

The Science of Pelvic Dynamics and The Subluxation of the Sacral X Axis at S3

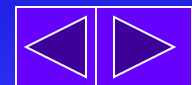
**•THE MECHANICS OF IDIOPATHIC LOW BACK PAIN
SYNDROME AND ITS IMMEDIATE RELIEF**

**•An integrated analysis of pelvic dynamics to
include anatomy, structure, movement, function,
kinesiology, biomechanics and biotensegrity.**

Conceived, researched, illustrated and developed by

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V. 668



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The Author



- **Richard DonTigny, PT**
- **Montana State College, BS in Applied Science in 1954**
- **U of Iowa PT school, Cert. 1958**
- **Wife Josephine, four children**
- **Worked at St Francis Hosp, Colorado Springs, CO., N.P.B.A. Hospital, Missoula, MT, Havre Hospitals, Havre. MT. Private Practice for ten years. Retired 1996**
- **Has conducted a personal search into the cause of idiopathic low back pain since 1959 and found it in the sacroiliac joint in 1965.**

Author Background

- ◆ Mr. DonTigny was a clinical physical therapist for 38 years and has treated over 8,000 cases of dysfunction of the sacroiliac joint.
- ◆ He has studied the works of James and John Mennell as well as those of Cyriax, Maigne, Grieve, Bourdillon and others.
- ◆ Workshops with John Mennell and David Lamb helped him to hone his skills in manual therapy.
- ◆ He has published over 40 articles, has chapters in four textbooks and has presented at local, national and international meetings.

Author Background (2)

He started the common use of cold packs for muscle spasm in 1962.

DonTigny, RL: Sheldon KW: Simultaneous use of heat and cold in the treatment of muscle spasm. Arch Phys Med 43:235-237, 1962

He introduced a new system of passive shoulder exercises.

DonTigny, RL: Passive shoulder exercises. Phys Ther 50:1707-1709, 1970

His knee exercises started the movement "When the foot hits the ground everything changes."

DonTigny, RL: Terminal extension exercises for the knee. Phys Ther 52:45, 1972

His first article on the sacroiliac joint was published in 1973 after four rejections by the PTJ.

DonTigny, RL: Evaluation, manipulation and management of anterior dysfunction of the sacroiliac joint. The D.O. 14:215-226, 1973

Author Background (3)

He developed an effective method of treatment for headache and nausea.

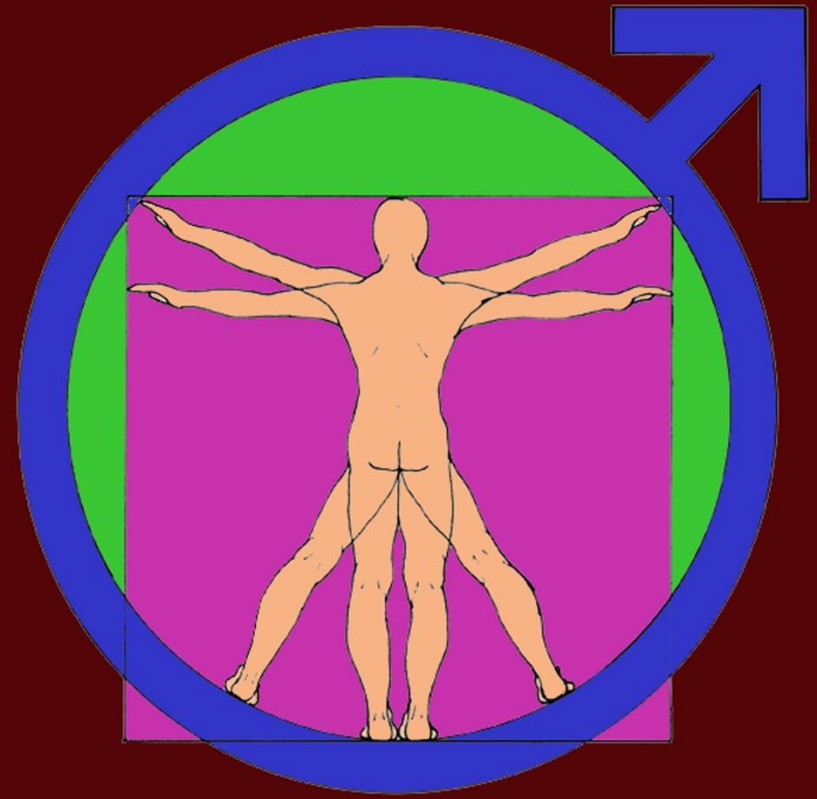
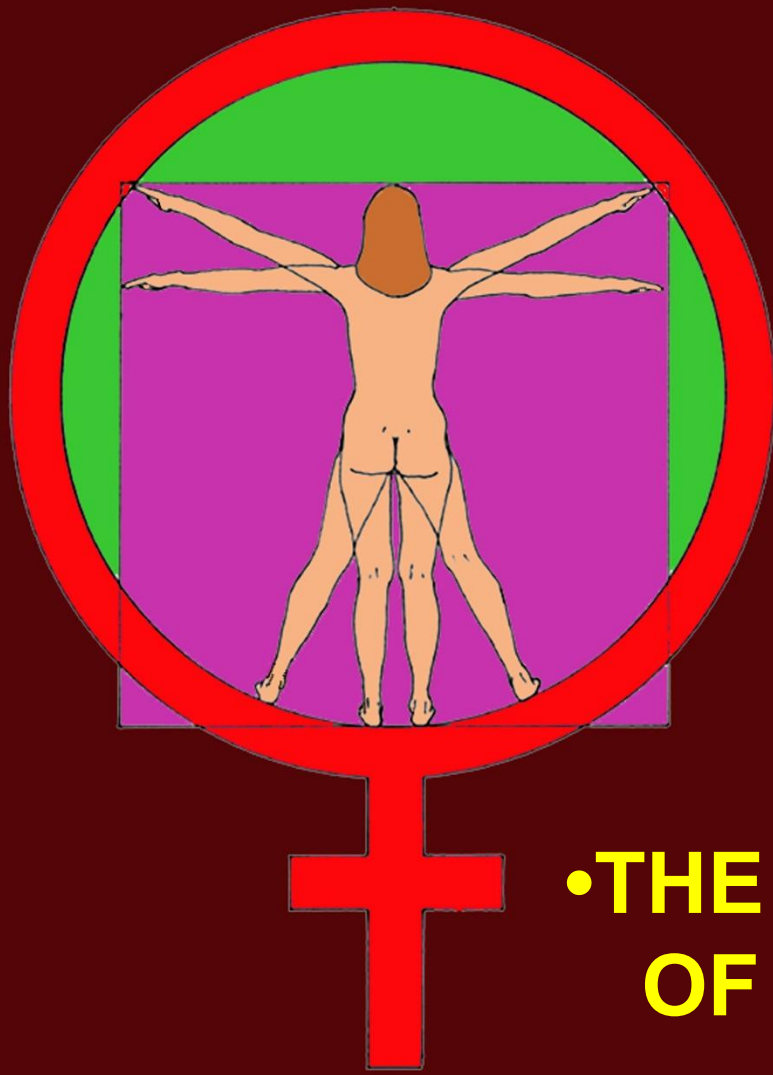
DonTigny, RL: Inhibition of nausea and headaches. Phys Ther 54:864-865, 1974

His devices for hand and wrist exercises are in use in centers all over.

DonTigny, RL: Device for assistive and resistive exercise for wrist and hand. Phys Ther 56:426-7, 1976

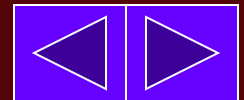
DonTigny, RL: Use of sponge to improve hand strength and coordination, Phys Ther 56:573, 1976

He described the sacral x axis and its mechanics in 2006. DonTigny, RL: A detailed and critical biomechanical analysis of the sacroiliac joints and relevant kinesiology: the implications for lumbopelvic function and dysfunction. In Vleeming A, Mooney V, Stoeckart R (eds): Movement, Stability & Lumbopelvic Pain: Integration of research and therapy. Churchill Livingstone (Elsevier). Edinburgh, 2007, pp 265-279



•THE SCIENCE AND ART OF PELVIC DYNAMICS

•DONTIGNY ©



Learning About The Sacroiliac Joint From The Sacroiliac Joint

RES IPSA LOQUITUR

•(THE THING SPEAKS FOR ITSELF)

- “If you think to reveal the pathology and the conditions of the pathology in words, forget it! The more minute your description, the more you will confuse the reader. It is necessary to **ILLUSTRATE** and describe.

LEONARDO DA VINCI

-
- This program is designed to use a large number of detailed illustrations to clarify and describe the properties of this remarkable, dynamic joint.
-

TO RUN THIS COURSE

- ❖ FIRST, CLICK ON THE 'SLIDE SHOW' ICON IN THE BOTTOM RIGHT TOOL BAR.
- ❖ THE BULLETS WILL COME UP ON MOUSE CLICK, OR CLICK ON BUTTONS LOWER RIGHT OR WITH THE ARROWS ON YOUR KEYBOARD.
- ❖ THE INTENT IS TO SLOW SCANNING TO SPEND MORE TIME ON EACH BULLET IN ORDER TO INCREASE RETENTION.

Course Outline

- ◆ History
- ◆ Anatomy
- ◆ Movement
- ◆ Functional Biomechanics
- ◆ Pathomechanics
- ◆ Impairments
- ◆ Examination
- ◆ Interventions
- ◆ Medical Management
- ◆ The Disk

Course Objectives

- ❖ By the time students finish this course they will be able to :
 - ❖ 1. Describe the biomechanics of the pelvis;
 - ❖ 2 Identify the mechanism of idiopathic low back pain syndrome.
 - ❖ 3 Manage this dysfunction so as to have the majority of such patients free of pain immediately and able to self-correct.
- ❖ The students will know and understand that this dysfunction is a commonly overlooked, reversible, biomechanical lesion of the sacral x axis.
- ❖ When the students finish this course, they should be of the opinion that this is the only truly effective, science based method of evaluation and treatment for low back pain, and that when evaluating a patient they must first correct and reduce the subluxation of the sacral x axis and then re-assess.

Purpose

- ❖ The purpose of this program is to establish a sound anatomical and biomechanical rationale for the appropriate evaluation, testing and treatment of common low back pain.
- ❖ This is the point of the beginning of a new direction for research.
- ❖ With the application of these principles you should be able to have at least four out of five patients essentially free of back pain within ten minutes.

Predictability

- ❖ With the comprehension of these various complexities will come clarity and provide for extreme ease and efficacy in the treatment of common low back pain.
- ❖ The exacerbations, complexities, corrections and results become predictable.....

Course Study Suggestions

- ◆ As the course material is somewhat detailed and complex, it is recommended you study THE ANATOMY AND FUNCTIONAL BIOMECHANICS first (to include gait) and go slowly.
 - ◆ Second session, review the first sessions and study the PATHOMECHANICS AND IMPAIRMENT sections.
 - ◆ Third session review the first two sessions and study the sections on EXAMINATION, INTERVENTIONS AND MEDICAL MANAGEMENT.
- www.thelowback.com

Introduction

- ❖ There are many problems with the present management of low back pain.
- ❖ Various interventions are unable to identify or provide immediate relief of the problem.
- ❖ Mr. DonTigny has identified a commonly overlooked, reversible, biomechanical vulnerability in the sacroiliac joint that appears to be a partial dislocation or subluxation of a sacral x axis just posterior to the S3 sacral segment.
- ❖ Terms subluxation of the sacral x axis, subluxation of the S3 segment, dysfunction of the sacroiliac joint or SIJD all refer to essentially the same condition.

Introduction (2)

- ❖ At least four out of five patients with low back pain can be essentially free of pain within ten minutes following a complete reduction of this subluxation.
- ❖ It does not matter if the pain is recent or long term, severe or mild or in women during or after pregnancy.
- ❖ A precise manual correction of this subluxation will provide immediate relief of common low back pain.

Introduction (3)

- ❖ Measurements before and after reduction of this subluxation have demonstrated a pathological movement of the innominates cephalad and laterally on the sacrum.(13)
- ❖ This movement has also been demonstrated on plain roentgenography.(76)
- ❖ An investigation into the functional biomechanics of this joint is necessary to understand how this dysfunction can affect such a wide variety of structures.

Introduction (4)

- ❖ The sacroiliac joint is a unique, dynamic and incredibly complex joint with several varieties of movement and important actions that have a profound effect on normal gait.
- ❖ Everything about this joint is important and this program will walk you through the intricate mechanics in detail.

History – SIJ and the Disk

- ❖ In the early 1900s dysfunction of the SIJ was a common diagnosis and commonly associated with pain in the sciatic nerve.
- ❖ McConnell and Teall (1906) described the condition in which the ilium is thrown downward on the sacrum “causing an apparent lengthening of the limb which will be noticed by comparing the heels.” when the patient is supine.(77)

History – SIJ and the Disk

- ❖ In 1925 Danforth and Wilson studied the relationship between the SIJ and the sciatic nerve and concluded that the SIJ could not be at fault because there was no canal that held the nerves against the joint.(53)
- ❖ Chamberlain (1930) identified this dysfunction using stereoscopic roentgenograms.(78)
- ❖ In 1934 with the work of Mixter and Barr, all emphasis in research and treatment shifted to the herniated intervertebral disk.(54)

History – The Disk

- ❖ Because nonspecific back pain often precedes disk herniation, White concluded that the disk is a likely source of the preceding idiopathic low back pain.(58)
- ❖ Idiopathic low back disorders are frequently ascribed to disk disease, but this etiology has never been proven.(59)
- ❖ Intervertebral disks frequently degenerate without producing any symptoms of low back disorders.(59)

History (White)

- ❖ White also stated that “It may well be that idiopathic low back pain will be found to be some condition that is a subtle variation from normal.
- ❖ Otherwise, we probably would have found the cause already.
- ❖ If back pain were caused by a highly unusual condition then fewer people would suffer from this disorder.”

History – The AAOS Symposium in Toronto in 1982

- ❖ Presently used procedures for the conventional evaluation and treatment of low back pain were developed and endorsed at the American Academy of Orthopaedic Surgeons (AAOS) symposium in Toronto in 1982.
- ❖ The participants also agreed that even after an extensive work-up using those procedures **only about 15%** of patients can be given a definitive diagnosis.

History - AAOS

- ❖ Scant consideration was given to the sacroiliac joints because it was widely assumed that they were immune to injury through minor trauma.
- ❖ If you use the recommended AAOS testing you will find what they found and those tests will compel you to be unable to arrive at a definitive diagnosis about 85% of the time.
- ❖ Recent research on the SIJs has found that different tests are necessary to evaluate the sacroiliac joints.(1-3)

History (Abraham and Killackey-Jones)

- ◆ Abraham and Killackey-Jones lamented the lack of evidence based research for idiopathic low back pain. (79)
- ◆ They further stated that “The validity of non-specific or idiopathic low back pain seems to be a historical myth.”
- ◆ “ We believe the apparent un-critical acceptance of idiopathic and nonspecific LBP as valid concepts has badly affected research and national medical policy. It is time to re-think this position”.

The Problem

- ❖ Evidence of errors by early researchers regarding the sacral x axis has stymied evidence based research in low back pain.
- ❖ Errors in the functional biomechanics of the sacroiliac joints and of the precise nature of the pathomechanics has lead to inappropriate testing, inappropriate interpretation of tests and inappropriate treatment of low back pain.

Testing/Treatment

- ❖ Testing should reveal how and to what degree pathology varies from normal function.
- ❖ Treatment of dysfunction should be the restoration of normal function.
- ❖ First of all you must understand the mechanics of normal function.

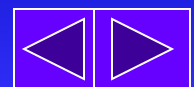
The Sacroiliac Joint

(CONTENTS, LINKS)

- ❖ [Anatomy](#)
- ❖ [Movement](#)
- ❖ [Functional Biomechanics and Gait](#)
- ❖ [Pathomechanics](#)
- ❖ [Impairments](#)
- ❖ [Examination](#)
- ❖ [Interventions](#)
- ❖ [Medical Management](#)

ANATOMY

THE BASICS



Anatomy Outline

- ❖ Developmental anatomy
- ❖ The structural angulations of the SIJ.
- ❖ Bones
- ❖ Joints
- ❖ Ligaments
- ❖ Fascia
- ❖ Muscles
- ❖ Innervations

Anatomical Objectives

- ❖ To study the development and composition of the SIJ.
- ❖ To explain the interrelationships of the various tissues.
- ❖ To describe the direction of movement allowed by the structural angulations of the SIJ.
- ❖ To demonstrate the structural factors involved in the stability of the SIJ.

Developmental Anatomy

- ❖ The SIJ has a unique developmental anatomy that is responsible for an unusual and underdeveloped iliac cartilage surface.(34)
- ❖ A thin layer of fibrocartilage on the iliac surface has a tendency to develop early signs of osteoarthritis in males by the third decade and in females by the fourth or fifth decade.(34)

Developmental Anatomy (2)

- ❖ Early signs of iliac osteoarthritis include surface fibrillation, large crevice formation and early erosion.(34)
- ❖ A layer of hyaline articular cartilage on the sacral surface is two to three times thicker than the fibrocartilage on the iliac surface and shows degenerative changes much later in life.(34)

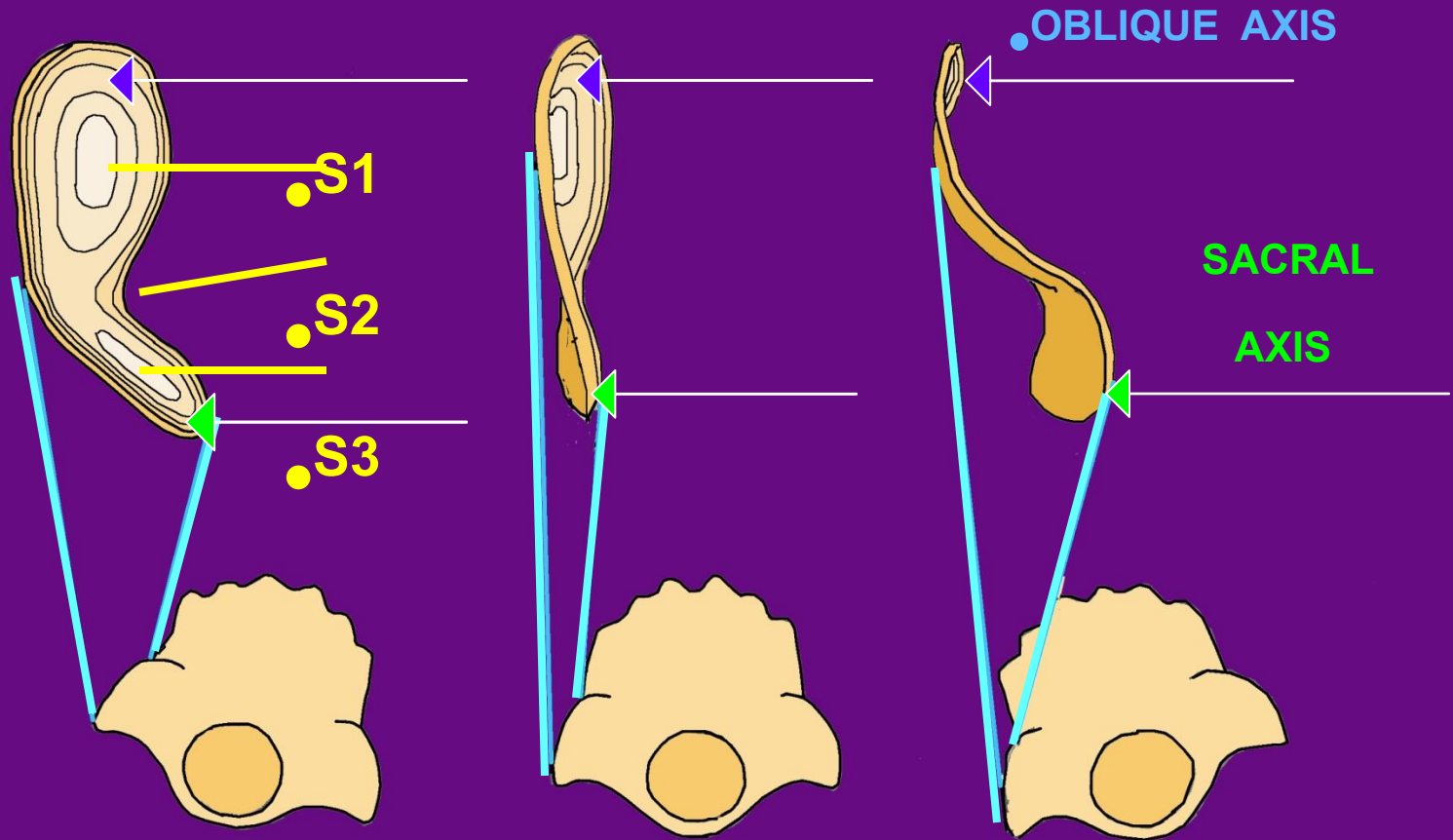
Developmental Anatomy (3)

- ❖ Bony ankylosis is rare.(34)
- ❖ A crescent shaped ridge develops along the entire length of the ilial surface with a corresponding depression on the sacral side.
- ❖ With increasing age the surfaces become more irregular and prominent.(34)
- ❖ The effect is to gain stability at the expense of mobility. (34)
- ❖ This is a high friction joint, (2) but high friction is not a factor in normal function.

The Joint Surface

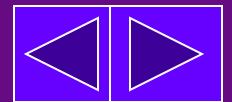
- ❖ The ilial surface is essentially convex
- ❖ The sacral surface is essentially concave.
- ❖ The sacroiliac joint is somewhat “L” shaped.
- ❖ The sacral surface of the joint is most likely made up of an early fusion of the costo-vertebral joints of the S1, S2 and S3 sacral segments.

•ILIAL SURFACE AT THE SACROILIAC JOINTS



THIS IS A HIGH FRICTION JOINT

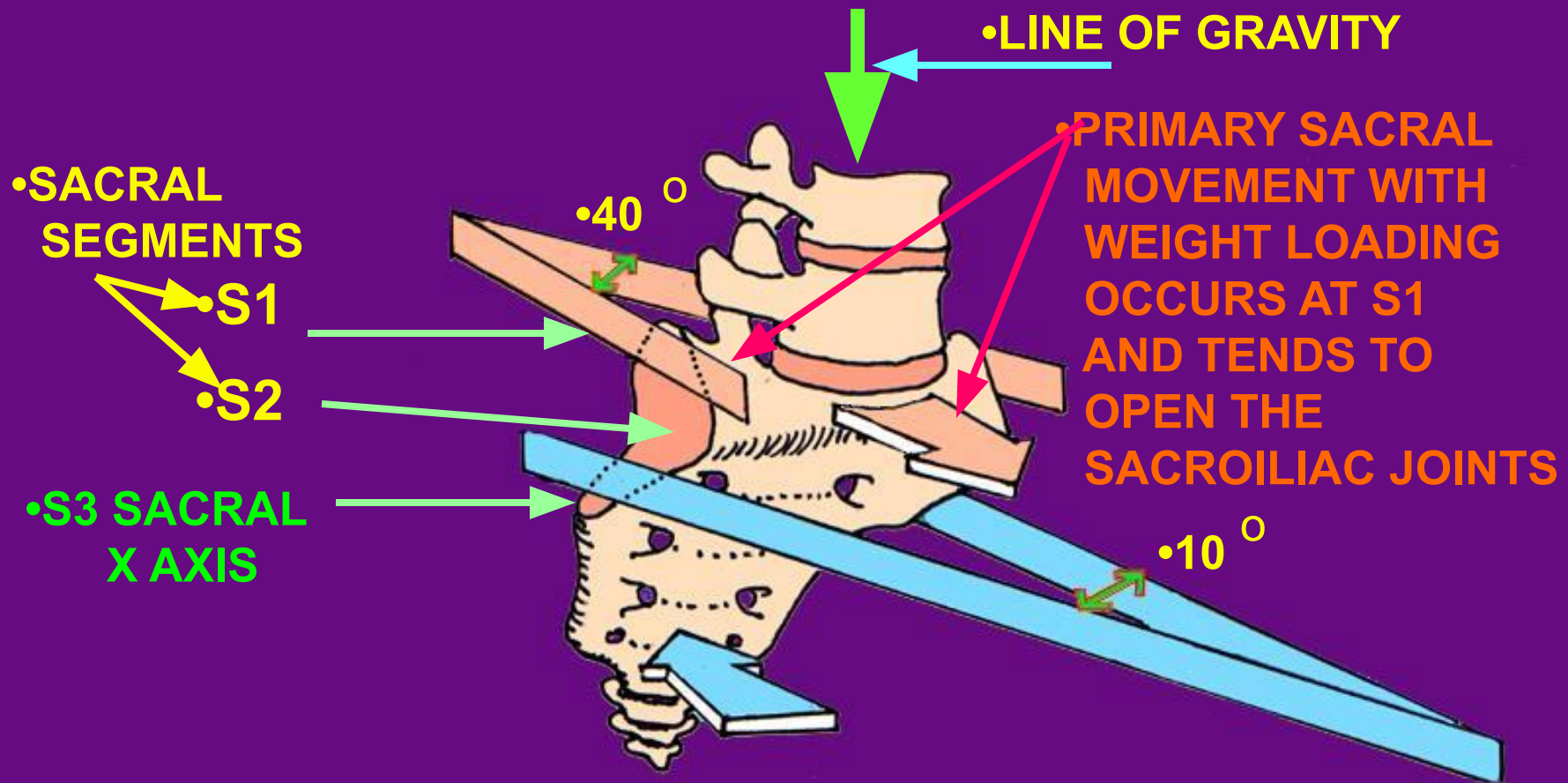
FROM SOLONEN (83)



Structural Angulations Of The Sacroiliac Joints

- ❖ An understanding of the structural angulations of the SIJs is essential to any analysis of functional biomechanics.
- ❖ The angle of each S1 segment is about 20 degrees off sagittal antero-lateral and that of each S3 segment off sagittal about 5 degrees postero-lateral.
(Illustration follows)

•STRUCTURAL ANGULATIONS OF THE SIJ



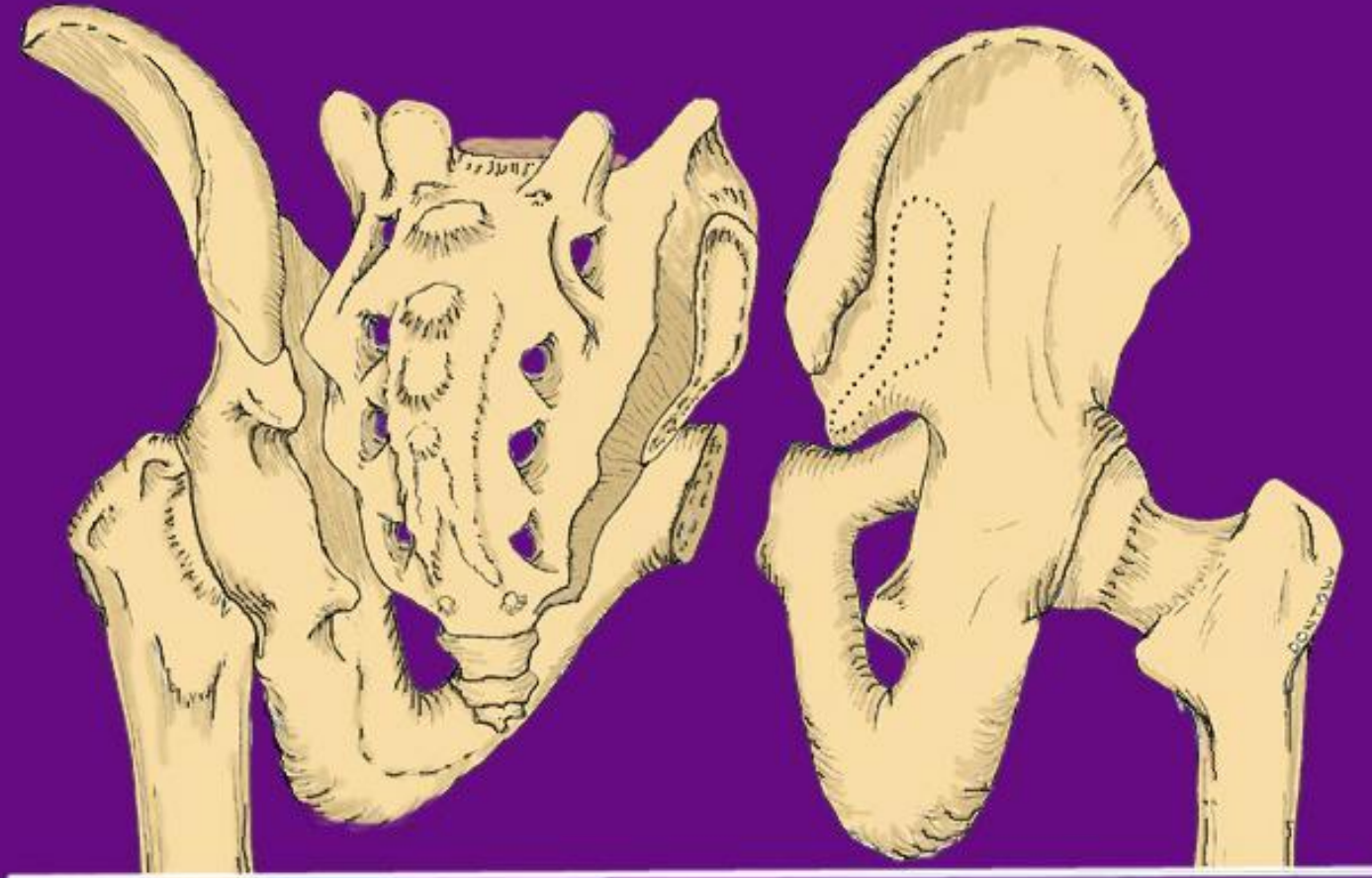
•PRIMARY SACRAL LOADING IS ON THE POSTERIOR INTEROSSEOUS LIGAMENTS AND THE ENTIRE SACRAL SURFACE ROTATES SLIGHTLY. THE SACRAL X AXIS KEEPS THE ILIAL JOINT SURFACES FROM APPROXIMATING.



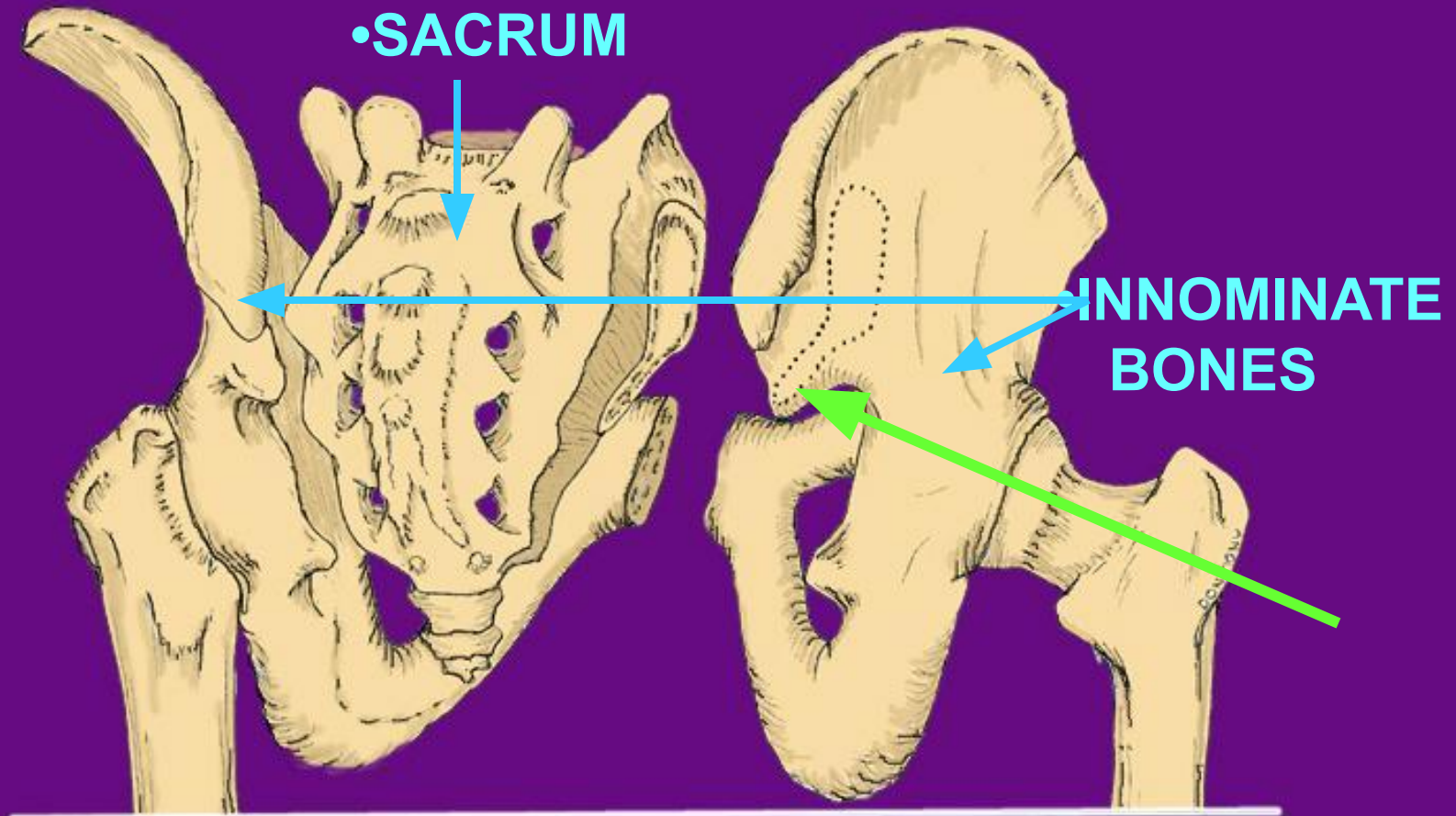
The Sacroiliac Joint

- ❖ Lies within the pelvic ring.
- ❖ The S1 segment is anterior and superior to the S3 segment and broader.
- ❖ The posterior aspect of the S3 segment is located at the posterior inferior iliac spine.

•THE PELVIC RING

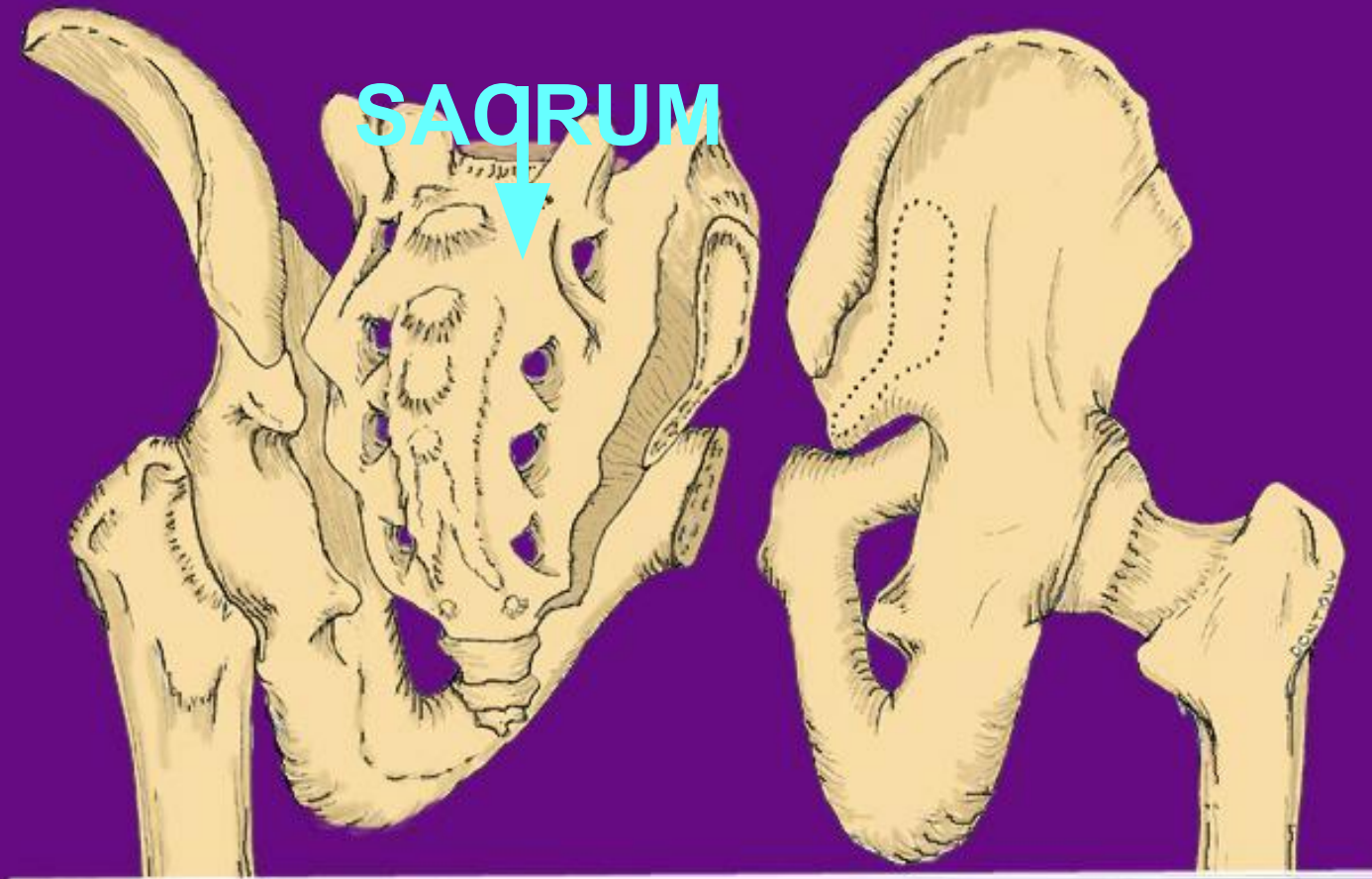


- THE PELVIC RING IS COMPOSED OF THREE BONES, THE SACRUM AND TWO INNOMINATES.



- NOTE THE DIRECTION OF THE FEMORAL HEAD.

The Sacrum is Not Like a Keystone

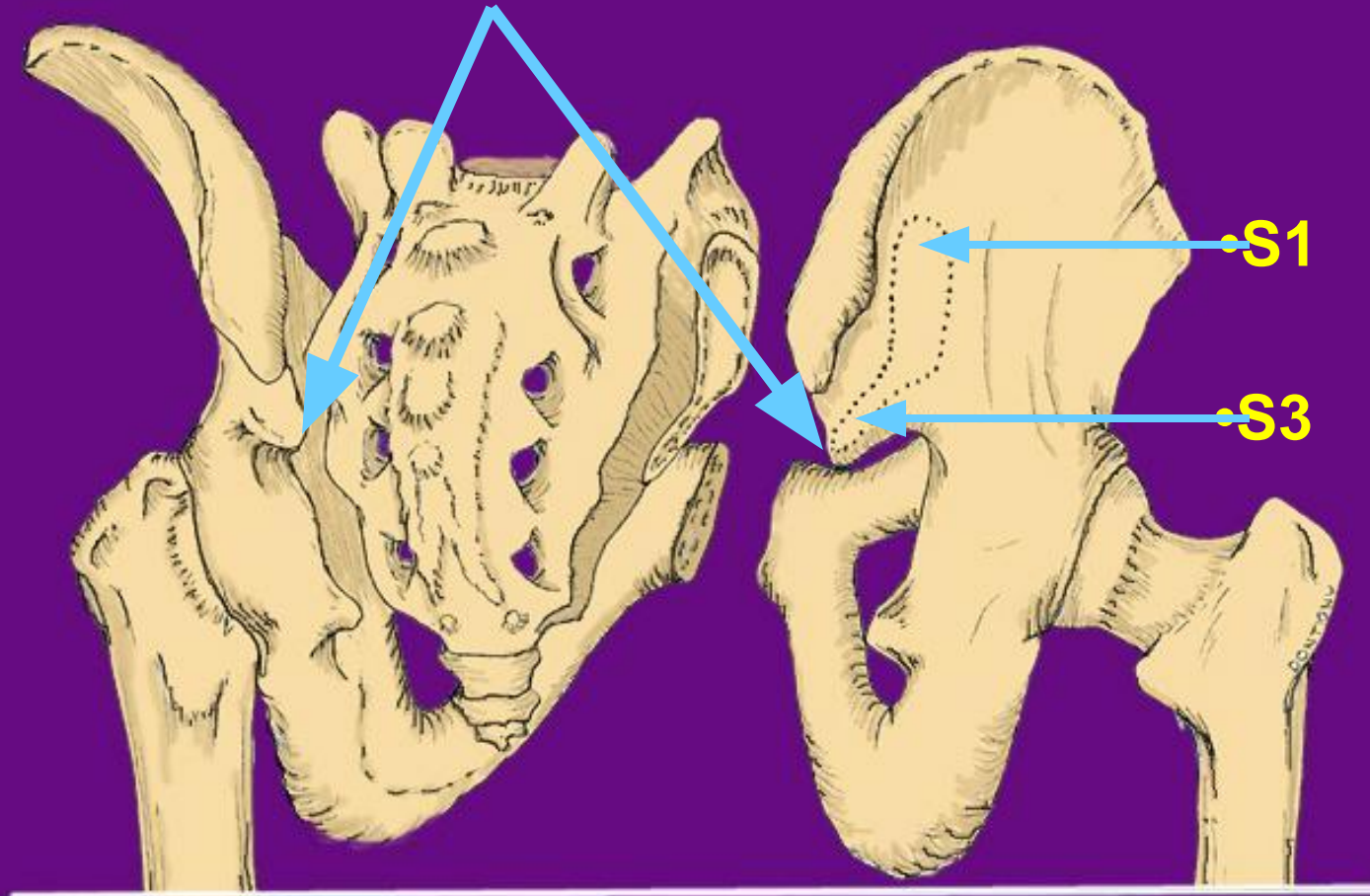


- The sacrum acts as the reverse of a keystone, hangs from the posterior sacroiliac ligaments and is carried by the ilia. The SIJ is essentially non-weightbearing. (Ref 86-89)

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- TAKE SPECIAL NOTE OF THE RELATIONSHIP OF THE S3 SEGMENT OF THE SACROILIAC JOINT TO THE POSTERIOR INFERIOR ILIAC SPINE.



•LUMBAR SPINE AND PELVIS

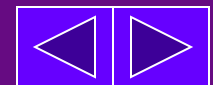
•LUMBAR
SPINE

•SACRUM

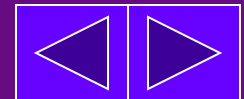
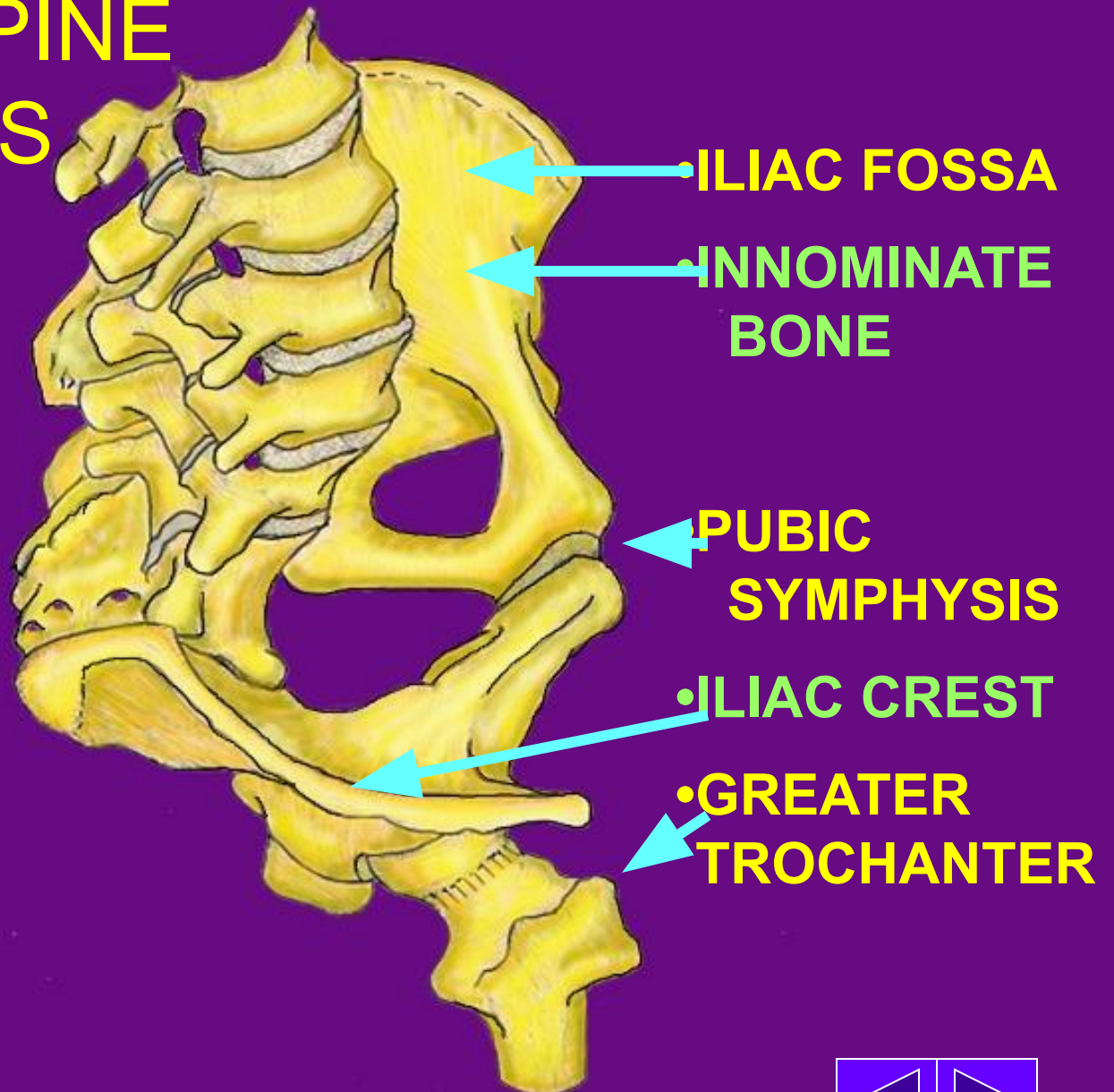
•PSIS

•ISCHIAL
TUBEROSITY

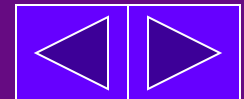
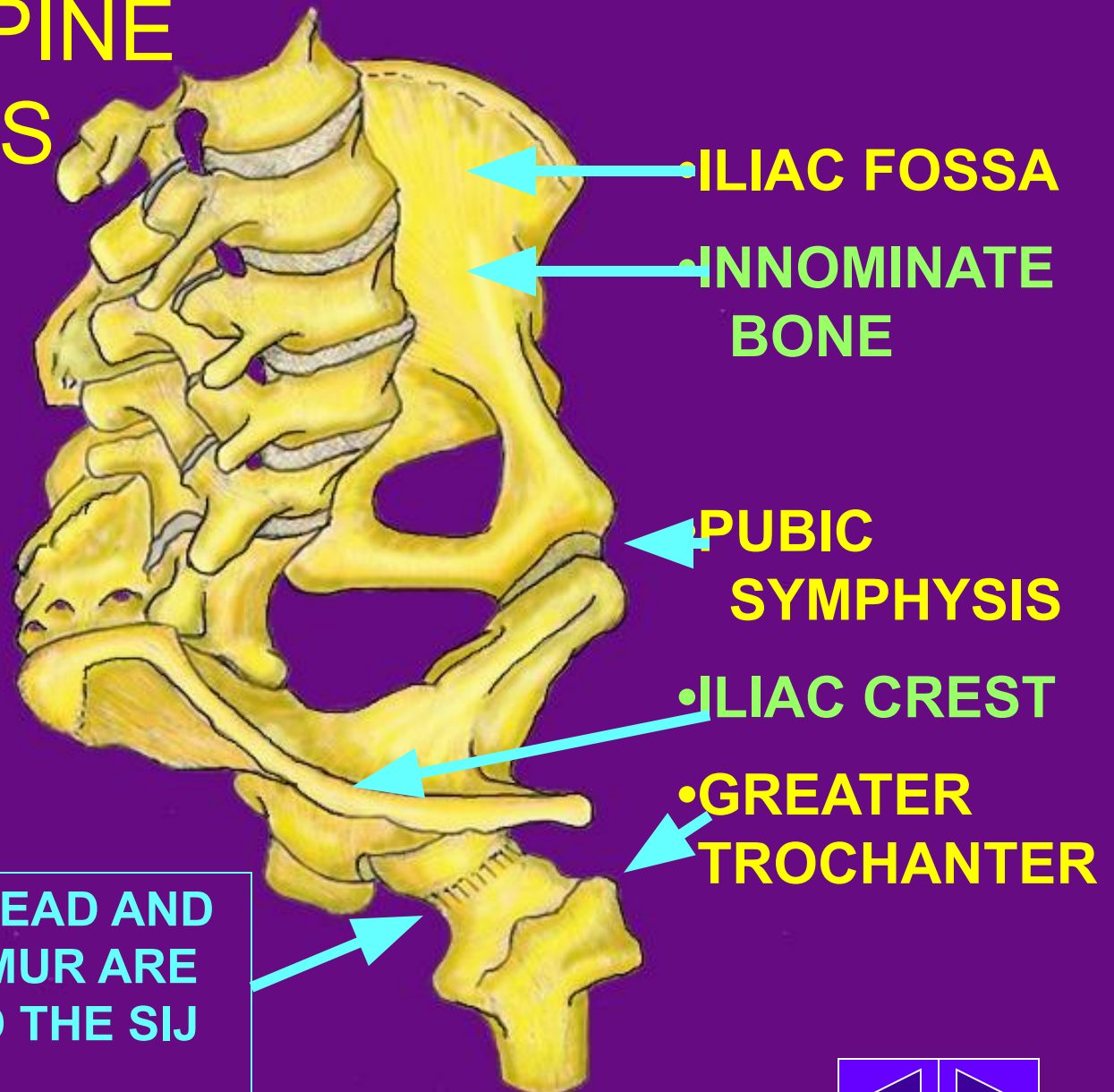
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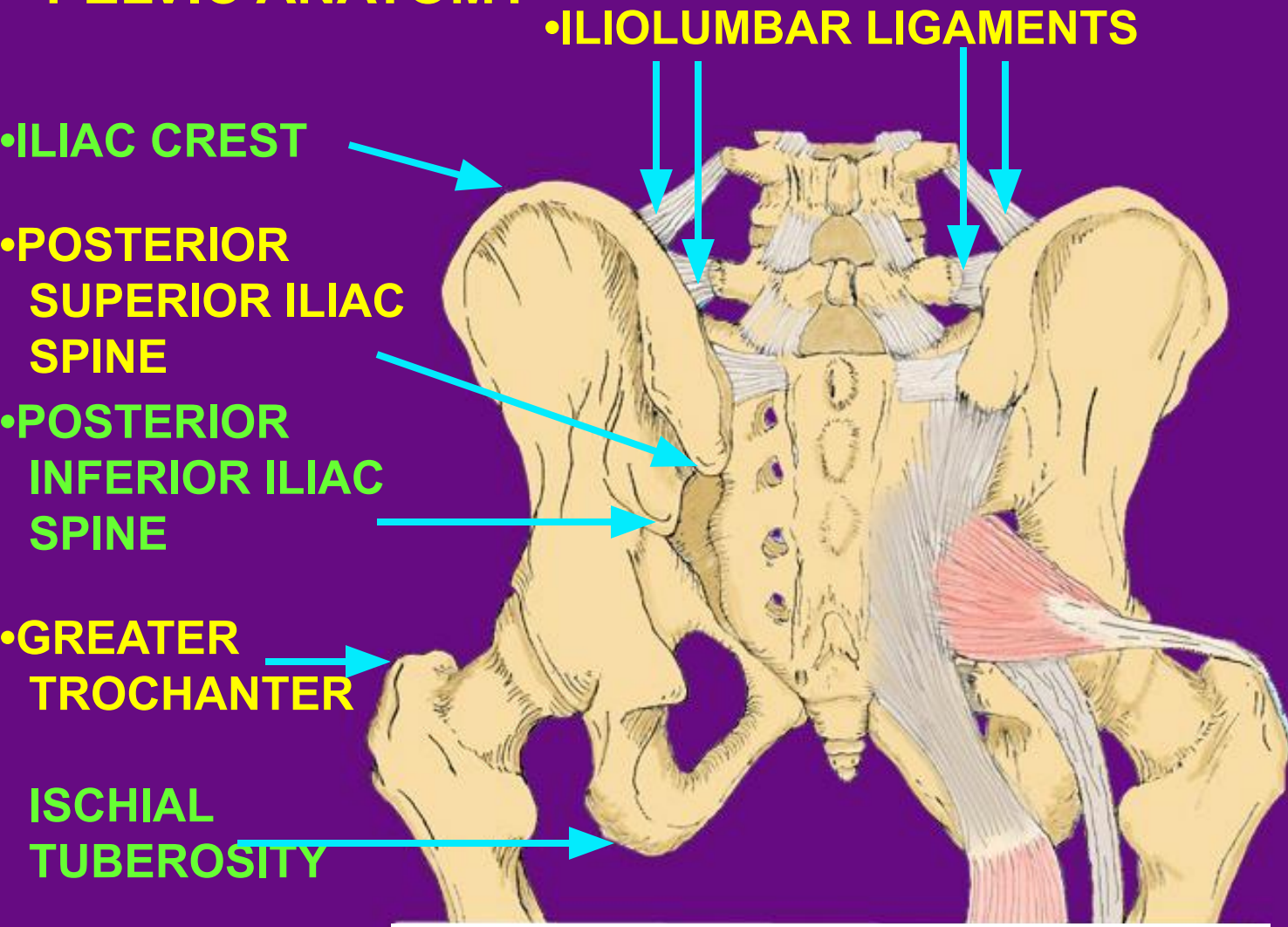
•LUMBAR SPINE AND PELVIS



•LUMBAR SPINE AND PELVIS



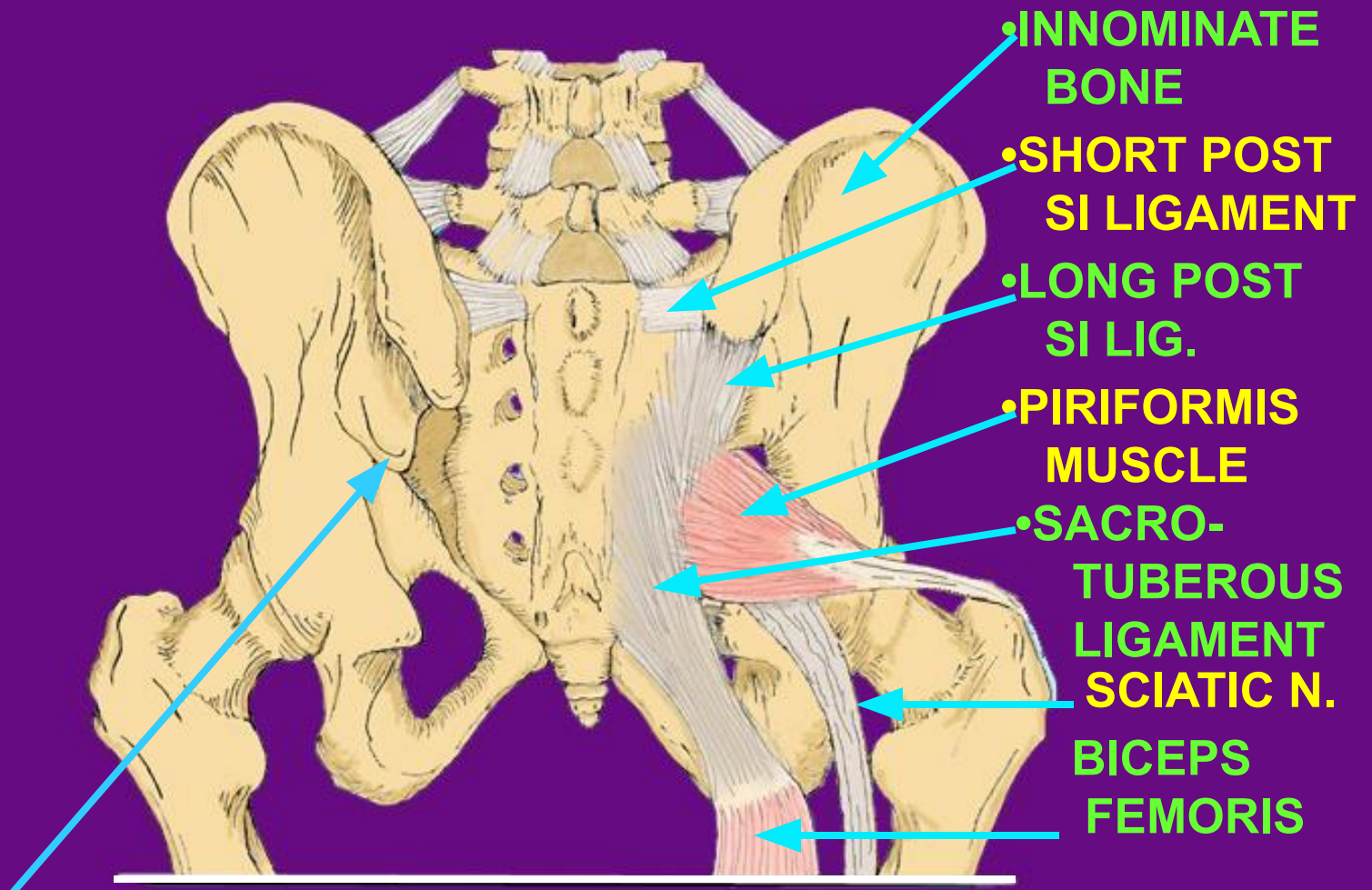
PELVIC ANATOMY



•REDRAWN FROM MOONEY

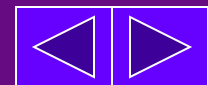


•PELVIC ANATOMY

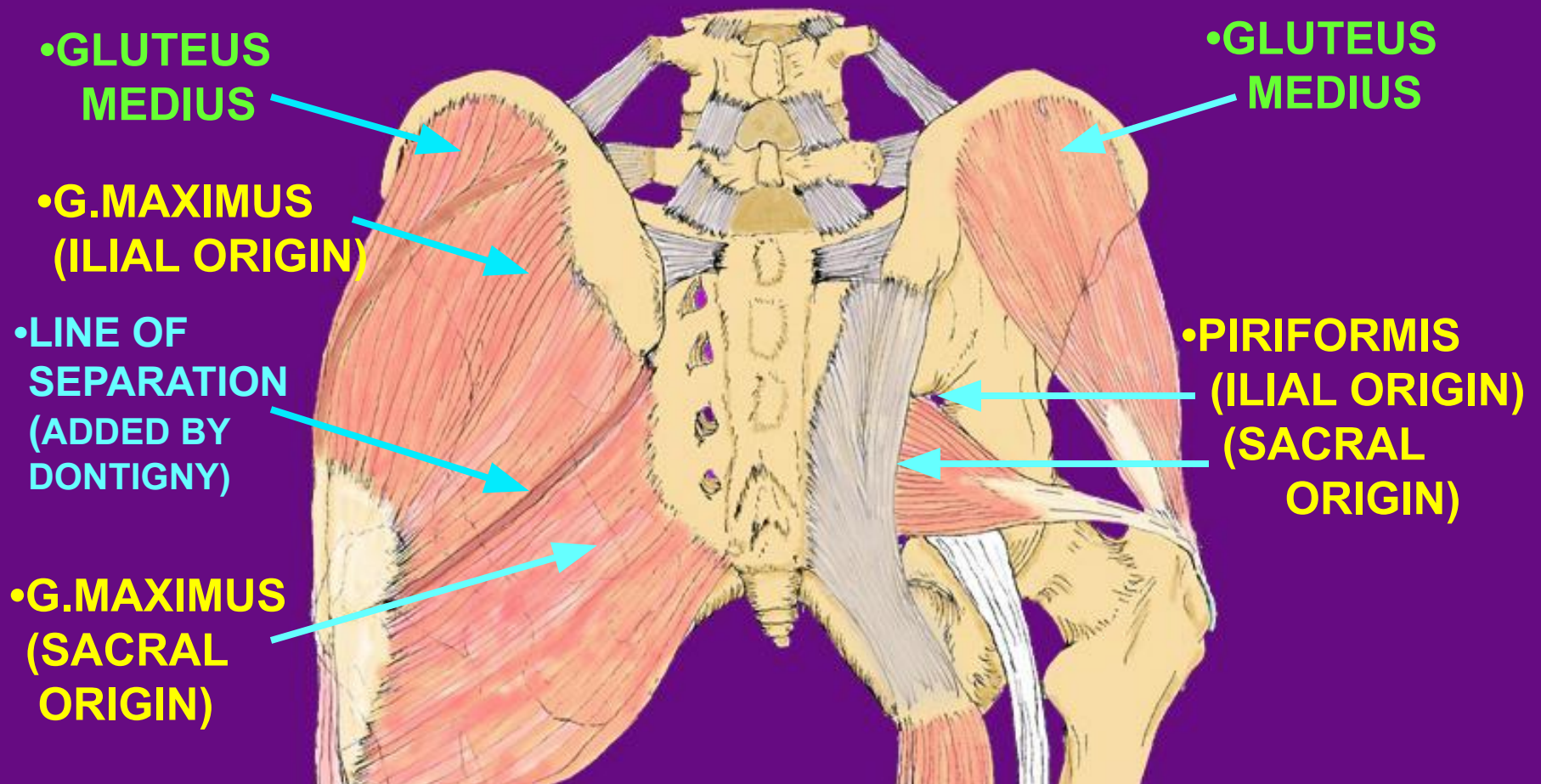


•NOTE AGAIN HOW THE NECK AND HEAD OF THE FEMUR ARE DIRECTED TOWARD THE SIJ.

•REDRAWN FROM MOONEY



•PELVIC ANATOMY



•THE FIBERS OF THE G.MAX ALONG THIS LINE MAY BE SEPARATED AND STRAINED WITH PATHOLOGICAL MOVEMENT OF THE INNOMINATES

•REDRAWN FROM MOONEY



Function of Primary Ligaments

- ❖ The long posterior sacroiliac ligament limits anterior rotation of the innominate bone on the sacrum.
- ❖ The short posterior sacroiliac ligament limits lateral movement of the innominate on the sacrum.
- ❖ The iliolumbar ligaments stabilize L4-5 on the sacrum, but originate from the ilia.

•Function of Primary Ligaments Relative to Biotensegrity

- Resting tension on both the posterior interosseous and sacrotuberous ligaments is relatively high and balanced in supine, prone or cadaver.
- Erect and weight loaded tension is higher yet and balanced in the symmetrical

Function of Primary Ligaments Relative to Biotensegrity (2)

- ❖ When loaded with the superincumbent weight the sacrum hangs from the posterior interosseous ligaments superior and anterior to the sacral x axis.

A secondary loading on the sacrotuberous ligament provides lateral stability and balances ventral loading of the sacrum posteriorly and caudad to the sacral x axis.

- ❖ Erect and weight loaded tension is higher yet and balanced in the symmetrical pelvis

The Sacrotuberous Ligament

- ❖ This ligament deserves special comment.
- ❖ The sacrotuberous ligament is helical.
- ❖ The helical coil improves dynamics, allows for greater elasticity, movement and a greater storage of energy during normal ambulation without a commensurate increase in joint compression.

Fascial Interconnections

- ❖ Dorsally the thoracolumbar fascia obliquely crosses the sacroiliac joint.(2)
- ❖ Some fibers of the gluteus maximus, gluteus medius and the iliotibial tract are connected to the thoracolumbar fascia.(2)
- ❖ The sacrotuberous ligament is continuous with and frequently has a tendinous attachment to the biceps femoris muscle.(2)

Fascial Interconnections (2)

- ❖ The sacrospinous ligament frequently has fibrous connections with the pelvic diaphragm.(2)
- ❖ The thin dorsal fascia of the piriformis muscle is continuous with the sacrotuberous ligament.(2)
- ❖ The iliolumbar ligament connects the ilium with L4-5 without any involvement of the sacrum and has a fascial connection with the quadratus lumborum. (2)

Fascial Interconnections (3)

- ❖ The psoas major has fascial attachments to the diaphragm and adjacent structures, the anterior layer of the thoracolumbar fascia, the iliolumbar ligament, the pelvic floor, the transversus abdominis and the pelvic brim.(62)
- ❖ Anything that changes the tension on the psoas major can affect any or all of these fascial attachments.

Innervation

- ❖ The innervation to the SIJs is highly variable and complex. (65)
- ❖ Pain may be referred in a sclerotomal fashion.(65)
- ❖ Adjacent structures may be affected by intrinsic joint pathology and become active nociceptors.(65)
- ❖ Pain referral patterns may be dependent on the distinct locations of injury in the sacroiliac joint.(65)

Innervation (2)

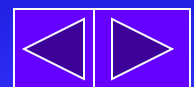
- ❖ The anterior portion of the SIJ receives innervation from the posterior rami of the L2-S2 roots, but these contributions are highly variable and may differ in the joints of a given individual. (65,66,67)
- ❖ Additional innervation to the anterior joint may arise directly from the obturator nerve, the superior gluteal nerve, and the lumbosacral trunk. (67)

Innervation (3)

- ❖ The posterior portion of the joint is innervated by the posterior rami of L4-S3.(67)
- ❖ An additional autonomic component of the SIJ's innervation further increases the complexity of its neural supply and likely adds to the variability of pain referral patterns.(24)
- ❖ The sciatic nerve passes immediately beneath or traverses through the piriformis and may become irritated by spasm or injury to the piriformis.(65)

MOVEMENT

BASIC PELVIC MOVEMENT



Movement Outline

- ❖ Loading and unloading
- ❖ Sacral movement on the sacral x axis
- ❖ Innominate rotation
- ❖ Structural angulations of the sacroiliac joints
- ❖ Oblique axis
- ❖ Lateral sacral flexion and rotation
- ❖ Ligamentous constraints

Movement Objectives

- ❖ To study basic sacral and innominate movement.
- ❖ To explain how movement is guided by the structural angulations of the SIJ.
- ❖ To describe the sequence and effect of ligamentous loading.
- ❖ To demonstrate lateral sacral flexion and rotation.

Sacral Unloading

- ❖ When moving from standing with a loaded sacrum to supine the posterior interosseous and the sacrotuberous ligaments are unloaded simultaneously.
- ❖ The sacrum inclines dorsally and moves snugly against the ilia and demonstrates both form and force closure.
- ❖ Form and force closure only occurs in the unloaded pelvis or in the cadaver pelvis.

•UNLOADED SACRUM

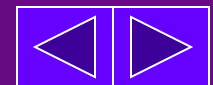
•SUPINE

•LAVIGNOLLE ET AL
DEMONSTRATED A
LARGE AMOUNT OF
INSTABILITY IN THE
SUPINE POSITION. (11)



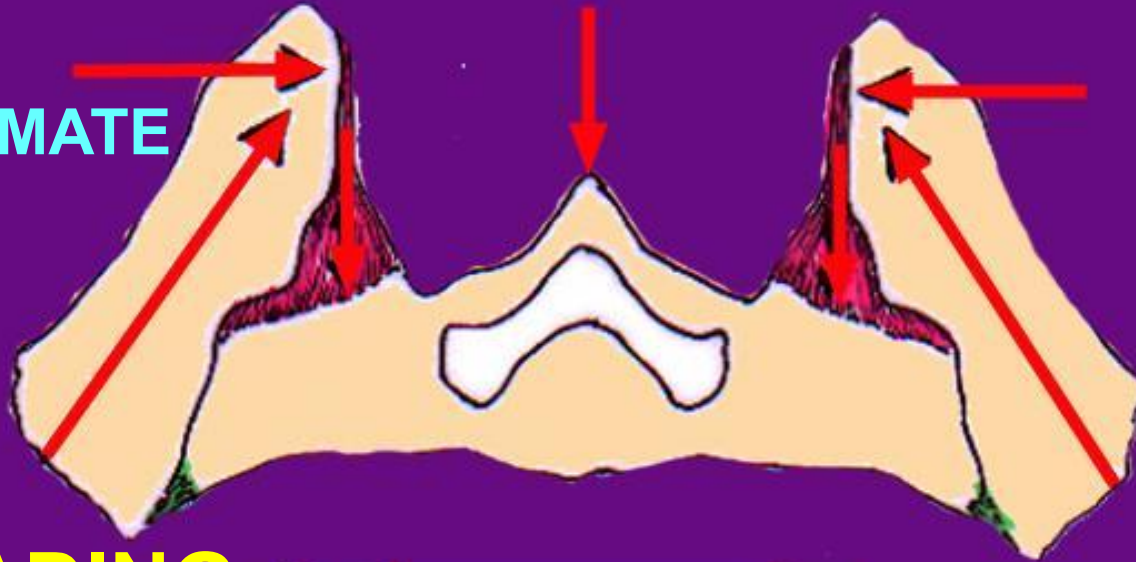
•LIGAMENTS UNLOADED
•FRICTION DECREASED
•DECREASED STABILITY
•NO AXIS OF ROTATION

•THE SACRUM SINKS
WHEN LOADED AND
RISES WHEN IT IS
UNLOADED



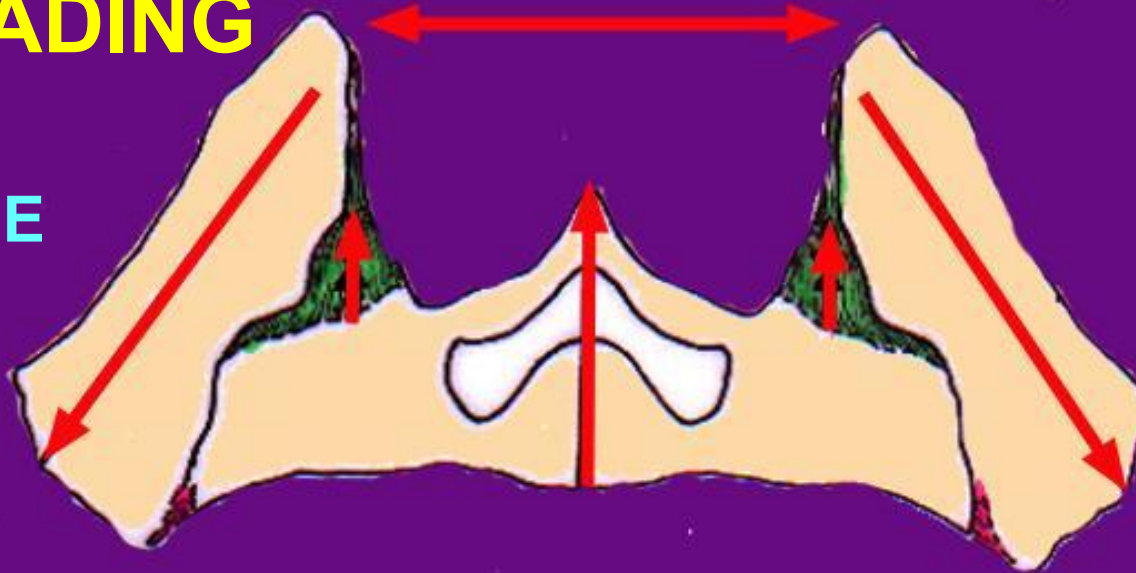
•WEIGHT LOADING ON SACRUM

- PSISs
APPROXIMATE

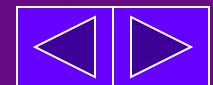


•UNLOADING

- PSISs
DIVERGE



•DONTIGNY



Movement

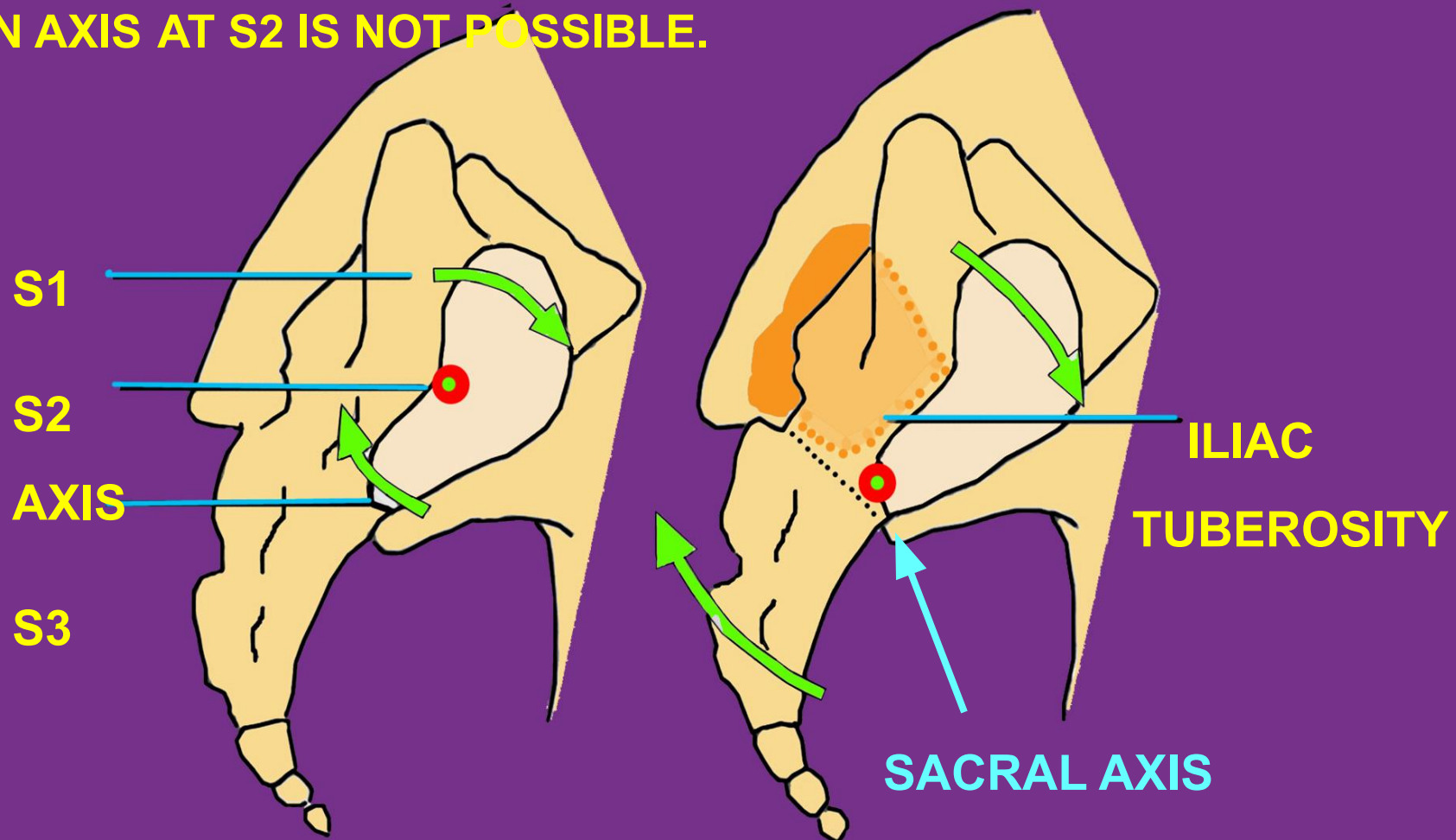
- ❖ Dorman suggested that the SIJs move rather like gears and function similar to a clutch.(18)
- ❖ During loading there is a little movement of one joint surface on the other. After loading, movements of the ilial surfaces cause and control movement of the sacrum.
- ❖ During normal gait, at two-point support, as one innominate rotates posteriorly and the other rotates anteriorly, the sacrum is caused to flex laterally and rotate.

The Forced Sacral Axis

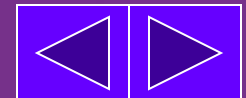
- ❖ The iliac tuberosity, cephalad to the S3 sacral segment, will not allow a sacroiliac axis.
- ❖ This prominent tuberosity forces the axis posteriorly to create a sacral x axis at S3 rather than an axis of the sacroiliac joint.
- ❖ **This tuberosity also effectively prevents any normal or abnormal movement of the innominate bones posteriorly on the sacrum**

The Forced Sacral Axis

AN AXIS AT S2 IS NOT POSSIBLE.



THE ILIAC TUBEROSITY FORCES THE SACRAL X AXIS TO BE POSTERIOR TO S3.



Structural Factors Contributing to the Stability of the SIJ

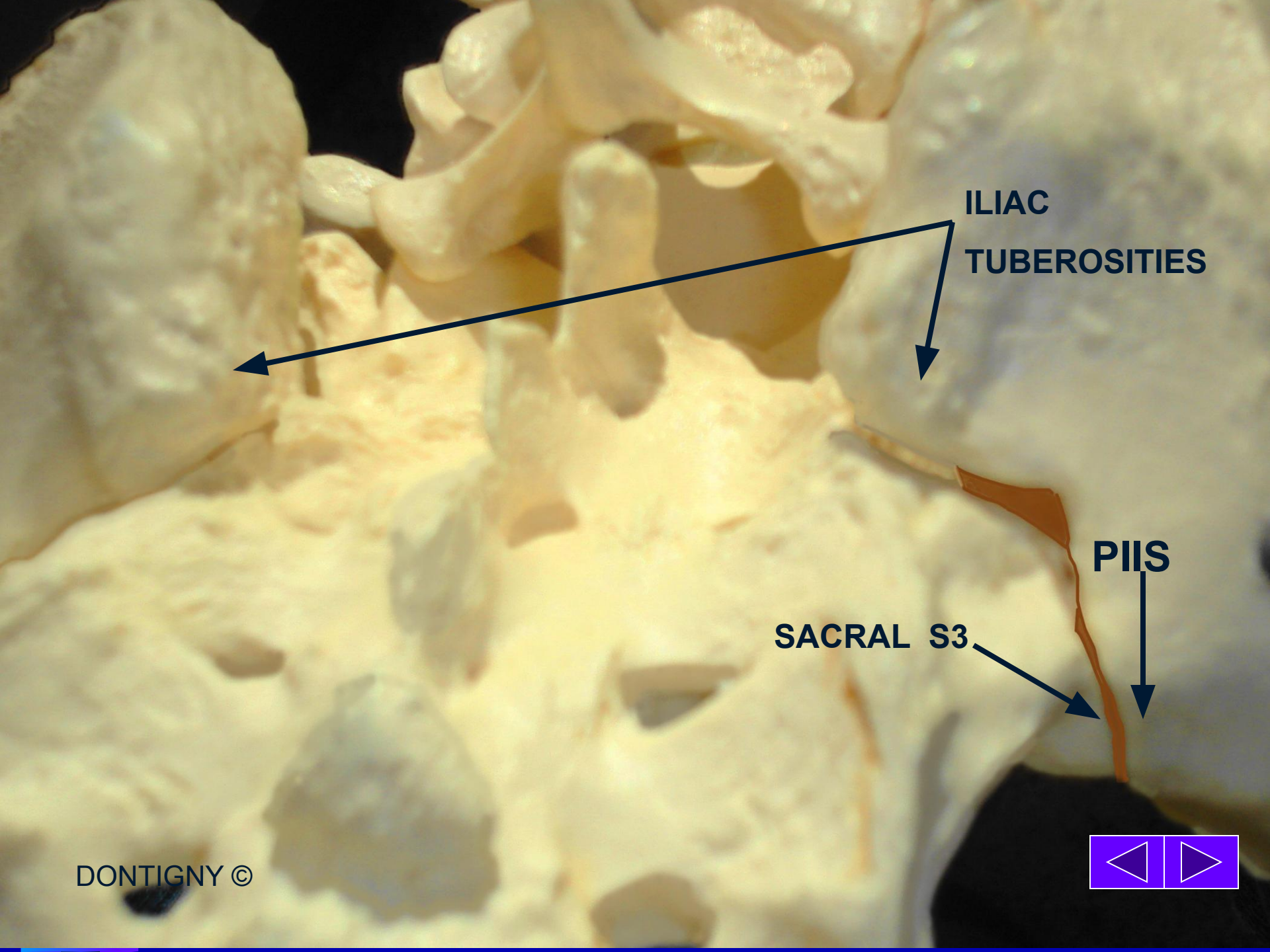
- ❖ The sacral surface of the SIJ is some-what “L” shaped with an essential variation in the structural angles at each arm of the “L”.
- ❖ An irregular shallow depression runs the length of the sacral surface in which is seated the congruent convexity of the ilial surface.
- ❖ When the sacrum is weight-loaded the concavities of both sacral surfaces function as complex dynamic troughs that allow movement **with**, but **not on** the congruent ilial surfaces.

Iliac Tuberosity

◆ Note how the iliac tuberosity of the innominate bone over S3 sacral will force the sacral axis.

◆ The location of this tuberosity will block any **sacroiliac** axis and forces the axis posteriorly to function as a **sacral x axis**.

◆ Posterior innominate rotation causes the iliac tuberosity to depress the sacrum on the side of loading and opens S3.



**ILIAC
TUBEROSITIES**

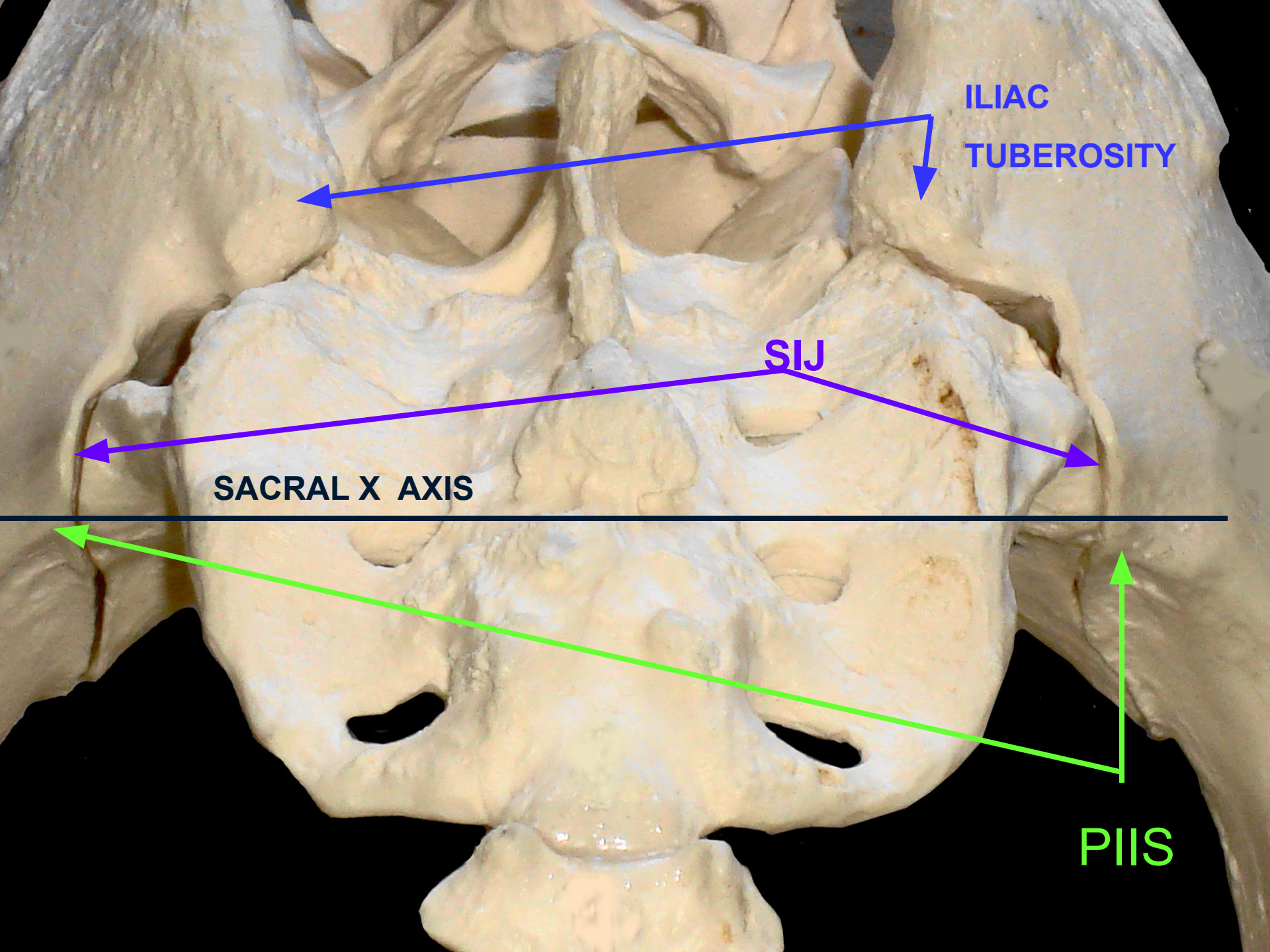
PIIS

SACRAL S3

The Sacral X Axis

Note the location of the sacral x axis.
Note also not only does this ilial tuberosity not cause any dysfunctional movement in posterior innominate rotation, but functions to flex the sacrum laterally toward the side of loading to create pelvic asymmetry.

Posterior innominate rotation on the side of loading occurs on an axis through the pubic symphysis.



ILIAC
TUBEROSITY

SIJ

SACRAL X AXIS

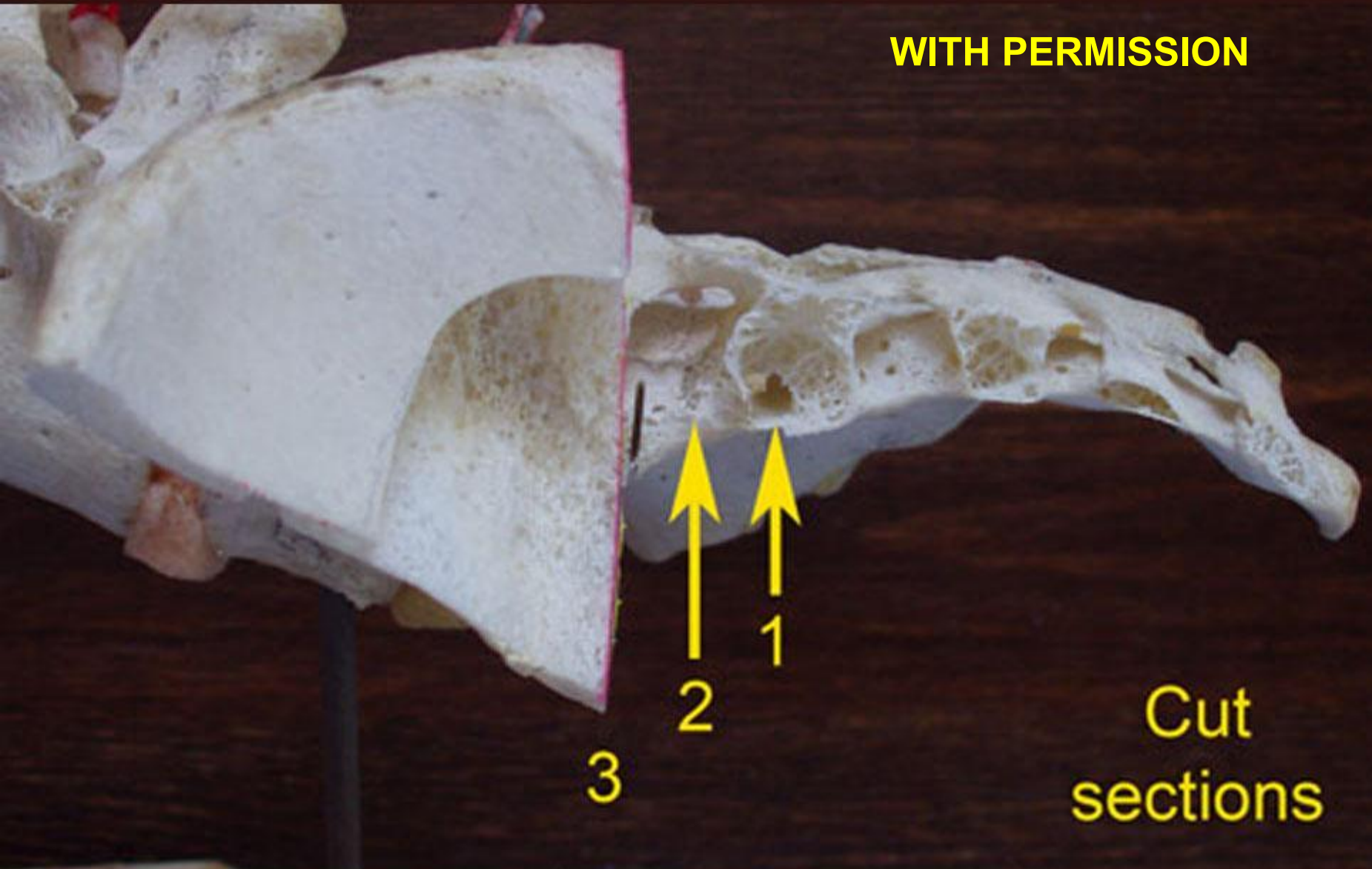
PIIS

Gracovetsky Sections

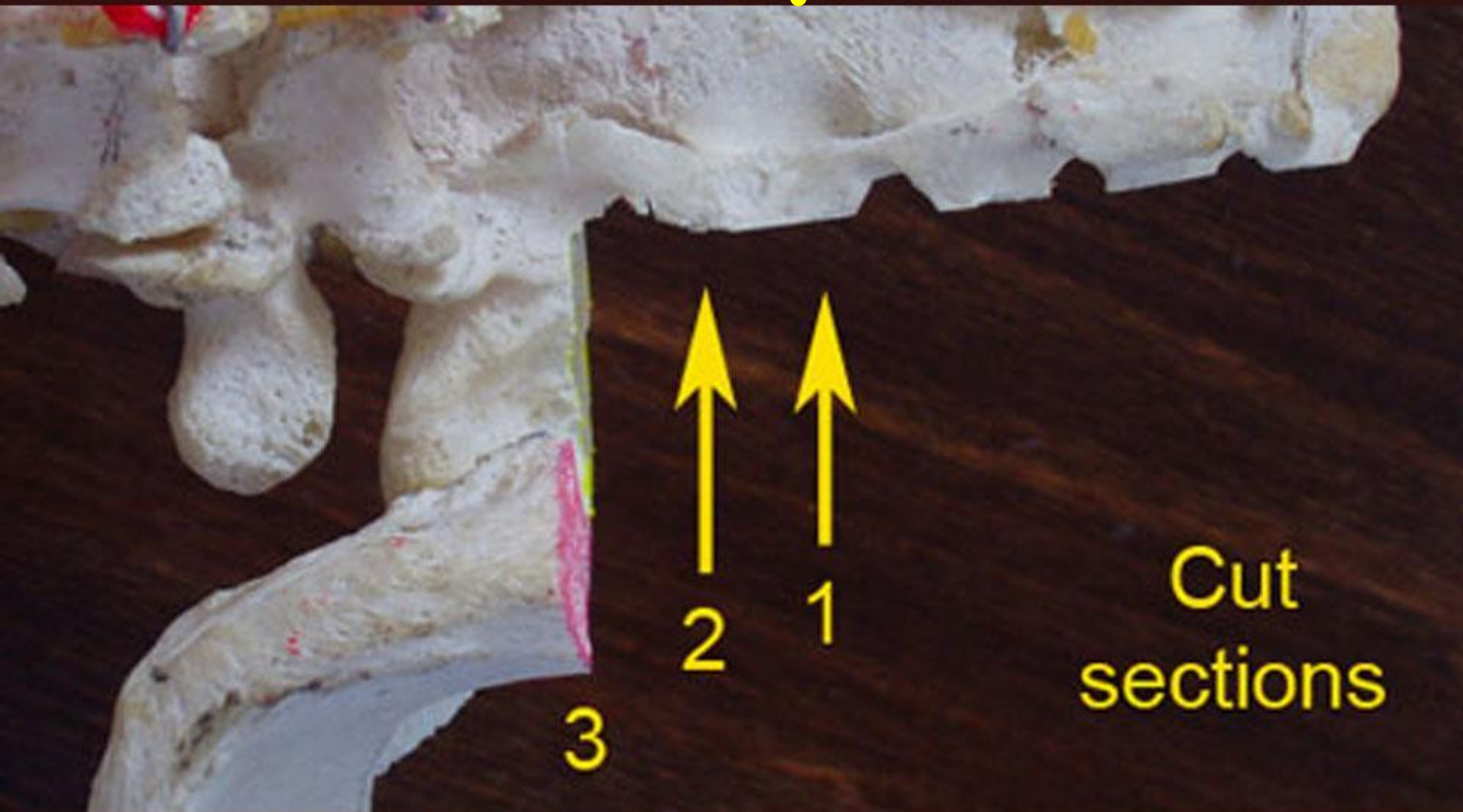
- ◆ Gracovetsky has sectioned the area of the P1IS and the caudal part of the S3 segment and has verified this bony axis.
- ◆ Note that this bony axis at S3 is at the most medial aspect of the sacral surface of the sacroiliac joint.
- ◆ This insures that with loading the entire sacral surface of the SIJ will tend to fall away from the ilial surface of the SIJ restricted only by ligaments.

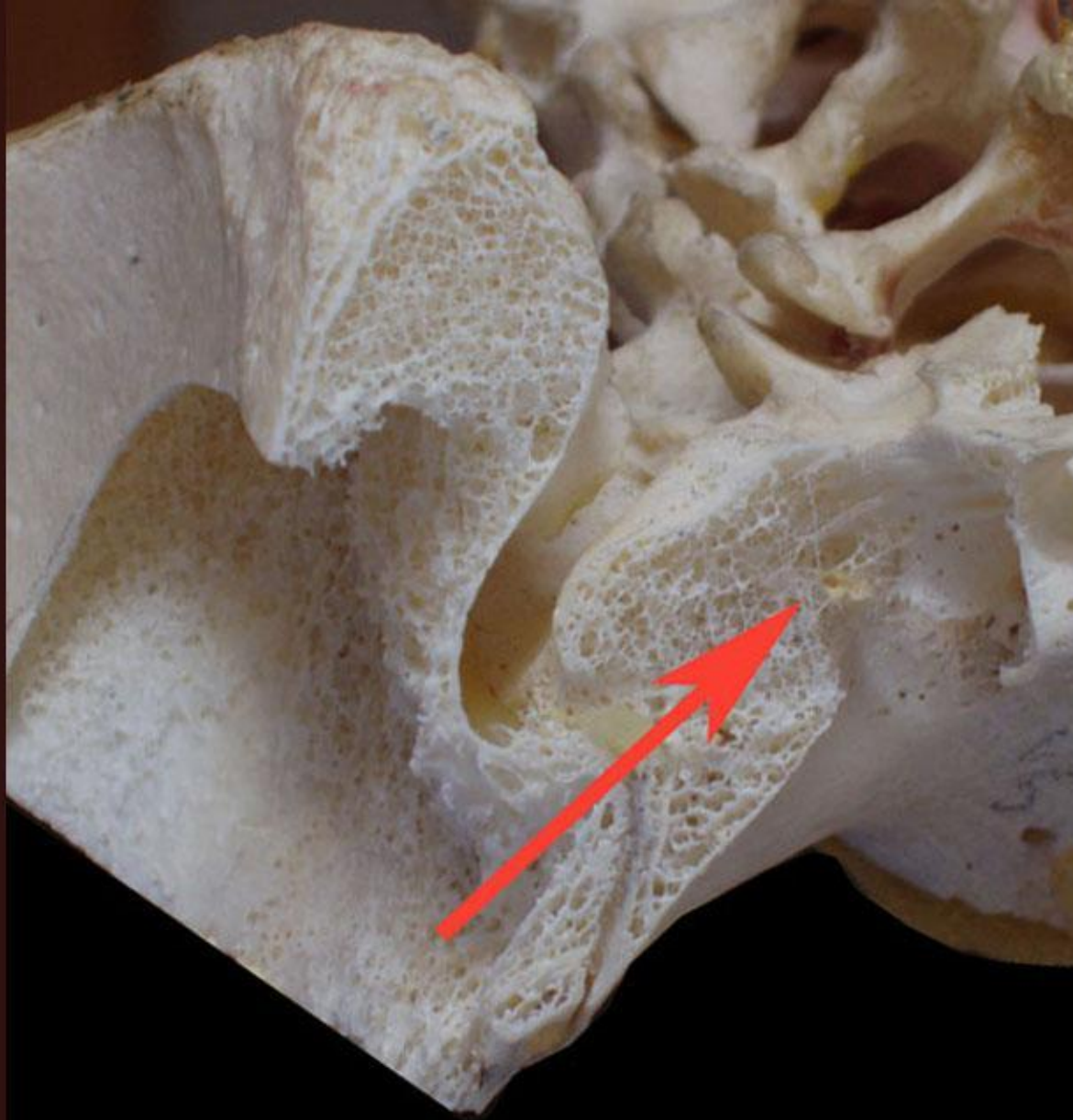
FROM GRACOVETSKY ©

WITH PERMISSION



FROM GRACOVETSKY ©





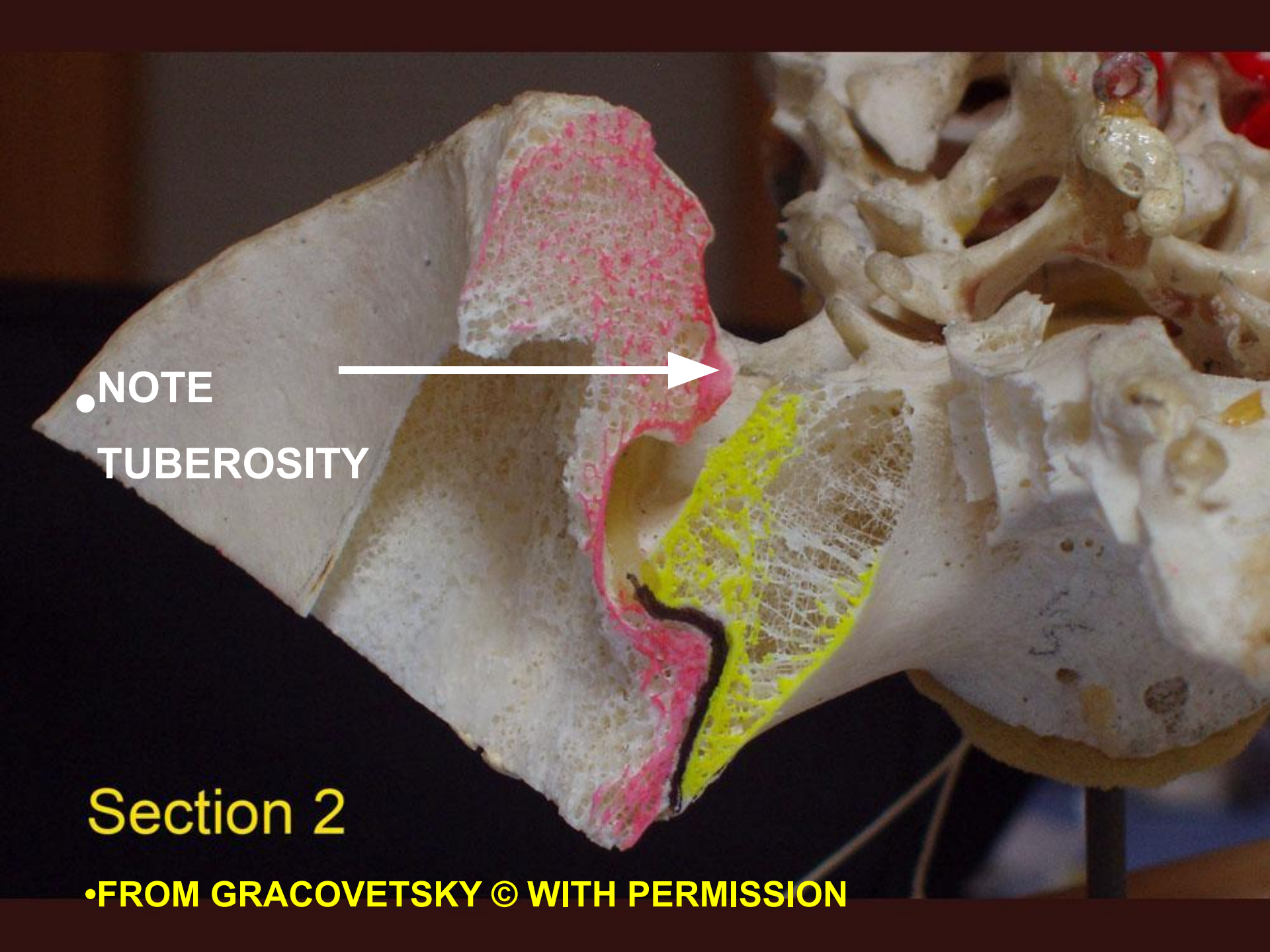
Path for force transmission

• FROM GRACOVETSKY © WITH PERMISSION



Section 1

• FROM GRACOVETSKY © WITH PERMISSION

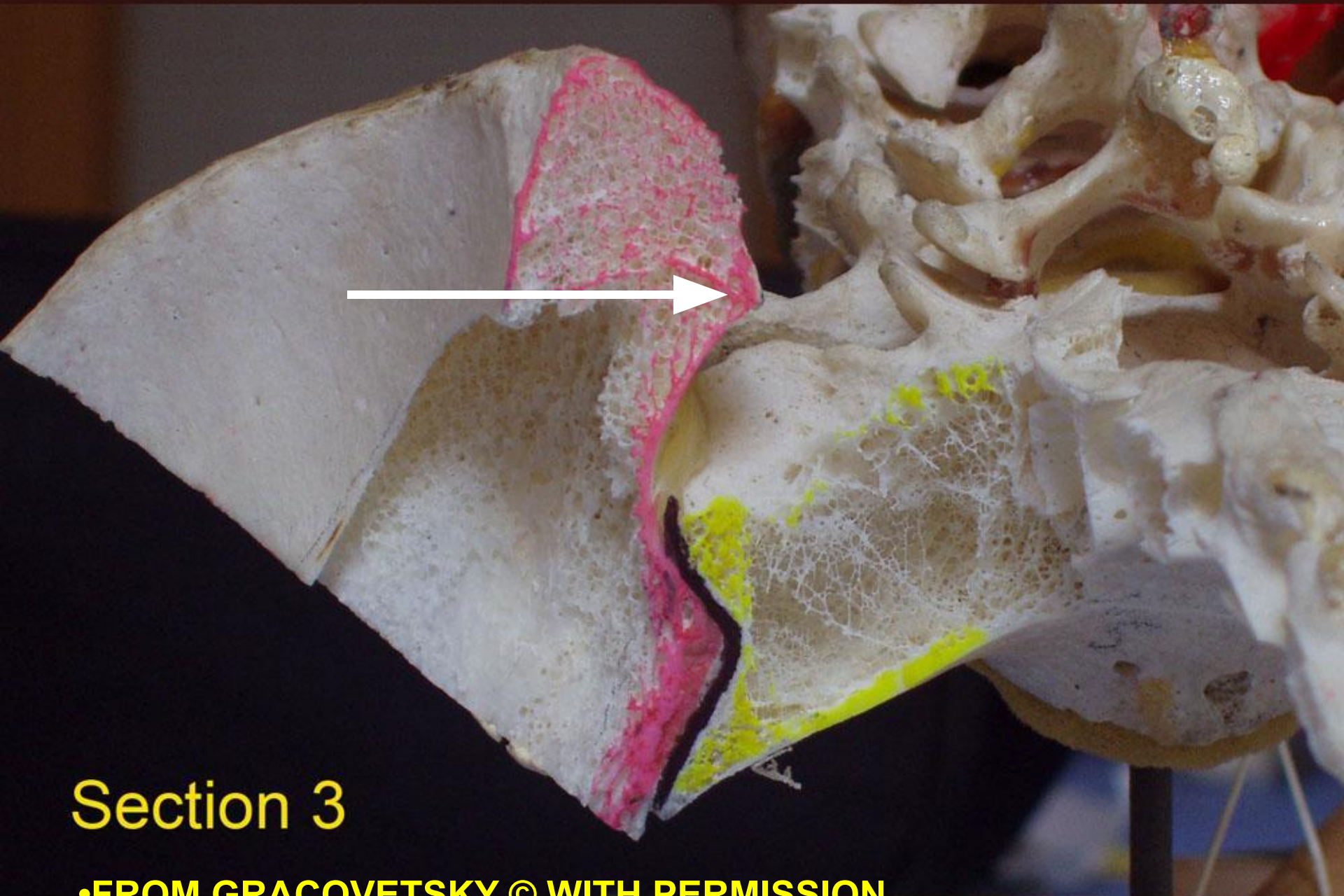


•NOTE
TUBEROSITY

The image shows a cross-section of a bone specimen. A white arrow points from the text 'NOTE TUBEROSITY' to a specific area on the bone. This area is stained pink and shows a distinct, rounded protrusion. Below this, a yellow-stained area is visible, along with a dark, irregular line. The bone itself is white and porous. In the background, other parts of the skeletal structure are visible, including what appears to be a joint and some ligaments.

Section 2

•FROM GRACOVETSKY © WITH PERMISSION



Section 3

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Potential Movement

- ❖ The structural angulations of the sacroiliac joints allow for specific potential movement.
- ❖ Realize that actual movement is strictly controlled by ligaments and high friction and provides for rather unique specific movements and functions.

- **BASIC SACRAL MOVEMENT**

DORSAL INCLINATION OF THE SACRUM IS ALSO KNOWN AS CONTRA NUTATION.

THIS LOOSENS THE SACROTUBEROUS LIGAMENT.

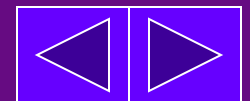
SACRAL X AXIS(82, 83)



VENTRAL INCLINATION OF THE SACRUM IS ALSO KNOWN AS NUTATION.

THIS TIGHTENS THE SACROTUBEROUS LIGAMENT.

THE SACRUM TENDS TO MOVE ON THE INNOMINATES WITH FLEXION AND EXTENSION ON A SACRAL X AXIS.



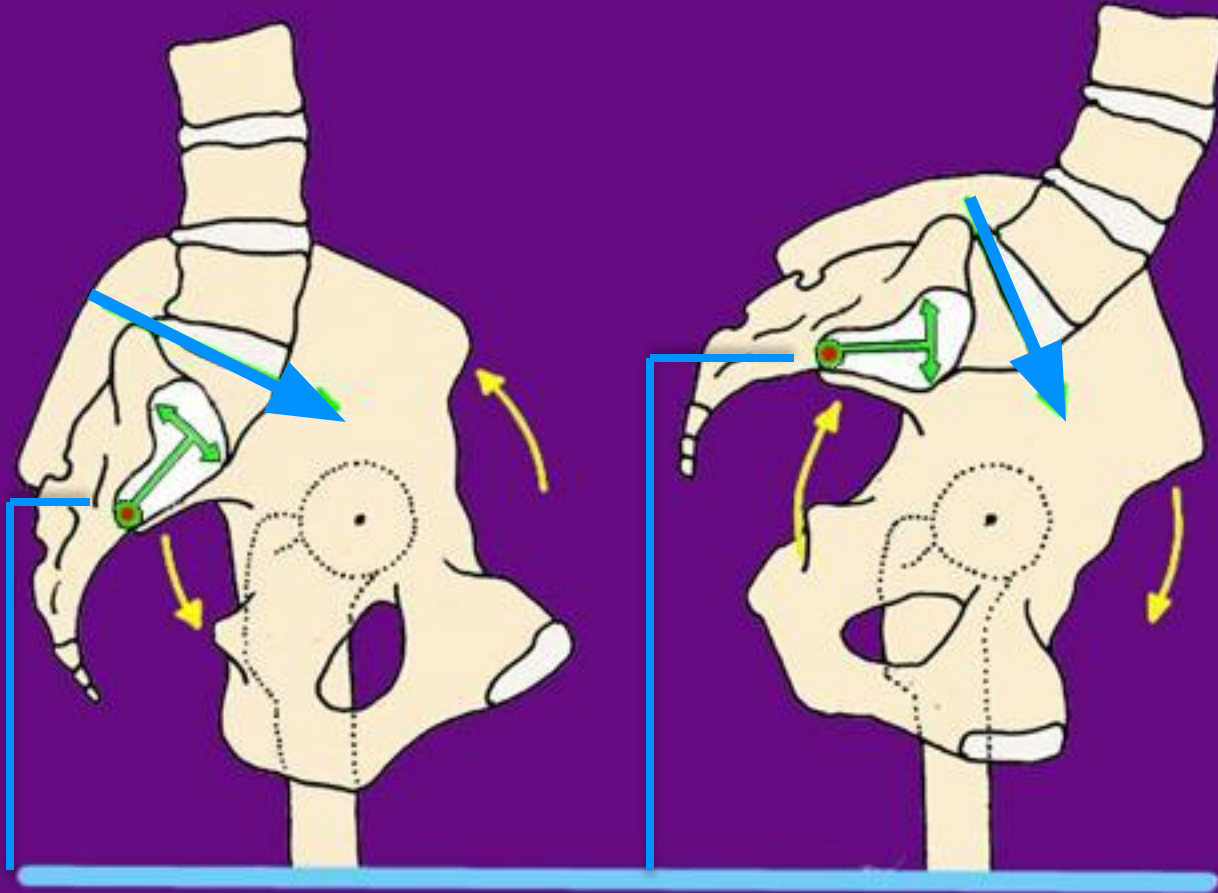
Innominate Rotation

- ❖ Posterior symmetrical rotation of the innominates on an acetabular axis will increase tension on both the posterior interosseous and sacrotuberous ligaments, decrease the lumbosacral angle, decrease the lumbar lordosis and decrease shear at L5-S1.
- ❖ Posterior asymmetric innominate rotation on an axis through the symphysis pushes caudad on the sacrum causing a lateral sacral flexion.
- ❖ Dysfunction only occurs when the line of gravity moves anterior to the acetabular axis causing an anterior rotation of the innominates on the acetabular axis

Anterior Rotation and the Lordotic Posture

- ❖ Anterior pelvic rotation is on an acetabular axis and increases the **lumbosacral angle**, shear at L5-S1, **the lordotic posture**, and tends to decrease tension on the sacrotuberous ligaments and iliolumbar ligaments. **This is a probable cause of spondylolisthesis.**
- ❖ Weight loading on the sacrum increases the ventral inclination of the sacrum and increases tension on the sacrotuberous ligament.

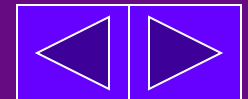
- **INNOMINATE ROTATION**



POSTERIOR
(NUTATION)

ANTERIOR
(CONTRA NUTATION)

DONTIGNY©

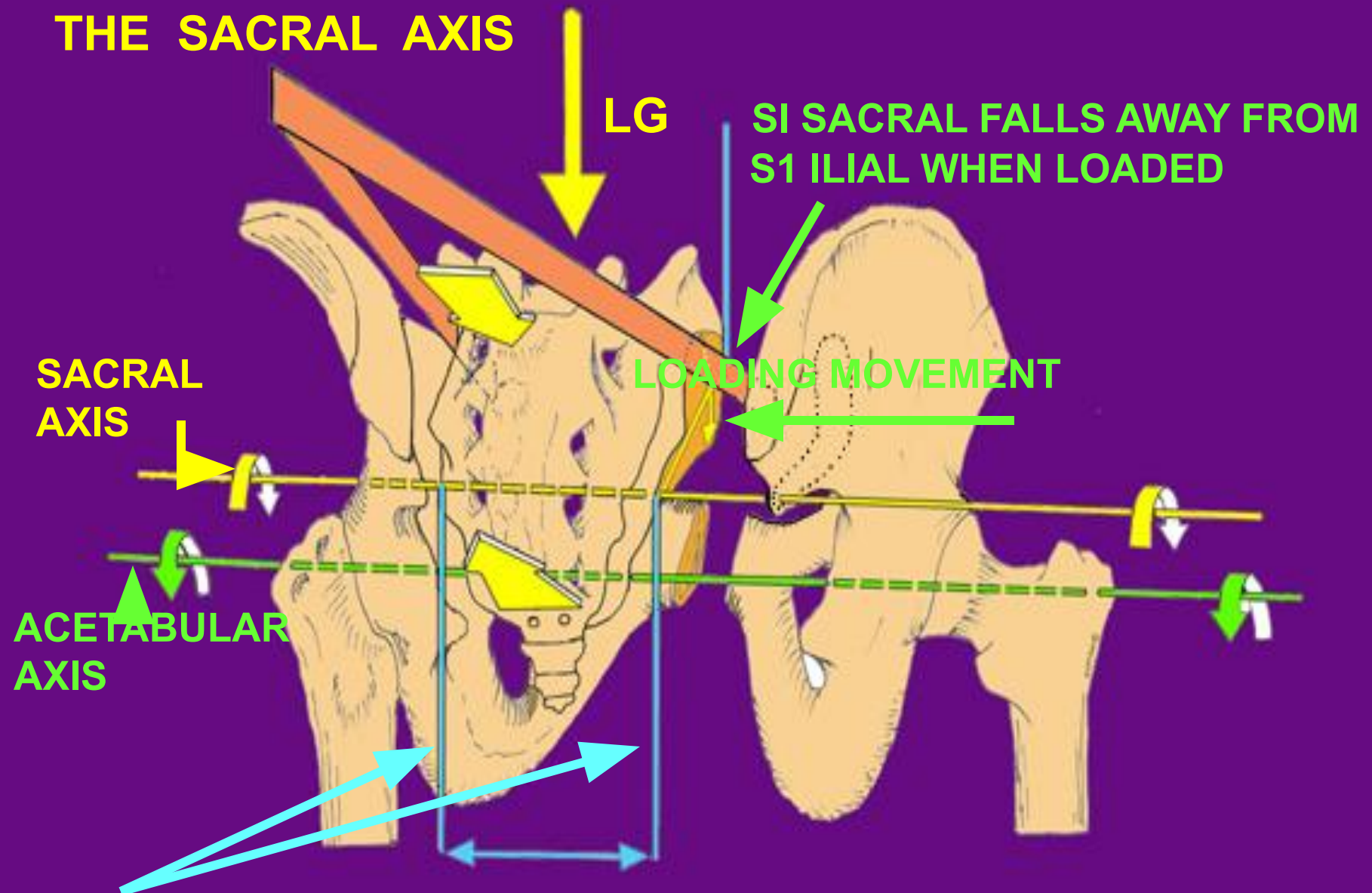


When the Sacrum is Loaded Everything Changes



MOVEMENT OF THE SACRUM THAT OCCURS DURING LOADING AND UNLOADING OF THE SUPERINCUMBENT WEIGHT IS NOT THE SAME AS THE MOVEMENT THAT OCCURS AFTER THE SACRUM IS LOADED.

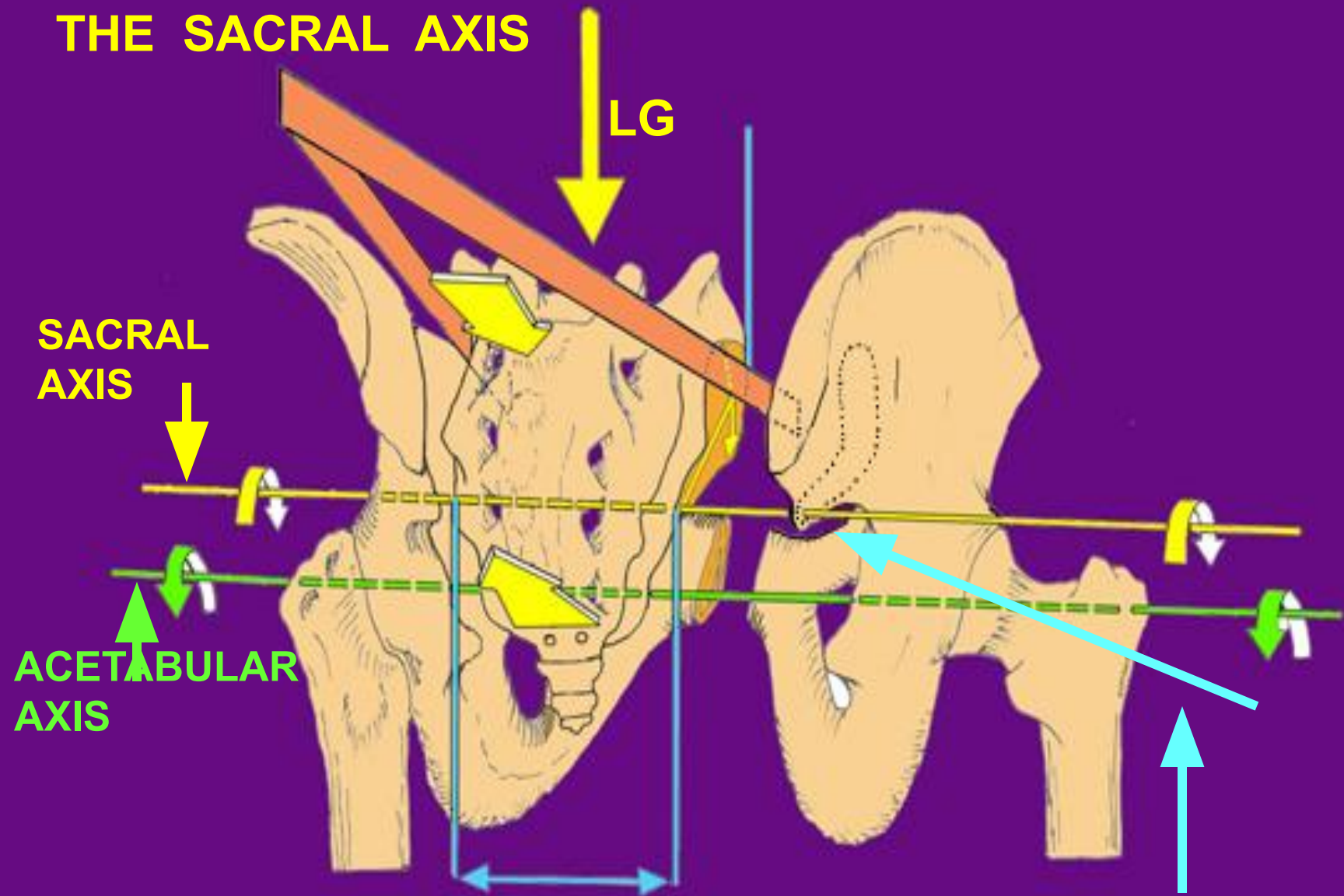
THE SACRAL AXIS



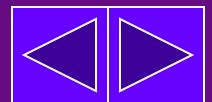
THE SACRAL AXIS IS AT THE MOST POSTERIOR ASPECT OF S3,
WHICH IS AT THE MOST NARROW ASPECT OF THE SIJ



THE SACRAL AXIS



•NOTE THAT THE FEMORAL HEAD IS DIRECTED TOWARD THE SACRAL AXIS



When the Sacrum is Loaded Everything Changes (2)

- ❖ **AFTER LOADING**, ESSENTIALLY NO MOVEMENT OCCURS IN THE SIJ ON A TRANSVERSE AXIS ON THE SYMMETRICAL PELVIS EVEN THOUGH LIGAMENTOUS TENSION WILL VARY.

Movement (2)

❖ Basic mechanics

Potential movement

Loading/unloading

Ligamentous restrictions

Dynamic ligamentous balance

❖ Objectives

Learn movement potential

See how dynamic ligaments create a force couple.

Understand how loading enables movement

The Potential For Movement Is Considerable

- ❖ Without ligamentous restrictions, the super-incumbent weight causes the sacrum to tilt ventrally essentially unimpeded by structure.
- ❖ When there are no ligamentous restrictions the form of the joint allows it to open.

Weight Loading On The Sacrum

- ❖ Primary loading of the superincumbent weight on the sacrum loads the posterior interosseous ligaments and tends to separate the SIJs while approximating the PSISs.
- ❖ It is the sequential secondary loading of the sacrotuberous ligaments that rotates the pelvis posteriorly decreasing the lumbosacral angle and creating a secondary force to enhance and balance the primary loading forces.

Vukicevic

- ❖ Vukicevic found that in normal standing, the sacroiliac joints can withstand a wide range of loading without pelvic or sacral deformation even after the elimination of the sacrotuberous and sacrospinous ligaments.(37)
- ❖ The joint surfaces do not approximate with this loading, however, these joints become profoundly unstable after the removal of the posterior interosseous ligaments. (37)

Movement Without Ligamentous Restrictions

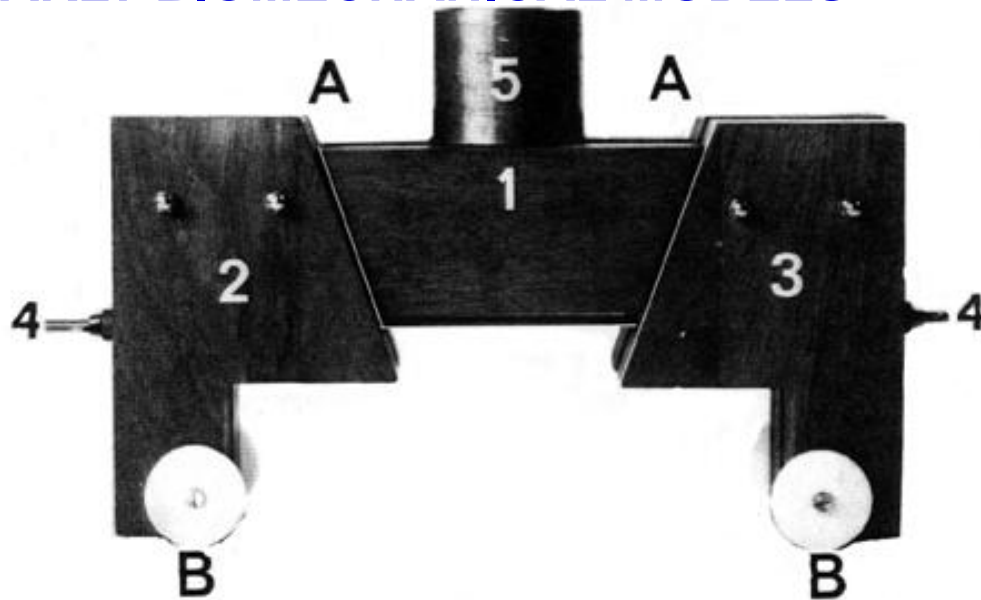
- ❖ If the sacroiliac ligaments were removed and the subject moved from supine to erect and loaded the sacrum, the sacrum would continue to incline ventrally.
- ❖ It would move ventrally at S1 and because of the ilial tuberosity superior to S3, the distal sacrum moves dorsally on the sacral x axis.
- ❖ If it were not for the ligamentous restrictions, the sacroiliac joints could not sustain weight loading.

Form and Force Closure

- ❖ Snijders and Vleeming described a model of **form and force closure** in the stabilization of the SIJs and referred to it as self-bracing. (38)
- ❖ The concept of **form and force closure** as they described it **may be inappropriate** as joint closure can not occur with movement on the sacral x axis.
- ❖ The structural angulations of the SIJ allow it to **open** with a decrease in the secondary forces.

•FORM CLOSURE

•EARLY BIOMECHANICAL MODELS



represents ligament or muscle forces.

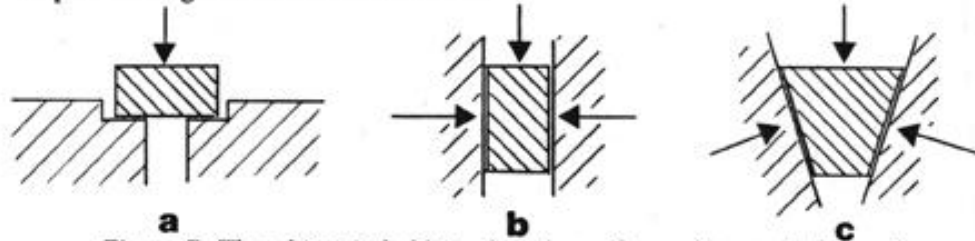


Figure 7. The object is held in place by a: form closure, b: force closure and c: combination of form and force closure.

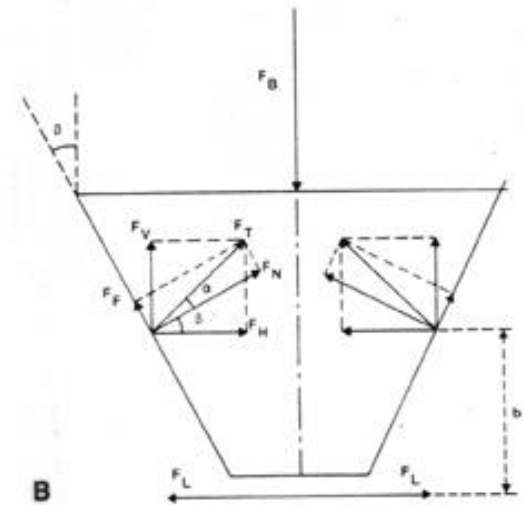
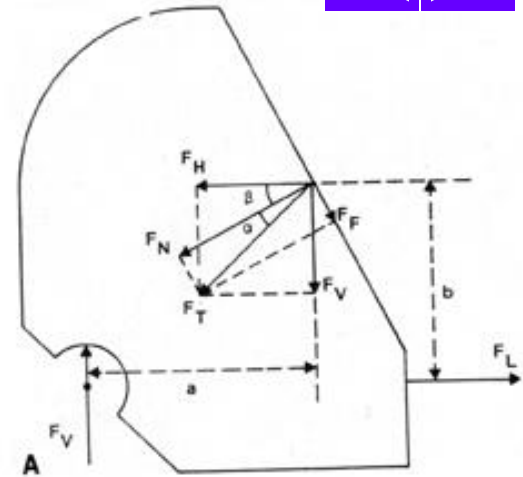
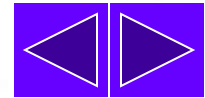


Fig 3. Free body diagram of the os ilium, A, and the os sacrum, B. This model comprises a self-bracing effect, depending on the friction coefficient $[\tan(\alpha)]$ of the sacroiliac joint surfaces, the wedge angle (β) of the sacrum and the lever arms (a and b) of, respectively, the supporting force of the hip joint (F_V) and the resultant of ligament forces (F_L) with respect to the SI joint reaction force.

•FROM SNIJDERS AND VLEEMING

Form and Force Closure (2)

- ❖ The form of the sacroiliac joints illustrated in the previous slide is inappropriate as closure of the joints can not occur in the absence of tension on the sacrotuberous ligaments.
- ❖ The sacrum is pictured and analyzed as a keystone, but it functions as the reverse of a keystone by hanging more deeply between the ilia with increased weight loading. (86-89)
- ❖ The keystone of an arch becomes wedged more tightly as weight is applied from above.

Form and Force Closure (3)

- ❖ After weight loading of the ligaments a type of form closure may occur when the matching convexities of the ilial surfaces and concavities of the sacral surfaces of the SIJs serve to center and stabilize the joints, and maintain congruency to increase stability and efficacy.

Form and Force Closure(4)

- ❖ Vleeming found that virtually no motion occurs in the fresh cadaver pelvis even with forcible attempts to create an asymmetric pelvis.
- ❖ It would appear that both form and force closure may be present only when the sacrum is unloaded or in the cadaver pelvis.

Form and Force Closure (5)

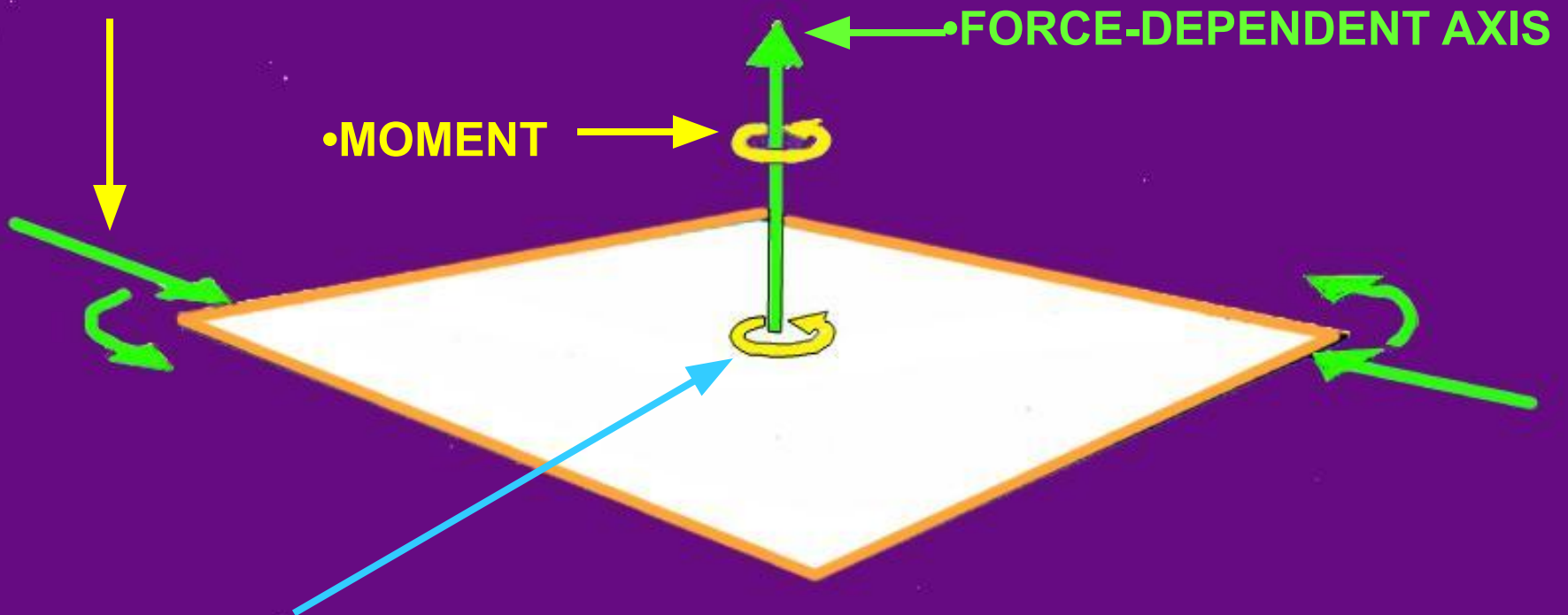
- ❖ It also appears that the loading of the sacrum negates the form and force closure allowing for the considerable movement occurring with pelvic dynamics.
- ❖ **When the sacrum is loaded everything changes.**

Force Couples

- ❖ Loading the sacrum causes a primary loading on the posterior interosseous ligaments (F1) and a secondary balancing loading on the sacrotuberous ligaments in the opposite direction(F2).
- ❖ The opposing forces created when these ligaments are loaded create multiple, interchangeable force couples.
- ❖ The moments created by the force couples create force-dependent transverse and oblique axes of rotation for the SIJs when the sacrum is loaded.

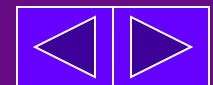
•FORCE COUPLE

- A COUPLE IS TWO PARALLEL AND EQUAL FORCES EXERTING IN OPPOSITE DIRECTIONS AND RESULTING IN A FORCE-DEPENDENT AXIS.



- A MOMENT IS A VECTOR QUANTITY AND IS THE TENDENCY TO ROTATE ABOUT AN AXIS.

•DONTIGNY



•FORCE COUPLE

($F1=F2$)

SACRAL X AXIS

• $F1 - F2 = 0$

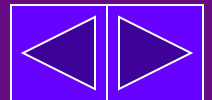
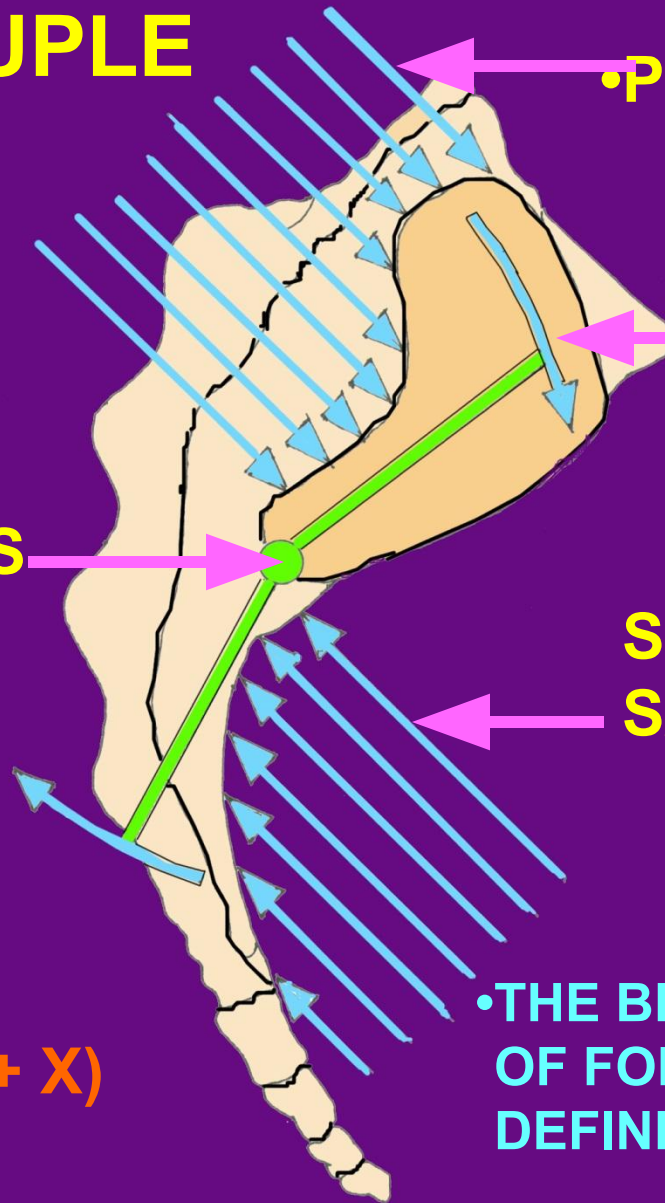
• $(F1 + X) = (F2 + X)$

•PRIMARY SACRAL
LOADING
($F1$)

DIRECTION OF
MOVEMENT

SECONDARY
SACRAL LOADING
($F2$)

•THE BROAD APPLICATION
OF FORCES MORE NARROWLY
DEFINES THE SACRAL AXIS



LOADING MECHANICS

- ❖ The secondary loading caudal to S3 must be strong enough to equal the primary sacral loading at S1 in order to stabilize the ilial convexities in the sacral concavities.
- ❖ This is totally dependent upon the line of gravity being posterior to the acetabular axis causing a posterior innominate rotation, which further balances tension on the posterior interosseous and sacrotuberous ligaments.

The Loaded Sacrum

- ❖ When moving from a supine to an erect posture, the posterior interosseous ligaments are loaded first (F1) causing the S1 sacral segments to move slightly anteriorly and downward.
- ❖ The sacrum inclines ventrally causing a simultaneous secondary loading on the sacrotuberous ligaments caudal to S3 (F2).
- ❖ The secondary sacral loading at S3 balances the primary sacral loading at S1. (F1 = F2)

Ligamentous Tension

- ❖ It must be remembered that the primary loading force is constant after loading.
- ❖ The secondary loading force is dependent upon, is directly related to, must equal and thus balance the primary loading force.
- ❖ When these forces are in balance the closing force is probably nil. ($F_1 - F_2 = 0$)

Loading Forces

- ❖ The secondary loading forces at S3 (F^2) must equal, but can not exceed the primary loading forces at S1 (F^1).
- ❖ $F^1 = F^2$
- ❖ With normal loading, force closure equals 0
 $F^1 - F^2 = 0$
- ❖ **With overloading (X Kg)** $F^1 + X = F^2 + X$
- ❖ Force closure must still equal 0, therefore
 $(F^1 + X) - (F^2 + X) = 0$

Loading Forces (2)

- ❖ Thus the primary loading force (F^1) and the secondary loading force (F^2) are always in balance.
- ❖ Any increase in weight carrying will increase both primary and secondary loading equally.
- ❖ Thus the closing force at the sacroiliac joints will be essentially nil.
- ❖ The joints are only stable in posterior rotation and extremely vulnerable to injury through minor trauma in anterior innominate rotation.

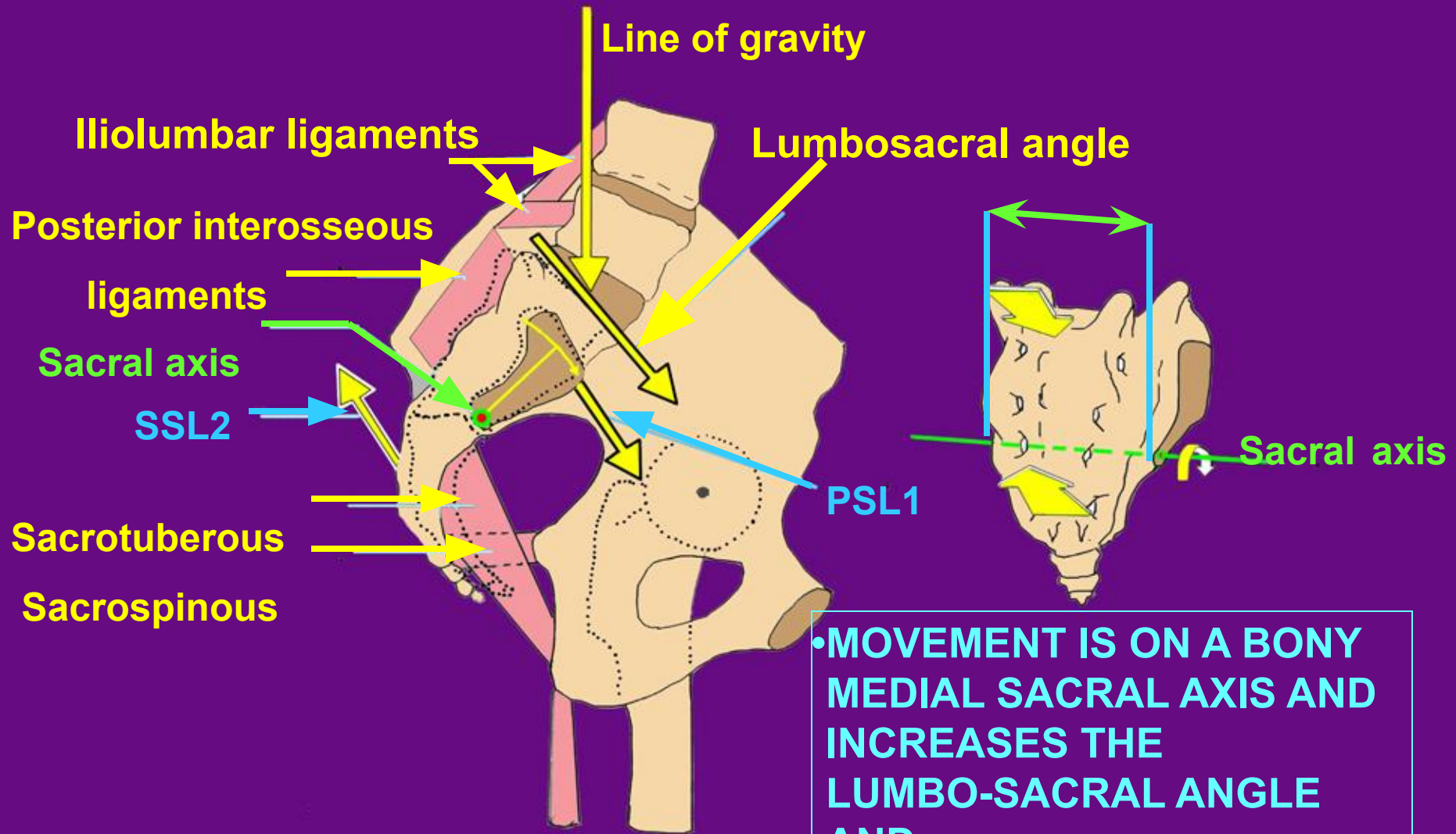
Loading Force (3)

- ❖ Once the joint is loaded, the pelvis is symmetrical, the ilial convexity is seated in the sacral concavity and the joint surfaces are congruent it takes a scant increase in the secondary loading force to hold it there.
- ❖ These joints are extremely vulnerable to a shift in the line of gravity anterior to the acetabular axis, such as occurs when lifting, bending, lowering, shoveling, sweeping, vacuuming, etc.

Primary Sacral Loading

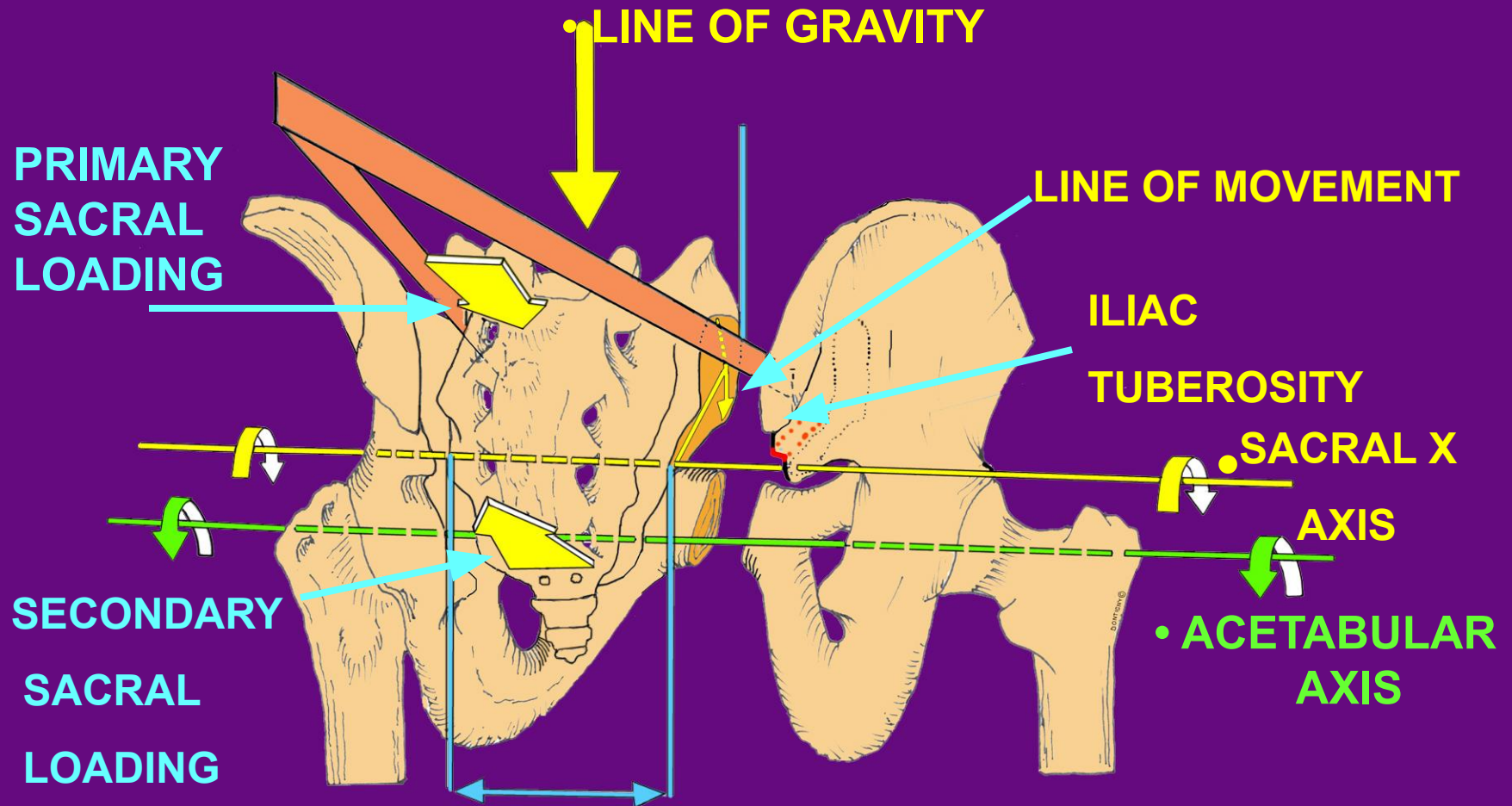
- ❖ Primary sacral loading (PSL1) is represented by the line of gravity, which loads the iliolumbar and the posterior interosseous ligaments.
- ❖ This results in a secondary sacral loading (SSL2) of the sacrotuberous and sacrospinous ligaments from the opposite direction.
- ❖ Loading is on a sacral x axis and increases the lumbosacral angle, increases shear at L5-S1 and tends to open the joint.

PRIMARY SACRAL LOADING (PSL)



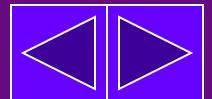
• MOVEMENT IS ON A BONY MEDIAL SACRAL AXIS AND INCREASES THE LUMBO-SACRAL ANGLE AND THE LUMBAR LORDOSIS.

• PRIMARY SACRAL LOADING



• NOTE THE LINE OF MOVEMENT (LM) ON THE SACRAL X AXIS AND THE TUBEROSITY THAT LIMITS POSTERIOR ILIAL ROTATION

• DONTIGNY ©



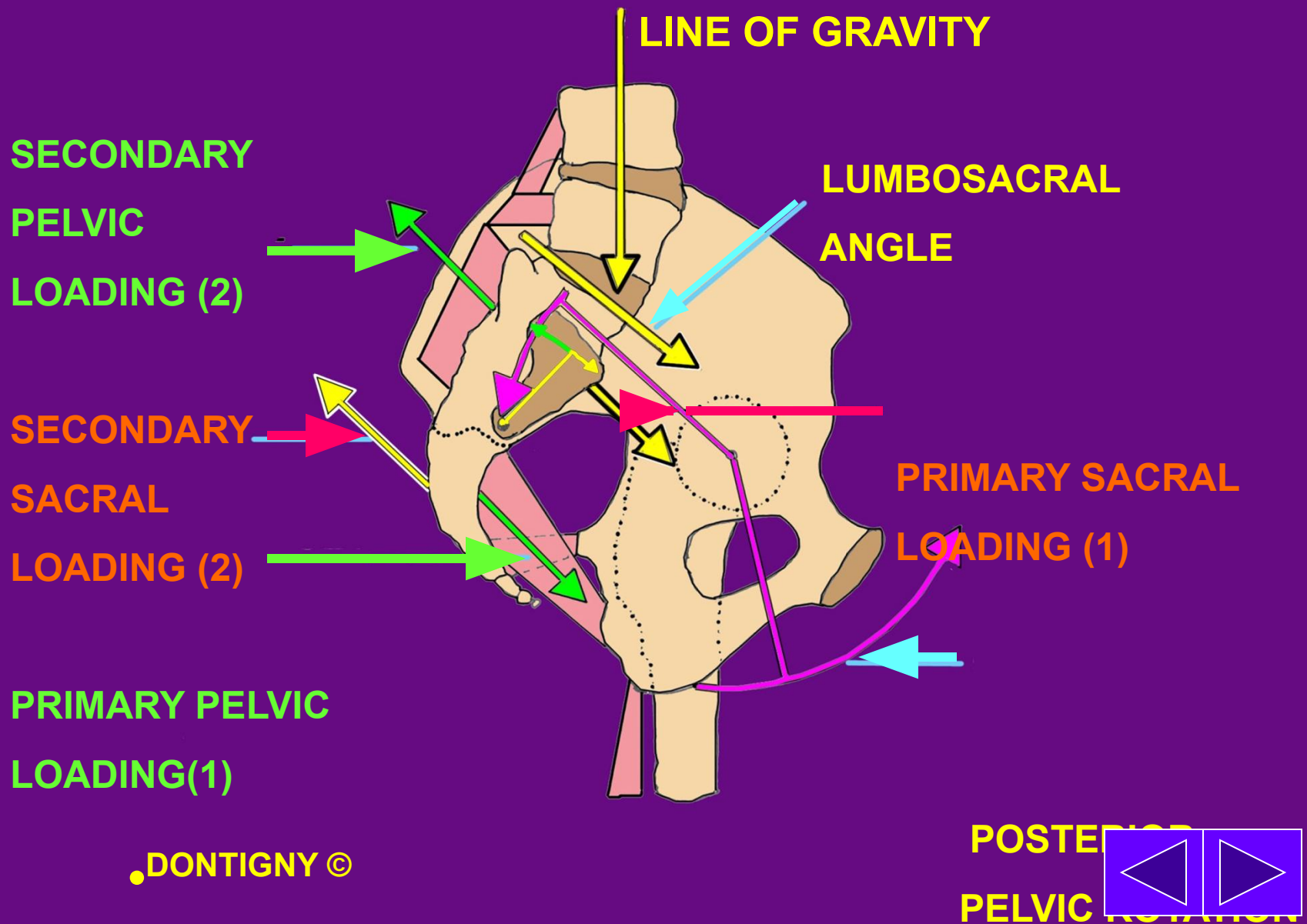
The Line Of Gravity Insures Balanced Ligamentous Tension

- ❖ When the line of gravity is posterior to the acetabula the innominate bones rotate posteriorly on an acetabular axis.
- ❖ Posterior rotation of the innominate bones causes a primary pelvic loading (PPL1) to the sacrotuberous ligaments and a secondary pelvic loading (SPL2) to the posterior interosseous ligaments to insure balanced dynamic tension.
- ❖ The balanced dynamic tension enhances normal function.

Dynamic Loading With Posterior Pelvic Rotation

- ❖ Primary Sacral Loading on the sacral x axis increases lordosis, increases the lumbosacral angle and causes the joint to separate.
- ❖ Primary Pelvic Loading with posterior pelvic rotation decreases lordosis, decreases the lumbosacral angle and **balances** the ligamentous loading.
- ❖ This prepares the pelvis for dynamic movement.

DYNAMIC PELVIC LOADING



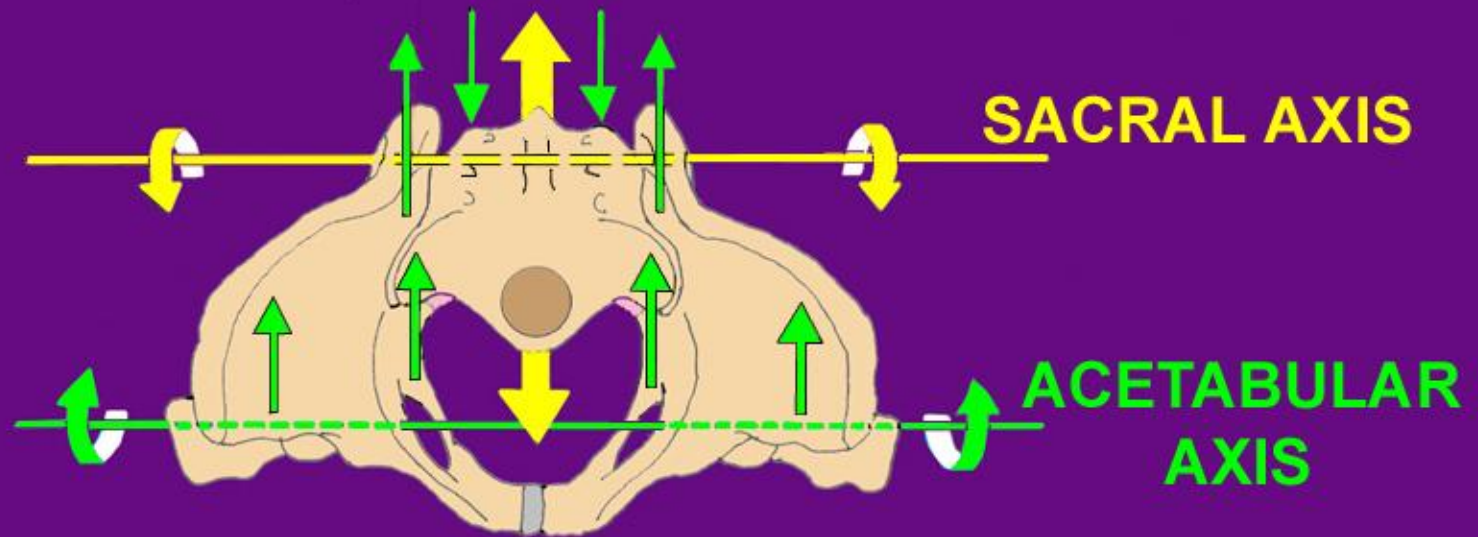
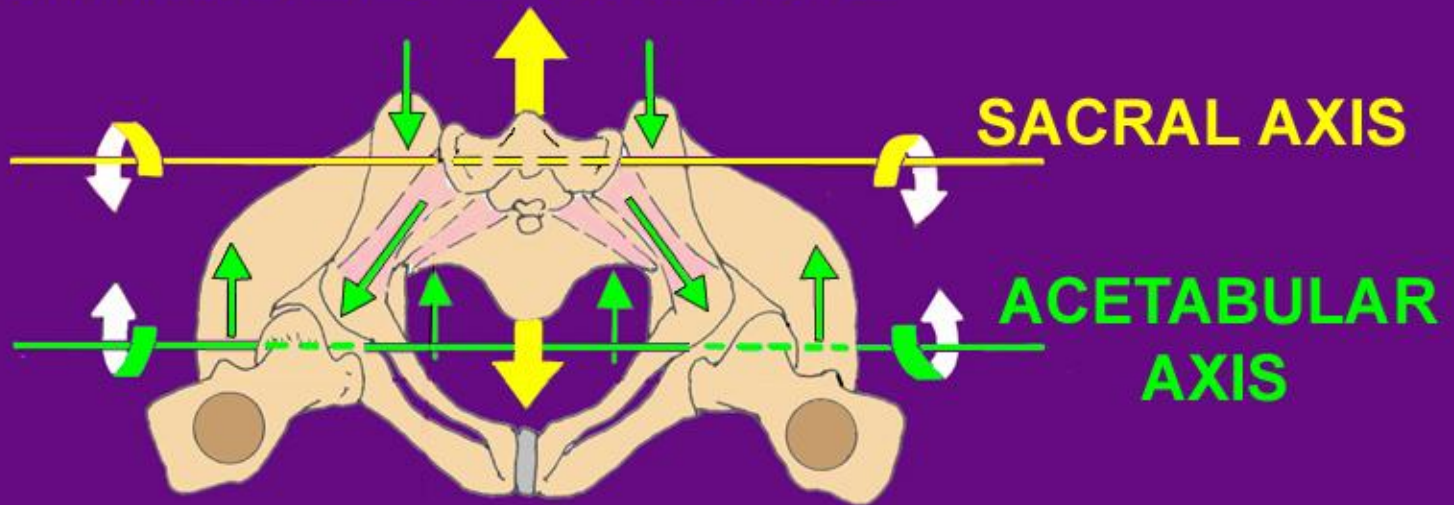
Balanced Loading

- ❖ Sacral loading causes ventral inclination of the sacrum on the sacral axis with primary loading on the posterior interosseous, short posterior and iliolumbar ligaments and secondary loading on the sacrotuberous and sacrospinous ligaments.

Balanced Loading

- ❖ The innominate rotates posteriorly on an acetabular axis and increase loading on these ligaments, balancing the ligamentous loading, and increasing stability.

BALANCED LOADING



Ligamentous Restrictions

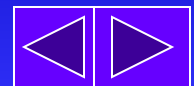
- ❖ The sacrum is essentially slung from the innominate bones by the posterior interosseous ligaments.
- ❖ Primary weight loading is on the posterior interosseous ligaments with an instantaneous sequential secondary loading to the sacrotuberous ligaments.
- ❖ The SIJs are essentially non-weight bearing joints with a balanced loading.

Ligamentous Balance and Sacral Deformation

- ❖ Once the ligaments are loaded and balanced, loading may be increased without causing further movement in the SIJ **because all loading is balanced and interdependent.**
- ❖ 15Kg of pressure to the apex of the sacrum caused sacral deformation of 0.5-1.0 cm with no movement of the SIJ. (Vleeming et al, First Congress Book, 1992, p 150)(1)
- ❖ Movement of the loaded sacrum occurs as a consequence of innominate movement.

FUNCTIONAL BIOMECHANICS

**THE OBLIQUE AXIS ,
SACRAL OSCILLATION
AND NORMAL GAIT**



Functional Biomechanics

- ❖ Function as force couples
- ❖ Lateral sacral flexion
- ❖ Force dependent oblique axis
- ❖ Movement on the oblique axis
- ❖ Sacral oscillation
- ❖ Rhythmic sacrocranial vertebral oscillation
- ❖ Normal gait

Functional Biomechanics Objectives

- ❖ To study how the SIJ moves and functions as force couples.
- ❖ Discern how unilateral posterior innominate movement creates lateral sacral flexion.
- ❖ Explain about movement on the oblique axis.
- ❖ Describe how this movement can drive rotation and rhythmic sacrocranial vertebral oscillation.
- ❖ Demonstrate how this all works with specific muscle functions to drive normal gait.

Functional Biomechanics

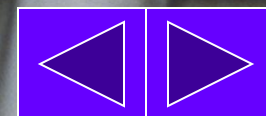
- ❖ The SIJs function as interdependent, self-compensating force couples with variable, force-dependent, transverse axes of rotation.
- ❖ These force couples modify, absorb and redirect forces such as linear and angular acceleration and deceleration, linear and angular momentum, impact loading and unloading and others.
- ❖ Force couples help to enhance function, preserve the systems, and prevent injury.

Functional Biomechanics

- ❖ A posterior innominate rotation on the side of loading and on an axis through the pubic symphysis causes the ilial tuberosity to push the sacrum caudad unilaterally causing a lateral sacral flexion, an asymmetric pelvis and opens S3 on that side.
- ❖ The force couple changes instantly to move the sacrum anterior at S1 on the off loaded side and posterior at S3 on the loaded side moving on an oblique axis from S1 on the loaded side to S3 on the off loaded side.
- ❖ The sacrum flexes laterally and rotates to drive counter rotation of the trunk to decrease loading forces on the femoral head.

Movement to Asymmetry

- ❖ The sacrum is moved back to symmetry at mid step with a transverse sacral axis at S3 and reverses pelvic symmetry and force couples at the next step
- ❖ This is a guided, involuntary, ligamentous movement to reverse pelvis asymmetry and sacral movement at each step.
- ❖ Any dysfunction of the sacrum will cause movement on dysfunctional axes.



•S1
OPENS

•ANTERIOR
ROTATION

•S3
CLOSES

•OBLIQUE
SIJ AXIS

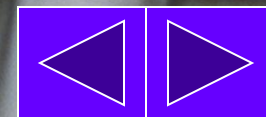
•LATERAL SACRAL
FLEXION

•S1
CLOSES

•POSTERIOR
ROTATION

ILIAC
TUBEROSITY

•S3
OPENS



•POSTERIOR
ROTATION

•S1 CLOSES

•ANTERIOR
ROTATION

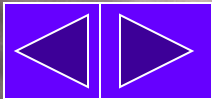
•S1
OPENS

•S3
CLOSES

•LATERAL SACRAL
FLEXION

•OBLIQUE
SIJ AXIS

•S3
OPENS



Biotensegrity

- ❖ For those with a biotensegrity background this is a right side asymmetrical pelvis with a four bar linkage and a left asymmetrical pelvis with a four bar linkage.
- ❖ The sacrum is forced into asymmetry and to flex laterally right or left with posterior rotation, which causes alternating transient oblique force couples.
- ❖ The sacrum moves smoothly back and forth with the alternate changes in posterior innominate rotation.
- ❖ Thanks to Steve Levin, biotensegrity expert, for pointing that out. www.biotensegrity.com

Biotensegrity

- ❖ Lateral sacral flexion is initiated with unilateral posterior innominate rotation into pelvic asymmetry. It is the iliac tuberosity of the innominate on the side of loading that actually pushes the sacrum down or caudad on S1 on that side and to create an oblique axis with the S3 axis on the off-loaded side.
- ❖ Lateral sacral flexion is reversed at mid-step with a reversal of asymmetry, of the oblique axis and of the oblique force couple.
- ❖ This alternating obliquity is all essentially based on the initiation and reversal of ligamentous tension and assisted by the piriformis and the sacral origin of G. Max at mid-step at recovery of symmetry.
- ❖ The S3 Left-S1 Right axis alternates obliquely to the S3 Right-S1 Left axis and reverses. The transverse S3 sacral x axis is functional only in the position of the symmetrical pelvis.

Biotensegrity

Ligamentous tension is increased until heel strike.

Posterior innominate rotation forces lateral sacral flexion.

At heel strike the sacrum is rotating anteriorly at S1 on the off-loaded side and posteriorly at S3 on the side of loading, moving on S3-S1 axis.

Excess tension caused by loading forces on the oblique force couple increasing posterior innominate rotation is accommodated in the helical sacrotuberous ligament.

Forces decrease after loading and oblique force couples reverse instantly at mid-step when the pelvis is briefly symmetrical.

ANTERIOR INNOMINATE
ROTATION

POSTERIOR INNOMINATE
ROTATION

ANTERIOR SACRAL
MOVEMENT
AT S1

SACRAL ROTATION ON
S1-S3 AXIS

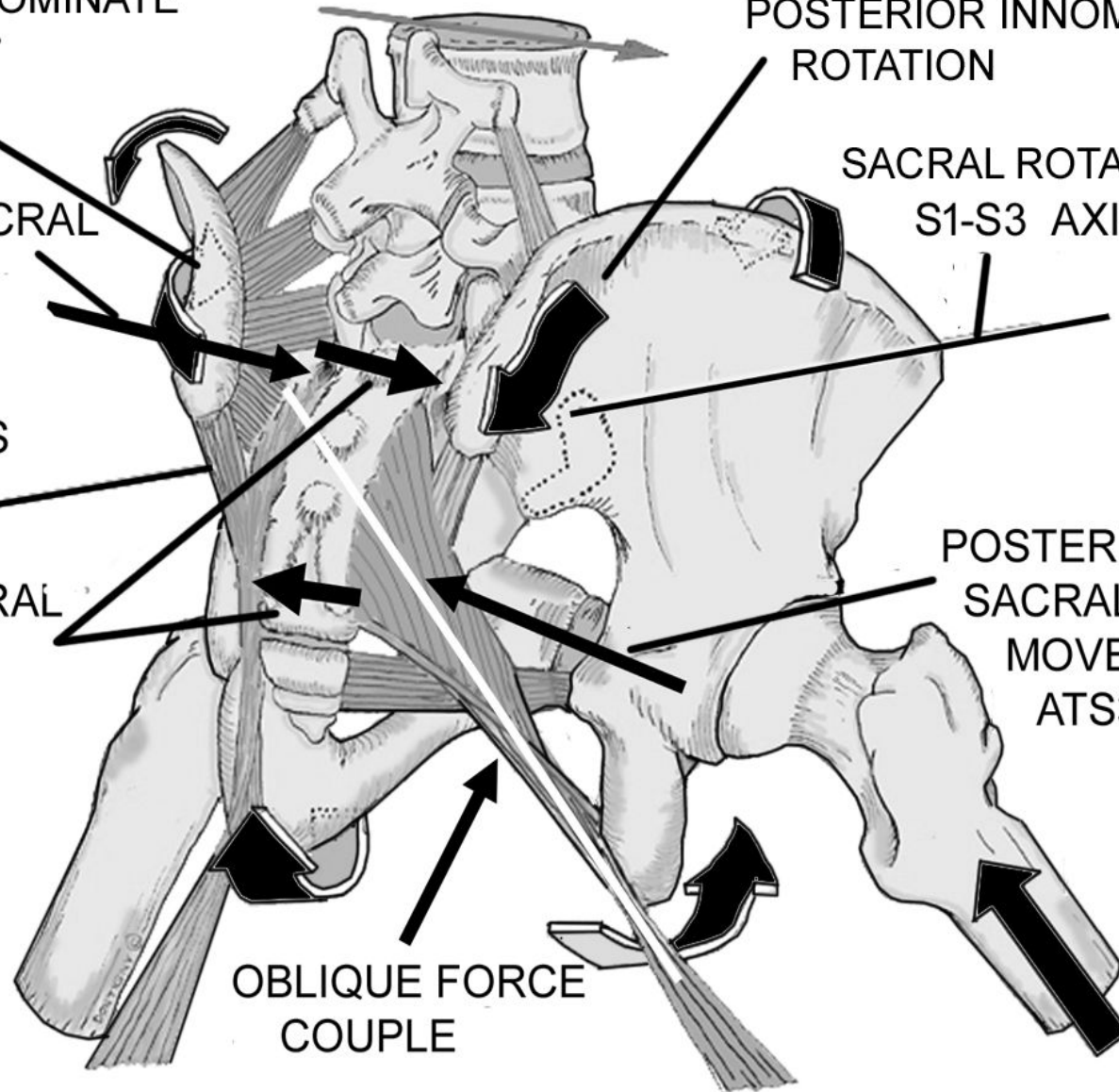
S3-S1 AXIS

LATERAL SACRAL
FLEXION

POSTERIOR
SACRAL
MOVEMENT
AT S3

OBLIQUE FORCE
COUPLE

SACRAL MOVEMENT ON THE S3-S1 AXIS

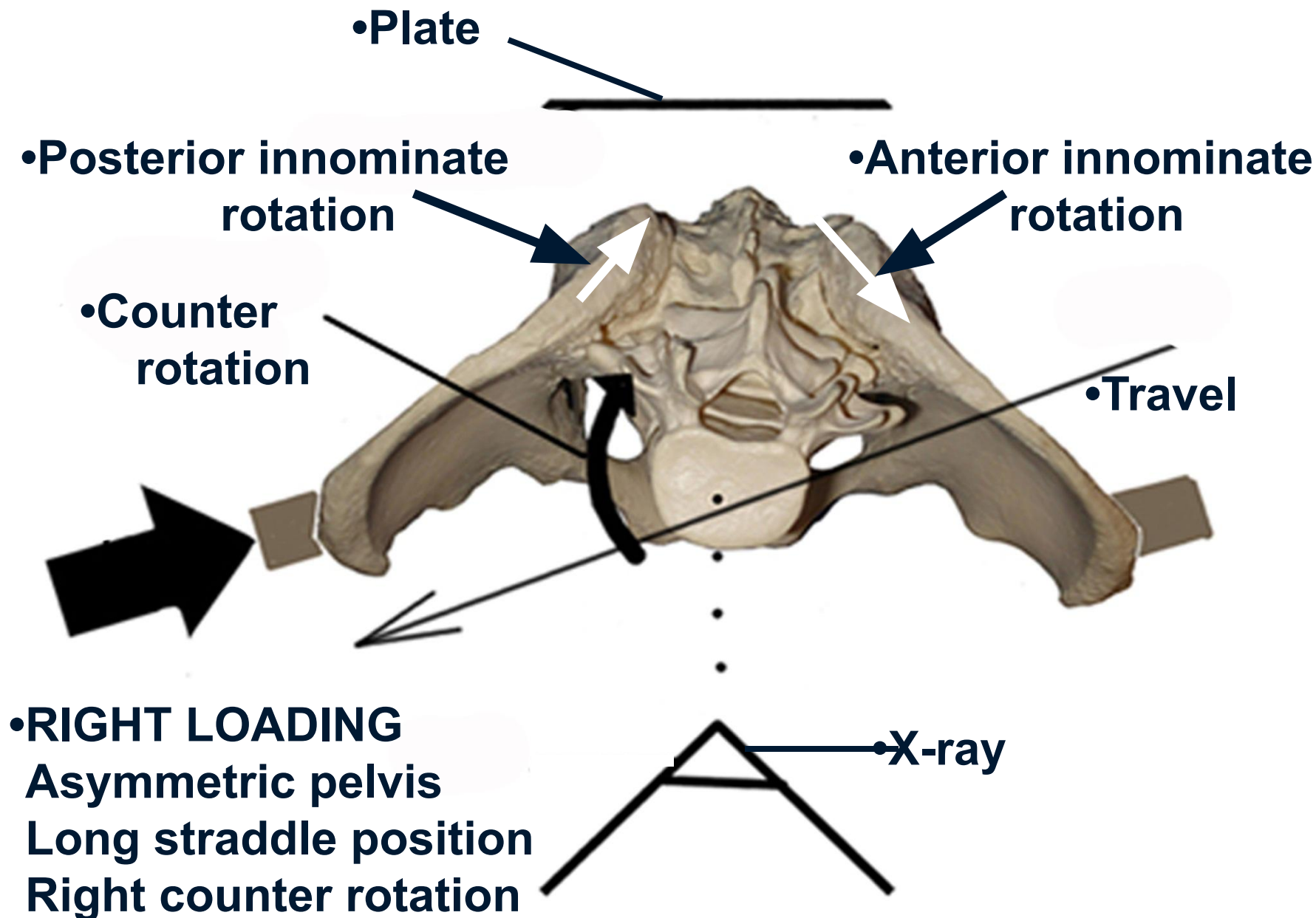


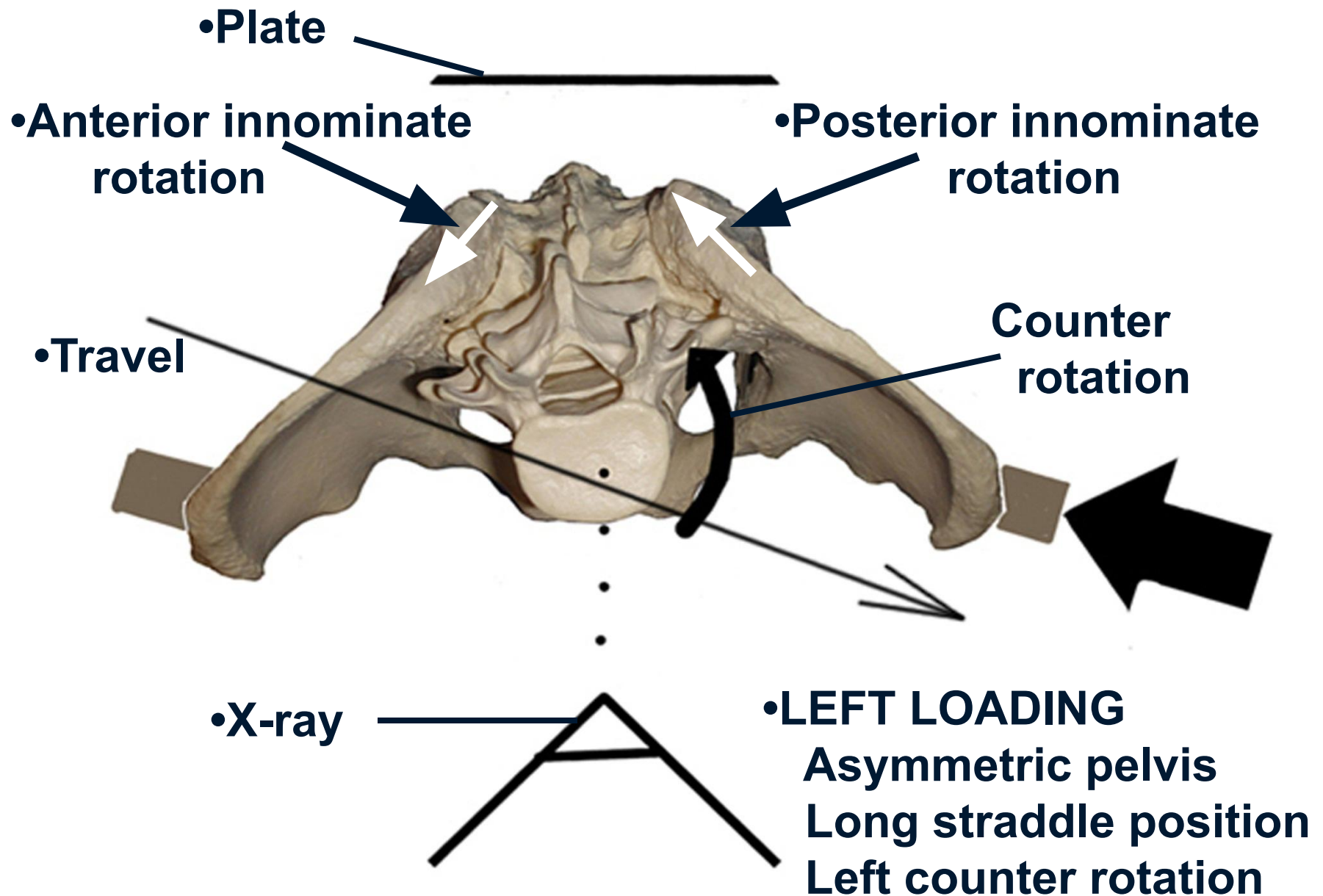
Biotensegrity

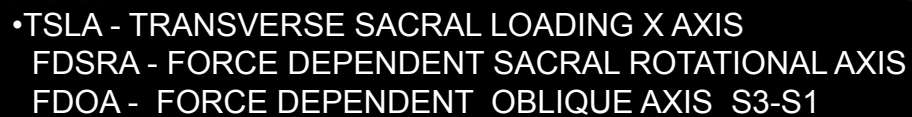
- ❖ Tension is probably equal on both force couples and on the S3 axis at mid-step and changes immediately to the S3-S1 axis and an oblique force couple.
- ❖ There is a vast variance in this movement system dependent on the individual length and speed of stride, variance in pelvic flexibility, posture and ambulatory pattern.
- ❖ Functional posterior innominate rotation is essential to biotensegrity mechanics.
- ❖ Any dysfunction in anterior innominate rotation will alter these mechanics.

X-RAYS OF INNOMINATE MOVEMENT ON THE SACRUM

- ❖ X-rays were taken of the pelvis with the subject in the extreme long straddle position with counter rotation of the trunk.
- ❖ Loading was to the right and compared to loading to the left.
- ❖ This was a static loading rather than dynamic, which would probably demonstrate more sacral movement on the oblique axis.

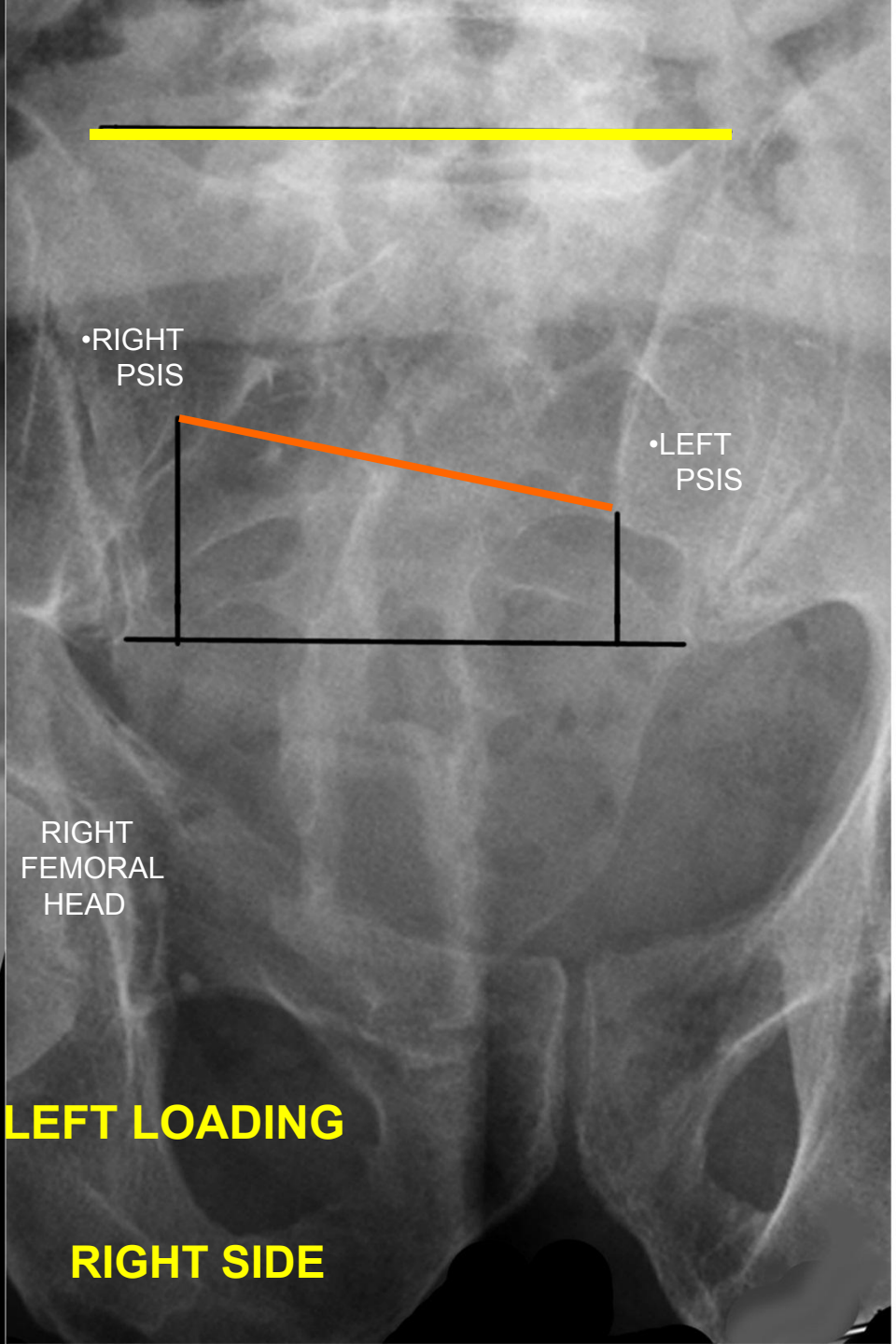
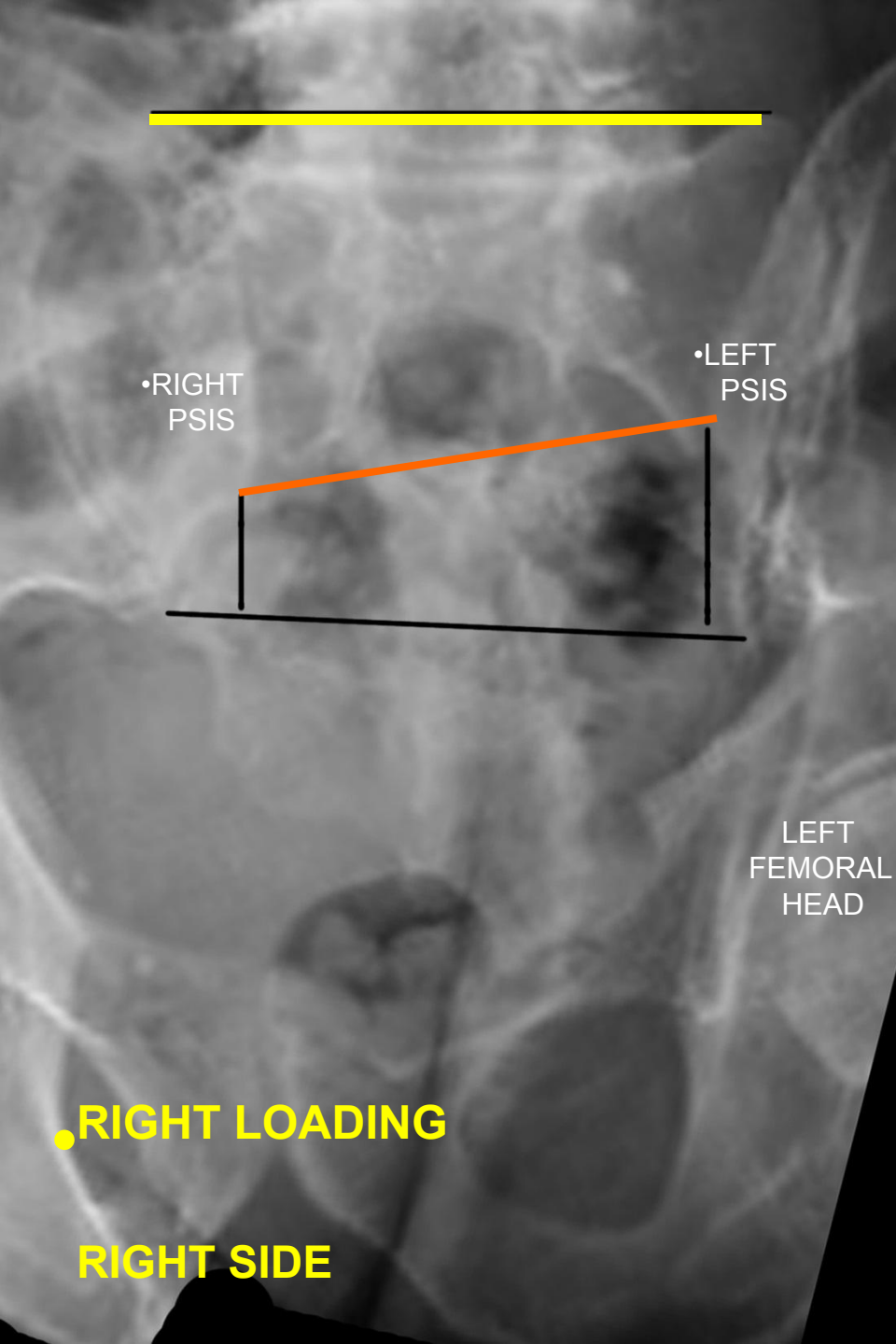






Comparison on a level sacral axis

- ❖ Each x-ray was altered in Photoshop, cropped and the sacral x axes were leveled to better compare movement of the PSISs.
- ❖ Lateral sacral flexion with rotation is demonstrated as is movement of the PSISs.
- ❖ This movement must take place on the sacroiliac joints.



The Potential For Movement Is Considerable

- ❖ Actual movement measured in subjects without low back pain varies from 2 degrees (35) to 22-36 degrees in world class athletes.(36)
- ❖ Movement is less in subjects with low back pain (11).

Comments on Measurements of Movements of the SIJs

- ❖ Lavignolle (10) measured innominate movement on a fixed **unloaded** sacrum in fresh cadavers and in vivo in asymmetric posture in supine subjects with unloaded sacrums.
- ❖ His measurements demonstrated some gliding of the **unloaded** SIJs
- ❖ He did not measure asymmetric movement of the SIJs when the sacrum was loaded.

Comments on Measurements (2)

- ❖ Smidt (12,36) measured movement in elite athletes, with no back pain, well stretched out, with loaded sacrum from relaxed standing to asymmetric pelvis.
- ❖ His measurements were from 22-36 degrees in world class athletes, much greater than Stureson.
- ❖ Measurements on the asymmetric pelvis demonstrated a lateral flexion of the sacrum with rotation.

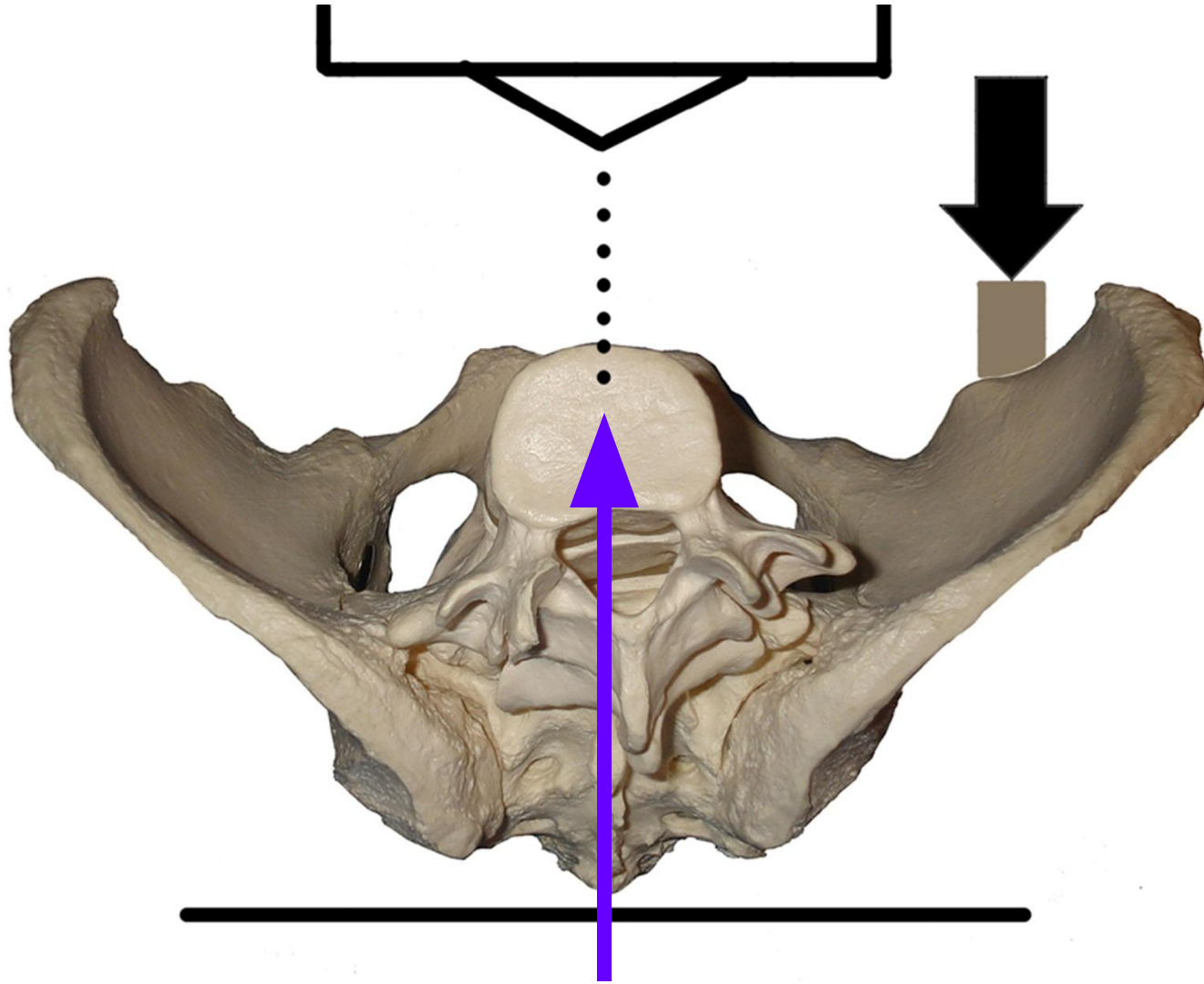
Comments on Measurements (3)

- ❖ **Sturesson (11) measured movement in subjects with low back pain with loaded sacra from relaxed standing to asymmetric pelvis, but made some critical errors in his measurements in the extreme long straddle position.**
- ❖ **He blocked the pelvis anteriorly to better measure sacral movement from a frontal position.**
- ❖ **As a result the pelvis could not move into asymmetry and so he inadvertently measured movement in the symmetrical pelvis even though the legs were in the long straddle position.**

Frontal View with Blocked Pelvis as Per Sturesson

- ❖ So as to make measurement of the pelvis more accurate, Sturesson x-rayed from the front with the subject facing front.
- ❖ In facing front, the pelvis immediately went from asymmetry to a symmetrical pelvis even though the legs were still in the extreme long straddle position.
- ❖ Counter rotation was eliminated

●FRONTAL LOADING



●DIRECTION OF TRAVEL

• SYMMETRICAL LOADING

Right
PSIS

Left
PSIS

• Right
femoral
head

• RIGHT SIDE

Right side loaded in extreme long straddle position with the pelvis blocked to the front. No counter rotation. As per Stuesson. No PSIS movement.

DONTIGNY ©

ASYMMETRIC LOADING

Right
PSIS

Left
PSIS

• Right
femoral
head

• RIGHT SIDE

Right side loaded in extreme long straddle position with counter rotation. No blocking. As per DonTigny. Note PSIS movement.

EXTREMELY IMPORTANT

- ❖ Notice the position of the right PSIS on the left side in both of the previous x-rays.
- ❖ **It is critical to understand that the innominate on the side of loading carries the sacrum caudad, but does not and can not move caudad on the sacrum.**

Sacral Movement

- ❖ The lateral sacral flexion with rotation will **increase the lumbar lordosis** as it drives counter rotation of the trunk toward the side of loading.
- ❖ Counter rotation always precedes loading to decrease the loading forces to the femoral head at initial impact.

Lateral Sacral Flexion (2)

The Oblique Sacral Axis

- ❖ At impact, right, the pelvis is asymmetrical.
- ❖ The right innominate is posteriorly rotated and the left innominate is anteriorly rotated.
- ❖ The sacrum is flexed to the right and the joint surfaces at S3 right and at S1 left close to establish an oblique axis of rotation in the SIJs.

Lateral Sacral Flexion (3)

The Oblique SIJ axis

- ❖ Because the line of gravity is anterior to the SIJs, the joint surfaces of S3 left and S1 right open somewhat, driving movement on the oblique axis anteriorly at S1 left and posteriorly at S3 right.
- ❖ The amount of rotation that occurs appears to be directly related to the degree of asymmetry present.

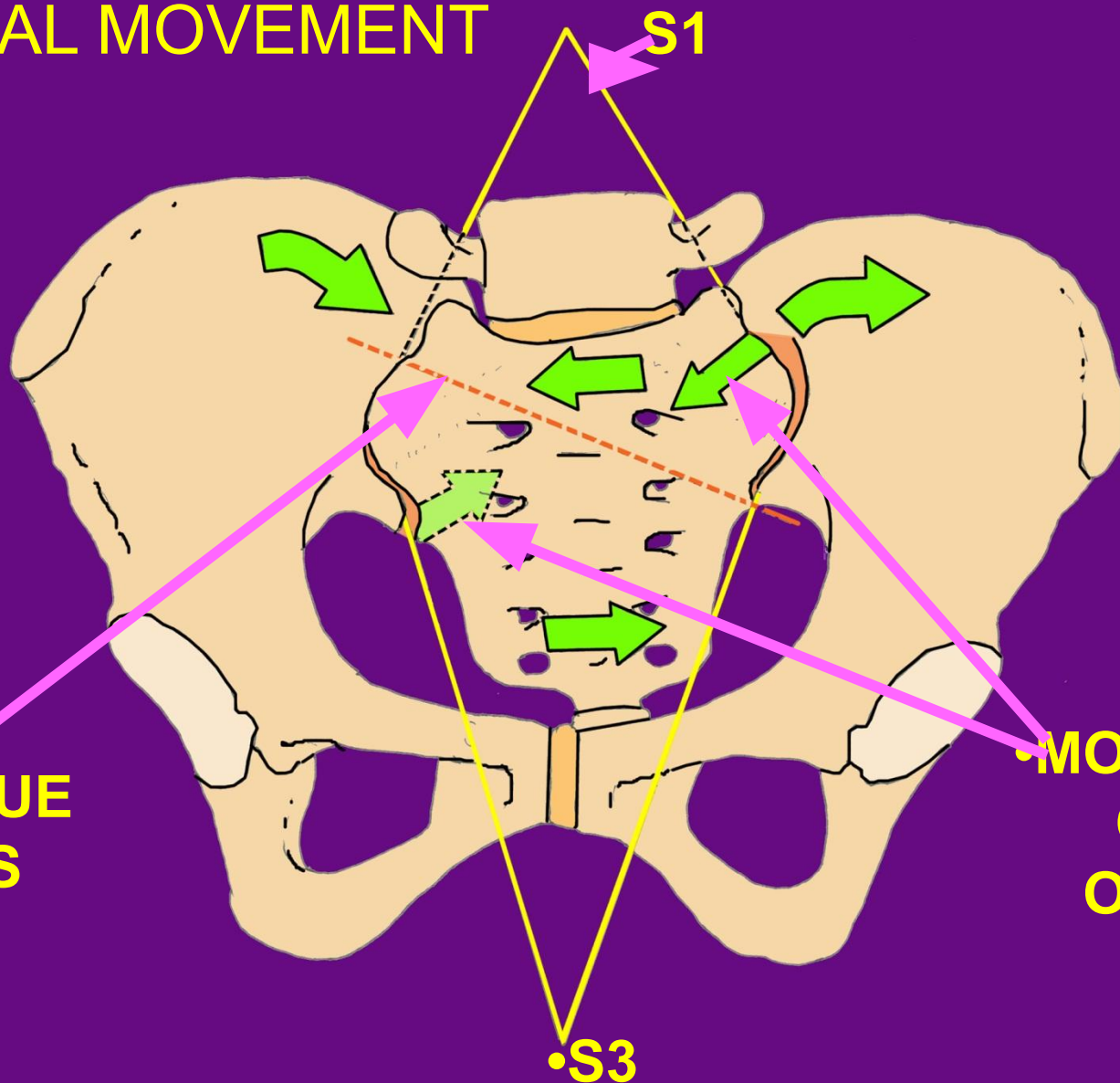
Lateral Sacral Flexion (4)

The Oblique SIJ axis

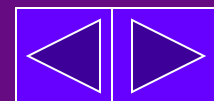
- ❖ The movement on the oblique axis occurs because the line of gravity is anterior to the sacral axis.
- ❖ This is an induced, controlled and functional biomechanical instability.
- ❖ *Because the movement is an opening and closing of the joint, high friction, roughness of the joint or accessory joints are probably not a factor.*

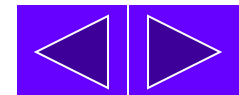
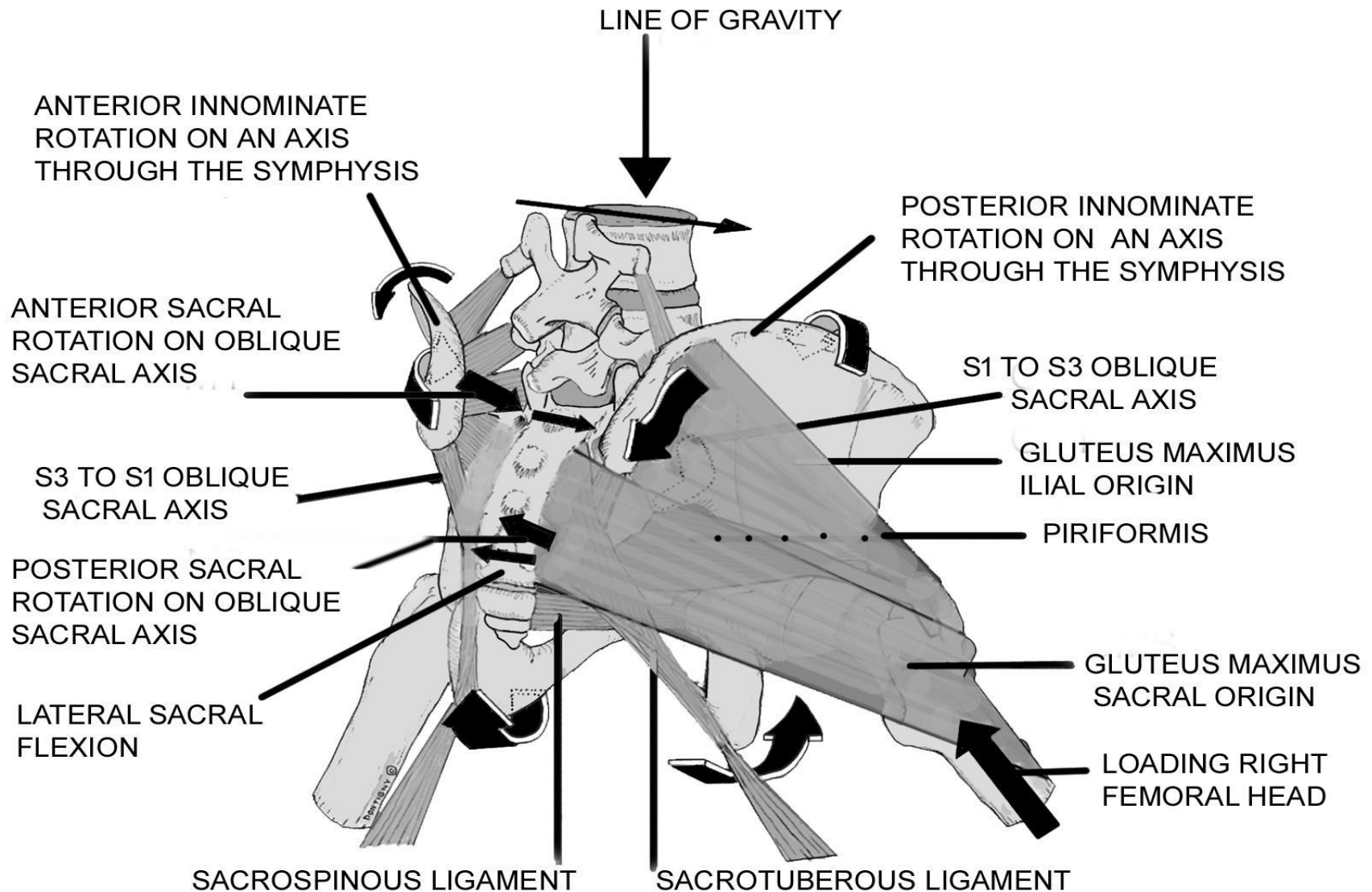
•SACRAL MOVEMENT

•OBLIQUE
AXIS

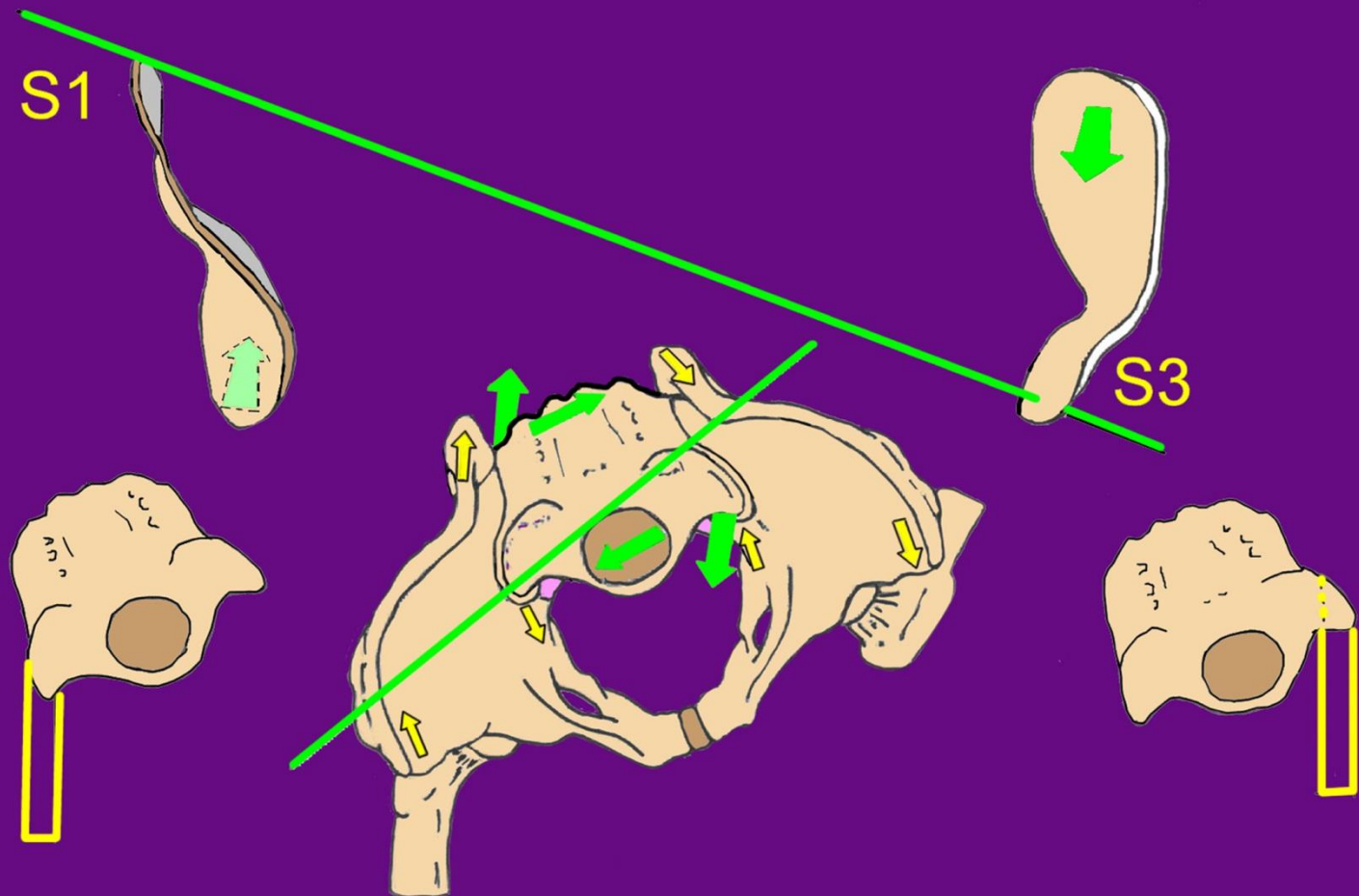


•MOVEMENT
ON THE
OBLIQUE
AXIS





• MOVEMENT ON THE OBLIQUE AXIS



•ASYMMETRIC PELVIS AT TWO-POINT SUPPORT

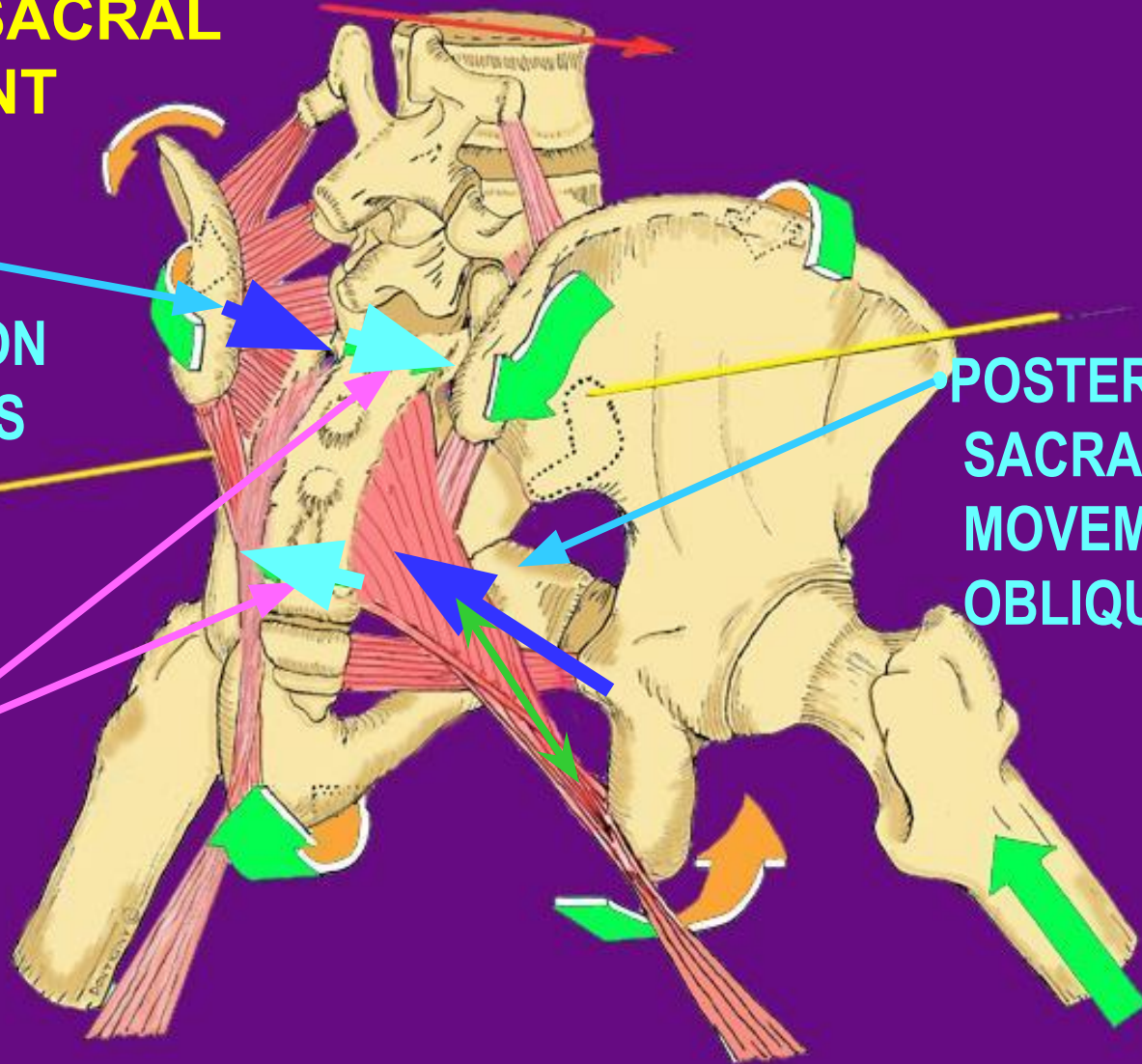
•OBLIQUE SACRAL MOVEMENT

•ANTERIOR
SACRAL
MOVEMENT ON
OBLIQUE AXIS

•OBLIQUE
SACRAL AXIS

•LATERAL
SACRAL
FLEXION

POSTERIOR
SACRAL
MOVEMENT ON
OBLIQUE AXIS



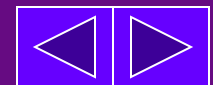
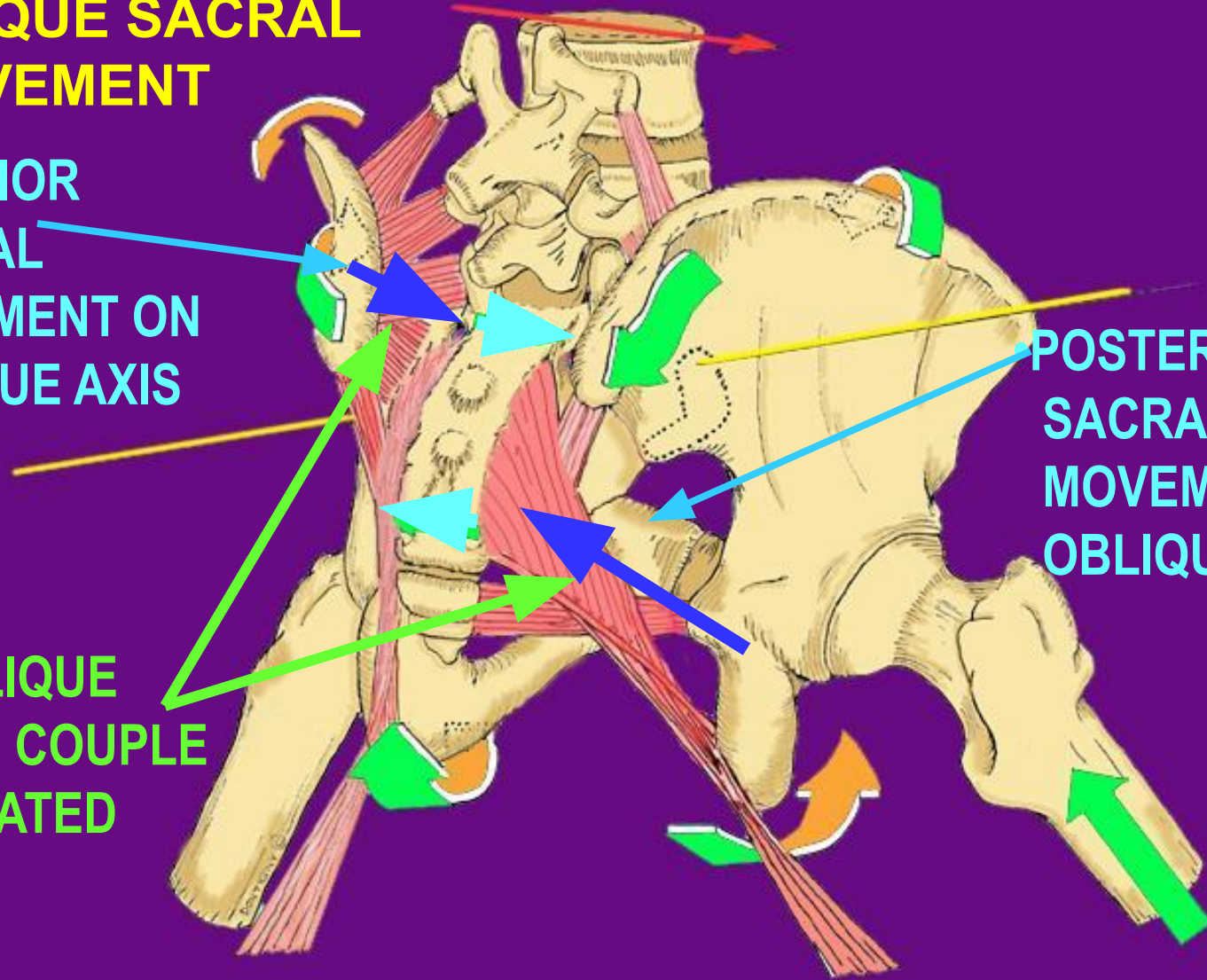
•ASYMMETRIC PELVIS AT TWO-POINT SUPPORT

•OBLIQUE SACRAL MOVEMENT

•ANTERIOR
SACRAL
MOVEMENT ON
OBLIQUE AXIS

POSTERIOR
SACRAL
MOVEMENT ON
OBLIQUE AXIS

•AN OBLIQUE
FORCE COUPLE
IS CREATED



Movement at the SIJ

- ❖ A critical analysis of the movement in the sacroiliac joints on the oblique axis appears to reveal an opening of the joints with an oblique movement of the sacrum on the innominates.
- ❖ The anterior movement at S1 is far less than the posterior movement at S3 because the posterior interosseous ligaments supporting S1 are far shorter than the sacrotuberous ligaments supporting S3.

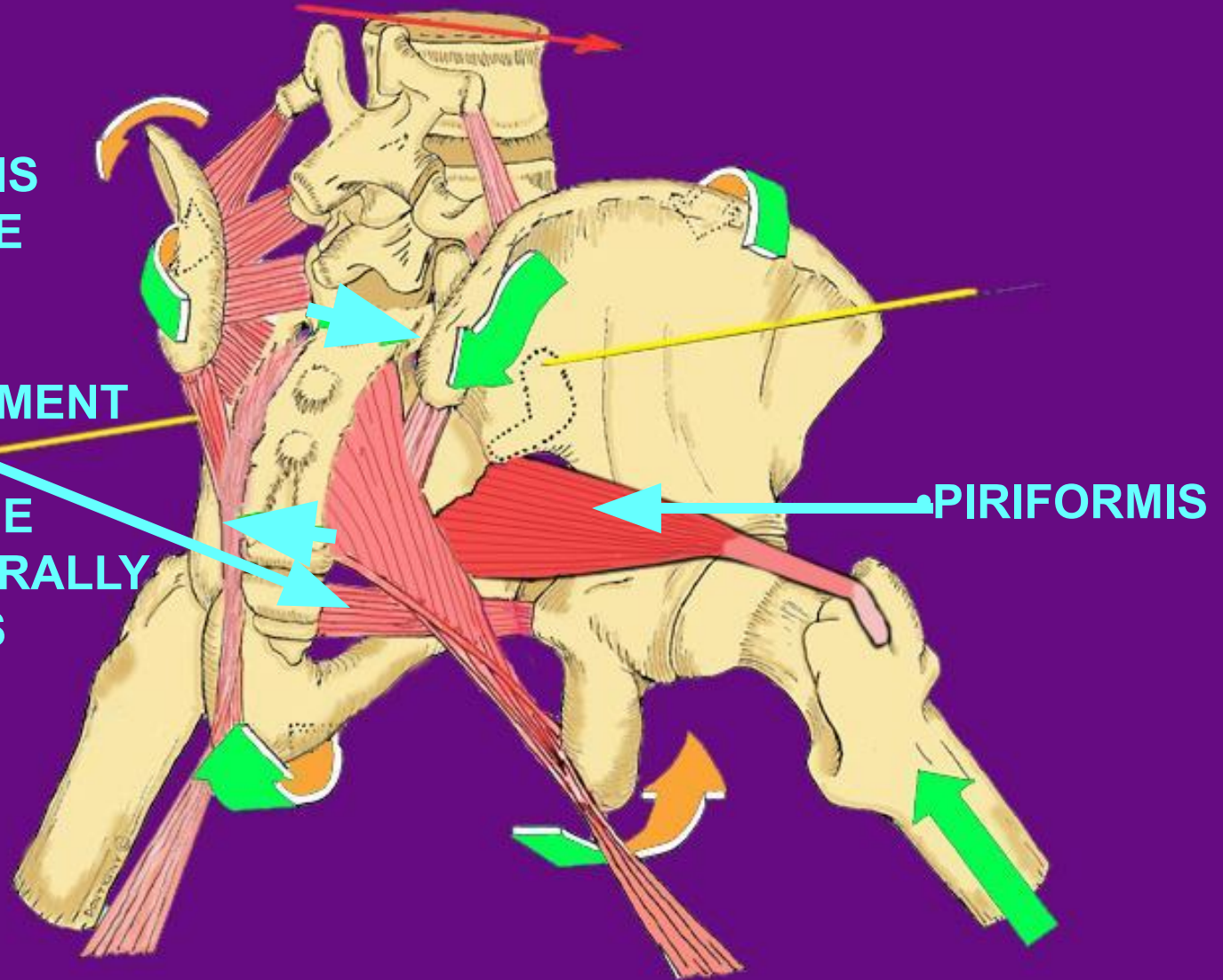
Prime Movers of the SIJ

- ❖ Critical analysis of sacral movement on the asymmetric pelvis suggests that the sacral origin of the gluteus maximus works with the piriformis muscle to help to straighten the sacrum as the pelvis moves to symmetry at mid-step. (80)
- ❖ This indicates that these two muscles should probably be considered to function as prime movers of the sacroiliac joint.

•ASYMMETRIC PELVIS AT TWO-POINT SUPPORT

- THE PIRIFORMIS SUPPORTS THE FUNCTION OF THE SACRO-SPINOUS LIGAMENT

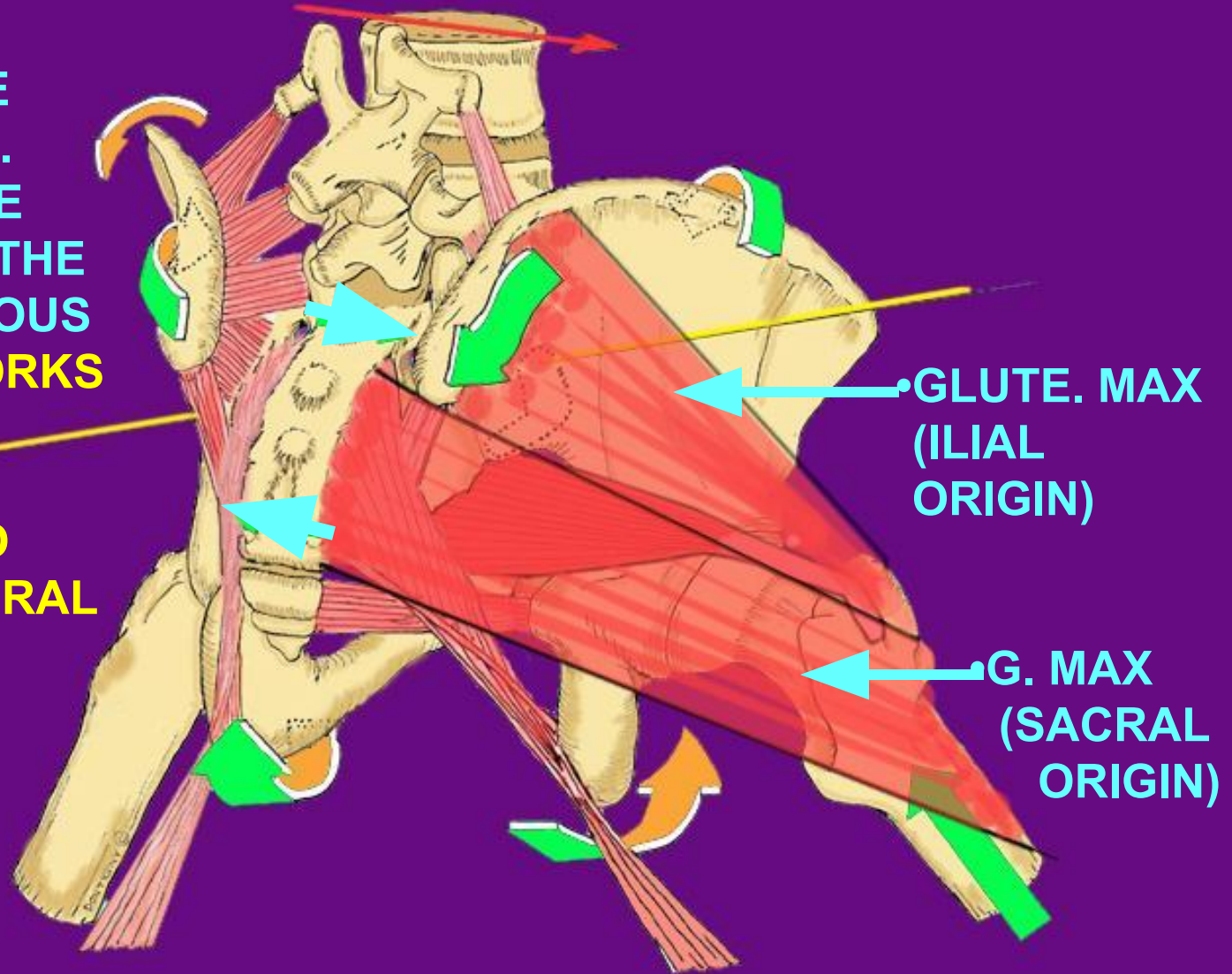
AND PULLS THE SACRUM
LATERALLY
AS THE PELVIS
MOVES TO
SYMMETRY



•ASYMMETRIC PELVIS AT TWO-POINT SUPPORT

- THE SACRAL ORIGIN OF THE GLUTEUS MAX. SUPPORTS THE FUNCTION OF THE SACROTUBEROUS LIGAMENT, **WORKS WITH THE**

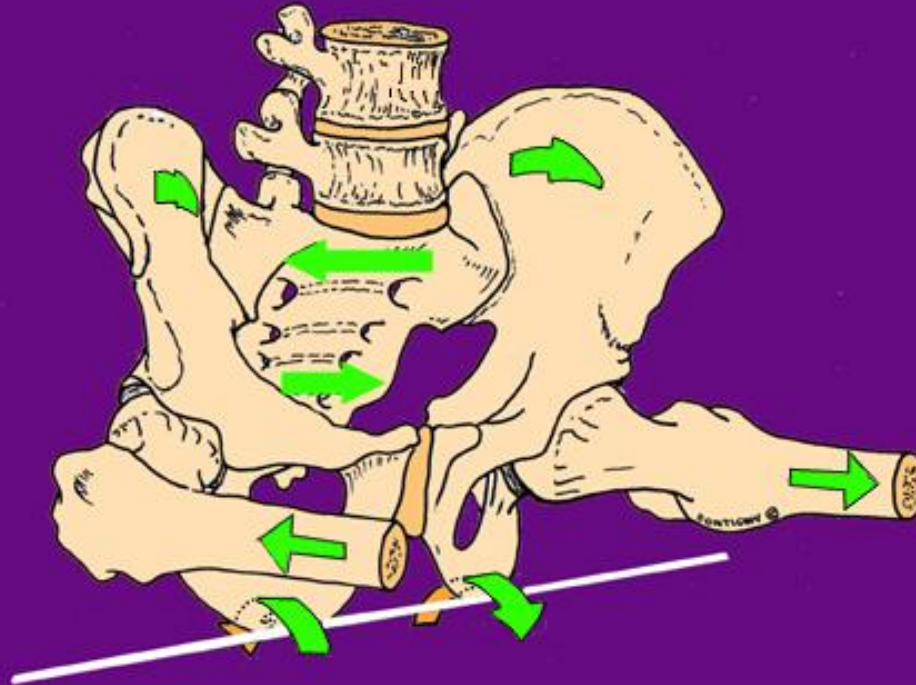
**PIRIFORMIS TO
CONTROL SACRAL
FLEXION AND
PULLS THE
BODY
FORWARD
UNTIL THE
LEG IS
PERPENDICULAR**



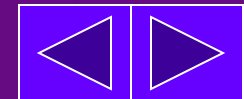
Sacral Oscillation

- ❖ With each step the sacrum is uniquely positioned by the innominate to initiate and drive rotation and counter rotation of the trunk with minimal torsion to the lumbar spine.
- ❖ This provides for the storage and release of energy in the adjacent ligaments through the interaction of the force couples.
- ❖ The alternate lateral sacral flexing causes an oscillation of the sacrum during normal gait.

- **DEMONSTRATION OF LATERAL SACRAL FLEXION**
WHEN SEATED, PUT ONE FINGER ON YOUR COCCYX
TRANSLATE ONE LEG BACK AND THE OTHER FORWARD



- **FEEL THE SACRUM FLEX LATERALLY BACK**
AND FORTH AS YOU TRANSLATE YOUR LEGS



Demonstration of Lateral Sacral Flexion

- ❖ When sitting, feet flat, put your finger on the tip of your coccyx or put the index finger of each hand on each side of the coccyx.
- ❖ Now translate your right thigh forward and the left back creating an asymmetric pelvis and feel the sacrum flex back and forth as you translate your legs.

Demonstration of Lateral Sacral Flexion (2)

- ❖ Now hold the right thigh back and the left forward, bend your trunk down and rotate it to the right to feel the sacral movement on the oblique axis, as the distal sacrum moves posteriorly on the oblique axis.

Demonstration (3)

- ❖ Now, still holding the right thigh back and the left forward, bend forward and to the right.
- ❖ Palpate the right sacral origin of the gluteus maximus and as you straighten your body notice how it works to help to straighten the distal sacrum.

Demonstration (4)

- ❖ Now, while holding the right thigh retracted and the left projected, turn your trunk to the right and then to the left.
- ❖ Note how rotation to the right is facilitated and rotation to the left is inhibited.
- ❖ Now, with both thighs neutral, turn your trunk to the right and left and note how you facilitate the turning by projecting and retracting your thighs to create pelvic asymmetry.

Demonstration (5)

- ❖ Now sit with pelvis neutral facing ahead and create pelvic asymmetry as before.
- ❖ Note how the asymmetry causes your trunk to rotate toward the side of posterior innominate rotation (loading).
- ❖ This demonstrates how the asymmetric pelvis and the lateral sacral flexion and rotation drives counter-rotation of the trunk during normal gait to decrease loading forces.

Demonstration (6)

- ❖ Sit with the pelvis neutral, facing ahead and create pelvic asymmetry as before.
- ❖ Note the movement of the PSIS.
- ❖ When the pelvis is in asymmetry when sitting, note on the high side how the sacrum, if fixated, could cause a scoliosis.

Demonstration (Comments)

- ❖ Attempting to demonstrate these movements on a fresh cadaver pelvis is nearly impossible because the sacrum is unloaded at that time.
- ❖ The loaded sacrum is necessary for the movement occurring during pelvic dynamics

Demonstration (Comments)

- ❖ It may be that form and force closure occurs on the unloaded sacrum and in the fresh cadaver, but not on the loaded sacrum.
- ❖ **WHEN THE SACRUM IS LOADED EVERYTHING CHANGES!!!**

Function of Lateral Sacral Flexion and Rotation

- ❖ The longer the stride, the greater the force of impact, however, the long stride also increases pelvic asymmetry and lateral sacral flexion.
- ❖ The lateral sacral flexion inclines the sacral base and drives the spine to rotate.
- ❖ The greater the lateral sacral flexion, the greater the counter-rotation, which precedes loading and serves to lessen the increased impact impulse to the femoral head.

Rhythmic Sacrocranial Vertebral Oscillation (RSVO)

- ❖ With the movement of the pelvis from symmetry at the single support phase of normal ambulation to the initial double support phase, the sacrum flexes laterally and rotates.
- ❖ This causes an increase in lordosis which coincides with the deceleration of initial impact and acts to increase and then decrease the spinal curves from the sacrum cephalad.

RSVO (2)

- ❖ In treadmill studies, Thorstensson (9) found the excursion of this oscillation to be about 2-2.5 cm at L3 and 1-1.5 cm at C7.
- ❖ During this rhythmic sacro-cranial vertebral oscillation the spine functions as a decreasing wave form to damp this spinal oscillation in order to keep the head stable. (80)
- ❖ Thus it appears to function as a biological image stabilizing system.

RSVO (3)

- ❖ Stabilizing the head and the visual plane makes possible the observation of pelvic dynamics in vivo with minimal ambulatory ocular disturbance.
- ❖ The posterior recovery motion that occurs with the reversal of asymmetry assists the hip flexors in the initiation of the next step.(43)

•RSVO

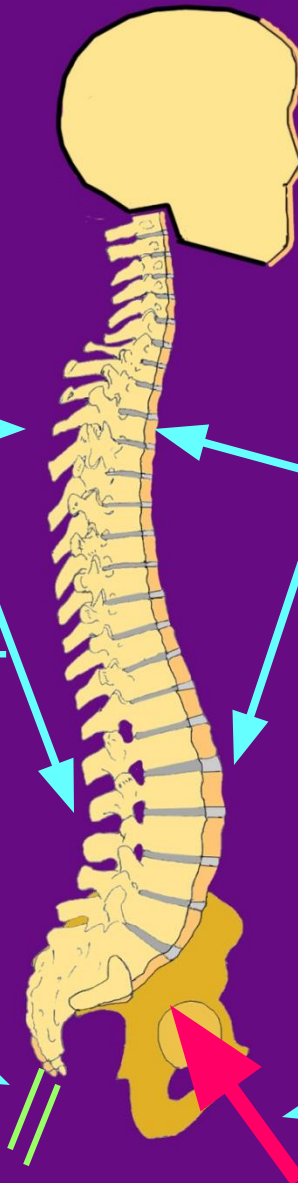
AT TWO-POINT SUPPORT

- VERTEBRAL POSITION
WITH REVERSAL OF
ASYMMETRY

- THIS ANTERIOR/
POSTERIOR MOVEMENT
IS ACCOMPANIED WITH
ROTATION AND
COUNTER-ROTATION.

- SACRAL OSCILLATION

•DONTIGNY ©



- VERTEBRAL MOVEMENT
WITH SACRAL MOVEMENT
ON AN OBLIQUE SIJ AXIS

- DECELERATION
VECTOR

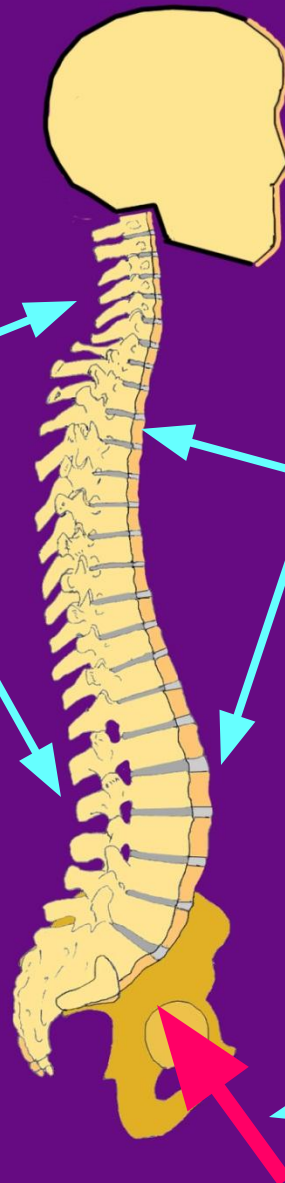


•RSVO

AT TWO-POINT SUPPORT

- THE SPINE FUNCTIONS AS A DECREASING WAVE FORM TO CONTROL RSVO AND TO KEEP THE HEAD STABLE

- THE A/P EXCURSION IS ABOUT 1-1.5CM AT C7 AND 2-2.5CM AT L3



- VERTEBRAL MOVEMENT WITH SACRAL MOVEMENT ON AN OBLIQUE SIJ AXIS

- DECELERATION VECTOR



RSVO Function

- ❖ At initial impact, when the pelvis is asymmetrical and the sacrum is flexed and rotates toward the side of loading, the spinal curves are increased and the spine is rotated toward the loaded side.
- ❖ The rotation of the trunk moves in the same direction as the impact impulse, precedes the impact impulse, and serves to lessen the loading force to preserve the system.

RSVO Function (2)

- ❖ The rotation of the vertebra torques the annulus decreasing the height of the disks.
- ❖ Disks are mostly water and water is not compressible so part of the torsion force is briefly stored in the annulus and the spinal ligaments.
- ❖ This torsion force is released, the spinal curves straighten at midstance and then rotate in the other direction with the next step, storing and releasing energy.

RSVO Function (3)

- ❖ The spine is lengthened and shortened as the spinal curves increase and decrease with the rhythmic vertebral oscillation.
- ❖ This action also probably functions to provide nutrition to the discs.

Less Frequently Considered Muscle Functions

- ❖ The portion of the gluteus maximus originating from the sacrum supports the function of the sacrotuberous ligament during normal gait, works with the piriformis in order to control sacral oscillation and assists the hamstrings to pull the body forward until the leg is perpendicular.
- ❖ The piriformis works to support the function of the sacrospinous ligament and works with the sacral origin of the gluteus maximus to control and straighten the lateral sacral flexion.

Less Frequently Considered Muscle Functions (2)

- ❖ The portion of the gluteus maximus originating from the ilia functions during normal gait to decelerate and ease impact loading on the contra lateral side.
- ❖ Both the gluteus maximus and the tensor fascia lata have fascial insertions into the iliotibial band.

Eccentric Contraction of The Gluteus Maximus

- ❖ Following initial impact, the sacral origin of the gluteus maximus undergoes a concentric contraction to pull the leg posteriorly to perpendicular.
- ❖ Then primarily the ilial origin undergoes an eccentric contraction to decelerate and decrease impact loading on the contralateral side.
- ❖ This functions as two different muscles.

Eccentric Contraction of The Gluteus Maximus

- ◆ The pelvis swings horizontally and anteriorly on the femoral head without causing torque to the femur or the planted foot.
- ◆ The tibial condyles serve to stabilize the knee and minimize torque to the knee and ankle.

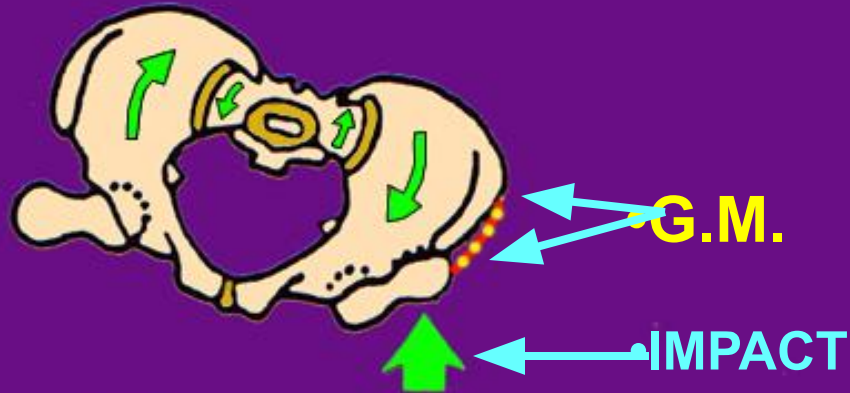
GLUTEUS MAXIMUS

- ILIAL ORIGIN

- UNDERGOES AN ECCENTRIC CONTRACTION

- DECELERATES CONTRA LATERAL SIDE TO DECREASE IMPACT LOADING

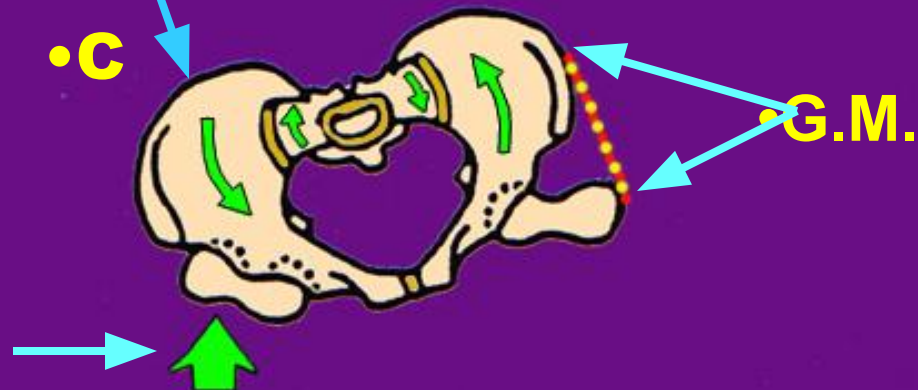
• A



• B

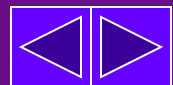


• C



• IMPACT

DONTIGNY ©



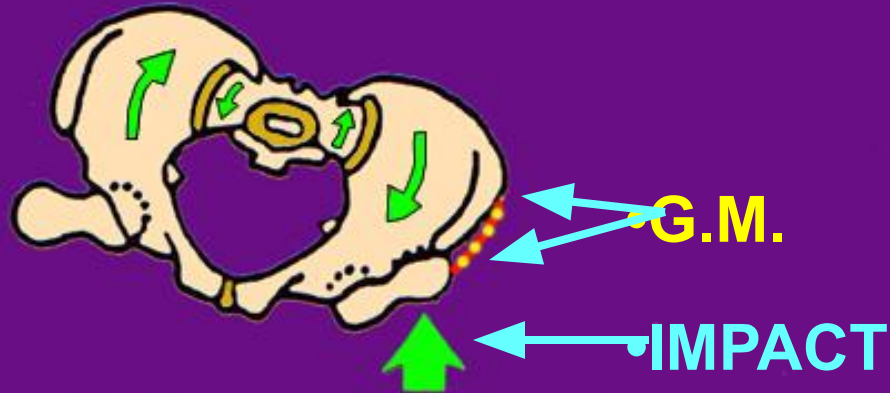
GLUTEUS MAXIMUS

- ILIAL ORIGIN

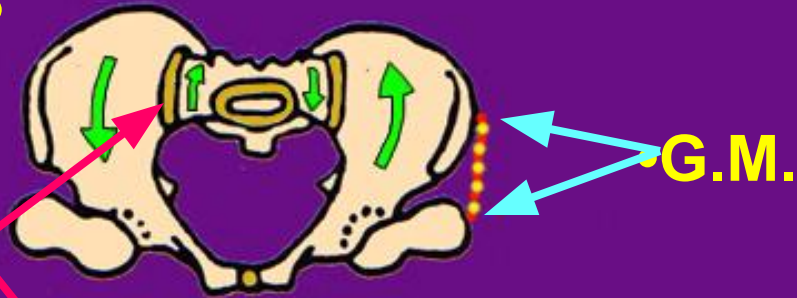
- UNDERGOES AN ECCENTRIC CONTRACTION

- COUNTER ROTATION PRECEDES IMPACT TO DECREASE THE IMPACT LOADING FORCE

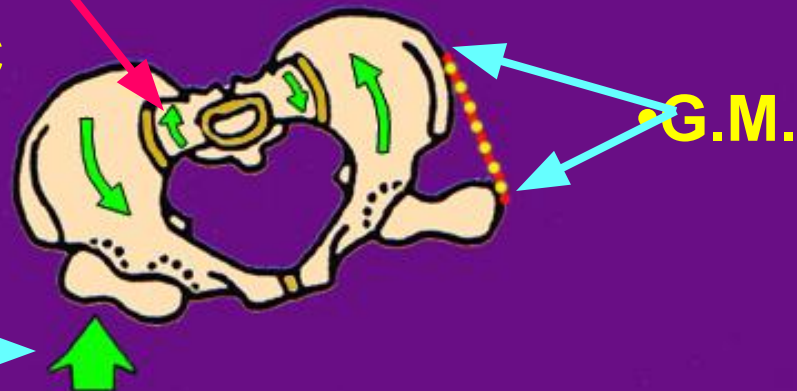
•A



•B

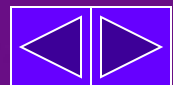


•C



•IMPACT

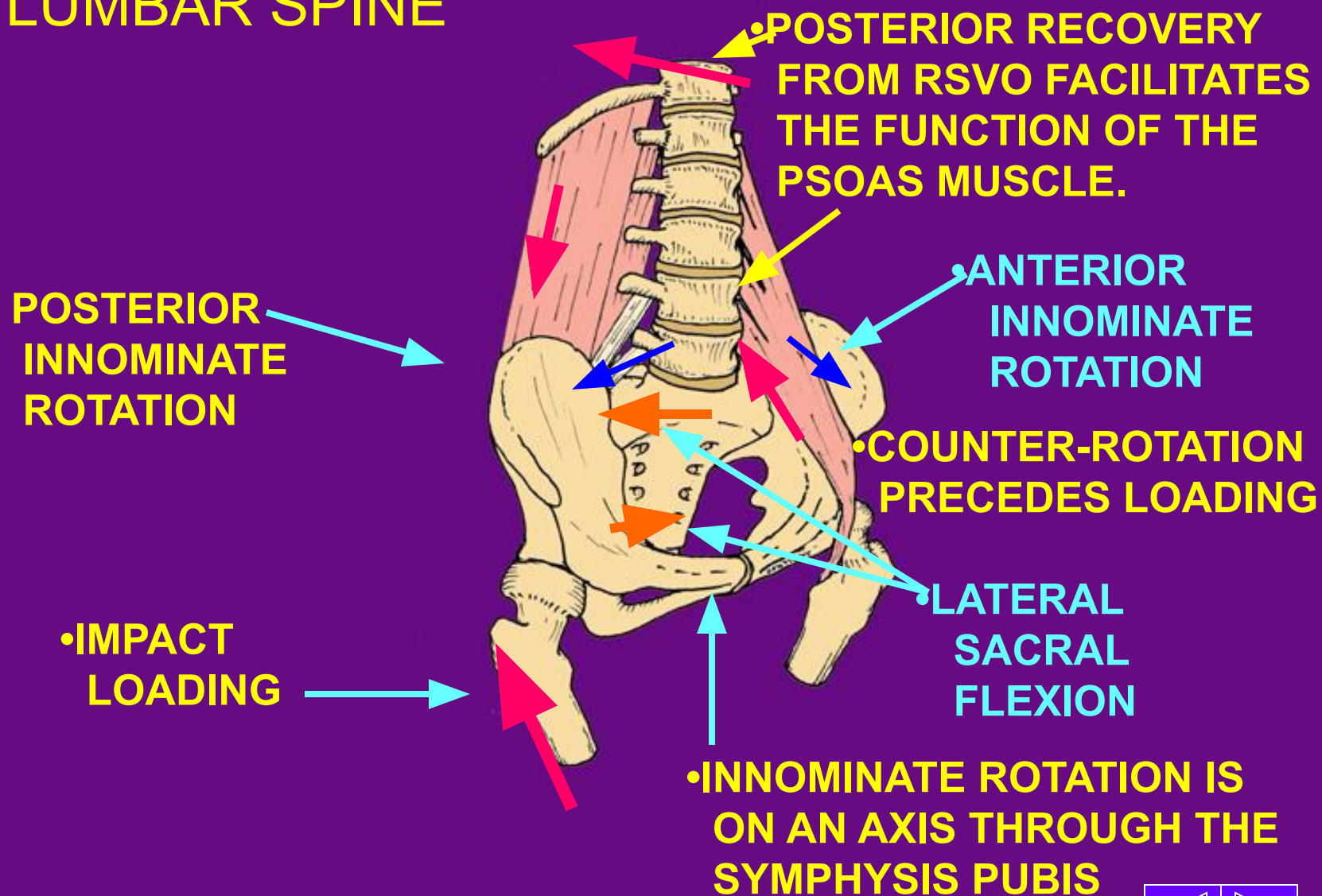
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Muscle Functions (3)

- ❖ With the posterior recovery of the trunk with RSVO, the psoas works with the iliacus to bring the trailing leg forward.
- ❖ The multifidus on the side of impact loading derotates, extends and stabilizes the lumbar spine, and is supported by the ipsilateral quadratus lumborum and probably by the ipsilateral transversus abdominis.

•STABILIZATION OF THE LUMBAR SPINE



•STABILIZATION OF THE LUMBAR SPINE

- RIGHT MULTIFIDUS
- QUADRATUS LUMBORUM
- ABDOMINAL OBLIQUE AND TRANSVERSUS

- ILIOLUMBAR LIGAMENTS
- LATERAL SACRAL FLEXION

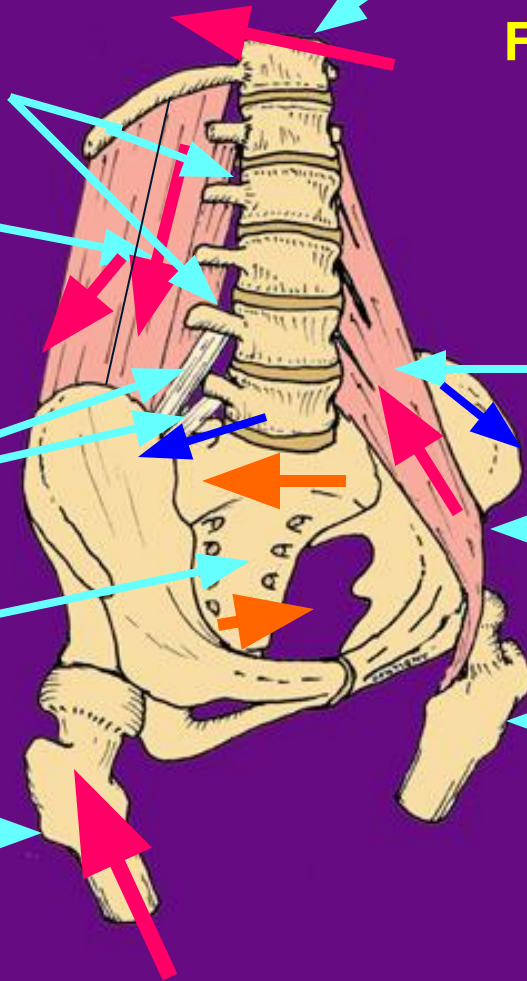
•IMPACT
LOADING

•POSTERIOR
RECOVERY
FROM RSVO

•PSOAS

•(BURSA)

•TRAILING LEG



Muscle Functions (4)

- ◆ The hamstrings have several interesting functions:
 - 1. To control the innominate and, through the sacrotuberous ligament, the sacrum when leaning forward to perform a task.
 - 2. To work with the quadriceps and pull the knee posteriorly into terminal extension during normal gait.
 - 3. To stabilize the knee in extension, while working with the quadriceps and gastrocnemius during normal gait.

Muscle Functions (5)

4. To provide lateral stability to the knee in extension
5. To pull the body forward over the side of initial contact until the leg is perpendicular during normal gait and then:
6. To work with the gluteus maximus and gastrocnemius to decelerate and ease impact loading on the contralateral side as the body 'falls forward' off of the perpendicular leg.

Muscle Functions (6)

The peroneus longus stabilizes the cuneiform and metatarsal during normal gait and provides up to 18% of the stability of the sacrotuberous ligament through the kinetic chain. (49)

Muscle Functions (7)

- ◆ The abdominal muscles provide important support for the anterior pelvis.
- ◆ The rectus abdominis supports the anterior pelvis to stabilize the lumbar spine and sacroiliac joints while leaning forward to perform some task.
- ◆ The abdominal obliques control pelvic rotation, especially during normal ambulation.
- ◆ The transversus abdominis probably provides support for the ipsilateral quadratus lumborum, the ipsilateral multifidus and the contralateral psoas during normal ambulation.

Muscle Functions (8)

- ❖ The psoas major is an important stabilizer of the lumbar spine.(62)
- ❖ Free body diagrams illustrate that the psoas contributes to forces across the sacroiliac joint.(62)

Muscle Functions (9)

- ❖ These forces include: posterior rotation of the innominate, and support to the SIJ and pubic symphysis(62)
- ❖ The psoas major links the diaphragm to the pelvic floor.(62)
- ❖ The dominant force of the bilateral psoas is axial compression.(62)

ARM SWING

- ❖ Arm swing during normal gait also serves to decrease impact loading at initial contact.
- ❖ It may be helpful to increase the posterior swing of the arm on the side of loading to decrease this loading rather than concentrating on the anterior swing.

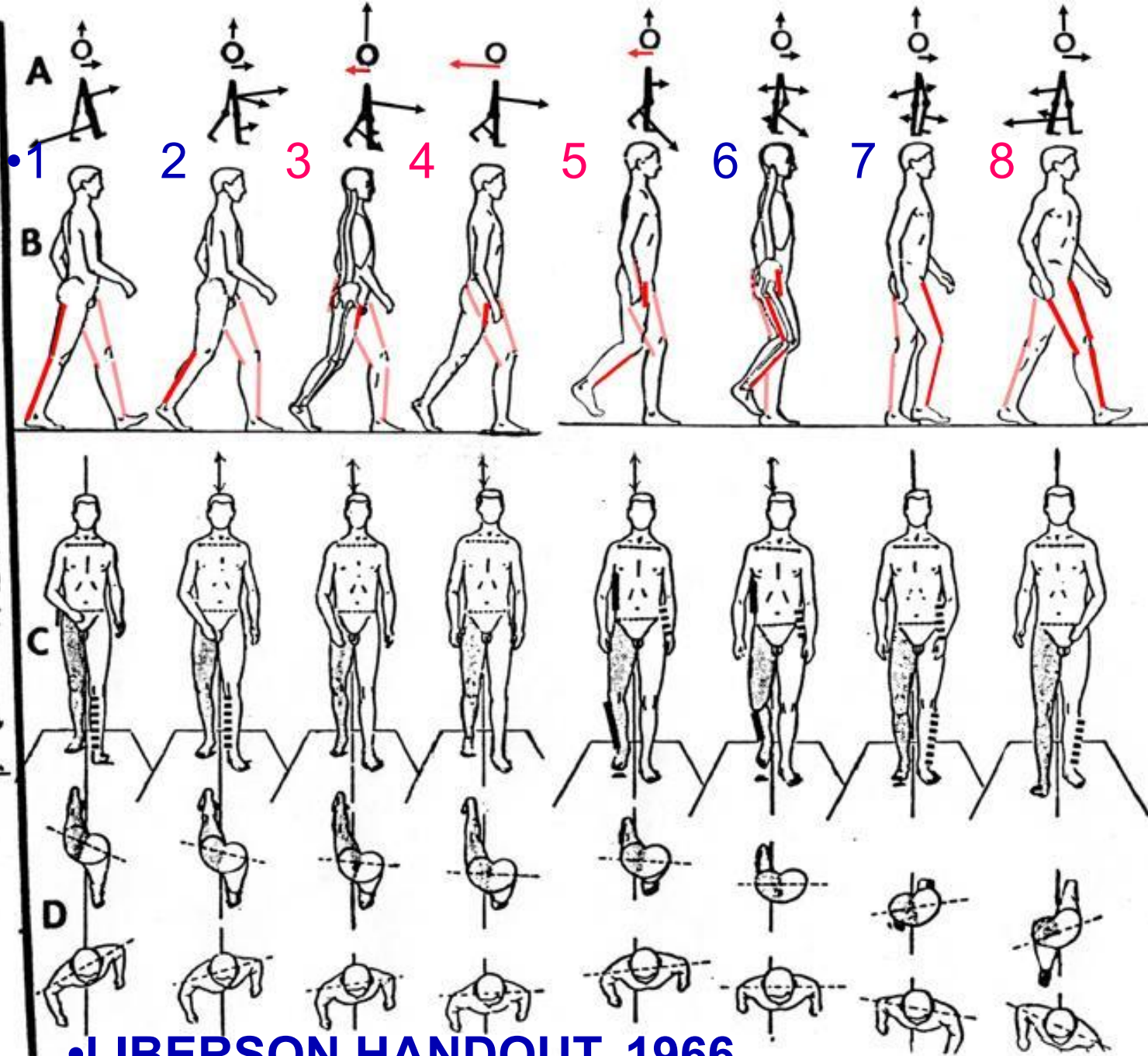
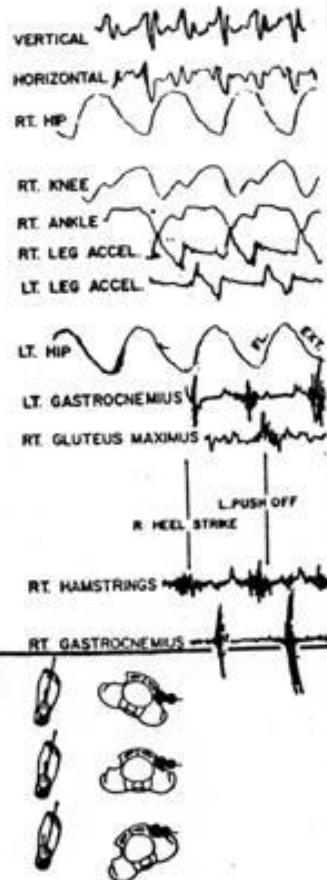
Normal Gait

- ❖ Pelvic dynamics have a profound effect on normal gait.
- ❖ In order to fully understand normal gait, it is essential to understand pelvic dynamics.
- ❖ It is also necessary to understand the sequence of normal gait, to include movement on the oblique axis of the sacroiliac joint, in order to comprehend how it can be affected by pathological changes in the pelvis.

Accelerometer Studies by Liberson et al

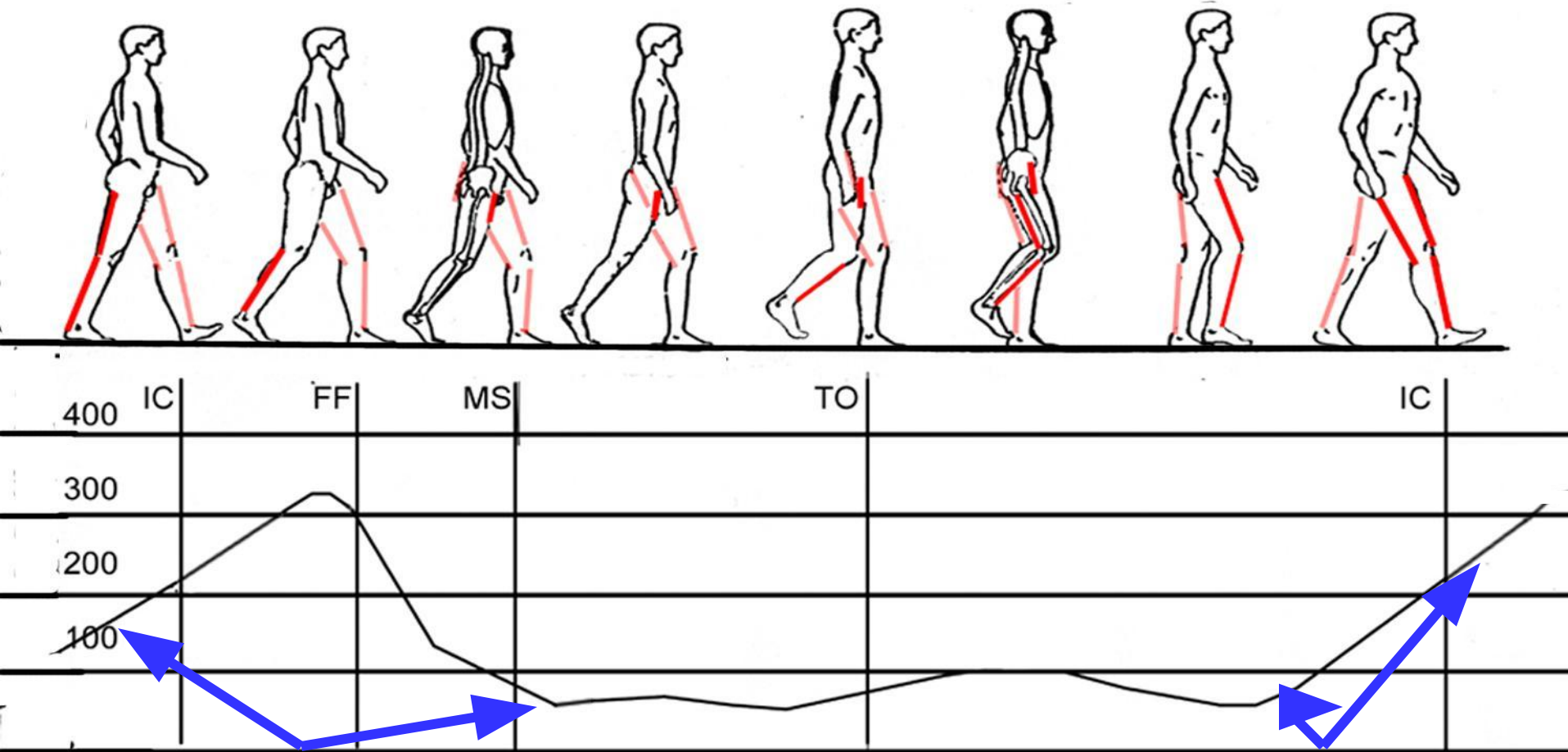
- ❖ Note figures 3,4 & 5 how the trunk moves posterior with RSVO.
- ❖ Note how this coincides with the psoas function as it picks up the trailing leg.
- ❖ Note in figure 8 how the hamstrings work with the quadriceps to extend the knee.
- ❖ An analysis of normal gait follows

COMPILED FROM
DATA OF DUCROQUET,
JOSEPH AND LIBERSON
BY
W.T. LIBERSON, M.D.
LOYOLA UNIVERSITY
AND
VAH, HINES, ILL.



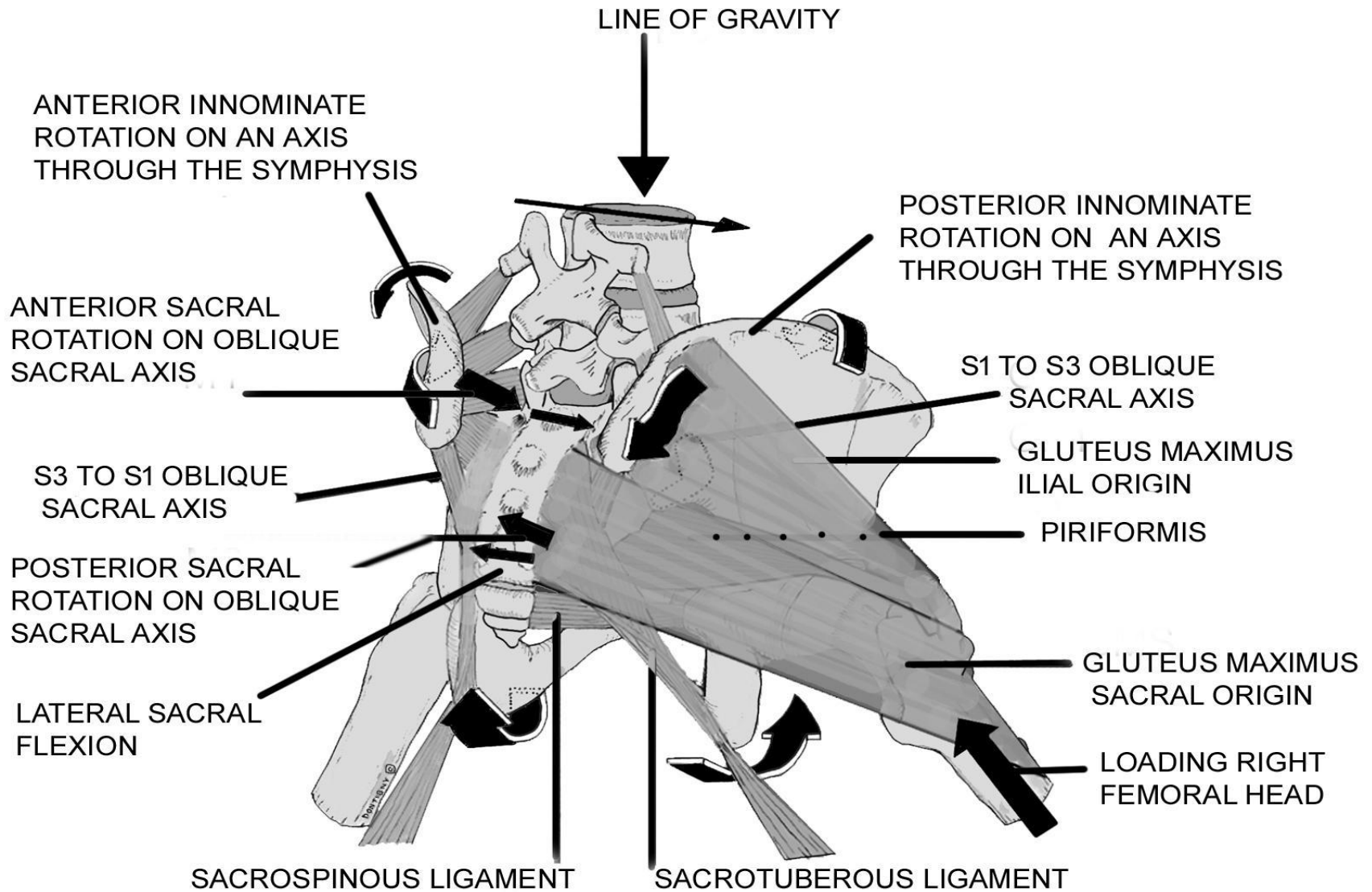
•LIBERSON HANDOUT, 1966

•FUNCTIONS OF THE GLUTEUS MAXIMUS



•LEFT SACRAL ORIGIN HELPS STRAIGHTEN LATERAL SACRAL FLEXION AND PULLS BODY FORWARD TO PELVIC SYMMETRY.

LEFT ILIAL ORIGIN DECELERATES RIGHT (CONTRA LATERAL) LEG. TO DECREASE LOADING FORCE ON THE RIGHT FEMORAL HEAD.



Sequence of Normal Gait

- ❖ In the following sequence the various muscle functions will be described as they act with the sacroiliac joint during lateral sacral flexion and rhythmic sacrocranial vertebral oscillation.
- ❖ Everything functions essentially to ease impact loading and to preserve the systems.

•NORMAL GAIT

- INITIAL DOUBLE SUPPORT
- OBLIQUE FORCE COUPLE
- ASYMMETRIC PELVIS
- OBLIQUE AXIS

•SACRUM FLEXES
LATERALLY

•HAMSTRINGS AND
GASTROCNEMIUS
STABILIZE THE KNEE
AND DECELERATE
THE CONTRA
LATERAL SIDE.

•PERONEUS LONGUS
STABILIZES
CUNEIFORM AND
FIRST METATARSAL

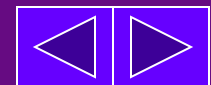
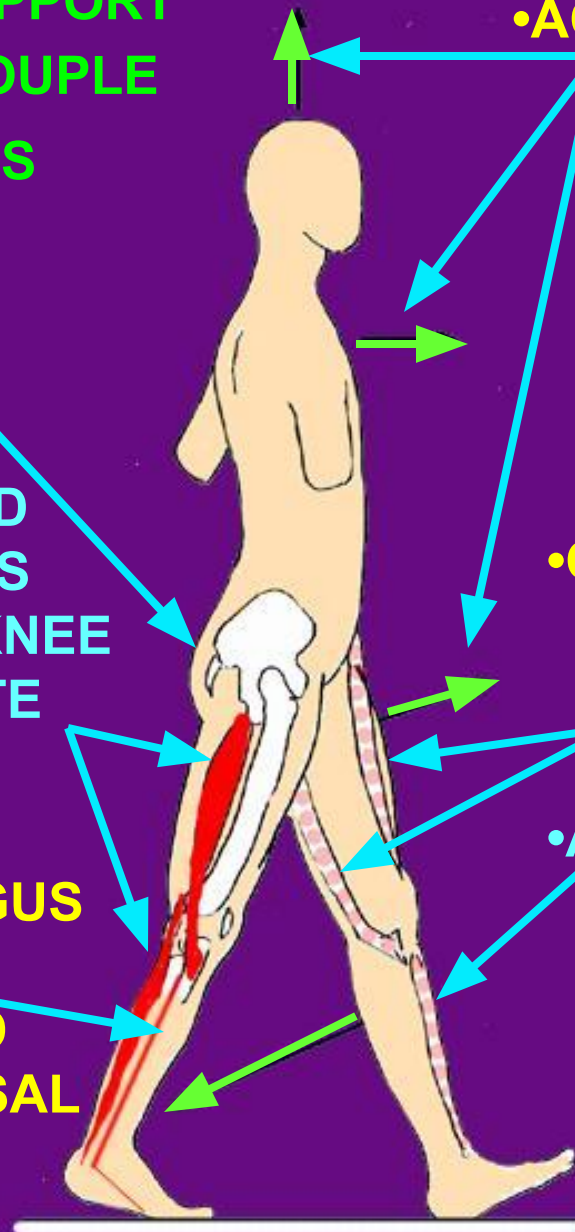
•DONTIGNY ©

•ACCELEROMETER
VECTORS

•TRUNK IS COUNTER
ROTATED AND MOVING
ANTERIORLY

•QUADRICEPS AND
HAMSTRINGS EXTEND AND
STABILIZE THE KNEE

•ANTERIOR TIBIALIS
DECELERATES THE FOOT



•NORMAL GAIT

•2

•WEIGHT LOADING LEFT

•TRUNK IS
DECELERATING

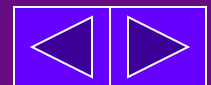
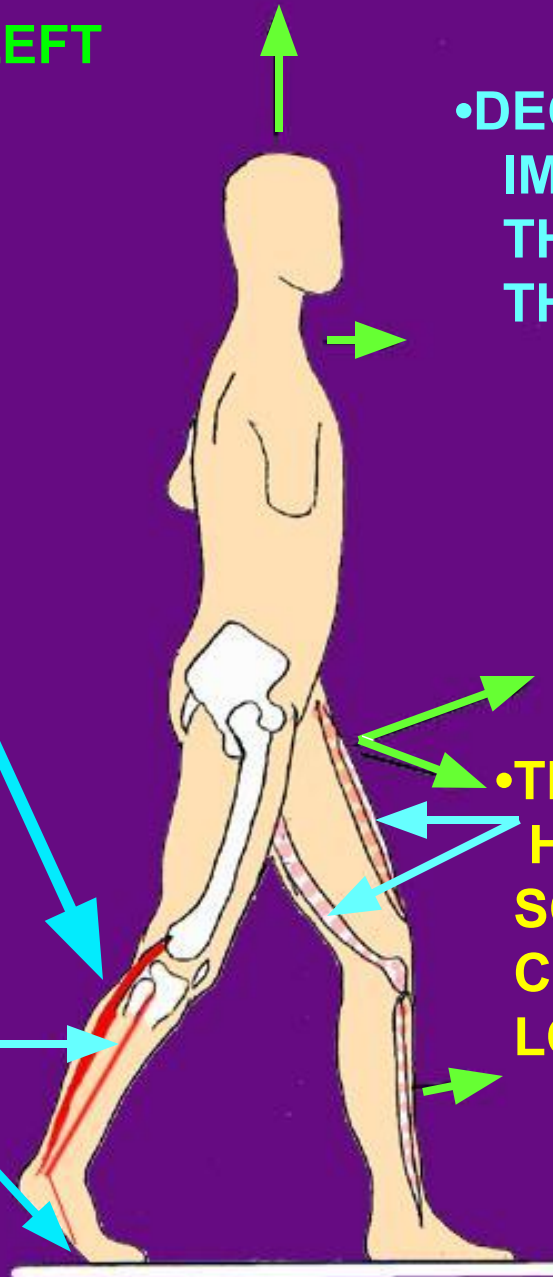
•DECELERATION FORCE OF
IMPACT LOADING SLOWS
THE ANTERIOR MOTION OF
THE UPPER BODY

•GASTROCNEMIUS
IS DECELERATING
THE CONTRA
LATERAL SIDE

•PERONEUS IS
STABILIZING THE
CUNEIFORM AND
METATARSAL

•THE QUADRICEPS AND
HAMSTRINGS ALLOW
SOME KNEE FLEXION TO
CUSHION IMPACT
LOADING

•DONTIGNY ©



•NORMAL GAIT

•3

•TRUNK REVERSAL

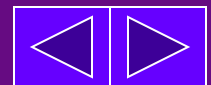
•THE POSTERIOR MOVEMENT OF THE UPPER BODY WITH REVERSAL OF ASYMMETRY FACILITATES THE HIP FLEXORS IN THE FORWARD PROPULSION OF THE TRAILING LEG.

•THE SACRAL ORIGIN OF THE LEFT GLUTEUS MAXIMUS WORKS WITH THE LEFT PIRIFORMIS TO CONTROL SACRAL OSCILLATION AND PULL THE BODY FORWARD .

•DONTIGNY ©

•THE IPSILATERAL INNOMINATE ON THE SIDE OF WEIGHT LOADING DECELERATES ALTHOUGH THE CONTRA-LATERAL INNOMINATE CONTINUES ANTERIORLY IN THE HORIZONTAL PLANE.

•HAMSTRINGS ALSO PULL THE BODY FORWARD UNTIL THE LEG IS PERPENDICULAR. (SEEM TO BE AIDED BY THE HIP ADDUCTORS)



•NORMAL GAIT (TERMINAL DOUBLE SUPPORT) •4

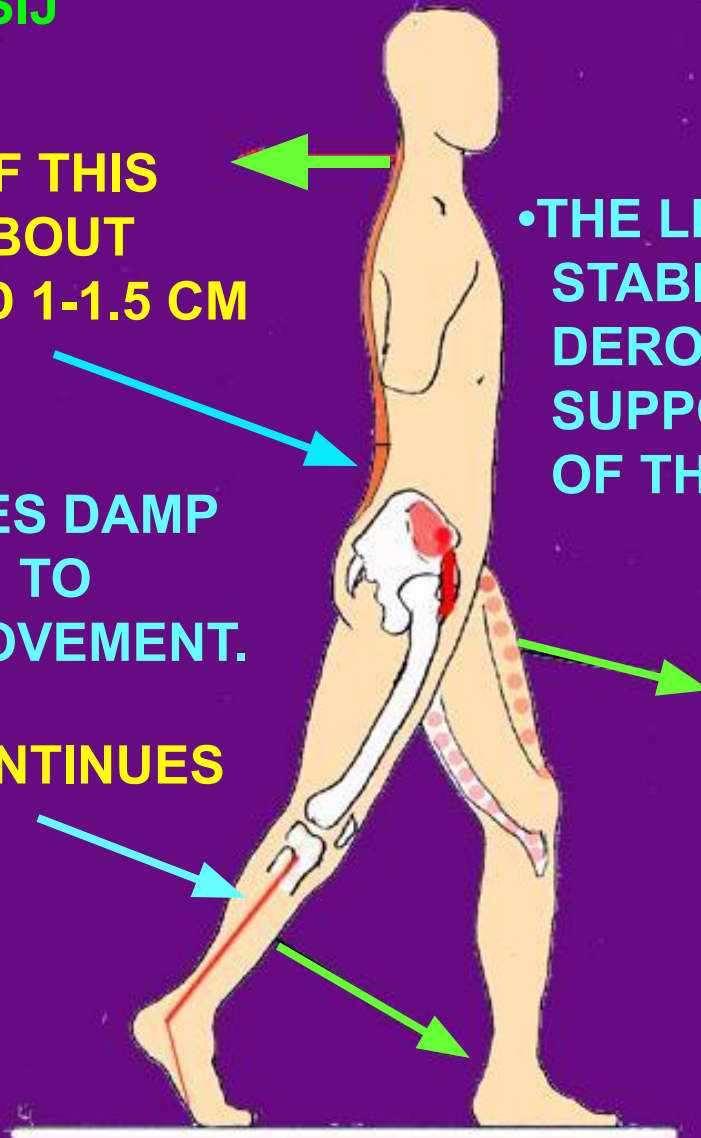
- RHYTHMIC SACROCRANIAL VERTEBRAL OSCILLATION
- OBLIQUE AXIS OF SIJ

- THE EXCURSION OF THIS OSCILLATION IS ABOUT 2-2.5 CM AT L3 AND 1-1.5 CM AT C7.(9)

- THE SPINAL CURVES DAMP THIS OSCILLATION TO MINIMIZE HEAD MOVEMENT.

- DECELERATION CONTINUES UNTIL TOE-OFF TO MINIMIZE CONTRA-LATERAL LOADING IMPULSE

•DONTIGNY ©



- THE LEFT MULTIFIDUS STABILIZES AND DEROTATES THE SPINE TO SUPPORT THE FUNCTION OF THE RIGHT PSOAS.



•NORMAL GAIT

•5

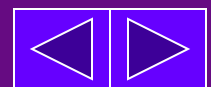
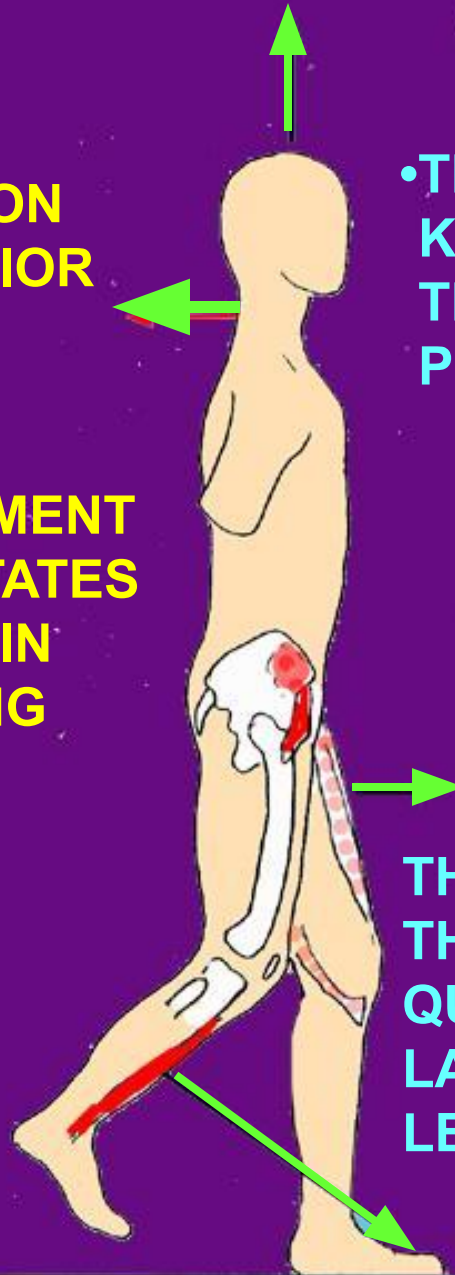
•SINGLE SUPPORT

•AFTER TOE-OFF, TENSION STORED IN THE ANTERIOR FASCIA OF THE LEG IS RELEASED.

•THE POSTERIOR MOVEMENT OF THE TRUNK FACILITATES THE RIGHT ILIOPSOAS IN BRINGING THE TRAILING LEG FORWARD.

•THE CONDYLES OF THE KNEE FACILITATE STRAIGHT TRACKING IN THE SWING PHASE.

THE CO-CONTRACTION OF THE HAMSTRINGS WITH THE QUADRICEPS PROVIDES LATERAL STABILITY TO THE LEFT KNEE.



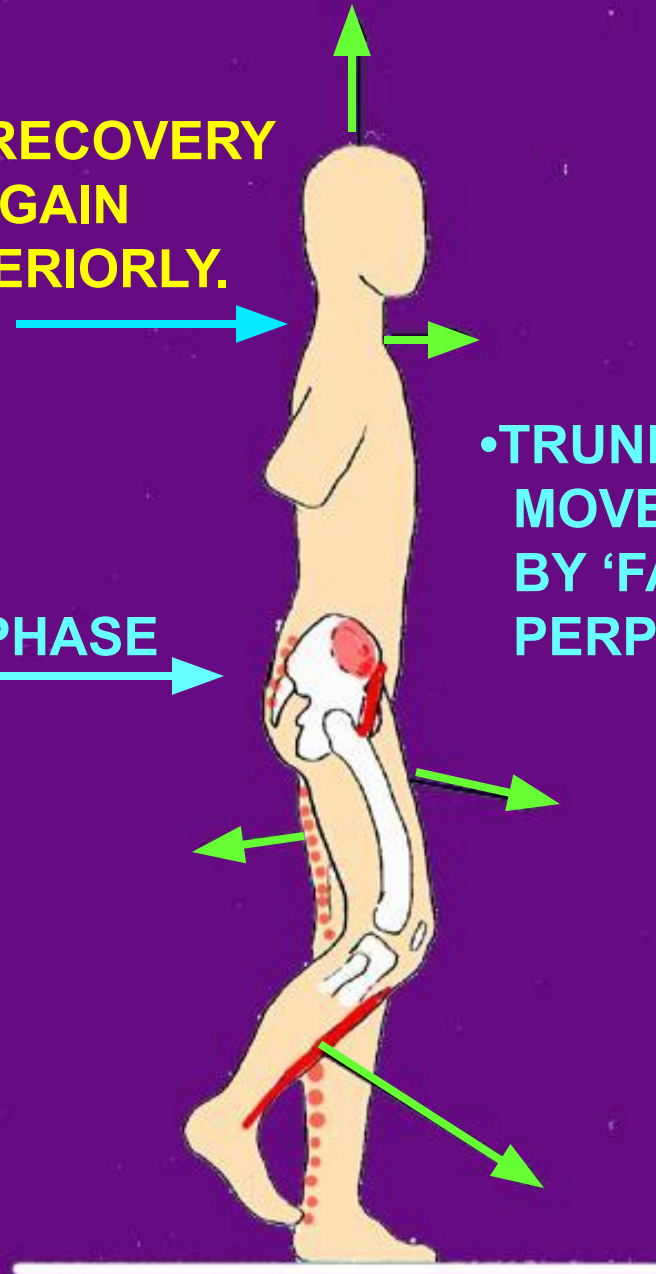
•NORMAL GAIT

•6

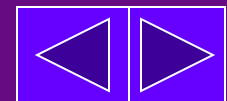
•AFTER POSTERIOR RECOVERY OF THE TRUNK, IT AGAIN ACCELERATES ANTERIORLY.

•PELVIS IS AGAIN SYMMETRICAL AT SINGLE SUPPORT PHASE

•TRUNK CONTINUES TO MOVE FORWARD NOW BY 'FALLING' OFF OF THE PERPENDICULAR LEG.



•DONTIGNY ©



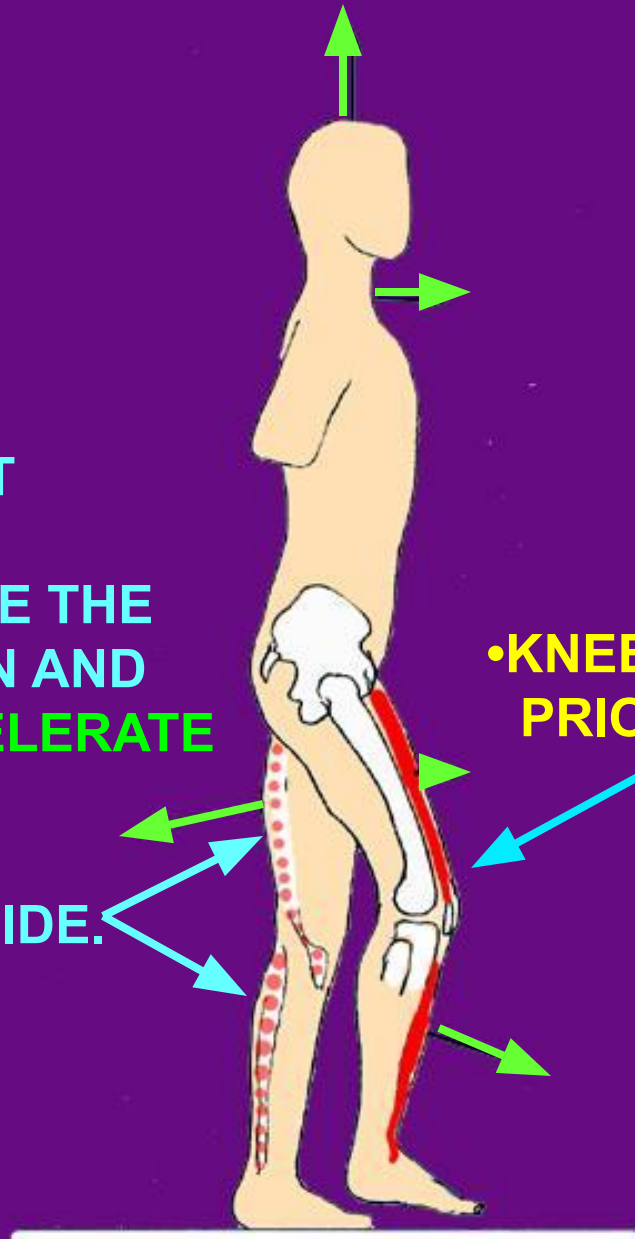
•NORMAL GAIT

•7

•SINGLE SUPPORT

•THE LEFT GLUTEUS MAXIMUS, THE LEFT HAMSTRINGS AND GASTROCNEMIUS STABILIZE THE KNEE IN EXTENSION AND FUNCTION TO **DECELERATE** AND EASE IMPACT LOADING ON THE CONTRALATERAL SIDE.

•KNEE BEGINS TO EXTEND PRIOR TO INITIAL CONTACT.



•DONTIGNY ©



•NORMAL GAIT

•8

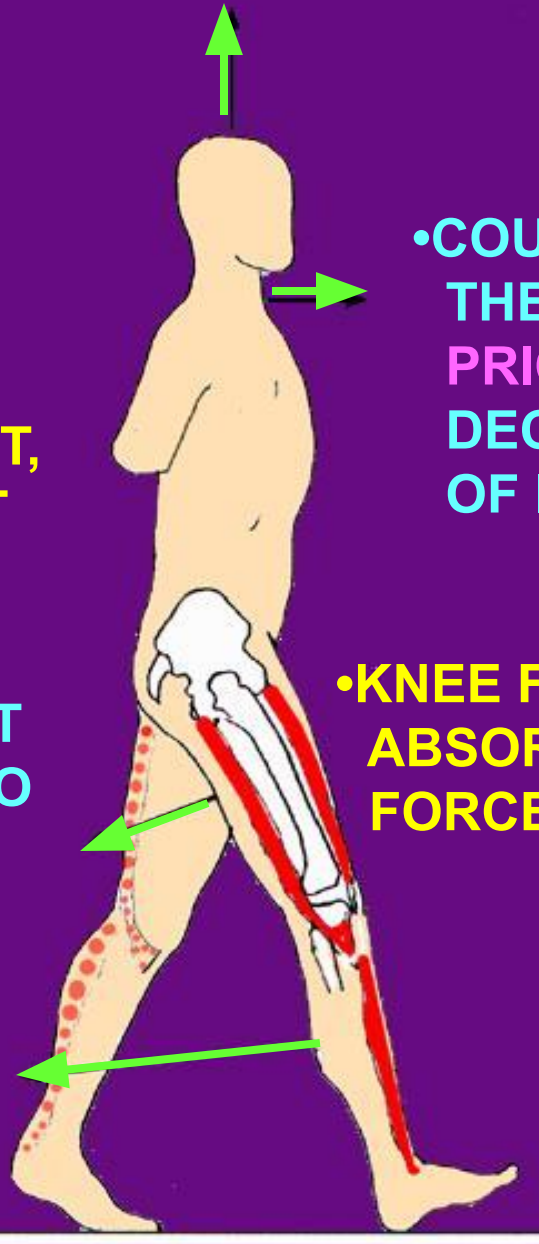
- ASYMMETRIC PELVIS
- INITIAL DOUBLE SUPPORT

•PSIS LOWER ON RIGHT, HIGHER ON THE LEFT

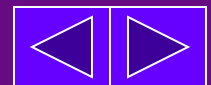
•SACRUM LATERALLY FLEXED TO THE RIGHT DRIVING ROTATION TO THE RIGHT.

•COUNTER- ROTATION OF THE TRUNK OCCURS PRIOR TO IMPACT AND DECREASES THE FORCE OF IMPACT LOADING

•KNEE FLEXES SLIGHTLY TO ABSORB DECELERATION FORCE OF IMPACT LOADING



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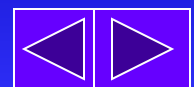


SPECIAL NOTE

THIS IS NOT A PUSH-OFF OF THE TRAILING LEG!!

THE TRAILING LEG IS DECELERATING THE LEADING LEG TO EASE THE LOADING FORCES ON THE CONTRALATERAL SIDE.

NOTE ALSO THAT THE COUNTER ROTATION ON THE RIGHT, DRIVEN BY THE SACROILIAC JOINT, ALSO DECREASES LOADING FORCES ON THE FEMORAL HEAD

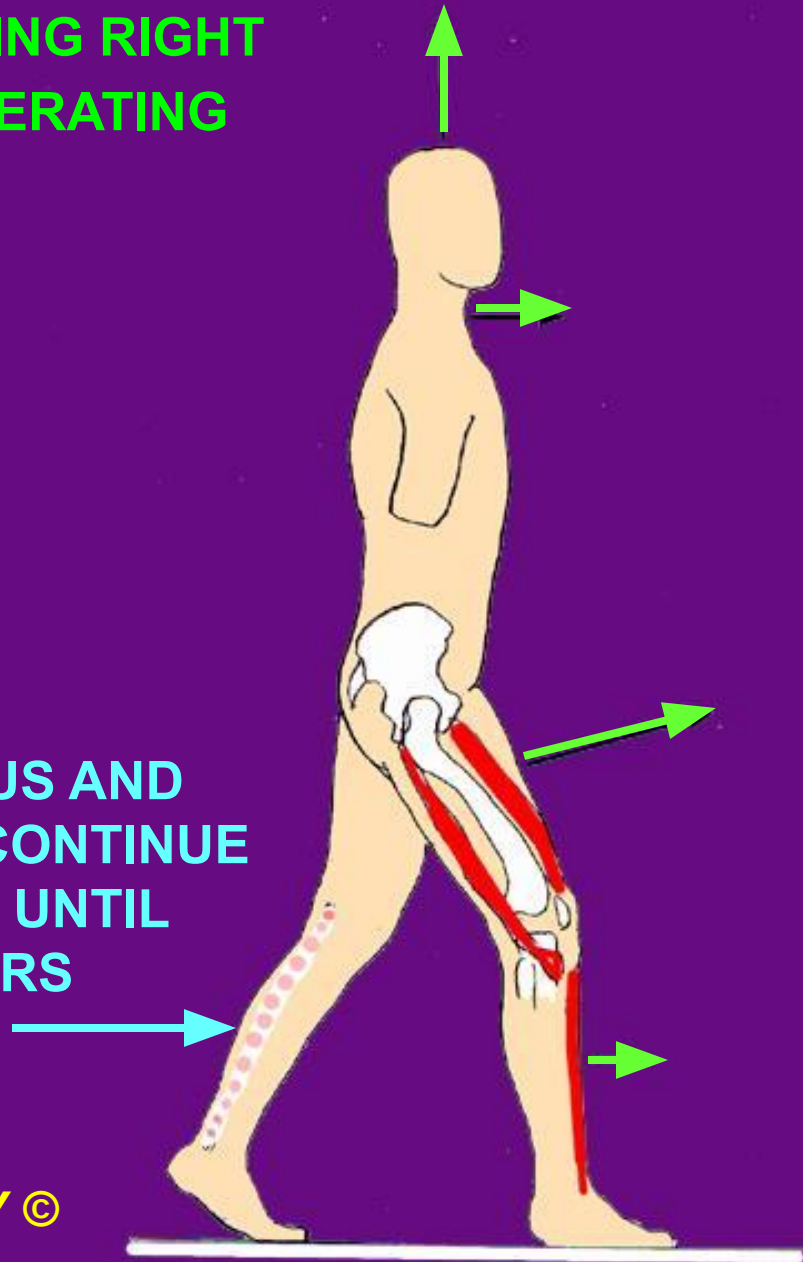


•NORMAL GAIT

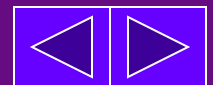
•9

- WEIGHT LOADING RIGHT
- TRUNK DECELERATING

- GASTROCNEMIUS AND TOE FLEXORS CONTINUE DECELERATION UNTIL LOADING OCCURS



•DONTIGNY ©



•NORMAL GAIT

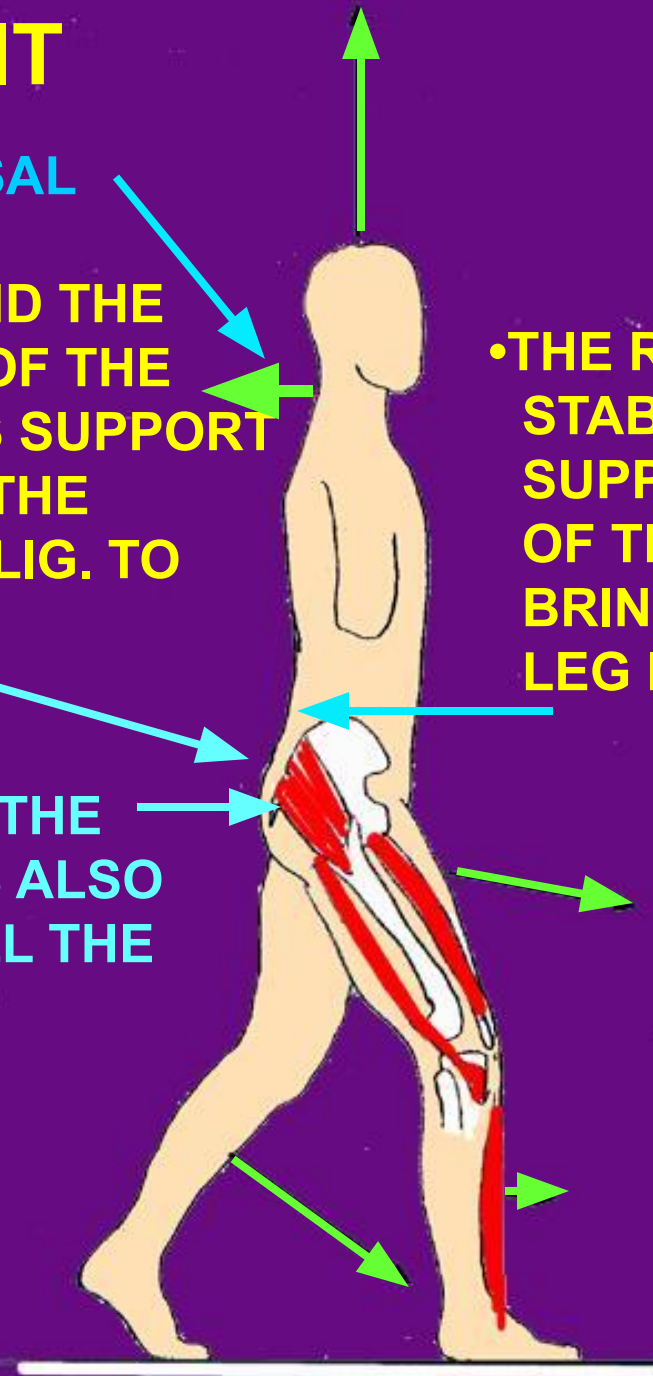
•10

• TRUNK REVERSAL

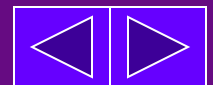
•THE PIRIFORMIS AND THE SACRAL PORTION OF THE GLUTEUS MAXIMUS SUPPORT THE FUNCTION OF THE SACROTUBEROUS LIG. TO CONTROL SACRAL OSCILLATION.

•SACRAL ORIGIN OF THE GLUTEUS MAXIMUS ALSO FUNCTIONS TO PULL THE BODY FORWARD UNTIL THE LEG IS PERPENDICULAR

•THE RIGHT MULTIFIDUS STABILIZES THE SPINE TO SUPPORT THE FUNCTION OF THE LEFT PSOAS AS IT BRINGS THE TRAILING LEG FORWARD.



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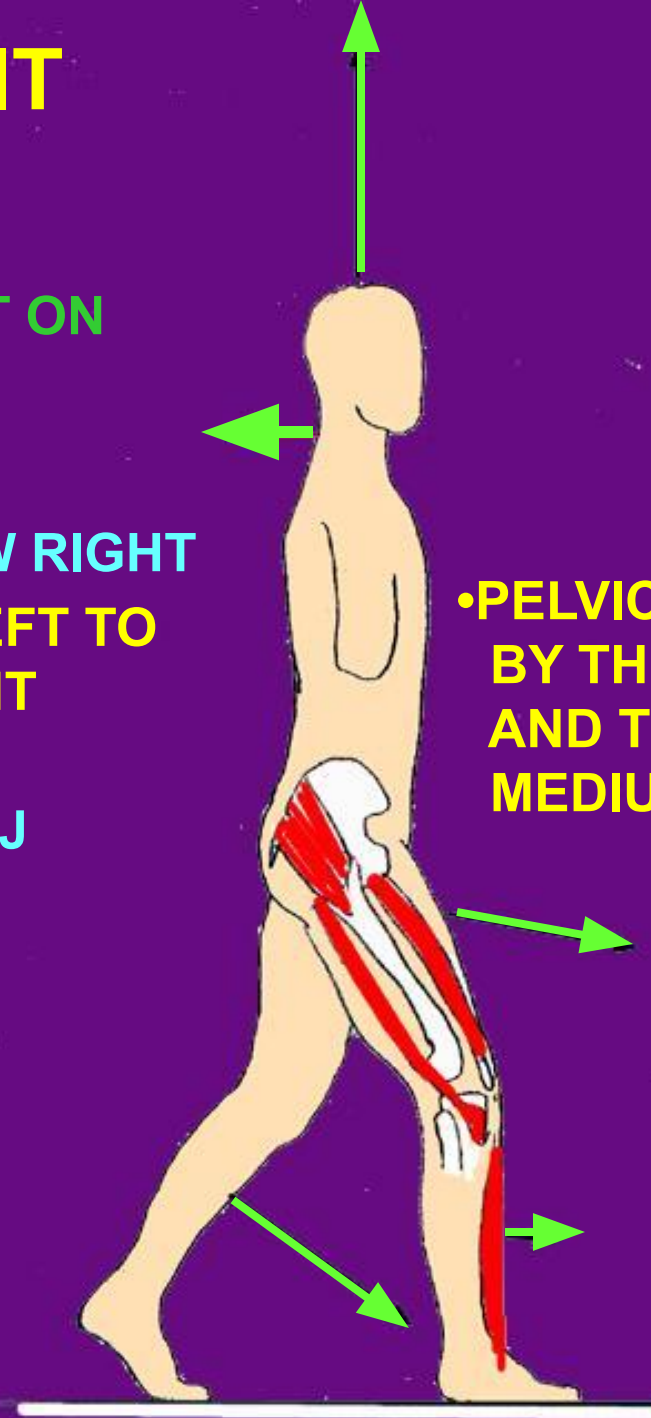
•NORMAL GAIT

•11

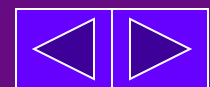
- TERMINAL DOUBLE SUPPORT
- SACRAL MOVEMENT ON AN OBLIQUE AXIS

- HIGH PSIS LEFT, LOW RIGHT
- AXIS FROM S3 SIJ LEFT TO S1 SIJ ON THE RIGHT
- OBLIQUE SACRAL MOVEMENT AT S1 SIJ LEFT AND AT S3 SIJ ON THE RIGHT

- PELVIC STABILIZATION BY THE GLUTEUS MAXIMUS AND THE GLUTEUS MEDIUS



•DONTIGNY ©



•NORMAL GAIT

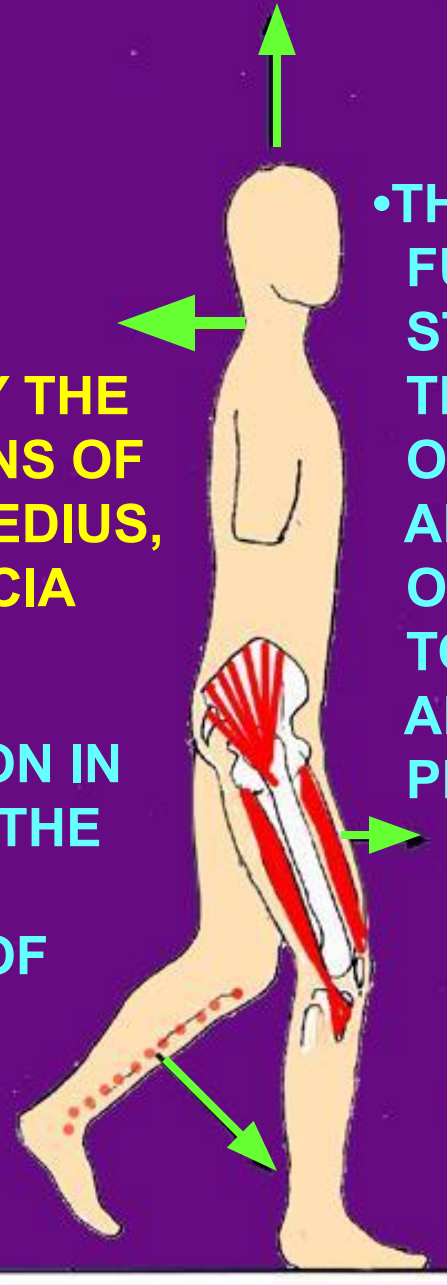
•12

•SINGLE SUPPORT

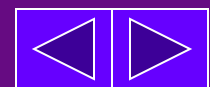
- PELVIC STABILIZATION IS BY THE SEQUENTIAL CONTRACTIONS OF THE GLUTEUS MAXIMUS, MEDIUS, MINIMUS AND TENSOR FASCIA LATA

- TOE OFF RELEASES TENSION IN THE ANTERIOR FASCIA OF THE TRAILING LEG, WHICH FACILITATES THE ACTION OF THE LEFT ILIOPSOAS AND RSVO

•DONTIGNY ©



- THE TIBIAL CONDYLES FUNCTION TO PROVIDE STRAIGHT TRACKING OF THE KNEE ON THE SIDE OF SWING-THROUGH AND PROTECTS THE OTHER KNEE FROM TORSION DURING THE ANTERIOR HORIZONTAL PELVIC SWING PHASE.



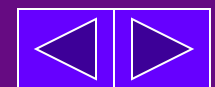
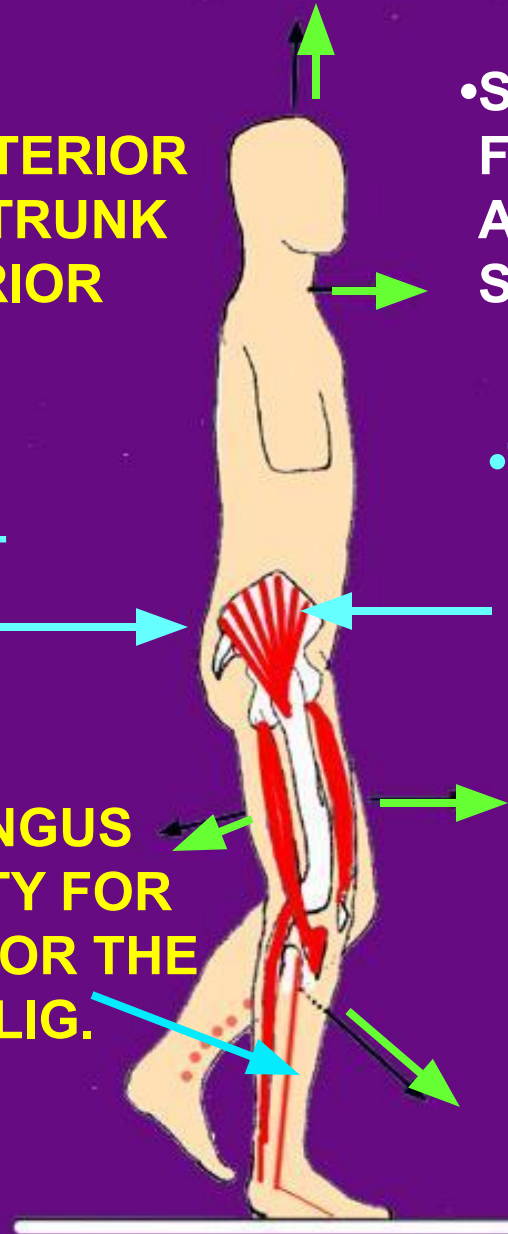
•NORMAL GAIT

•13

•SINGLE SUPPORT

- FOLLOWING POSTERIOR RECOVERY THE TRUNK RESUMES ANTERIOR ACCELERATION
- PELVIS IS AGAIN SYMMETRICAL AT MID-STEP →
- THE PERONEUS LONGUS PROVIDES STABILITY FOR THE HALLUX AND FOR THE SACROTUBEROUS LIG. ↘

- SACRAL OBLIQUE AXIS AND FORCE COUPLES REVERSE AT TRANSIENT PELVIC SYMMETRY.
- THE GLUTEUS MAXIMUS, MEDIUS AND MINIMUS AND THE TENSOR FASCIA LATA STABILIZE THE PELVIS.



•NORMAL GAIT

•14

•SINGLE SUPPORT

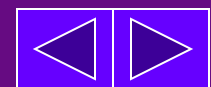
•ILIAC ORIGIN OF THE RIGHT GLUTEUS MAXIMUS CONTROLS LEFT ANTERIOR PELVIC SWING TO DECELERATE TO DECREASE IMPACT LOADING ON LEFT FEMORAL HEAD.

•HAMSTRINGS AND GASTROC STABILIZE KNEE AND DECELERATE.

•DONTIGNY ©

•THE PERONEUS LONGUS PROVIDES UP TO 18% OF THE STABILITY TO THE SACROTUBEROUS LIGAMENT

•LEFT KNEE EXTENDS PRIOR TO INITIAL CONTACT.



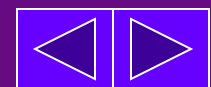
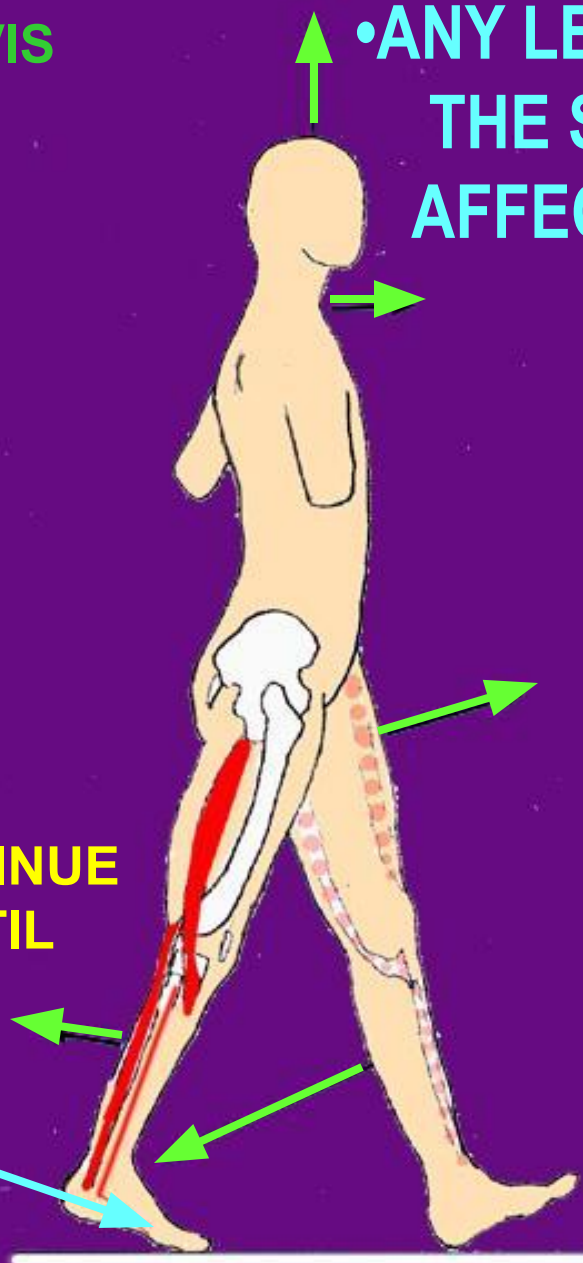
•NORMAL GAIT

- ASYMMETRIC PELVIS
- OBLIQUE AXIS
- OBLIQUE FORCE COUPLE
- INITIAL DOUBLE SUPPORT

•ANY LESION THAT AFFECTS THE SACROILIAC JOINTS AFFECTS NORMAL GAIT!!!

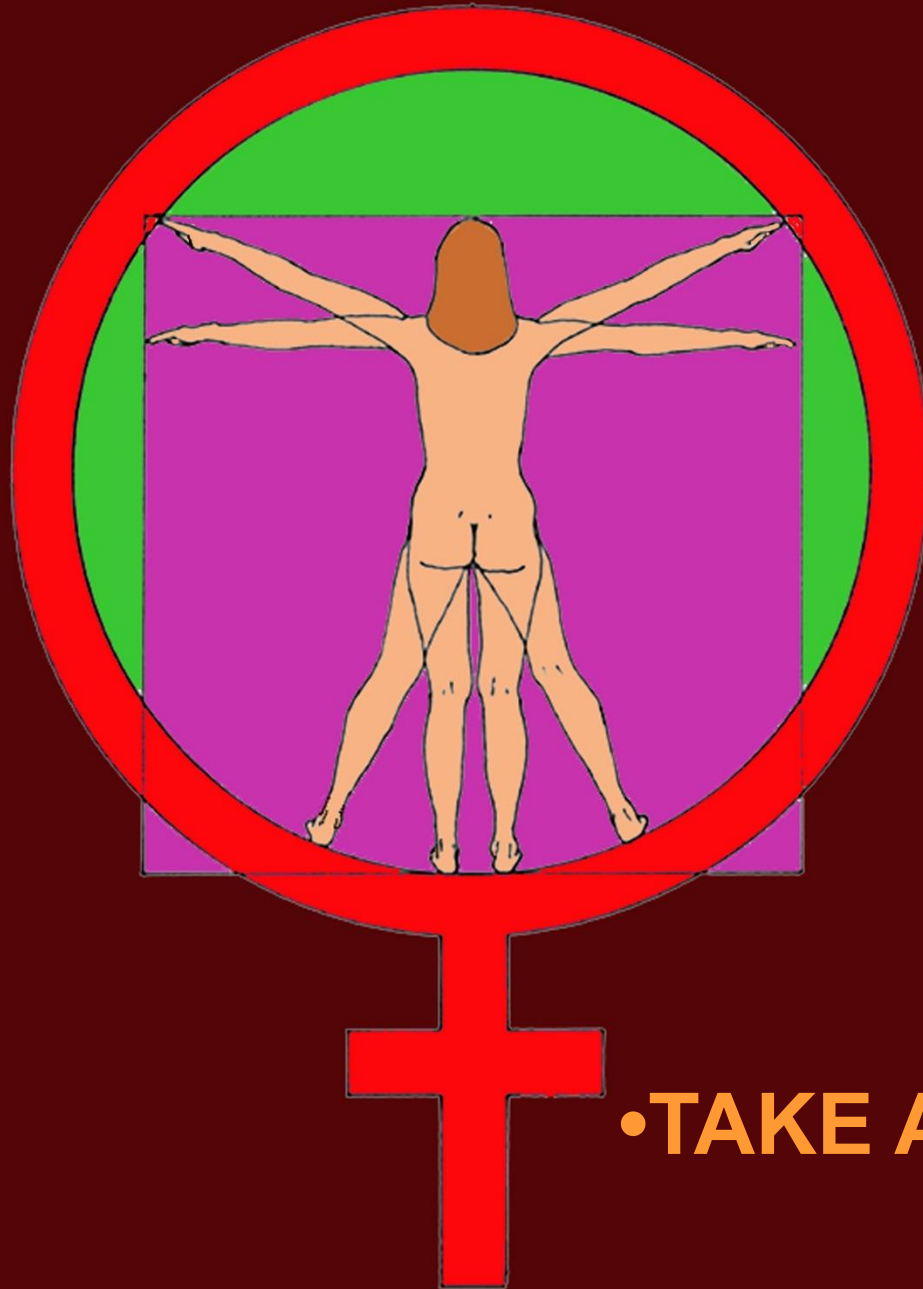
•TOE FLEXORS CONTINUE DECELERATION UNTIL CONTRALATERAL IMPACT

•DONTIGNY ©

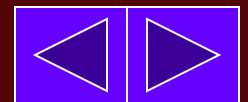


Walking Erect

- ❖ Man has evolved over hundreds of thousands of years to stand and walk erect efficiently.
- ❖ Walking erect and standing erect have no relationship to the onset of common low back pain.

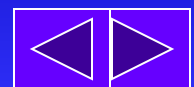


•TAKE A BREAK



Pathomechanics

The Principal Precipitating Factors of The Subluxation of The Sacral Axis at S3



Pathomechanics

- ❖ Onset, insidious and rapid
- ❖ Compensation posture
- ❖ Role of the abdominal muscles
- ❖ Failure of the force couple
- ❖ Sequence of onset of pathology
- ❖ Effects of onset
- ❖ Associated symptoms

Pathomechanics Objectives

- ❖ You will study how a failure of the force couple will cause a pathological release of the dynamic ligamentous balance resulting in a subluxation, diastasis or loosening at the S3 sacral X axis of the sacroiliac joint.
- ❖ You will analyze how this can cause a broad range of detrimental effects on nearly all of the tissues and structures in and around the pelvis.

Pathomechanics of SIJD

- ❖ Loss of ligamentous balance and its associated force couple will cause a loss of the force dependent axis of rotation of the SIJ.
- ❖ This may cause a slow or a sudden pathological release from the balanced position forcing the innominate bones to rotate anteriorly on the sacrum on an acetabular axis.
- ❖ Subluxation of the innominate bones on the sacrum occurs at the S3 sacral x axis of the sacroiliac joints. (81)

An Anterior Shift in the Line of Gravity Can Cause Dysfunction

- ❖ When you lean forward to perform any task your line of gravity moves anteriorly to the acetabula.
- ❖ The anterior aspect of the innominate then tends to rotate down and the posterior aspect tends to rotate up on the sacrum on an acetabular axis.

An Anterior Shift in the Line of Gravity Can Cause Dysfunction

- ❖ This anterior innominate rotation tends to decrease tension to the resting level of the sacrotuberous ligament causing a pathological loss of the ligamentous balance, a loss of the force couple, a loss of stability and a pathological vertical shift of the sacral X axis on ilial S3 resulting in a subluxation of that X axis with multiple consequences.

Biotensegrity

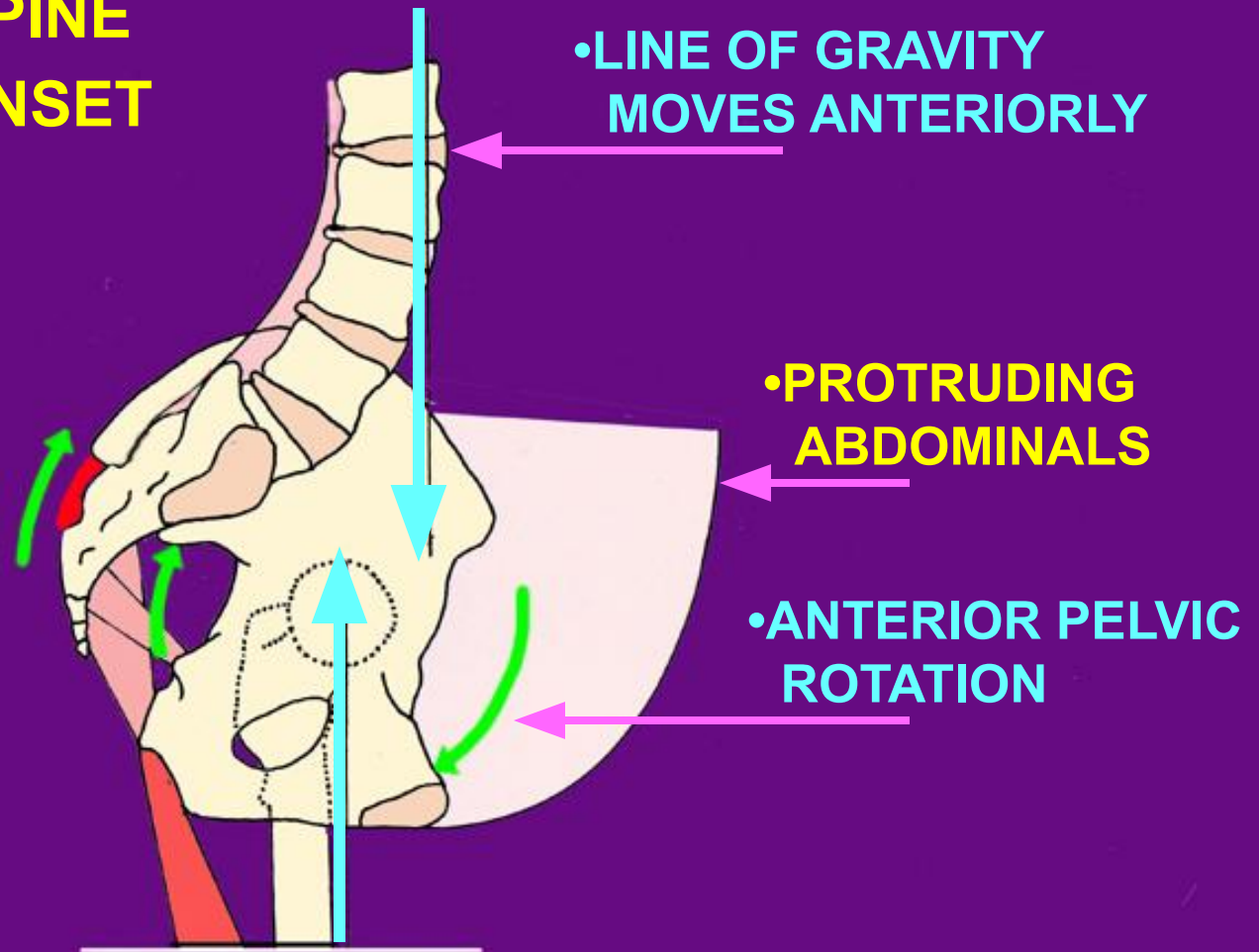
- ❖ With dysfunction weight loading is symmetrical and balanced and high on both sides. As the line of gravity moves anterior to the acetabula the pelvis rotates downward anteriorly and upward posteriorly decreasing loading to the iliolumbar ligaments and increasing loading to the posterior interosseous ligaments and the long posterior ligaments, while the sacrotuberous ligament tension reduces to the high resting level.
- ❖ The force couple still functions, but on a pathological axis.

Insidious or Rapid Onset

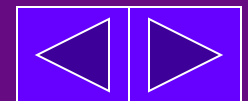
- ❖ An insidious onset of SIJD may result from excess weight being deposited on the anterior pelvis in people who are overweight or in women during pregnancy, or even just working over a counter with the trunk weight anterior to the acetabula.
- ❖ This can result in a slow onset of low back pain.

•OVERWEIGHT POSTURE (1)

- LORDOTIC SPINE
- INSIDIOUS ONSET



•SLOW POSTURAL CHANGES



•OVERWEIGHT POSTURE (1)

•LORDOTIC SPINE

•POSITIONAL INHIBITION
OF ERECTOR SPINAE

•COLLAGEN FAILURE IN
LONG POSTERIOR
SACROILIAC
LIGAMENT

•DECREASED
TENSION ON
ST AND SS LIGS.

•INCREASED
TENSION ON
HAMSTRINGS

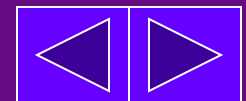
•LINE OF GRAVITY
MOVES ANTERIORLY

•PROTRUDING
ABDOMINALS

•ANTERIOR PELVIC
ROTATION

•LIGAMENTOUS BALANCE IS DECREASED

•DONTIGNY ©

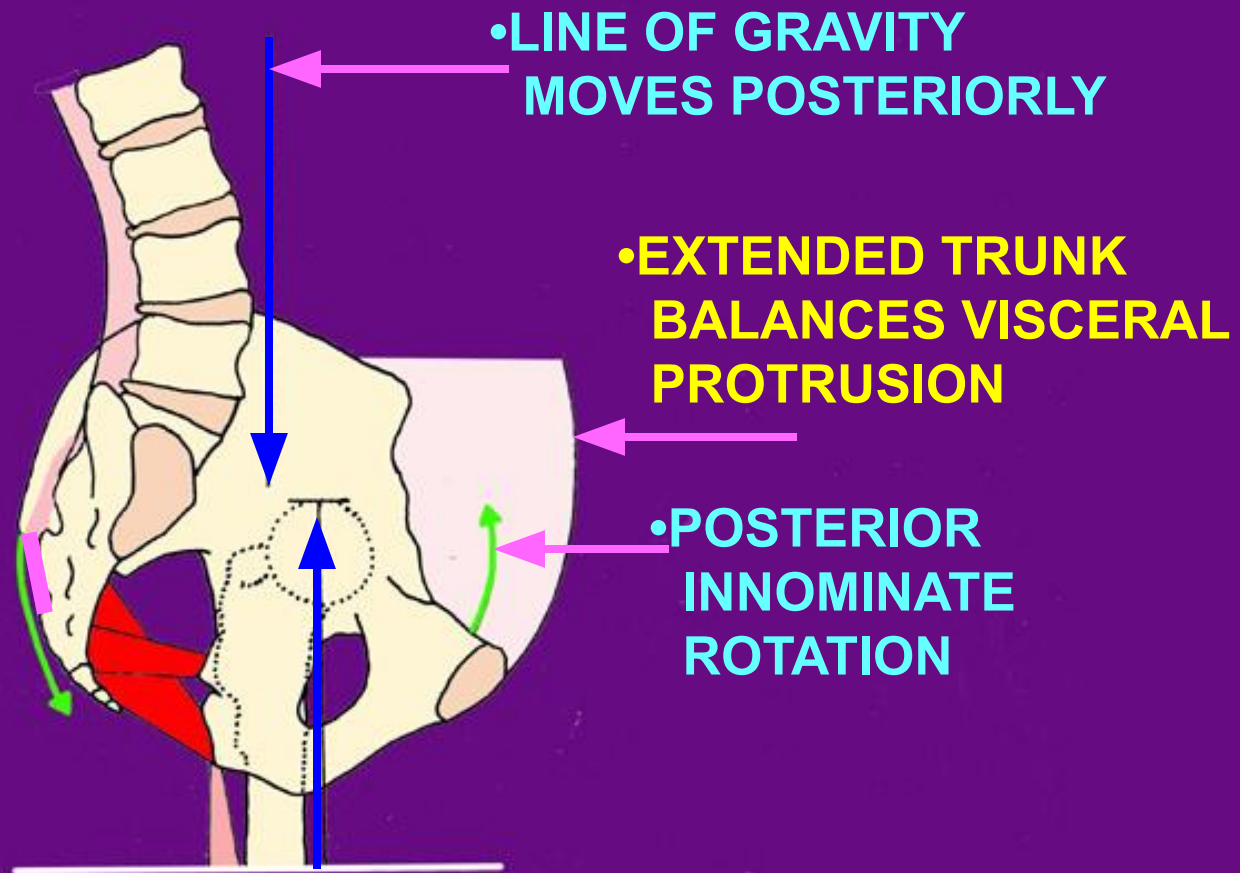


Compensation Posture

- ❖ The insidious onset may be postponed by adopting a compensatory posture.
- ❖ Some overweight patients will extend the spine to counterbalance the weight on the front of the pelvis.
- ❖ This shifts the line of gravity posterior to the acetabula causing a posterior innominate rotation and an increase in dynamic ligamentous balance with no assistance from the abdominal muscles.

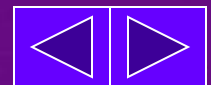
•OVERWEIGHT POSTURE (2)

•COMPENSATION POSTURE IN EXTENSION



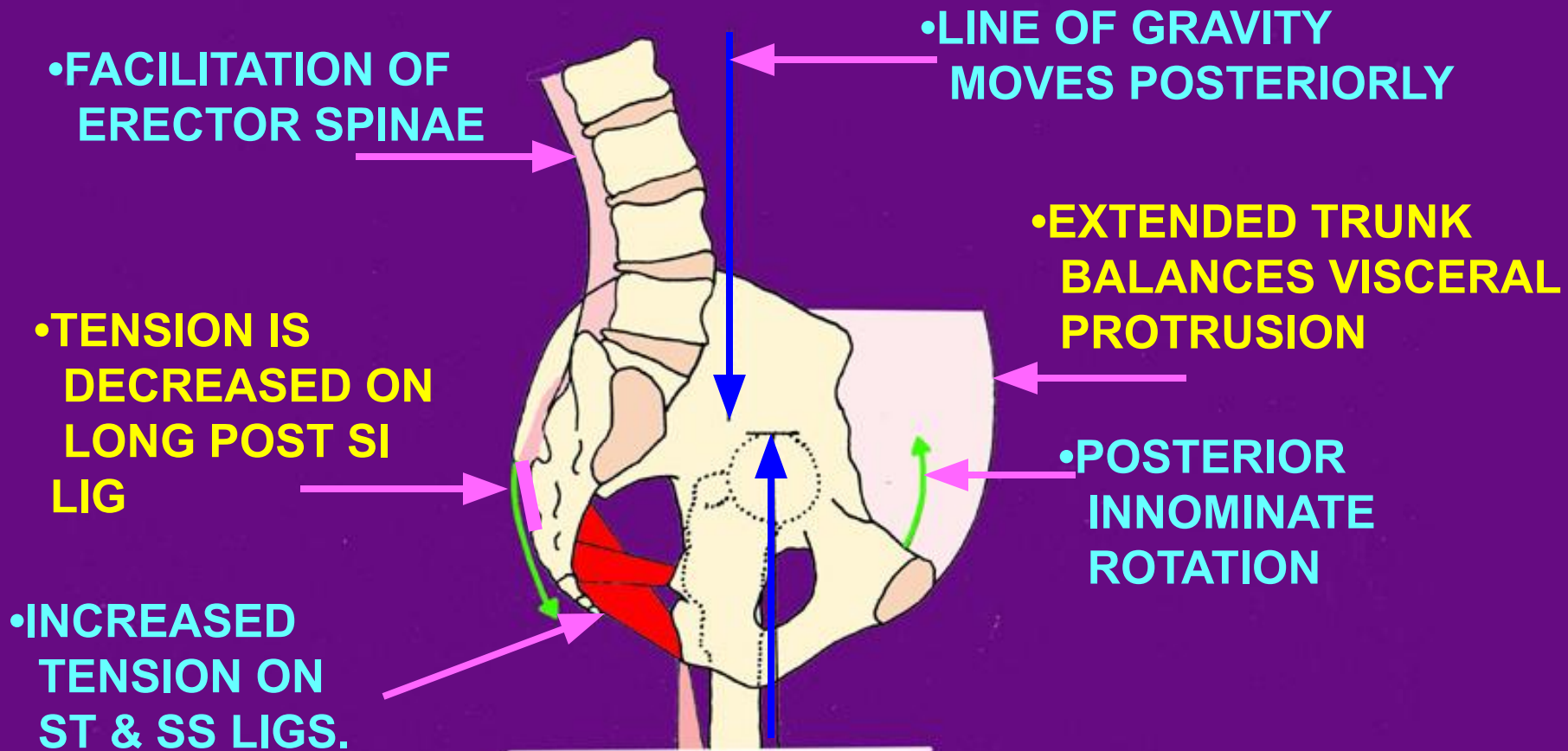
•THE OVERWEIGHT PATIENT MAY LEAN BACKWARD TO COUNTER THE WEIGHT ON THE ANTERIOR PELVIS

•DONTIGNY ©

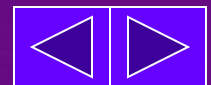


•OVERWEIGHT POSTURE (2)

•COMPENSATION POSTURE IN EXTENSION



•LIGAMENTOUS BALANCING IS INCREASED WITHOUT ACTIVE SUPPORT FROM THE ABDOMINAL MUSCLES



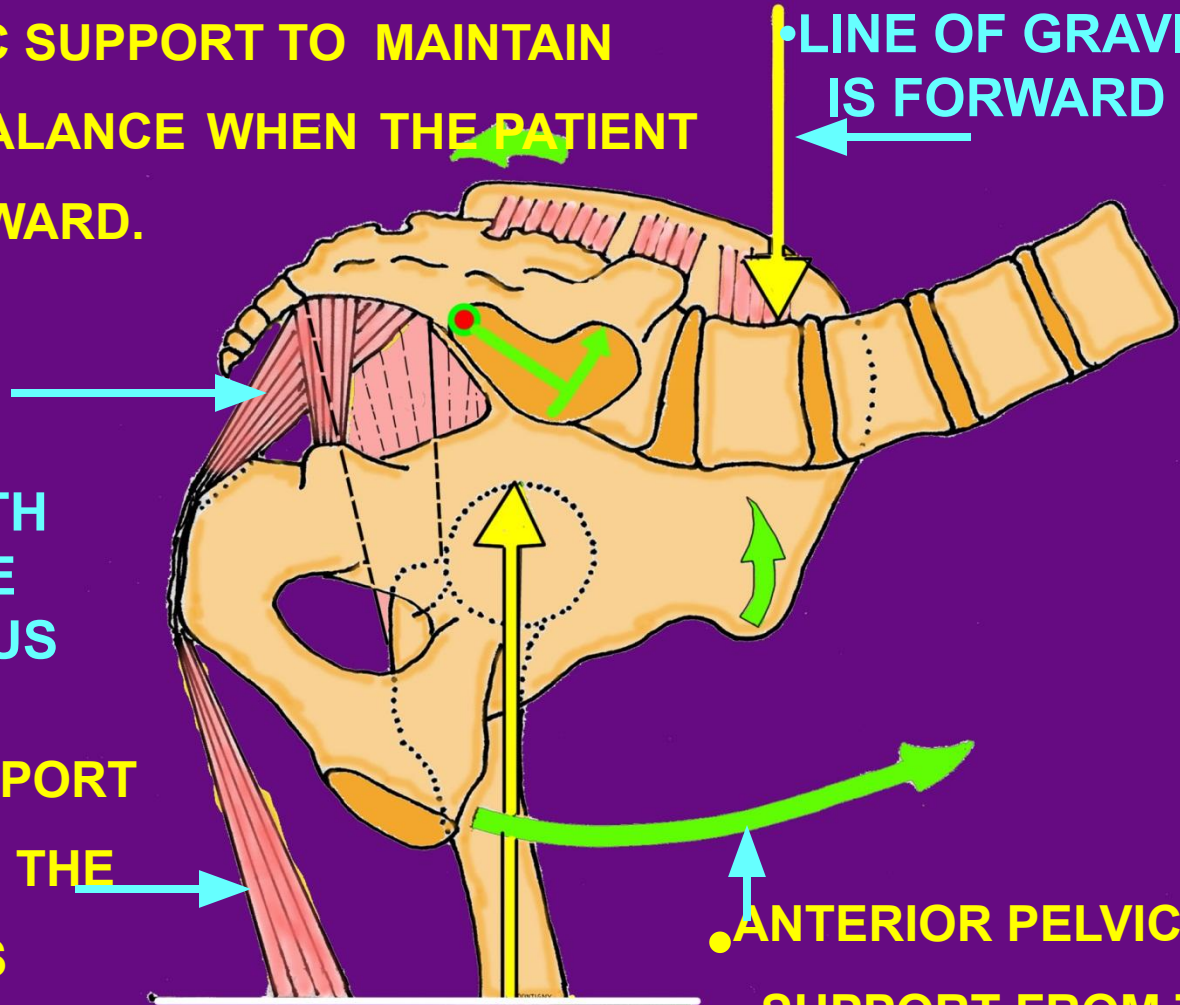
The Abdominal Muscles

- ❖ When leaning forward to perform any task it is essential to maintain the nutational relationship of the innominales to the sacrum in order to maintain the balanced position.
- ❖ As long as the abdominal muscles firmly support the anterior pelvis when leaning forward low back pain can be prevented.(81)

- LINE OF GRAVITY IS FORWARD

- # ●HAMSTRINGS SUPPORT THE FUNCTION OF THE SACROTUBEROUS LIGAMENTS

- **ANTERIOR PELVIC SUPPORT FROM THE ABDOMINAL WALLS**



Role Of The Abdominal Muscles

- ❖ The erector spinae muscles are mechanically unable to balance loads exceeding roughly 20 Kg. (39)
- ❖ The abdominal muscles are essential in balancing large axial and torsional loads. (40)

Role of The Abdominal Muscles

- ❖ Failure to maintain a balanced relationship between the abdominal muscles and the pelvic extensors will cause one to ambulate with the pelvis in anterior rotation.
- ❖ Ambulating with the pelvis in anterior rotation puts an additional loading on the pelvic extensors causing them to hypertrophy.
- ❖ Paul Chek pointed out that this imbalance leads to larger buttocks and is probably not reversible.

Role Of The Abdominal Muscles

- ❖ When lifting, the abdominal muscles serve to preserve dynamic ligamentous balance by maintaining the nutational relationship of the innominate bones to the sacrum by holding a strong posterior pelvic tilt.

Abdominal Muscles

- ❖ The abdominal muscles flatten the lumbar lordosis, decrease the lumbosacral angle, increase the weight loading capabilities of the vertebra, tighten the iliolumbar ligaments and decrease shear forces on L4,5 and S1.
- ❖ Tension is increased on the ligaments increasing balanced ligamentous tension and stability.
- ❖ This also facilitates the function of the erector spinae group, to include the multifidus and the sacrospinalis.

Abdominal Muscles

- ❖ “The significance of the oblique muscles and in particular the transversus abdominis in weightlifting should not be understated as they represent a much longer lever arm to oppose lumbar torsion loads than the short rotary spinal muscles. “ (42)

Abdominal Muscles

- ❖ Prior to lifting you should tighten the abdominal muscles and pinch the buttocks tightly together to maintain ligamentous balancing in the SIJs.
- ❖ While lifting, keep the lumbar spine flat to maintain tension on the iliolumbar ligaments and to prevent compromise of the intervertebral foramina.

Abdominal Muscles

- ❖ The initial 40-50 degrees of trunk flexion during sit-up exercises is associated with the greatest abdominal activity involving the upper rectus, and to a lesser degree the obliques. (41)
- ❖ Rotation during sit-ups will augment oblique musculature activity.(41)

Sequence of Onset of Pathology

- ❖ 1. Prior to pathology the posterior interosseous ligaments and the sacrotuberous ligaments are loaded and the SIJs are balanced.
- ❖ 2. Loss of anterior pelvic support allows anterior rotation of the innominates on the sacrum on an acetabular axis.
- ❖ 3. Anterior rotation decreases the secondary loading on the sacrotuberous ligaments.
- ❖ 4. Friction is lost, the force couple is lost, and the force dependent sacral axis is lost.

Sequence of Onset (2)

- ❖ 5. Loading is increased on the posterior interosseous ligaments.
- ❖ 6. There is a sudden pathological release of the dynamic ligamentous balance.
- ❖ 7. There is a sudden increase in tension on the hamstring muscles and the sciatic n.
- ❖ 8. The innominates rotate on the sacrum on an acetabular axis and subluxate at the S3 segment of the sacroiliac joint.

•SEQUENCE OF ONSET

•ANTERIOR ROTATION

•LOOSENS ST LIGAMENT

•LOSS OF FRICTION

•LOSS OF STABILITY

•LOSS OF LIGAMENT
BALANCE

•LOSS OF FORCE
COUPLE

•LOSS OF SIJ AXIS

•SUBLUXATION AT S3

•SUDDEN INCREASE
IN TENSION ON
HAMSTRINGS

•S1 ANGULATION

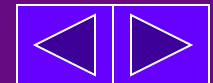
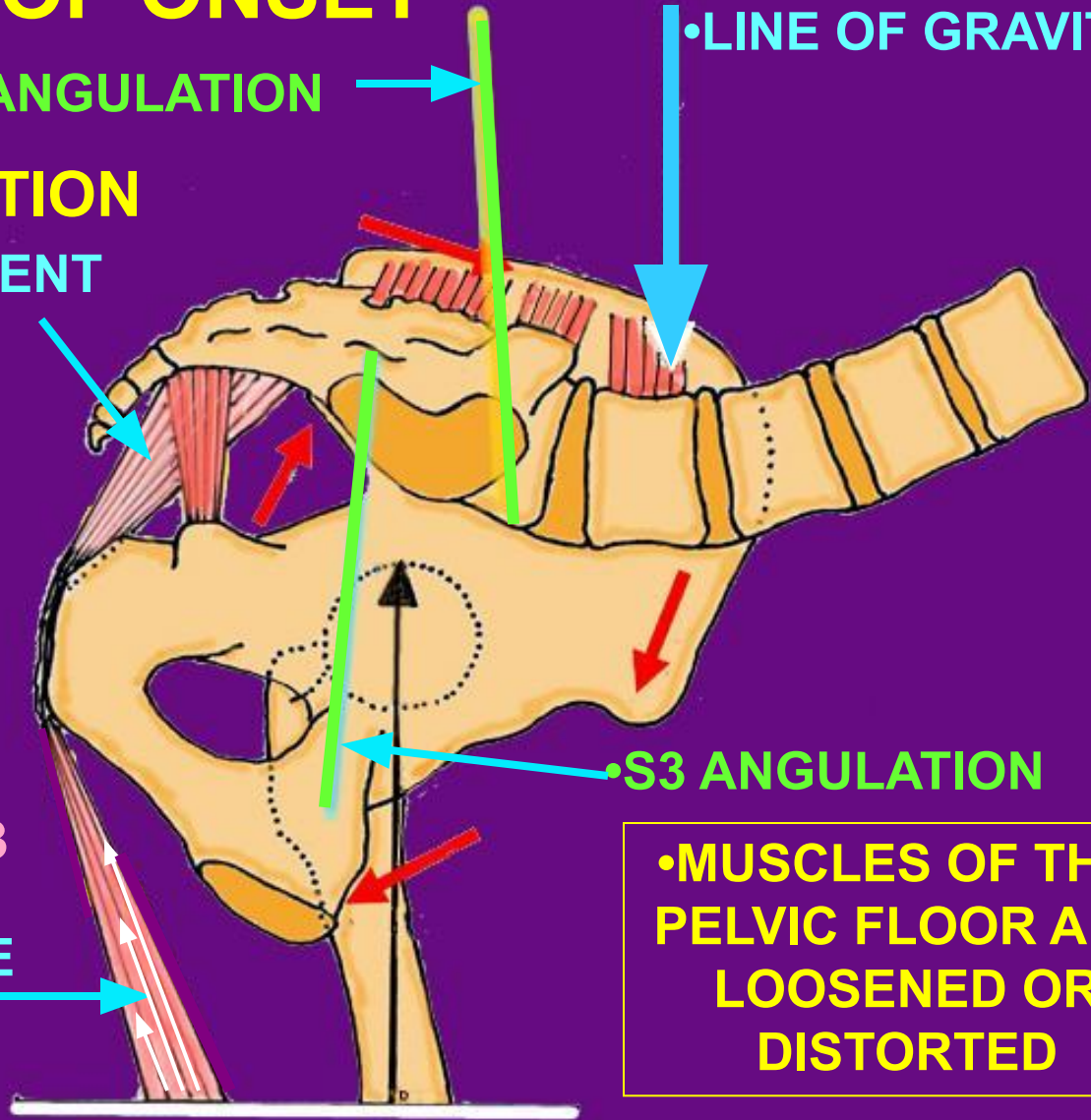
•LINE OF GRAVITY

•S3 ANGULATION

•MUSCLES OF THE
PELVIC FLOOR ARE
LOOSENED OR
DISTORTED

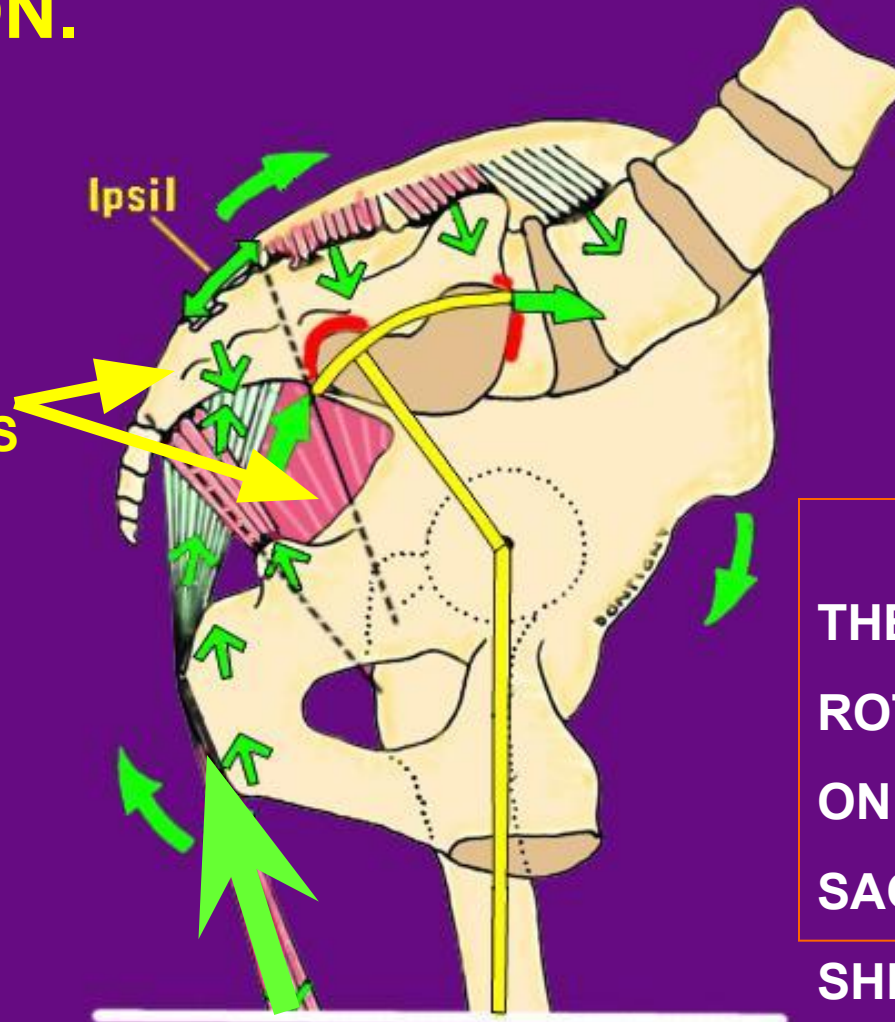
•THE S3 SUBLUXATION

•DONTIGNY ©



- **GLUTEUS MAXIMUS AND PIRIFORMIS ACT TO STABILIZE THE SACRUM DURING INNOMINATE ROTATION.**

- **PIRIFORMIS & GLUTE MAXIMUS**



**THE INNOMINATES
ROTATE ANTERIORLY
ON THE STABILIZED
SACRUM CAUSING**

SHEAR AT THE

S3 SACRAL X AX



Direct and Indirect Effects of the S3 Subluxation

- ❖ The sprains, strains and muscle shear caused by SIJD are directly related to and vary with the severity of the dysfunction.
- ❖ Prolonged uncorrected subluxation may cause visco-elastic failure of the collagen in stressed ligaments, inflammatory and arthritic changes and changes in gait.
- ❖ The loss of the function of the force couples may increase loading forces that directly affect and 'punish' many other adjacent structures.

•SOME DIRECT EFFECTS OF THE S3 SUBLUXATION

- THE LONG PSI LIGAMENT MAY BE STRETCHED AND TORN (15, 16)

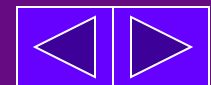
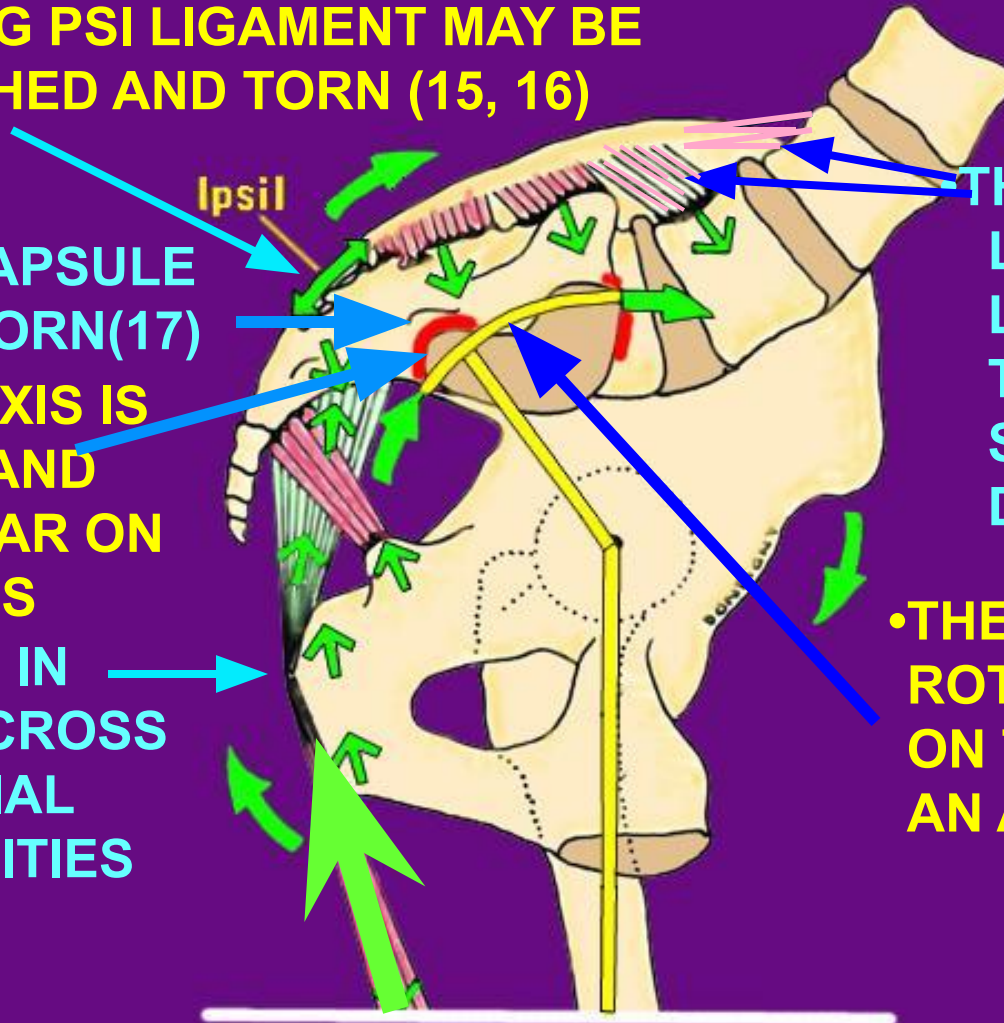
- THE SIJ CAPSULE
MAY BE TORN(17)

**SACRAL AXIS IS
SHIFTED AND
PUTS SHEAR ON
PIRIFORMIS**

- INCREASE IN — SHEAR ACROSS THE ISCHIAL TUBEROSITIES

**THE ILIOLUMBAR
LIGAMENTS ARE
LOOSENED AND
THE L4-5,S1
SEGMENTS ARE
DESTABILIZED (8, 23)**

- THE INNOMINATES ROTATE ANTERIORLY ON THE SACRUM ON AN ACETABULAR AXIS.



•ONSET

•ANTERIOR ROTATION

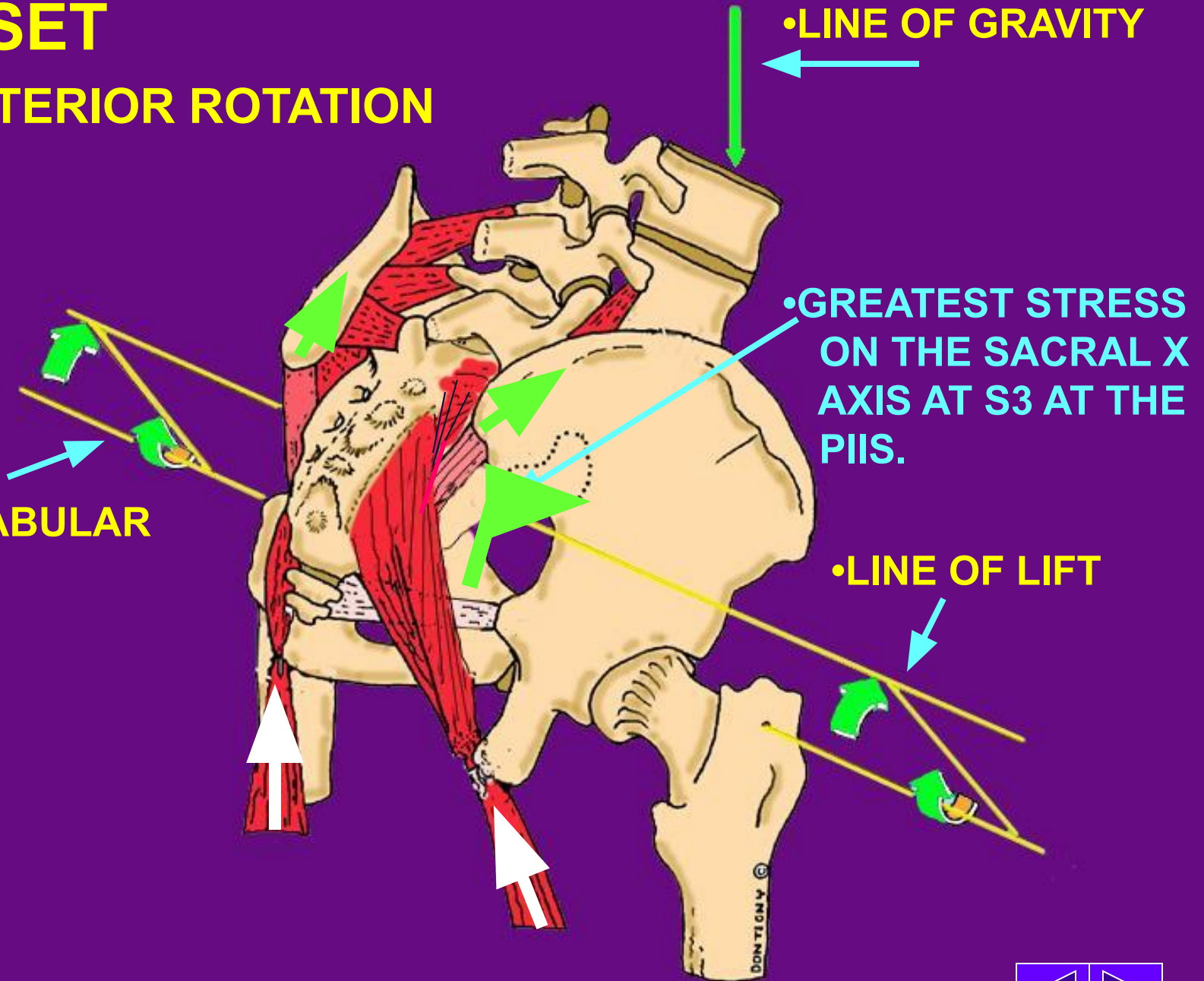
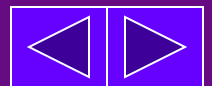
•ACETABULAR
AXIS

•LINE OF GRAVITY

•GREATEST STRESS
ON THE SACRAL X
AXIS AT S3 AT THE
PIIS.

•LINE OF LIFT

•DONTIGNY ©



•LOSS OF ANTERIOR PELVIC SUPPORT

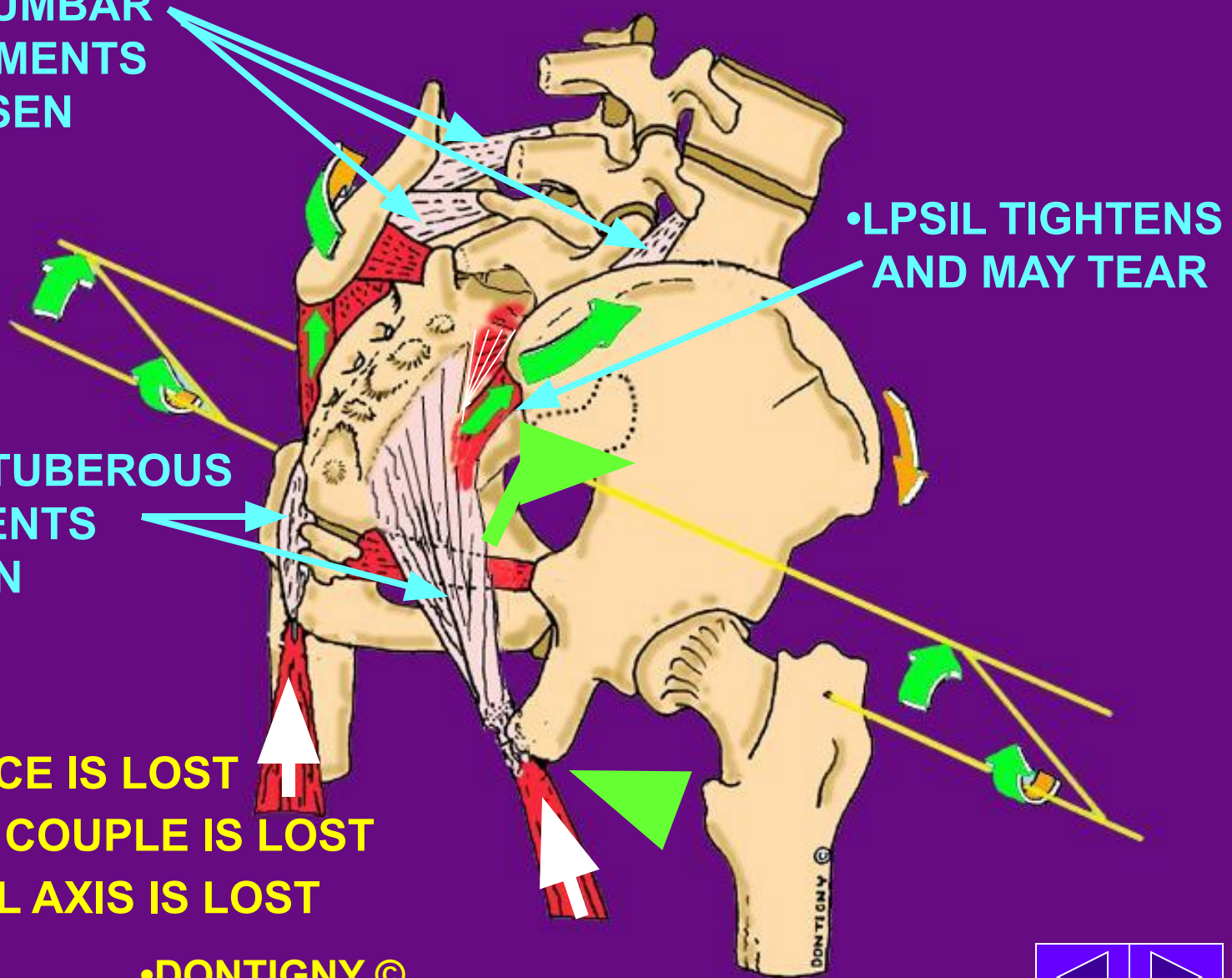
•ILIOLUMBAR
LIGAMENTS
LOOSEN

•LPSIL TIGHTENS
AND MAY TEAR

•SACROTUBEROUS
LIGAMENTS
LOOSEN

•BALANCE IS LOST
•FORCE COUPLE IS LOST
•SACRAL AXIS IS LOST

•DONTIGNY ©



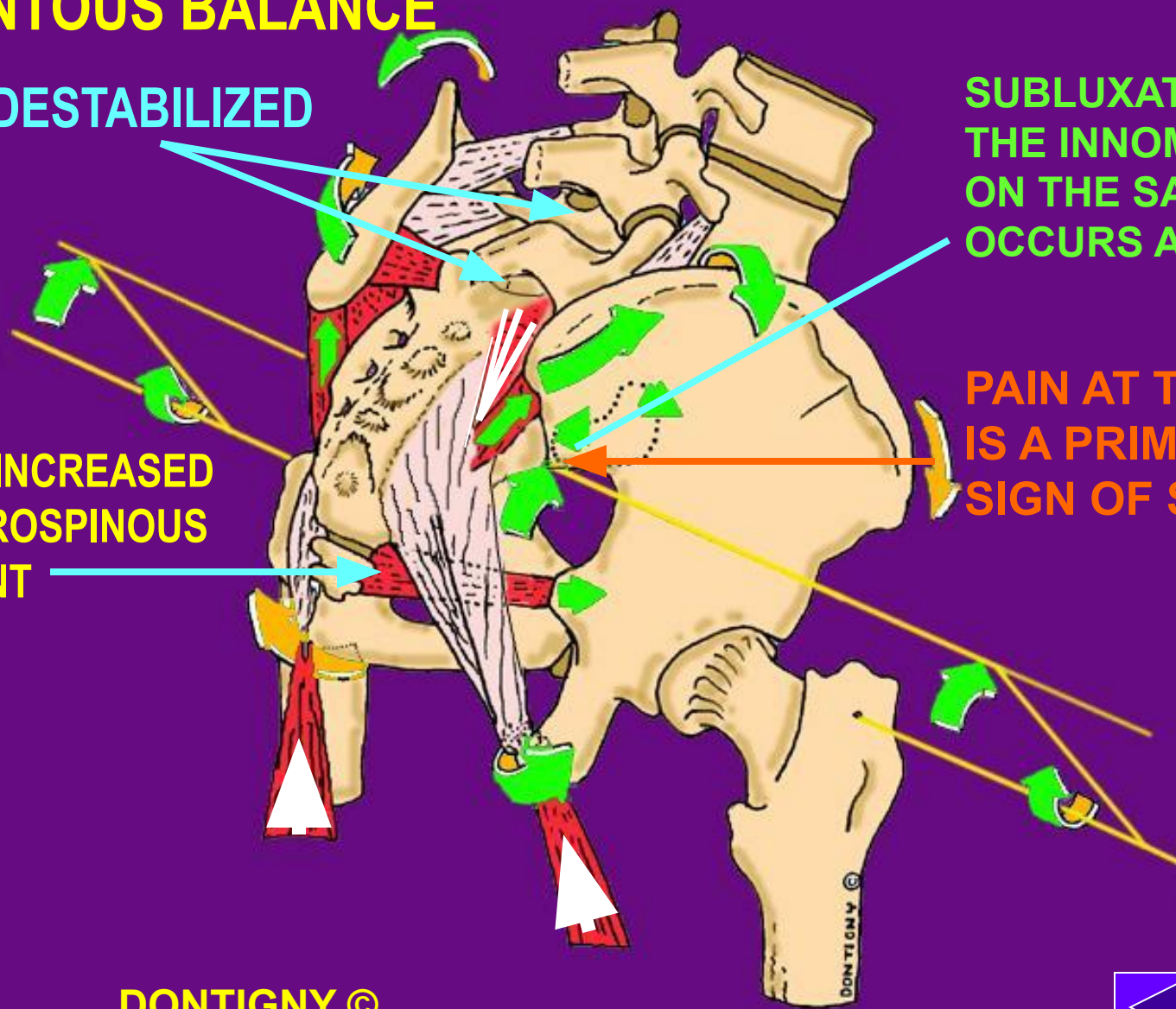
•SUDDEN PATHOLOGICAL RELEASE OF DYNAMIC LIGAMENTOUS BALANCE

•L4,5-S1 DESTABILIZED

SUBLUXATION OF
THE INNOMINATES
ON THE SACRUM
OCCURS AT S3

•TENSION INCREASED
ON SACROSPINOUS
LIGAMENT

PAIN AT THE PIIS
IS A PRIMARY
SIGN OF SIJD



DONTIGNY ©



EFFECTS OF AND ON G. MAX

DECREASED STRESS ON
ILIOLUMBAR LIGAMENTS

SACRAL AXIS

PRIMARY POINT OF
LIFT

LINE OF SEPARATION
G. MAX. ILIAL FROM
G. MAX. SACRAL

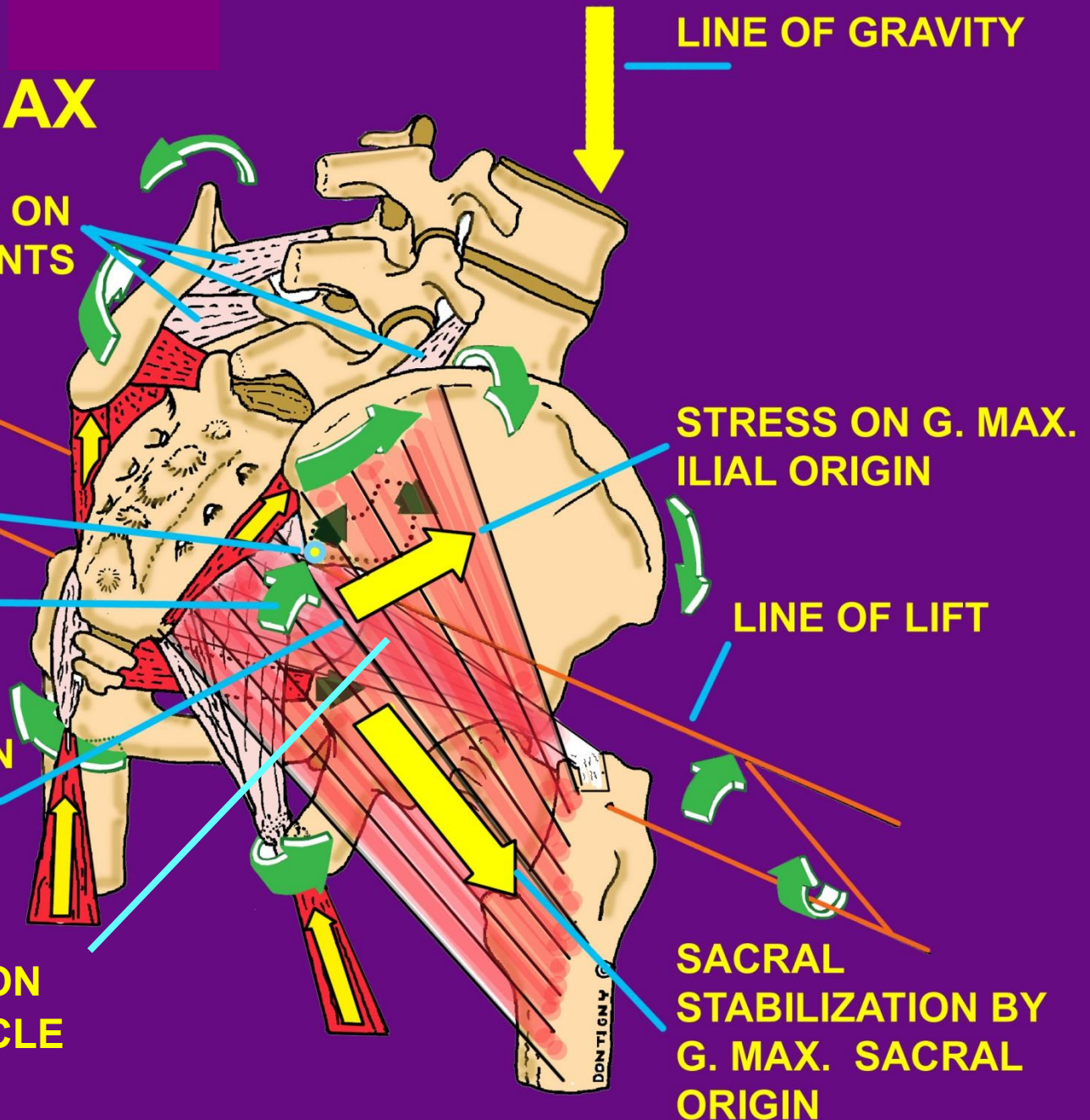
SACRAL STABILIZATION
BY PIRIFORMIS MUSCLE

LINE OF GRAVITY

STRESS ON G. MAX.
ILIAL ORIGIN

LINE OF LIFT

SACRAL
STABILIZATION BY
G. MAX. SACRAL
ORIGIN



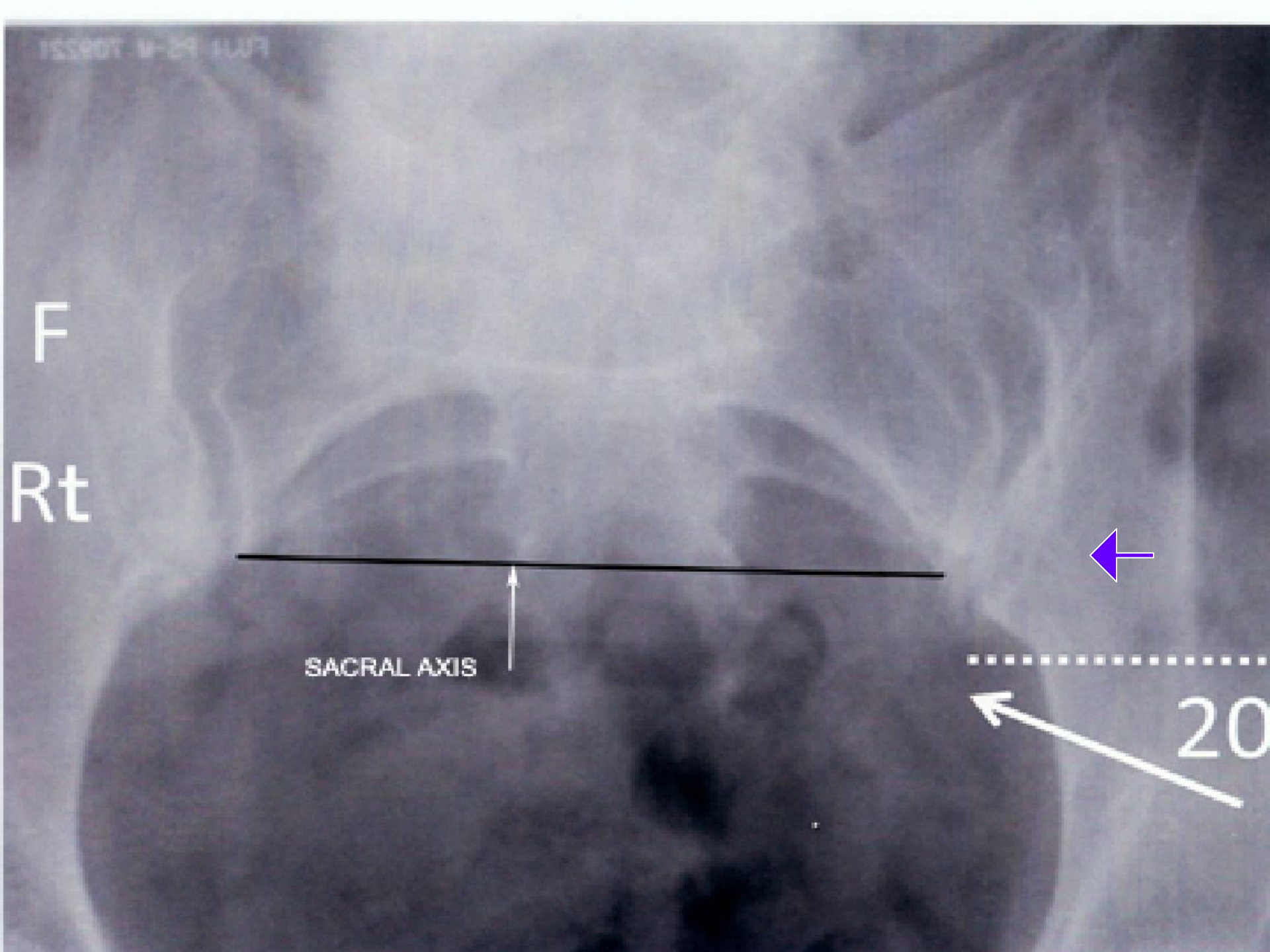
Subluxation of the Sacral Axis

- ❖ To my knowledge this is the first X-ray of the subluxation of the sacral axis.
(Left side)
- ❖ This was done at my request by
Dr. Mitoshi Fukushima, MD, Ph D
Fukushima Orthopaedic Clinic
Hiroshima, Japan

F
Rt

SACRAL AXIS

20



•SECONDARY LOADING FROM PPR IS ABSENT

SECONDARY LOADING FROM PPR IS ABSENT

•LINE OF L

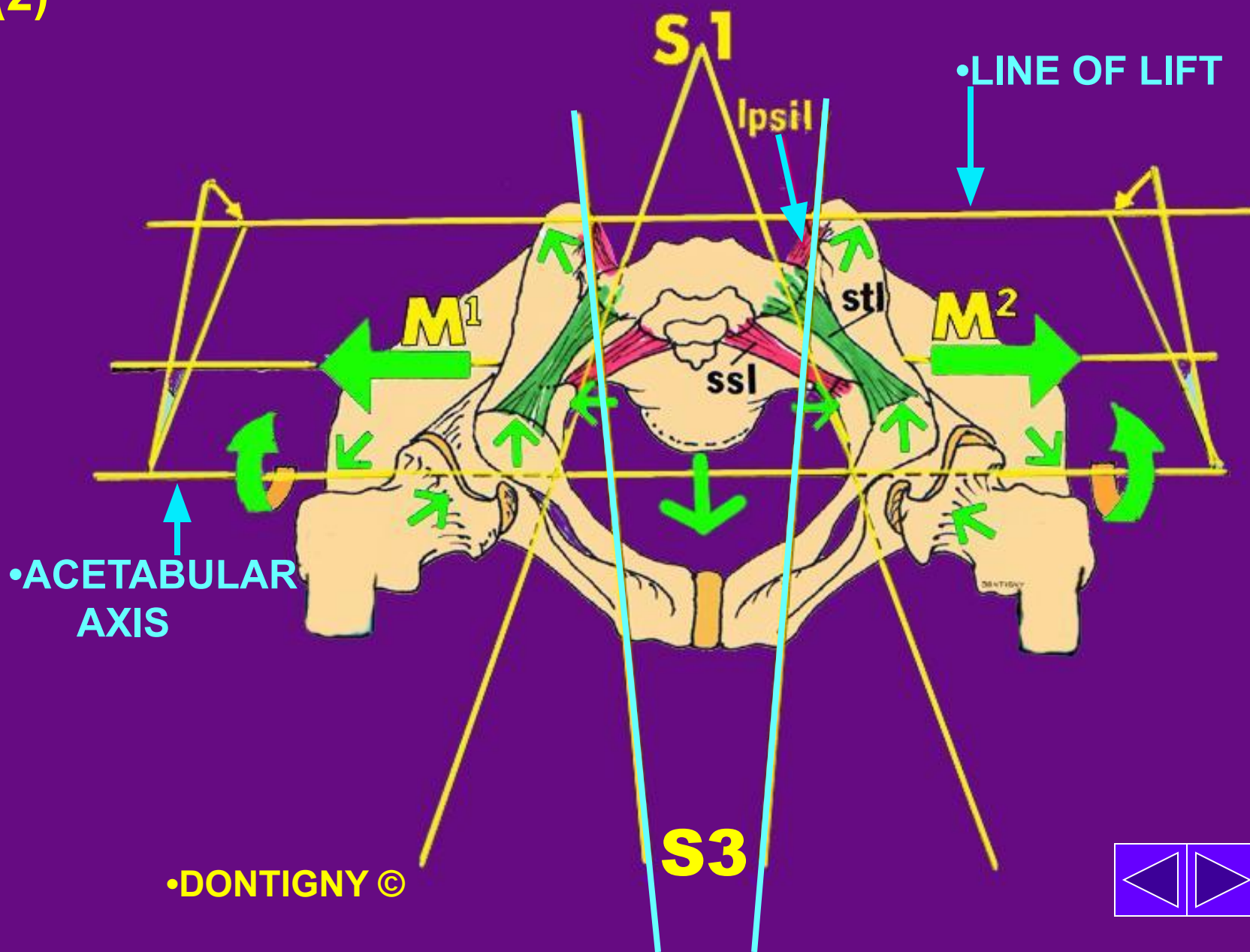
•DONTIGNY ©

• ACETABULAR AXIS

•DONTIGNY ©



•PATHOLOGICAL RELEASE OF LIGAMENTOUS BALANCE (2)



Increase in Ventral Inclination

- ❖ After subluxation at S3 the sacrum will incline ventrally, taking up the slack in the sacrotuberous ligament
- ❖ This increases tension on the sacrospinous ligament.
- ❖ Unilaterally, this may allow some apparent sacral torsion.
- ❖ Bilaterally, this will increase ventral inclination of the sacrum increasing shear at the lumbosacral angle.

SPECIAL NOTE

- ❖ The high friction at the subluxation at S3 limits motion at that segment, but motion is still available at the S1 segment because of the variation in the structural angulations.
- ❖ The superincumbent weight anteriorly on the sacrum causes the sacrum to move downward at the S1 segment and tilt ventrally by rotating on the S3 segment.
- ❖ The sacral x axis is displaced and becomes a pathological axis of rotation.

SPECIAL NOTE (2)

- ❖ It is possible to manipulate the front of the pelvis up or down, moving it on the S1 segment, changing the leg length and even making the legs to appear to be of equal length, **without getting a correction of the subluxation at the S3 segment.**

Associated Symptoms

- ❖ With the subluxation at S3 the convexities of the ilial surface of the SIJs tend to ride up out of the concavities of the sacral surfaces to spread and flare the innominates.
- ❖ The piriformis passes immediately caudad to this subluxation and has a secondary bony origin on the ilium at the superior margin of the greater sciatic notch.
- ❖ Any vertical shearing at that point can strain the dual origins of the piriformis muscle and can cause piriformis syndrome and sciatica.

Associated Symptoms

- ❖ Care must be taken in assessing a 'piriformis syndrome' because of its location near the S3 segment at the PIIS and the line of the separation of the gluteus maximus from just below the PSIS obliquely downward and laterally toward the trochanter.
- ❖ Pain along the line of separation of the gluteus maximus is frequently mistaken for piriformis pain, although both may be affected.

•ASSESSING THE PIRIFORMIS

•LONG POSTERIOR
SACROILIAC LIG.

•SACROTUBEROUS
LIGAMENT

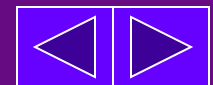
•SUBLUXATION AT
S3 STRAINS THE
DUAL ORIGINS OF
THE G. MAX AND
THE PIRIFORMIS

•G. MAXIMUS
(ILIAL ORIGIN)

•PIRIFORMIS

•LINE OF
SEPARATION

•G. MAXIMUS
(SACRAL ORIGIN)



Associated Symptoms

- ❖ An impairment of the function of the sacral origin of the gluteus maximus secondary to SIJD may precipitate a trochanteric bursitis and pain in the iliotibial band.
- ❖ Shear at the ischial tuberosity may cause a local bursitis/tendinitis with pain and tightness in the biceps femoris extending into the lateral capsule of the knee.

Associated Symptoms

- ❖ The sudden release of ligamentous balance via the biceps femoris can strain the lateral capsule of the knee, the tibiofibular ligaments, or cause a subluxation of the head of the fibula.

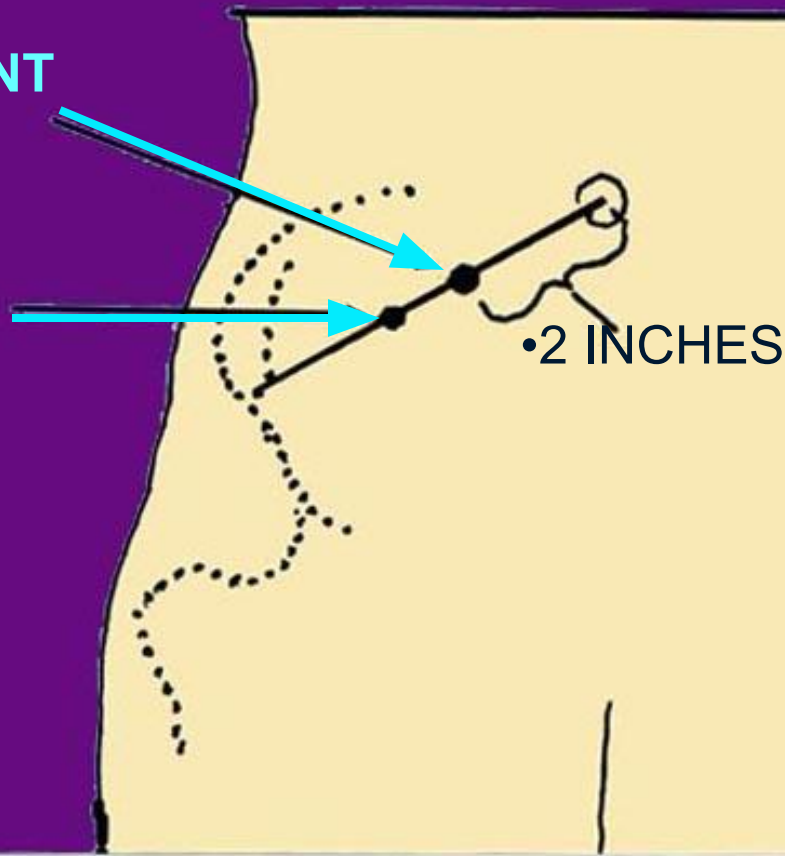
Baer's Sacroiliac Point

- ❖ Abdominal pain may be present at Baer's sacroiliac point. (21,90)
- ❖ This has been described as being on a line from the umbilicus to the ASIS, two inches from the umbilicus.(21,90)
- ❖ Injection of anesthetic into the SIJ can relieve this abdominal pain. See Baer (90) Mennell (21) and Norman (22)

•BAER'S SACROILIAC POINT

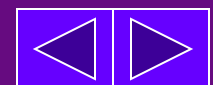
•BAER'S SI POINT

•MCBURNEY'S
APPENDICITIS
POINT



•REDUCTION OF THE SUBLUXATION WILL RELIEVE
THE PAIN AT BAER'S POINT.

•DONTIGNY



Case in Point

- ❖ A 35 YOF with H/O lower abdominal pain and low back pain for four years.
- ❖ Both ovaries had been removed with no relief of the lower abdominal pain.
- ❖ Correction of the SIJ to the balanced position relieved both the lower abdominal pain and the low back pain immediately.

Associated Symptoms

- ❖ Pain may be referred into the groin and cause a pseudoepididymitis.(Jungman, 19)
- ❖ Rents in the capsule may leak synovia to the lumbosacral plexus, the root of the fifth lumbar nerve and into the body of the psoas and cause neurological symptoms.(Fortin, 17)

Associated Symptoms

- ❖ This may give the appearance of a multifactorial etiology or mimic symptoms of a herniated intervertebral disk.
- ❖ Leaking synovia may become encapsulated and form cysts on the SIJ.

Associated Symptoms

- ❖ A pelvic obliquity may cause oblique tension on the pelvic diaphragm (20)
- ❖ Pelvic congestion plays a major role in female patients with dysmenorrhea, ovarian cysts, and premenstrual syndrome as well as in male patients with prostatitis and prostatodynia (19).

Associated Symptoms

- ❖ Anterior rotation of the innominates, if asymmetrical, may cause a reversible pelvic asymmetry.
- ❖ The resulting asymmetry may then cause an idiopathic scoliosis that may also be reversible.

Associated Symptoms

- ❖ The pelvic obliquity caused by the asymmetric pelvis is probably the cause of idiopathic scoliosis in the prepubertal child.
- ❖ This may not be accompanied by pain.
- ❖ This is easily relieved and pelvic symmetry restored with correction of the dysfunction of the sacral x axis.

Associated Symptoms

- ❖ The gluteus maximus, the piriformis and the iliacus muscles all have origins on both the sacrum and the ilium.
- ❖ SIJD can strain or separate these dual origins and cause pain in any or all of these muscles.
- ❖ Correction in posterior rotation will relieve the strain and approximate the conjoint origins.

Associated Symptoms

- ❖ A dysfunction in anterior rotation stretches the psoas muscles and gives the appearance of tight hip flexors.
- ❖ Correction of SIJD restores normal tension in the psoas muscles.

Associated Symptoms

Muscle Scarring

- ❖ Grieve describes another condition that may affect the piriformis and other muscles.(70,p113)
- ❖ “Long and continued occupational and postural stress, asymmetrically imposed upon the soft tissues, tends to cause fibroblasts to multiply more rapidly and produce more collagen.”
- ❖ “Besides occupying more space within the connective tissue elements of the muscle, the extra-fibres encroach on the space normally occupied by nerves and vessels.”(70, p 113)

Associated Symptoms

Muscle Scarring Continued

- ❖ “Because of this trespass, the tissue loses elasticity and may become painful when the muscle is required to do work in coordination with others.”
- ❖ “In the long term, collagen would begin to replace the active fibres of the muscle, and since collagen is fairly resistant to enzyme breakdown, these changes tend to be irreversible.” (70, p 113)

Associated Symptoms

Bursitis

- ❖ Various bursae may become inflamed and require treatment.
- ❖ These include:
- ❖ The ischial bursa of the gluteus maximus.(68, p 668)
- ❖ The bursa that separates the gluteus maximus from the greater trochanter. (68, p 875)

Associated Symptoms

Bursitis (Continued)

- ❖ The psoas major has a large subtendinous bursa on the superior ramus below the anterior superior iliac spine. (68, p 869)
- ❖ The piriformis has a large bursa between the tendon of the muscle and the summit of the great trochanter and a second bursa just above the insertion. (69, p 623)

Associated Conditions

T12-L1 Facet Syndrome

- ❖ As the innominates rotate downward in relationship to the spine the psoas muscles are put on a stretch.
- ❖ This may result in a facet tightness at T12-L1, just above the origins of the psoas.
- ❖ This will require a correction of the SIJ to relieve the stretch on the psoas and a mobilization of T12-L1 to relieve the tightness there.

Associated Symptoms

Pain at the Pubic Symphysis

- ❖ A bilateral subluxation may inhibit movement from the symmetric to the asymmetric pelvis when walking or climbing stairs.
- ❖ If the forces that create asymmetric movement are blocked posteriorly, they may stress the anterior pelvis by increasing shear and torsion shear on the pubic symphysis.

Associated Symptoms

Referred Pain Patterns

- ❖ It is well known that pain in the low back can seem to be referred to many areas.
- ❖ However, prior to assuming that some area of pain might be a referred pain, it behooves the investigator to actually determine what tissues are involved and how they may be related to the primary dysfunction.

Associated Symptoms

Referred Pain Patterns (Cont.)

- ❖ Some of these areas of 'referred' pain with actual tissue involvement are:
- ❖ The lateral sacrum – the long posterior sacroiliac ligament
- ❖ The coccyx – the sacrospinous ligament
- ❖ The groin – the pubic symphysis
- ❖ The buttock – the PIIS, the separation of the gluteus maximus and the piriformis.

Associated Conditions

Referred Pain vs. Tissue

- ❖ Ischial tuberosity – biceps tendinitis
- ❖ Posterior thigh – biceps femoris strain
- ❖ Lateral thigh – sacral origin of the gluteus maximus insertion into the iliotibial band
- ❖ Lateral knee capsule and fibular head-insertion of the biceps femoris
- ❖ Lateral leg – peroneus longus
- ❖ It is not appropriate to assume a pain to be referred without examination of the relevant structure.

Associated Conditions

Pain With Straining

- ❖ As the innominate bones tend to spread and separate the SIJs with this subluxation, any increase in intra abdominal pressure such as caused by a sudden cough or straining with a bowel movement will tend to further increase this spreading and thus increase the pain.

Sciatic Neuritis

- ❖ The sciatic nerve exits just below the piriformis muscle and often penetrates it.
- ❖ Any pain or spasm in this muscle from an injury or separation can cause pain in the sciatic nerve.
- ❖ The sciatic nerve is also stretched with this dysfunction also increasing sciatic pain.
- ❖ Sciatic neuritis often exists without evidence of disc disease.

Muscle Inhibition

- ❖ Dorman found a positional inhibition of the gluteus medius when the innominate is held in anterior rotation. (18)
- ❖ Dananberg found an inhibition of the peroneus longus with SIJD causing a functional hallux limitus. (46,47)
- ❖ An increase in the lumbosacral angle with lordosis will approximate the origins and insertions of the multifidus and may cause a positional inhibition of those muscles.

Muscle Inhibition (2)

- ❖ When the patient is supine, with active straight leg raising, an S3 subluxation may cause a painful or positional inhibition of the hip flexors. This is not usually neurological.
- ❖ Paresis of the hallux extensor or the foot dorsiflexors are usually primary indicators of a herniated nucleus pulposus.
- ❖ Degenerative disk disease, however, may be the result of instability of L4,5-S1 secondary to the S3 subluxation of the sacral axis.(8,23)

Iliolumbar Ligaments

- ❖ SIJD loosens the iliolumbar ligaments, destabilizing L4-5 and S1 and increasing shear and torsion shear on the disks.(8, 23)
- ❖ L5 tends to shear anteriorly on S1 and may initiate or increase a spondylolisthesis.
- ❖ The anterior shearing movement of spondylolisthesis will tend to tighten the iliolumbar ligaments again which might prevent reduction of the subluxation at the S3 segment.

Neck Pain

- ❖ Fukushima found sacroiliac joint dysfunction is associated with cervical dysfunction.(86)
- ❖ Intracapsular or pericapsular injection into the sacroiliac joint can give immediate relief of neck pain.(86)

Neck Pain (2)

- ◆ Increase in angle of cervical joints, atlanto-axial distance and subsidence of neck pain correlate with release of sacroiliac joint syndrome.(86)
- ◆ “We believe that recurrence of episode is due to incomplete release of sacroiliac joint dysfunction.” (86)

Sensory Changes

- ❖ When the innominate rotates downward anteriorly on the sacrum, the nerve roots may be stretched.(50)
- ❖ When a nerve root gets stretched, it gets smaller and compression deformity of the nerve roots occurs.(50)
- ❖ Total mechanical block occurs before 15% of elongation.(50)

Sensory Changes (2)

- ❖ Dorsal root ganglia are more susceptible to mechanical stimulation than axons (51), therefore, sensory changes such as numbness, burning and paresthesias may be more common than motor deficits.
- ❖ Traction on nerve roots may also produce a lancinating pain.(52)

Sensory Changes (3)

- ❖ The lateral division of the dorsal rami of S1-S3 pass through the long posterior sacroiliac ligament.
- ❖ The third sacral nerve divides into upper and lower branches, the lower becoming a portion of the pudental plexus
- ❖ Any stretch on this ligament or injury to it could affect these nerves also.

- The lateral division of the dorsal rami of S1-S3 passes through the long posterior sacroiliac ligament.

- From Vleeming



Sacral S3 n. and Pudental Nerve Entrapment

- ❖ A high percentage of people with so-called pudental nerve entrapment have SIJD, which indicates that SIJD may be a cause of rather than an effect.
- ❖ Sectioning of the sacrotuberous ligament to relieve entrapment can cause instability of the sacroiliac joint
- ❖ Correct the SIJ first and then reassess.

Changes In Gait With The S3 Subluxation

- ❖ With a bilateral subluxation the horizontal pelvic swing is shortened.
- ❖ With a unilateral subluxation and long leg you will ambulate with a high iliac crest on the more painful side.

Changes In Gait With The S3 Subluxation (2)

- ❖ With the compromised bilateral subluxation at S3 you will ambulate with a short leg on the more painful side.
- ❖ Functional lateral sacral flexion is blocked and function of the piriformis and the sacral origin of the G. Max. is impaired.

Changes in Gait (2)

Abductor Inhibition

- ❖ Dorman described inhibition of the gluteus medius with anterior innominate rotation. (18)
- ❖ After initial impact the ipsilateral abductors stabilize the pelvis as it carries the weight of the trailing leg forward on the contra lateral side.
- ❖ Weakness in the abductors will allow the pelvis to drop prematurely on the contra lateral side increasing loading forces and shortening the length of the step.

Changes In Gait (3)

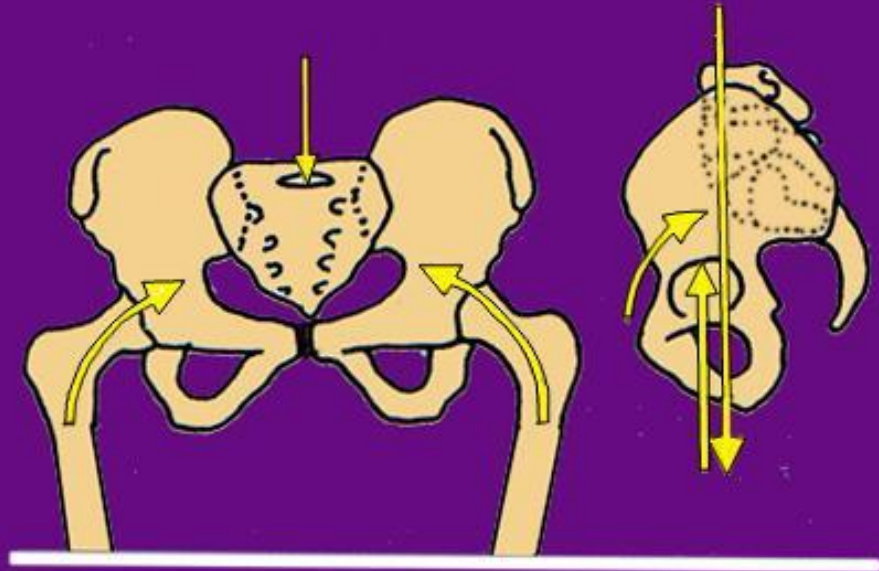
- ❖ May develop a functional hallux limitus.
- ❖ Shear will increase at L4-5 and L5-S1 with the interruption of rhythmic sacrocranial vertebral oscillation.
- ❖ All of these changes will reverse with manual correction to the self-bracing position
- ❖ Heel lifts are unnecessary and usually contraindicated as they only level the sacral base without correcting the dysfunction.

Pain on Sitting

- ❖ Pain on sitting is common with SIJD.
- ❖ When you stand you carry your weight on your legs and the femoral heads have a buttressing effect on the pelvis which increases the ligamentous balance.
- ❖ When you sit you carry your weight on your ischial tuberosities, which reverses the buttressing and increases imbalance.

PAIN ON SITTING

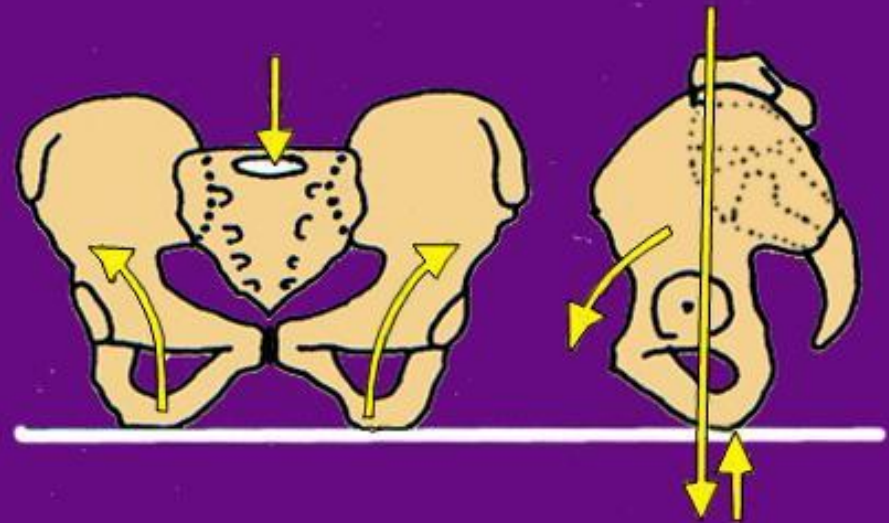
- WHEN STANDING THE FEMURS HAVE A BUTTRESSING EFFECT THAT ENHANCES LIGAMENTOUS BALANCE



- THE INNOMINATES TEND TO ROTATE POSTERIORLY AND INCREASE BALANCED LIGAMENTOUS TENSION.

• DONTIGNY ©

- FEMORAL BUTTRESSING IS LOST WHEN SEATED. WEIGHTBEARING ON THE ISCHIAL TUBEROSITIES REVERSES THE BUTTRESSING AND DECREASES THE PRIMARY PELVIC LOADING.

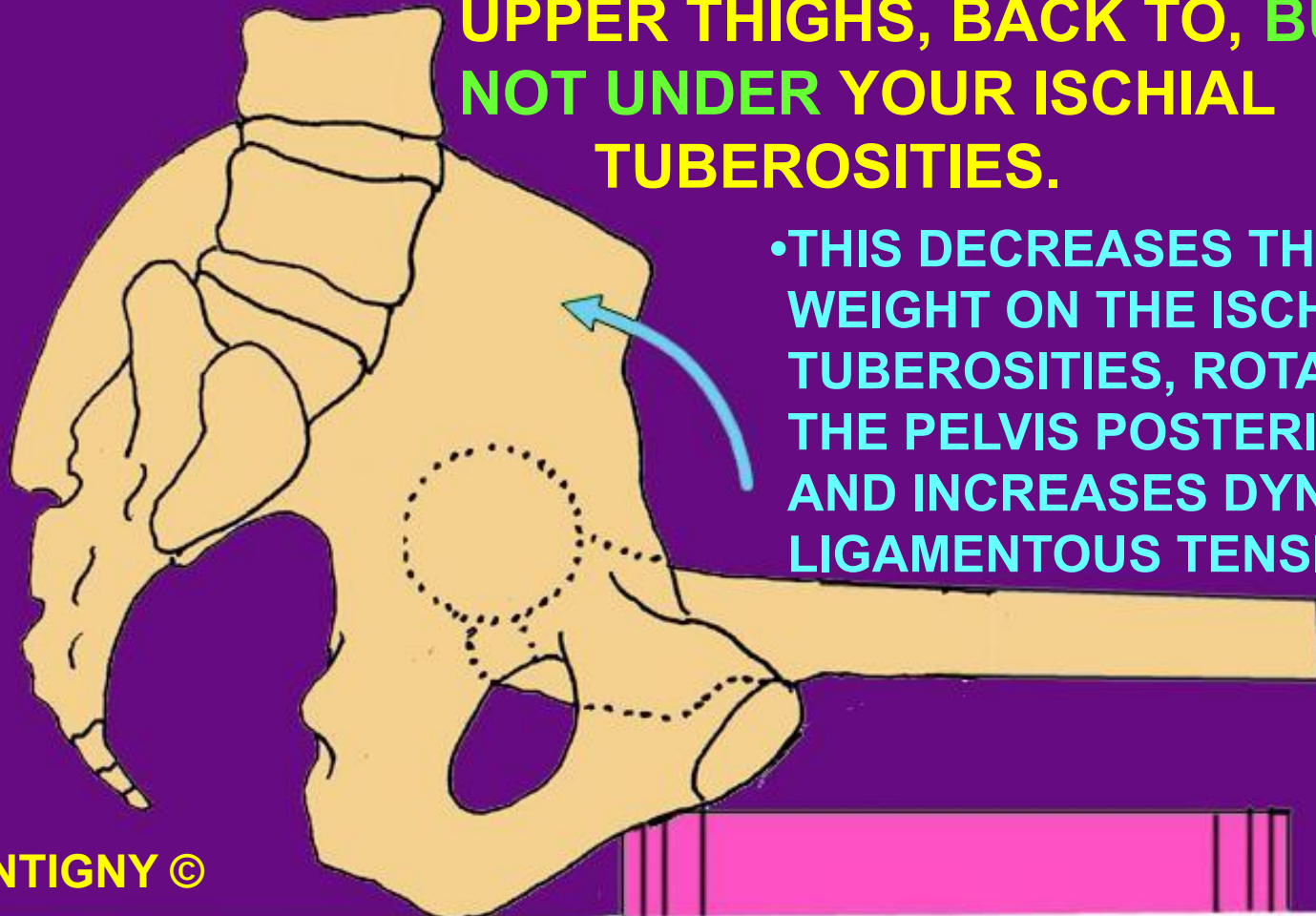


- THE INNOMINATES DIVERGE AND ANTERIORLY ROTATE TO INCREASE IMBALANCE.

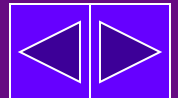


- RELIEF OF PAIN ON SITTING**

- TO RELIEVE PAIN ON SITTING, SIT WITH A PAD ACROSS THE FRONT OF A CHAIR, UNDER YOUR UPPER THIGHS, BACK TO, BUT NOT UNDER YOUR ISCHIAL TUBEROSITIES.**



•**DONTIGNY ©**



Pain on Sitting

- ❖ For relief of pain on sitting try sitting on a high density thermal foam pillow. One that is shaped with a large and a small curvature.
- ❖ Sit on it with the large curvature under your upper thighs and the small curvature just behind your sacrum.
- ❖ Or try sitting with a book about $\frac{3}{4}$ inch thick under the more painful side.

•PILLOW AS A SEAT SUPPORT

- A HIGH DENSITY THERMAL LATEX COUNTOUR PILLOW WILL ALSO GIVE GOOD SEAT SUPPORT.



Fascial Tightness

- ❖ With skin rolling, Mennell found fascial tightness in dermatomes affected by vertebral facet syndromes(21).
- ❖ Similar increases in fascial tightness may occur in dermatomes related to dysfunction of specific levels of the sacroiliac joints.
- ❖ This fascial tightness may cause some stiffness and limit hip motion or passive straight leg raising.

Loss of the Force Couple

- ❖ The S3 subluxation prevents the force couples from functioning normally.
- ❖ Forces normally mediated, redirected and dispersed are still present and may cause pathological changes in the muscles, ligaments, fascia and joints of the hips, the spine and the pelvis (to include the pelvic diaphragm).
- ❖ This may precipitate the symptoms of fibromyositis or fibromyalgia.

Loss of the Force Couple (2)

- ❖ When the force couple is blocked, loading is increased to the femoral head.
- ❖ This might cause microfractures in the subchondral bone, roughening of the joint surface and result in arthritis of the hip.
- ❖ Hip disease is frequently preceded by a long history of chronic low back pain on the ipsilateral side.

Congenital Anomalies

- ❖ Congenital anomalies may not be clinically significant.
- ❖ Almost every pathological change (Troup, 55) and lumbosacral anomaly (Wiltse, 56) to which back pain has been attributed has subsequently been demonstrated in the symptom free population.
- ❖ Correct the subluxation and then reassess.

Special Note

- ❖ A colleague who specializes in incontinence training in Hong Kong recently informed the author that after correction of SIJD, the patient frequently regains continence and no longer requires the training.
- ❖ Correct the sacroiliac joint and then reassess

Asymmetry and Leg Length

- ❖ Most tests for dysfunction of the sacroiliac joint (SIJD) are based on finding an asymmetrical pelvis and an inequality of leg length.
- ❖ It is widely assumed that an anatomical inequality of leg length is a primary cause of SIJD.
- ❖ Actually it is the dysfunction of the SIJs that causes a change in apparent leg length, which is reversible with correction.

Pelvic Obliquity And Changes In Leg Length

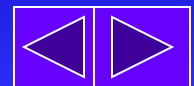
- ❖ As the innominates rotate on the sacrum, the SIJs move more up and over the acetabula causing a change in apparent leg length.
- ❖ Bilateral SIJD is usually a symmetrical lesion and causes both legs to appear longer.
- ❖ Following bilateral SIJD, when both sides are subluxed at S3, some secondary movement is available at the S1 segments and may further alter apparent leg length.

Simple Diagnostic Point

- ◆ The single most relevant point to a diagnosis of dysfunction of the sacral x axis is that at the **posterior inferior iliac spine**.
- ◆ Even though a diagnosis can be made with identification of this critical point, almost nobody palpates for it.
- ◆ The PIIS is deep, immediately lateral and caudal to the PSIS, between the ilial and sacral origins of the gluteus maximus.

IMPAIRMENTS

ONE BASIC IMPAIRMENT
WITH FOUR VARIATIONS



Impairments

- ❖ The four basic variations of impairment
- ❖ The caudad slip at the S1 segment
- ❖ The lateral trunk shift

Impairment Objectives

- ❖ You will learn to identify the pathomechanics of the four major variations of the S3 subluxation.

SIJD Taxonomy

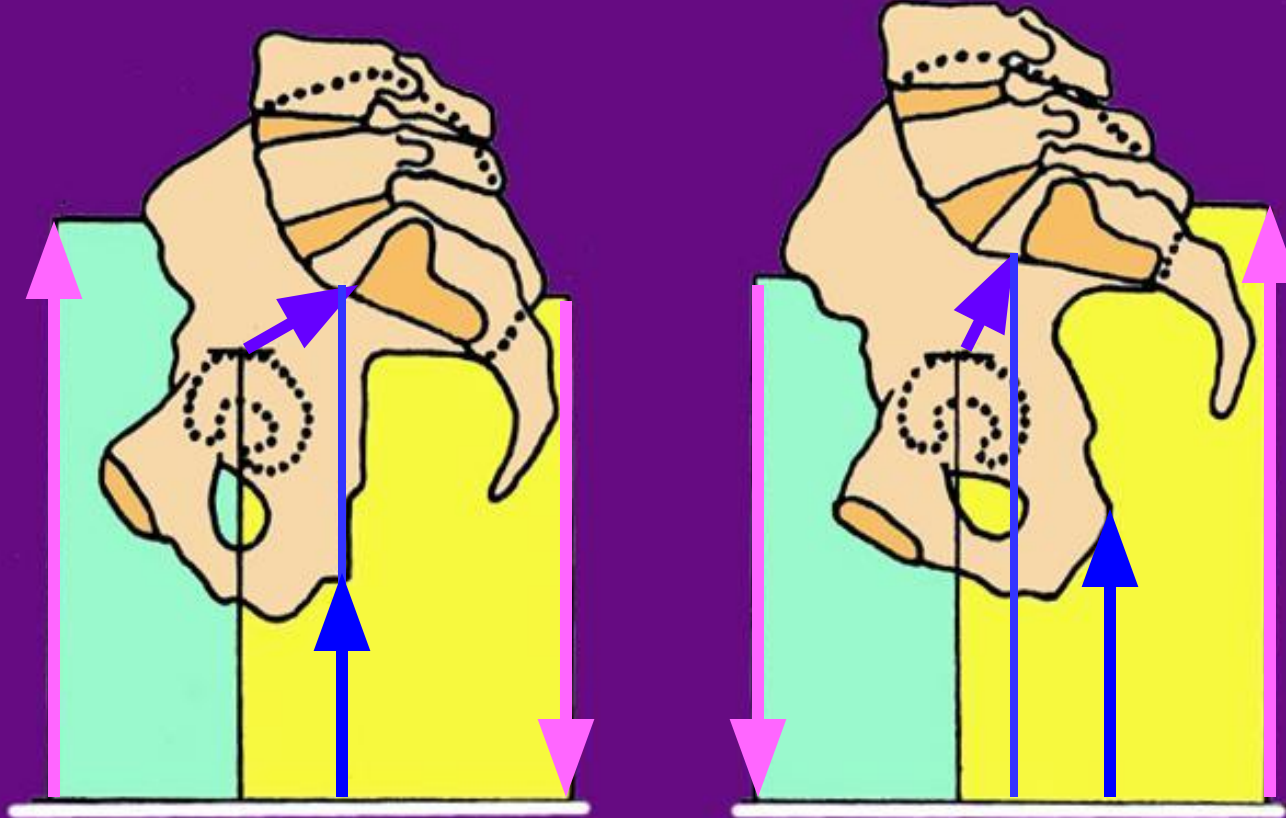
❖ Although all SIJD is essentially a pathological release of self-bracing with a cephalic subluxation of the innominates on the sacrum at the S3 sacral x axis, there are four basic manifestations, which may vary in severity. These are:

- ❖ 1. Bilateral symmetrical
- 2. Bilateral oblique (asymmetrical)
- 3. Unilateral oblique (asymmetrical)
- 4. Bilateral with a secondary caudad movement at the S1 sacral segment.

Basic Pelvic Movement With the S3 Subluxation

- ❖ The pelvis will rotate anteriorly on an acetabular axis causing the sacroiliac joint to rise relative to the acetabula.
- ❖ This causes the iliac crests to become higher when standing and the legs to appear longer when supine.

•PELVIC MOVEMENT WITH SIJD



•POSTERIOR ROTATION

•ANTERIOR ROTATION

•NOTE IN THE POSITION OF ANTERIOR ROTATION HOW THE SIJ RISES RELATIVE TO THE ACETABULA TO GIVE THE APPEARANCE OF AN INCREASE IN LEG LENGTH.

•DONTIGNY ©



Bilateral Symmetrical Lesion

- ❖ The innominates are rotated anteriorly increasing the lumbar lordosis and the lumbosacral angle.
- ❖ The sacrotuberous ligaments are loosened.
- ❖ Ligamentous balance is disrupted.
- ❖ The force couple is disabled.

Bilateral Symmetrical Lesion

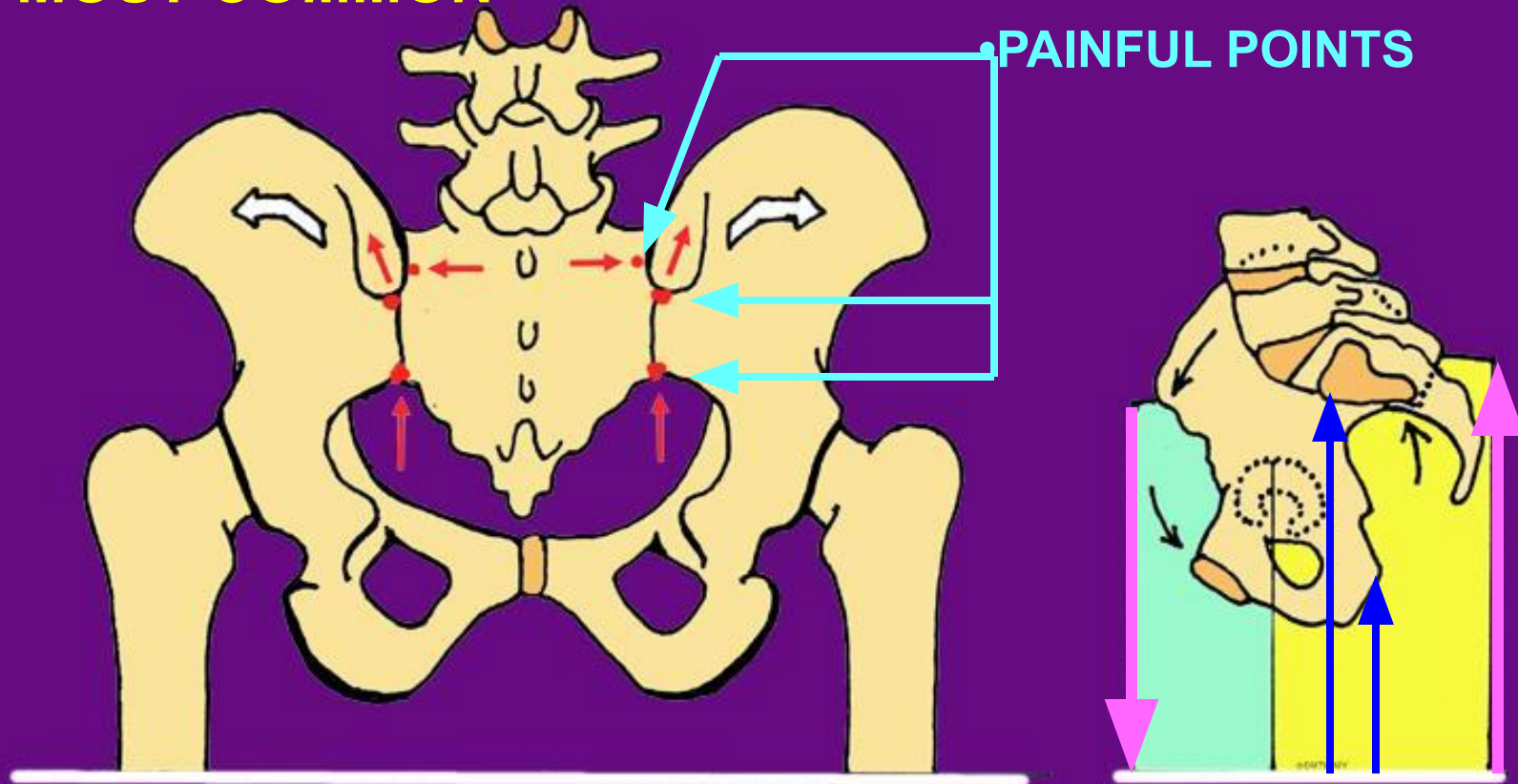
- ❖ The superincumbent weight increases the ventral tilt of the sacrum within the limits of the loosened sacrotuberous ligaments.
- ❖ The origins and insertions of the multifidus and sacrospinalis muscles are approximated and may result in a positional inhibition with atrophy.

Bilateral Symmetrical Lesion

- ❖ Both SIJs move cephalad and anteriorly relative to the acetabula increasing the height of the iliac crests and the apparent length of both legs.
- ❖ Posteriorly, the innominate bones move cephalad, laterally and anteriorly on the sacrum on the S3 sacral axis.
- ❖ Anteriorly, the ASISs and the pubes, with the innominates, move posteriorly and caudad on the S1 sacral segment.

•BILATERAL SUBLUXATION AT S3(SIJD)

- SYMMETRICAL
- MOST COMMON



- LUMBAR LORDOSIS IS USUALLY INCREASED
- TIGHTENED HAMSTRINGS MAY CAUSE A RECURVATUM

Bilateral Oblique Subluxation

- ❖ Asymmetric pelvic loading at the time of subluxation may cause the SIJs to sublux bilaterally, anteriorly and obliquely, one side more than the other.
- ❖ The oblique bilateral subluxation will cause an asymmetrical pelvis.

Bilateral Oblique Subluxation

- ❖ The resultant pelvic obliquity will stress the pelvic diaphragm.
- ❖ Both legs will appear to lengthen, one more than the other.
- ❖ This is similar to a unilateral SIJD, which is also asymmetrical, but far less common.

Unilateral Oblique Pelvis

- ❖ With a unilateral SIJD the sacrum moves above the acetabulum on one side making the crest and PSIS higher on that side when standing. The sacral base tilts away from the painful side.
- ❖ When supine, the sacral base is level and the leg on the painful side appears longer.
- ❖ This is less common than the bilateral SIJD, which can be symmetrical or asymmetrical.

- RIGHT SIJD STANDING

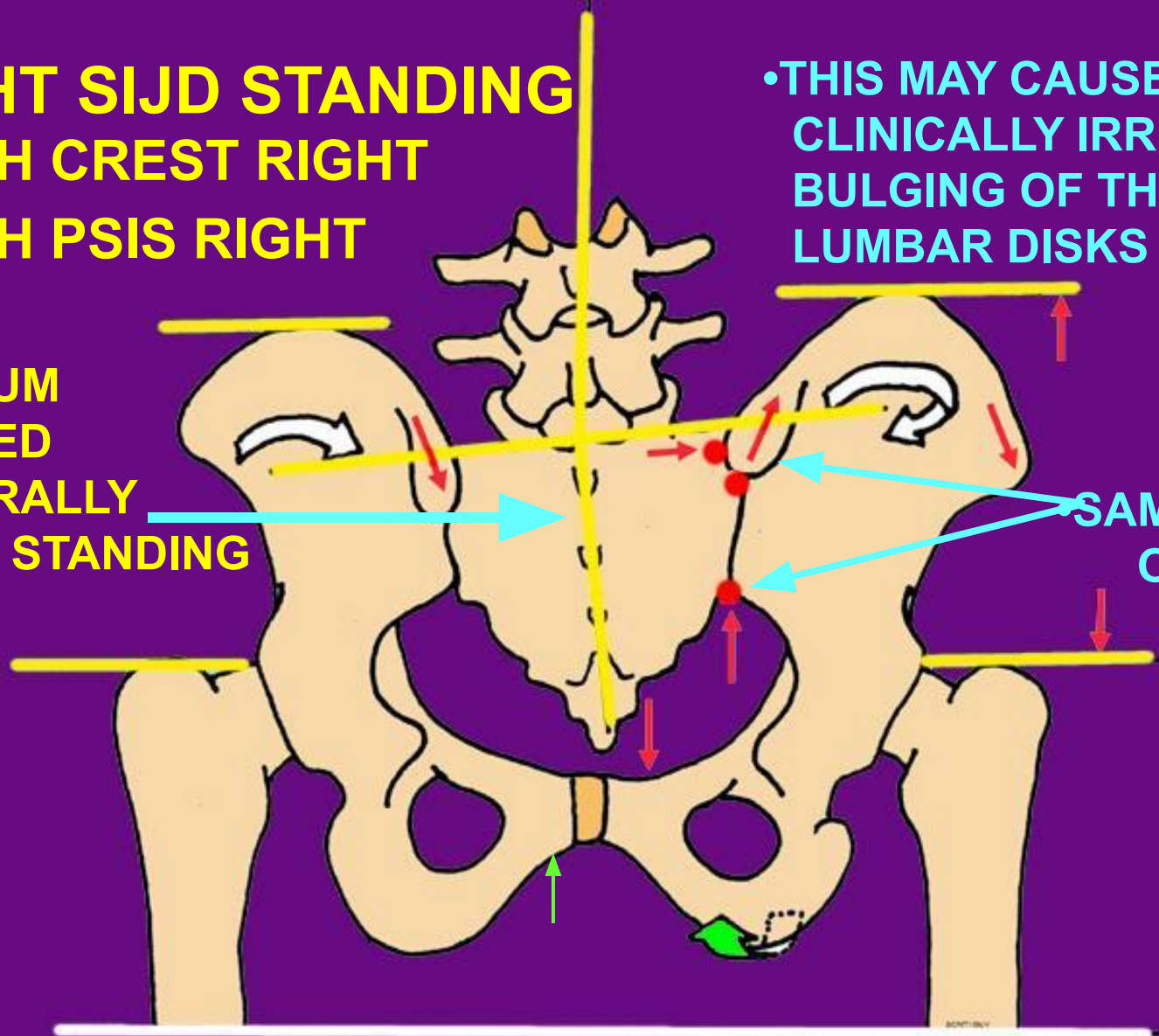
- HIGH CREST RIGHT

- HIGH PSIS RIGHT

- THIS MAY CAUSE SOME CLINICALLY IRRELEVANT BULGING OF THE LOWER LUMBAR DISKS

- SACRUM FLEXED
LATERALLY
WHEN STANDING

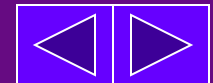
SAME POINTS
OF PAIN



- AMBULATES WITH AN APPARENT LONG LEG ON THE RIGHT

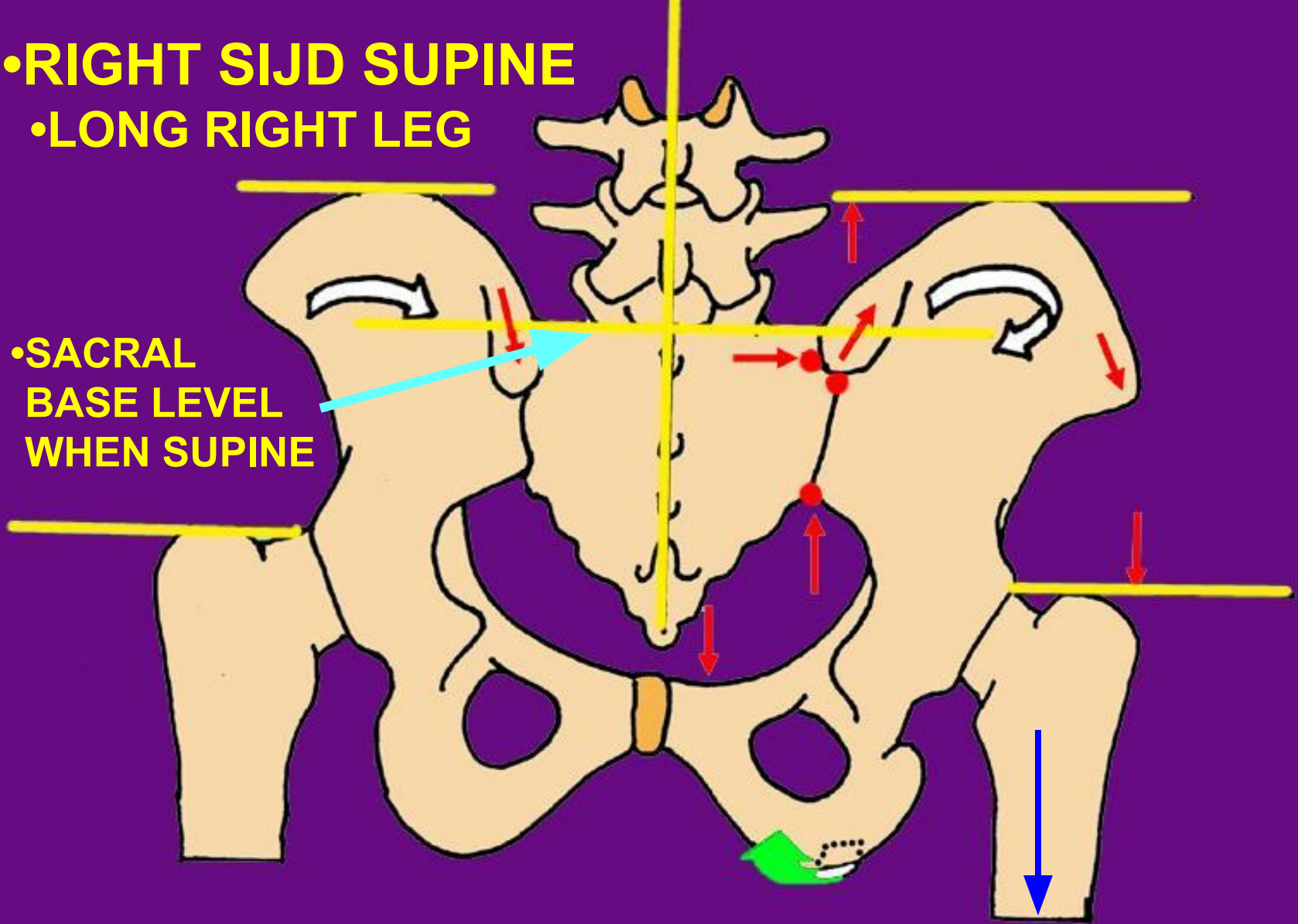
- LUMBAR SCOLIOSIS TO THE LEFT

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- RIGHT SIJD SUPINE
- LONG RIGHT LEG

•SACRAL
BASE LEVEL
WHEN SUPINE



Oblique Pelvis With Secondary Caudad Slip

- ❖ After a bilateral anterior subluxation, on one side gravity may cause the S1 sacral segment to slip caudad on the S1 ilial segment moving on a pathological axis at S3 and compromising the original lesion.
- ❖ The crest is lower on the more painful side when standing and the leg appears shorter on that side when supine.

Oblique Pelvis With a Secondary Caudad Slip

- ❖ This secondary movement only occurs with and after the bilateral subluxation at S3 and because of the variation in the angulations in the S1 and S3 segments.
- ❖ It may give the impression of an anterior dysfunction on one side and a posterior dysfunction on the other or an 'upslip' on one side or an out-flare on one side and an in-flare on the other.
- ❖ It is corrected in the same manner as a bilateral anterior subluxation.

Mechanics of the Compromised Caudad Slip

- ❖ The subluxation/fixation is at or near the S3 segment, the sacral x axis may be displaced and **can function as a pathological axis of rotation.**
- ❖ Some cephalad/caudad motion is still available at the S1 segment.
- ❖ While walking, on initial contact the S1 sacral segment may slip vertically caudad on the S1 ilial segment, moving on a pathological axis at the S3 segment.

Mechanics of the Compromised Caudad Slip (2)

- ❖ This might cause an empty feeling with increased pain and frequently causes a fall.
- ❖ The basic precipitating factor is a caudad movement of sacral S1 on ilial S1 and is actually a gravitational 'down-slipping' of the sacrum on the ilium at S1.

Mechanics of the Convexities and Concavities

- ❖ The convexities of the ilial surfaces always seek the concavities of the sacral surfaces.
- ❖ With bilateral anterior subluxation, the ilial convexities ride up out of the sacral concavities opening the joint slightly and spreading or 'flaring' the innominates.

Mechanics of the Convexities and Concavities (2)

- ❖ The sacrotuberous loosening allows S3 ilial to move up and slightly out of the S3 sacral axis.
- ❖ The anterior innominate rotation at S1 loosens the posterior interosseous ligaments allowing S1 ilial to move down and out of S1 sacral.
- ❖ The long posterior sacroiliac ligament is tightened.

Mechanics of the Convexities and Concavities (3)

✦ The secondary caudad shift of the sacrum at S1 reflects the ilial convexity of that segment seeking the sacral concavity as it moves with gravity against the loosened posterior interosseous ligaments.

✦ **In effect, the S1 segment has corrected itself.**

✦ All that is necessary now is to correct the subluxation at the S3 segment by moving the posterior aspect of the innominate caudad and medially on the sacrum.

Consequences of the Secondary Slip at S1

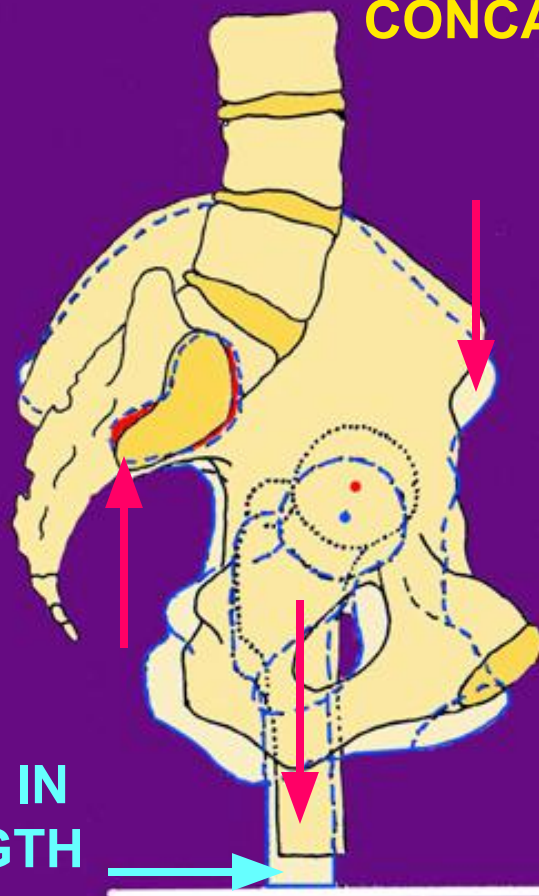
- ❖ The anterior aspect of the sacrum on that side moves caudad on the innominate at the S1 segment making the leg on that side appear to be shorter than the other when supine.
- ❖ The leg on that side can be manipulated to be longer than it was and make the legs to be of equal length, but all you have done is to manipulate the S1 segment into anterior rotation without correcting the subluxation at the S3 segment.

•SECONDARY CAUDAD SLIP OF SACRUM AT S1

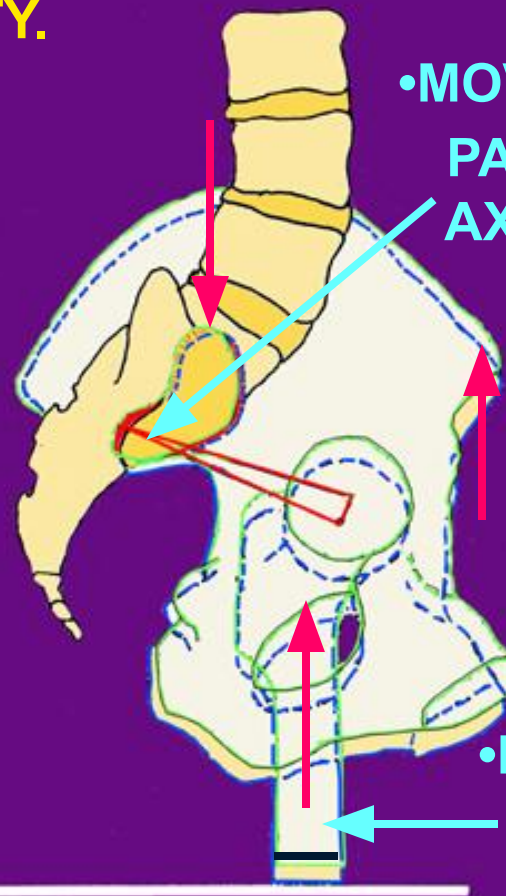
- PRIMARY S3
SUBLUXATION

- SECONDARY CAUDAD SLIP

- S1 ILIAL SLIPS BACK UP INTO ITS SACRAL
CONCAVITY.



- INCREASE IN
LEG LENGTH



- MOVEMENT ON
PATHOLOGICAL
AXIS AT S3

- DECREASE IN
LEG LENGTH

•THIS IS THE BASIS OF THE PAINFUL LATERAL SHIFT

•DONTIGNY ©



The Lateral Trunk Shift

- ❖ A symmetrical, bilateral subluxation at S3 may loosen the iliolumbar ligaments and destabilize L4-5 and L5-S1 to cause or increase a spondylolisthesis.
- ❖ Similarly the secondary caudad slip at S1 causes an asymmetry with an apparent short leg on the ipsilateral side.
- ❖ The iliolumbar ligaments are loosened, the lower vertebral segments destabilized and the trunk may shift laterally toward the side of the apparent short leg.

Lateral Trunk Shift (2)

- ❖ As the gluteus medius is inhibited with the innominate in anterior rotation, pelvic stabilization will be compromised during normal gait probably increasing impact loading on the femoral head of the apparent short leg.
- ❖ If the multifidus is compromised by a positional inhibition the spine would also tend to shift laterally toward the side of the apparent short leg.
- ❖ Vibrational tissue creep can exacerbate the asymmetric lesion.

Lateral Trunk Shift (3)

- ❖ If the lateral trunk shift remains uncorrected, secondary changes may occur that may slow recovery.
- ❖ These may include postural changes, changes in the resting position of the disk nucleus, fascial tightness and sarcomere subtraction of shortened intervertebral muscles.

•BILATERAL SIJD WITH CAUDAD SLIP AT S1

•STANDING

•RIGHT SIDE SLIP

•LOWER PSIS

•LOWER ILIAC CREST

•SHIFT

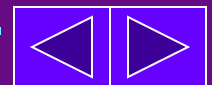
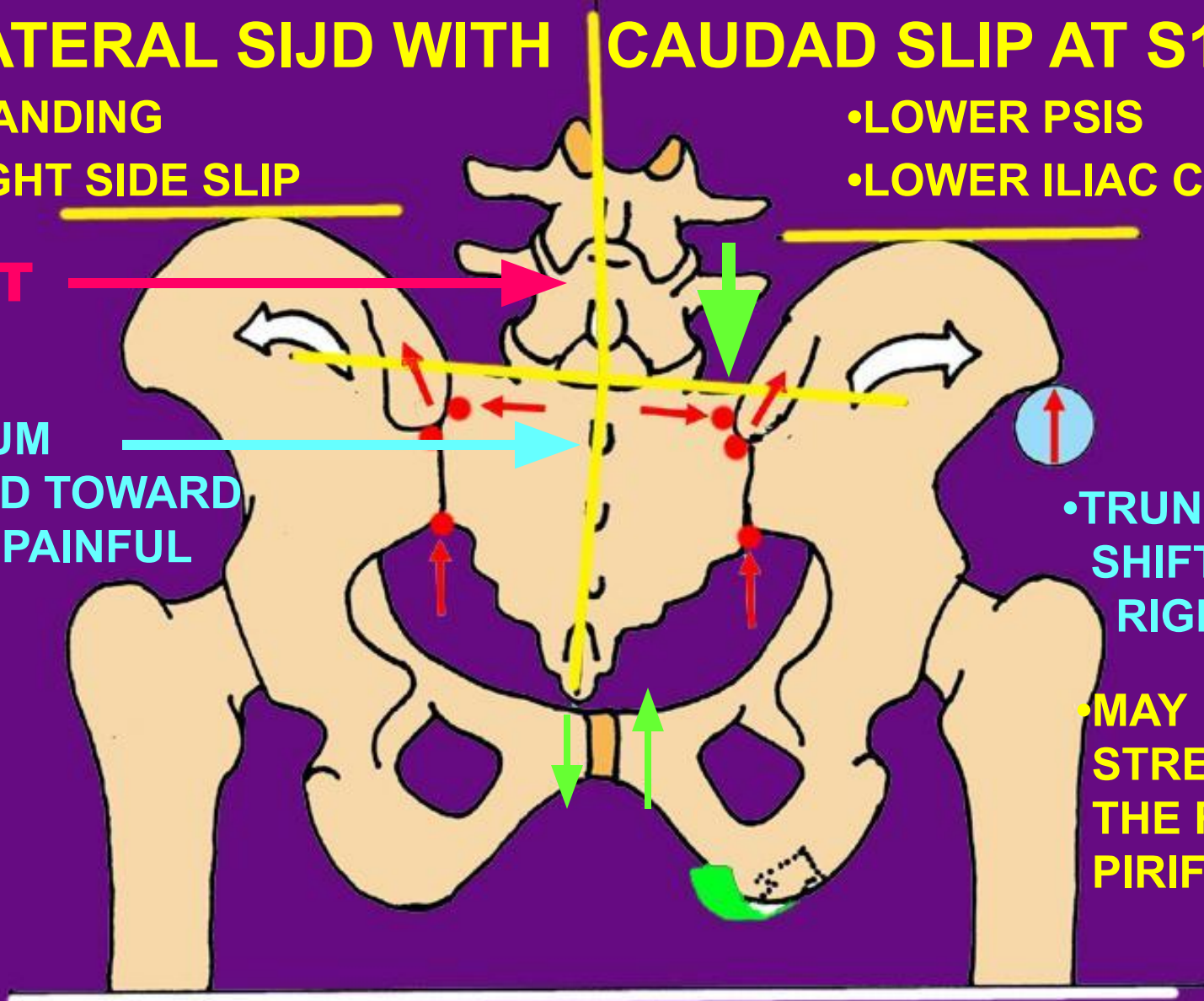
•SACRUM
FLEXED TOWARD
MORE PAINFUL
SIDE

•TRUNK MAY
SHIFT TO THE
RIGHT.

•MAY
STRETCH
THE RIGHT
PIRIFORMIS

•FREQUENTLY MISTAKEN FOR AN ANTERIOR DYSFUNCTION ON ONE
SIDE AND A POSTERIOR DYSFUNCTION ON THE OTHER.

•DONTIGNY ©



Further Complications

- ❖ The S3 subluxations will restrict SIJ motion posteriorly during activities that require reciprocal asymmetric movement such as walking and climbing stairs and increase stress anteriorly on the pubic symphysis.
- ❖ Decrease in function of the force couples will increase impact loading, may also be a factor in degenerative hip disease and/or idiopathic scoliosis.

Further Complications (2)

- ❖ An unstable sacral base or a sudden asymmetric dysfunction of the SIJ may cause an asymmetry in stabilization of the lumbar spine, even with relatively light loads.
- ❖ This may result in a lateral buckling of the lumbar spine as described by McGill.(64)

Various Descriptions of SIJD

- ❖ Some practitioners have described many varieties of SIJD with little or no regard to normal function, ligamentous constraints, the various types of normal movement, or the structural angulations of the joints.
- ❖ Inappropriate analysis of dysfunction obfuscates the problem, invalidates testing, leads to inappropriate treatment and delays recovery.

Suggested Dysfunctions

- ❖ Any practitioner who proposes the existence of these many and various lesions of the SIJ must be able to describe and illustrate them in detail in terms of the structural angulations of the SIJs, ligamentous involvement, biomechanics, onset and appropriate correction.

Special Note

- ❖ It does not matter if one leg is longer or shorter than the other, or if one pubis is higher or lower, or if the sacrum is laterally flexed or rotated, or if one iliac crest is higher or lower than the other.

Special Note

- ◆ All of these things are merely minor variations of the primary subluxation at the sacral axis.
- ◆ They will all be corrected, pelvic symmetry restored and pain relieved with manual correction of both of the innomimates to the balanced position on the sacrum.
- ◆ Correct the SIJD first and then reassess.

Special Note

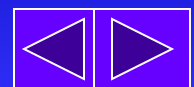
- ❖ The trunk may shift laterally over the apparent short leg that occurs with the secondary caudad slip at S1.
- ❖ The lateral trunk shift can also usually be corrected in two or three treatments with the correction of both innominates in posterior rotation to the position of dynamic ligamentous balance.

Special Note

- ❖ The oblique pelvis with an apparent long leg on one side can be a cause of lumbar scoliosis in pre-pubertal children.
- ❖ The S3 subluxation may occur in these children without c/o pain.
- ❖ If left uncorrected the canted sacral base will stimulate asymmetric development and can result in vertebral malformation.

EXAMINATION

LOOK FOR THE LEG LENGTH TO
SHORTEN WHEN YOU RESTORE
THE POSITION OF DYNAMIC
LIGAMENTOUS BALANCE.



Examination

- ❖ History
- ❖ Physical examination
- ❖ The PSLR test
- ❖ Restoration of the balanced position as a test that has the advantage of correcting the subluxation.

Examination Objectives

- ❖ To rule out potentially hazardous conditions.
- ❖ To determine the presence or absence of disk disease.
- ❖ To verify the presence of an S3 subluxation.
- ❖ To correct that subluxation.

History and Physical

- ❖ The history should identify whether the problem is insidious or traumatic.
- ❖ Identify any numbness or weakness in the extremities or loss of bowel or bladder control.
- ❖ Do a **relevant** PSLR test.
- ❖ Restore the balanced position and watch for changes in leg length

Negative Testing

- ❖ History and testing are important, but one prime indicator of SIJD is when essentially all conventional testing, x-rays, CAT scans, MRIs, and myelograms are negative. Frequently the only thing left is a subluxation at the S3 sacral axis.
- ❖ Unless the patient demonstrates obvious neurological deficits I believe that all scans, x-rays, MRIs and myelograms can safely be delayed until after correction of the SIJD.

Inadequacies of a Thorough Orthopaedic Examination

- ❖ This is a lesion that is overlooked about 85% of the time in the most comprehensive orthopaedic examination.
- ❖ Most present testing has low inter-rater correlation with little or no relationship to this dysfunction.
- ❖ The bias against any dysfunction of the sacroiliac joints is so ubiquitous and profound that any dysfunction here is usually not even considered.

Correct the Dysfunction and Then Reassess

- ❖ If you can gently correct the dysfunction with a posterior innominate rotation and the patient is immediately relieved of his/her pain it is far preferable to putting him/her through a wide range of testing that will fail to reveal the lesion.
- ❖ It is far more effective and revealing to attempt to correct the sacral x axis first and then reassess.

Examination

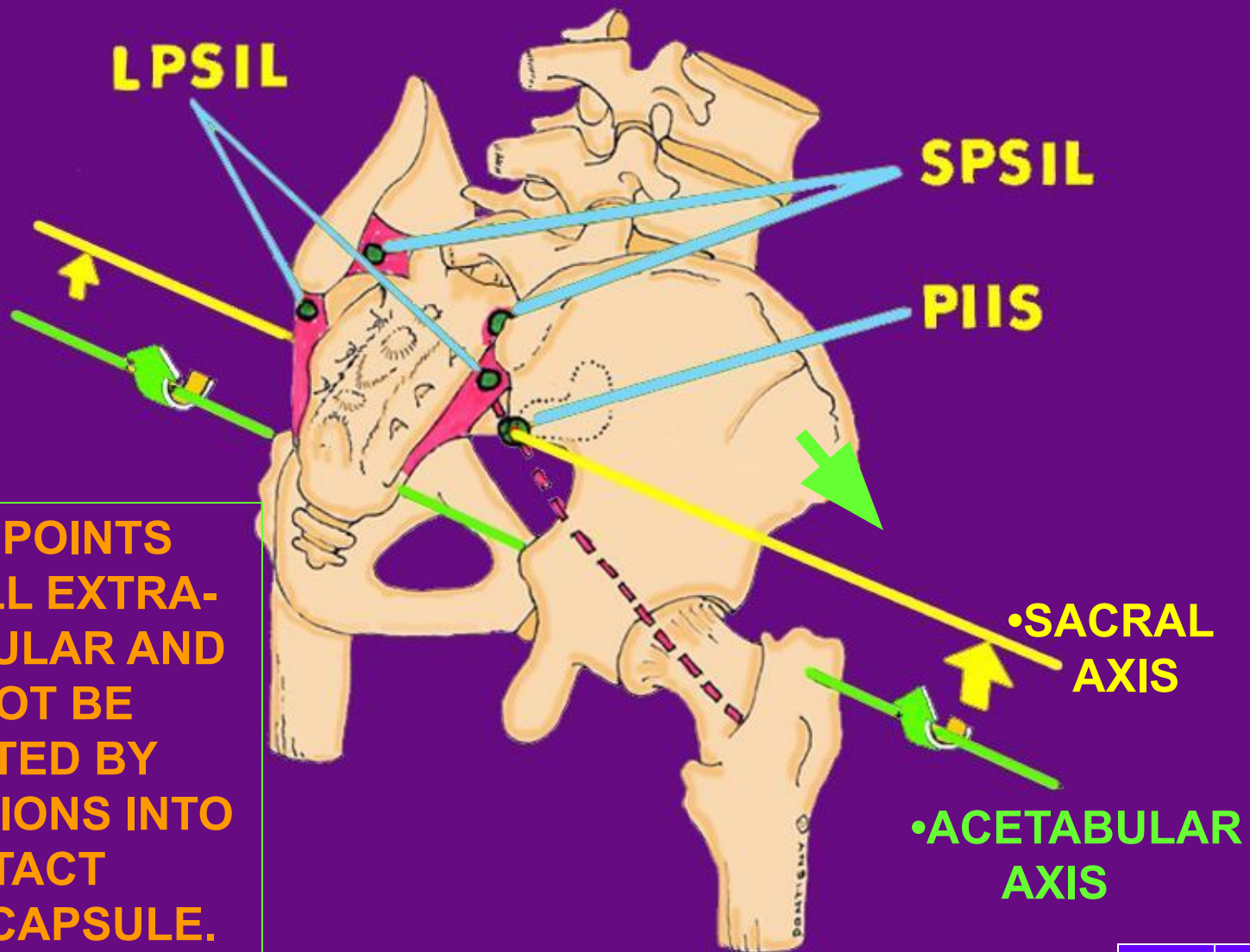
❖ The three most important signs of the subluxation at S3 are:

1. The primary painful points at the PIIS and the PSIS.
2. An appropriate PSLR test
3. The manner in which the legs appear to shorten and the pain is relieved with correction of the SIJs to the position of ligamentous balance.

Basic Painful Points

- ❖ There are a few painful points common to essentially all instances of the S3 subluxation, although the severity of the subluxation varies greatly and may involve many structures.
- ❖ Primary indication of SIJD is pain at the PIIS, and points medial and caudal to the PSIS.
- ❖ Loss of the function of the force couples may stress tissues in the back, pelvis and legs and cause secondary painful areas.

•PRIMARY PAINFUL POINTS COMMON TO ALL SIJD



•THESE POINTS ARE ALL EXTRA-ARTICULAR AND WILL NOT BE AFFECTED BY INJECTIONS INTO THE INTACT JOINT CAPSULE.

Tests

- ❖ Most tests now used to determine SIJD are based on an asymmetrical pelvis. As many cases of SIJD can be bilateral and symmetrical or bilateral and asymmetrical or unilateral and asymmetrical, these tests are usually inappropriate to the dysfunction.
- ❖ Tests should determine how and to what degree the dysfunction varies from normal function.
- ❖ First you must understand normal function.

Injectons

- ❖ Injections into the intact joint may become encapsulated and give a false negative result.
- ❖ It is far more effective to give injections into the surrounding tissues which are the most stressed. (85)

Injections

- ❖ Murakami et al used periarticular injections of local anesthetic on 25 patients with SJD and found the it was effective in **all** patients.
- ❖ In a comparable group, intraarticular injections were effective in 9 of 25 patients.
- ❖ An additional 16 patients who had no relief from the initial intraarticular injection were **all** relieved with a periarticular injection (85).

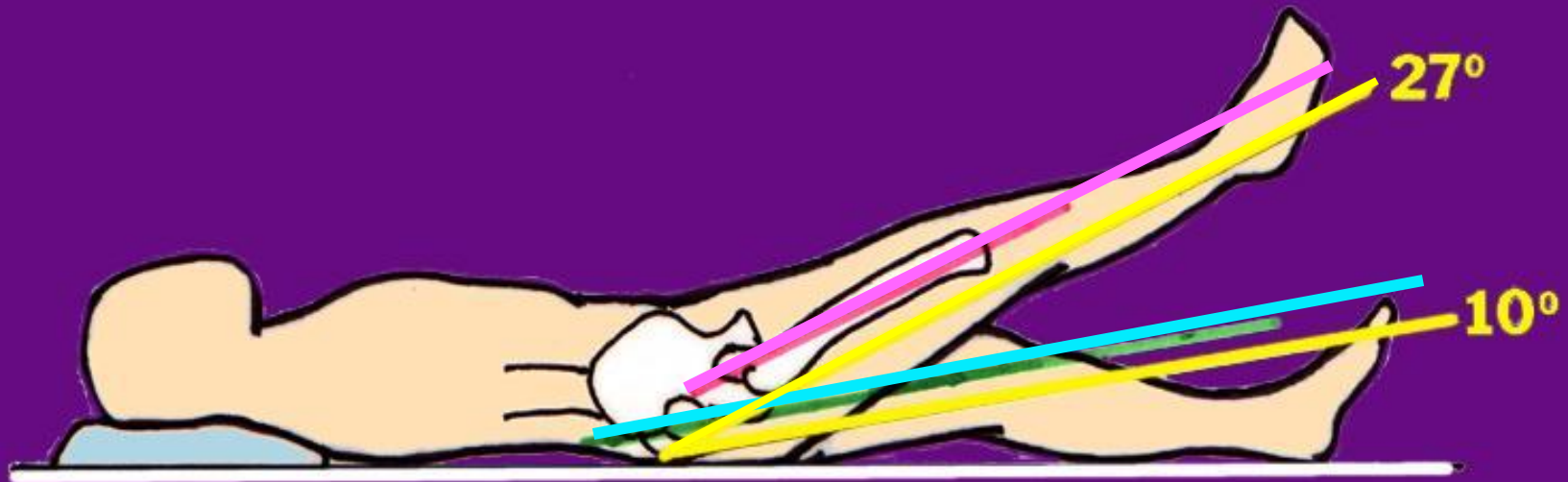
Injections

- ❖ The improvement rate after periarticular injection was 96% compared to 62% for the intraarticular injection (85).
- ❖ They concluded that for patients with SIJ pain, periarticular injection is more effective and easier to perform than the intraarticular injection and should be tried initially (85).

The PSLR Test

- ❖ The PSLR test has been used to determine the presence of sciatic pain in the leg, but can be helpful in evaluating the subluxation at S3.
- ❖ Bohannon measured pelvic movement occurring with PSLR (48)
- ❖ A 'positive' PSLR may not have any relationship to disc disease.

- **PASSIVE PELVIC MOVEMENT WITH PSLR**
- **EVERY 2.7 DEGREES OF PSLR/HORIZONTAL IS ACCOMPANIED BY 1.7 DEGREES OF PSLR/PELVIC ANGLE AND 1 DEGREE OF PELVIC ROTATION TO THE HORIZONTAL (48)**



- **PELVIC ROTATION OF THE INNOMINATE ON THE SACRUM OCCURRED IN EVERY SUBJECT BY 9 DEGREES OF PSLR AND USUALLY BEFORE 4 DEGREES. (48)**

Lasegues Sign

- ❖ Pain or limitation of motion with PSLR that is increased with passive dorsiflexion indicates a sciatic neuritis.
- ❖ This may be disc related or caused by pain or spasm in the piriformis muscle.
- ❖ As the sciatic nerve passes just beneath and oft times infiltrates this muscle, it can be affected by pain or spasm of this muscle.

Interpretation Of PSLR Tests

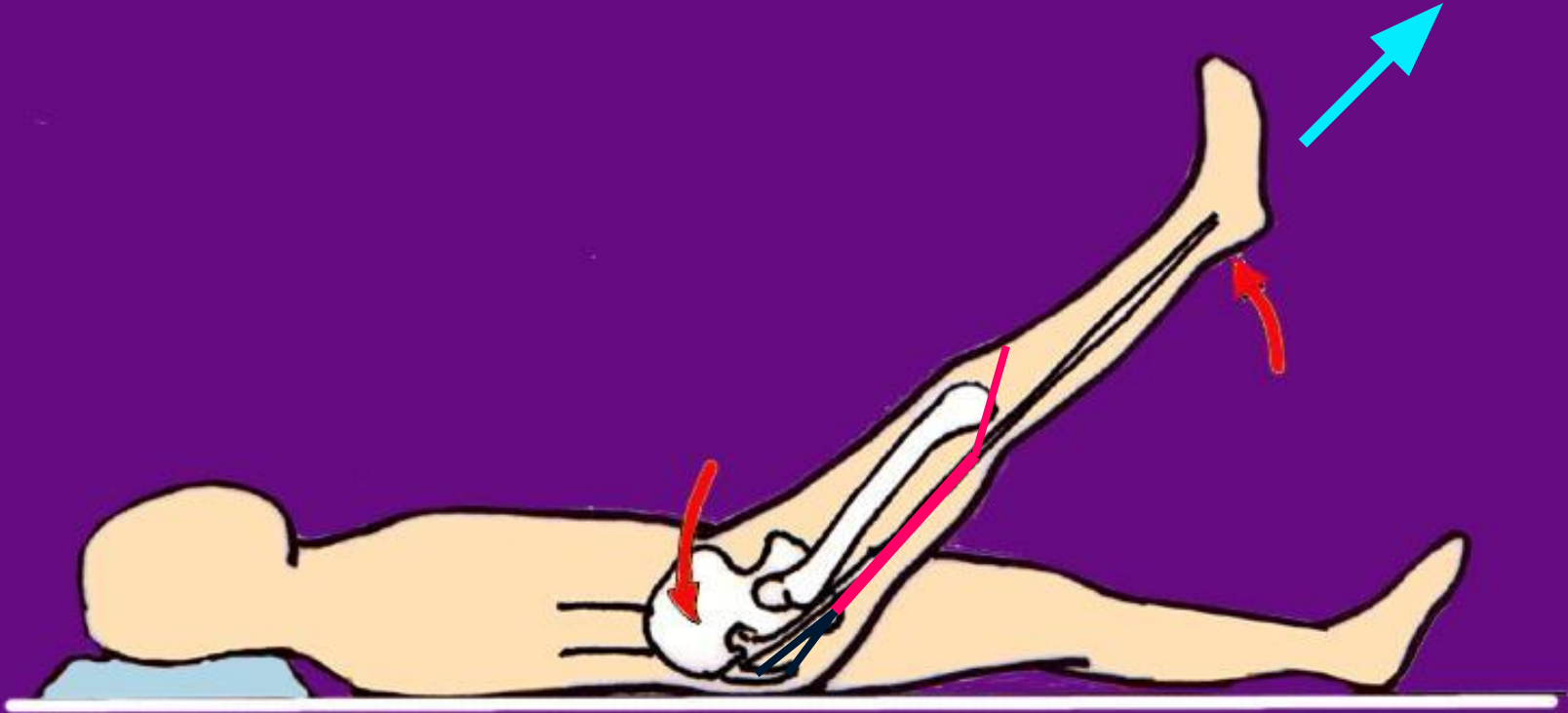
- ❖ PSLR may **ease** the pain of this subluxation by rotating the innominates posteriorly on the sacrum.
- ❖ If PSLR increases ipsilateral pain in the low back an anterior subluxation with a compromised caudad sacral slip at S1 is indicated.

Interpretation Of PSLR Tests

- ❖ Contralateral pain in the low back with PSLR indicates a subluxation in anterior rotation on that side.
- ❖ With bilateral subluxations it is possible to have bilateral contralateral pain with PSLR.

•PSLR INTERPRETATIONS

- PSLR MAY EASE THE PAIN OF SIJD BY ROTATING THE INNOMINATE POSTERIORLY ON THE SACRUM



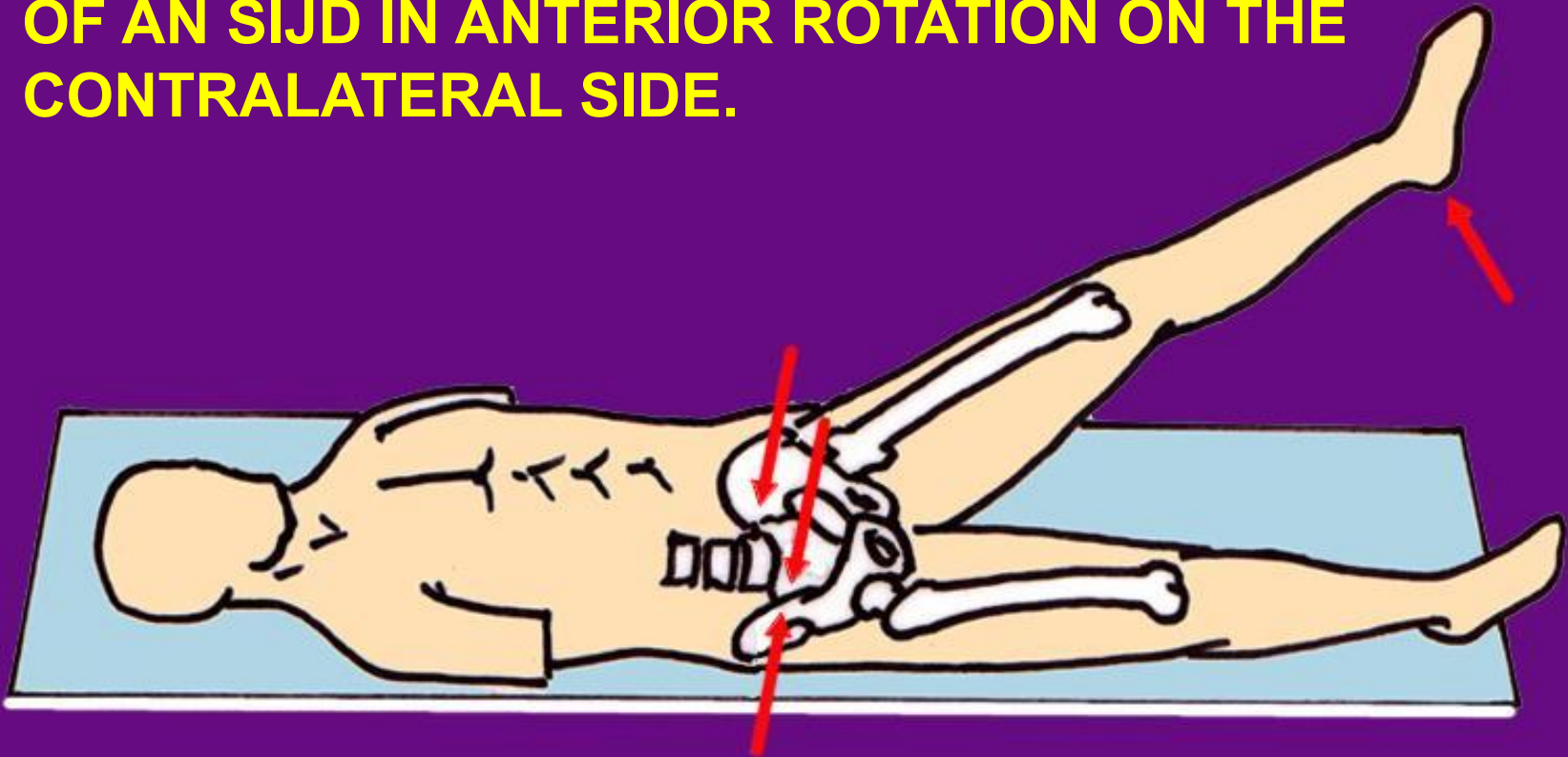
- THIS CAN BE COMBINED WITH TRACTION ON THE LEG IN THE LONG AXIS TO CORRECT THE DYSFUNCTION

PSLR Interpretations

- ❖ If PSLR causes pain on the contralateral side it indicates an anterior rotation on that side.
- ❖ As the leg is lifted it rotates the innominate bone posteriorly which in turn carries the sacrum posteriorly on the contralateral side.
- ❖ This is the same as moving the contralateral innominate anteriorly.

•PSLR INTERPRETATIONS

- CONTRALATERAL PAIN WITH PSLR IS INDICATIVE OF AN SIJD IN ANTERIOR ROTATION ON THE CONTRALATERAL SIDE.



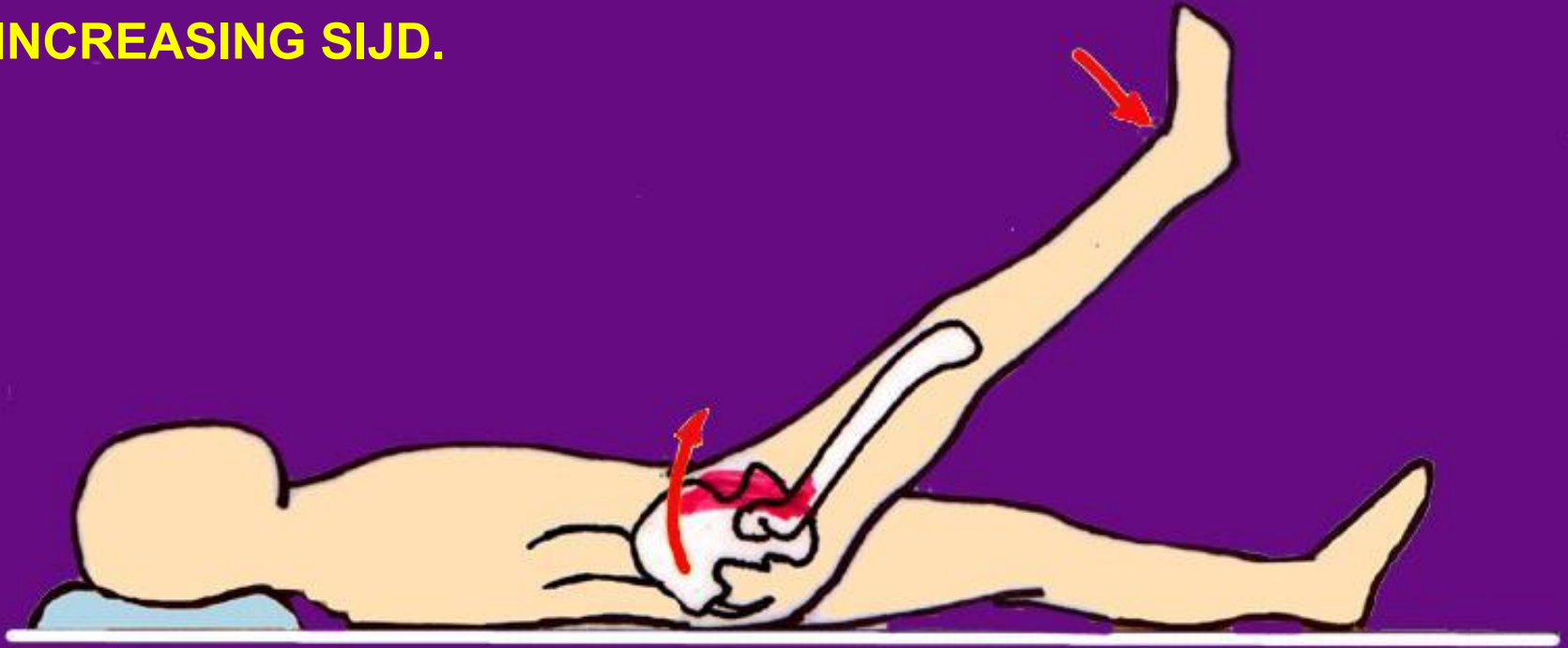
- PSLR CARRIES THE SACRUM POSTERIORLY ON THE CONTRALATERAL SIDE INCREASING THE STRESS IN ANTERIOR ROTATION ON THAT SIDE.

PSLR Tests (Continued)

- ❖ After PSLR if the patient has pain in the back while lowering the leg, a subluxation is indicated.
- ❖ The iliacus pulls the innominate anteriorly increasing the subluxation.
- ❖ This mechanism also causes pain with active straight leg raising.
- ❖ Have the patient stabilize with the abdominals and then raise or lower the leg.

•PSLR INTERPRETATIONS

- INCREASED BACK PAIN WHILE LOWERING THE LEG IS BECAUSE THE PATIENT IS HOLDING BACK WITH THE HIP FLEXORS INCREASING SIJD.



- PAIN IS EASED IF THE PATIENT LIFTS THE HEAD TO TIGHTEN THE ABDOMINALS TO STABILIZE THE PELVIS WHILE LOWERING THE LEG, OR ACTIVELY LOWERS THE LEG AGAINST RESISTANCE.

Active Straight Leg Raising

- ❖ Active straight leg raising can precipitate or increase pain in the low back because the pull of the iliacus on the innominates pulls the innominates anteriorly and increases the subluxation.
- ❖ Bilateral active straight leg raising is contra indicated unless you are first able to stabilize the anterior pelvis in flexion with a strong force from the abdominal muscles.
- ❖ Remember that the SIJs are not stable when supine and the sacrum is unloaded.

Active Straight Leg Raising (2)

- ❖ A painful or positional inhibition of the hip flexors may occur with active straight leg raising.
- ❖ To determine if this is related to the subluxation or neurological, have the patient lift his or her head, tighten the abdominal muscles and then try to actively raise the leg.
- ❖ Or have the examiner stabilize the innominate on the sacrum by holding it in posterior rotation and then try to actively raise the leg.

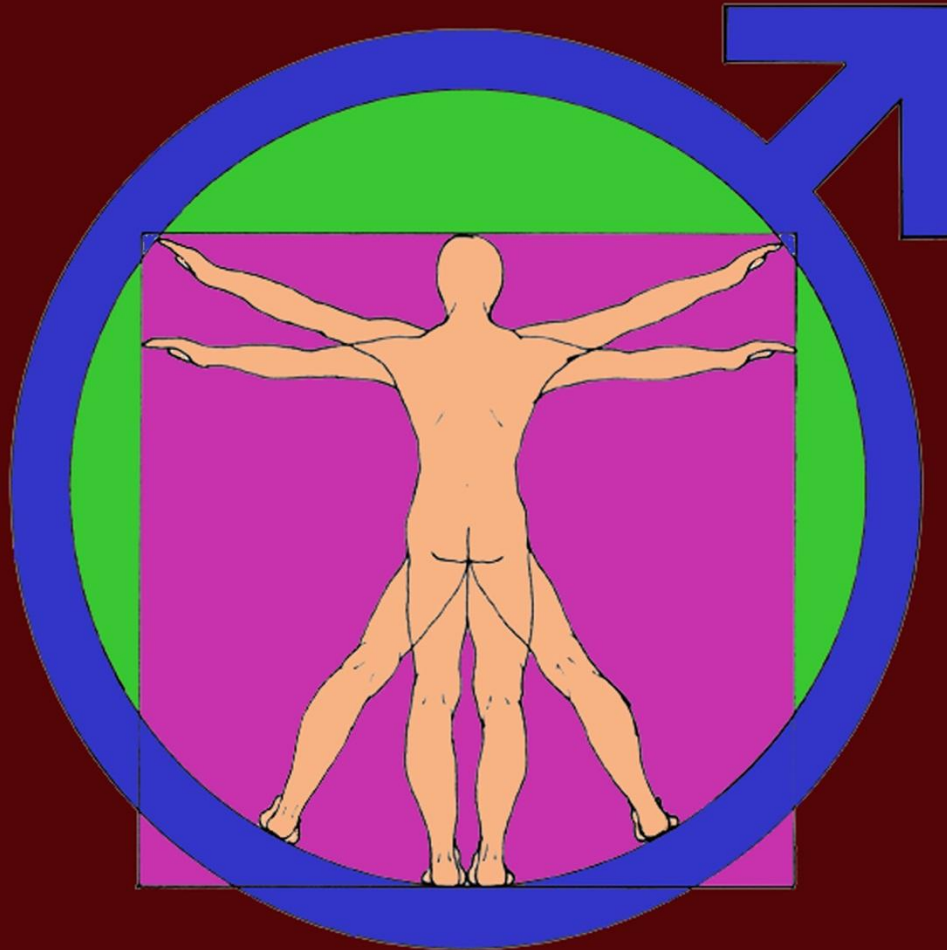
Active Straight Leg Raising (3)

- ❖ Similar to active straight leg raising, climbing steps may increase pain from the subluxation.
- ❖ Raising the trailing leg to the next step may increase pain because the weight of the leg hangs from the innominate bone and may increase anterior innominate rotation.
- ❖ Use strong abdominal support to maintain self-bracing while climbing steps to prevent increasing low back pain.

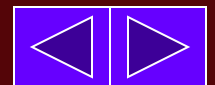
Restoration of the position of ligamentous balance as a test

- ❖ As apparent leg length always appears to get longer with the pathological release of the balanced position, then a controlled movement to cause the innominate to move caudad and medially on the sacrum will cause the legs to appear to shorten.
- ❖ The shortening of the legs is a positive test that also serves to correct the dysfunction.

- TAKE ANOTHER
BREAK

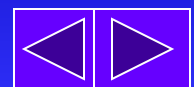


- DONTIGNY ©



INTERVENTIONS

CORRECTION OF THE SUBLUXATION



Interventions

- ❖ The traction correction
- ❖ The direct correction
- ❖ The isometric correction
- ❖ How to check the leg length
- ❖ X-ray evidence of correction
- ❖ Patient self management
- ❖ Exercising on the asymmetric pelvis

Intervention Objectives

- ❖ To perform the various methods of correction of the subluxation of the sacral axis.
- ❖ Explain differences in apparent leg length.
- ❖ Proficiency in a corrective exercise program.
- ❖ Review proper posture and lifting procedures.
- ❖ Recognize changes in gait.
- ❖ Describe proper use of supports.

Initial Treatment

❖ SIJD is essentially always a pathological release of the balanced position with an anterior rotation of the innominates on the sacrum.

❖ Treatment is simply restoring the SIJs to the balanced position by rotating the posterior aspect of the innominates caudad and medially on the sacrum to correct the subluxations at S3.

❖ The legs will always appear to shorten with correction of the subluxation to the balanced position.

Clinical Basis of Treatment

- ❖ As with the subluxation/dislocation of any joint, the first priority is to reduce the subluxation.
- ❖ If the subluxation tends to recur, the patient can be taught to self-correct.
- ❖ If the lesion is unstable, a lumbosacral support or invasive procedures may be necessary.

Assessing Leg Length

- ❖ First you must assess the **apparent** leg length.
- ❖ With the patient supine grasp the ankles with a saddle grip, abduct the legs from 15-18 inches, bring them together in the mid-line and approximate the malleoli.
- ❖ Do not look at the ankles until you have them in the midline.
- ❖ The leg length will become easier to assess if you hold the medial side of each thumb just below each medial malleolus.

The Nature of the Correction

- ❖ The corrective procedure is not a vertebral manipulation.
- ❖ No high or low speed manipulative thrust is necessary or indicated.
- ❖ No jerking or popping or twisting is necessary or desirable.

Manual Correction of the S3 Subluxation

- ❖ Any of several similar methods can be used to restore the SIJ to the self-bracing position.
- ❖ Traction at about 35-45 degrees of PSLR.
- ❖ Direct posterior rotation, either knee to axilla or simply by grasping the innominate bone and rotating it.
- ❖ Or by using isometric or muscle energy techniques.

Sequence of Correction

- ❖ Many low back pain patients have been put through much arduous and non-revealing testing.
- ❖ I highly recommend beginning with the least vigorous corrections first until the patient is assured that these corrections will help and not hurt him or her.
- ❖ Begin with traction correction, then a direct correction and finally the isometric correction.

Correction And Confirmation

- ❖ It does not matter if one leg appears to be longer or shorter on the more painful side or if the legs appear to be of equal length, they will always appear to get shorter with correction of the SIJs to the self-bracing position.
- ❖ If there is no history of a congenital leg length difference, polio or serious leg fracture the legs will appear to be of equal length after correction.

Manual Correction (One)

- ❖ Stand to one side of the patient, lift one leg to about 45 degrees and put enough traction on that leg in the long axis in the sagittal plane to raise the buttock on that side. Have patient lift head and tighten abdominal muscles during distraction.
- ❖ Lower the leg gently and then compare the leg length again.

Manual Correction (Two)

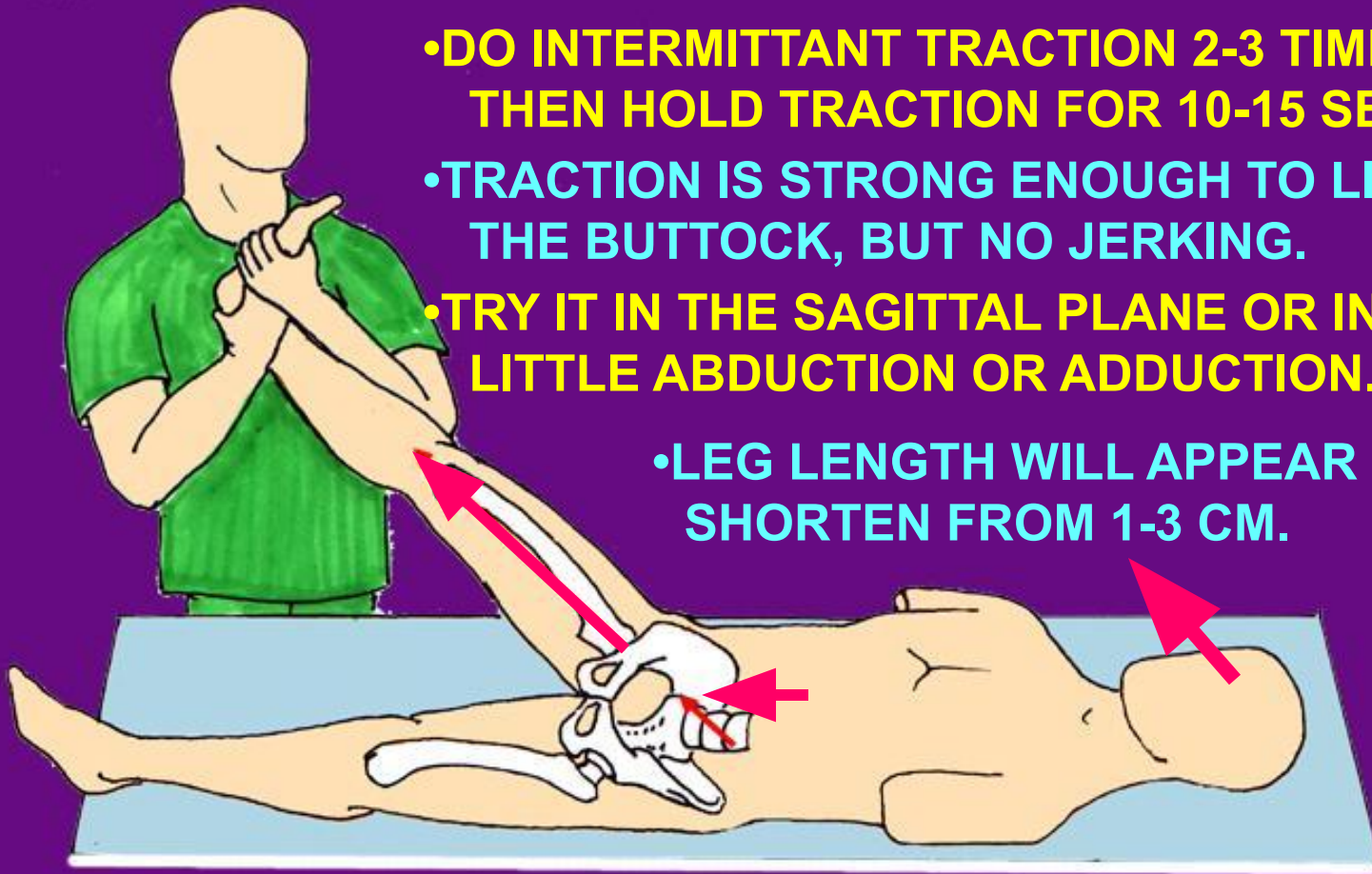
- ❖ If the patient attempts to lower the leg actively without stabilizing the pelvis with the abdominal muscles, the weight of the leg may pull the SIJ anteriorly again and causing a “pop”.
- ❖ The patient must always hold a strong posterior pelvic tilt when lifting and lowering the leg and during the correction.

Correction (Three)

- ❖ Repeat the procedure on the other leg.
- ❖ Continue to repeat the procedure alternating with each leg several times and continue monitoring the change in leg length, not only until the legs appear to be of equal length, but **until the leg length no longer changes.**
- ❖ Then try one of the other procedures to see if you can gain any more correction.
- ❖ **Always treat both sides**

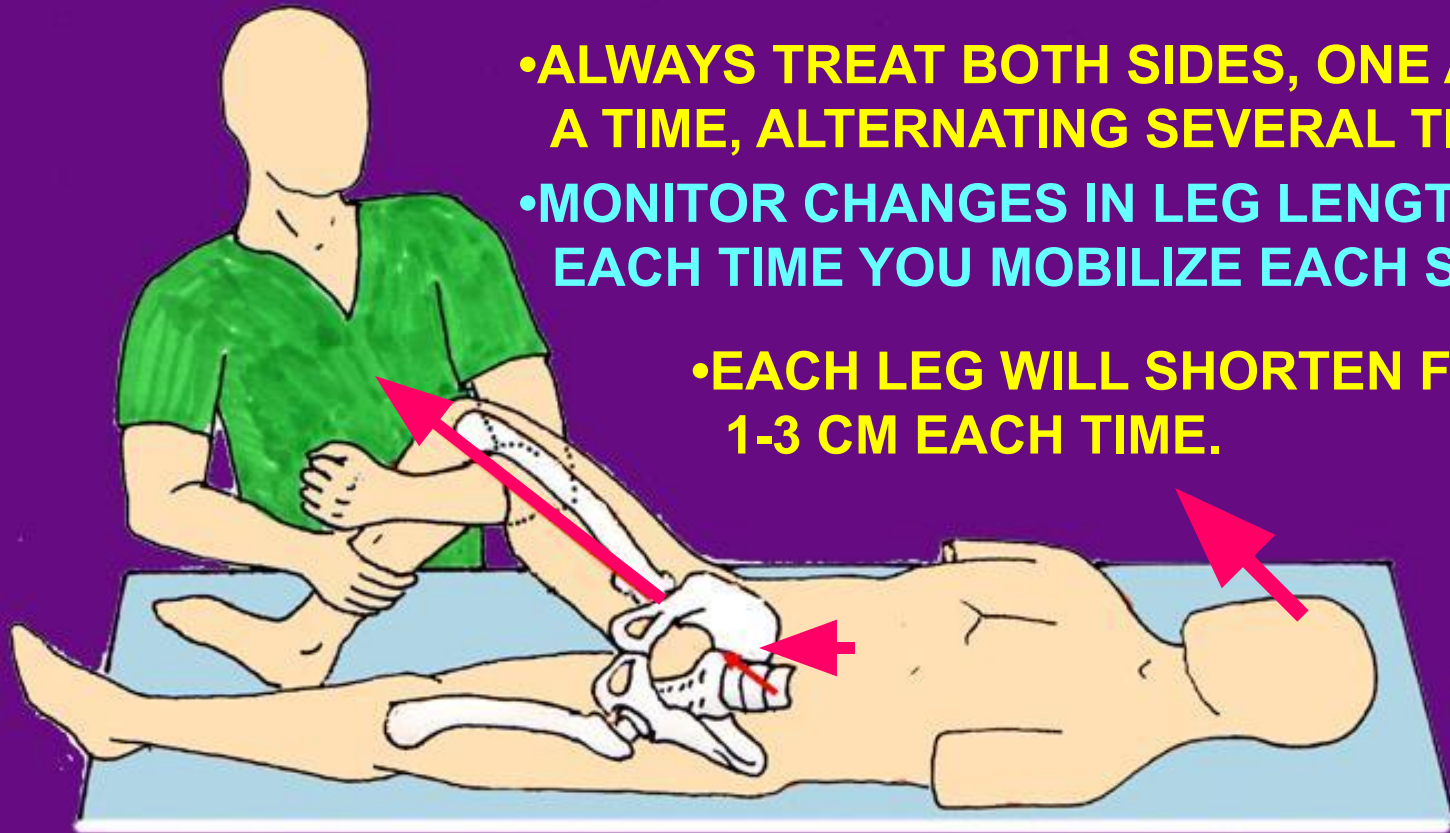
•TRACTION REDUCTION OF S3 SUBLUXATION (SIJD)

- DO INTERMITTANT TRACTION 2-3 TIMES THEN HOLD TRACTION FOR 10-15 SECONDS.
- TRACTION IS STRONG ENOUGH TO LIFT THE BUTTOCK, BUT NO JERKING.
- TRY IT IN THE SAGITTAL PLANE OR IN A LITTLE ABDUCTION OR ADDUCTION.
- LEG LENGTH WILL APPEAR TO SHORTEN FROM 1-3 CM.



- ALWAYS REPEAT THE PROCEDURE ON THE OTHER LEG, ALTERNATING RIGHT LEG, LEFT LEG, RIGHT LEG AT LEAST 4-5 TIMES.
- (HAVE THE PATIENT LIFT HIS HEAD TO TIGHTEN HIS ABS DURING TRACTION)

•ALTERNATE METHOD OF CORRECTION



- ALWAYS TREAT BOTH SIDES, ONE AT A TIME, ALTERNATING SEVERAL TIMES.
- MONITOR CHANGES IN LEG LENGTH EACH TIME YOU MOBILIZE EACH SIDE.
- EACH LEG WILL SHORTEN FROM 1-3 CM EACH TIME.

•DO NOT STOP CORRECTING WHEN THE LEGS APPEAR JUST TO BE OF EQUAL LENGTH, BUT ONLY AFTER THE LEGS **NO LONGER APPEAR TO SHORTEN**. THIS MAY TAKE SEVERAL ATTEMPTS AT CORRECTION ON EACH SIDE.

•THE EZ FIX ALTERNATE CORRECTION

- APPLY ONLY ENOUGH PRESSURE TO THE LEG TO KEEP IT FROM STRAIGHTENING

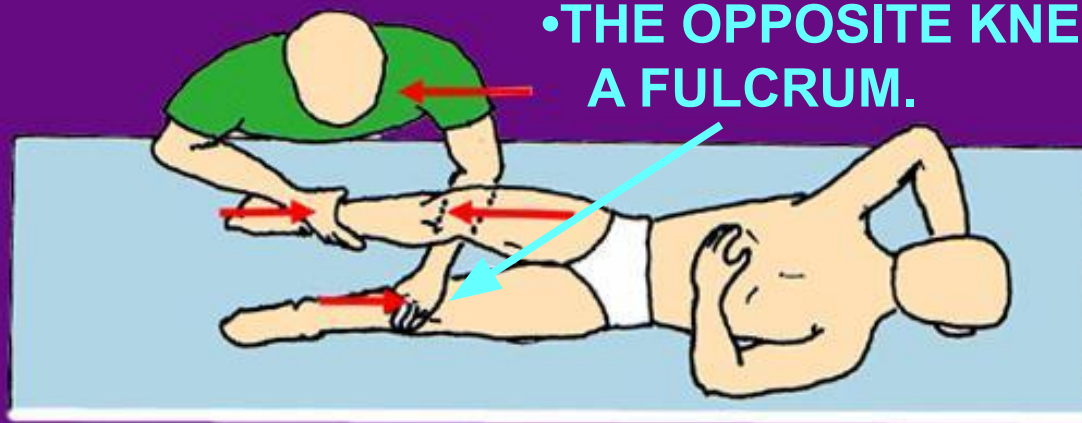
•SIDE



- TRACTION IS APPLIED BEHIND ONE KNEE WHILE USING THE OTHER KNEE AS A FULCRUM.
- ALWAYS TREAT BOTH SIDES SEVERAL TIMES, ALTERNATING

•LEAN BACK TO APPLY STRONG TRACTION

•TOP



- THE OPPOSITE KNEE IS USED AS A FULCRUM.

•THIS IS AN EXCEPTIONALLY NICE PROCEDURE. EASY TO APPLY STRONG TRACTION AND VERY WELL TOLERATED.

•DONTIGNY ©

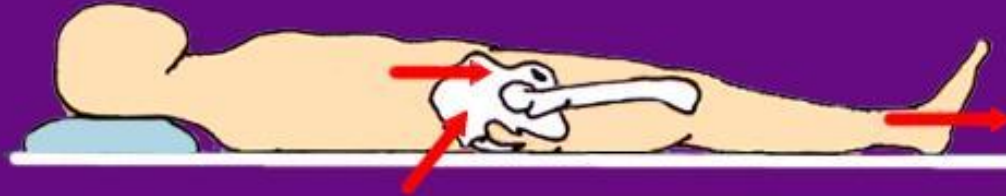


SPECIAL NOTE

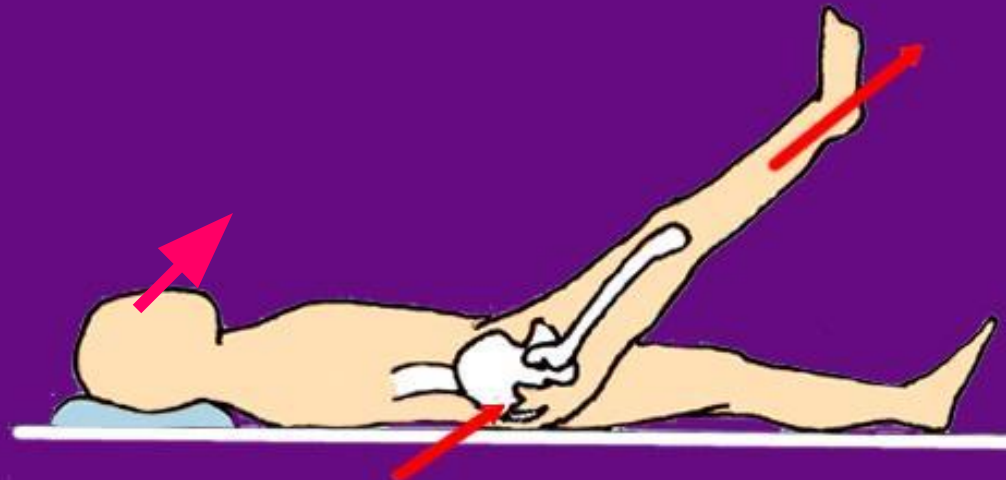
- ❖ If a leg appears to get longer after an attempt at correction, you have only caused the S1 area of the ilial surface to move caudad on the S1 area of the sacral surface and you did not get a correction at the S3 segment.
- ❖ You must move S3 ilial caudad on S3 sacral and the leg will appear to shorten with correction.

•CAUTION

- IF YOU PUT TRACTION ON THE LEG IN THE LONG AXIS OF THE BODY YOU WILL ONLY CORRECT A SECONDARY CAUDAL SLIP AT S1.



- THIS WILL CHANGE THE PAIN IN THE SIJ, BUT WILL NOT CORRECT THE BILATERAL SUBLUXATION AT S3.



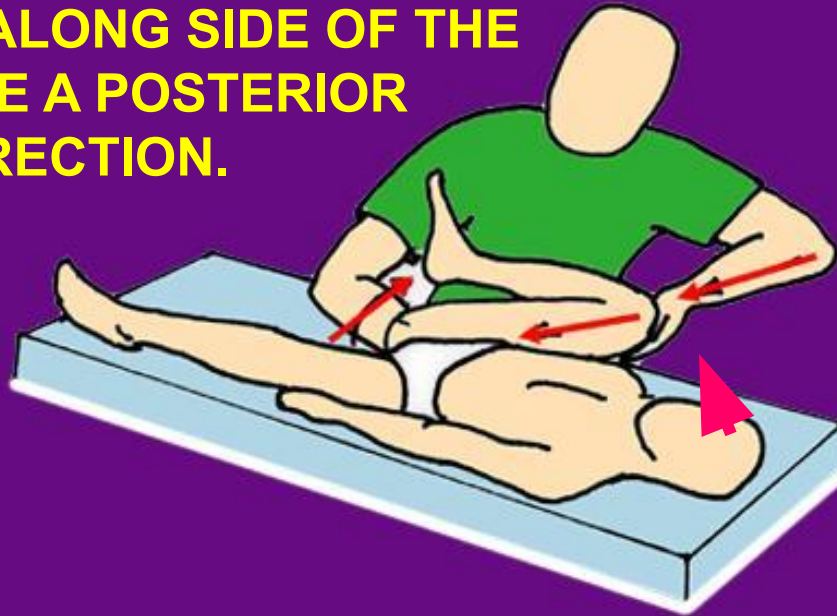
- TRACTION MUST BE APPLIED IN THE LONG AXIS WITH THE LEG AT ABOUT 45-50 DEGREES OF PSLR TO CORRECT SIJD.

Manual Rotation

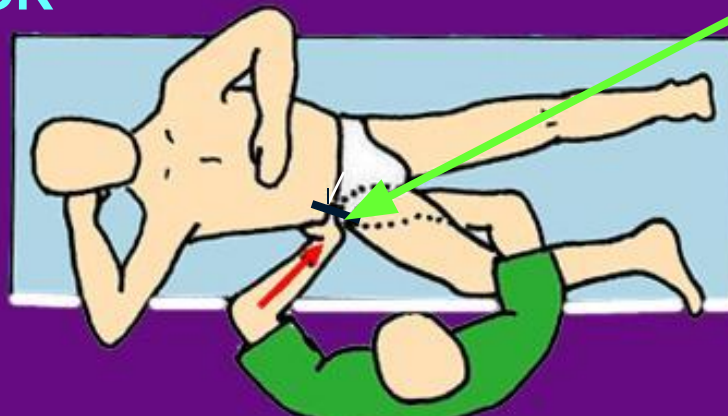
- ❖ Correction can be achieved by flexing the knee into the axilla, which flexes the pelvis on the spine whereas knee to chest flexes the pelvis and the spine.
- ❖ The innominate bone can also be rotated by reaching one hand under the ischial tuberosity and buttock and the other on the posterior aspect of the iliac crest, then rotate it so as to cause the innominate to move caudad and medially on the sacrum.

•MORE ALTERNATE METHODS

- FLEX THE KNEE ALONG SIDE OF THE CHEST TO CAUSE A POSTERIOR SHEARING CORRECTION.



- DIRECT POSTERIOR ROTATION OF THE INNOMINATE ON THE SACRUM



MOBILIZING HAND IS PLACED ON THE BACK PART OF THE ILIAC CREST

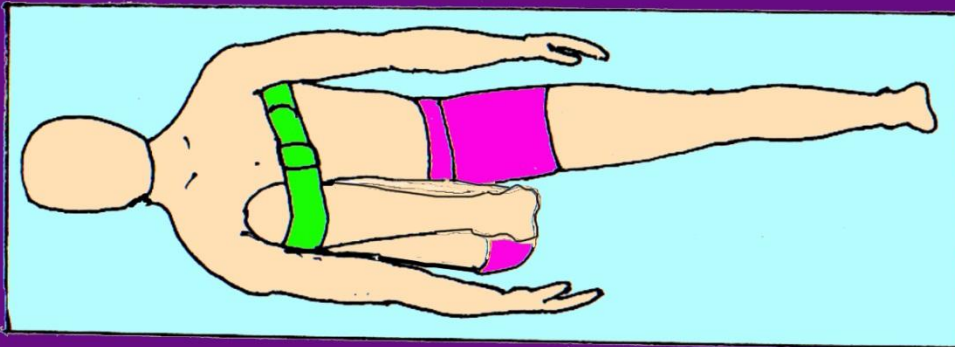
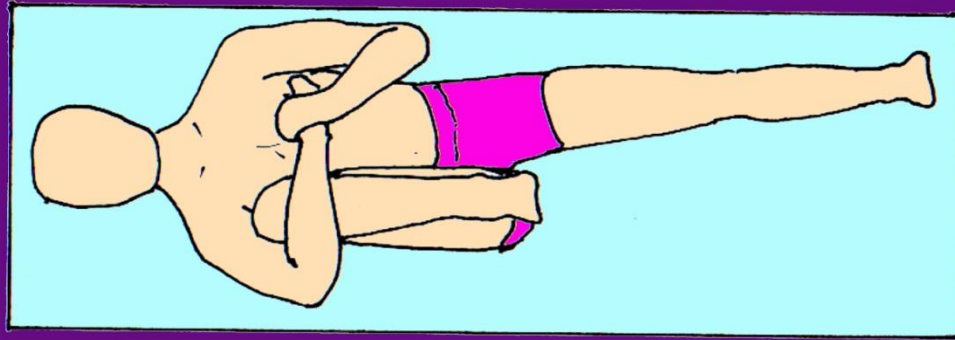
- GRASP THE PELVIS DIRECTLY AND MOBILIZE TO CAUSE THE BACK OF THE INNOMINATE TO ROTATE CAUDAD AND MEDIALY ON THE SACRUM.

Isometric Correction

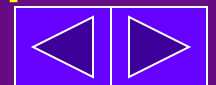
- ❖ On large or muscular individuals a direct correction may be difficult.
- ❖ Have the patient push hard against his arm or a belt for resistance then check to see if that leg has shortened and repeat on the other side.
- ❖ Alternate sides each time until no more shortening of the legs occurs.

•ISOMETRIC CORRECTION

- PUSH HARD AGAINST FIRM RESISTANCE
- RAISE THE HEAD AND TIGHTEN THE ABDOMINALS



- THIS IS AN EXCELLENT WAY FOR A SMALL THERAPIST TO CORRECT A SUBLUXATION ON A LARGE PATIENT



Direct Posterior Rotation of The Innominate (The Art)

- ❖ To correct a lesion on the right side with the patient supine, first compare the apparent length of the legs at the malleoli in the midline. Holding a thumb under each malleolus while approximating the ankles will make any difference more obvious.
- ❖ Now stand at the right side of the patient and reach between the legs with your right hand and grasp the right ischial tuberosity and buttock.

Direct Posterior Rotation (2)

- ❖ Take the cupped left hand with the thumb beside the index finger and place the thenar eminence on the top posterior part of the right iliac crest (Not over the ASIS).
- ❖ Now, lift with the right hand and put pressure with the left hand so as to cause the posterior part of the innominate bone to move caudad and medially on the sacrum.
- ❖ Start easy and gradually increase to strong pressure in posterior rotation.

Direct Posterior Rotation (3)

- ❖ Now compare the apparent leg length again to see if that leg has shortened.
- ❖ Repeat the procedure on the left side.
- ❖ Continue to repeat the procedure, alternating sides and comparing the leg length each time, not just until the legs appear to be of equal length, but **until no more apparent shortening of the legs occurs.**

Sequence of Correction

- ❖ 1. Do an easy traction on each leg to see how the patient responds.
- ❖ 2. Gradually increase the traction.
- ❖ 3. Do the EZ Fix further increasing traction and watching patient response.
- ❖ 4. Do a direct correction, grasping the patients pelvis and rotating directly or stretch knee into axilla.

Sequence of Correction (2)

- ❖ 5. Do a fascial release on both legs.
- ❖ 6. Have patient do an isometric correction giving himself/herself resistance.
- ❖ 7. Do hard isometric contraction against the belt.
- ❖ 8. Check leg length at the malleoli after each procedure and look for shortening.

Purpose of Sequence

- ❖ Most of these patients have been put through many inappropriate testing and treatment procedures.
- ❖ Begin with simple procedures to gain confidence and demonstrate that these procedures indeed feel good and relieve pain.
- ❖ After full correction has been gained you may wish to use a much stronger method such as a strong isometric contraction.

If You Can't Get a Full Correction

- ❖ Occasionally the patient will have so much local edema that it will not be possible to get a full correction with the first visit.
- ❖ Just correct as much as comfortably possible, instruct the patient in home correction and then see him/her again the next day.

Short-Cuts

- ❖ Because the test/correction can be somewhat tedious you may wish to try to use short-cuts.
- ❖ In some instances this will still work out all right, but if your treatments tend be less effective it is best to go back to the original procedure.

X-RAYS

- ❖ The subluxation at S3 is not immediately obvious on plain films, but it is possible to demonstrate the movement at the PSIS before and after a corrective procedure.
- ❖ It may be worth while to try diagnostic ultrasound to determine the status of the adjacent structures.

X-RAYS

- ❖ Chamberlain identified this dysfunction in 1930 using stereoscopic roentgenograms. (44)
- ❖ Using bone scanning in 50 women with LBP, Davis and Lentle found 44% had sacroiliitis. 36% had unilateral and 64% had bilateral sacroiliitis. 90% of those with abnormal scans had normal radiographs. (44)
- ❖ Conventional x-rays will not demonstrate this subluxation.

- CORRECTION OF SIJD
- BEFORE
- SIJ APPEARS NORMAL

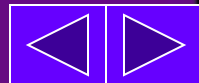
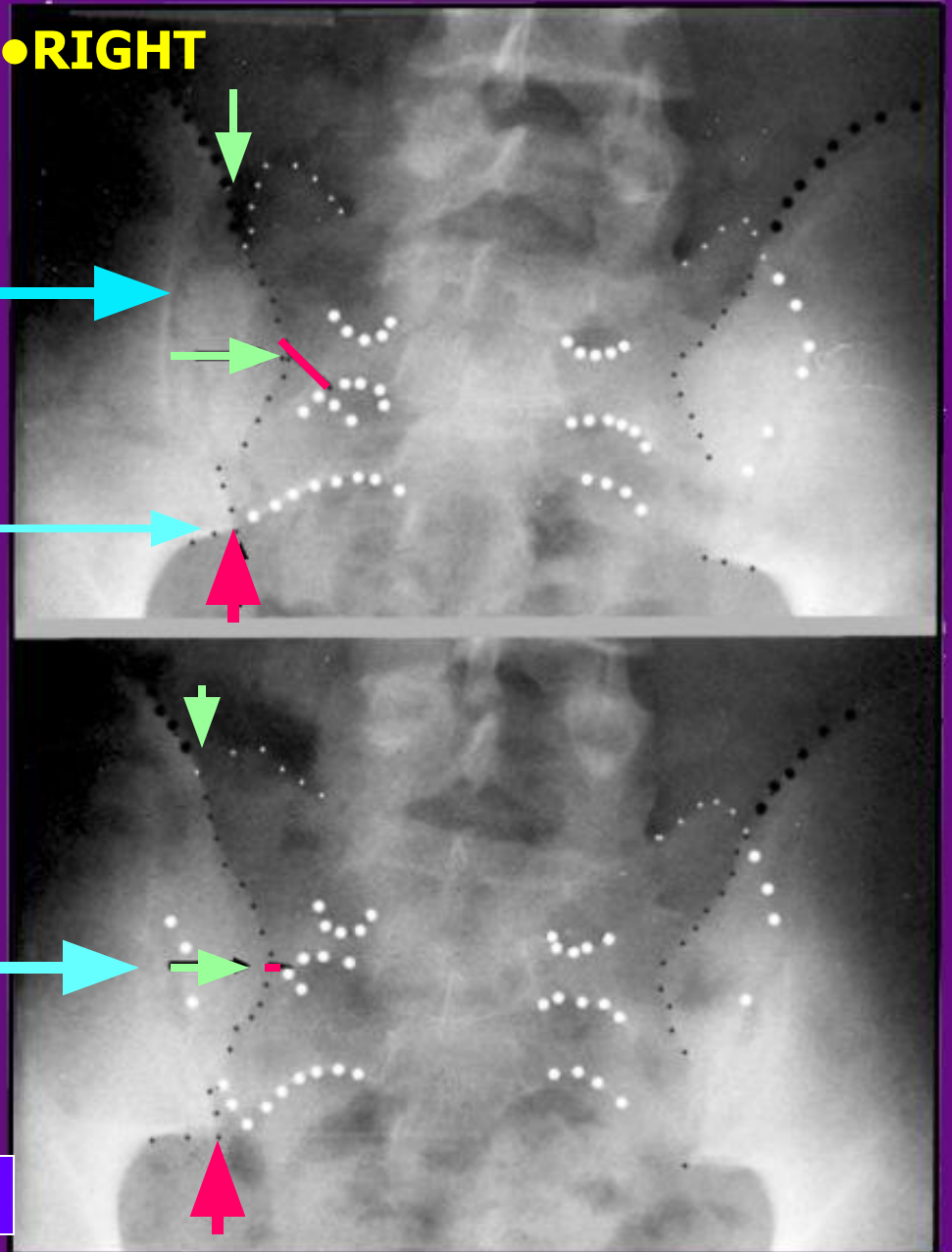
•PIIS

•AFTER

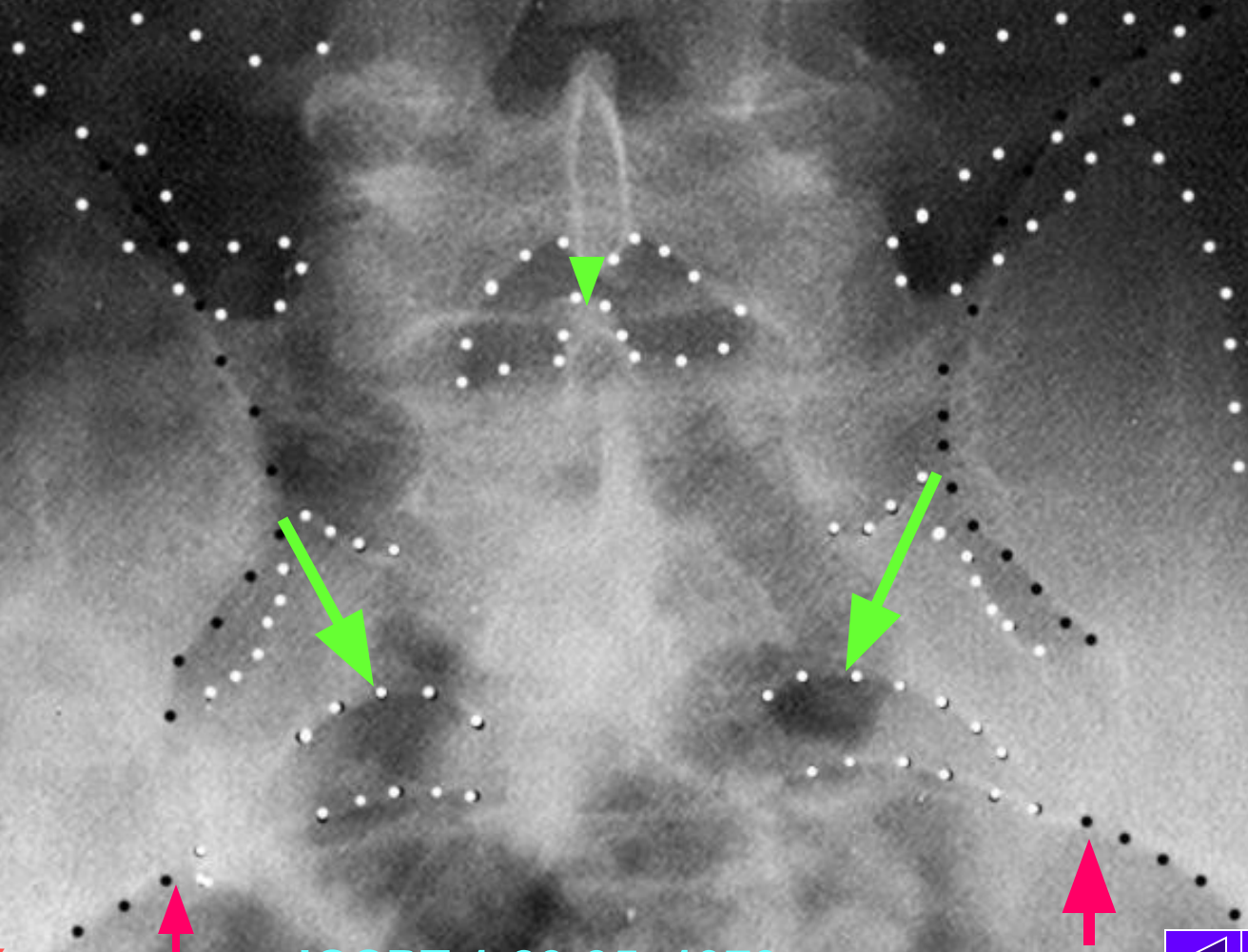
- NOTE MOVEMENT OF PSIS ON THE RIGHT

•DONTIGNY

•RIGHT



•BILATERAL SIJD BEFORE CORRECTION

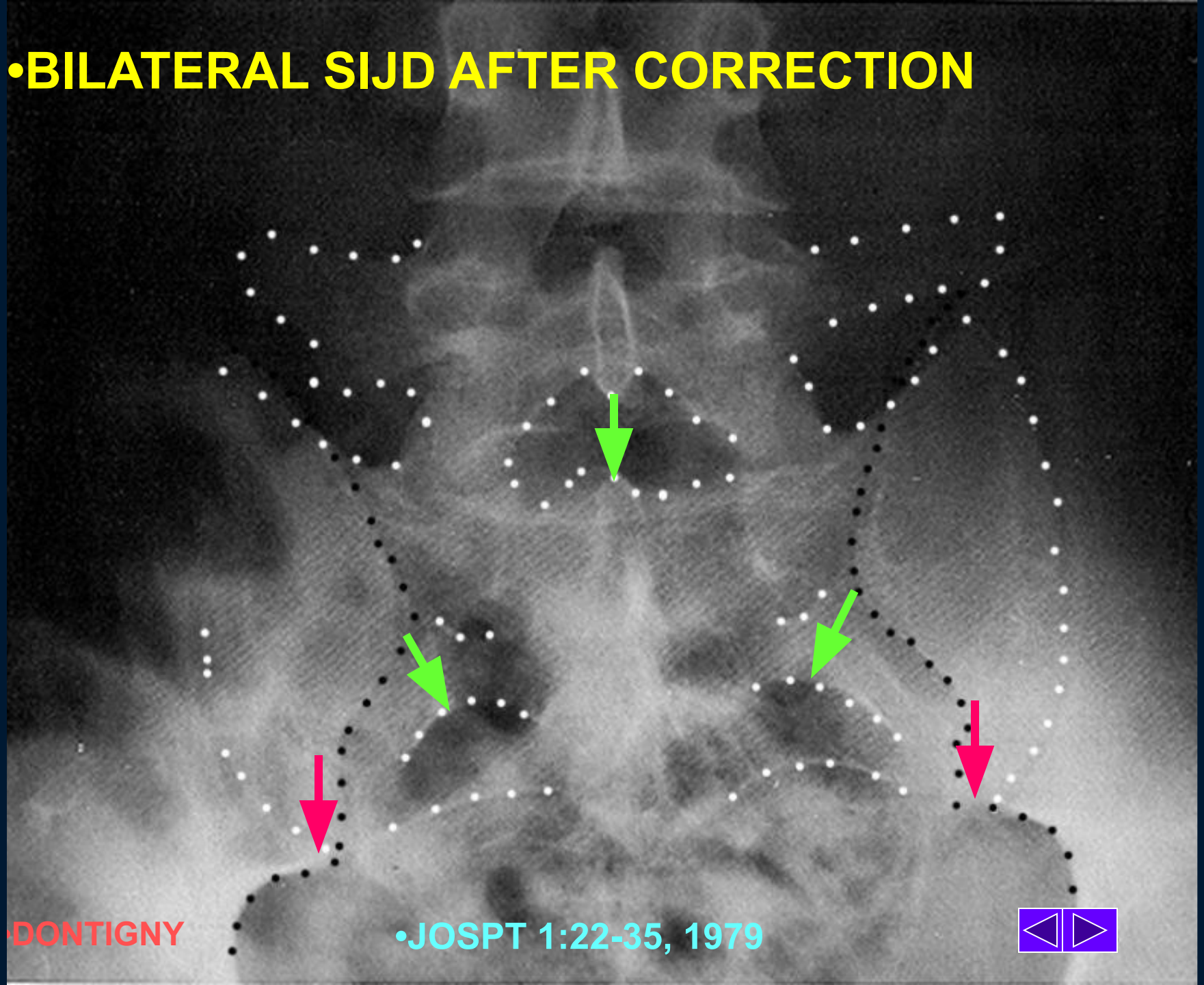


•DONTIGNY

•JOSPT 1:23-35, 1979



•BILATERAL SIJD AFTER CORRECTION



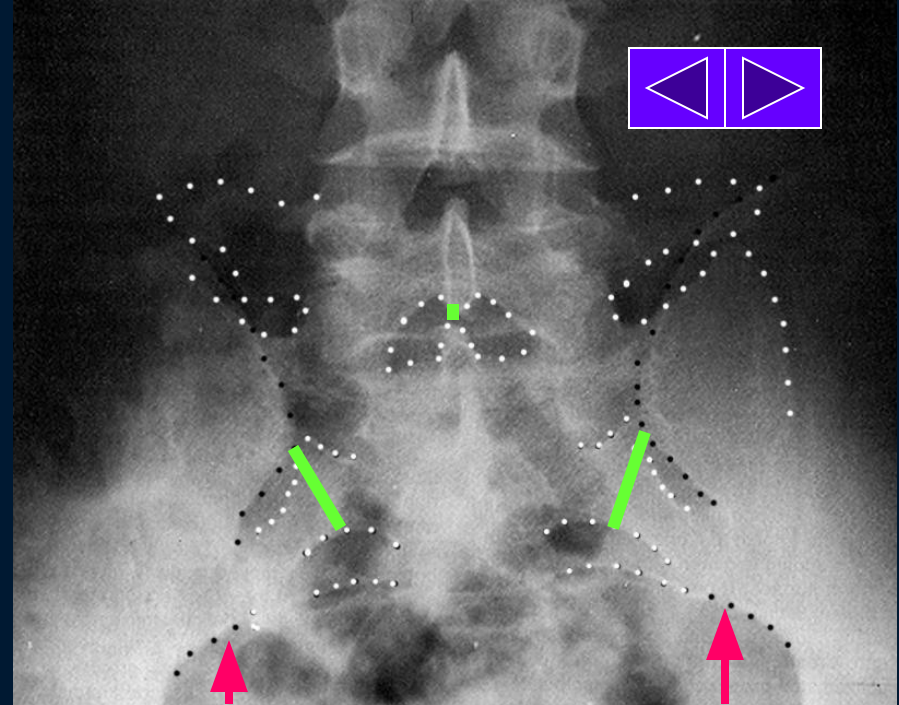
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•JOSPT 1:22-35, 1979

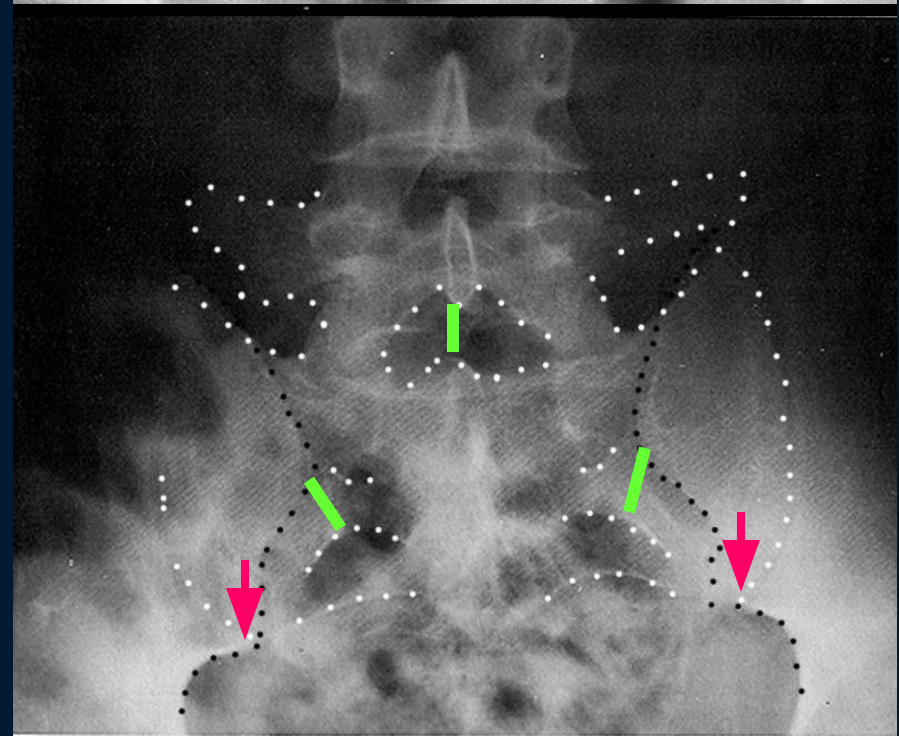


- **BILATERAL SIJD**
- **COMPARISON OF THE TWO PREVIOUS SLIDES**

• **BEFORE**



• **AFTER**



• **DONTIGNY ©**

Lack of Congruency on X-ray

- ❖ The patient in the next slide could not lie flat because of the pain in her right SIJ.
- ❖ Fortuitously the angle at which she was lying allowed visualization of the surfaces of the right sacroiliac joint which are obviously incongruent.
- ❖ The pelvis is obviously asymmetrical.

•ALICE BEFORE CORRECTION (RIGHT SIDE)

•NOTE LACK OF
CONGRUENCY

•PIIS →

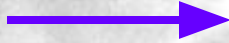
•PELVIS IS ASYMMETRICAL

•DONTIGNY



•ALICE AFTER CORRECTION (FIVE MINUTES LATER)

•PIIS



•CONGRUENCY
RESTORED

•SYMMETRY RESTORED

•DONTIGNY



Reversible Asymmetry

- ❖ The patient obviously had a reversible, biomechanical, asymmetry of the pelvis.
- ❖ She was free of pain following correction to a balanced, symmetrical pelvis.
- ❖ This is common condition, frequently overlooked in patients with low back pain.
(91)

Radiographic Visualization of SIJ Dysfunction

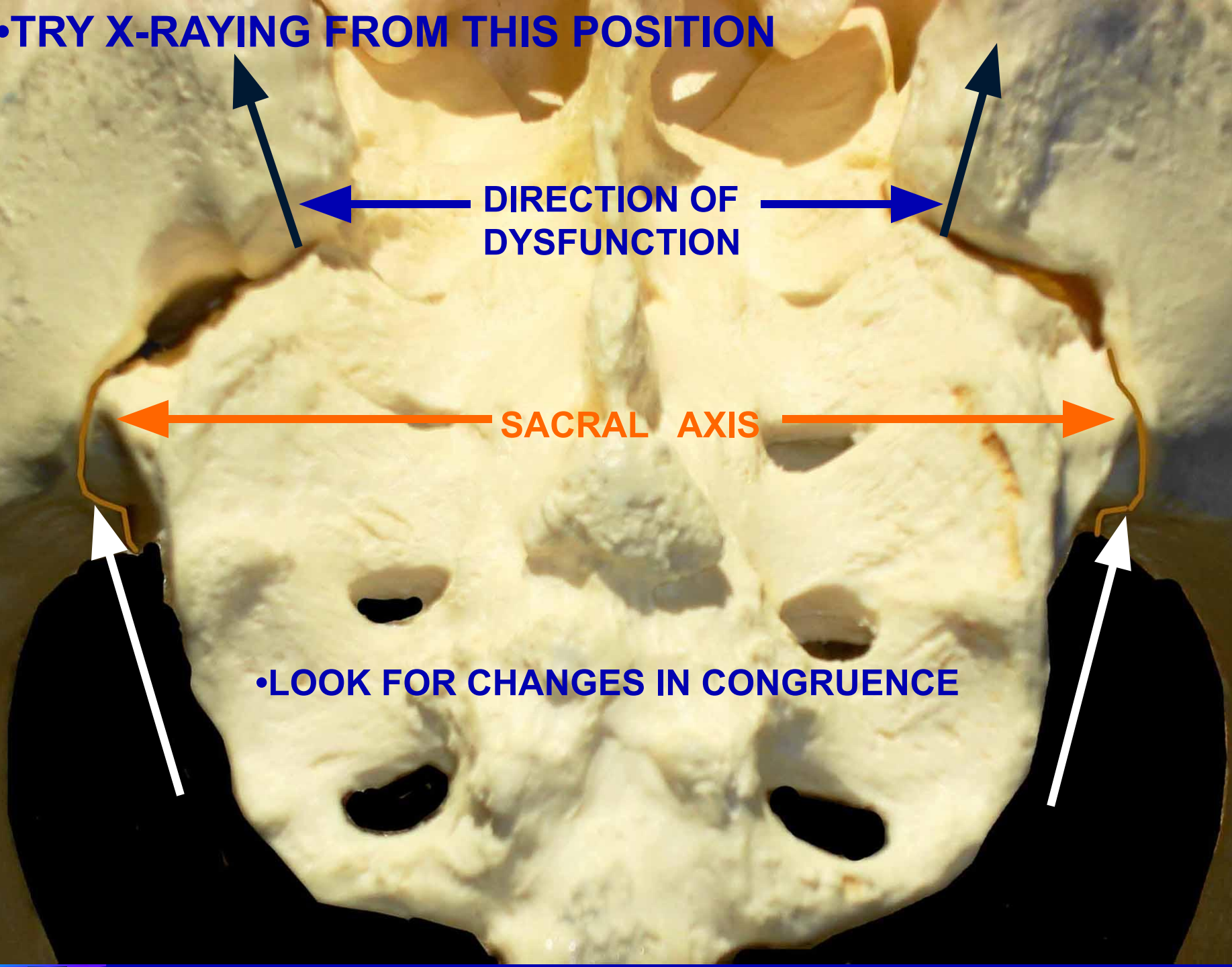
- ❖ It may be possible to visualize a dysfunction in the sacroiliac joint with plain films.
- ❖ Look for incongruence at S3 as the PSISs move cephalad and laterally.

•TRY X-RAYING FROM THIS POSITION

DIRECTION OF
DYSFUNCTION

SACRAL AXIS

•LOOK FOR CHANGES IN CONGRUENCE



Diagnostic Ultrasound

- ❖ Because of the superficial nature of the long and short posterior sacroiliac ligaments it may be possible to access them visually with diagnostic ultrasound.
- ❖ Look for loosening or avulsion at the insertion to the posterior superior iliac spine, failure of the collagen or shredding of the ligaments.

Diagnostic Ultrasound

- ❖ Especially look for unusual strain or muscle separations of the gluteus maximus at its conjoint origin near the PSIS and of the piriformis at the PIIS.
- ❖ Look for tears in the long posterior sacroiliac ligament of avulsion from the PSIS

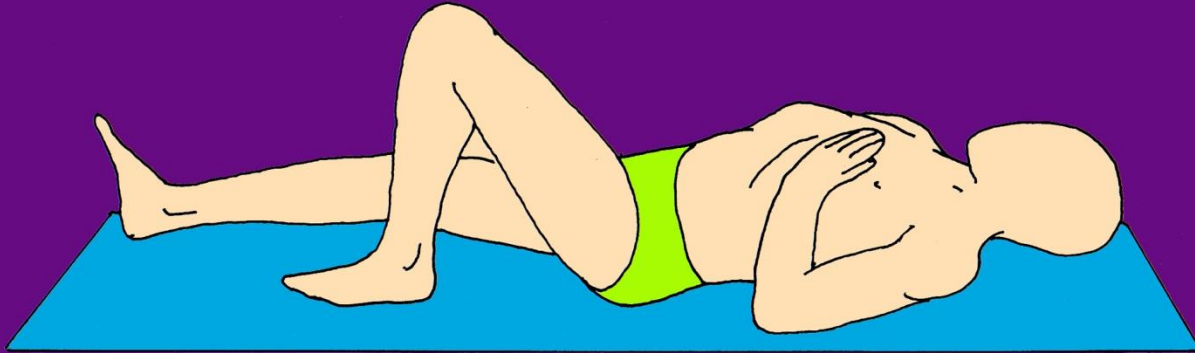
Patient Self-Management

- ❖ The patient must be instructed in self-correction in the event of occasional recurrence.
- ❖ Correction may be by a direct stretch or a muscle energy technique.
- ❖ The correction may be done using any of several methods. One may be more effective than the others.

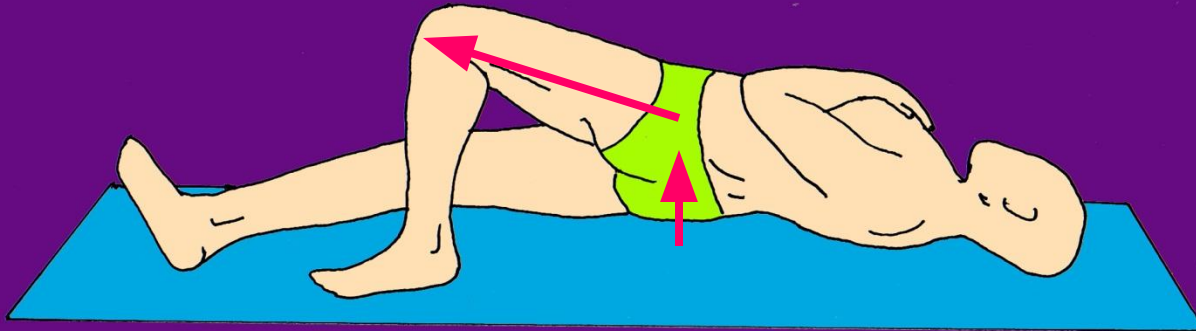
Self Correction

- ❖ Always correct both sides, one side at a time, alternating right, left, right, left.
- ❖ Vary the method of correction.
- ❖ After using a direct stretch several times, as in the next two slides, do a hard muscle energy correction a few times on each side, alternating each time to see if you can gain any additional correction.

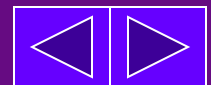
- SELF-TRACTION CORRECTION**
- THIS IS A SIMPLE METHOD OF CORRECTION**



- LIE SUPINE WITH HIP AND KNEE FLEXED**

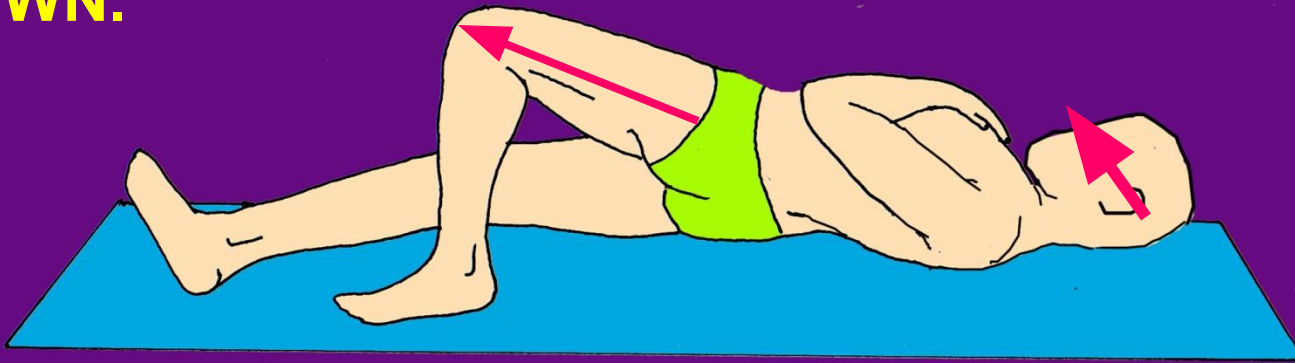


- PUSH THE KNEE FORWARD LIFTING THAT BUTTOCK**
(CONTINUED ON NEXT SLIDE)



•SELF-TRACTION CORRECTION (2)

- CORRECTION IS ENHANCED WITH AN ISOMETRIC ABDOMINAL EXERCISE TO PULL THE FRONT OF THE PELVIS UP AS THE BACK OF THE PELVIS MOVES DOWN.



- CONTINUE TO PUSH WITH THE LEG AND LIFT YOUR HEAD TO TIGHTEN YOUR ABDOMINAL MUSCLES HOLDING BOTH THE LEG PUSH AND THE ABDOMINAL CRUNCH FOR 8-10 SECONDS.

REPEAT ON THE OTHER SIDE. DO EACH SIDE 4-5 TIMES, ALTERNATING SIDES EACH TIME.

•STANDING SELF-TRACTION CORRECTION

•SIMILAR TO THE SUPINE CORRECTION

•DO A STRONG POSTERIOR PELVIC TILT. —————→

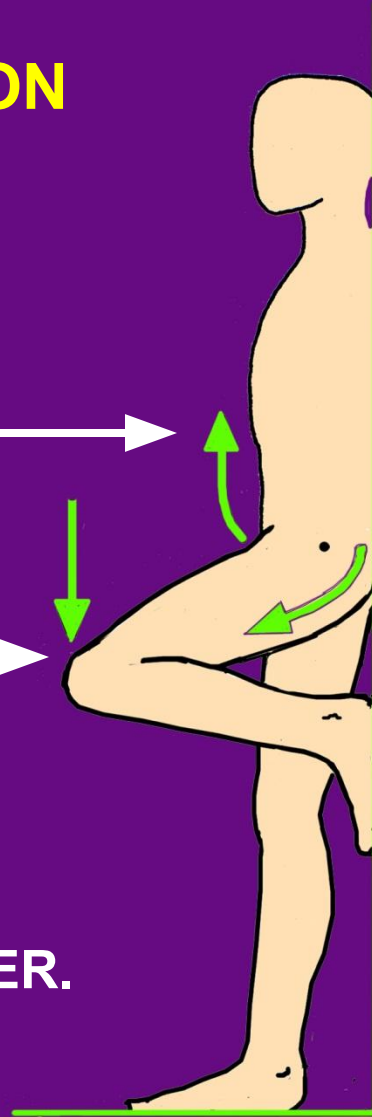
•PUSH KNEE TOWARD FLOOR STRONGLY. —————→

•CORRECT ONE SIDE AND THEN THE OTHER.

DO EACH SIDE 4-6 TIMES.

ALTERNATE SIDES EACH TIME.

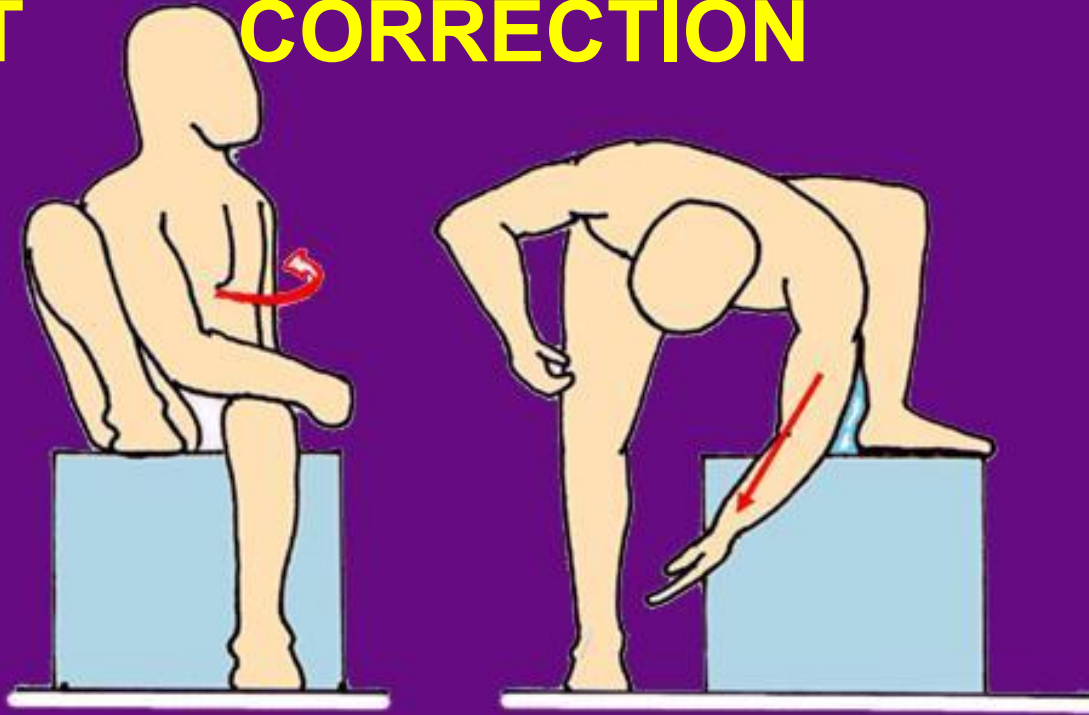
REPEAT INTERMITTANTLY THROUGHOUT THE DAY.



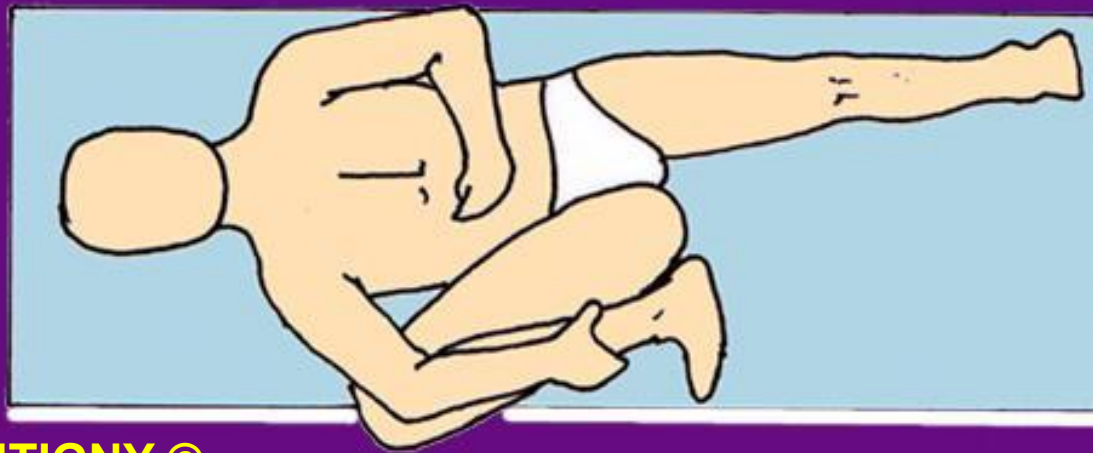
Using a Direct Stretch

- ❖ The SIJ can be corrected no matter what position you happen to be in.
- ❖ If you are sitting, put a foot on the chair with you and twist away from it.
- ❖ If you are standing, put a foot on a chair or high stool and reach down toward the opposite foot.

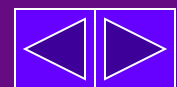
•DIRECT CORRECTION



•STRETCH AS HARD AS YOU ARE ABLE FOR 10 SECONDS



•DONTIGNY ©

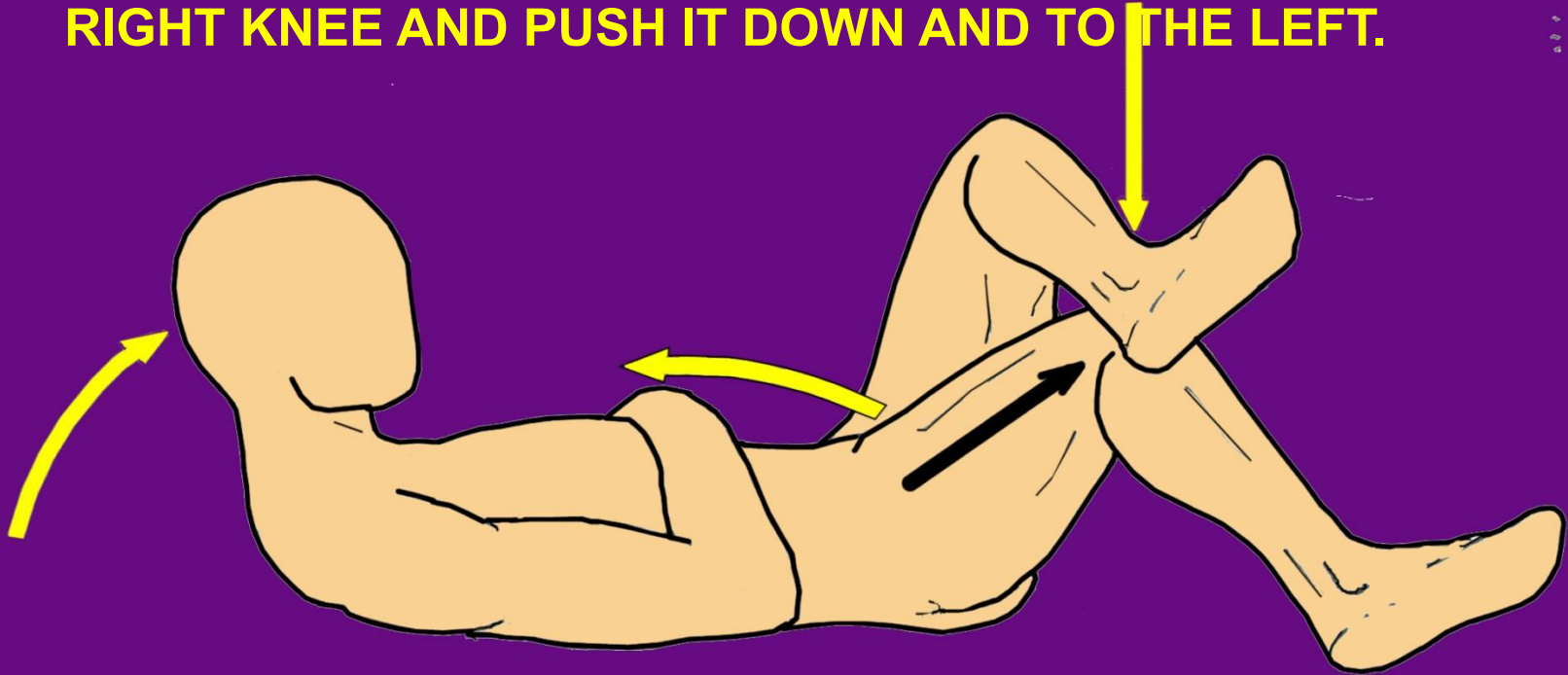


Flank Traction Correction

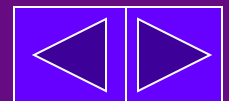
- ❖ After the direct correction it is frequently helpful to do a flank traction correction.
- ❖ Stretch two-three times on each side, alternating sides each time as per the following illustration.
- ❖ Be sure to hold your abs tight when lifting and lowering your legs.

•ALTERNATE FLANK TRACTION

- 1. LIFT HEAD TO TIGHTEN ABDOMINAL MUSCLES
- 2. PUT THE LEFT FOOT ON THE TOP RIGHT OF THE RIGHT KNEE AND PUSH IT DOWN AND TO THE LEFT.



- 3. STRETCH FOR 30 SECONDS.
- 4. REPEAT ON THE OTHER LEG.
- DONTIGNY ©



Knee to Chest

- ❖ Flexing both knees to chest may be helpful in stretching a tight lordotic spine.
- ❖ Flexing one knee to the chest will tend to flex the pelvis AND the spine, but will NOT correct the subluxation.
- ❖ Flexing the knee along side of the chest creates a posterior shearing force of the innominate on the sacrum and can correct the subluxation in anterior rotation at S3.

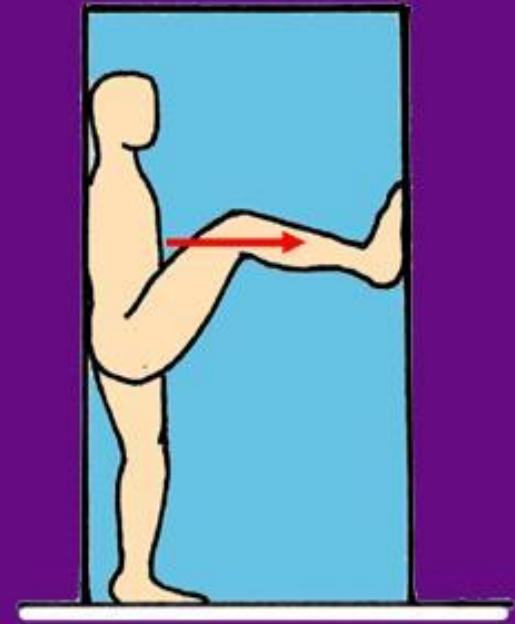
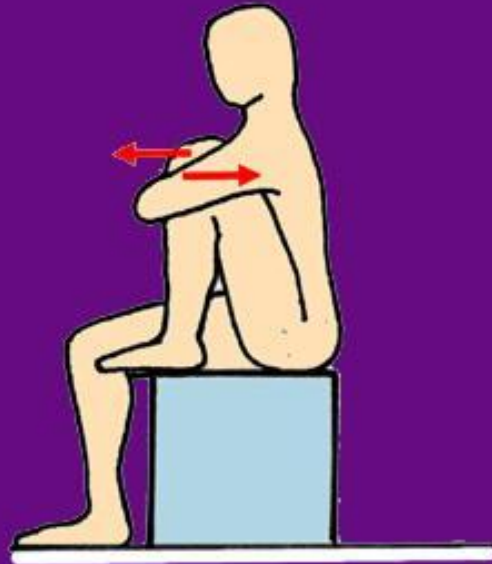
Isometric Corrections

- ❖ As previously, this exercise can be done whether you are lying, standing or sitting.
- ❖ You may also stand in a door frame, put a foot up on the opposite jam and push hard against it.
- ❖ Repeat several times on each side, alternating sides each time.
- ❖ See next slide

•CORRECTIONS USING MUSCLE ENERGY



•PUSH AS HARD AS YOU CAN AGAINST FIRM RESISTANCE



•HOLD THE CONTRACTION FOR 5-10 SECONDS

•DONTIGNY ©



IMPROVED TECHNIQUE

- ❖ Whenever doing a correction be sure to hold a strong posterior pelvic tilt while doing so.
- ❖ This is especially important when correcting in the standing position when you must lower your leg to the ground after correction.

IMPROVED TECHNIQUE (2)

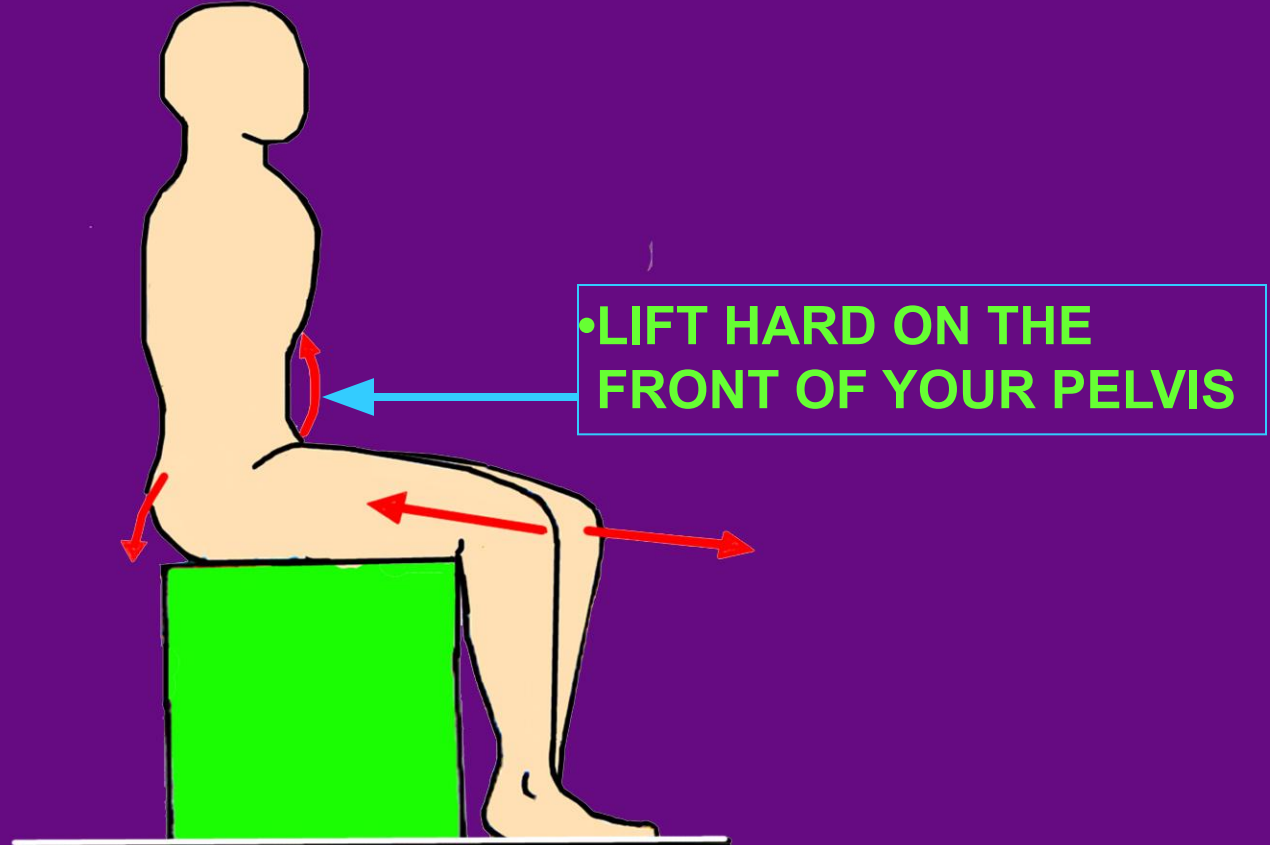
- ❖ If you lower your leg without holding a strong posterior pelvic tilt the weight of your leg may pull your innominate bone down into anterior rotation precipitating a recurrence of dysfunction.

THE SEATED CORRECTION

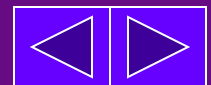
- ❖ This is an excellent correction for when you have pain while seated.
- ❖ It can be safely done while driving in a car or a golf cart or even while seated at your desk.
- ❖ It can be repeated intermittently throughout the day.

•SEATED CORRECTION

- CAN BE DONE IN YOUR OFFICE OR CAR.



- FOR CORRECTION ON THE RIGHT, RETRACT THE RIGHT THIGH AND PROJECT THE LEFT. LIFT THE FRONT OF THE PELVIS WITH THE ABDOMINAL MUSCLES. HOLD HARD FOR 6-8 SECONDS. REPEAT ON THE LEFT SIDE. REPEAT SEVERAL TIMES ON EACH SIDE. ALTERNATE SIDES EACH TIME.

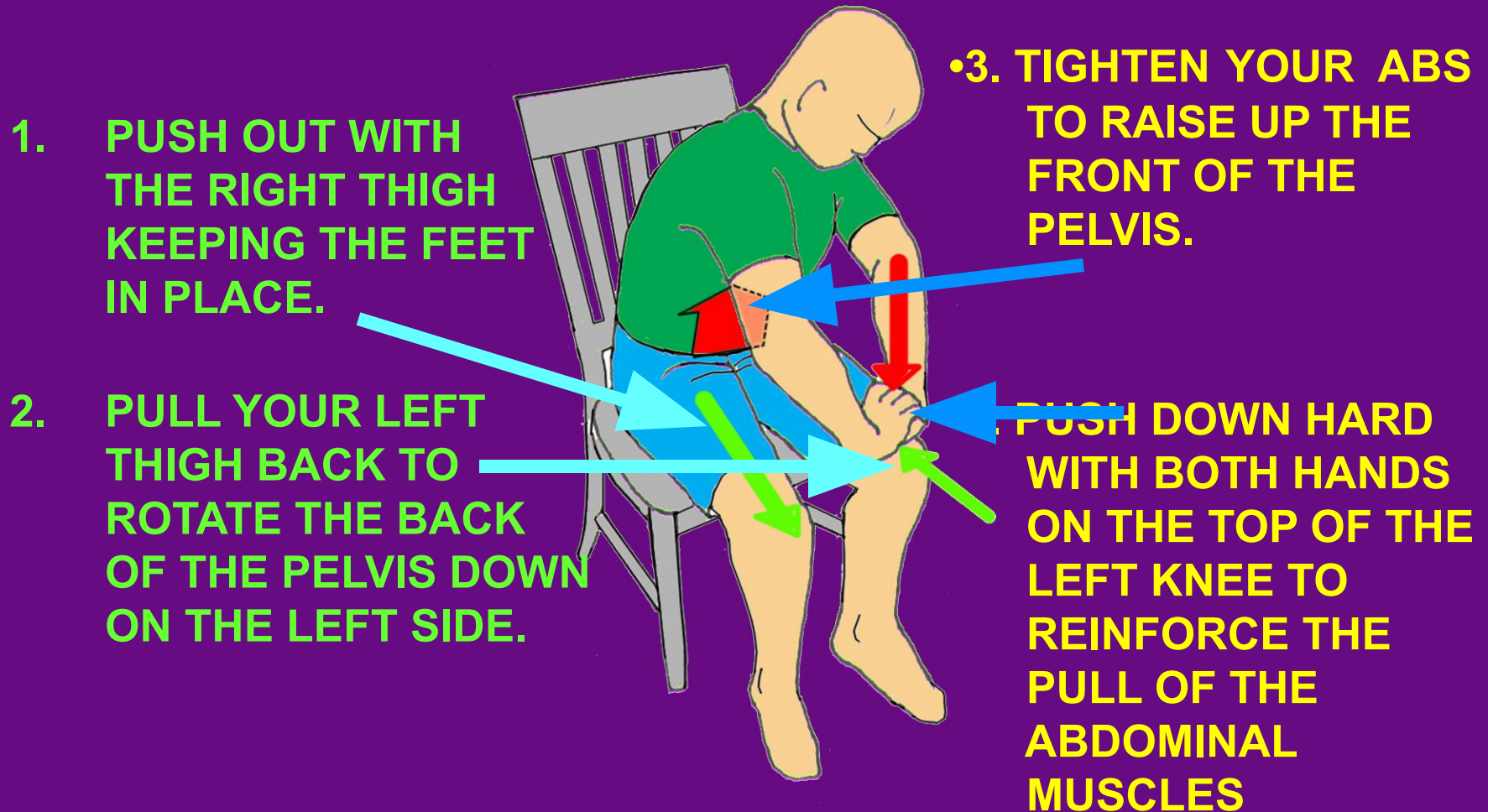


Enhanced Seated Correction

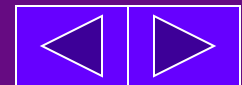
- ❖ For a more powerful seated correction.
- ❖ When you pull the right thigh back and the left forward, put both hands on the right knee push down hard on that knee as you tighten your abdominal muscles to pull up the front of the pelvis.
- ❖ Repeat on the left side.
- ❖ Do each side several times, alternating sides each time.

ENHANCED SEATED CORRECTION

CORRECTION OF THE LEFT SIDE



REPEAT ON THE RIGHT SIDE



A Few Things to Also Try

- ❖ Have the patient walk backwards for several steps and note reaction.
- ❖ Have the patient walk upstairs backwards a few steps and see if this relieves the symptoms.
- ❖ Have patient stand with feet apart and do isometric abduction and isometric adduction.

At First Treatment

- ❖ Instruct in basic mechanics.
- ❖ Instruct in corrections.
- ❖ Give him printed instructions.
- ❖ Next day have patient demonstrate what you have taught him.
- ❖ He will probably require further instruction.

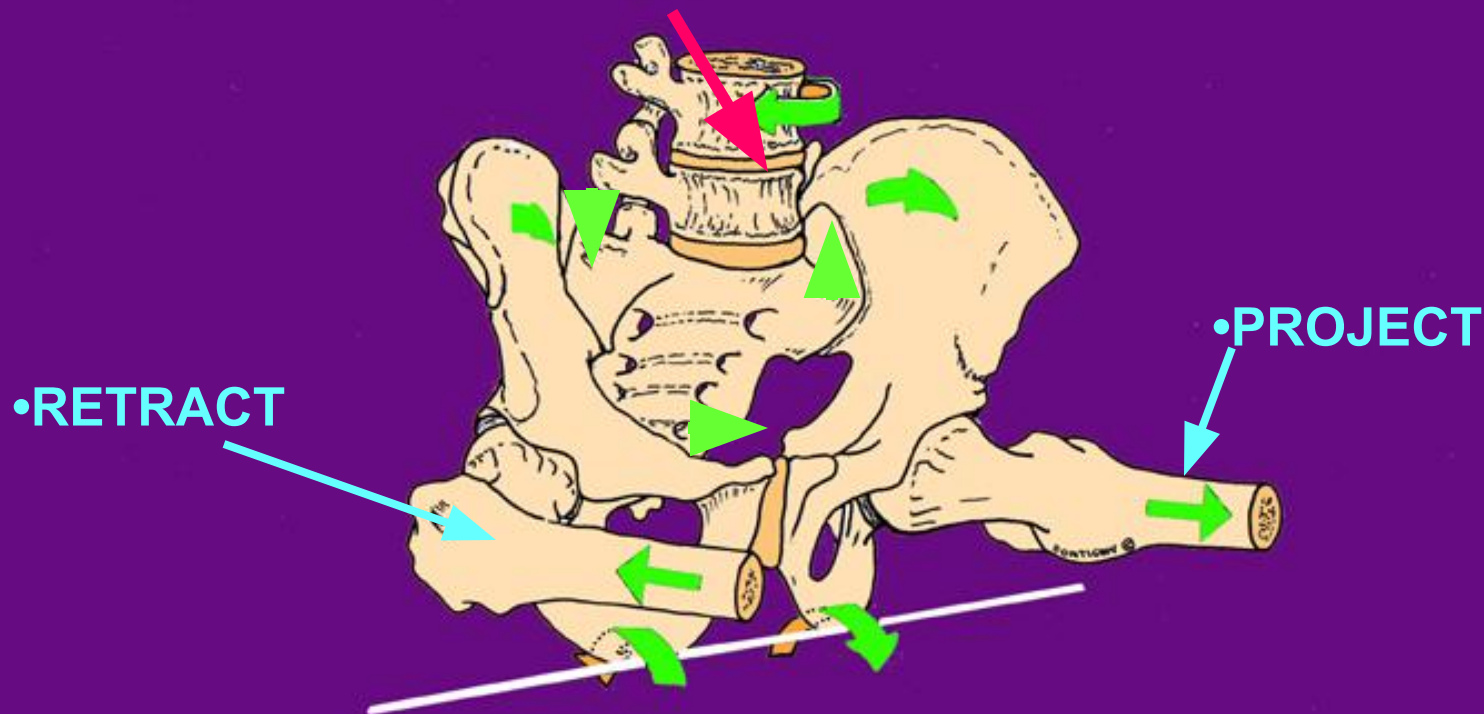
Exercises For the Core on the Asymmetric Pelvis

- ❖ As most normal movement at the SIJs occurs on the asymmetric pelvis during normal gait, controlled exercise on the asymmetric pelvis can be helpful.
- ❖ Stretching exercises can be used to release tight fascia and muscles.
- ❖ Isometric exercises can strengthen multiple synchronous muscle groups.

Exercises For the Core on the Asymmetric Pelvis (2)

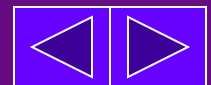
- ❖ Begin with the pelvis in asymmetry as described in the demonstration of sacral side flexion.
- ❖ Seated, with the right leg retracted and the left projected, rotate and flex the trunk to the right so that the left elbow is brought toward and past the outside of the right knee.
- ❖ The sacrum will flex laterally and move on an oblique axis stretching the piriformis and the lower gluteus maximus.

- EXERCISE ON THE ASYMMETRIC PELVIS
- STRETCHING FOR THE CORE
- ISOMETRIC EXERCISE FOR THE CORE



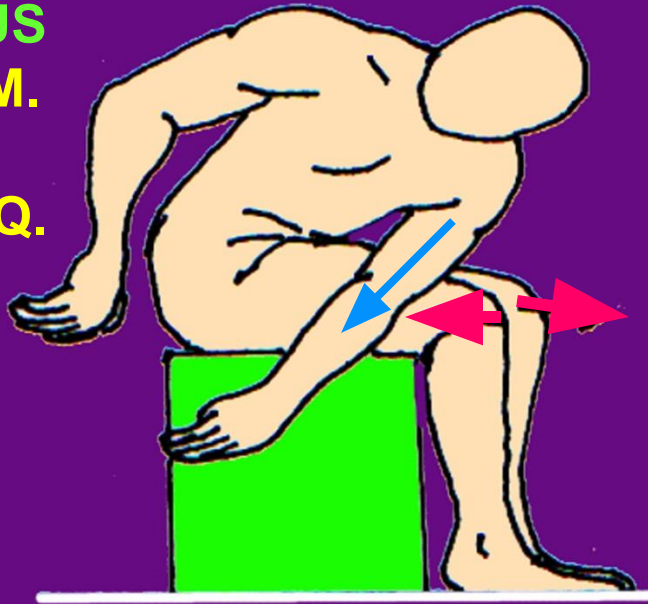
- REVERSE THE LEG POSITION AND REPEAT ON THE OTHER SIDE
- BE SURE TO DO A CORRECTIVE EXERCISE BEFORE AND AFTER DOING THESE EXERCISES.

•DONTIGNY ©



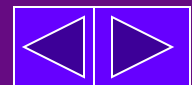
•STRETCHES FOR THE ASYMMETRIC PELVIS

- STRETCHES THE:
 - PIRIFORMIS
 - GLUTEUS MAXIMUS
 - QUADRATUS LUM.
 - MULTIFIDUS
 - ABDOMINAL OBLIQ.
 - LATISSIMUS DOR.
 - AND OTHERS



- WHEN TWISTING,
PROJECT ONE KNEE
AND RETRACT THE
OTHER

- TWIST AND STRETCH AND HOLD FOR 10-20 SECONDS
- REPEAT TOWARD THE OTHER SIDE
- STRETCH 3-5 TIMES ON EACH SIDE, ALTERNATING



To Strengthen the Piri., Lats., G. Max., Mult., Ab. Ob. & Q.L.

- ❖ The piriformis and the lower fibers of the gluteus maximus support the function of the sacrotuberous ligament to control and correct lateral sacral flexion during normal gait when the pelvis is asymmetrical.
- ❖ These muscles can be exercised actively or with muscle energy methods while seated.
- ❖ The multifidus, quadratus lumborum and the abdominal obliques are active with the resisted de-rotation and extension of the spine.

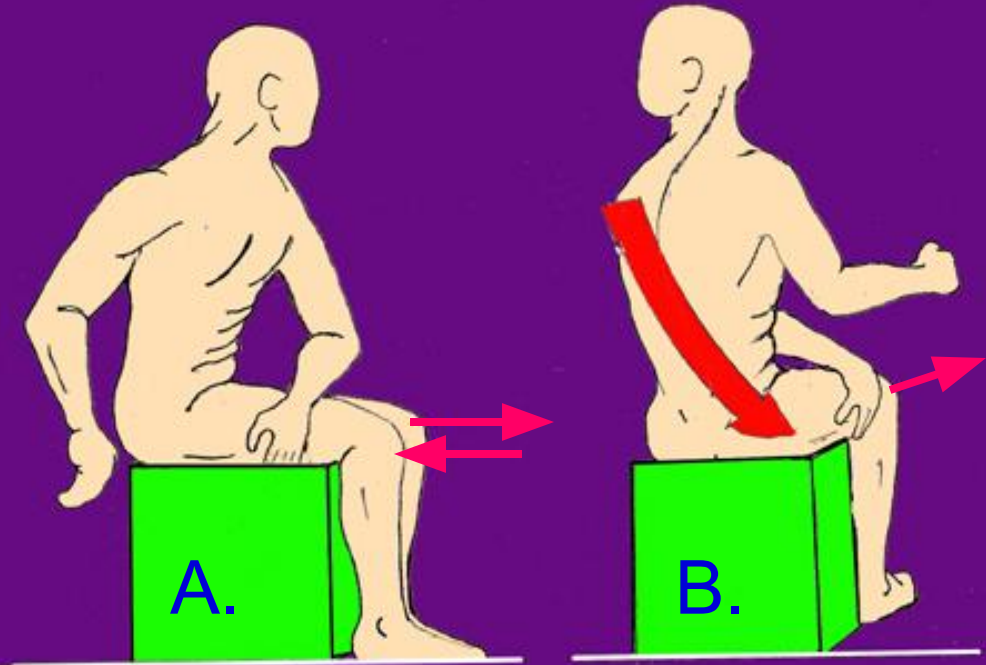
Isometric Exercise on the Asymmetric Pelvis

- ❖ When you de-rotate and extend to the starting position, the multifidus and the quadratus will de-rotate and extend, and the gluteus maximus and piriformis will help to straighten the sacrum.
- ❖ Grasp the right leg with the left hand, to give yourself some resistance, and then extend and de-rotate to strengthen these muscles with an isometric exercise.
- ❖ Hold strong resistance 6-10 seconds each direction 2-3 times.

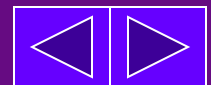
•EXERCISING ON THE ASYMMETRIC PELVIS

•ISOMETRIC EXERCISE FOR THE CORE:

- LATISSIMUS DORSI
- QUADRATUS LUMBORUM
- MULTIFIDUS
- PIRIFORMIS
- SACRAL ORIGIN OF THE GLUTEUS MAXIMUS
- ABDOMINAL OBLIQUES

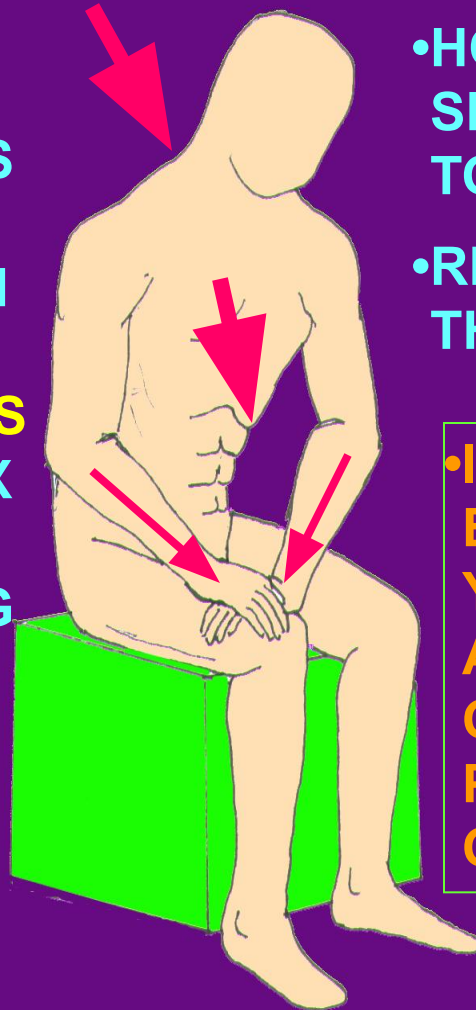


- A. RETRACT RIGHT THIGH, PROJECT LEFT AND FLEX AND ROTATE TRUNK TO THE RIGHT. GRASP RIGHT LEG WITH THE LEFT HAND.
- B. EXTEND AND ROTATE TRUNK TO THE LEFT, PROJECT RIGHT THIGH AND RETRACT LEFT, PROVIDING RESISTANCE AGAINST THE TRUNK ROTATION WITH THE LEFT HAND. DO BOTH SIDES.



- SEATED ISOMETRIC CORE EXERCISE
- TO STRENGTHEN THE RECTUS ABDOMINIS AND OBLIQUES

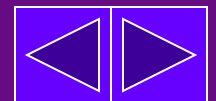
- SEATED, WITH KNEES SPREAD, **HANDS ON ONE KNEE.** TIGHTEN THE ABDOMINALS, **PINCH THE GLUTEALS TOGETHER** AND FLEX THE TRUNK TOWARD THAT KNEE, HOLDING BACK WITH YOUR ARMS.



- HOLD HARD FOR 8-10 SECONDS AND REPEAT TOWARD THE OTHER KNEE.

- REPEAT SEVERAL TIMES THROUGHOUT THE DAY

- IT IS ABSOLUTELY ESSENTIAL TO HOLD YOUR ABDOMINALS TIGHT AND SUPPORT THE FRONT OF YOUR PELVIS TO PREVENT RECURRENCE OF THIS SUBLUXATION



•SIT TO STAND EXERCISE

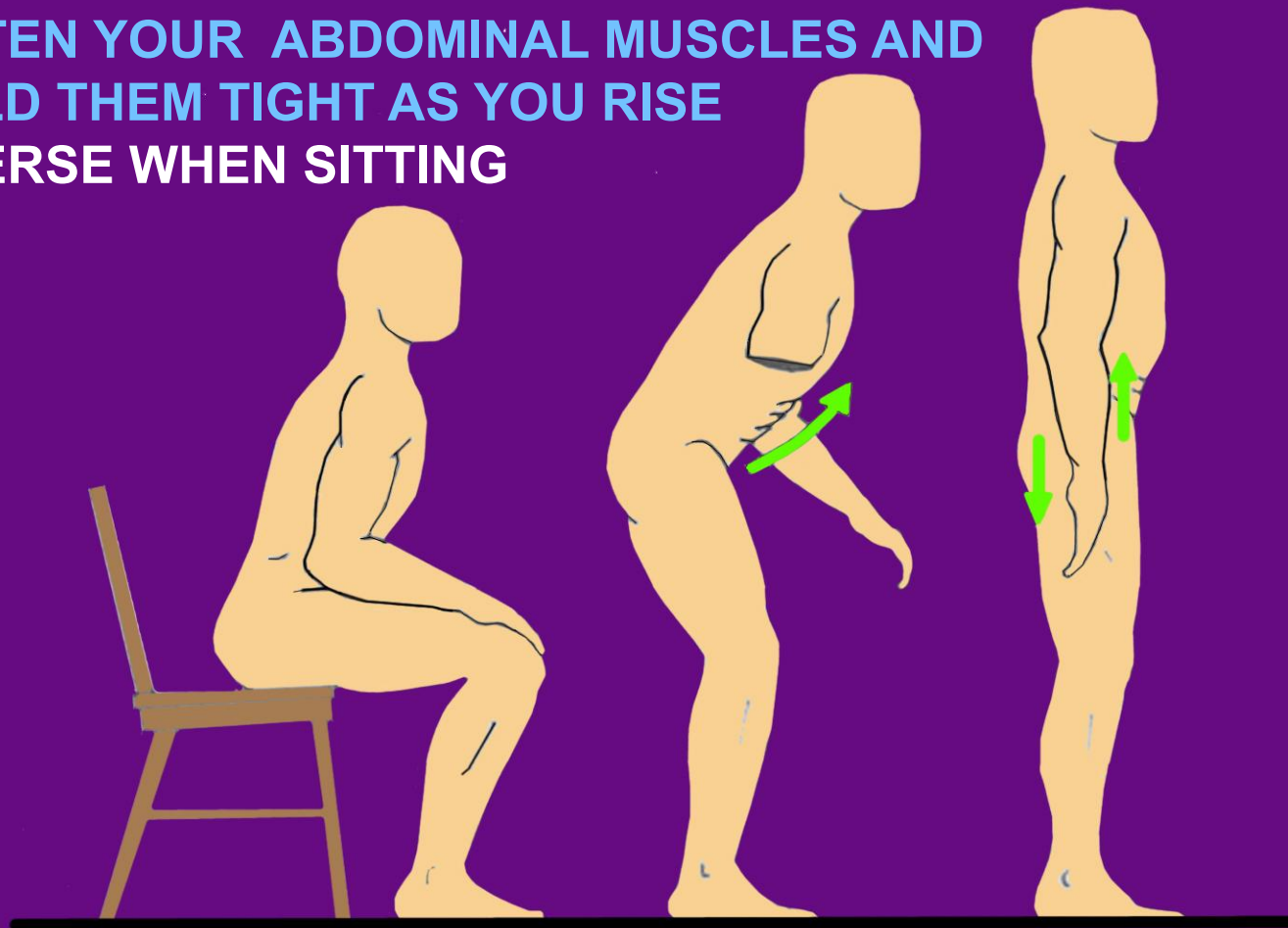
TO RISE FROM A CHAIR OR STOOL WITHOUT PAIN

FIRST MOVE TO THE FRONT OF THE CHAIR

TIGHTEN YOUR ABDOMINAL MUSCLES AND

HOLD THEM TIGHT AS YOU RISE

REVERSE WHEN SITTING



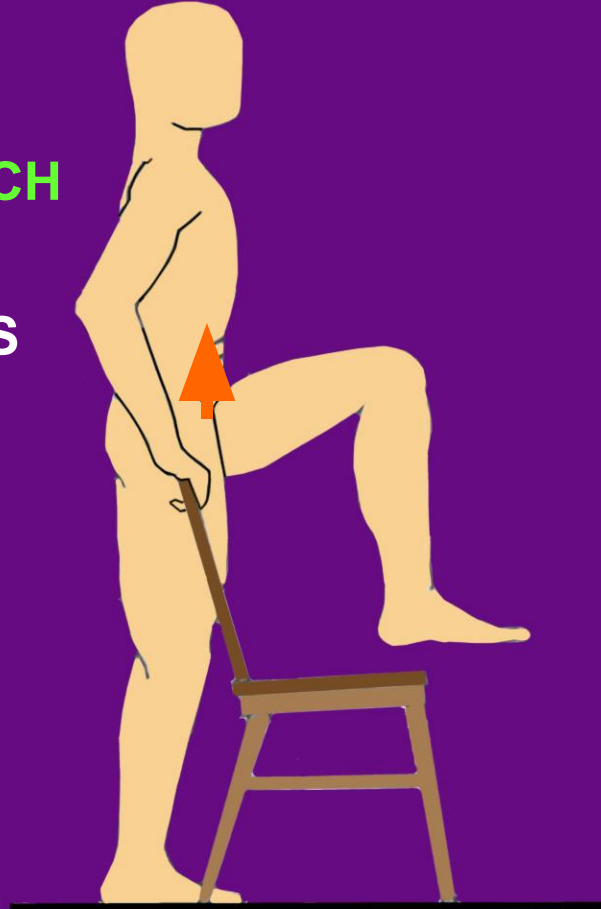
•REPEAT TEN TIMES AND WORK UP TO 25 TIMES

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•HIP FLEXION EXERCISE

- HOLD A STRONG POSTERIOR PELVIC TILT AS YOU LOWER AND LIFT YOUR LEG
- REPEAT TEN TIMES
- ALTERNATE LEGS EACH TIME
- WORK UP TO 25 TIMES



- ALWAYS HOLD A STRONG PELVIC TILT WHEN GOING UP OR DOWN STEPS.

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•HIP ABDUCTION EXERCISE

- THE HIP ABDUCTORS ARE IMPORTANT STABILIZERS WHEN WALKING

- GRASP SOMETHING FOR BALANCE

- HOLD STRONG PELVIC TILT AND LIFT LEG OUT TO THE SIDE AND BACK



- REPEAT TEN TIMES ON EACH SIDE. WORK UP TO 25 TIMES

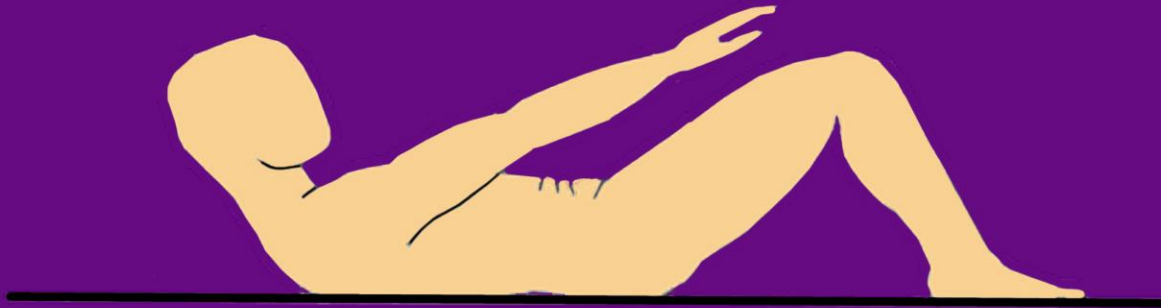
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•CRUNCHES

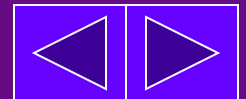
CRUNCHES BUILD STRENGTH IN THE ABDOMINAL MUSCLES.

- BEGIN LYING ON YOUR BACK WITH KNEES BENT AND FEET FLAT FIRST, JUST TIGHTEN YOUR ABS AND LIFT YOUR HEAD. HOLD YOUR HEAD UP FOR TEN SECONDS AND PREPEAT X 10**



- NOW LIFT YOUR HEAD AND SHOULDERS AND HOLD 6 SECONDS.**
- WORK UP TO 25 REPETITIONS.**

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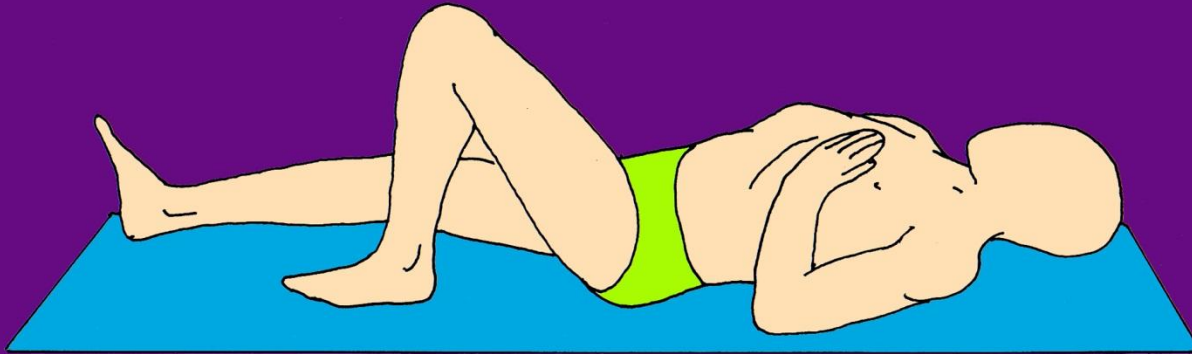


The All-in-one Exercise From Feldenkrais

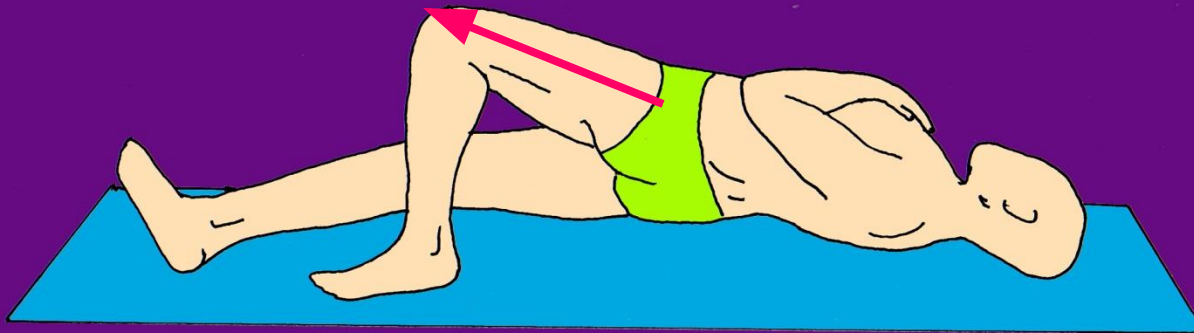
- ❖ This exercise is designed to correct the SIJ and mobilize and strengthen the cervical, thoracic and lumbar spine.
- ❖ Stretch gently at first.
- ❖ Care must be taken in the elderly.

•ALL-IN-ONE EXERCISE

•TO MOBILIZE THE SIJS AND THE CERVICAL AND THORACIC BACK

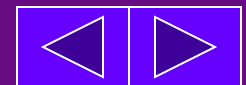


•START WITH THE KNEE BENT AND THE FOOT FLAT



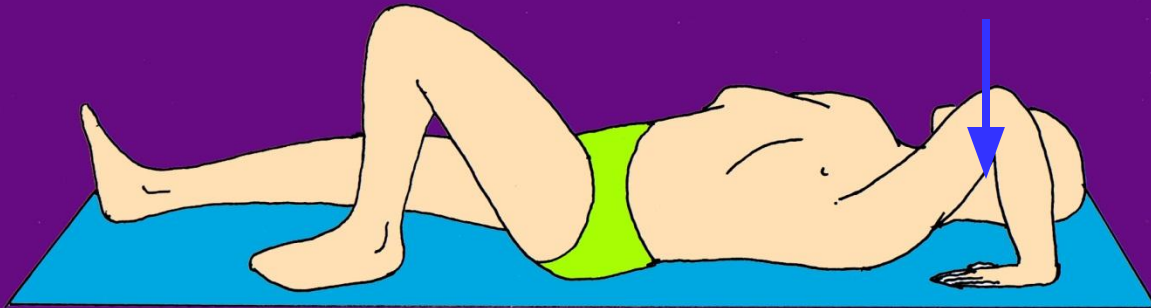
•PUSH YOUR KNEE TOWARD YOUR FOOT, RAISING THE BUTTOCK AND ROLLING TOWARD THE OTHER SIDE. REPEAT 3-5 TIMES. (CONTINUED ON NEXT SLIDE)

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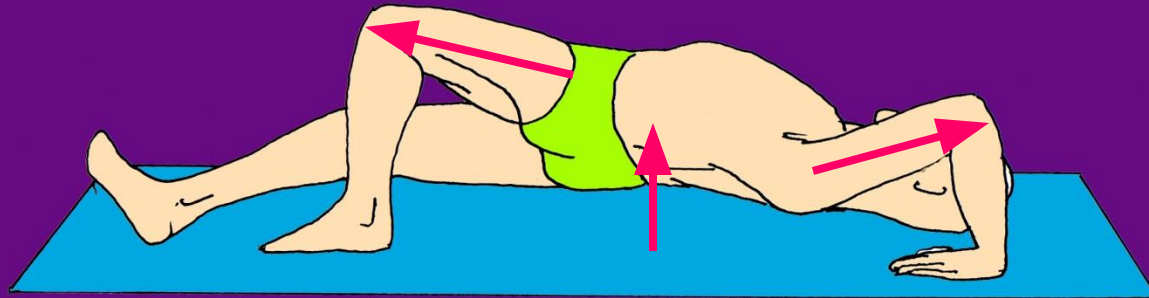


•ALL-IN-ONE EXERCISE (2)

•(NOTE THE HOLE
UNDER YOUR ARM)



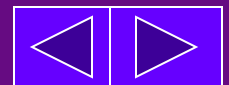
•NOW FLEX YOUR ELBOW AND SHOULDER AND PLACE YOUR
HAND ALONG SIDE OF YOUR HEAD WITH FINGERS POINTING
DOWN



•PUSH YOUR KNEE TOWARD YOUR FOOT AND YOUR ELBOW
TOWARD THE TOP OF THE TABLE, RAISING YOUR BUTTOCK
AND ARCHING YOUR BACK. REPEAT 3-5 TIMES.

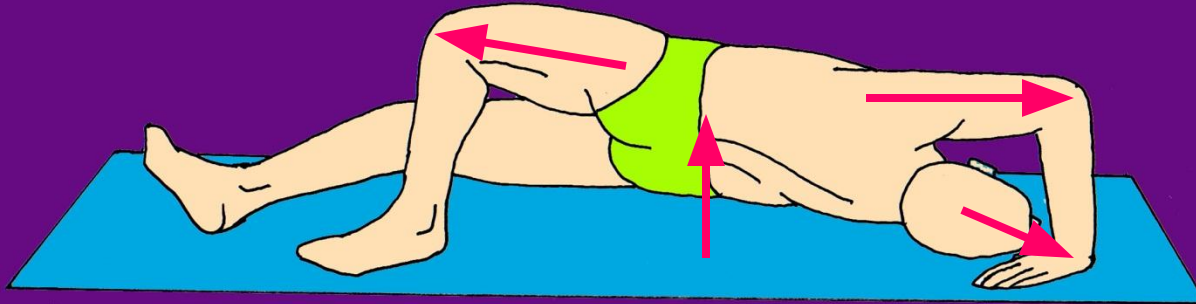
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•(NEXT SLIDE)

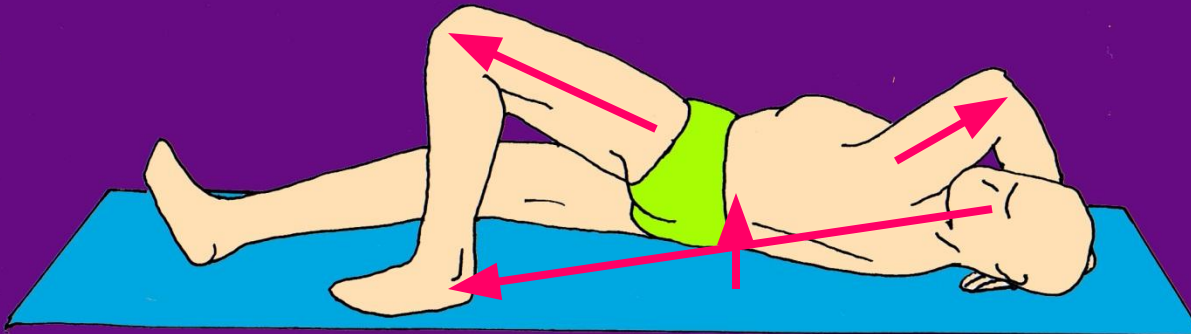


•ALL-IN-ONE EXERCISE (3)

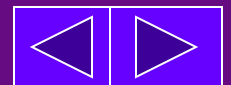
•(AGAIN, NOTICE THE HOLE UNDER THE ARM IN THE RESTING POSITION)



•PUSH WITH YOUR KNEE AND YOUR ELBOW AND PUT THE BACK OF YOUR HEAD THROUGH THE HOLE AND LOOK AT YOUR HAND



•NEXT, PUSH WITH YOUR KNEE AND YOUR ELBOW AND PUT THE FRONT OF YOUR HEAD THROUGH THE HOLE AND LOOK DOWN AT YOUR FOOT. REPEAT ALL ON THE OTHER SIDE.



Fascial Tightness

- ❖ Fascial tightness may be present in the buttocks, especially with chronic SIJD, and limit internal and external rotation of the hip.
- ❖ May give a false positive Patrick's test.

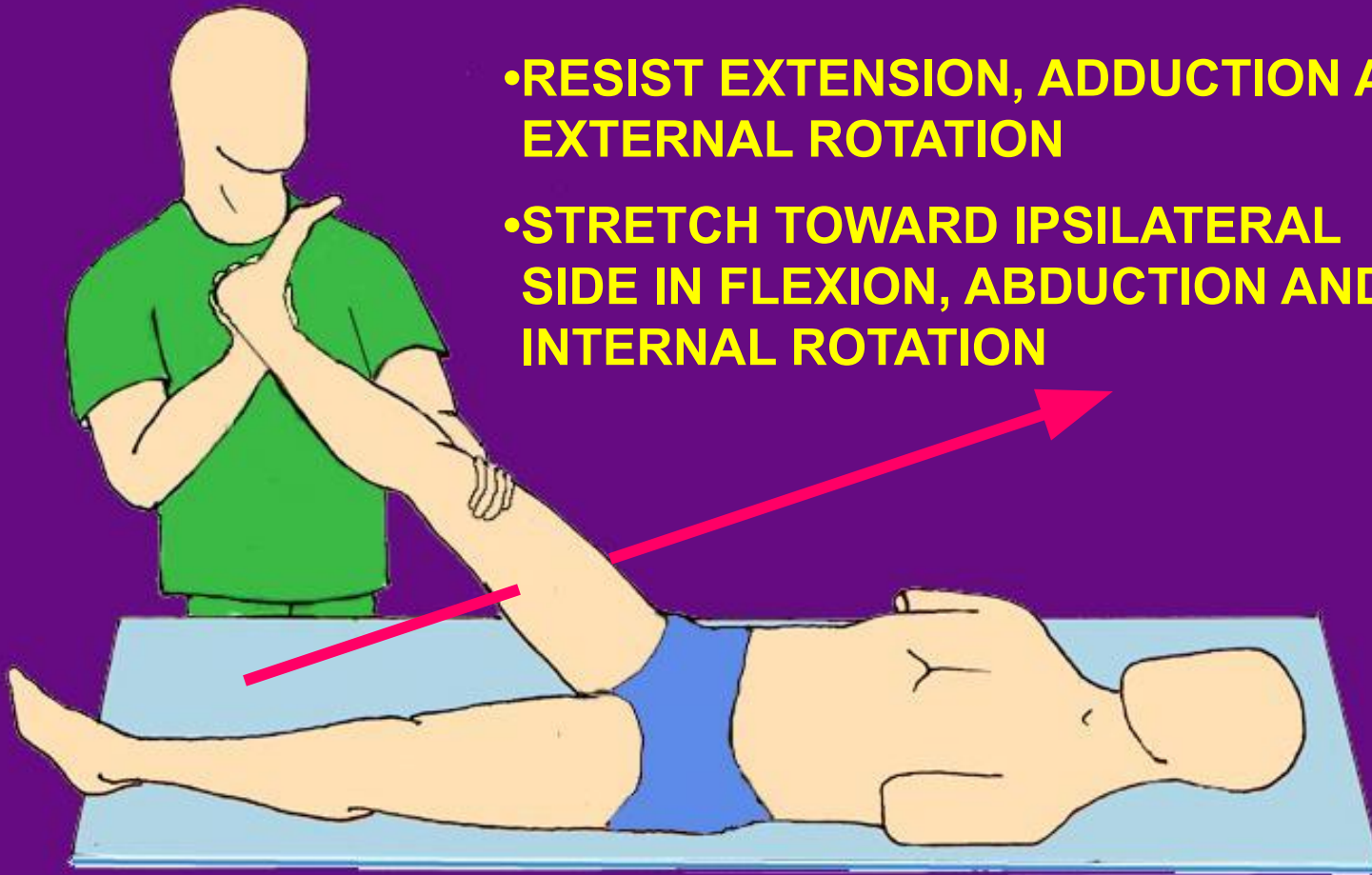
Fascial Tightness

- ❖ This motion can be regained with gentle stretching.
- ❖ Especially effective are contract/ relax stretching techniques in the lower extremity primitive motion patterns used in proprioceptive neuromuscular facilitation.
- ❖ Be sure to do a corrective exercise before and after these exercises.

PNF Patterns

- ❖ Ideally the physical therapist should do the fascial release using contract/relax methods.
- ❖ The following slides demonstrate the direction of movement.
- ❖ Do not do the pattern stretching in extension, abduction and internal rotation.
- ❖ This will increase the dysfunction and stretch the psoas.

•PNF PATTERNS



- RESIST EXTENSION, ADDUCTION AND EXTERNAL ROTATION

- STRETCH TOWARD IPSILATERAL SIDE IN FLEXION, ABDUCTION AND INTERNAL ROTATION

- DO NOT FORCE WHEN TAKING UP THE SLACK

- REPEAT WITH KNEE IN FLEXION, SAME PATTERN



•PNF PATTERNS



- RESIST IN EXTENSION, ADDUCTION AND INTERNAL ROTATION

- STRETCH TOWARD CONTRA LATERAL SIDE IN FLEXION, ABDUCTION AND EXTERNAL ROTATION

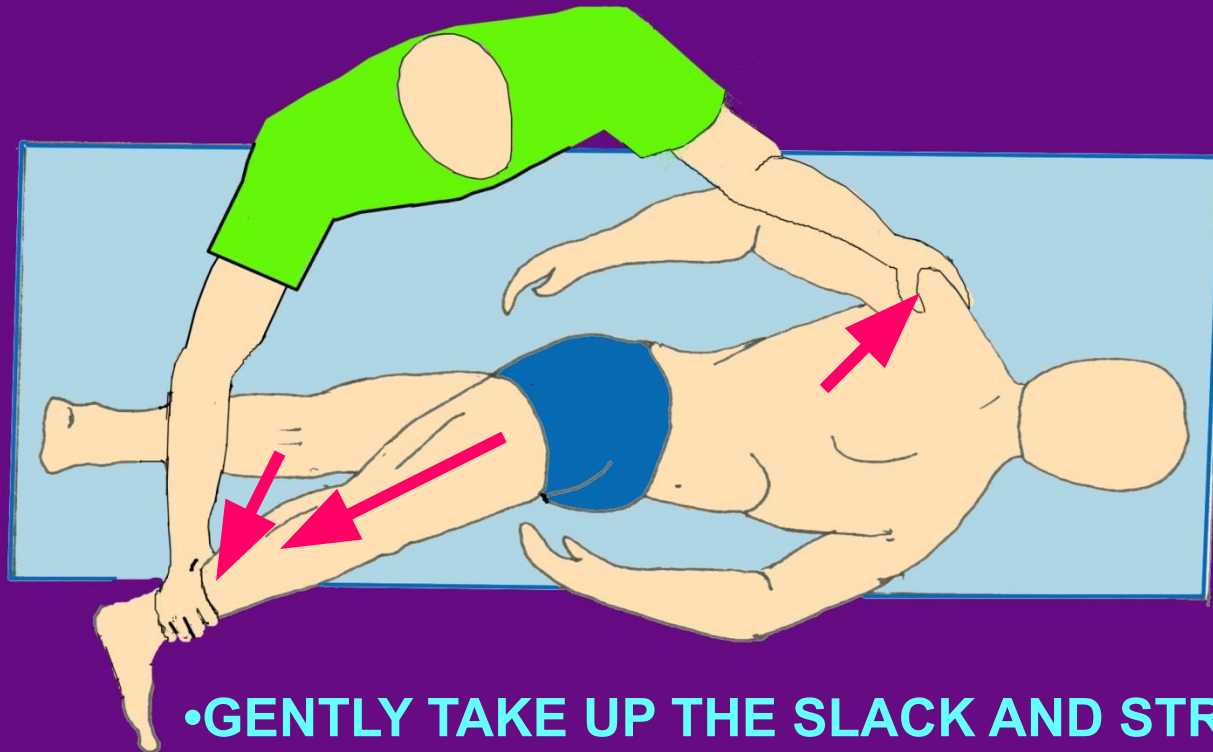
- DO NOT FORCE

- TAKE UP SLACK TOWARD THE OUTSIDE OF THE CONTRA LATERAL SHOULDER.

- REPEAT PATTERN WITH KNEE IN FLEXION.

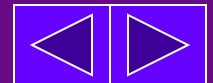
•PNF RELEASE

HAVE PATIENT FLEX, ABDUCT AND EXTERNALLY ROTATE AND THEN RELAX TO RELEASE THE QUADRATUS, ABDUCTORS AND EXTERNAL ROTATORS. LEG IS STRAIGHT.



•GENTLY TAKE UP THE SLACK AND STRETCH THE LEG IN THE LONG AXIS.

•REPEAT ON THE OTHER SIDE

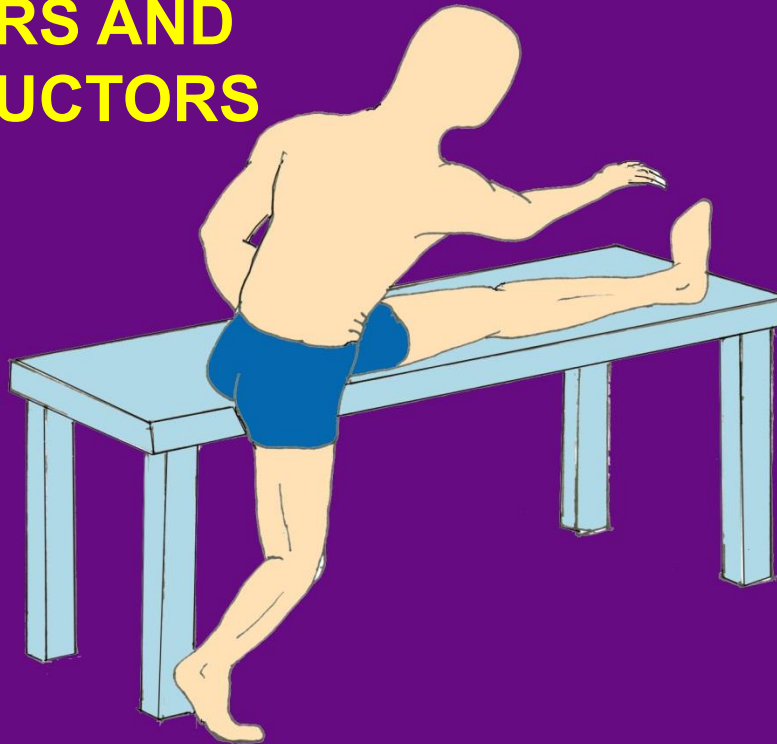


FASCIAL SELF-RELEASE

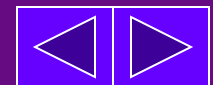
- ❖ If unable to find a skilled therapist to release the fascia, the patient can do a self-release simply by placing the body in specific positions and stretching gently for 2-3 minutes in each position.

•MYOFASCIAL RELEASE (1)

RELEASES THE HIP EXTENSORS, THE INTERNAL ROTATORS AND HIP ABDUCTORS

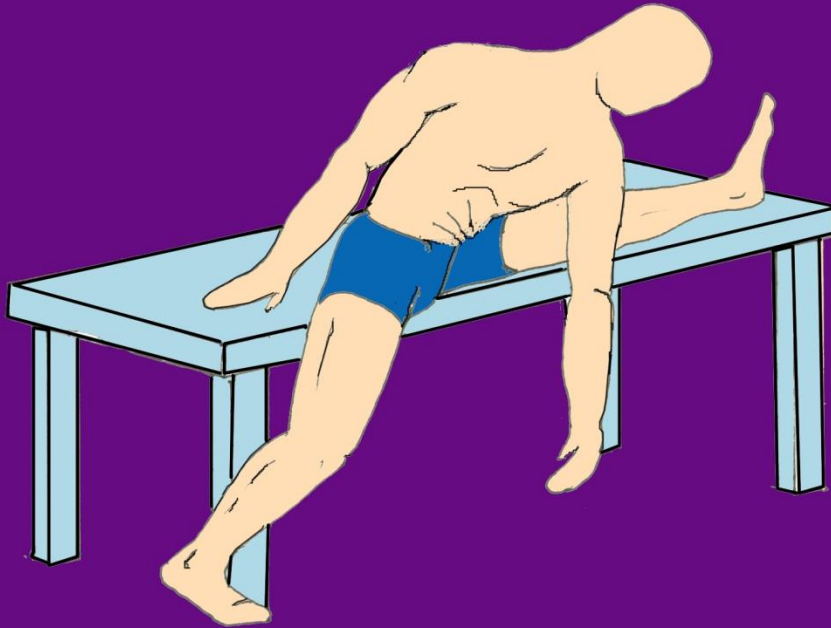


•SIT ON THE EDGE OF A TABLE OR BED, AS ABOVE. TWIST YOUR BODY TO THE LEFT AND BEND FORWARD. HOLD GENTLE STRETCH FOR 1-2 MINUTES. REPEAT ON OTHER SIDE.



•MYOFASCIAL RELEASE (2)

- RELEASES THE HIP EXTENSORS, ADDUCTORS, AND EXTERNAL ROTATORS

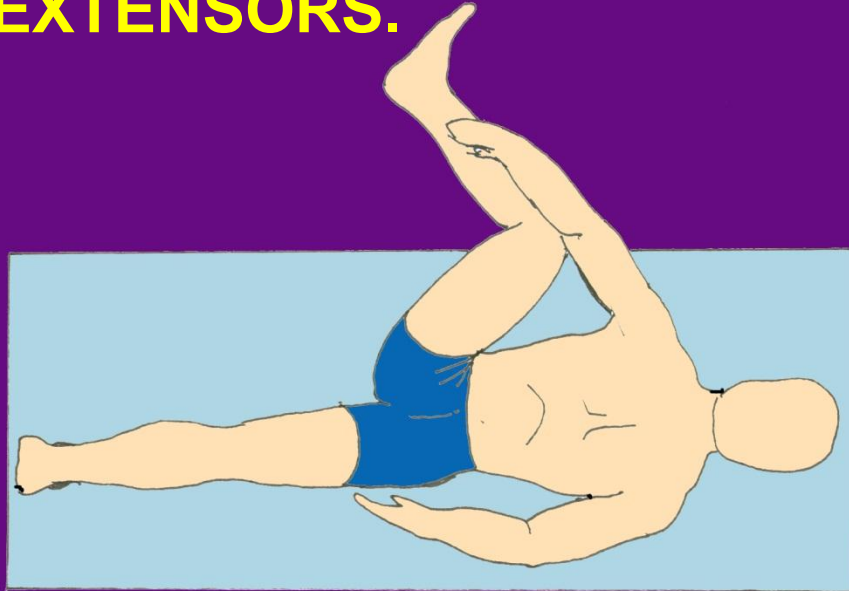


- SIT ON THE EDGE OF THE TABLE AS ABOVE. TWIST TO THE RIGHT AND BEND FORWARD AND DOWN. STRETCH EASY FOR 1-2 MINUTES. REPEAT ON THE OTHER SIDE



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- **MYOFASCIAL RELEASE (3)**
 - **RELEASES THE HIP ADDUCTORS, ROTATORS AND EXTENSORS.**

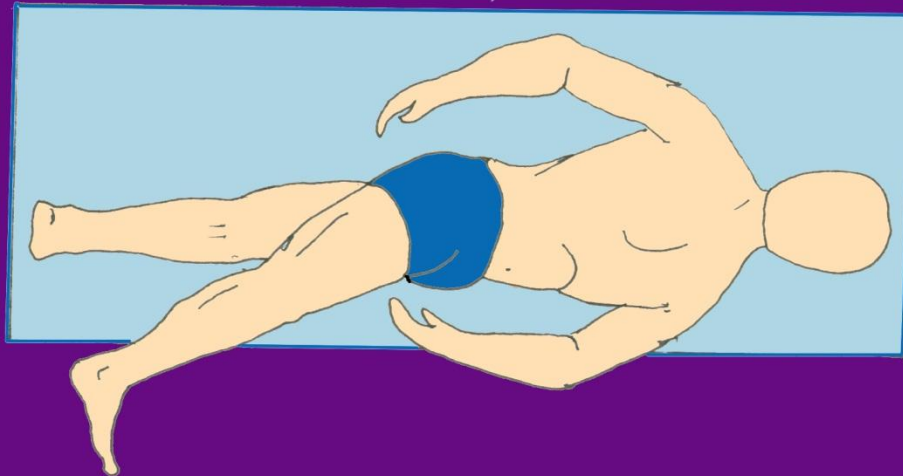


- **FLEX YOUR HIP AND KNEE UP AND OUT TO THE SIDE AS SHOWN. STRETCH GENTLY TO INCREASE MOTION 1-2 MINUTES. REPEAT ON THE OTHER SIDE.**

- MYOFASCIAL RELEASE (4)**

- FLANK STRETCH**

- RELEASES THE QUADRATUS, HIP ABDUCTORS, AND EXTERNAL ROTATORS**

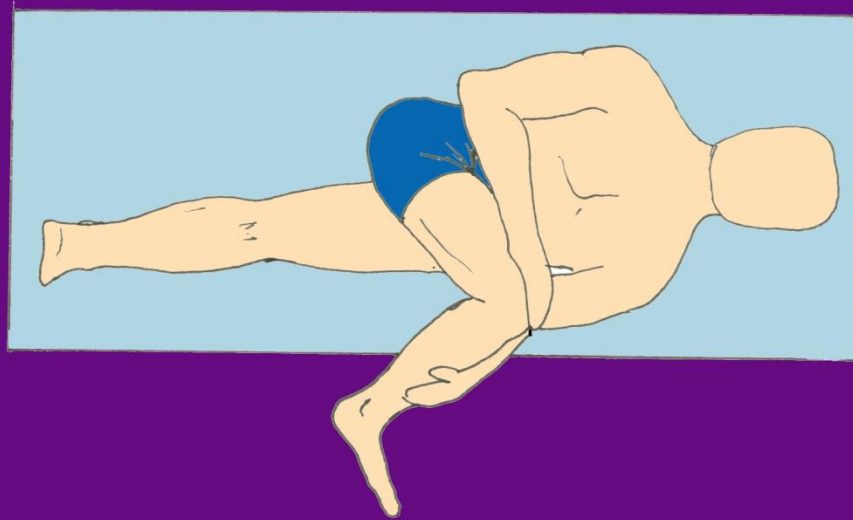


- SWING YOUR RIGHT LEG OVER THE LEFT AS SHOWN. STRETCH GENTLY FOR 1-2 MINUTES. REPEAT ON THE OTHER SIDE.**



- MYOFASCIAL RELEASE (5)**

- RELEASES THE HIP EXTENSORS, ABDUCTORS AND INTERNAL ROTATORS.**



- FLEX YOUR HIP AND KNEE UP ACROSS YOUR BODY. STRETCH GENTLY FOR 1-2 MINUTES. REPEAT ON THE OTHER SIDE.**

Frequency Of Exercise

- ❖ In the acute phase do self-traction maneuvers every two-three hours throughout the day for one day.
- ❖ Then direct corrections every 2-3 hours for one day.
- ❖ Then muscle energy corrections for one day
- ❖ Then use whichever corrections work best for you in whatever position you happen to be in, whenever you feel your SIJ goes out.

Prevention Of SIJD

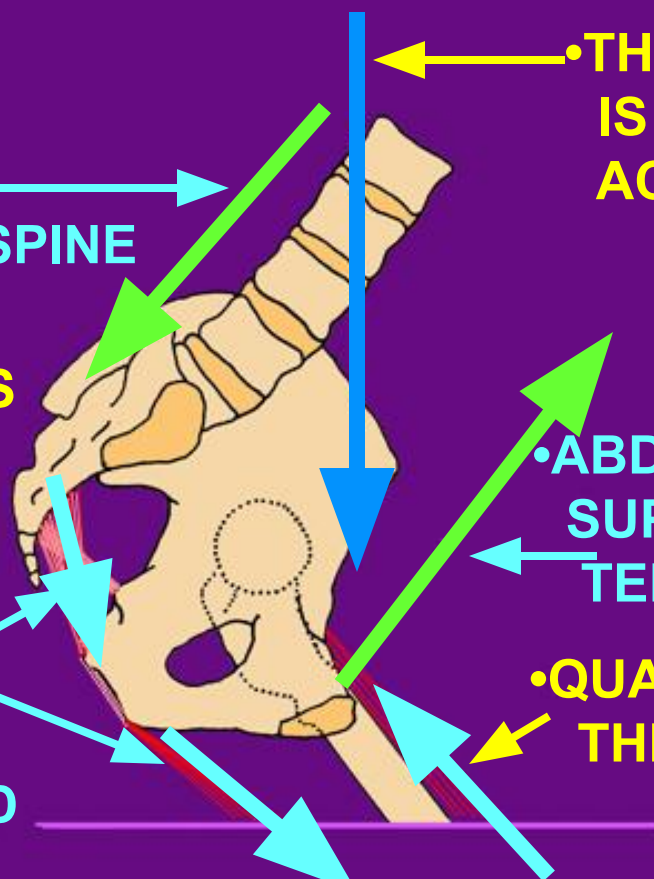
- ❖ TO PREVENT THE ONSET OR RECURRENCE OF SIJD, WHENEVER YOU BEGIN TO LEAN FORWARD TO PERFORM ANY TASK ALWAYS TIGHTEN YOUR ABDOMINAL MUSCLES TO HOLD UP THE FRONT OF YOUR PELVIS AND PINCH YOUR BUTTOCKS TOGETHER TO STABILIZE YOUR LOW BACK AND SIJs.
- ❖ PRACTICE ERECT, MILITARY POSTURE.

BEND THE KNEES WHEN LIFTING.

- ❖ When you are preparing to lift something, first tighten your abdominal muscles to stabilize the front of your pelvis.
- ❖ Then pinch your buttocks tightly together to stabilize your low back and provide a strong stable sacral base.
- ❖ Bend your knees and lean forward and then lift using your legs, keep your spine straight and tuck your chin.

•THE BENT-KNEE LIFT

•MAINTAINS BALANCED LIGAMENT TENSION

- 
- The diagram illustrates a person in a bent-knee lift position. A vertical blue arrow points downwards from the center of gravity, labeled 'THE LINE OF GRAVITY IS ANTERIOR TO THE ACETABULA'. A green arrow points upwards from the pelvis, labeled 'ABDOMINAL MUSCLES SUPPORT BALANCED TENSION'. A red arrow points upwards from the knee, labeled 'QUADRICEPS EXTEND THE KNEES'. A blue arrow points upwards from the hip, labeled 'HAMSTRINGS STABILIZE PELVIS AND SACRUM, AND HELP EXTEND KNEES'. A green arrow points upwards from the spine, labeled 'GLUTEUS MAXIMUS EXTENDS AND STABILIZES PELVIS AND SACRUM'. A blue arrow points upwards from the spine, labeled 'MULTIFIDUS AND ERECTOR SPINAE EXTENDING AND STABILIZING THE SPINE'.
- MULTIFIDUS AND ERECTOR SPINAE EXTENDING AND STABILIZING THE SPINE
 - THE LINE OF GRAVITY IS ANTERIOR TO THE ACETABULA
 - ABDOMINAL MUSCLES SUPPORT BALANCED TENSION
 - QUADRICEPS EXTEND THE KNEES
 - HAMSTRINGS STABILIZE PELVIS AND SACRUM, AND HELP EXTEND KNEES.
 - GLUTEUS MAXIMUS EXTENDS AND STABILIZES PELVIS AND SACRUM.

Lifting Mechanics

- ❖ When leaning forward or lifting, if you straighten your back and try to lift **before** you bring up your pelvis with the abdominal muscles, you are at risk.
- ❖ You must tighten your abdominal muscles and hold them tight **before** leaning forward and hold them tight **while** attempting to straighten up and lift.

Practice the Standing Posterior Pelvic Tilt

- ❖ Support of the anterior pelvis is essential to prevent recurrence of the S3 subluxation.
- ❖ Practice strengthening and using the abdominal muscles throughout the day.

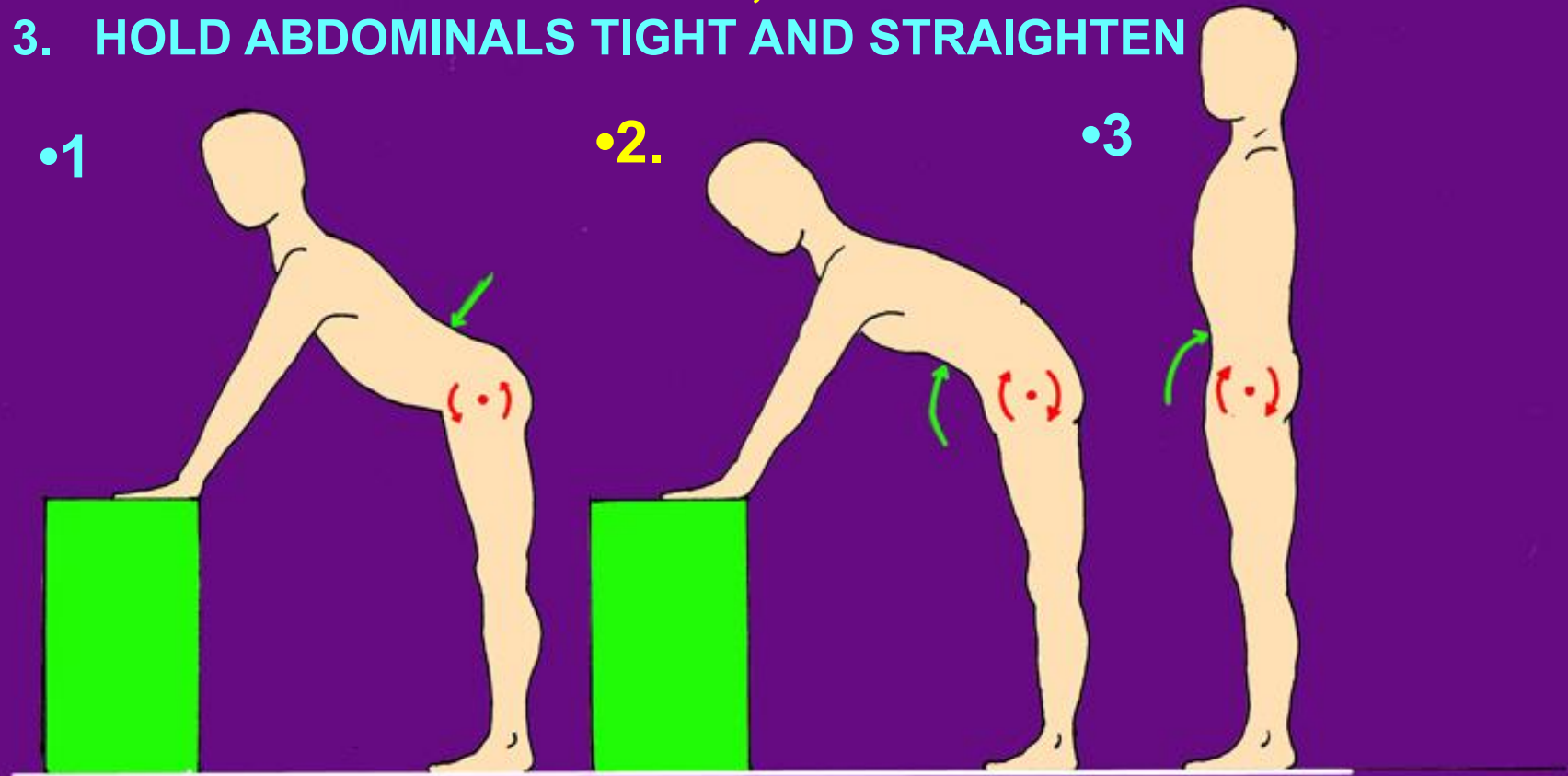
Practice the Standing Posterior Pelvic Tilt (2)

- ❖ Lean forward and place your hands on a counter to support your upper trunk, then tighten your abs to round your lower back.
- ❖ Hold the abs tight as you straighten up.
- ❖ Support the pelvis like this throughout the day and especially when leaning forward.

•STANDING PELVIC LIFT

•FOR STRENGTHENING THE LOWER ABDOMINALS

1. STAND WITH HANDS RESTING ON A COUNTER
2. TIGHTEN THE ABDOMINALS, ARCHING BACK
3. HOLD ABDOMINALS TIGHT AND STRAIGHTEN



•PRACTICE AND HOLD THE PELVIC TILT LONG AND OFTEN.



CAUTION WITH THE PELVIC TILT

- ❖ The posterior pelvic tilt is essential in the prevention of recurrence, **HOWEVER**, the SIJs must be in a corrected position first.
- ❖ If you work too hard on doing the pelvic tilt without correcting the dysfunction, you may reverse the lumbar lordosis and cause a flat back.
- ❖ Always correct the subluxation first and then use the posterior pelvic tilt to prevent recurrence.

Abdominal Hollowing

- ❖ “Richardson’s group developed a therapy program designed to re-educate the motor system to activate the transverse abdominis in a normal way with low back pain patients.
- ❖ Hollowing was developed as a motor re-education exercise and not necessarily as a technique to be recommended to patients who require enhanced (cont.)

Abdominal Hollowing (2)

“stability for performance of the activities of daily living, which has been misinterpreted by some practitioners.

- ❖ Rather, abdominal bracing, that activates the three layers of the abdominal wall with no “drawing in” is much more effective at enhancing spine stability”. McGill (64)

Proper Posture

- ❖ Proper posture is the key to a healthy back and the key to proper posture is head position.
- ❖ Keep your head erect and your chin tucked and your upper back will straighten automatically.
- ❖ Once your upper back is straight it is much easier to do a posterior pelvic tilt.

•PROPER POSTURE

- THE HEAD IS ERECT AND BALANCED ON THE NECK. THIS KEEPS THE LINE OF GRAVITY POSTERIOR TO THE ACETABULA



- THE CHEST IS UP, INCREASING VITAL CAPACITY



- THE ABDOMINAL MUSCLES ARE POSITIONED FOR MAXIMAL EFFICACY AS ARE THE HIP FLEXORS.

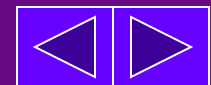
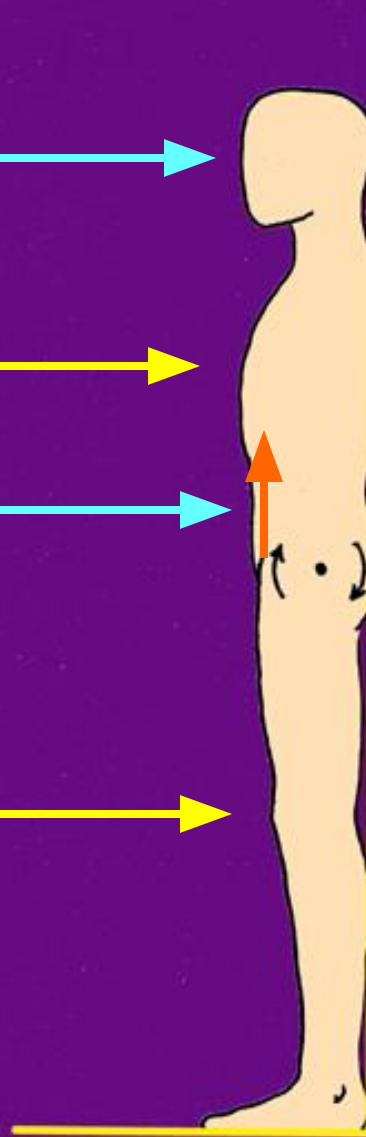


- KNEES ARE RELAXED



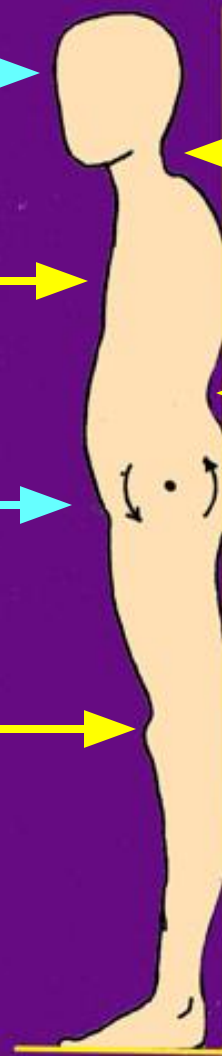
- PRACTICE PROPER ALIGNMENT BY STANDING UP AGAINST A WALL

- THE PELVIS IS ROTATED POSTERIORLY



•POOR POSTURE

- A FORWARD HEAD FORCES THE LINE OF GRAVITY FORWARD AHEAD OF THE ACETABULA, LOCKS THE CERVICAL FACETS AND LIMITS HEAD ROTATION.
- THE CHEST DROPS LIMITING VITAL CAPACITY.
- WITH THE LINE OF GRAVITY ANTERIOR TO THE ACETABULA THE PELVIS ROTATES ANTERIORLY AND IMPAIRS HIP FLEXION.
- THE HAMSTRINGS TIGHTEN AND MAY CAUSE A RECURVATUM OF THE KNEES.
- THE ANTERIORLY ROTATED PELVIS WILL CAUSE ADDUCTOR WALKING WITH THE FEET EXTERNALLY ROTATED.
- C7 CAN SHEAR FORWARD ON T1 WITH VIBRATIONAL TISSUE CREEP.
- THE FORWARD WEIGHT OF THE HEAD CAUSES A DORSAL KYPHOSIS.
- A LUMBAR LORDOSIS NARROWS THE INTERVERTEBRAL FORAMINA AND CAUSES THE DISKS TO BULGE POSTERIORLY.



Changes in Gait Adductor Walking

- ❖ Positional inhibition of abdominal muscles causes anterior rotation of pelvis.
- ❖ Anterior pelvic rotation causes a positional inhibition of the hip flexors.
- ❖ Subject will then ambulate with hips in external rotation bringing each leg forward with the thigh adductors.

Changes in Gait From Poor Posture (2)

- ❖ Impact loading with the leg in external rotation stresses the medial collateral ligament and may cause a valgus deformity of the knee and impair patellar tracking.
- ❖ The subject then 'rolls over' the hallux during the final stage of deceleration which may cause a hallux valgus.

Use of a Support

- ❖ A sacroiliac belt can be helpful to maintain ligamentous balance, but must be put on when lying supine after making a correction to the balanced position.
- ❖ If the support is put on when the joint is subluxed, it will increase the pain by holding the joint in the subluxed position.
- ❖ A wide luggage belt, available at most Marts in the luggage department for about five dollars, can be adjusted or cut down to fit and works very well.

The Lumbosacral Support (2)

- ❖ I recommend a lumbosacral support if you have a protruding abdomen or are in the later stages of pregnancy.
- ❖ I prefer an elastic lumbosacral support about 6 inches wide, with a velcro closure, two lateral support straps and a lumbar pad.
- ❖ Put on with the patient supine after correction is achieved, the bottom of the support is just above the trochanters and the support is fastened snugly.

The Lumbosacral Support (3)

- ❖ The secondary straps are then stretched toward the symphysis so they provide a mild lift in posterior rotation.
- ❖ The support now helps to maintain the balanced position, has a mild corrective force in posterior rotation and is wide enough to help stabilize L4,5-S1, which is destabilized with the subluxation.

To Decrease Pain at Night When Sleeping

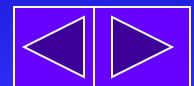
- ❖ When you first go to bed, do your corrective exercises to put the joints in a good position for the night.
- ❖ The pelvis is not stable when unloaded and supine.
- ❖ To stabilize your pelvis when you are sleeping, sleep in an elastic garment such as Spandex bike shorts or a panty girdle.

To Decrease Night Pain

- ❖ Sleep in silk or acetate pajamas so that you don't have to fight the covers.
- ❖ If you sleep on your back put a pillow up under your upper thighs.
- ❖ If you sleep on your side, pull your knees up and put a pillow between them.
- ❖ Try to avoid sleeping on your stomach unless you draw one knee up along side of you.

MEDICAL MANAGEMENT

PREFERRED PROCEDURES AND INVASIVE TECHNIQUES



Medical Management

- ❖ Modalities
- ❖ Exercise during pregnancy
- ❖ Contraindications
- ❖ Trend
- ❖ Results
- ❖ Invasive techniques

Management Objectives

- ❖ Demonstrate fascial release using methods of proprioceptive neuromuscular facilitation.
- ❖ Study the problems with sacral fixation.
- ❖ Learn the problems with inappropriate proliferation techniques.
- ❖ Describe the preservation of function with invasive techniques

Modalities

- ❖ Modalities will provide only scant relief if the subluxation is not corrected.
- ❖ After the subluxation is corrected modalities are very helpful to relieve any residual pain.
- ❖ If you apply the modalities while the patient is in the prone position, the SIJs can subluxate again and the pain will recur.
- ❖ If the patient is still sore after the treatment, repeat the corrective procedure.

Preferred Procedure (1)

- ❖ Heat is analgesic, but not anesthetic and cold is anesthetic, but not analgesic.
- ❖ Cold is helpful at onset, but heat is usually better tolerated later. If you use cold, do not allow the patient to shiver or you will increase spasms.
- ❖ The heat and electric stimulation may be helpful in flushing local accumulation of prostaglandins.

Preferred Procedure (2)

- ❖ Ultrasound with electrical stimulation in the side-lying position can also be helpful.
- ❖ Phonophoresis with cortisone can be used, but cortisone is effective against only one type of prostaglandin.
- ❖ For phono try using a lotion containing 10-15% methyl salicylate. The salicylate is absorbed topically and is effective against both types of prostaglandins.

Preferred Procedure (3)

- ❖ On the second visit, have the patient first demonstrate how he/she is doing the corrective exercises.
- ❖ Invariably you will find them doing some of the exercises improperly and they will need some little correction in method to enhance the efficacy of the procedure.
- ❖ If the patient continues to improve, no further treatment is necessary.

Preferred Procedure (4)

- ❖ If the subluxation continues to recur after two weeks a lumbosacral support is indicated.
- ❖ If instability continues after 4-6 weeks, prolo should be considered to the long and short posterior SI ligament.
- ❖ Only prolo when the SIJ is in the corrected position.
- ❖ Prolo should not be used in the iliolumbar ligaments until the SIJ is pain free and stable.

Influence of Relaxin

- ❖ Kristiansson found that back pain during pregnancy was clearly associated with serum levels of Relaxin. (Ref. 2, p 204)
- ❖ Serum levels of Relaxin are increased during the last trimester of pregnancy, during menopause and about 7-10 days before menstruation.(73, 74)
- ❖ Relaxin does not cause back pain, but softens pelvic ligaments and increases the risk of SIJD through minor trauma.

Influence of Relaxin (2)

- ❖ Postmortem specimens of the SIJ in various stages of pregnancy clearly showed that the range of motion at full term increased by about 2 ½ times.(60)
- ❖ In one subject, the anterior margins of the joint could be separated by almost 2 cm.(60)
- ❖ Movement abnormalities of the SIJs and pubic joints are a common cause of persistent postpartum pain and respond to simple mobilizing techniques.(61)

Exercise During Pregnancy

- ❖ The S3 subluxation is very common during and after pregnancy.
- ❖ The patient should be taught to self-correct and the patient's spouse to assist to correct regularly in order to minimize the dysfunction, relieve pain and limit excessive ligamentous instability.
- ❖ After pregnancy, the corrective exercises should be continued until the ligaments regain stability.

Fitness

- ❖ If the abdominal muscles are weak, they must be strengthened.
- ❖ Begin with crunches lying supine and with the hips and knees flexed and when sitting tightening the abdominal muscles and the gluteals while pushing down on your knee .
- ❖ Practice tightening them and holding them tight throughout the day.
- ❖ Any fitness program must be appropriate to the problem.

Special Note With Regard to Exercise Programs

- ❖ Not all exercise programs are appropriate for this specific lesion!!!
- ❖ If you exercise inappropriately while the SIJs are subluxed, you can irritate the joints and increase inflammation, pain and spasm in the low back, the buttock, down the leg and up the back.
- ❖ Special care must be taken so that the SIJs are corrected prior to and following exercise.

Home Exercise Program

- ❖ The DonTigny Dynamic Core Program is available on this program in PDF format.
- ❖ When you close out this SIJ course, go back to the Exercise Program folder for instructions
- ❖ You may print it out and use it as all or any part of it as a patient handout.

Contraindications

- ❖ Contra indications are few and may include fractures or bone disease of the pelvis.
- ❖ In the presence of a leg fracture or a fracture of the surgical neck of the femur the S3 subluxation can still be corrected by gently grasping each innominate bone directly without using the leg as a lever or for traction.
- ❖ Disc disease, compression fractures or spondylolisthesis are not contraindications, although care and proper technique are essential.

Contraindications (2)

- ❖ These techniques are very precise, must be well controlled and require no jerking, popping, twisting or any attempt to cause cavitation.
- ❖ The patient should not be mobilized or exercised in the prone position.
- ❖ Active straight leg raising is contraindicated unless holding a strong posterior pelvic tilt.

Contraindications (3)

Shot-gun Prolo

❖ Indiscriminate injection of prolo into uninvolved SI ligaments may result in stabilizing the joint in the uncorrected position resulting in continued pain and may make correction difficult, if not impossible.

❖ If you prolo the iliolumbar ligaments prior to correcting and stabilizing the SIJs you may not be able to correct the SIJs and the patient will remain in the dysfunctional position.

Contraindications (4)

- ❖ Do not stretch an apparent tight hip flexor.
- ❖ Methods usually used to stretch a tight hip flexor will increase a subluxation of the sacral axis.
- ❖ Reducing the subluxation will restore normal tension to the hip flexors.
- ❖ Do not attempt to restore function with mobilization to an SIJ that has been surgically fixated.

Contraindications (5)

- ❖ The traditional method of manipulation of the SIJ, whereby the patient is side lying, the shoulder is pulled back and the innominate thrust forward and down hard enough to achieve cavitation is potentially dangerous
- ❖ This is meant to correct a 'posterior dysfunction' or an 'upslip'.
- ❖ This may open the joint, free up the dysfunction and the ilia may rebound into a corrected position, however if done repeatedly the joint will eventually lose stability.

Contraindications (6)

- ❖ The dangers in the side-lying maneuver in an attempt to cause cavitation are several:
- ❖ As the iliolumbar ligaments are loosened and the lower vertebra destabilized with dysfunction, this maneuver can tear the annulus, increase shear and torsion shear to the discs and may cause extrusion of disc material.

Contraindications (7)

- ❖ This maneuver can also increase the dysfunction, tear the long and short posterior ligaments, tear the joint capsule, increase muscle separations and cause chronic instability.
- ❖ You may be held liable for causing a chronic instability and continuing low back pain.

Forced Hyperextension

- ❖ Fortin and Falco remind us that the incidence of neural arch defects in athletes involved in sports requiring repeated forceful hyperextension has been well established, with a 30% incidence of spondylolysis in one series of weightlifters.(40)

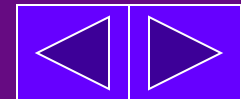
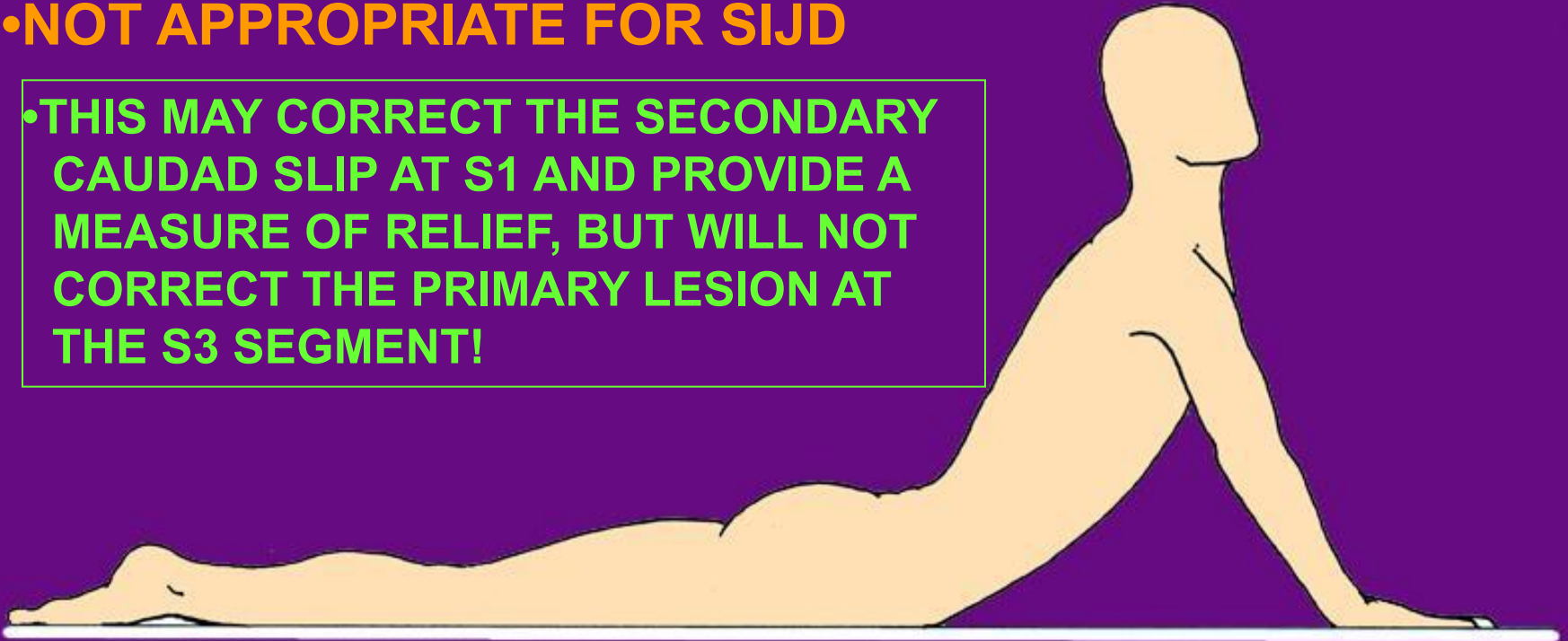
Extension Press-up

- ❖ This exercise will cause a narrowing of the intervertebral foramina, a movement of the disk nucleus anteriorly and a bulging of the disk posteriorly.
- ❖ It may relieve the secondary caudad slip, but it was not developed to treat the SIJ.
- ❖ It is not included in this program and is not recommended.

•FORCED EXTENSION

- NARROWS THE LUMBAR INTERVERTEBRAL FORAMINA
- CAUSES THE DISK NUCLEUS TO MOVE ANTERIORLY
- CAUSES THE DISK TO BULGE POSTERIORLY
- NOT APPROPRIATE FOR SIJD

•THIS MAY CORRECT THE SECONDARY CAUDAD SLIP AT S1 AND PROVIDE A MEASURE OF RELIEF, BUT WILL NOT CORRECT THE PRIMARY LESION AT THE S3 SEGMENT!



Results

- ❖ Shaw's study of 1000 consecutive cases of low back pain found 98% to have SIJD. His surgical incidence for herniated discs dropped to 0.2% (32).
- ❖ His findings were so stunning that they seemed outrageous and few examined the evidence, but if you do what he did, you will find what he found and get similar results.

Results

- ❖ An outcome audit of 145 patients with LBP in 1969 found 80% to have SIJD. Treatments averaged 5.9 per patient.
- ❖ In 1971 an audit of 54 consecutive outpatients with LBP found that 83.3% had SIJD. Treatments averaged 2.9 per patient and relief was frequently dramatic (31).

Positions: AAOS vs. McKenzie vs. DonTigny

- ❖ The American Academy of Orthopedic Surgeons state that in spite of thorough evaluation a firm diagnosis can be established in **only about 15%** of all cases of low back pain and about 7% are disk related.
- ❖ If you do what they did you will find what they found and you will get the same results.

Positions: AAOS vs. McKenzie vs. DonTigny

- ❖ McKenzie finds that about 98% of low back pain is disk related and perhaps 2% are SIJ.
- ❖ If you do what he did, you will find what he found and you will get similar results.
- ❖ DonTigny states that at least 85-95% of low back pain is SIJ related and the destabilization of L4,5-S1 from the subluxation of the sacral axis is probably the principal cause of disk disease.

Trend

- ❖ Immediately after complete reduction of the subluxation **at least 85-90%** of all patients with low back pain will be essentially free of pain.

Trend

- ❖ After instruction in self-correction, over 30% of all patients may not find it necessary to return for further treatments, although every few years they may have a recurrence that requires some assistance to correct.
- ❖ If pain continues to recur past 7-10 days, a lumbosacral support is indicated.

Trend

- ❖ The support is worn during the day in conjunction with a corrective program.
- ❖ If instability continues after two months, proliferant injection should be considered..

Trend

- ❖ The proliferant is a chemical irritant that simulates the production of connective tissue to make the ligaments stronger.
- ❖ The proliferant should only be used in the specific weakened ligaments, specifically the long and short posterior sacroiliac ligaments and NOT the iliolumbar or the sacrotuberous.
- ❖ Prolo can also be used to stabilize an unstable symphysis pubis.

Trend

- ❖ In the event of gross instability or significant trauma, a two-screw or bony arthrodesis may be considered.
- ❖ It is essential to correct the S3 subluxation to assure joint congruency prior to surgical stabilization.

Trend

- ❖ Rents in the joint covering may have to be repaired to prevent synovial fluid from leaking to adjacent neural elements and to prevent formation of cysts.

Trend

- ❖ Be aware that any procedure to fixate the SIJs will eliminate the flexibility to move to an asymmetric pelvis, but will not eliminate the forces that create the asymmetric pelvis, which occur during normal ambulation.

Trend

- ❖ If the forces that create asymmetry are blocked posteriorly, they will manifest anteriorly and may cause instability at the pubic symphysis.
- ❖ With fixation the SIJs will bear weight and lose the function of the balancing ligaments.

Ambulatory Forces on The Pelvis Following Fixation

- ❖ Movement to an asymmetric pelvis is blocked.
- ❖ The lateral sacral flexion is blocked.
- ❖ Movement on the oblique pelvis is blocked.
- ❖ Any counter rotation of the upper trunk will increase shear on the lower disks.
- ❖ The loading force will be increased to the head of the femur during normal gait.

•AMBULATORY FORCES ON PELVIS FOLLOWING FIXATION OF THE SACROILIAC JOINTS

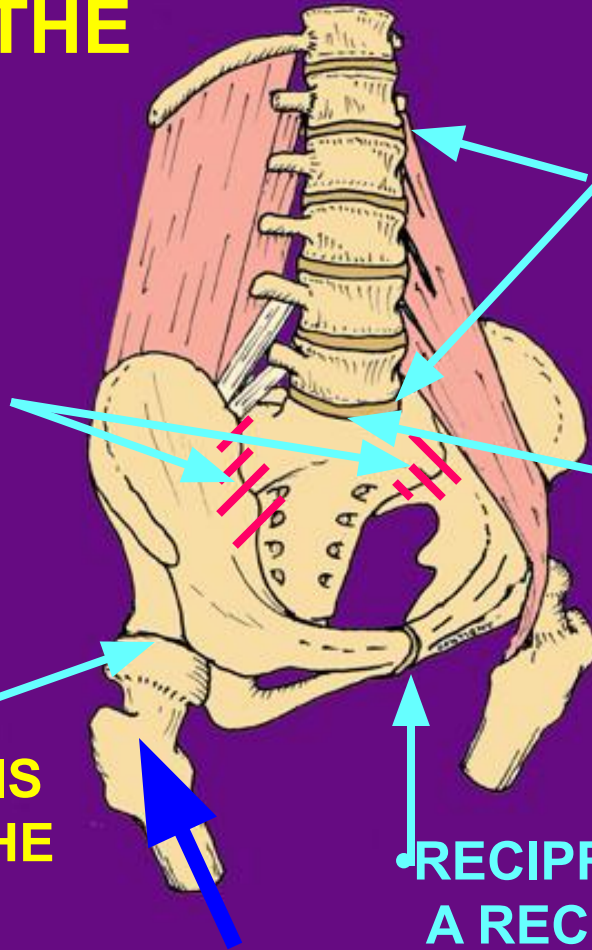
•NO MOVEMENT AT
THE SACROILIAC
JOINTS

•RSVO IS BLOCKED

•COUNTER ROTATION
INCREASES TORSION
SHEAR ON THE DISK.

•IMPACT LOADING IS
INCREASED TO THE
FEMORAL HEAD

•RECIPROCAL MOTION CAUSES
A RECIPROCAL SHEARING
FORCE ON THE SYMPHYSIS



Preserving Function

- ❖ Consideration should be given to preserving function of the force couples in the chronically unstable sacroiliac joint.
- ❖ Once the joint is reduced to the corrected position it may be possible to strengthen the long posterior sacroiliac ligament with a ligamentous transfer.
- ❖ Fibers from the adjacent sacrospinalis tendon might possibly be used to reinforce the long posterior sacroiliac ligament.

Preserving Normal Stability

- ❖ There may be some value in proliferating the long and short posterior sacroiliac ligaments in the early stages of low back pain.
- ❖ This might strengthen those ligaments to limit collagen failure, help to prevent recurrence of dysfunction and preserve the systems.
- ❖ If the balanced position is not maintained, the collagen may still fail in the long posterior sacroiliac ligament even if it has been proliferated.

Invasive Techniques

- ❖ Invasive procedures may be necessary if conservative measures fail.
- ❖ Begin with the **least invasive** measures first.
- ❖ Sarapin is non-steroidal, and can be injected into local trigger points with good relief.
- ❖ Periarticular injections of local anesthetic and steroid to the **area** of PIIS and PSIS to relieve inflammation (85).

Invasive Techniques

- ❖ Proliferant injections to the long and short posterior sacroiliac ligaments. (16,26,27)
- ❖ Ligamentous repair to the long posterior sacroiliac ligament.
- ❖ Surgical fixation in the balanced position. (28,29,30)

The Epidural

- ❖ Because of the lumbar innervation of the SIJs, an epidural anesthetic may relieve the pain of SIJD, but this should not be interpreted as relief of a referred pain of lumbar origin.
- ❖ It is probably more effective to treat the SIJ locally with injections to relieve pain and inflammation.

Injections

- ❖ Norman and May (57) treated over 300 patients with injection of local anesthetic into the SIJs, relieving pain immediately in patients who had both sensory changes and an absent Achilles reflex.
- ❖ Several patients with continuing low back pain following one or two laminectomies for the removal of discs were successfully treated after three or four injections.(57)

Injections (2)

- ❖ Murakami et al compared periarticular and intraarticular injections in 25 consecutive SIJ patients in each group.(85)(2007)
- ❖ Periarticular injection was effective in all patients.
- ❖ Intraarticular injection was effective in 9 of 25
- ❖ An additional 16 patients who had no relief from the intraarticular injection were all relieved from a periarticular injection.

Injections (3)

- ❖ The improvement rate after periarticular injection was 96%.
- ❖ Improvement for intraarticular injection was 62%
- ❖ They concluded that for patients with SIJ pain, periarticular injection is more effective and easier to perform than the intraarticular injection and should be tried initially. (85)

Injectons (4)

- ❖ **Borowsky and Fagen found significant extra-articular sources of sacroiliac region pain exist.**
- ❖ **They concluded that intra-articular diagnostic blocks underestimate the prevalence of sacroiliac region pain. (85)**

The Piriformis Release

- ❖ If surgical release of a tight piriformis is being considered:
- ❖ First correct the SIJ to see if it resolves the problem.
- ❖ If it does not, then consider releasing only the secondary origin of the piriformis from the roof of the greater sciatic notch in order to preserve as much function in that muscle as possible.

CAVEAT

- ❖ No matter what type of procedure is done to strengthen these ligaments and to stabilize the unstable joint, it is absolutely essential to endeavor to maintain the sacroiliac joints in the balanced position with strong, active anterior pelvic support from the abdominal muscles.

CAVEAT

- ❖ Weak abdominal muscles and a lordotic posture will also compromise the posterior elements of the spine and narrow the intervertebral foramina.

INVASIVE NEVERS

❖ NEVER proliferate the iliolumbar ligaments. Normal tension in these ligaments is restored with correction of the subluxation. If these ligaments are proliferated without correction, you may preclude the possibility of correction of the subluxation.

INVASIVE NEVERS

- ❖ NEVER proliferate the sacrotuberous ligaments. Normal tension in these ligaments is restored with correction to the balanced position. Proliferation may prevent correction.

NEVER

- ❖ NEVER surgically fixate the SIJ in the position of subluxation as you will leave too much tension on the short and long posterior SI ligaments and too little tension on the iliolumbar and sacrotuberous ligaments.

NEVER

- ❖ Except when doing an arthrogram, **NEVER** inject into the joint capsule as you may encapsulate the injection and prevent it from reaching the adjacent painful tissues except if it leaks out through rents in the joint capsule.

The Failed Back

- ❖ In the patient with multiple fusions and a failed back, in the likely event of an unstable SIJ, it is probably critical to preserve function rather than stabilize.
- ❖ The importance of these joints to absorb, modify and redirect the various forces that occur during normal gait can not be overstated.
- ❖ **Excess rigidity will predispose to systems failures.**

Failed Prolo

- ❖ Prolo may not be effective if:
 1. The superficial long posterior sacroiliac ligament has undergone extreme visco elastic failure.
 2. The ligament is avulsed from its attachment to the posterior superior iliac spine.
 3. The ligament is shredded or otherwise traumatized.
 4. The ligament is not in a corrected and shortened position when injected.

Hypothetical Surgical Scenario to Preserve Function

- ❖ 1. Correct subluxations to the balanced position.
- ❖ 2. Fixate each side with two screws posterior to each joint.
- ❖ 3. Transfer tendon from the sacrospinalis muscle to the long posterior sacroiliac ligaments and the PSIS.
- ❖ 4. Proliferate posterior SI ligaments and the pubic symphysis.
- ❖ 5. Allow healing and then remove screws.

Suggested Basics For Post Op Rehab

- ❖ 1. No asymmetric pelvic exercises at first.
- ❖ 2. Take shorter steps when walking.
- ❖ 3. Encourage patient to use elevators and ramps instead of stairs.
- ❖ 4. Begin with flexibility and breathing exercises, isometric trunk exercises and active resistive exercises to extremities.
- ❖ 5. Posture and movement training.
- ❖ 6. Weight loss program if necessary.

Suggested Basics (2)

Use of Crutches

- ❖ When using crutches following procedures for the temporary or permanent fixation of the SIJs it is probably better to use a swing through, partial weight bearing gait.
- ❖ This avoids the stresses of the asymmetric pelvis and prevents the non-weight bearing leg from hanging on the fixated side, which tends to pull that side into anterior rotation and to disturb the site of fixation.

Malingering, Hysteria and Depression

- ❖ Merskey examined the life experience of 141 chronic pain patients. (71)
- ❖ Data provided support for the view that a significant proportion of the emotional disturbance associated with chronic pain is a secondary effect. (71)
- ❖ Although pain may follow psychological illness, lesions that cause chronic pain tend to produce psychiatric disturbances. (71)

Malingering, Hysteria and Depression (2)

- ❖ Grieve noted that “experienced manual therapists are very familiar with the simple antidepressant effect of relieving the pain which has engendered the depression.” (70)
- ❖ “Backache associated with hysteria or malingering is rare and usually suspected on the basis of other features in the presentation. (70)
- ❖ Relief of the organic pain is essential to the resolution of the emotional complaint”(70)

Nutritional Supplements

- ❖ There may be some advantage in taking nutritional supplements to help to restore and preserve the good health of the injured tissues.
- ❖ Those that presently come to mind are glucosamine, chondroitin, MSM (a derivative of DMSO), and ester C.

Platitudes and Stroking

- ❖ Dr. Andrew Still once remarked, “When a cat gets its tail caught in a door, don’t say ‘poor kitty’ or try to appease its pain by petting it. Open the door and turn it loose! You must get at the cause!”
- ❖ It takes more than platitudes and stroking to really be effective in the treatment of low back pain.

Need To Do List

- ❖ Relevant research
- ❖ Interrater reliability studies
- ❖ Comparative studies
- ❖ Double blind studies
- ❖ Develop better methods of stabilizing the unstable SIJ to maintain function.
- ❖ Develop better x-ray procedures to visualize the dysfunction
- ❖ Develop more appropriate measurements of dysfunction

Need to Do List (2)

- ❖ Measurements of SIJ motion from standing to asymmetric pelvis at two-point support plus with the addition of the anterior/posterior, rotation/ counter rotation of the trunk that occurs on the oblique sacral axis.
- ❖ Measurement of the movement of the innominate on the sacrum that occurs with correction of the subluxation.(13) (DonTigny: Measuring PSIS movement. Clinical Management 10:43-44, 1990) (Full text in Archives)

Ockham's Razor

- ❖ Ockham's Razor is a scientific rule of investigation that holds that of all theories that fit the facts, the preferable one is the simplest.
- ❖ The subluxation of the sacroiliac joints that occurs at the S3 segment is the simplest lesion that fits the facts known about the mechanics of idiopathic low back pain syndrome.

Conclusions

- ❖ The SIJ is a dynamic joint that functions as a force couple through a balance of ligamentous tension with sacral loading
- ❖ A pathological release of this balance may cause a subluxation at the S3 sacral segment, which may mimic disc dysfunction or give the impression of a multifactorial etiology.
- ❖ Treatment is by the manual correction of the subluxation and restoration and maintenance of the position of ligamentous balance.

Conclusions (2)

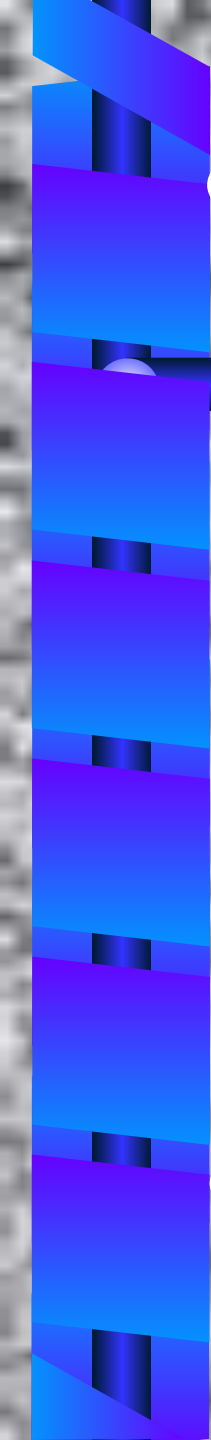
- ❖ Prevention of dysfunction is by using a strong active abdominal support of the anterior pelvis to maintain ligamentous balance, especially when leaning forward to perform any task.
- ❖ Stabilization of the unstable joint is by lumbosacral support, proliferant injections or surgical stabilization of the sacroiliac joints.
- ❖ Surgical stabilization of the SIJs must be done with the joints in the balanced position.

Conclusions (3)

- ❖ Destabilization of the iliolumbar ligaments from the subluxation at S3 is probably the principal cause of disk disease.(23)
- ❖ This is the most likely mechanism of idiopathic low back pain syndrome, a subtle, measurable, reversible, biomechanical lesion of the SIJs that is a commonly overlooked variation from normal.
- ❖ In most instances it is easily corrected and preventable with proper exercise.

Conclusions (4)

- ❖ Most articles that have been published on low back pain without appropriate consideration of the many and varied effects of the sacroiliac joints must be considered to be of questionable value.
- ❖ Evidence gathered under a faulty hypothesis is not valid and must be reevaluated.
- ❖ Critical analysis of any data related to low back and pelvic pain must include these major dynamic joints.



- **CUT THIS IN STONE**

**CORRECT
THE SIJ**

- **AND THEN REASSESS**

Sports Applications

◆ Golf

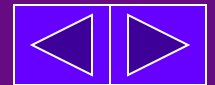
- When leaning forward to address the ball always tighten your abs and hold tension on them throughout the swing.
- ◆ If your abs are relaxed your pelvis will hang down in front increasing dysfunction and the curve (lordosis) in your low back.
- ◆ The increased lordosis closes the joints in the back of the spine limiting rotation and increasing shear and torsion shear to the disks in the front of the spine.

•UNSTABLE STANCE

- AN INCREASED LUMBAR CURVE LIMITS ROTATION IN THE VERTEBRAL FACETS AND INCREASE ROTATIONAL SHEAR ON THE ANTERIOR ASPECT OF THE DISK.



- INACTIVE ABDOMINAL MUSCLES ALLOW ANTERIOR PELVIC ROTATION, WHICH IS INCREASED BY LEANING FORWARD.
- SWING CONTROL IS DECREASED.



STABLE STANCE

- STRAIGHT SPINE IS STRONGER AND ALLOWS MAXIMUM ROTATION.

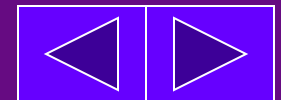


- SHEAR ON THE DISKS IS DECREASED.



- STRONG, ACTIVE, ANTERIOR PELVIC SUPPORT PREVENTS INJURY WITH ANTERIOR PELVIC ROTATION.

- PROMOTES A STRONGER MORE CONSISTENT SWING



Sports Applications

Weightlifting

- ❖ Hold your abs tight and pinch the cheeks of your buttocks together as you lean forward to lift and hold through the lift.
- ❖ Keep your spine straight and do not try to hold a lordosis.
- ❖ If you do this you should not require a weight belt.

Sports Applications

Soccer/Football

- ❖ A common cause of the onset of back pain when kicking occurs when the kick is blocked.
- ❖ The action of the hip flexor muscle pulls the pelvis forward and down on the sacrum.
- ❖ When kicking the ball pull the pelvis up with the abs as you kick.
- ❖ This will reinforce the kick and prevent the onset of back pain if your kicking leg is blocked.

Sports Applications

◆ Tennis

When you serve tighten your abs during the serve to add power and consistency.

Sports Applications

◆ Exercising

Do corrections before and after your exercise program.

Do NO single or double straight leg raises unless you are holding a strong posterior pelvic tilt with your abdominal muscles.

Pull should come from the rectus abdominis and the abdominal obliques.

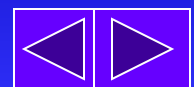
The transversus abdominis effect is minimal

Prevention Of SIJD

- ❖ TO PREVENT THE ONSET OR RECURRENCE OF SIJD, WHENEVER YOU BEGIN TO LEAN FORWARD TO PERFORM ANY TASK ALWAYS TIGHTEN YOUR ABDOMINAL MUSCLES TO HOLD UP THE FRONT OF YOUR PELVIS AND PINCH YOUR BUTTOCKS TOGETHER TO STABILIZE YOUR LOW BACK AND SIJs.
- ❖ PRACTICE ERECT, MILITARY POSTURE.

Consideration of the Disks

The clinical significance of the mechanical characteristics of the disks must be carefully reconsidered, especially as regarding the disk as a causative factor in idiopathic low back pain.



Consideration of The Disks

- ❖ Movement of the nucleus with offset loading
- ❖ The bulging disk
- ❖ Increases in intradiskal pressure
- ❖ Failure of the annulus
- ❖ Hyperextension posture
- ❖ Tension on nerve roots
- ❖ Surgery

The Disks Objectives

- ❖ The participant will be made aware of certain conditions of the disks that may not be clinically significant in the assessment procedure.

Consideration of the Disks Loading

- ❖ In symmetrical axial loading of the spine the nucleus pulposus is pressed against the annulus, thus stiffening the annulus, increasing weight loading capability and providing stability to the disk (1).
- ❖ This stiffening of the annulus serves as a damper on the axial loading of the spine.(1)
- ❖ With bending or compression, a vertebral fracture will occur sooner than an injury to the intact intervertebral disk (2,3,4).

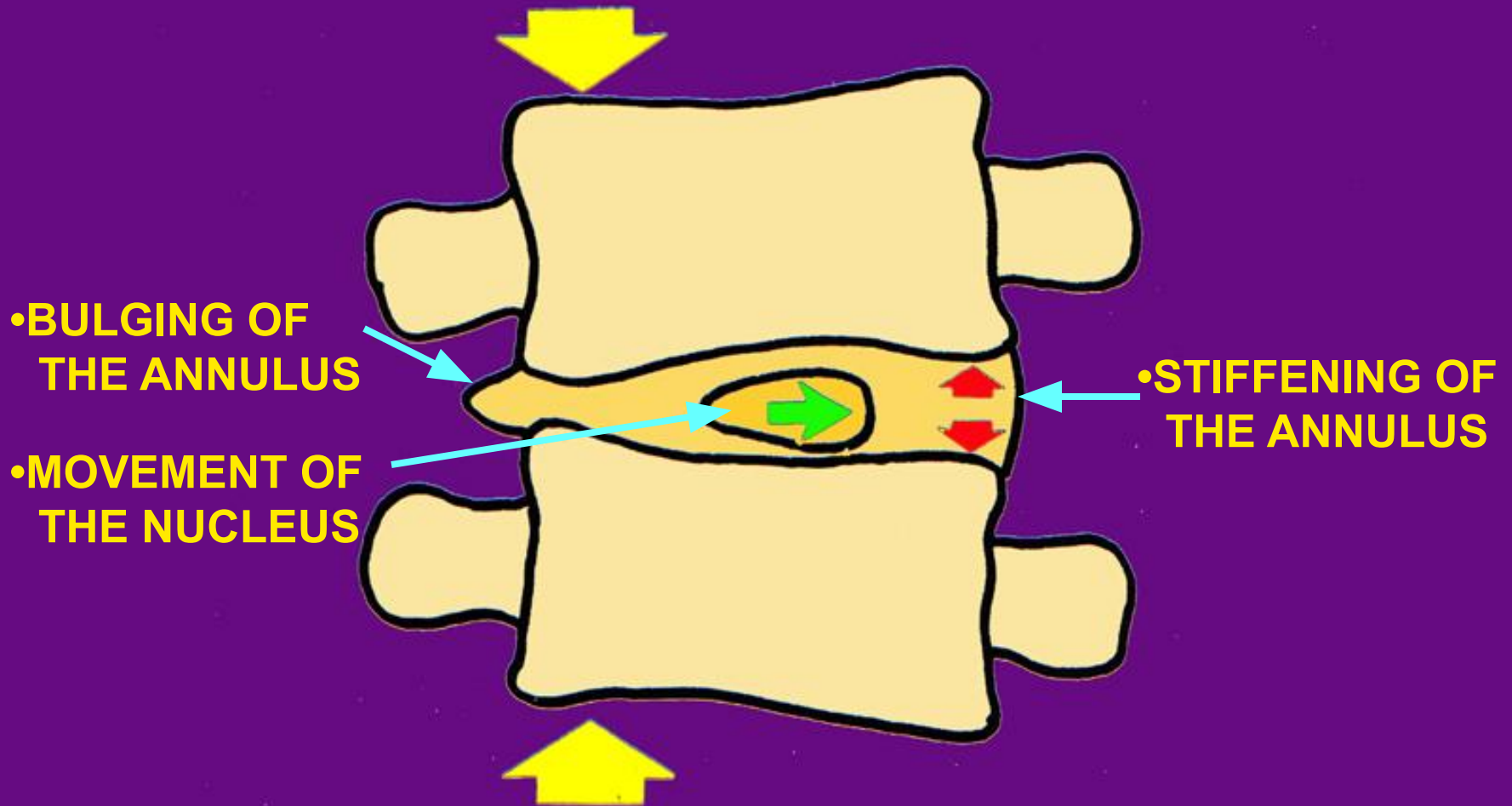
Movement of the Nucleus

- ❖ With asymmetric loading the nucleus pulposus moves slowly toward the unloaded side at 0.6 mm/min for a maximum of three minutes.(2,5)
- ❖ With this slow migration, the nucleus pulposus functions as a slowly moving fulcrum to prevent rapid and acute flexion of the annulus on the loaded side.(6)

Offset Loading

- ❖ With offset compressive loading, the side of the annulus under compression always bulges and the side under tension stiffens. (3,4,7-11)
- ❖ Stiffening the annular wall on the off-loaded side serves to protect the disk from shear forces.(6)

•ASYMMETRIC LOADING



The Bulging Disk

- ❖ When disks are called bulging, the vertebra either above or below is both side bent and rotated to the side of the bulge.(20)
- ❖ Muscle spasm is also a common cause of disk bulge.(20)
- ❖ The disk bulge, per se, is not clinically significant.

Intradiskal Pressure

- ❖ Increased intradiskal pressure is a normal, necessary phenomenon that stiffens the annulus and allows it to tolerate increased loading.
- ❖ No evidence exists to show that the reduction of intradiskal pressure is therapeutic or relieves pain better than other methods.(8)

Failure of the Annulus

- ❖ The annulus does not tend to fail with compressive loading, but rather as a result of shear loading (12), although compressive loading may cause a Schmorl's node.
- ❖ Small amount of torsion will produce a relatively large loss of disk volume.(12)
- ❖ The disk is subject to injury from horizontal shear forces produced by rotation.(4)

The Lumbar Lordosis and the Disks

- ❖ Exaggerated cervical and lumbar lordosis is associated with a decrease in height of the intervertebral disks, and narrowing of the intervertebral foramina, with compression of the nerve roots.(1)
- ❖ The lumbar lordosis increases the lumbo-sacral angle increasing shear forces on the disks at L4-5 and L5-S1 and tension on the iliolumbar ligaments.

Hyperextension of the Spine

- ❖ With hyperextension of the spine the posterior elements of the spine transmit a substantial part of the load.(13)
- ❖ Stress fractures leading to spondylolisthesis are likely to be produced by repeated extension under load.(13)

Pain in the Annulus

- ❖ Because abnormal disks are commonly found in subjects with no history of pain, pain production is not necessarily an indication of an abnormal disk.(14,15)
- ❖ Many disks are abnormal, degenerated and have some tears in the annulus, but are not usually a source of continuing or even infrequent pain.(6)

Tension on the Nerve Roots

- ❖ Clinical implications of spinal nerve root compression have been well documented (16) and appear to point to disk degeneration as a causative factor.
- ❖ Similar neurological changes, can be caused by a stretch of the spinal nerve roots.(17)

Tension on the Nerve Roots

- ❖ Nerve roots are more vulnerable to stretch than peripheral nerves.(17)
- ❖ During elongation the cross-sectional area is reduced with deformity of axons and blood vessels.(17)
- ❖ The elastic limit of nerve roots is reached at 15% elongation when a total mechanical block occurs.(17)

Tension on the Nerve Roots

- ❖ Dorsal root ganglia are more susceptible to stimulation than axons (18); therefore, sensory changes may be more common than motor defects.
- ❖ Traction on nerve roots may also produce a lancinating pain.(19)

Surgery

- ❖ Nachemson observed that “Even though in elective, carefully selected lumbar disk surgery, 90% of the patients will enjoy the relief of leg pain, as many as 60-70% may continue to have some low back pain. (21)
- ❖ That this 60-70% might have some dysfunction of the SIJs was not a consideration.

Summary

- ❖ In disk disease, compression is not a primary factor.
- ❖ In low back pain, annular tears may not be a factor.
- ❖ The disk bulge is probably not clinically significant.
- ❖ Changes in sensation may not be disk related.
- ❖ Destabilization of the iliolumbar ligaments with SIJD is probably the principal factor in degenerative disk disease.

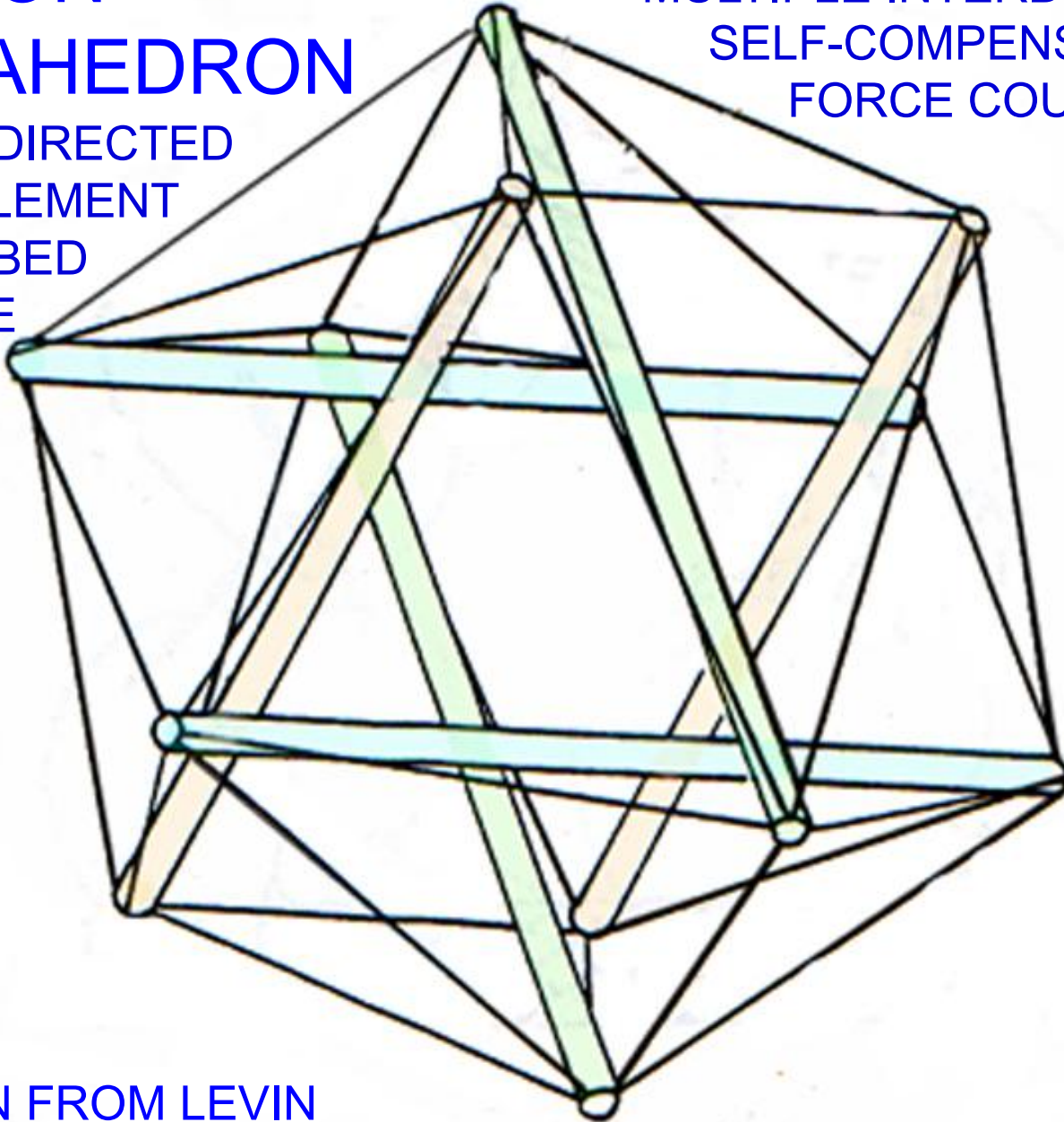
Biotensegrity And The SIJ

- ❖ Biotensegrity relates to tension structures such as the icosahedron as described by B. Fuller.
- ❖ It appears that the fundamental functionality of biotensegrity is multiple, self-compensating interdependent force couples.
- ❖ The sacroiliac joints function as a pair of self-compensating interdependent force couples and are a basic form of biotensegrity.
- ❖ See www.biotensegrity.com (Steve Levin, MD)
(78)

•TENSION ICOSAHDEDRON

- A FORCE DIRECTED AT ONE ELEMENT IS ABSORBED IN ALL THE OTHERS.

- MULTIPLE INTERDEPENDENT
SELF-COMPENSATING
FORCE COUPLES



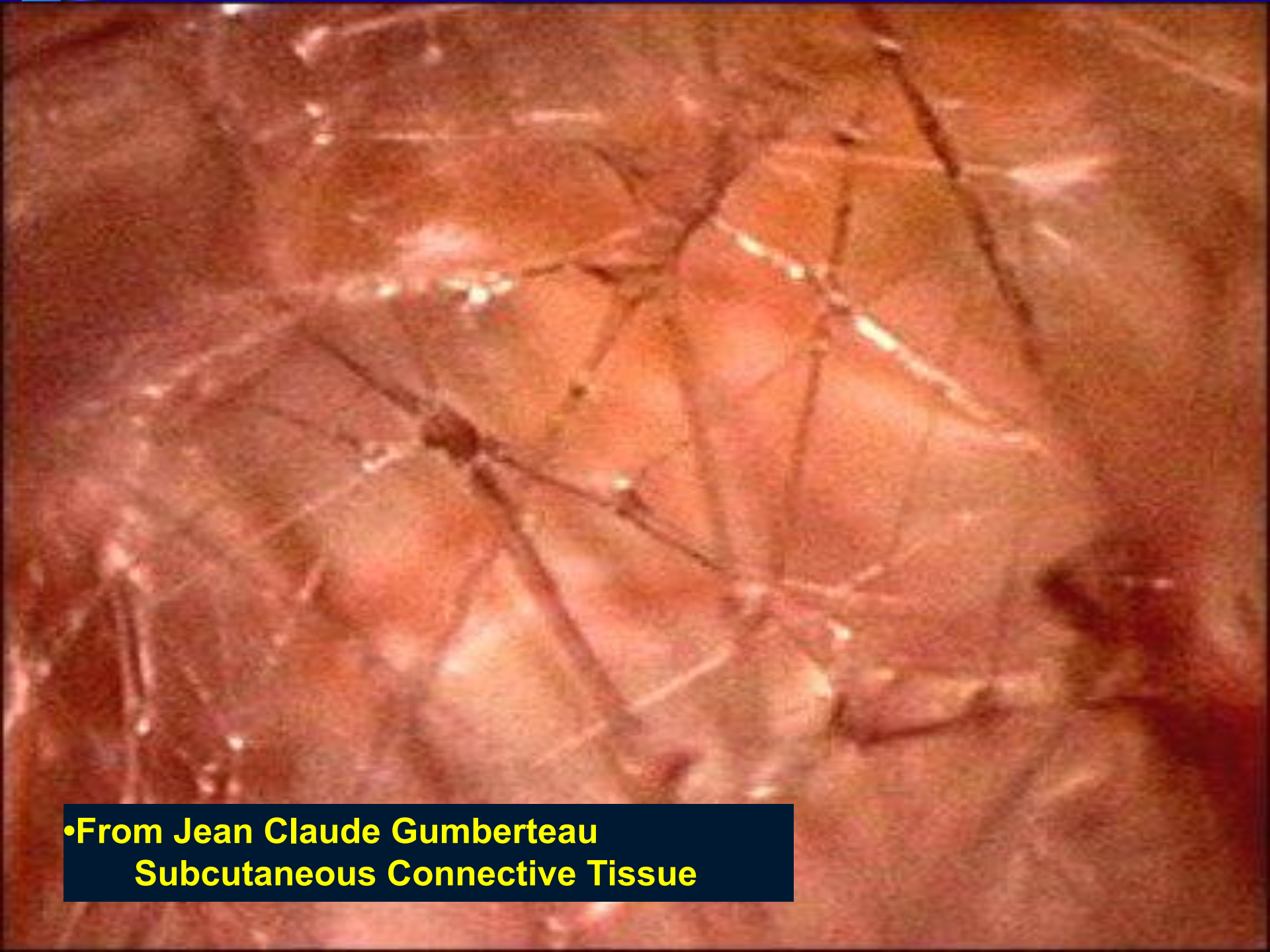
- REDRAWN FROM LEVIN





● From Jean Claude Gumberteau

Subcutaneous Connective Tissue

A high-magnification light micrograph of subcutaneous connective tissue. The image displays a dense network of collagen fibers, which appear as thick, wavy, eosinophilic (pink) bundles. Interspersed among these fibers are numerous small, spindle-shaped cells, likely fibroblasts, which are stained with hematoxylin, giving them a dark purple nucleus. The overall texture is fibrous and somewhat disorganized, characteristic of loose connective tissue.

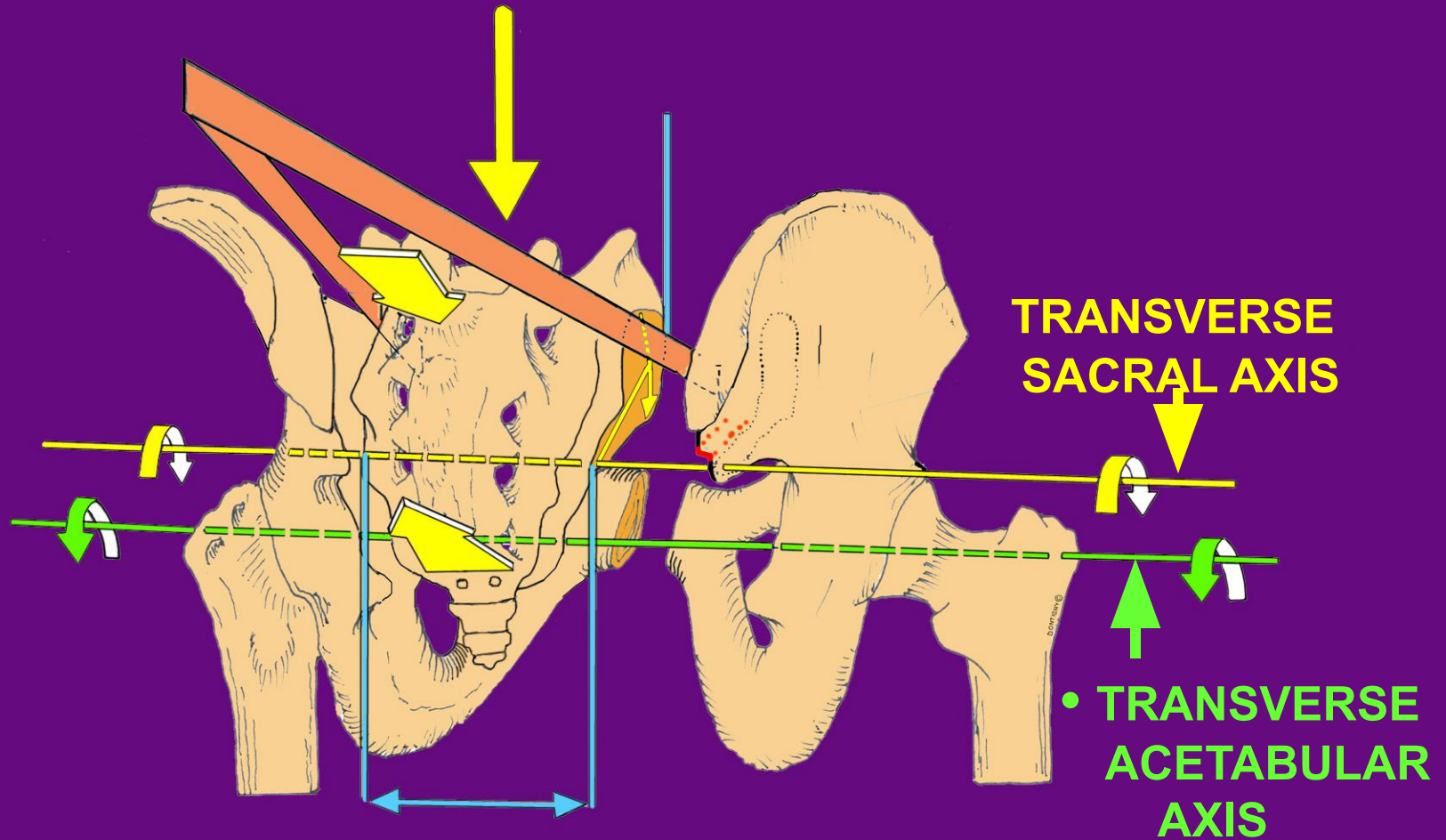
•From Jean Claude Gumberteau
Subcutaneous Connective Tissue

Biotensegrity 1

- ❖ The biomechanical concepts described are consistent with biotensegrity concepts.
- ❖ 1. The transverse sacral axis through S3 with loading and with flexion and extension. A short radius rotational component is perpendicular to the central axis (Single axis).
- ❖ 2. The transverse acetabular axis with anterior and posterior pelvic rotation has a long radius rotational component perpendicular to the central axis (Single axis)

BIOTENSEGRITY 1

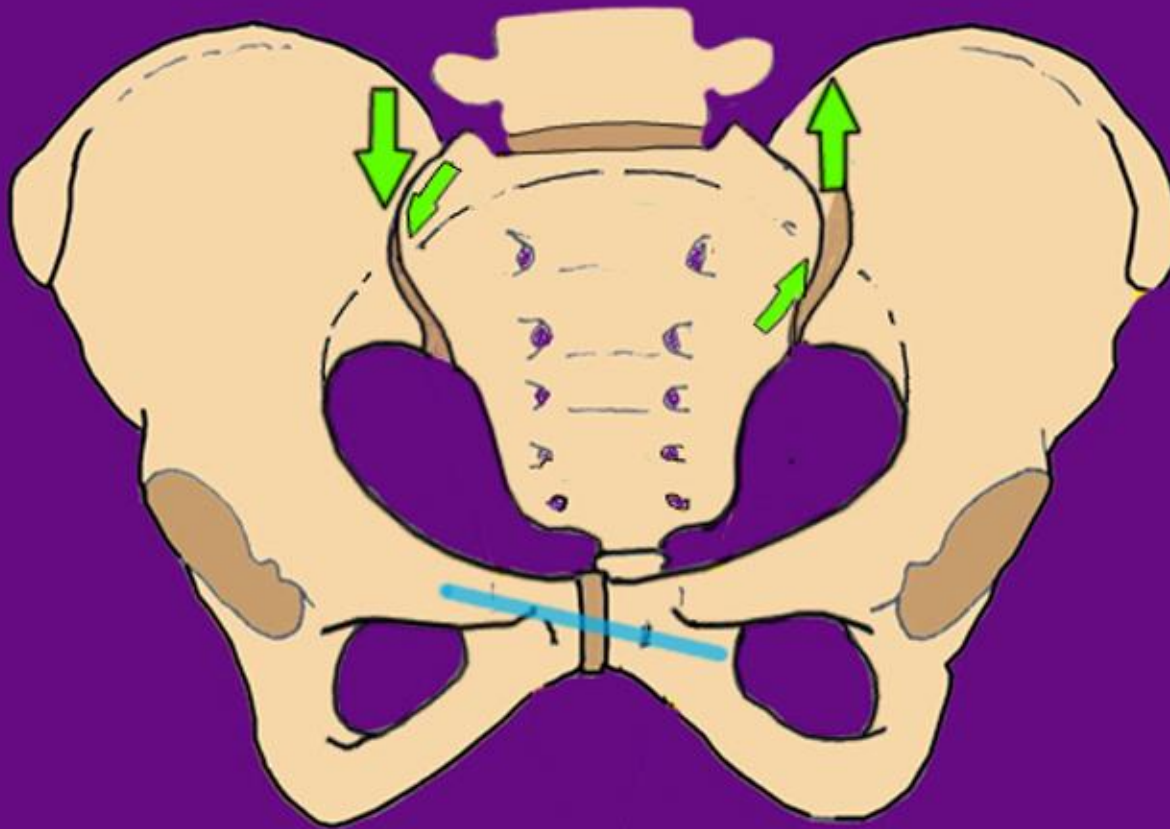
TWO TRANSVERSE AXES



Biotensegrity 2

- ❖ Posterior innominate rotation on the side of loading and anterior rotation on the side of the trailing leg occurs on the axis at the pubic symphysis.
- ❖ This causes the sacrum to rotate laterally toward the side of loading on an asymmetric pelvis during normal gait.
- ❖ Long radius rotational axis on each side (2 axes)

BIOTENSEGRITY 2

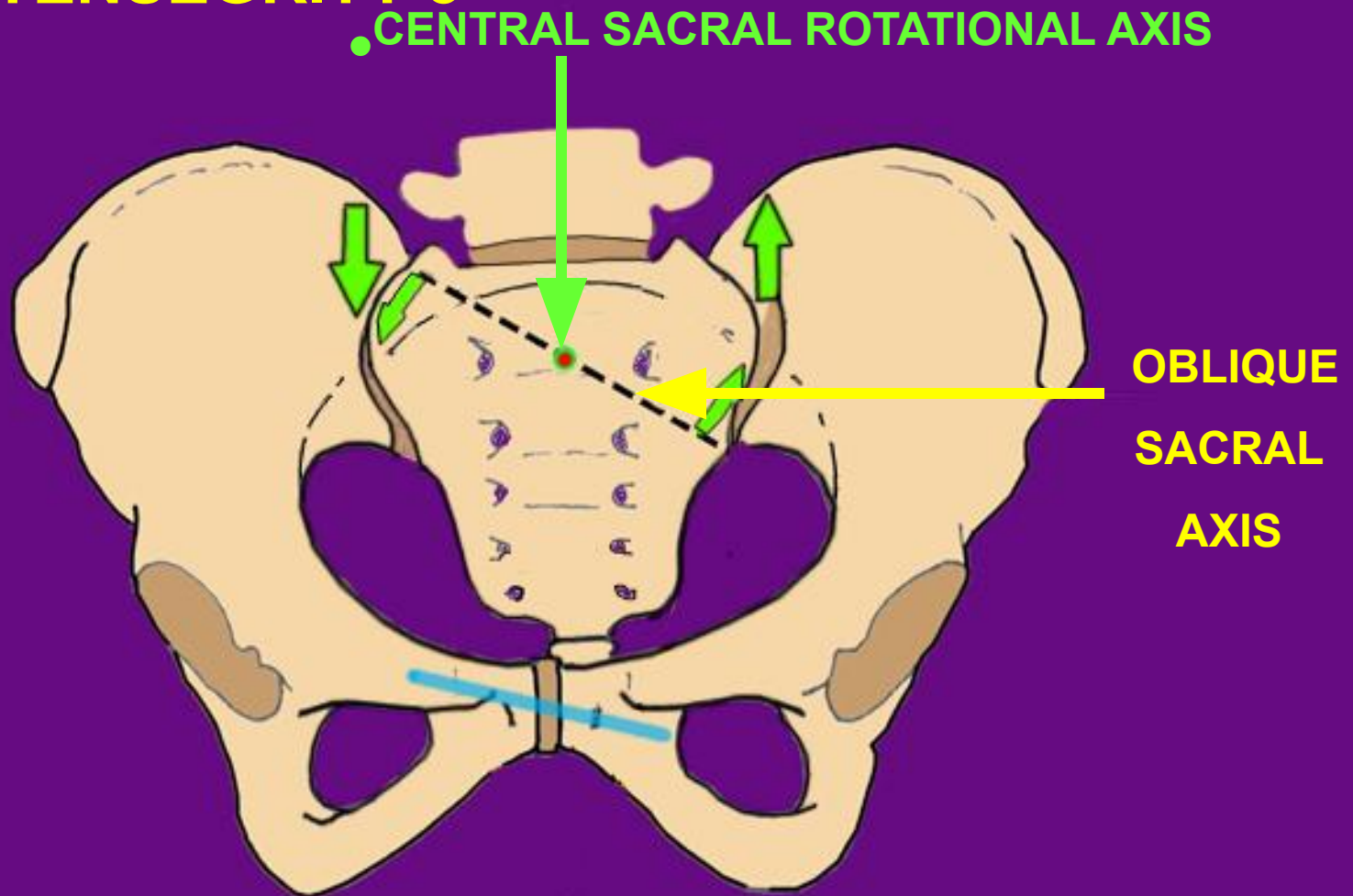


MOVEMENT TO ASYMMETRIC PELVIS ON AN AXIS THROUGH THE PUBLIC SYMPHYSIS CAUSES THE SACRUM TO FLEX Laterally TOWARD THE SIDE OF LOADING. (EACH SIDE = 2 AXES)

Biotensegrity 3

- ❖ This lateral sacral flexion takes place on a force dependent oblique axis perpendicular and central to the sacrum with a rotational component through both SIJs.
- ❖ This creates a single short radius axis with rotation in both directions = 2 axes)

BIOTENSEGRITY 3



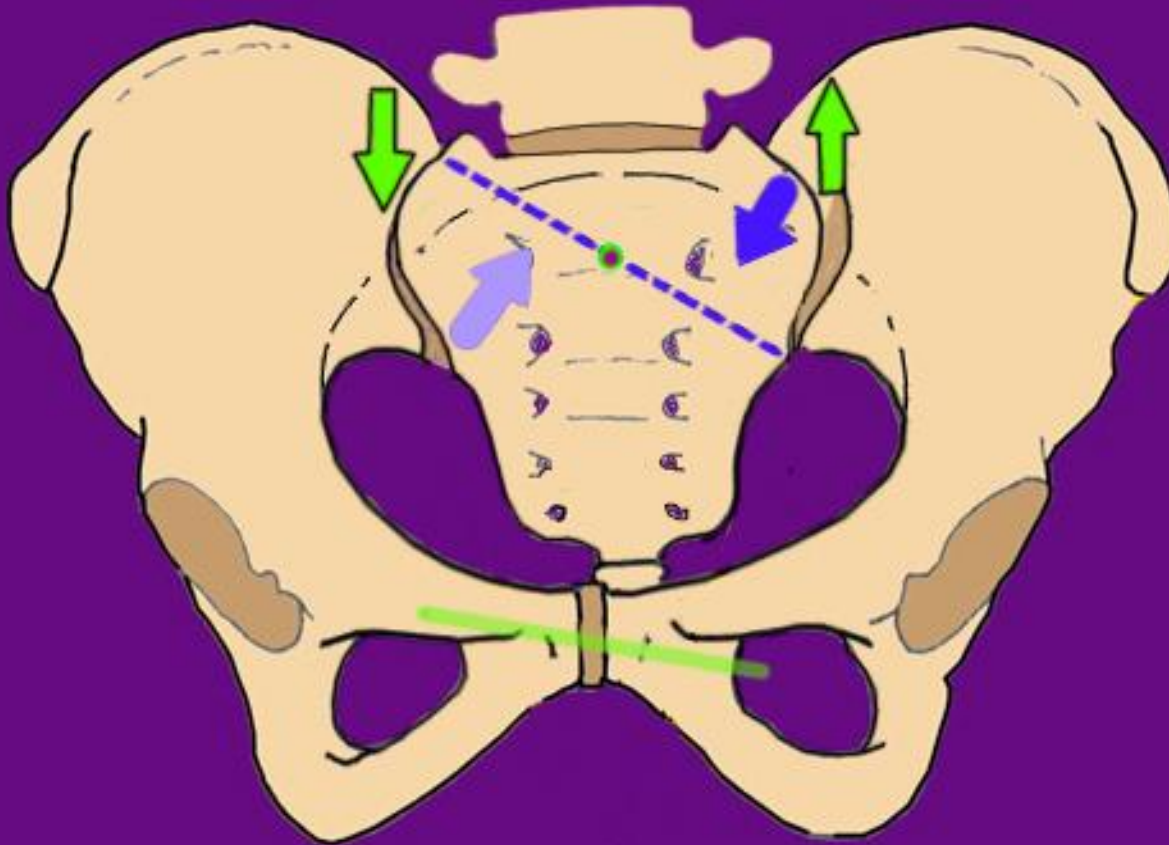
- THE SACRUM IS CAUSED TO ROTATE Laterally ON A CENTRAL AXIS CREATING SINGLE AXIS OF ROTATION.
(SINGLE ROTATIONAL SACRAL AXIS EACH SIDE = 2 AXES)

Biotensegrity 4

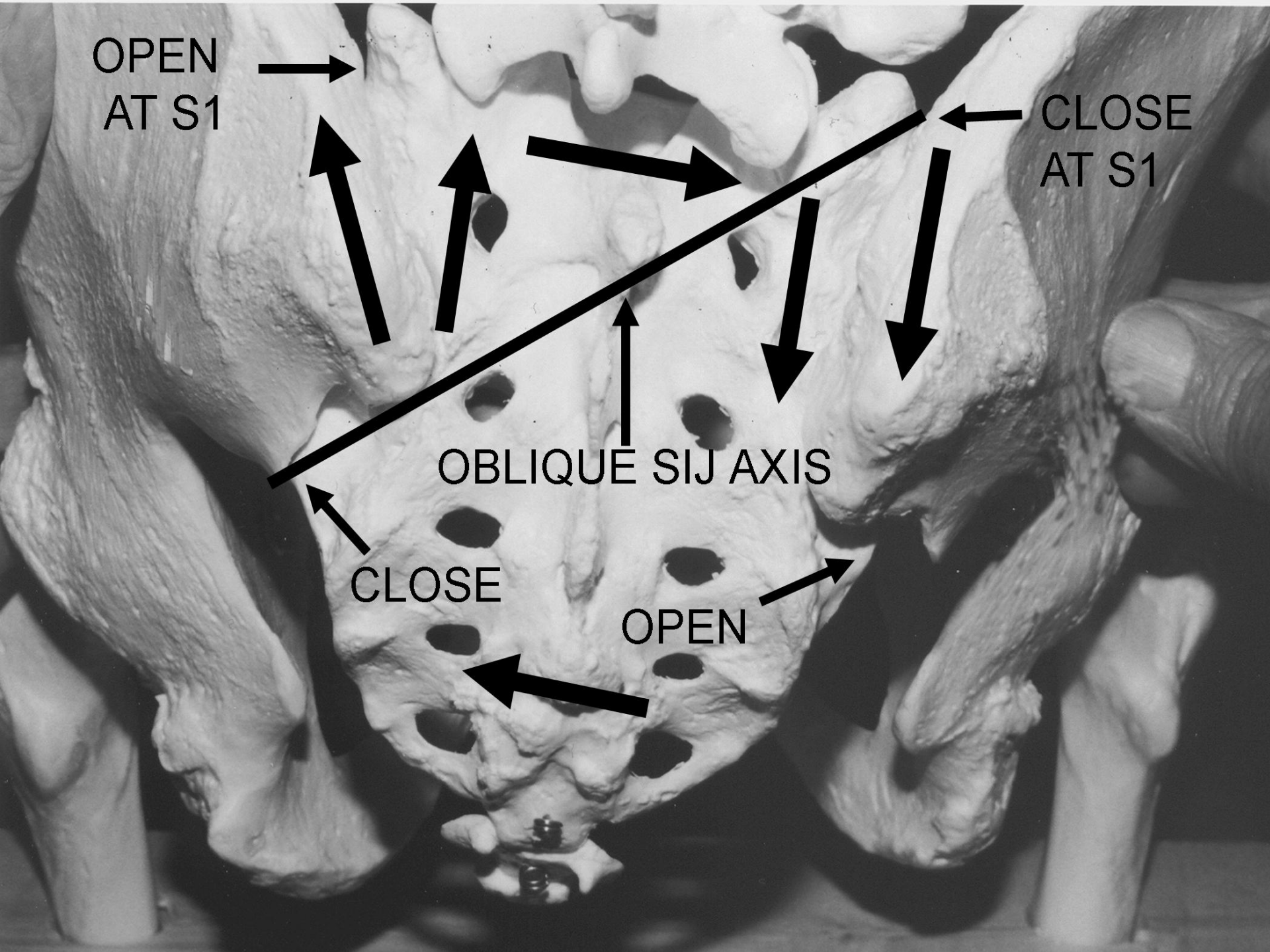
- ❖ The oblique axis of rotation is from S1 on the side of loading to S3 on the side of the trailing leg and is force-dependent.
- ❖ Sacral flexion is toward the side of loading with movement on the oblique axis anteriorly at S1 on the side of the trailing leg, posteriorly on the contra lateral side and drives counter rotation of the trunk.
- ❖ The short axis rotational component is at right angles to the oblique axis (2 axes).

BIOTENSEGRITY 4

SACRAL FLEXION AND ROTATION



- THE ANTERIOR LOCATION OF THE LINE OF GRAVITY FORCES THE SACRUM TO ROTATE ON THE OBLIQUE AXIS TOWARD THE SIDE OF LOADING. (ONE AXIS ON EACH SIDE = 2 AXES)



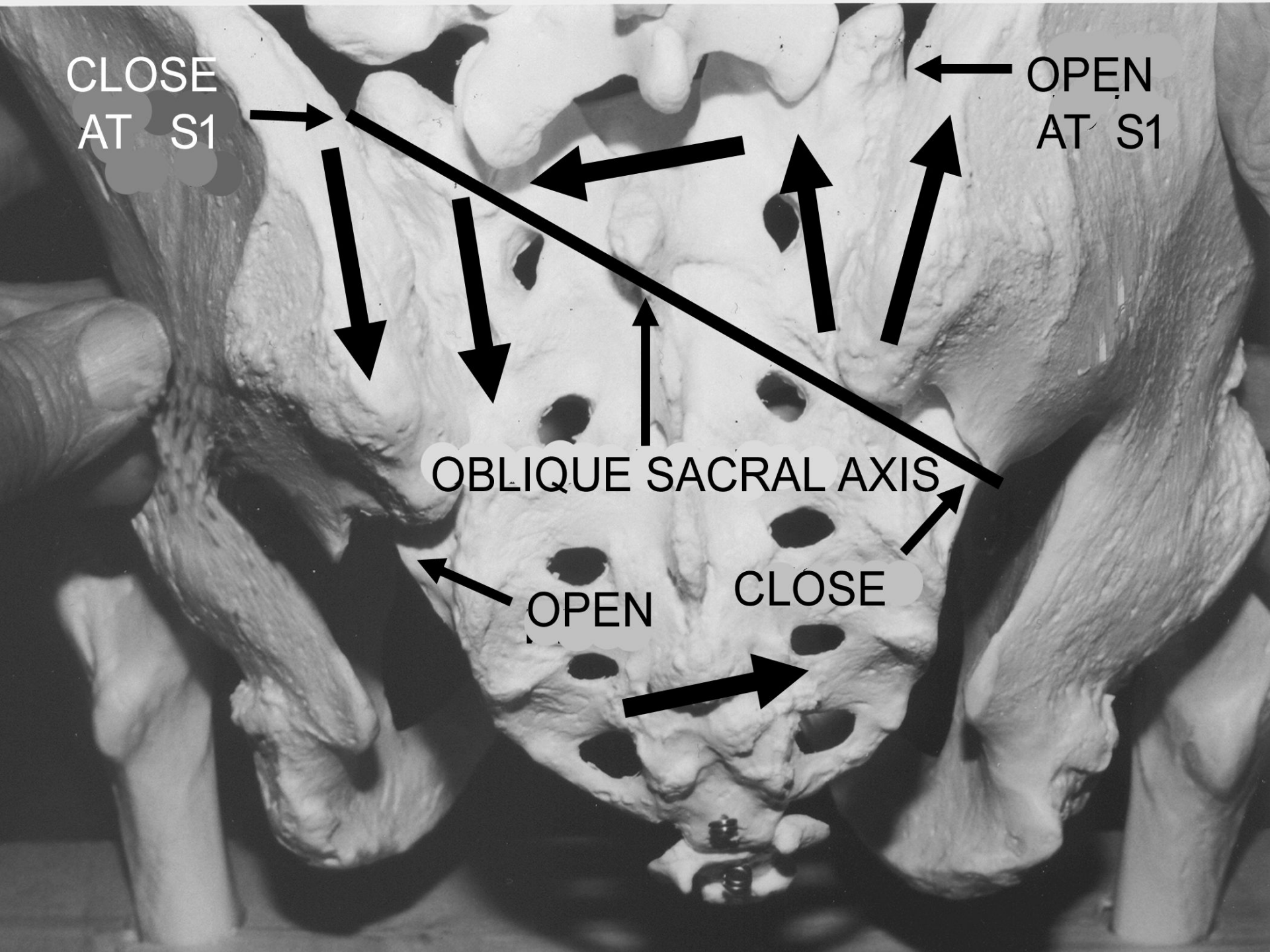
OPEN
AT S1

CLOSE
AT S1

OBLIQUE SIJ AXIS

CLOSE

OPEN



CLOSE
AT S1

OPEN
AT S1

OBLIQUE SACRAL AXIS

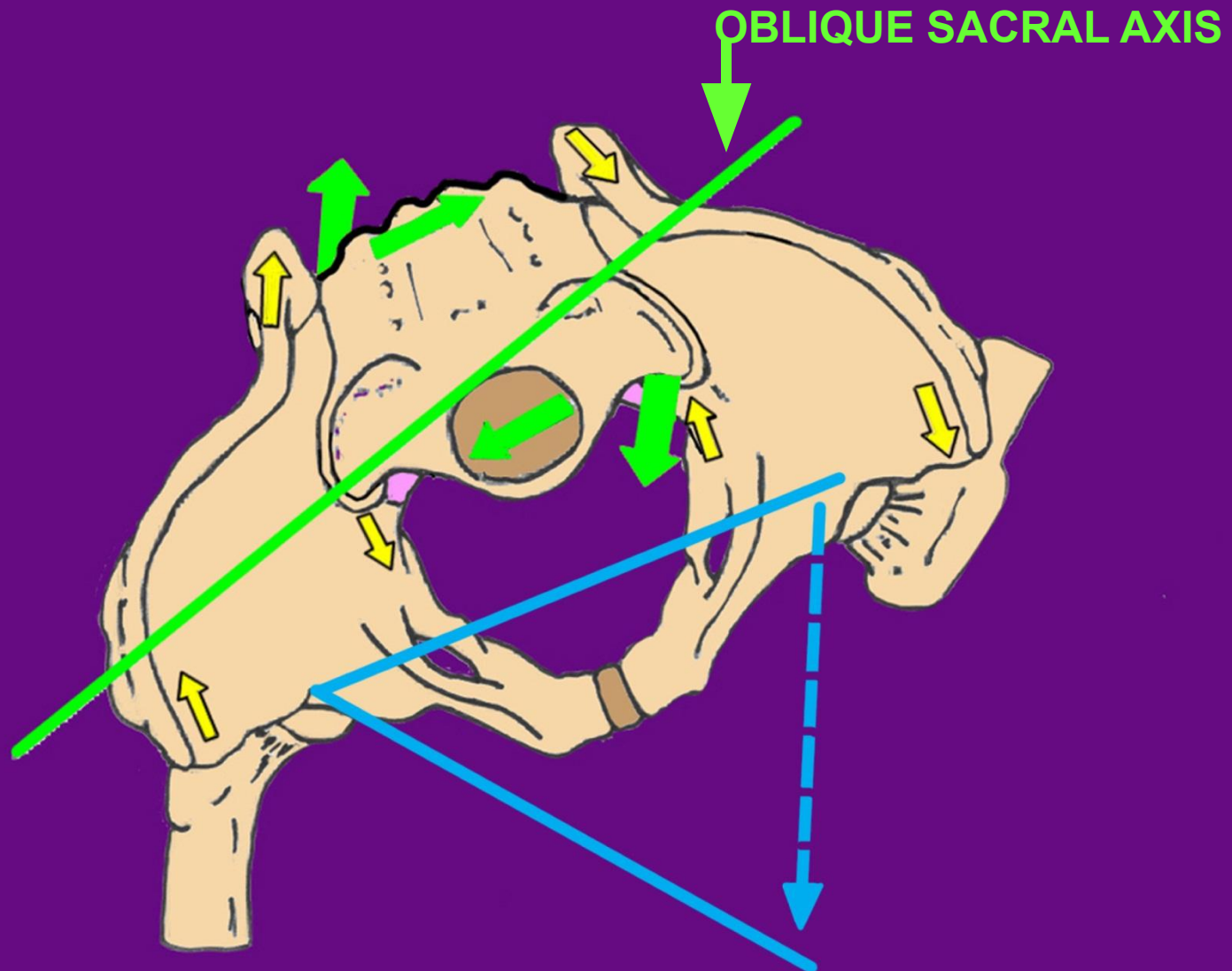
OPEN

CLOSE

Biotensegrity 5

- ❖ An acetabular axis for movement of one innominate on the femoral head or one femur on the innominate is from one acetabulum to the other.
- ❖ The pelvis rotates anteriorly in the horizontal plane while advancing.
- ❖ A long radius, force-dependent rotational component is perpendicular to the axis on each side. (2 axes)

BIOTENSEGRITY 5



- PELVIS ROTATES ANTERIORLY IN THE HORIZONTAL PLANE.
ONE LONG RADIUS AXIS EACH SIDE = 2 AXES

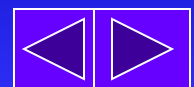
Biotensegrity 6

- ❖ Dysfunction of the sacroiliac joints will cause at least some dysfunction in all of these pelvic rotational axes.

Testing that practically guarantees failure to diagnose

Evidence based testing for reliability, sensitivity and specificity.

From Stuart Fife, D.P.T.



Palpation of Iliac Crests Standing

❖ Inter-examiner reliability..... 0.23

Flynn et al: Spine, 27: 2835-2843, 2002

This is a failure to accurately palpate
rate of about 77%

Palpation of the Posterior Superior Iliac Spine

- ❖ Inter-examiner reliability rate...0.33
O'Hare and Gibbons 2000

This is a failure to accurately palpate rate of 67%.

Standing Flexion Test

- ❖ Inter-examiner Reliability.....0.08
Flynn et al: 2002

This is a failure of performance
testing of 92%

Gillet Test

❖ Reliability Kappa Value.....0.22

❖ Sensitivity.....0.43

How many times the test will demonstrate the dysfunction.

❖ Specificity.....0.68

How well does the test isolate the structure it is supposed to test.

Dreyfuss et al: 1996

Reliability failure rate of 78%

Distraction Test

❖ Inter-examiner reliability... 0.26
Flynn et al: 2002

Examiner failure rate of 74%

Compression Test

- ❖ Inter-examiner reliability.....0.26
Flynn et al: 2002
- ❖ Failure of properly testing 74%

Gaenslen Test

- ◆ Inter-examiner reliability 0.54
Flynn et al:2002
- ◆ Sensitivity 0.71
- ◆ Specificity 0.26
Dreyfuss et al: 1996
- ◆ Failure of reliability 46%

Patrick Test

◆ Inter-examiner reliability.....0.54

Flynn et al: Spine, 2002

◆ Sensitivity.....0.69

◆ Specificity.....0.16

Dreyfuss et al: 1996

Reliability failure of 46%

Posterior Shear Test

❖ Sensitivity.....0.36

❖ Specificity.....0.50

Dreyfuss et al: 1996

Peri-articular Injections

- ❖ 9/25 patients better after inter-articular
- ❖ 25/25 better after peri-articular injection.
- ❖ 16/25 patients who did not improve with inter-articular injection all improved with peri-articular injection.
- ❖ 62% failure rate for inter-articular injections.

Murakami et al: J of Ortho Sci, May 2007

Experience

- ❖ It also appears that the intervention strategies proposed by the classification system can be applied effectively by physical therapists regardless of clinical experience.

Fritz, JM, Cleland JA, Childs JD: Sub grouping Patients With Low Back Pain: Evolution of a Classification Approach to Physical Therapy. JOSPT 37(6):290-302, 2007

Experience

- ❖ It appears that therapist-related factors of increased experience and specialty certification status **do not** result in an improvement in patients' disability associated with low back pain.

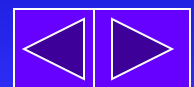
Whitman et al: JOSPT 34(11):662-675, 2004

Expanded Testing

- ❖ Doing a number of inappropriate tests will continue to give inaccurate diagnoses, cause inappropriate treatment results and expand costs to the patient and community.
- ❖ Just doing a bad thing in a more efficient manner will not give an improved result.

MEASUREMENT OF DYSFUNCTION

MEASUREMENT OF MOVEMENT OF
THE POSTERIOR SUPERIOR ILIAC
SPINES ON THE SACRUM
BEFORE AND AFTER CORRECTION



TRANSPARENT GRID

- ❖ A transparent grid is used to assist in making the measurements (13).
- ❖ This can be fabricated from clear acrylic or scanned from a grid and printed on overhead transparency plastic.

Holes for Relocation

Drill or punch holes through the center of the grid for precise relocation.

LEFT

RIGHT

8 7 6 5 4 3 2 1

1 2 3 4 5 6 7 8

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

Measurement Position

- ❖ The patient stands at the end of a plinth, flexes at the hips and rests his/her trunk supine with the pelvis resting on the plinth.

Palpation and Marking

- ❖ The medial edge of each PSIS is palpated and the most aspect marked with a point.
- ❖ Then the most palpable distal aspect of each PSIS is located and marked with a point.

Using the Grid

- ❖ The transparent grid is placed over the marks on the sacrum and centering marks are made on the skin through the holes.
- ❖ Note the location of the marked PSIS points on the corresponding chart.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILIAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain_____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD_____ Unilateral_____ Right_____ Left_____ Bilateral_____

Compromised_____ Right_____ Left_____ Bilateral_____

Position of PSISs before mobilization_____

Position of PSISs after mobilization_____

Distance moved: Right PSIS_____Left PSIS_____

Comments: _____

LEFT

RIGHT

8 7 6 5 4 3 2 1 1 2 3 4 5 6 7 8

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

Establishing Points

- ❖ Mark the medial and distal points from each PSIS on the chart.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILLAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain_____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD_____ Unilateral_____ Right_____ Left_____ Bilateral_____

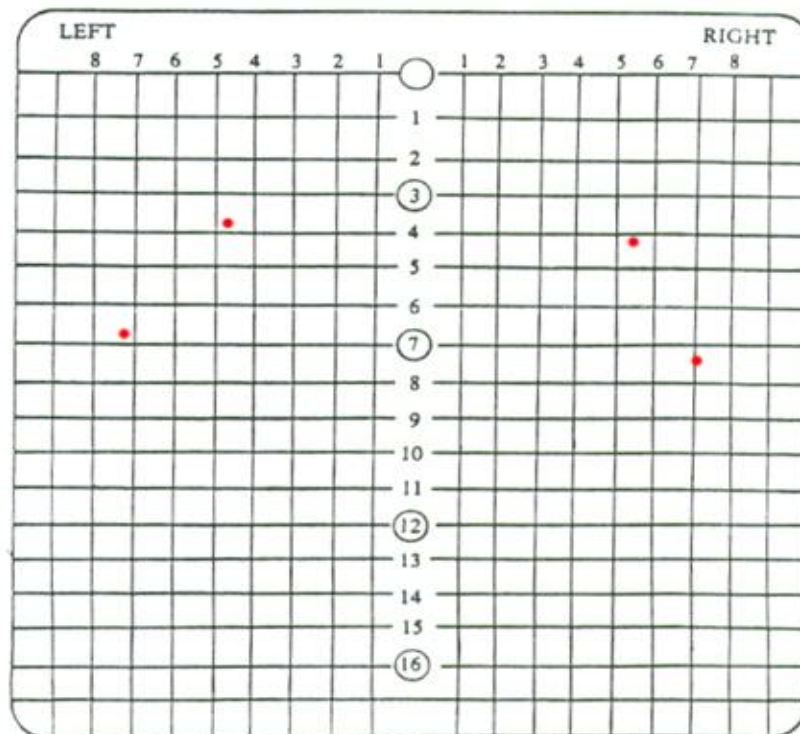
Compromised_____ Right_____ Left_____ Bilateral_____

Position of PSISs before mobilization_____

Position of PSISs after mobilization_____

Distance moved: Right PSIS_____Left PSIS_____

Comments: _____



Adding Lines to Establish Points

- ❖ Draw perpendicular lines through the medial points.
- ❖ Draw horizontal lines through the distal points.
- ❖ The intersections are the 'before' measuring points.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILLAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain _____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD _____ Unilateral _____ Right _____ Left _____ Bilateral _____

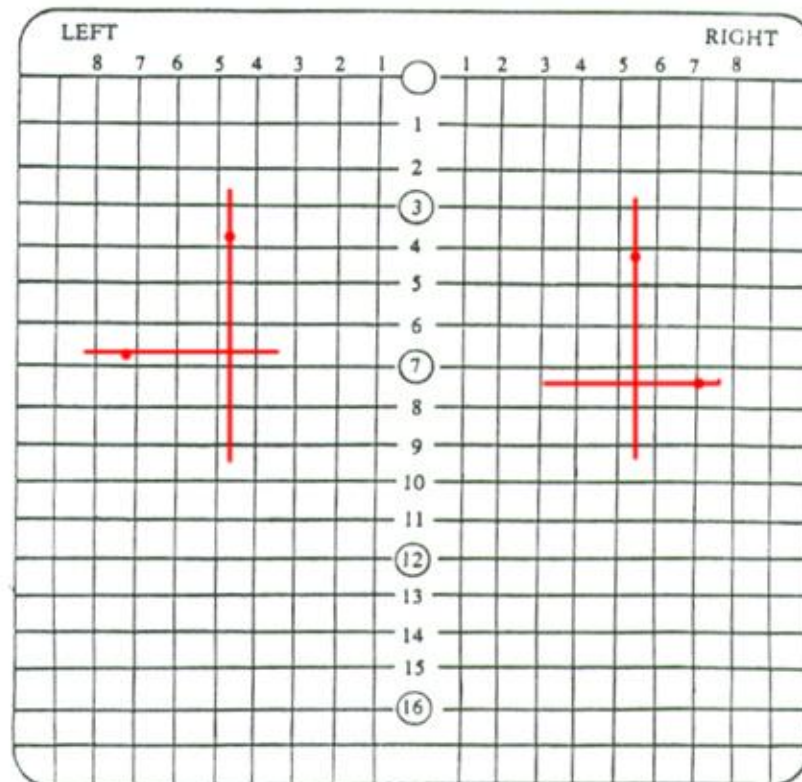
Compromised _____ Right _____ Left _____ Bilateral _____

Position of PSISs before mobilization _____

Position of PSISs after mobilization _____

Distance moved: Right PSIS _____ Left PSIS _____

Comments: _____



Correct Both Joints

- ❖ Fully correct, release and correct both SIJs.
- ❖ Reposition patient at the end of the plinth.
- ❖ Palpate and mark the medial and distal edges of the PSISs.
- ❖ Transfer marks to chart.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILIAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain _____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD _____ Unilateral _____ Right _____ Left _____ Bilateral _____

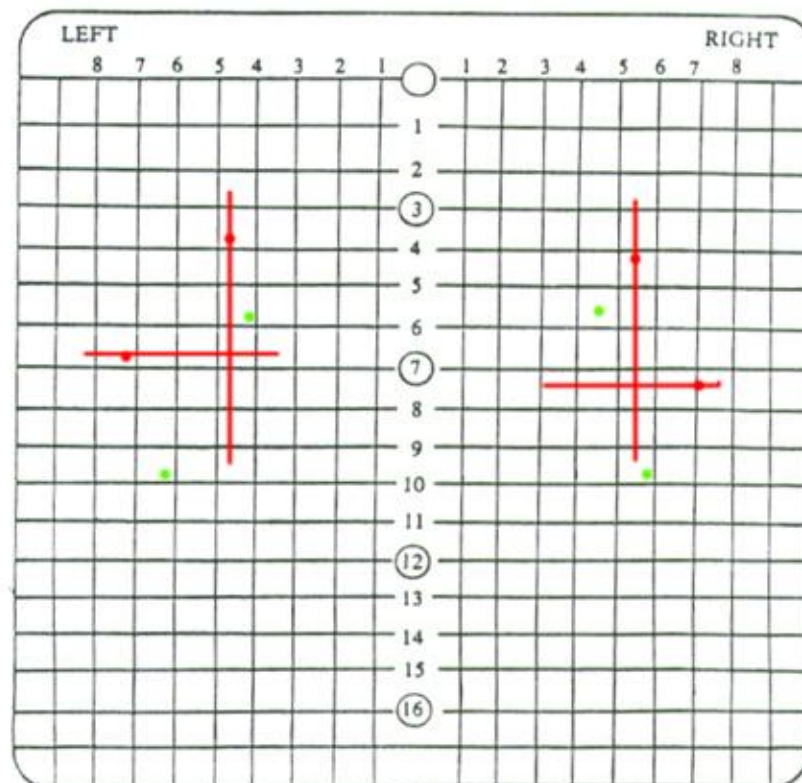
Compromised _____ Right _____ Left _____ Bilateral _____

Position of PSISs before mobilization _____

Position of PSISs after mobilization _____

Distance moved: Right PSIS _____ Left PSIS _____

Comments: _____



Replace Guide Over Center Marks

- ❖ Place transparent grid over the center skin marks.
- ❖ Make corresponding marks on the chart.
- ❖ Draw perpendicular and horizontal lines as before to establish 'after' points.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILIAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain _____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD _____ Unilateral _____ Right _____ Left _____ Bilateral _____

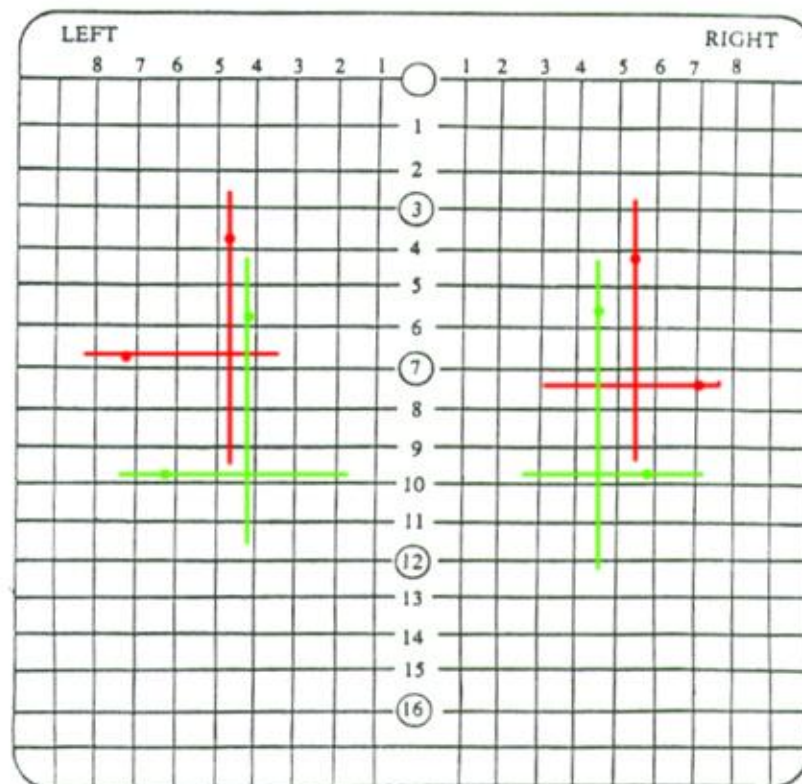
Compromised _____ Right _____ Left _____ Bilateral _____

Position of PSISs before mobilization _____

Position of PSISs after mobilization _____

Distance moved: Right PSIS _____ Left PSIS _____

Comments: _____



Measure

- ❖ Measure the distance between the two intersecting points on each side.
- ❖ This is the distance the PSISs have moved on the sacrum before and after correction.
- ❖ Chart the measurement.

MEASUREMENT OF MOVEMENT OF THE POSTERIOR SUPERIOR ILLAC SPINES ON THE SACRUM

NAME _____ DATE _____

AGE _____ SEX _____ PATIENT I.D. NUMBER _____

Primary location of pain _____

Variety of dysfunction as confirmed by changes in apparent leg length with corrective mobilization.

Anterior SIJD _____ Unilateral _____ Right _____ Left _____ Bilateral _____

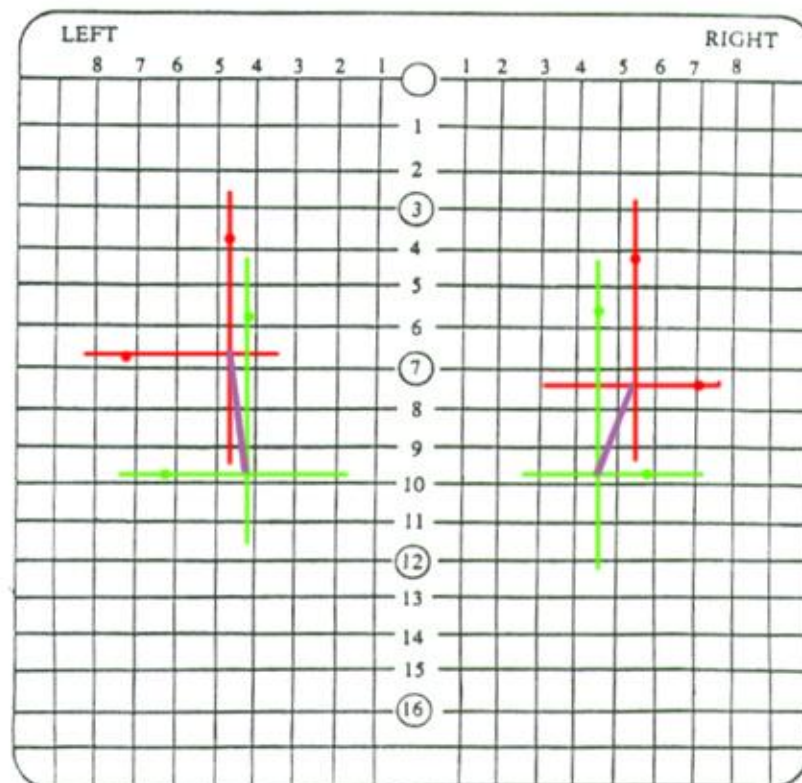
Compromised _____ Right _____ Left _____ Bilateral _____

Position of PSISs before mobilization _____

Position of PSISs after mobilization _____

Distance moved: Right PSIS _____ Left PSIS _____

Comments: _____



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Continue for the Addendum on the Disk

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INDEX LINKS

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- ABDOMINAL HOLLOWING
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 - FASCIAL INTERCONNECTIONS
 - INNERVATION
 - FUNCTION OF PRIMARY LIGAMENTS
 - LUMBAR SPINE AND PELVIS
 - LESS FREQUENTLY CONSIDERED MUSCLE FUNCTIONS
 - STRUCTURAL ANGULATIONS OF THE SACROILIAC JOINTS
 - STRUCTURAL FACTORS LEADING TO THE STABILITY OF THE SIJ
 - ASSOCIATED SYMPTOMS



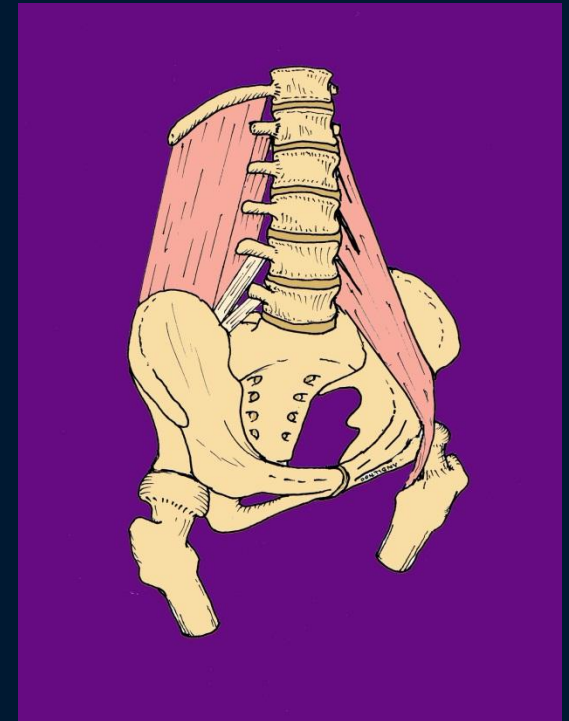
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- CONGENITAL ANOMALIES
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- DIRECT CORRECTION
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- PIRIFORMIS PIRIFORMIS

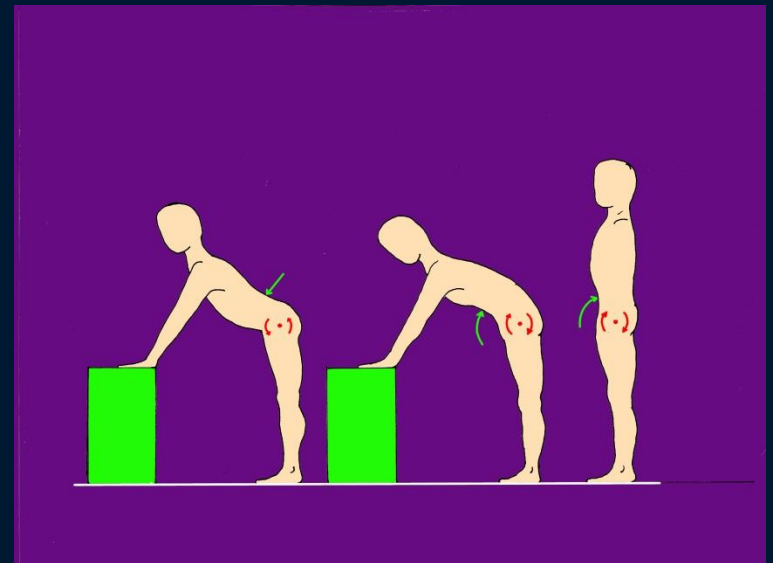
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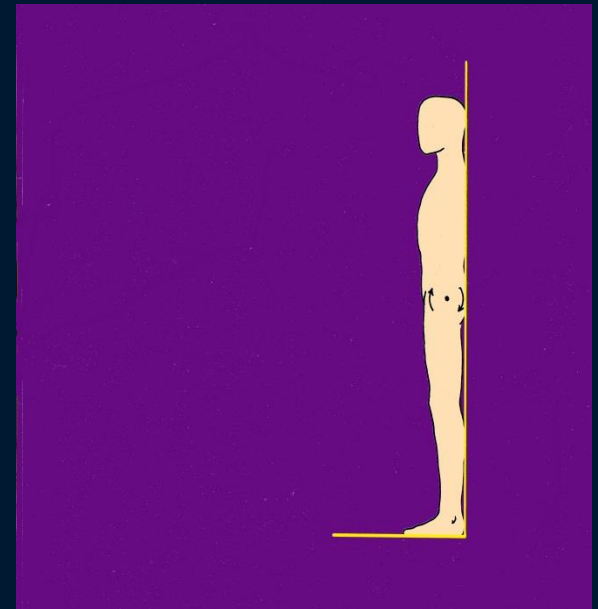
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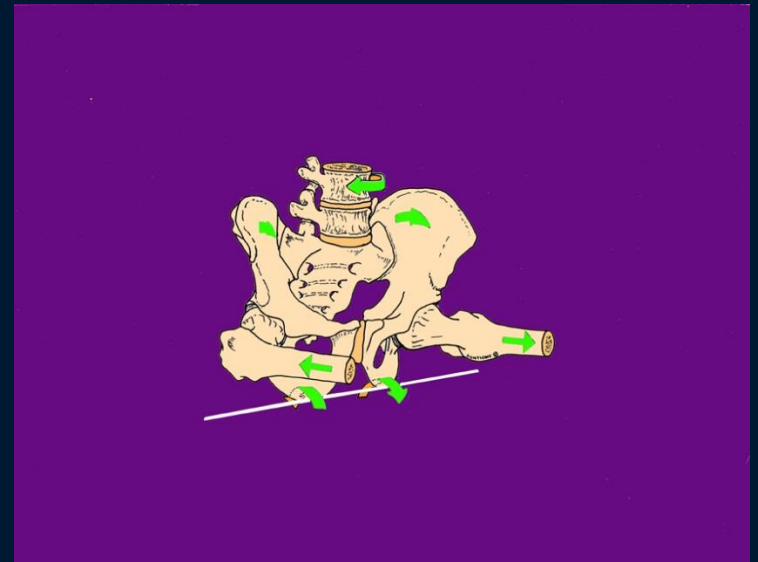
OF SACROTUBEROUS LIGAMENTS

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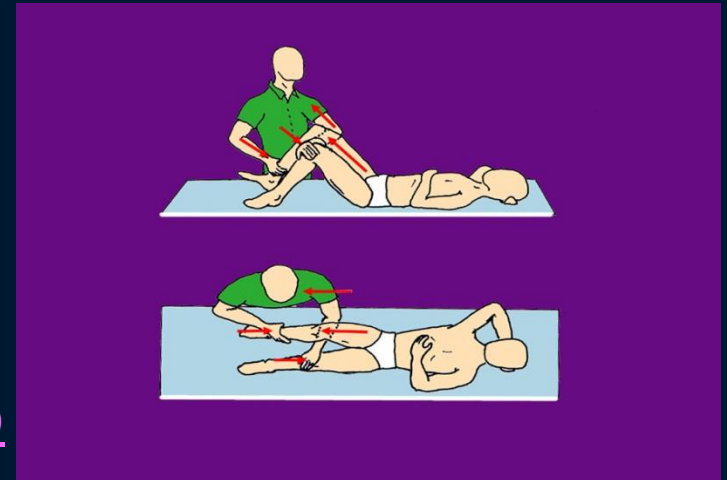
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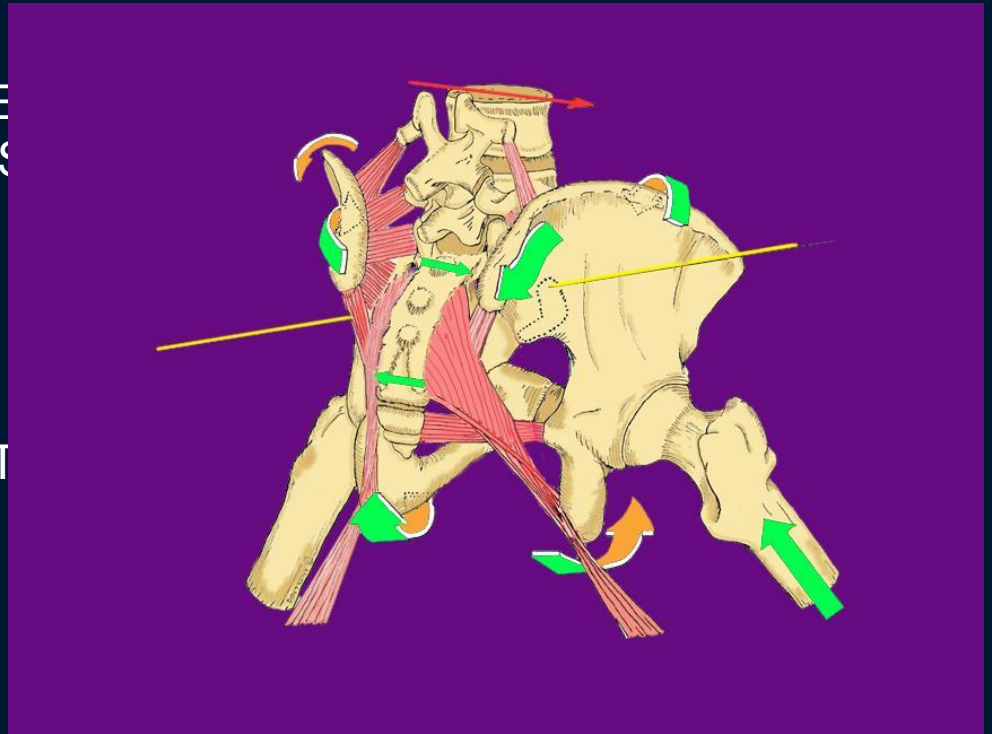
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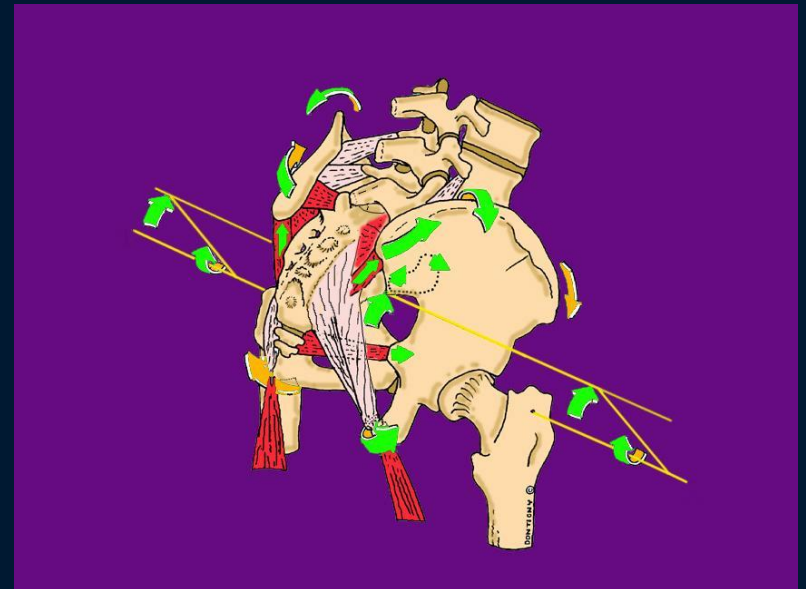
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- SUMMARY ADDENDUM ON DISK
- **TREATMENT**
 - CLINICAL BASIS
 - INITIAL
 - PREFERRED
- X-RAYS



Web Sites

For websites on the sacroiliac joint, prolo, surgery,

- ❖ www.kalindra.com/sacroiliac2.htm
- ❖ www.thelowback.com
- ❖ www.getprolo.com
- ❖ www.whiplash101.com/tag/sciatica/www.whiplash101.com/tag/sciatica/
- ❖ <http://www.americaspodiatrist.com/2010/06/is-your-pelvis-causing-your-back-knee-hip-neck-or-foot-pain/>
- ❖ <http://www.hicksvillephysicaltherapy.com/Conditions-Treated/Lower-Back-Pain/a~3298--c~343143/article.html>
- ❖ <http://www.dynamicchiropractic.com/mpacms/dc/article.php?id=50535>
- ❖ http://kopast-physicaltherapy.blogspot.com/2011_03_01_archive.html
<http://www.Endyourbackpainnow.com>, or <http://www.SamVisnic.com>.
<http://www.wellsphere.com/life-as-a-doc-article/is-your-pelvis-causing-your-back-knee-hip-neck-or-foot-pain/1130759>
<http://www.empower2go.org/si-joint-self-corrections/>

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A Work in Progress

- ❖ The author reserves the right to continually change and improve the basic SIJ course to reflect the most recent advances in this area.
- ❖ Constructive comments are welcome.

Richard L. DonTigny, PT

SACRO ILIO ARTICULATUM IPSE LOQUITUR