active Patients With Symptomatic Hip Disease: The International Hip Outcome Tool (iHOT-33) Vol 28 Arthroscopy

Nicholas G. H Mohtadi M.D., M.Sc., F.R.C.S.C., Damian R. Griffin B.M., B. Ch., M.A., M.Phil., F.R.C.S. (Tr&Orth) M. Elizabeth Pedersen M.D., F.R.C.S.C., Denise Chan M.B.T., M.Sc., Marc R. Safran M.D., Nicholas Parsons Ph.D., Jon K. Sekiya M.D., Bryan T Kelly M.D. Jason R. Werle M.D., F.R.C.S.C. Michael Leunig M.D., Joseph C. McCarthy M.D., Hal D. Martin D.O., J.W. Thomas Byrd M.D., Marc J. Philippon M.D., RobRoy L. Martin Ph.D., P.T., C.S.C.S. Carlos A. Guanche M.D. John C. Clohisy M.D., Thomas G. Sampson M.D. Mininder S. Kocher M.D., M.P.H., Christopher M. Larson M.D.



TIME TO INCLUDE ODI

A Short Version of the International Hip Outcome Tool (iHOT-12) for Use in Routine Clinical Practice

Hip Score Questionnaires

Questionnaire	Year	Target Population	Number of questions	Mode of administration
Merle D`Aubigne and Postel (18) Paris, France	1954	Acrylic Hip Arthroplasty	3	Observer administered
Harris Hip Score(11) Boston, United States	1969	Mold Hip Arthroplasty	8 + 2 observer measurements	Observer administered
WOMAC(19) London, Canada	1988	Hip and knee Osteoarthritis	24	Self-administered
Modified Harris Hip Score(12) Nashville, United States	2000	Hip Arthroscopy	8	Observer administered
NAHS(20) Bethesda, United States	2003	Young adults (16 to 45 years) with hip pain more > 6 moths	20	Self-administered
iHOT-33(14) MAHORN, international	2012	Active adults (18 to 60 years) with hip pathology	33	Self-administered
iHOT-12(15) MAHORN, international	2012	The same of the iHOT-33	12	Self-administered

Imaging Alone to Diagnose Etiological Hip Pathology other joints?

- Patients with Suspected Meniscal Tears: Prevalence of Abnormalities Seen on MRI of 100 Symptomatic and 100 Contralateral Asymptomatic Knees Zanetti, et al AJR 181, (3)

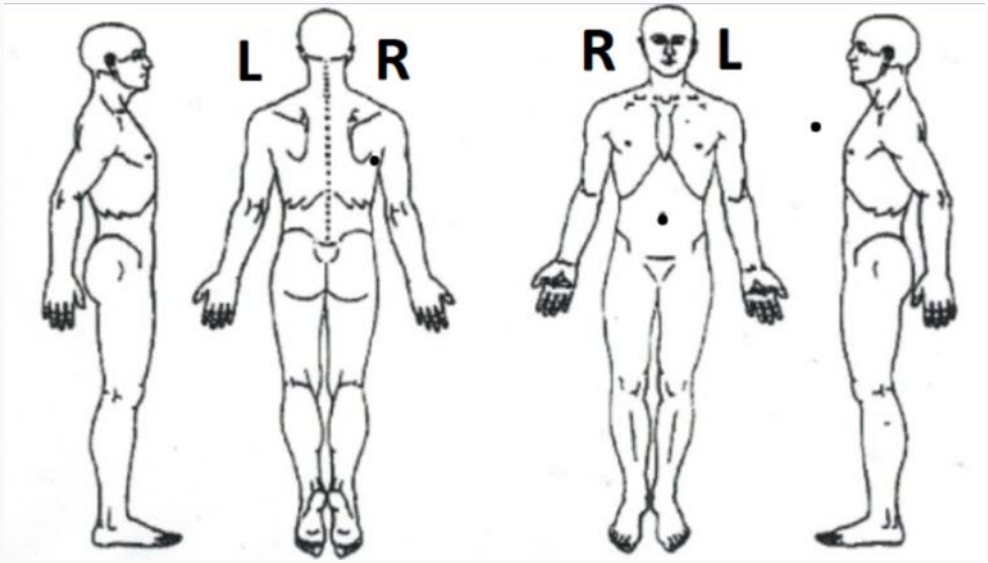
  - Meniscal tears found in 36/100 asymptomatic 57 symptomatic knees,

- Age-related prevalence of rotator cuff tears in asymptomatic shoulders Seigbert et al J Shoulder and Elbow 8 (4)

  - 23% overall asymptomatic RTC tears increasing with age

- The Prevalence of acetabular labral tears and associated pathology in young asymptomatic population Lee et al JBJS 97B

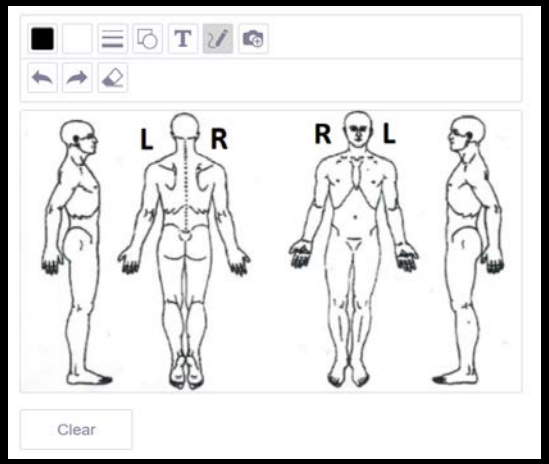
  - 38.6 % 27/70 asymptomatic volunteers with acetabular labral tear



IS INJECTION TEST OR PAIN DRAWING ENOUGH TO ESTABLISH A COMPREHENSIVE DIAGNOSIS OR HIP S/I PELVIC CORE DIAGNOSIS

Pain Drawing

83 consecutive patients who undergone IA injection



- From patients with positive IA injection
- 31% DID NOT mark the anterior hip area
- 59% marked the posterior hip area

The hip is complex connected TERRAIN……

- What is the best way to make sense in a clinical setting?

  - Consistent Comprehensive

    History and Physical Examination!

Discussion – Pain Drawings in Tech Advances

- Increased telemedicine utilization

- Boudreau et al. compared the level of agreement between paper and electronic (i.e. tablet) pain drawings in individuals with chronic neck pain
  - Intraclass correlation coefficient of 0.92 between electronic and paper pain drawings in pts with chronic neck pain

- Physical examination + in-person assessment remain the foundation for diagnosis of hip diseases

Boudreau SA, Badsberg S, Christensen SW, Egsgaard LL. Digital Pain Drawings: Assessing Touch-Screen Technology and 3D Body Schemas. *Clin J Pain*. 2016;32(2):139-145

Injection to determine Primary Diagnosis

- Hip-Spine Syndrome: The Diagnostic Utility of Guided Intra-articular Hip Injections Maldonado et al Orthopedics 43 (2)
  - Pub med and Cochrane databases 9 studies
  - Sensitivity 93.6%, specificity 95%, PPV 98.8 % and N PV 86.3%

Results

	Positive Injection	Negative Injection	P Value
Anterior hip pain on drawing, n (%)	42 (69%)	7 (32%)	0.0026
Posterior hip pain on drawing, n (%)	36 (59%)	17 (77%)	0.1345
Lateral hip pain on drawing, n (%)	38 (62%)	11 (50%)	0.3298
Low back pain on drawing, n (%)	27 (44%)	7 (32%)	0.3292

What is Enough to Establish a Comprehensive Hip Spine/SI Pelvic Core Diagnosis

An Algorithmic Approach to Mechanical Hip Pain

Lazaros A. Poultsides, MD, MSc, PhD PoultsidesL@HSS.EDU, Asheesh Bedi, MD, and Bryan T. Kelly, MDView all authors and affiliations

Volume 8, Issue 3

https://doi.org/10.1007/s11420-012-9304-xA clear understanding of the differential diagnosis of hip pain through a detailed and systematic physical examination, diagnostic imaging assessment, and the interpretation of how mechanical factors can result in such a wide range of compensatory injury patterns about the hip can facilitate the diagnosis and treatment recommendations.

2010, Arthroscopy

The Pattern and Technique in the Clinical Evaluation of the Adult Hip: The Common Physical Examination Tests of Hip Specialists

Hal D. Martin, D.O., Bryan T. Kelly, M.D., Michael Leunig, M.D., Marc J. Philippon, M.D., John C. Clohisy, M.D., RobRoy L. Martin, Ph.D., P.T., C.S.C.S., Jon K. Sekiya, M.D., Ricardo Pietrobon, M.D., Ph.D., Nicholas G. Mohtadi, M.D., Thomas G. Sampson, M.D., and Marc R. Safran, M.D.

MAHORN GROUP

Physical Examination

- 32 tests or group of maneuvers
- Assistant recording

Table 12. Physical examination of the hip - intake form

Height: ____ Weight: _____ Temperature: _____ Breath rate: _____ Pulse: _____ Blood pressure: _____

Standing Examination:

- Shoulder height: Equal Not equal
- Iliac crest height: Equal Not equal
- Active forward bend: _____degrees of lumbar flexion
- Spine: straight
  scoliosis: structural non-structural
- Lordosis : normal increased paravertebral muscle spasms
- Laxity tests: little fingers thumbs elbows knees spine
- Gait: normal antalgic/short stance phase abductor deficient (Trendelenburg)
  pelvic wink abnormal arm swing short stride length
  Foot progression angle: normal excessive external rotation internal rotation
- Single leg stance phase test (Trendelenburg test): R. ____ L ____

Seated Examination:

- Circulation: Dorsalis pedis _____ Posterior tibial _____
- Lymphatic: lymphedema no lymphedema pitting edema: 1+ 2+

Pain on palpation: lateral to ischial tuberosity (IT) hamstring origin medial to IT
Seated piriformis stretch test _____
Active Knee flexion test against resistance: 30 degrees_____ 90 degrees

Supine Examination:

- Leg lengths: R____cm L____cm equal/not equal
- Palpation:
  Abdomen: Tender Non-tender
  Palpation pubic symphysis/ Adductor Tender Non-tender
  Adductor Tubercle: Tender Non-tender
- ROM: Right Hip / Left Hip

	Right Hip	Left Hip
Abduction:	10 20 30 45 50	10 20 30 45 50
Adduction:	0 10 20 30	0 10 20 30
Flexion:	80 100 110 120 130 140	80 100 110 120 130 140

- Hip flexion contracture test (Thomas test): R + - L + -
- FABER (Patrick test) : R + - L + -
- DIRI: R + - L + -
- DEXRIT: R + - L + -
  Posterior rim impingement test: R + - L + -
- Heel strike: R + - L + -
- Passive supine rotation test (log roll test): R + - L + -
  Dial test R + - L + -
- Straight leg raise against resistance (Stinchfield test): R + - L + -

Lateral Examination

- Palpation:

Supra SI area	Tender	Non-tender	Piriformis	Tender	Non-tender
SI joint	Tender	Non-tender	Sciatic nerve	Tender	Non-tender
G. Max origin	Tender	Non-tender	TFL	Tender	Non-tender
Greater trochanter	Tender	Non-tender			

- Abductor strength: Straight leg _____ Gluteus max_____ Gluteus medius_____
- Tensor fascia lata contracture test: Grade(1-3)_____
- Gluteus medius contracture test: Grade(1-3)_____
- Gluteus maximus contracture test: Grade(1-3)_____
- FADDIR test: R + - L + -
- Lateral rim impingement test: R + - L + -
- Apprehension test R + - L + -
- Posterior extra-articular pain tests:
  Active piriformis test _____ Ischiofemoral impingement test _____

Prone Examination:

- Femoral Anteversion Test:_____ estimated degrees of anteversion
- Rectus Contracture Test (Ely's Test): R + - L + -
- Lumbar hyperextension test

The Pattern and Technique in the Clinical Evaluation of the Adult Hip: The Common Physical Examination Tests of Hip Specialists

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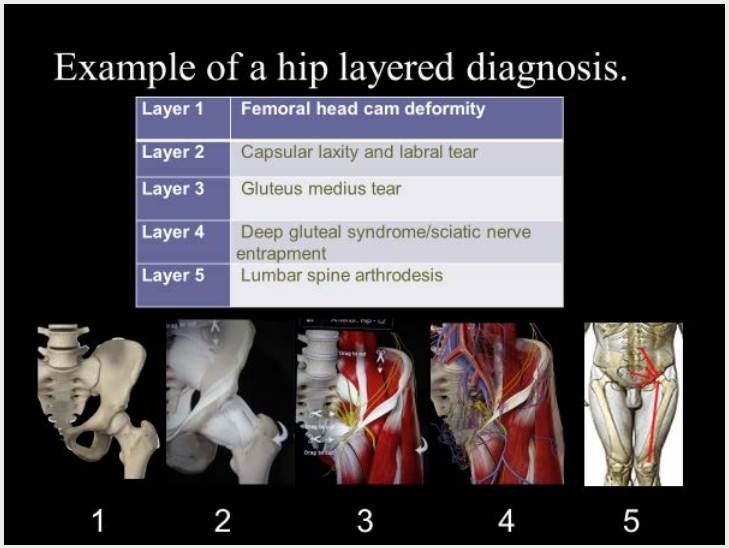


Hip Rehabilitation (J Edelstein, Section Editor)
Published: 28 February 2012
The layer concept: utilization in determining the pain generators, pathology and how structure determines treatment

Peter Draovitch, Jaime Edelstein & Bryan T. Kelly

Hip Physical Exam

The following five provocative tests, when performed in <u>combination</u>, are proven to have a high degree of sensitivity and specificity:

1. **Distraction*** (Highest PPV**)
2. **Thigh Thrust***
3. **FABER**
4. **Compression***
5. **Gaenslen's Maneuver**

	Laslett[1,2]	Szadek[3]
	3 or more positive tests	
Sensitivity	91%	85%
Specificity	78%	76%

* Most sensitive of tests
** PPV = *positive predictive value*

1. Laslett – *Man Ther* 2005
2. Laslett – *J Man Manip Ther* 2008
3. Szadek – *J Pain* 2009

SI-BONE®

Physical Examination test required for Extra articular Posterior Hip Pain

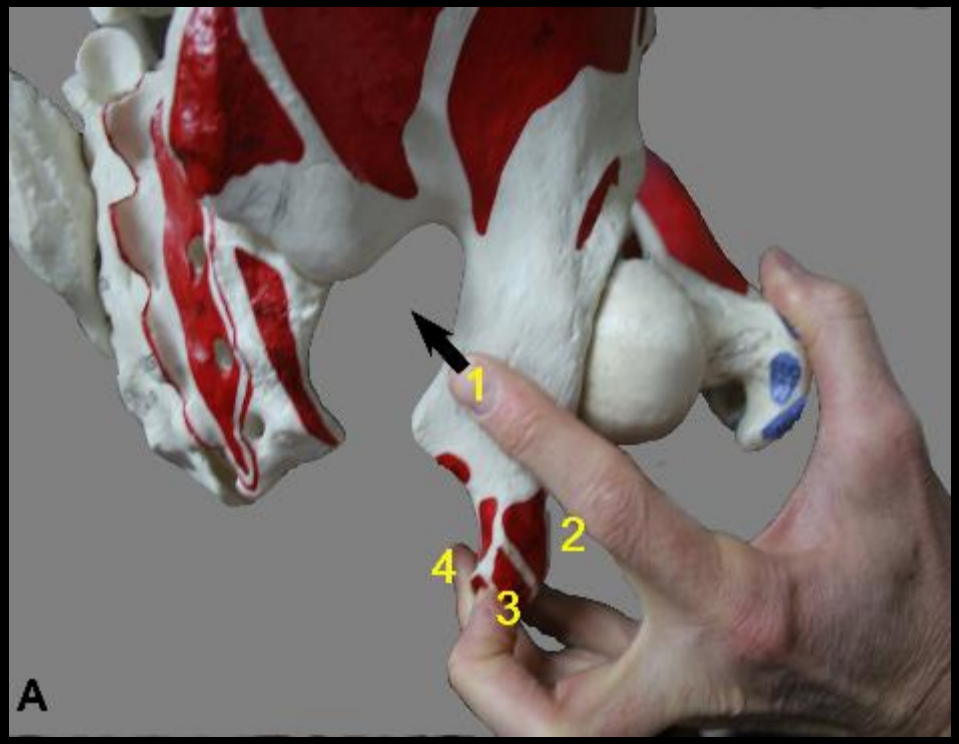
- Long stride / short stride gait assessment
- Palpation in sitting position
- Hamstring active 30degrees/ 90 degrees
- Passive piriformis test 30 sec
- Active piriformis test 30 sec
- Ischial femoral impingement test
- Hip-spine extension and flexion test

Gait

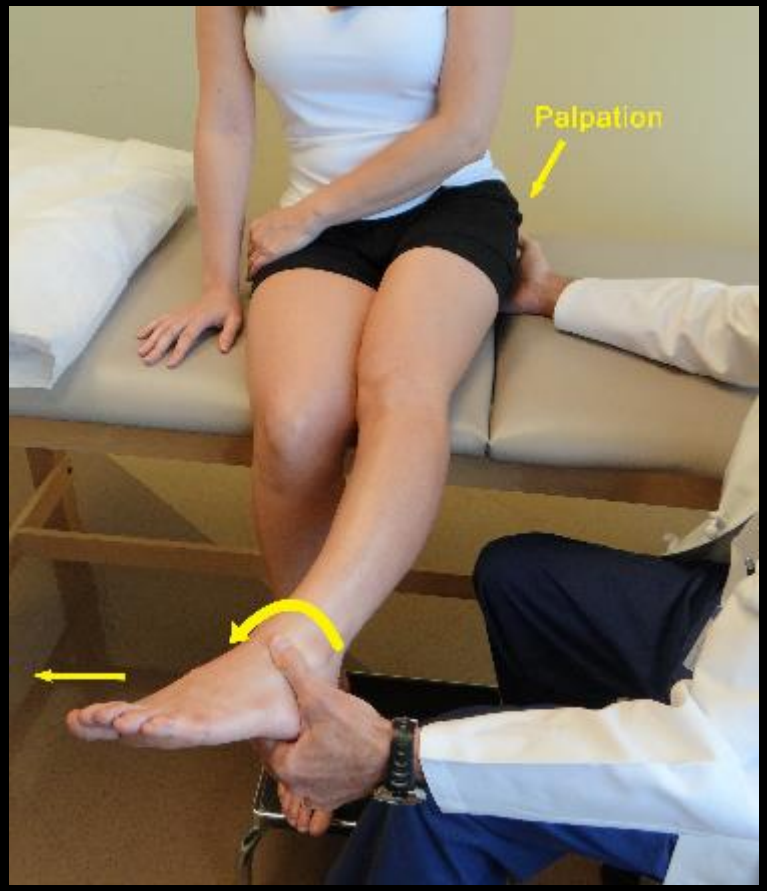
Long stride walking test

Every Hip Exam! Rule out the Spine

Palpation



Piriformis tests



Knee Surg Sports Traumatol Arthrosc (2014) 22:882–888
DOI 10.1007/s00167-013-2758-7

HIP

Diagnostic accuracy of clinical tests for sciatic nerve entrapment in the gluteal region

Hal D. Martin · Benjamin R. Kivlan · Ian J. Palmer · RobRoy L. Martin

2014, KSSTA

Diagnostic accuracy of clinical tests for sciatic nerve entrapment in the gluteal region

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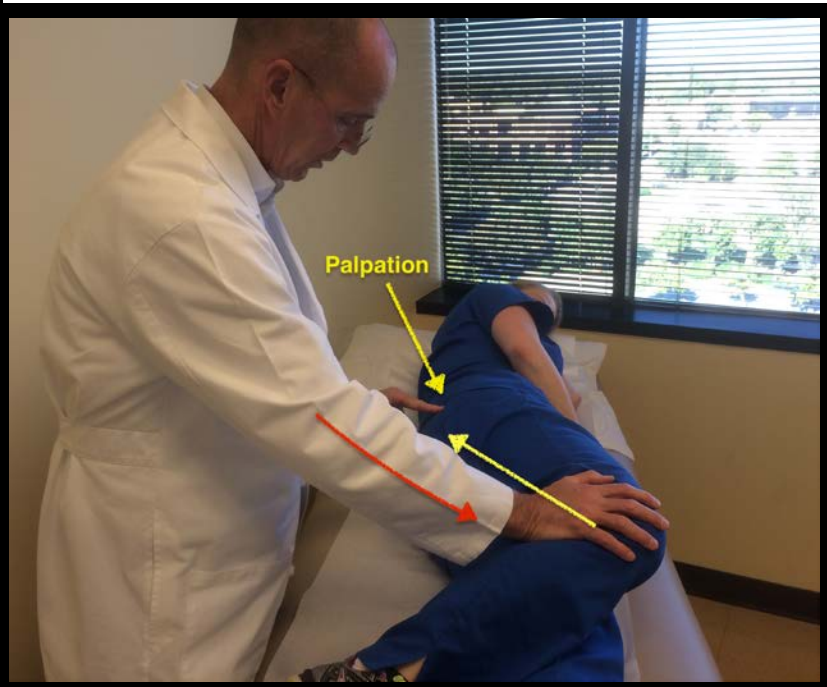


Active Piriformis Test

Sensitivity 0.78

Specificity 0.80

Passive Piriformis Stretch Test

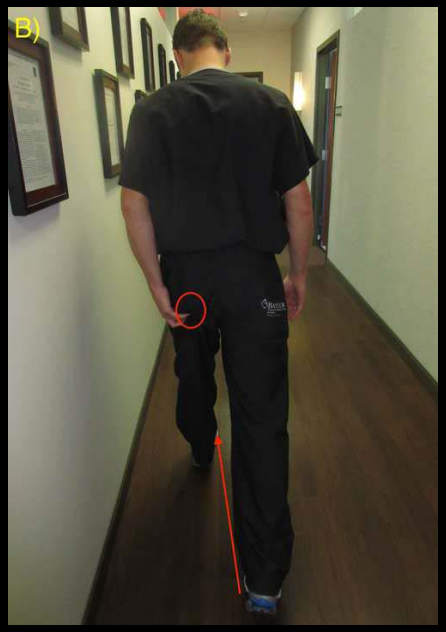
Sensitivity 0.52

Specificity 0.90

2017, Arthroscopy

Accuracy of 3 Clinical Tests to Diagnose Proximal Hamstrings Tears With and Without Sciatic Nerve Involvement in Patients With Posterior Hip Pain

RobRoy L. Martin, P.T., Ph.D., Ricardo Gonçalves Schröder, P.T., Juan Gomez-Hoyos, M.D., Anthony N. Khoury, M.S., Ian James Palmer, Ph.D., Ryan P. McGovern, M.S., A.T.C., and Hal David Martin, D.O.



Long Stride Heel Strike
Sensitivity 0.55
Specificity 0.97

Active 30°
Sensitivity 0.73
Specificity 0.97

Active 90°
Sensitivity 0.70
Specificity 0.97

Hip spine extension test

Increased femoral torsion now able to extend w IR

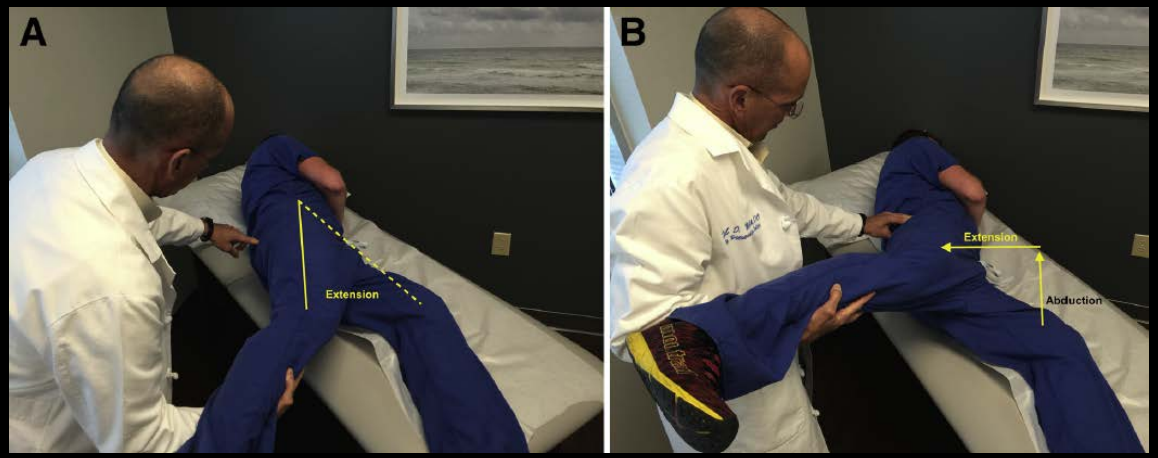
Decreased Femoral Torsion now able to extend w ER

IFI now able to extend with abduction

2016, Arthroscopy

Accuracy of 2 Clinical Tests for Ischiofemoral Impingement in Patients With Posterior Hip Pain and Endoscopically Confirmed Diagnosis

Juan Gómez-Hoyos, M.D., RobRoy L. Martin, P.T., Ph.D., Ricardo Schröder, P.T., Ian James Palmer, Ph.D., and Hal David Martin, D.O.



Long Stride Walk Test

Sensitivity 0.94

Specificity 0.85

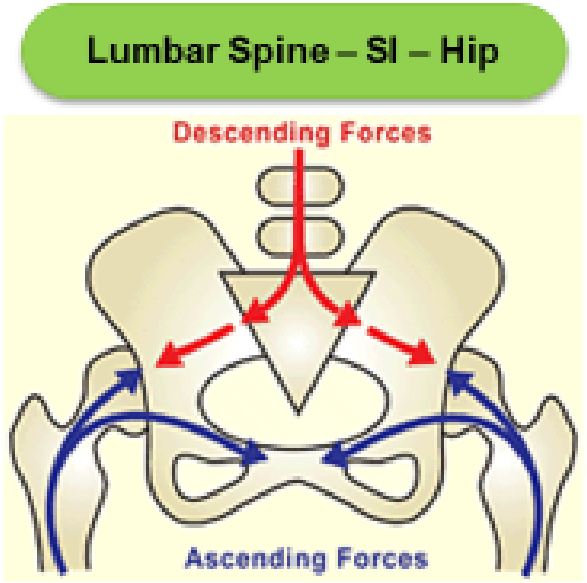
IFI TEST

Sensitivity 0.82

Specificity 0.85

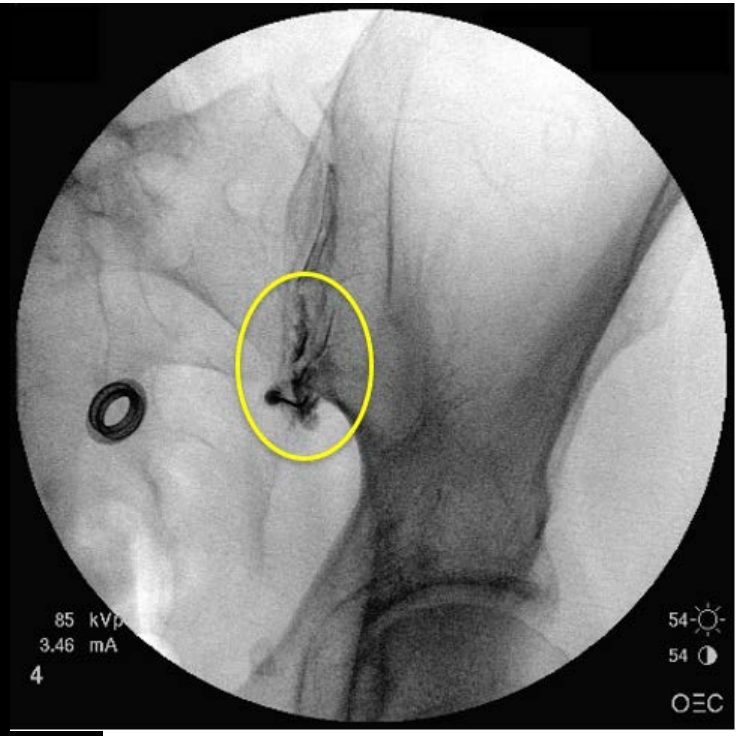
SI Joint Diagnostic Challenges

- SI joint symptoms are similar to those of other lumbar spine and hip conditions
- Referral pain patterns from the three structures overlap (Lumbar Spine – SI – Hip)
- Imaging studies often inconclusive



SI-BONE

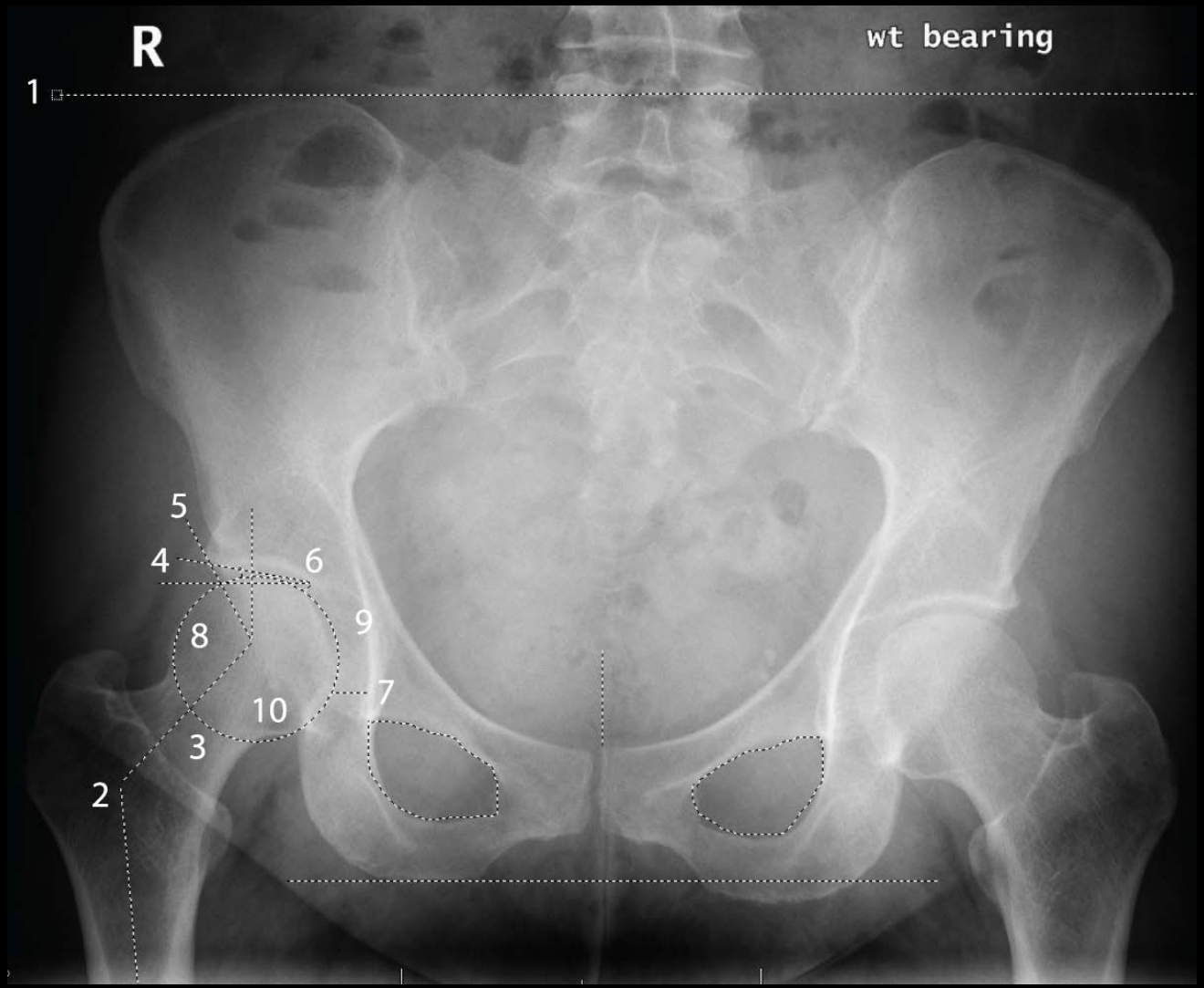
- Inject ~0.25ml contrast medium
- Note superior spread of dye in SI joint space
- Use AP + lateral views to confirm proper placement
- Once needle position confirmed, inject up to 2.25ml of local anesthetic
- Document:
  - Pre-injection pain level (VAS)
  - Post-injection, percentage pain relief during anesthetic phase



Maugars – *Br J Rheumatol* 1996; Maigne – *Spir* *Am J Roentgenol* 2008;
Rupert – *Pain Physician* 2009; Liliang – *Pain Med* 2011; Manchikanti – *Pain Physician* 2013.

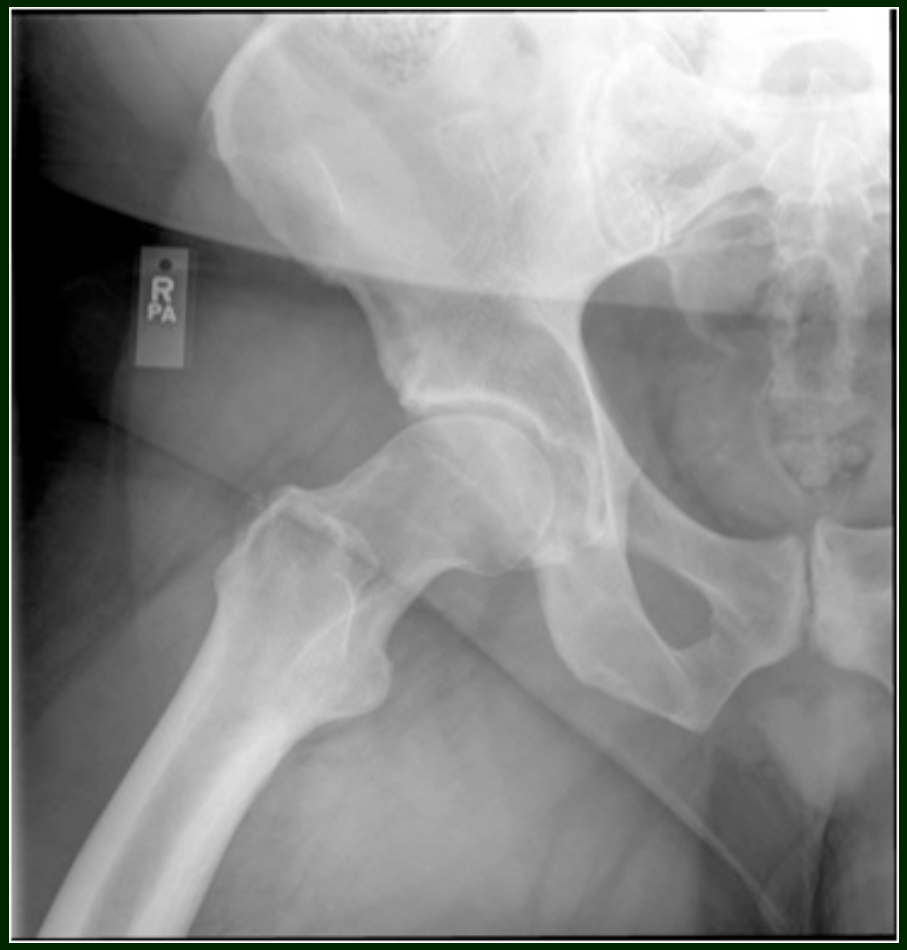
SI-BONE®

Standardized Imaging:



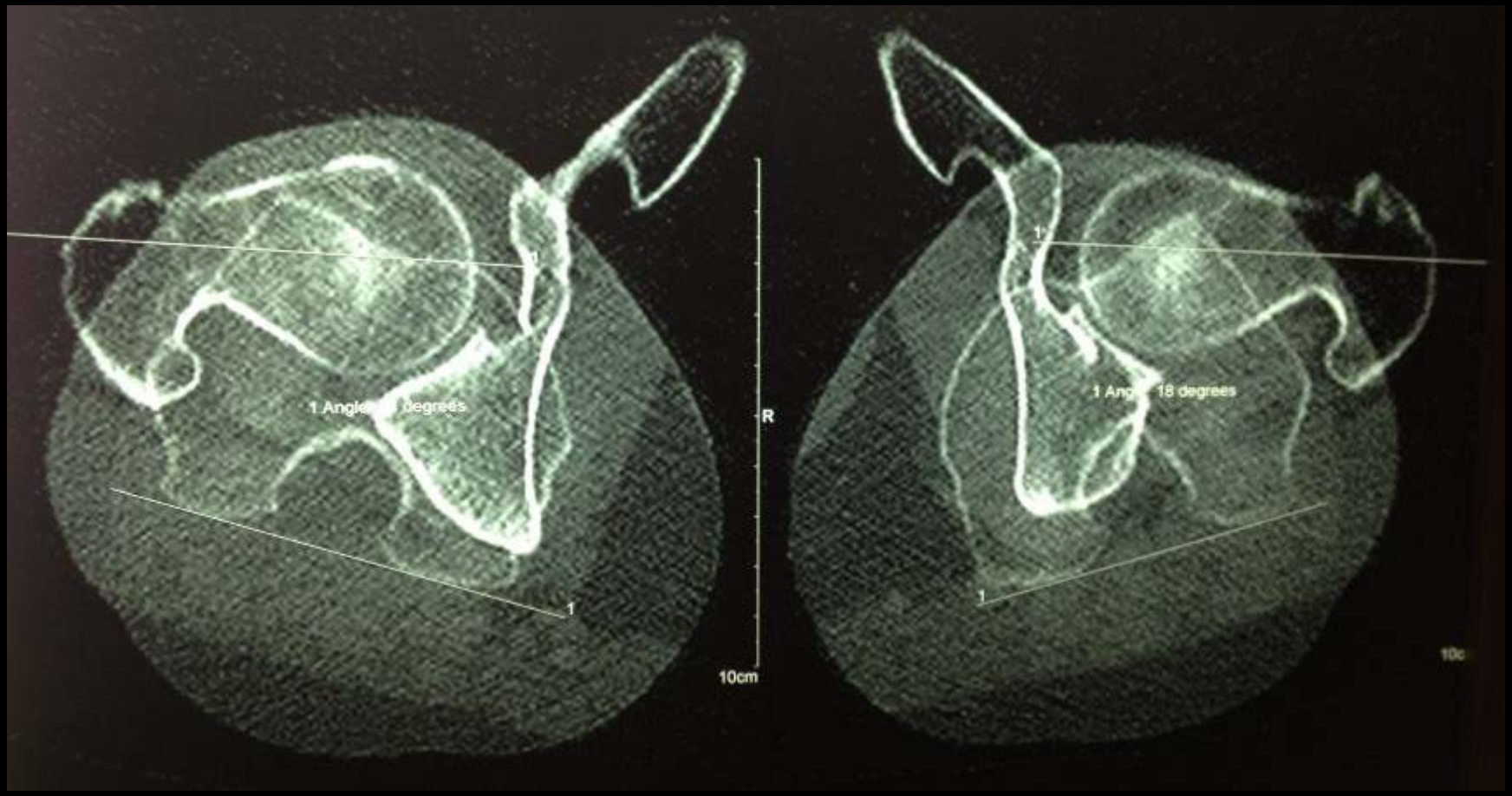
1. Leg Length
2. Neck Shaft Angle
3. Trabeculae
4. Acetabular Inclination
5. Center Edge
6. Joint Space
7. Lateralization
8. Head Sphericity
9. Cup Depth
10. Anterior/ Posterior Wall

LATERAL RADIOGRAPH



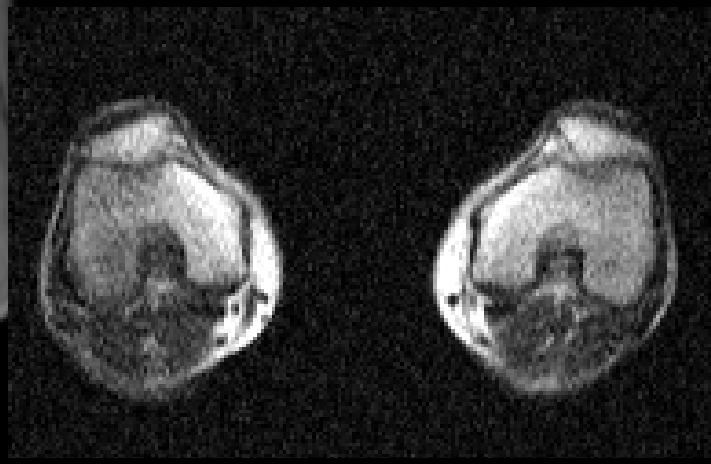
MRI ARTHROGRAM

Computerized tomography

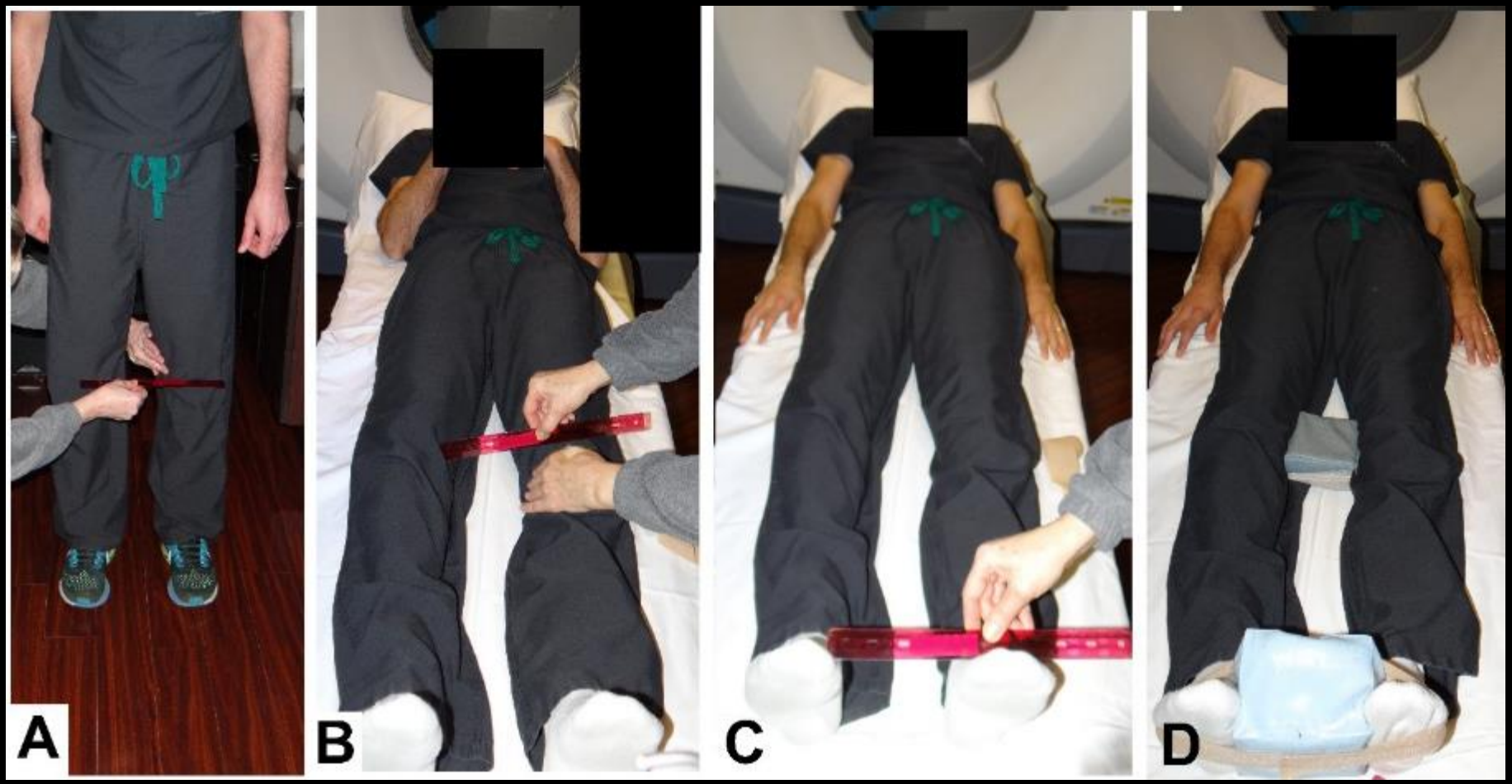


Magnetic resonance for femoral torsion

Feet taped in mid foot Stance Phase



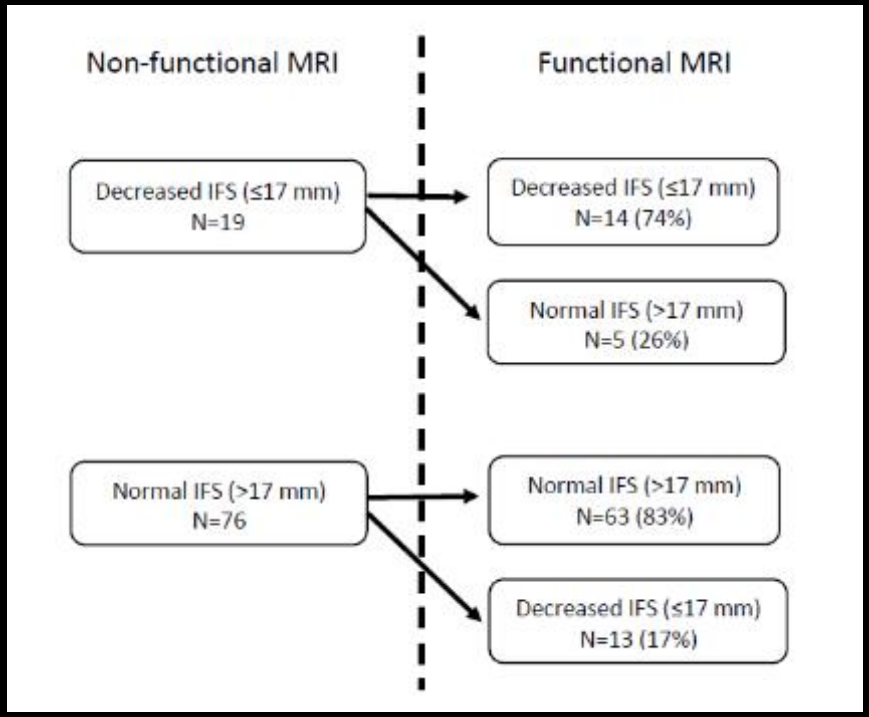
Douglas P. Beall, Hal D. Martin, Douglas N. Mintzd, Justin Q. Lye. Richard F. Costelloa, Brett A. Bralyc, Farida Yoosefianf. Anatomic and structural evaluation of the hip: a cross-sectional imaging technique combining anatomic and biomechanical evaluations. Clinical Imaging 32 (2008) 372–381


A
B
C
D

34% of hips had a difference ≥4 mm in the IFS due to:

- –hip flexion/extension positioning change in 47%
- – hip rotation in 44%
- –hip abduction/adduction in 9%

Hatem M, Martin RL, Nimmons SJ, Martin HD. Frequency of ischiofemoral space discrepancy when comparing magnetic resonance images of distinct institutions for the same patient. Proc (Bayl Univ Med Cent). 2020 Nov 20;34(2):242-246.



26% false positive
17% false negative

Cascade of pathology

Osseous pain with PROM

at end range motion

abnormal ROM

IN THREE PLANES!

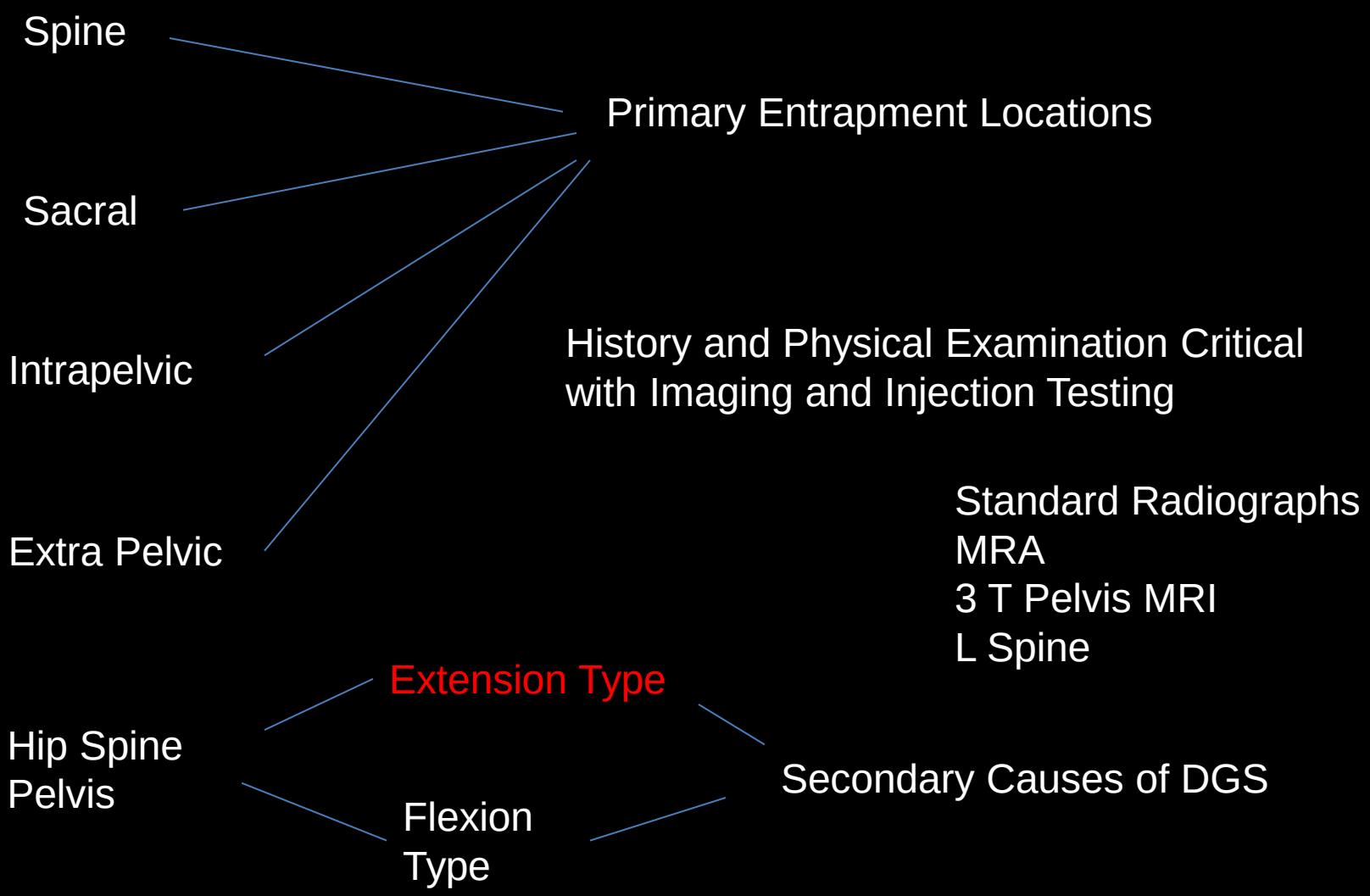
Capsulolabral Laxity / Impingement

Musculotendinous Weakness Contractures

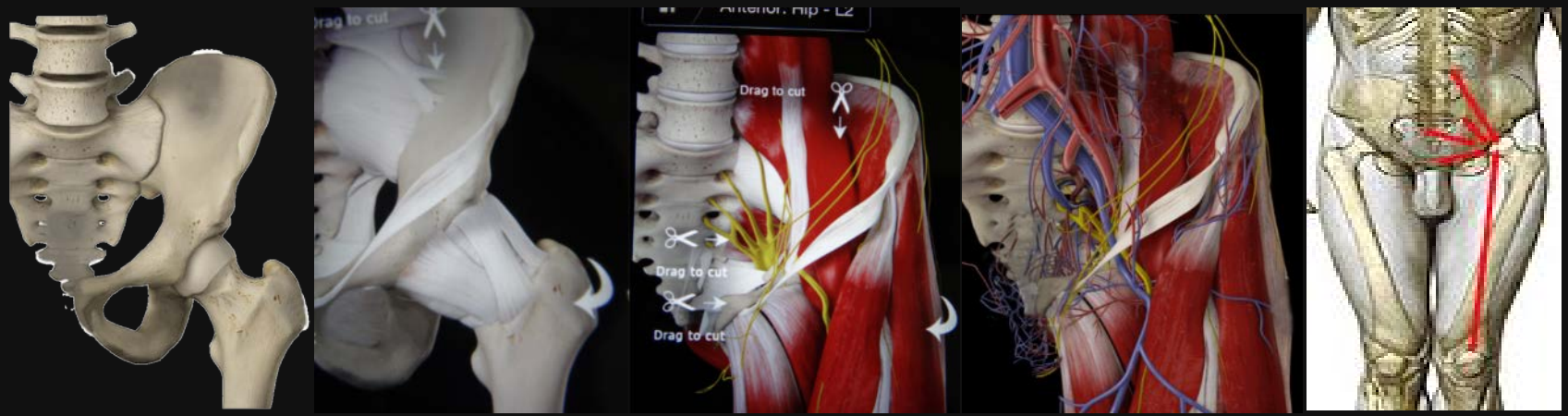
Neuro-Vascular

Kinematic Chain (spine/SI) Effects

Sorting Posterior Hip Pathologies



Hip Pathologies
3 Planes!
Anatomy, Biomechanics, and Comprehensive Clinical Examination with Diagnostic Injections



INJECTIONS

Intra articular Injection, Peritrochanteric, IFI, Piriformis, SIJ, TF SNRB

Hip Preservation Center Publications Books

- Posterior Hip Disorders: Evaluation and Treatment. Author and Editors: HD Martin & J Gómez-Hoyos. Springer (In Progress)
- Hal D. Martin DO, IJ Palmer PhD, and MA Hatem MD. Essential Findings in the Clinical Exam. In JC McCarthy, R Villar, and P Noble (Eds), Diagnosis and surgical Treatment of Hip Disease: A Worldwide Perspective on Approaches and Outcomes. Springer. (In Press)
- Hal D. Martin DO, IJ Palmer PhD, and MA Hatem MD. Ch. 89. Nerve Entrapment Lesions of the Hip and Thigh. In MD Miller, S Thompson (Eds) VM Iliziliturri JR. (Section Ed), DeLee and Drez: Orthopaedic Sports Medicine, 4th edition. Section 6: Pelvis, Hip and Thigh. Elsevier. (In Press)
- Hal Martin, DO, IJ Palmer PhD, and MA Hatem MD. Patient History and Exam. In J Callaghan, AG Rosenburg, HE Rubash, JC Clohisy, CJ Della Valle, and J Parvizi (Eds), The Adult Hip: Arthroplasty and Its Alternative and Hip Preservation, 3rd edition. Lippincott Williams & Wilkins. (In Press)
- Hal Martin, DO, IJ Palmer PhD, and MA Hatem MD. Surgical Technique: Endoscopic Sciatic Nerve Release. In SJ Nho, M Leunig, C Larson, A Bedi, BT Kelly, Hip Arthroscopy and Hip Joint Preservation Surgery. Springer. (In Press)
- Hal Martin, DO, IJ Palmer PhD, and MA Hatem MD. Patient History and Exam. In SJ Nho, M Leunig, C Larson, A Bedi, BT Kelly, Hip Arthroscopy and Hip Joint Preservation Surgery. Springer. (In Press)
- Hal Martin, DO, IJ Palmer PhD, and MA Hatem MD. Deep Gluteal Syndrome. In SJ Nho, M Leunig, C Larson, A Bedi, BT Kelly, Hip Arthroscopy and Hip Joint Preservation Surgery. Springer. (In Press)

Hip Preservation Center Publications Papers

- Contribution of the Pubofemoral Ligament to Hip Stability: A Biomechanical Study. *Arthroscopy* (Submitted, In Review) Martin HD, Khoury A, Schroder R, Johnson E, Campos S, Palmer IJ.
- Hip Spine Effect: A Cadeveric Study of Ischiofemoral Impingement in Hip Extension Effecting Loads in Lumbar Facet Joints. *Arthroscopy* (Accepted, In Revision). Gómez-Hoyos J, Schröder RG, Khoury A, Palmer IJ, Martin HD.
- Posterior Hip Pain: Evaluation and Treatment. *J Am Acad Orthop Surg* (Accepted, In Review) Gómez-Hoyos J, Martin RL, Martin HD.
- Endoscopy-Assisted Periacetabular Osteotomy. *Arthrosc Techn* 2015 (In Review). Matsuda DK, Martin HD, Parvizi J.
- Ischiofemoral Impingement and Hamstring Tunnel Syndrome, Distal Causes of Deep Gluteal Syndrome: Where Do We Go Next? *Clin Sports Med.* 2015 (Accepted, In Review) Martin HD, Khoury A, Schröder RG, Palmer IJ.
- Ischiofemoral Impingement: Defining the Lesser Trochanter-Ischial Space. *KSSTA* 2016. (Accepted, in Press). Kivlan B, Martin RL, Martin HD.

- Femoral Neck Anteversion and Lesser Trochanteric Retroversion in Patients with Ischiofemoral Impingement: a case-control MRI study. *Arthroscopy* 2015. Sept. 7 [Epub ahead of print]. Published 2016. 32(1):13-18. Gómez-Hoyos J, Schröder RG, Reddy MP, Palmer IJ, Martin HD. Gómez-Hoyos J, Schröder RG, Reddy MP, Palmer IJ, Martin HD.
- Accuracy of two clinical tests for ischiofemoral impingement in patients with posterior hip pain and endoscopic-confirmed diagnosis. *Arthroscopy* 2015. (Accepted, In Proof) Gómez-Hoyos J, Martin RL, PhD; Schroder RG, Palmer IJ, Martin HD.
- *J Hip Pres Surg* 2015. 2(2):91-122. Mini Symposium: Evolving Concepts in Extra-articular Hip Pathology. Editor Martin HD:
  - Mini-Symposium Introduction. Martin HD.
  - Laparoscopic Approach to Intrapelvic Nerve Entrapments. Lemos N, Possover M.
  - Deep Gluteal Syndrome. Martin HD, Reddy MP, Gomez-Hoyos J.
  - Endoscopic Hip Osteotomies: Less invasive approaches to peri-acetabular, proximal femoral, and pubic symphyseal procedures. Matsuda D.
  - Hamstring Injuries. Guanche CA.
- Pathological Findings in Patients with Low Anterior Inferior Iliac Spine Impingement. *Surg Radiol Anat* Nov. 2015 [Epub ahead of print]. Amar E, Warschawski Y, Scharfman ZT, Martin HD, Safran MR, Rath E.
- Orthopedic Round Table: Panel Discusses New Types and Treatments of Hip Impingement. *Orthopedics Today.* May, 2015. Moderator: Matsuda DK. Panelists: Martin HD, Larson CM, Trousdale RT.
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- Ischiofemoral Space Decompression Posterolateral Approach: Cutting Block Technique. *Arth Tech* 2014;3(6):e661-5.. Howse EA, Mannava S, Tamam C, Martin HD, Bredella MA, Stubbs AJ.
- Nerve Entrapments of the Hip and Thigh. *J Ortho Sports Phys Therap* (In Review) Hal D. Martin, DO, M. Hatem, RL Martin, I.J. Palmer.

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- Aterior Nerves of the Hip. *J Hip Pres Surg* (In Review) Hal D. Martin, DO, I.J. Palmer, M. Hatem.
- Heterotopic Ossification after Hip Arthroscopy: A Case Report of Bilateral Hip Arthroscopy with and without Anti-inflammatory Prophylaxis: A Case Report. *J Hip Pres Surg* (In Review). Ehud Rath, Hal D. Martin, *et al.*
- The Function of the Ligamentum Teres in Limiting Hip Rotation: A Cadaveric Study. *Arthroscopy* 2014; 30(9):1085-91. Hal D. Martin, DO, M. Hatem, BR Kivlan, RL Martin.
- Monopolar Radiofrequency Usage in Deep Gluteal Space Endoscopy: Sciatic Nerve Safety and Fluid Temperature. *Arthroscopy* 2014;30(1):60-4. Hal D. Martin, DO, M. Hatem, I.J. Palmer.
- Diagnostic Accuracy of Clinical Tests for Sciatic Nerve Entrapment in the Gluteal Region. *Knee Surg Sports Traumatol Arthros.* 2014. 22: 882-888. Hal D. Martin, DO, BR Kivlan, IJ Palmer, RL Martin.
- Closed Intramedullary Derotational Osteotomy and Hip Arthroscopy for Cam Femoroacetabular Impingement from Femoral Retroversion. *Artrhrosc Techn.* 2014; 3(1):e83-8. Matsuda DK, Gupta N, Hal D. Martin DO.
- History and physical examination of the hip: the basics. *Curr Rev Musculoskelet Med.* 2013;6:219-225. Hal Martin, DO, IJ Palmer PhD.

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Hip Preservation Center Publications Editorial Comments

- *JHPS Comment*: *JHPS* Authors. What the Papers Say. ***JHPS* 2015**;2(1):84-86. *"JHPS has selected six recent and topical articles for those who seek a brief summary if what is taking place in our ever-fascinating world of hip preservation."*
  - Featuring: Diagnosis and 2-year Outcomes of Endoscopic Treatment for Ischiofemoral Impingement. *Arthroscopy.* 2015;31(2):239-46. Hatem M, Palmer IJ, Martin HD.
- *JHPS Editorial*: Villar R. What is this Duplicate Publication Thing? ***JHPS* 2015**;2(3):203-205.
  - Comments on: Mini Symposium: Evolving Concepts in Extra-articular Hip Pathology. *J Hip Pres Surg* 2015. 2(2):91-122. Martin HD.
- *Arthroscopy Editorial Commentary.* Lubowitz JH. Hip Femoroacetabular Surgery Requires Improved Radiologic Research and Expert Understanding of Hip Clinical Examination. ***Arthroscopy* 2015**;31(7):1391.
  - Highlights: The pattern and technique in the clinical evaluation of the adult hip: The common physical examination tests of hip specialists. *Arthroscopy* 2010;26:161-72. Martin HD *et al.*
- *Arthroscopy Editorial Commentary.* Konyves A. Another Drop of Knowledge on Ischiofemoral Impingement. ***Arthroscopy* 2016**. 32(1):19.
  - Comment on two articles:
  - 1) Femoral Neck Anteversion and Lesser Trochanteric Retroversion in Patients with Ischiofemoral Impingement: a case-control MRI study. *Arthroscopy* 2015. Sept. 7 [Epub ahead of print]. Published 2016. 32(1):13-18. Gómez-Hoyos J, Schröder RG, Reddy MP, Palmer IJ, Martin HD.
  - 2) Diagnosis and 2-year Outcomes of Endoscopic Treatment for Ischiofemoral Impingement. *Arthroscopy.* 2015;31(2):239-46. Hatem M, Palmer IJ, Martin HD.

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Hip Preservation Center Publications Lectures

- 4th Biennial Hip Symposium and Souraski Tel Aviv Medical Shoulder Meeting, September 2017
  - Extension Hip Spine Disorders
  - Piriformis Release
  - Anferior Inferior Acetabular Instability
  - Posterior Hip
  - Psoas/Snapping Impingement
- Chicago Sports Medicine Symposium, August 2017
  - Clinical Evaluation of the Adult Hip
- Metcalf/AANA Combined Surgery Seminar. Sun Valley, ID. February 2016.
  - Physical Examination of the Hip
  - Extra-Articular Posterior Hip Pain
  - Hip Arthroscopy and Patient Selection. Who is at risk of a poor outcome?
- Vail Hip Symposium – A Decade of Education and Innovation. Vail, CO. January 2016.
  - Ligamentum teres
  - Moderator: Groin and Posterior Hip
  - Disorders of the Peritrochanteric and Deep Gluteal Space
- International Society of Neuropelveology VIP Meeting. “Clinical and Operative Neuropelveology” Aarhus, Denmark. December 11-12, 2015.
  - Extra-Pelvic Posterior Hip Pain and Sciatic Nerve Entrapment
- Orthopaedic Summit Evolving Techniques. International Perspectives on Advancements and the Future of Orthopaedics. Las Vegas, NV. December 5, 2015.
  - Evolving Technique Update: Hip Exam is it 5 or 15 min? How I Decide
  - Moderator: Mini Debate The Use of Diagnostic Injections
  - Moderator: Q&A with Case Presentations
- Brazilian Hip Society Sao Paulo State Region. Hip Specific Meeting. October 15, 2015.
  - Hip Physical Exam
  - Clinical Cases

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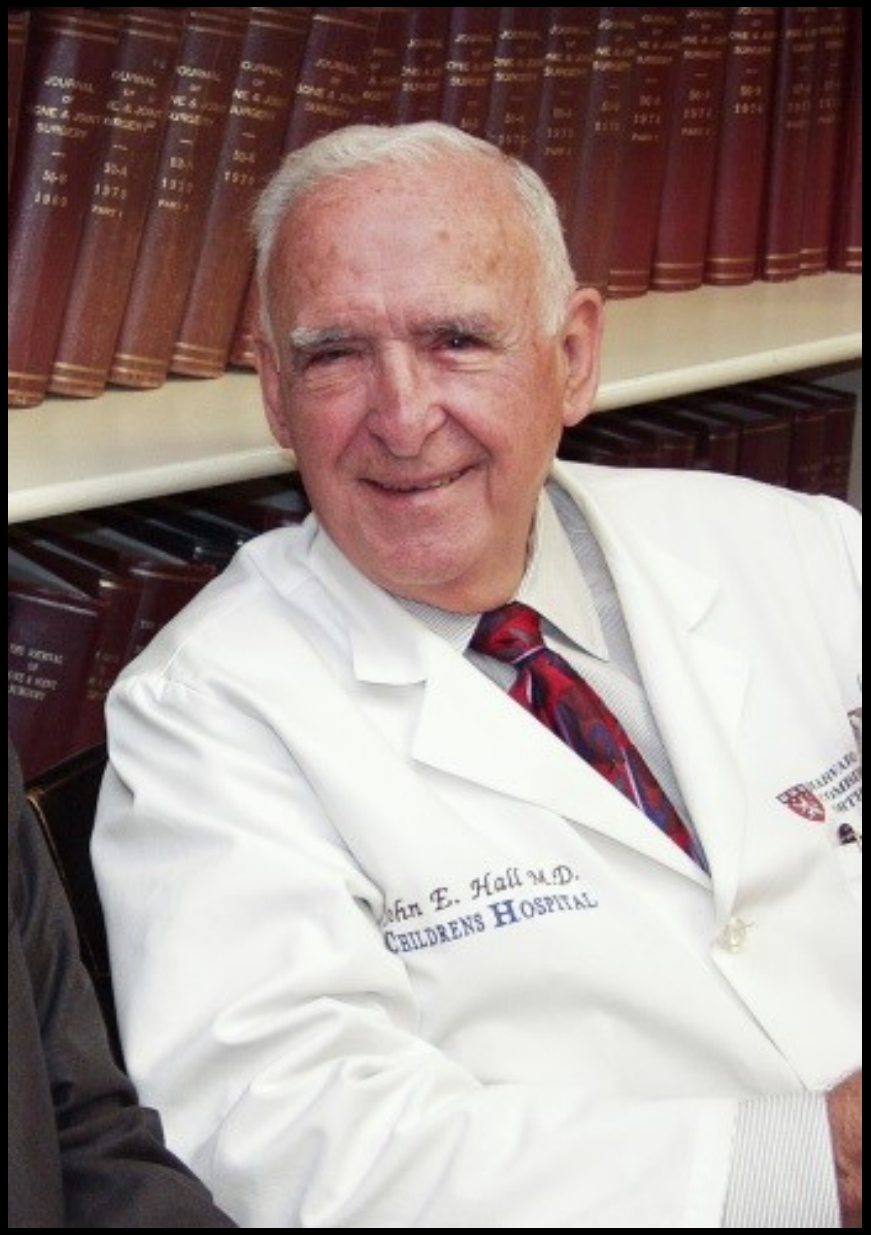
Dr. Michael Millis

Dr. John Hall

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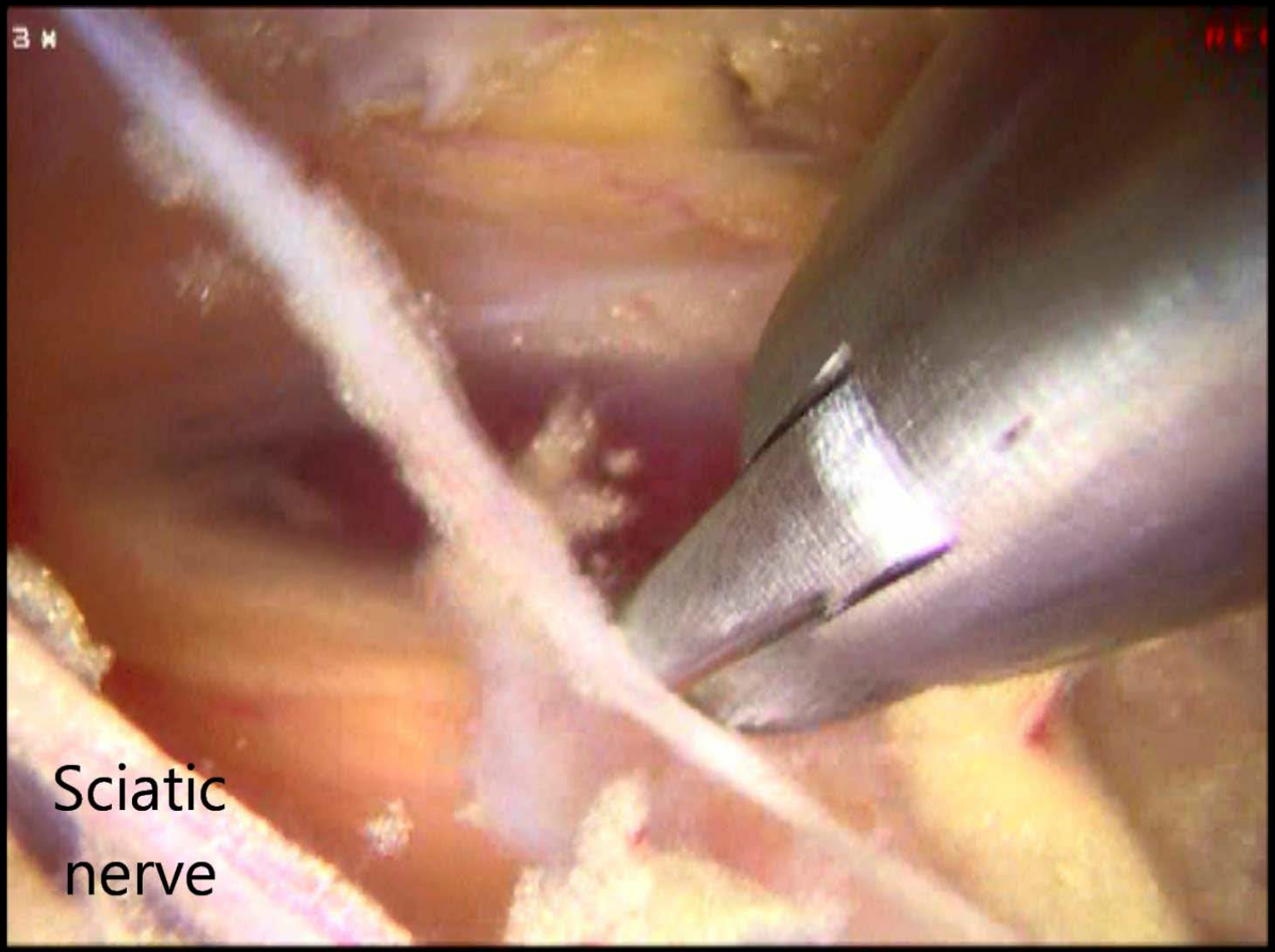
Thank You

Thank you

Endoscopic SN Decompression



- Arthroscopy Association of North America Fall Meeting. Las Vegas, NV. November, 2013.
  - Sciatic Nerve Entrapment
  - Hip Model Lab
- Harvard Medical School. 43nd Annual Course: Advances in Arthroplasty. Boston, MA. October, 2013.
  - Hip Pain: Pearls to Determine that it is from the Joint
  - Portal Placement: Safe Zones for the Central & Peripheral Compartments
  - Moderator: What Can Be Treated
  - Arthroscopic Quadratus Femoris and Sciatic Nerve Release.
- The 2nd Israeli Hip Surgery and Rehabilitation Symposium. Hertzeliya, Israel. October, 2013.
  - Advancements of Hip Anatomical/Biomechanical Considerations
  - Instability Labral Tears and Treatment
  - Tractionless Labral Repair
  - Sciatic Nerve Entrapment: Clinical Presentation and Endoscopic Release
  - Practical Workshop: Clinical Examination of the Hip Joint.
- ISHA Hip Arthroscopy Annual Scientific Meeting 2013. Munich, GermanyOctober, 2013.
  - The Peritrochanteric Space Anatomy, and Portals
  - Extrapelvic Sciatic Entrapment
  - Deep Gluteal Pain/Sciatic Nerve Entrapment
  - Clinical Examination of the Hip in FAI &Subgluteal Space
  - Sciatic Nerve Endoscopy & Piriformis Syndrome
- AANA Annual Meeting. San Antonio, TX. April, 2013
  - Peritrochanteric Space Disorders
- AAOS/AAHKS/POSNA Hip Preservation in the Adult and Adolescent Hip Meeting. Chicago, IL. April, 2013.
  - The Labrum
- Santander Hip Meeting. Santander, Spain. February, 2013
  - Coxa Profunda: Arthroscopic Treatment
  - Femoral Anteversion and Retroversion: Diagnosis and Treatment
  - The Ligamentum Teres of the Hip: Arthroscopic Classification and Treatment
  - Hamstrings, Ischiofemoral and Greater Trochanter Impingement: Endoscopic Treatment
  - Sciatic and Pudendal Nerve: Endoscopic Treatment
- 8th Annual Vail Hip Symposium. Faculty. Vail, CO. January, 2013
  - The Clinical Examination
  - The Effect of Traction
  - The Role of the Ligamentum Teres in Hip Instability
  - Hamstring Origin Endoscopy

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- ANNA Fall Meeting 2014. Palm Desert, CA. November 6-7, 2014
  - Subgluteal Space Endoscopy
  - Hip Model Lab
- International Society of Hip Arthroscopy Annual Scientific Meeting 2014. Rio de Janeiro, Brazil. October 10-11, 2014.
  - Moderator: ICL Periarticular Endoscopy The Peritrochanteric Space
  - Instability resulting in extra-articular impingement
  - How I address IFI-Trans Quadratus approach
  - IFI discussion
- Harvard Medical School. 44th Annual Course: Advances in Arthroplasty. Boston, MA. October 2014.
  - Hip Pain: Pearl to Determine that it is from the Joint
  - Moderator: Open and Arthroscopic Rx of Hip Deformities
- San Antonio Military Medical Center Grand Rounds. San Antonio TX. July 3, 2014.
  - Physical Examination of the Hip
- Spine and SI Joint Meeting. Cabo, Mexico. June 27, 2014.
  - Kinematics of the Lower Extremity and Hip: Implications for the SI Joint – ABCD's of the Hip Spine Complex.
- American Academy of Orthopaedic Surgeons Annual Meeting. New Orleans, LA. March, 2014
  - Endoscopic Treatment of Ischiofemoral Impingement, Poster Presentation – HD Martin, IJ Palmer, M Hatem (Presenter)
- 2nd Melbourne International Hip Arthroscopy Meeting. Melbourne, Australia. January, 2014.
  - Hip Exam
  - Posterior Hip Endoscopy
  - Role of the Capsule and Ligamentum Teres in Hip Stability.
- 1st European Hip Arthroscopy Course. Brussels, Belgium. December, 2013.
  - Clinical Evaluation of the Hip, Mini-Battle on Portals, Capsular Release: Central First – Capsulotomy Better
  - Moderator: Extra-Articular Hip Arthroscopy
  - Nerve Ischiadicus Release: Indication and Technique
  - Gluteus Medius Repair.
- XLIX Congreso Chileno de Ortopedia y Traumatologia. Viña del Mar, Chile. November, 2013.
  - Sciatic Nerve Release: Results
  - Anterior Approach
  - Hip Arthroscopy: My Approach/Vision
  - AVN Options Vascularized Fibular Graft
  - My Worst Case

- OLC AOSSM Surgical Skills Course – Rosemont, IL. April, 2015.
  - Deep Gluteal Space Syndrome
  - Iliopsoas: When and how to release it and when to leave it alone
  - Treatment Algorithm: Static and Dynamic Overload.
- Hughston Society Meeting. Columbus, GA. April, 2015.
  - Posterior Hip, Unusual Pathologies.
- American Physical Therapy Association National Meeting. Indianapolis IN. February, 2015.
  - Poster Presentation. GT-Ischial Impingement a Potential Source of Posterior Hip Pain. Martin HD, Martin RL.
- American Physical Therapy Association National Meeting. Indianapolis IN. February, 2015.
  - Poster Presentation. Ischiofemoral Impingement Defining the Ischial-Lesser Trochanteric Space. Martin HD, Martin RL.
- Vail Hip Symposium – A Decade of Education and Innovation. Vail, CO. January 2015.
  - Moderator: Hot Topics
  - The hip exam
  - Ligamentum teres
  - Deep gluteal pain syndrome.
- OSET Orthopaedic Summit. Las Vegas, NV. December 2014.
  - Diagnostic Tests to Succeed in Hip Arthroscopy
  - Hip Patient evaluation and op set up Q&A
  - Mini-Debate Psoas Snapping - Please no Releases It's a secondary mechanical problem
  - Subgluteal Space/Sciatic Nerve Entrapment
  - Hip Dilemmas Q&A
  - Hip Arthroscopy without Traction-All my colleagues are completely wrong
  - Sage Advice for Hip Arthroscopy - Faculty's One Tiip!
- European Society of Hip Arthroscopy Annual Scientific Meeting 2014. Munich, Germany. November 21-22, 2014.
  - Capsule and Ligaments - how they contribute to Stability
  - Physical Exam - What is Important?
  - Subspinal AIIS: Resection with and without Rectus Detachment
  - Gluteal and Ischial Space - Piriformis and hamstrings.
- JOJ Hip Arthroplasty Meeting 2014. San Francisco, CA. November 14, 2014
  - Soft tissue causes of hip pain: Gluteus Medius Tears and nerve entrapment syndromes
  - Managing soft tissue pain. 3 cases illustrating GM diagnosis and repair

- Israeli Hip Surgery and Rehabilitation Symposium. Hertzeliya, Israel. September 29-30, 2015.
  - History/Physical Exam and Diagnosis of Hip Pathology
  - Hip Spine Syndrome

- International Society of Hip Arthroscopy Annual Scientific Meeting 2015. Cambridge, UK. September 24-26, 2015.
  - Moderator: Posterior Compartment
  - Basic Science of the Ligamentum Teres and its Role in Hip Biomechanics
  - Sciatic Nerve and Deep Gluteal Syndrome
  - Ischiofemoral Decompression – Video with Q&A
- **Juan Gómez-Hoyos (Presenter)**
  - Iliopsoas tendon insertion footprint with surgical implications in lesser trochanterplasty for treating ischiofemoral impingement: an anatomic study.
  - Accuracy of two clinical tests for ischiofemoral impingement in patients with posterior hip pain.
  - The relationship of femoral neck version and lesser trochanter version with endoscopically confirmed extra-articular hip impingement.
- **E-Poster**
  - The Effects of Hip Abduction on Sciatic Nerve Biomechanics During the Kicking Motion.
  - Management of Deep Gluteal Nerve Syndrome – A case series.
  - Does Decreased Femoral Version Influence Pelvis and Lumbar Spine Kinematics During Gait?
  - Arthroscopic acetabuloplasty and labrum repair without traction: outcomes.
- Brazil Hip Congress XVI – Fortaleza, Brazil. September 2-5, 2015.
  - Kinematics Implications for Hip Spine Syndrome
  - Diagnosis and Treatment of Extra-Articular Posterior Hip Pain
  - Peritrochanteric Space Disorders
- Smith & Nephew Advanced Fellows Course – Austin, TX. May, 2015.
  - Clinical Examination of the Hip
  - Ischiofemoral Impingement
  - Deep Gluteal Syndrome
- Texas A&M Health Sciences Center College of Medicine Research Symposium. April 28, 2015. Dallas, T
  - Best Podium Presentation - Femoral Neck Anteversion and Lesser Trochanteric Retroversion in Patients Impingement – A Case-Control Study. Reddy MP (Presenter), Gomez-Hoyas J, Schroder RG, Palmer IJ, M

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