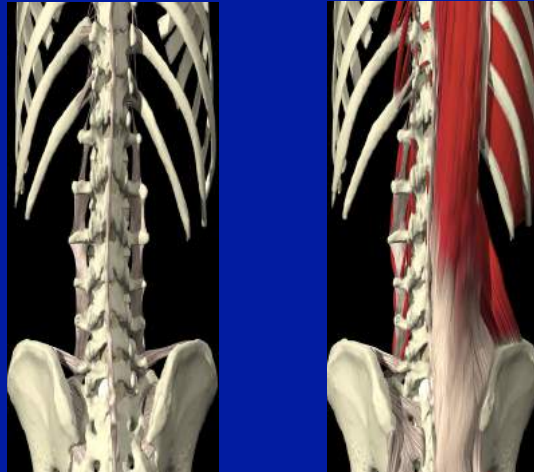


## Lumbar Spine Sonography



## Spinal Sonography

*Musculoskeletal sonography has hit “critical mass”. There exists more than sufficient literature, technology, and demand in the medical community to sustain it’s continued impact and change upon physical medicine.*

*However; I continually react with simultaneous excitement and trepidation when asked to speak or write on spinal or paraspinal sonography due to the broad spectrum of receptivity . Interest in spinal sonography is increasing, nonetheless.*

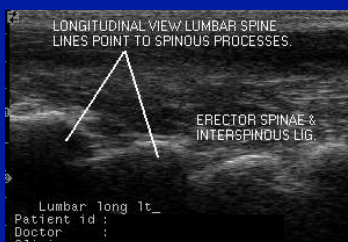
*I am confident imaging technology... protocols... and skills will develop spinal sonography and move it into a prominent place in musculoskeletal ultrasound.*

*At present, the predominant interest is in sonographically guided facet blocks, medial branch blocks, and SI injections. Multifidus cross-sectional area measurement has been applied to lumbar dysfunction assessment.*


- *Where might it “fit” in the physical medicine model ?*

## Lumbar Spine Sonography

### A Persistent Interest ...



*"The following structures were observed: the spinous process, transverse process, articulating surfaces and the musculature anterior and posterior to the transverse process. "*

Ultrasonography - Guided Identification of the Lumbar Epidural Space, Bonazzi,   
M. Italian Anesthesiology Journal, vol. 61, 1995.

## Lumbar Spine Sonography

### Topics to Cover

**Equipment Selection:** Probe, Frequency (MHz), Depth

**Spinal Sonography:**

**Two Specific Topics**

#### 1. Paravertebral musculo-ligamentous anatomy

*Erector Spinae, Multifidus, Long Posterior Sacro-iliac & Ilio-Lumbar ligaments*

#### 2. Articular and Epidural anatomy

*Lumbar Facets : Facet Injection vs. Medial Branch Blocks*

*Sacro-iliac Joints : SI Joint Imaging and Injections*

*Lumbar and Caudal Epidural spaces*

## Lumbar Spine Sonography Equipment Selection

- What kind of probe ?

Spinal anatomy is “deep” anatomy

And...

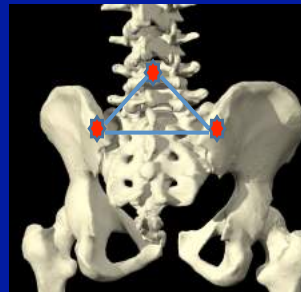
Imaging it requires a large acoustic “footprint”

Answer :

Low Frequency ( 2-5 MHz)... Curved Array



## Lumbar Spine Sonography Patient Positioning and Navigation



### Staying Oriented

*The patient is prone. Palpate and mark...*

*\* L4 Spinous Process*

*\* Right and Left PSIS*

*•The resulting “triangle” helps w/ navigation  
to other lumbar segments in LAX and SAX*

## Lumbar Spine Sonography

*Paravertebral musculo-ligamentous anatomy*

### Longitudinal Probe Orientation

Two (2) specific probe positions...2 angles of insonation (exposure to ultrasound)

#### 1. Left or Right of midline ...ANGLED TOWARD MIDLINE

Utility of position 1 : Good visualization of paraspinal muscle and ligaments  
... except Multifidus

#### 2. Left or Right of midline ... in a TRUE Parasagittal Plane. In line with the articular pillar

Utility of position 2: Good visualization of Multifidus in longitudinal plane.

Multifidus measurement and evaluate integrity, biofeedback.

## Lumbar Spine Sonography

*Paravertebral musculo-ligamentous anatomy*

### Longitudinal Probe Orientation

#### 1. Left or Right of midline ...ANGLED TOWARD MIDLINE



## Lumbar Spine Sonography

*Paravertebral musculo-ligamentous anatomy*

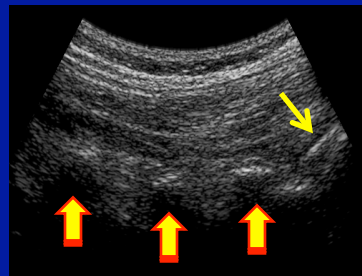
*Longitudinal Probe Orientation*

**Position 1:** Right or left of Mid-line. Aimed toward Mid-line

From left to right 3-4 spinouses present  
in a 'stair stepping' pattern...  
And the linear cortical outline of sacrum



Visualizing the sacral outline is the bony  
landmark that distinguishes the spinous  
processes from the articular pillars as  
seen in LAX Position 2



## Longitudinal Probe Orientation

**Position 1:** Right or left of Mid-line. Aimed toward Mid-line

**Anatomy : Deep to Superficial**



\* Thorco-Lumbar Fascia triple layered in lumbar region

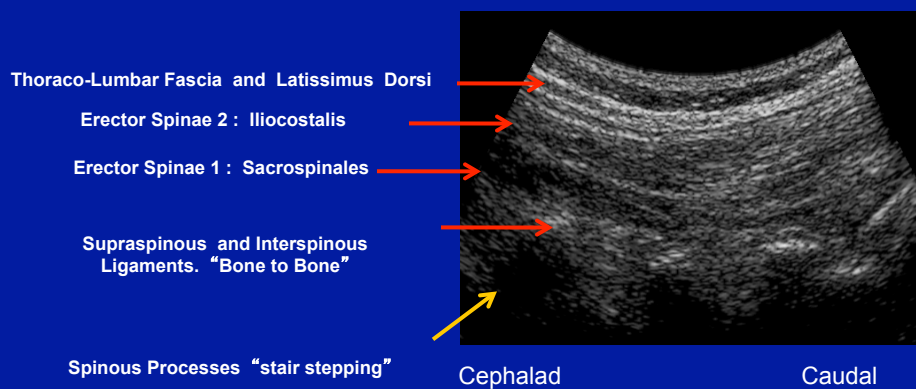
\*Posterior layer blends with Latissimus

\*Hyperechoic tendon of Latissimus with TL Fascia

## Longitudinal Probe Orientation

**Position 1:** Right or left of Mid-line. Aimed toward Mid-line

**Anatomy : Deep to Superficial**



## Lumbar Spine Sonography

*Paravertebral musculo-ligamentous anatomy*

**Longitudinal Probe Orientation**

**Position 2:** Right or left of Mid-line. In line with Articular Pillars



**Longitudinal Probe Placement**

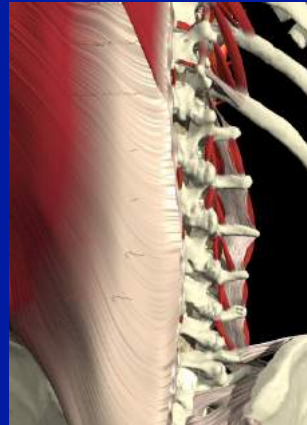
**No beam angulation toward midline**

### Lumbar Spine Sonography Longitudinal Probe Orientation

**Position 2:** Right or left of Mid-line. In line with Articular Pillars



Longitudinal Probe Placement  
No beam angulation



Is the bulk of the Multifidus specifically visualized in a parasagittal plane over the zygapophyseal joints?  
Why don't the 4 superficial layers appear thicker?

### Lumbar Spine Sonography

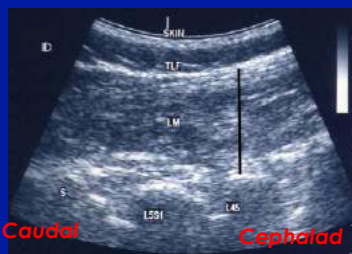
Is the bulk of the Multifidus accurately visualized in a parasagittal plane over the zygapophyseal joints?



Multifidus muscle fascicle or "cluster" allowing attachment at multiple levels occupies the groove between the spinous and lamina...  
Which is directly over the facet joint

## Lumbar Spine Sonography

The bulk of the Multifidus is accurately visualized in a parasagittal plane over the zygapophyseal joints !



NOTE ! Image orientation reversed !

Hyperechoic cortical margin of the complete facet articulation is seen. Fibrous capsule is hyperechoic & superficial to articulation. Inflections of the capsule into the joint. Hypoechoic regions between the bony landmarks are NOT the joint space on this image.

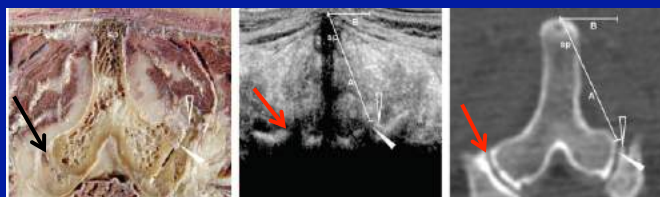
Benefits of this view

\*Multifidus measurement \*Biofeedback

## Lumbar Spine Sonography

### Transverse Probe Orientation

Comparative displays of cadaveric facet joint.



Axial Anatomic Speciman

Axial /Short Axis Ultrasound

Axial CT Scan

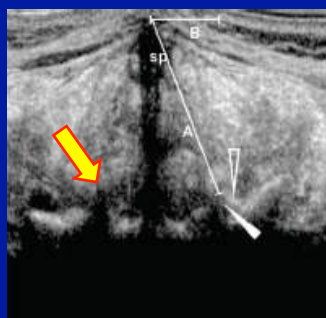
Ultrasound Guidance for Facet Joint Injections in the Lumbar Spine: A Computed Tomography-Controlled Study. *Anesth. Analg* 2005; 101:579-83



## Lumbar Spine Sonography

### Bony Landmarks

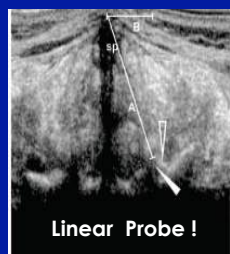
#### Transverse Orientation : Facet identification



Short Axis Ultrasound Image  
Linear probe  
Cadaver

## Lumbar Spine Sonography

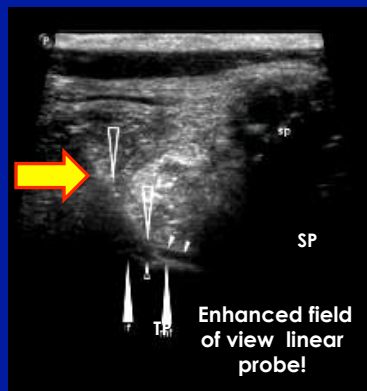
#### Transverse Orientation : Facet Identification



Linear Probe !

Short axis image :  
Cadaver  
Spinous Midline

No Needle



Short axis image: Native Anatomy  
**\*\* Spinous OFF-Midline; shorter distance to target !**

Needle advanced lateral to medial to anechoic line of joint space

## Lumbar Spine Sonography

Transverse Orientation : Facet Identification  
Comparison with a simple phantom with native study



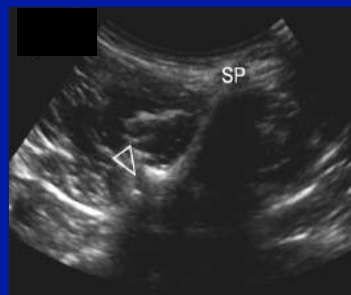
## Lumbar Spine Sonography

Transverse Orientation : Facet Identification  
Comparison with a simple phantom and native study



Off midline SAX image : Phantom

White "arrow" indicates anechoic joint space



Off midline SAX image : Native Anatomy

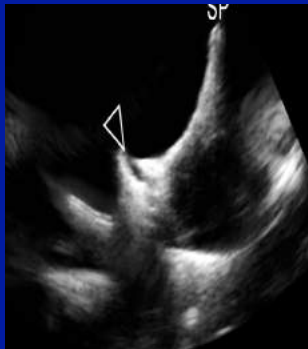
White "arrow" indicates anechoic joint space

Curved Array Probe employed

### Lumbar Spine Sonography

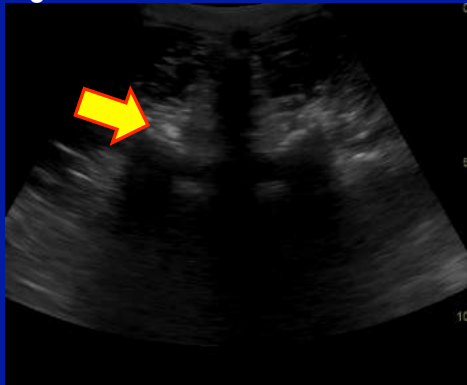
Transverse Orientation : Facet Identification  
Comparison with a simple phantom and native anatomy study

"What is it going to look like when I do it?"



Off midline SAX image :  
Phantom

Curved Array Probe  
White "arrow" indicates  
anechoic joint space

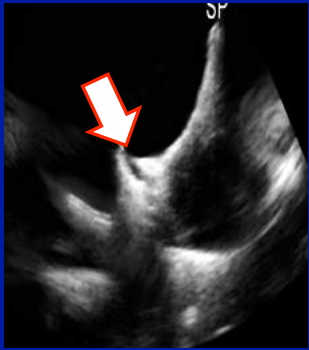


True midline SAX image : Native Anatomy  
Curved Array Probe

Yellow "arrow" indicates anechoic cartilage  
of joint space

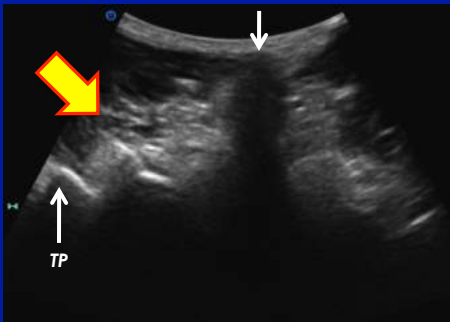
### Lumbar Spine Sonography

Transverse Orientation : Facet Identification



Off midline SAX image :  
Phantom

Curved Array Probe  
White "arrow" indicates  
anechoic joint space

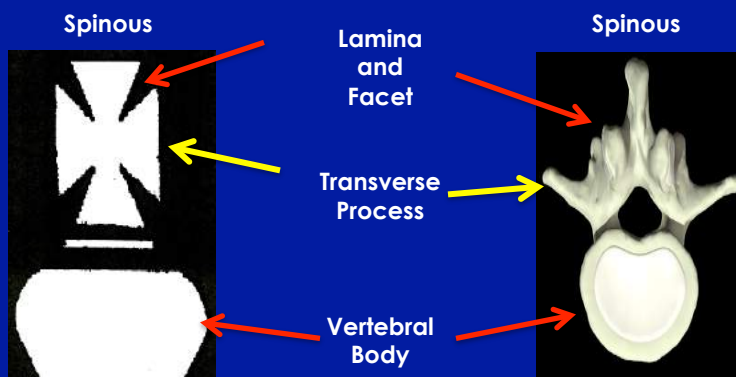


True midline SAX image : Native Anatomy  
Curved Array Probe

Yellow "arrow" indicates  
anechoic joint space

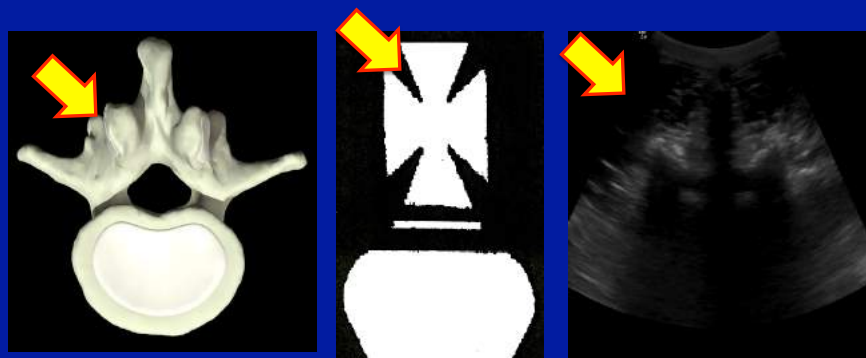
## Lumbar Spine Sonography

Transverse Probe Orientation... The "King Sign"  
Systematic...Reproducible Imaging



## Lumbar Spine Sonography

Bony Landmarks  
Transverse Probe Orientation... The "King Sign"



The facet joint is lined with hyaline cartilage which appears "anechoic" on ultrasound. A thin anechoic line or cleft deep to the multifidus... near the "spinous-lamina intersection" is indicative of the true joint space

## Lumbar Spine Sonography

### Bony Landmarks

Transverse Probe Orientation... The "King Sign"  
 "And if I can't see the anechoic facet joint space?"



Short Axis Lumbar Image  
 Anechoic Facet Line Not Clearly Distinguishable

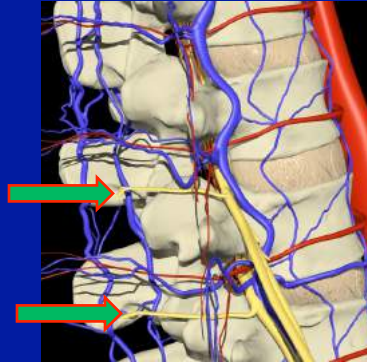
## Lumbar Spine Sonography

REMEMBER... Multifidus muscle fascicle or "cluster"  
 occupies the groove between the spinous and lamina...  
Which is directly over the facet joint



## Lumbar Spine Sonography

### Medial Branch Blocks vs True "Intra-articular"

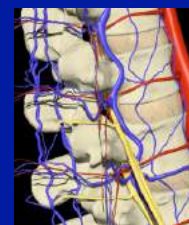


The Medial Branches of the Lumbar Dorsal Rami supply ...

- The multifidus & interspinales muscles
- The interspinous ligaments
- The facet/zygapophyseal joints

## Lumbar Spine Sonography

### Medial Branch Blocks vs True "Intra-articular" facet blocks



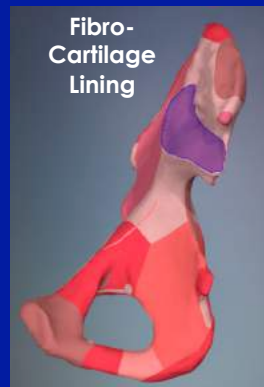
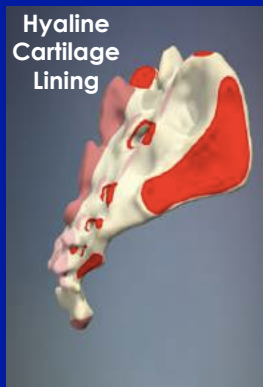
If the anechoic facet line is not visible, but the "king sign" is displayed...

1. The Multifidus overlies the joint
2. Advance the needle to the "spinous-lamina intersection". Lateral to Medial.
3. Remember the Multifidus is in the groove between the spinous and lamina.
4. Must block two separate levels for complete facet block

## Sacro-Iliac Joint Sonography

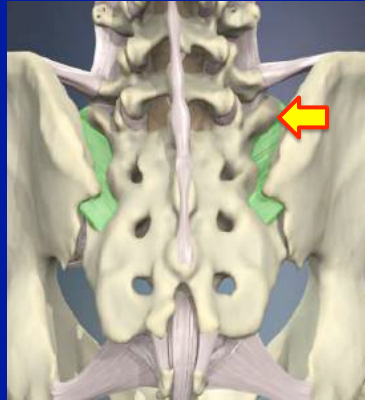


## Sacro-Iliac Joint Anatomy



- A synovial joint
- A layer/interface of hyaline or fibrocartilage ←
- Synovial fluid is present within the joint cavity
- Has a "rudimentary capsule" posteriorly

## Sacro-Iliac Joint Anatomy



- *Inter-Osseous Sacro-Iliac Ligament... (singular)*
  - Fills ...the joint space
- *Consistent throughout. No variation proximal to distal*

## Sacro-Iliac Joint Anatomy: Recap

Sacrum



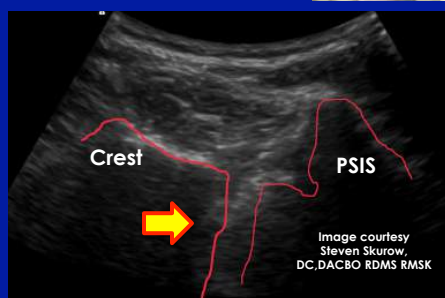
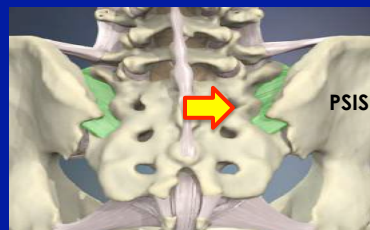
Ilium



- *Sacral Side: Hyaline cartilage lining proximal to distal*
  - *Iliac Side: Fibro-cartilage lining proximal to distal*
- *Interosseous SI Ligament (singular): Fills the SIJ proximal to distal*

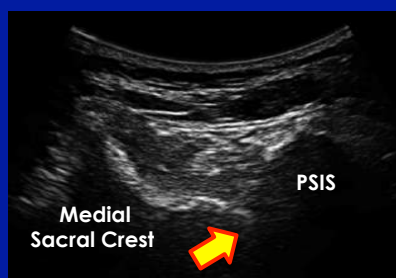


### Sacro-Iliac Joint Imaging



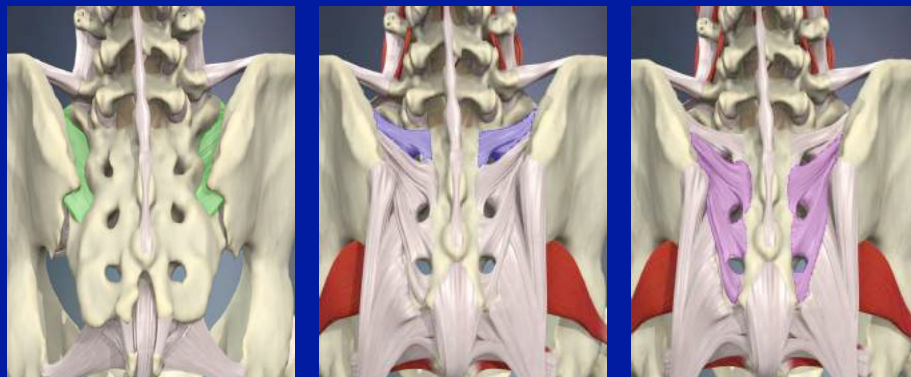
- SAX probe at PSIS
- Imaging Middle portion of joint

### Sacro-Iliac Joint Imaging



- Imaging Middle portion of joint
- SI joint is uniformly supported by the Inter-osseous ligament

### Sacro-Iliac Joint Imaging The Posterior Sacroiliac Ligaments



- **Intra-articular : Inter-osseous Ligament** (Green)
- **Extra-articular : Short AND Long Posterior SI Ligaments** (Blue and Pink)  
(Thickening of Posterior SI ligaments considered the "joint capsule")

### Sacro-Iliac Joint Imaging Diagnostic Value Is there inflammation ??

#### 2009 Study

Feasibility of... ultrasound contrast media in the detection of active sacroiliitis

- Intravenous injection of contrast media
- Detect "vascularization" of the clinically active SIJ inflammation ?

#### Results

**Active SIJ = hyperechoic signal extending deeper into joint space ( $\pm 18$ mm)**

Measuring from entry into SIJ to deepest visible intra-articular signal

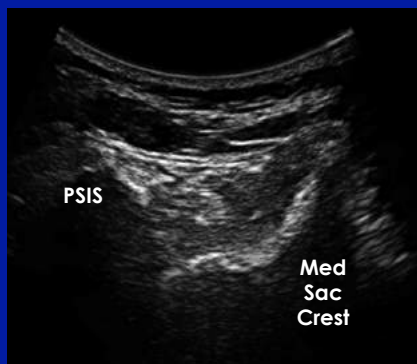
**100 %**

**Inactive SIJ = hyperechoic signal seen more "shallow", less deep ( $\pm 3$  to 4mm)**

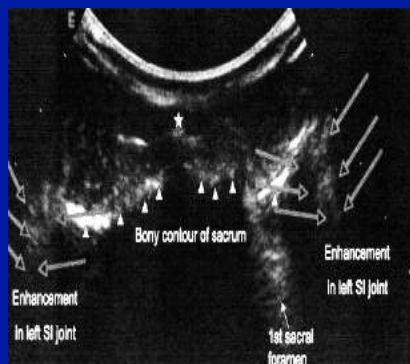
**100 %**

Arthritis Care & Research  
Volume 61, Issue 7, pages  
909-916, 29 JUN 2009 DOI:  
10.1002/art.24648  
[http://  
onlinelibrary.wiley.com/  
doi/10.1002/art.24648/  
full#fig1](http://onlinelibrary.wiley.com/doi/10.1002/art.24648/full#fig1)

**Sacro-Iliac Joint Imaging  
Diagnostic Value  
Is there inflammation ??**



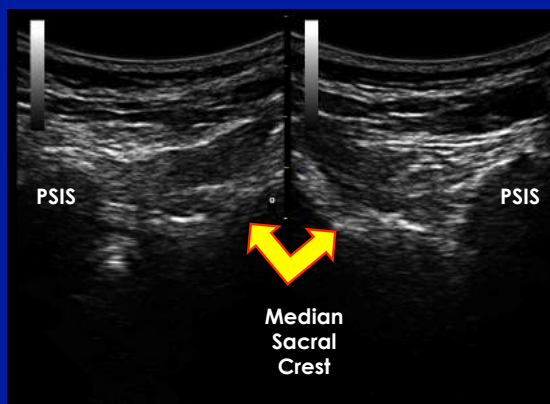
Inactive SIJ = No hyperechoic signal extending into joint  
Is seen more "shallow", less deep



Active SIJ = hyperechoic signal extending deeper into joint space

**Sacro-Iliac Joint Imaging  
Diagnostic Value  
"Composite Image"**

Utilizing split-screen feature for bilateral comparison



What is visualized ?

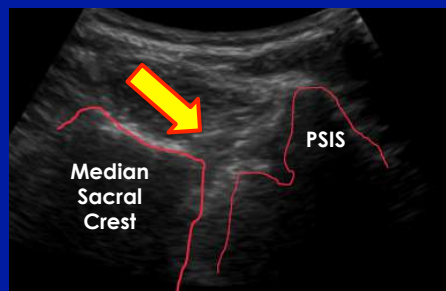
- Posterior SI ligaments in x-section
- Hyper echoic signal extending into joint space...

"vascularization"...

Inflammation...

**Sacro-iLitis**

## Sacro-Iliac Joint Injections



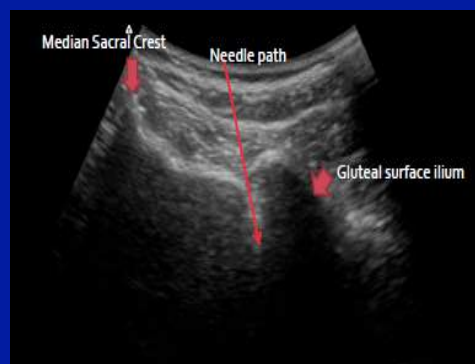
*Prone patient with bolster under abdomen to reduce lumbar lordosis*

*SAX probe at Rt or Lt PSIS*

*Needle advanced: Medial to Lateral*

*Unguided Injections: 12-22 % accuracy*

## Sacro-Iliac Joint Injections



*SAX probe at Rt or Lt PSIS*

*Needle advanced: Medial to Lateral*

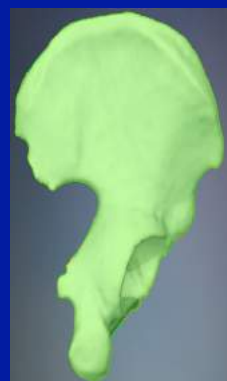
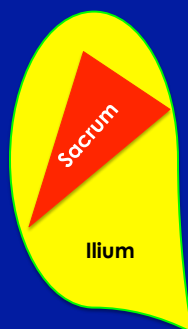
## Sacro-Iliac Joint Injections

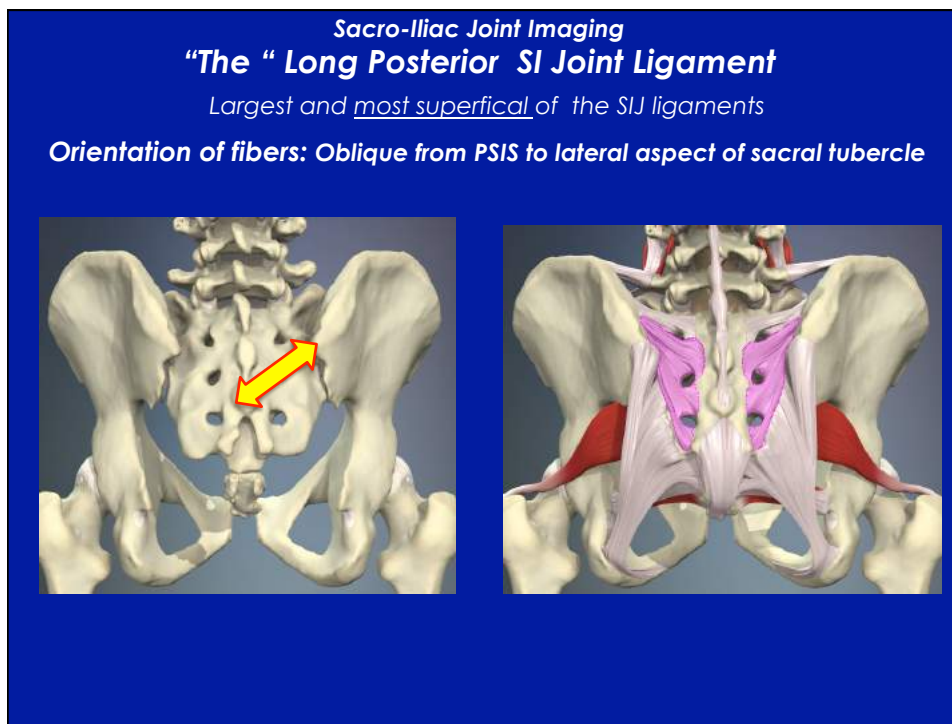


*SAX probe at Rt or Lt PSIS*  
*Needle advanced: Medial to Lateral*

## Sacro-Iliac Joint Imaging The Long Posterior SI Joint Ligament

*Largest and most superficial of the SIJ ligaments*  
*Primary function: Restrict posterior rotation of upper sacrum*





*Sacro-Iliac Joint Imaging*  
**“The “ Long Posterior SI Joint Ligament**  
*Diagnostic Value*  
**A source of lumbo-sacral pain**  
**Prominent in females during pregnancy**


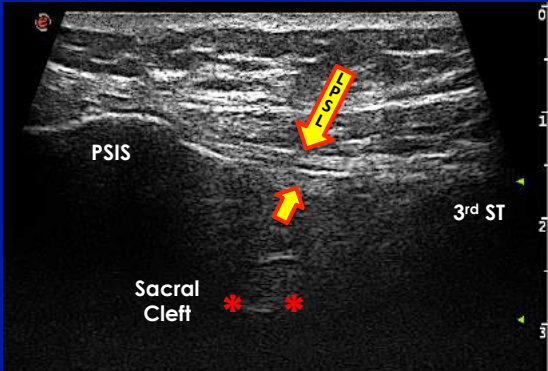
**Innervated with sensory nerves**

**As is the adipose/connective tissue deep to it.**

**Nerve compression/ entrapment can occur with posterior sacral rotation**

McGrath, MC. And Zhang, M. 2005  
 Surg Radiol Anat 27:327-330

### Sacro-Iliac Joint Imaging Long Posterior SI Joint Ligament (LPSL)

**Decubitus/fetal position is best**  
Standing/flexed is an option)

**Probe: Long Axis/Oblique**

**PSIS to 3<sup>rd</sup> sacral tubercle (3<sup>rd</sup> ST)**

**The tri-laminar fibers (3 layers) of the ligament extend across the image**

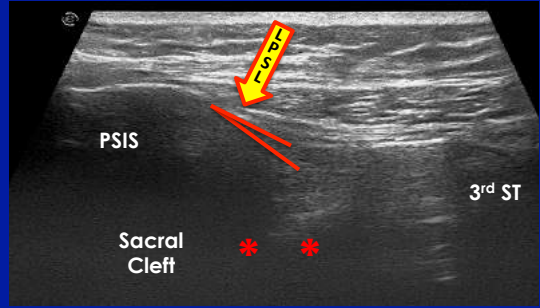
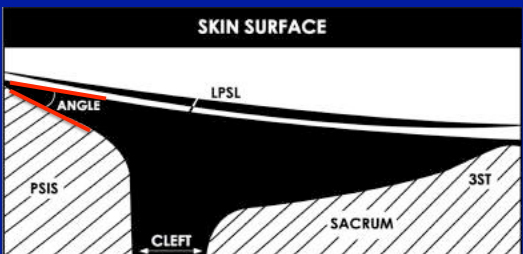
Moore, A. Clinical Anatomy  
23: 971-977 (2010)

### Sacro-Iliac Joint Imaging Long Posterior SI Joint Ligament (LPSL)

Diagnostic Criteria

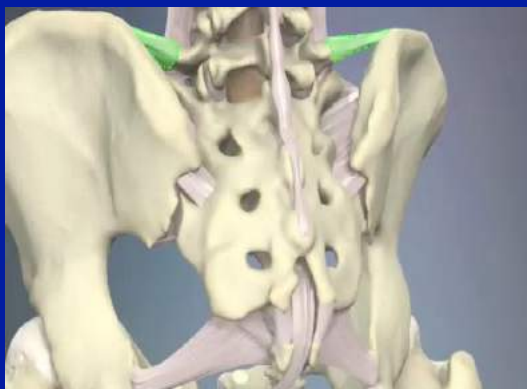
- Thickness of LPSL over the joint cleft
- Angle between the medial edge of PSIS and deep margin of LPSL

Average: 18°  
Decreased angle (< 18°)  
May indicate entrapment of sacral nerves deep to ligament

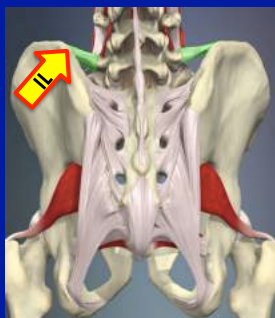
*Sacro-Iliac Joint Imaging*  
**Ilio-Lumbar Ligament**

*A large ligament... anterior to the Sacro-Iliac joint*  
*Essential to restraining movement in the lumbo-sacral region.*  
*Injury or instability is seen with painful lateral bending*



*Sacro-Iliac Joint Imaging*  
**Ilio-Lumbar Ligament**

*Highly innervated with... nociceptive/pain fibers*  
*Provides attachment of a muscle often implicated*  
*In chronic low back pain... Quadratus Lumborum*



Ilio-lumbar  
ligament



Posterior View



Anterior View

**The QL attaches to the Ilio-lumbar ligament via  
 A sheet-like, tendinous membrane... aka an aponeurosis**

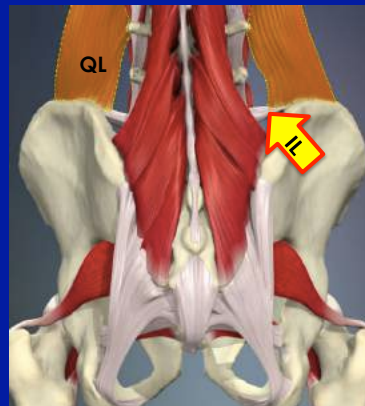


*Sacro-Iliac Joint Imaging  
Ilio-Lumbar Ligament*



QL =  
Quadratus

IL =  
Ilio-lumbar

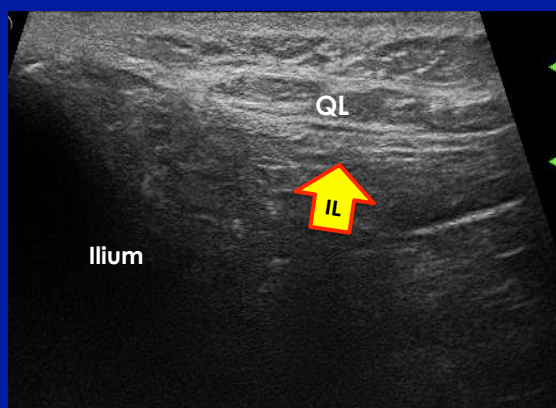


**Probe Placement**

SAX/Oblique from L5 transverse process to the Iliac crest.  
Proximal to Distal beam angulation

Remembering the “navigation triangle” for accuracy

*Sacro-Iliac Joint Imaging  
Ilio-Lumbar Ligament*



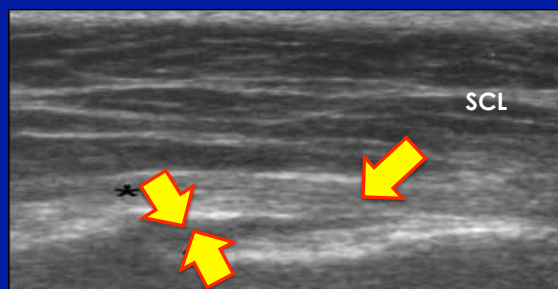
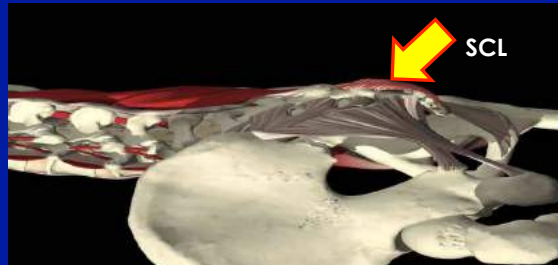
The primary bony landmark is the iliac crest .  
L5 transverse process is secondary and may be difficult to display.  
I-L ligament is fibrous, hyperechoic interface along the iliac crest.  
Quadratus Lumborum is seen in cross-section

## Lumbar Sonography Caudal Epidural Injection

Longitudinal Orientation

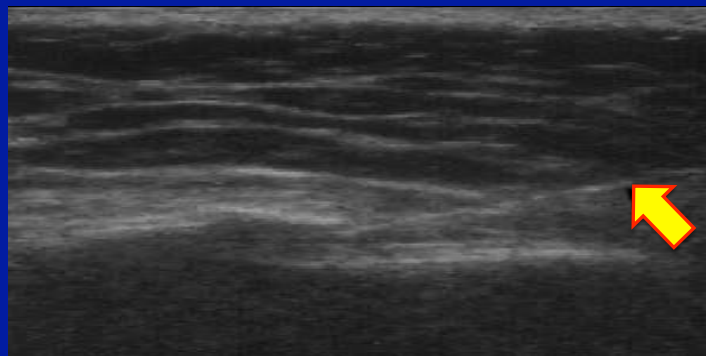
Ligament has a **hyperechoic**/bright fibrillar pattern

Fluid filled epidural space is **hypo** to **anechoic** deep to the ligament  
(between yellow arrows)



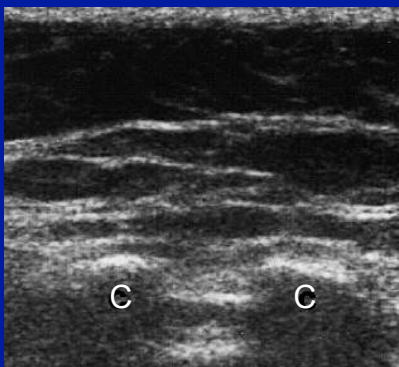
## Lumbar Sonography Caudal Epidural Injection

Needle advancement : distal to proximal/in-plane



*Lumbar Sonography*  
Caudal Epidural Injection  
*Short Axis Orientation*  
Sacral Cornu

May be helpful in verifying accurate visualization of sacral hiatus



C = Cornu

*Sonographically Guided Caudal Epidural Steroid Injections, Journal of Ultrasound in Medicine 22: 1229-1232, 2003*

Thank You !

*Ancora Imparo...*

*I'm still learning...*