

Story of Lumbar Spine:

1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

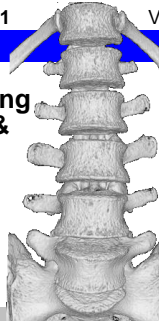
Goal Better understanding structure & function
 ✓ Spine
 ✓ Lumbar

Objectives

a) Illustrate anatomy
 > Bones
 > Nerves
 > Canal & Foramen

b) Importance of Radiographs
 > Big Picture
 > Alignment
 > Spondylolysis
 > Spondylolisthesis

c) What Order When
 > ACR



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Story of the Lumbar Spine:1 Variations of Normal

Spine is at our Core

Entire skeleton attaches to the spine

✓ Axial Skeleton
 ✓ Spine
 ✓ Head
 ✓ Ribs

✓ Appendicular Skeleton
 ✓ Shoulder girdle → Arms
 ✓ Pelvic girdle → Legs



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Story of the Lumbar Spine:1 Variations of Normal

Spine defines our place in the world

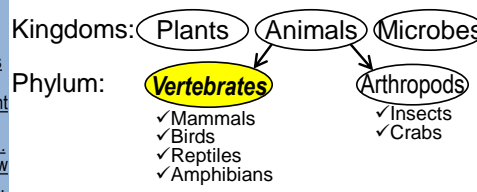
Taxonomy of Life on Earth

Kingdoms: Plants Animals Microbes

Phylum: **Vertebrates** Arthropods

Vertebrates:
 ✓ Mammals
 ✓ Birds
 ✓ Reptiles
 ✓ Amphibians

Arthropods:
 ✓ Insects
 ✓ Crabs



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Story of the Lumbar Spine:1 Variations of Normal

Spine Clinically Important

Back pain 2nd most common neurological ailment (headache most common)

Most common job-related disability

American spend >\$50 billion annually on LBP

"Nearly everyone at some point has back pain that interferes with work, routine daily activities, or recreation"

Half of what MSK does is the spine

> Acute trauma (ER, Clinics, Outside studies)
 > Chronic LBP (Spine Clinic, PCPs)
 > Image guided injections for pain

NIH Low Back Pain Fact Sheet



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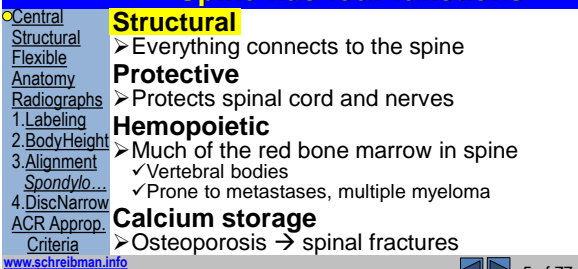
Spine has four functions

✓ **Structural**
 > Everything connects to the spine

✓ **Protective**
 > Protects spinal cord and nerves

✓ **Hemopoietic**
 > Much of the red bone marrow in spine
 ✓ Vertebral bodies
 ✓ Prone to metastases, multiple myeloma

✓ **Calcium storage**
 > Osteoporosis → spinal fractures




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Story of the Lumbar Spine:1 Variations of Normal

Spine is a structural element

If I were to build a statue, especially one I'd have to move across an ocean... I'd start with a central spine (2 columns) I'd hang a skeletal framework from spine Cover with skin

Rigid Central Spine



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Story of Lumbar Spine:

1) Variations of Normal

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Spine as a structural element

- Central
- Structural
- Flexible
- Anatomy
- Radiographs
- 1. Labeling
- 2. Body/Height
- 3. Alignment
- Spondylo...
- 4. Disc/Narrow
- ACR Approp.
- Criteria




If I were to build an imaginary robot... with a head... and feet... It might require hinged arms & legs... With lots of wires... **Rigid central conduit via which wires pass**

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Story of the Lumbar Spine:1 Variations of Normal

Robots have rigid spines

- Central
- Structural
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Story of the Lumbar Spine:1 Variations of Normal

Spine as Structural Conduit

- Central
- Structural
- Flexible
- Anatomy
- Radiographs
- 1. Labeling
- 2. Body/Height
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- Criteria



If I were to build a real robot... iPad for a head Segway-like wheels Rigid pipe (spine) for the wires to pass **"Ultimate tool for telecommuting"**


Order Now \$2,499

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Story of the Lumbar Spine:1 Variations of Normal

Humans have a flexible spine

- Central
- Structural
- Flexible
- Anatomy
- Radiographs
- 1. Labeling
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Story of the Lumbar Spine:1 Variations of Normal

Spine flexibility from individual vertebrae

- Central
- Structural
- Flexible
- Anatomy
- Radiographs
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- 2. Body/Height
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Vertebra: [L] vertere "to turn, bend"
 > Same root as versus

Literally: "Joints in the spine"
 > Joints between every vertebrae

24(±) vertebrae between skull/sacrum

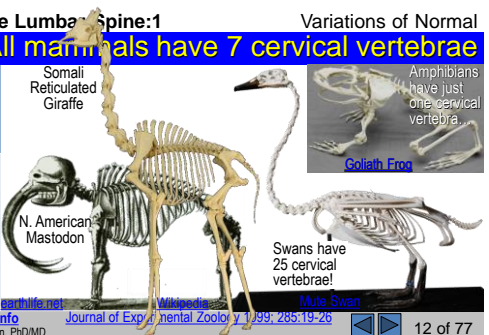
Ribs define the parts of the spine
 12 with ribs = Thoracic vertebrae } Variable number
 5 below ribs = Lumbar vertebrae }
 7 above ribs = Cervical vertebrae } Constant number

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Story of the Lumbar Spine:1 Variations of Normal

Trivia: All mammals have 7 cervical vertebrae

- Central
- Structural
- Flexible
- Anatomy
- Radiographs
- 1. Labeling
- 2. Body/Height
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- Spondylo...
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- ACR Approp.
- Criteria



Somali Reticulated Giraffe

N. American Mastodon

Amphibians have just one cervical vertebra... Goliath Frog

Swans have 25 cervical vertebrae! White Swan

Journal of Experimental Mental Zoology 1939; 285:119-26

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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

Vertebrae Permit Bending: Right/Left

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

Left Right

Posterior View

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Story of the Lumbar Spine:1 Variations of Normal

Vertebrae Permit Bending: Back/Front

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

Flexion Extension

Side View

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Story of the Lumbar Spine:1 Variations of Normal

Vertebral Flexion/Extension Not Uniform

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

Most of the spine's ROM

- > Lower Cervical spine ✓ C5-C6*
- *Where DDD Occurs
- > Lower Lumbar spine ✓ L4-L5*

Flexion Extension

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Story of the Lumbar Spine:1 Variations of Normal

Spine is Straight (from the back)

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

Vertical line all vertebrae

Scoliosis: Curved spine

- > Right curve: "Dextroscoliosis" ✓ [L] dexter: "dexterity"
- > Left curve: "Levoscoliosis" ✓ [L] laevus: "lame, weak"

Note: By convention, scoliosis radiographs are displayed like we're looking at the patient **from the back**

This patient has Dextroscoliosis of the T-spine... and Levoscoliosis of the L-spine

M,B 13yoF

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Story of the Lumbar Spine:1 Variations of Normal

Spine is NOT Straight (from the side)

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

C-spine: Normal forward curve > "Cervical Lordosis"

T-spine: Normal back curve > "Thoracic Kyphosis"

L-spine: Normal forward curve > "Lumbar Lordosis"

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Story of the Lumbar Spine:1 Variations of Normal

Lumbar Vertebrae

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body Height
3. Alignment
4. Disc Narrow

ACR Approp. Spondylo... Criteria

5 Lumbar Vertebrae (usually)

- > Named: L1-L5
- > Don't have ribs (usually)
- ✓ Thoracic vertebrae have ribs
- ✦ Lowest is T12 (usually)

Have Transverse Processes

Lowest Lumbar (L5 usually) Articulates with Sacrum

> S1

Anterior View

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2 Lumbar Articulations

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Discs
➤ Between "vertebral bodies"

Facets
➤ Between "posterior elements"

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Story of the Lumbar Spine:1 Variations of Normal

Parts of Vertebra: Processes

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Side View Top (Axial) View

Vertebral Body **Posterior Elements** **Spinous Process** **Transverse**

Body: Primary structural component
Spine: [Old French] espine "Thorn-like"

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Story of the Lumbar Spine:1 Variations of Normal

Parts of Vertebra: Facets

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Side View Superior articular process Top (Axial) View

Vertebral Body **Posterior Elements** **Pars Inter-articularis**

Inferior articular process Superior articular process

Facets: Sliding joints

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Story of the Lumbar Spine:1 Variations of Normal

Parts of Vertebra: Canal

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Side View Top (Axial) View

Vertebral Body **Posterior Elements** **Canal** **Lamina**

Pedicle

Pedicles: Connect posterior elements to vertebral body
Body + Pedicles + Lamina = Bony Canal
Bony Canal: Protects spinal cord/nerves

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Parts of Vertebra: Neural Foramen

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Side View Top (Axial) View

Neural Foramen: Keyhole-shaped opening Under pedicle Front of facet Behind Disc

Lumbar Nerves: Travel thru canal Exit at NF under pedicles

Canal

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Spinal Nerves

Central Structural Flexible Anatomy Radiographs 1. Labeling 2. Body Height 3. Alignment Spondylo... 4. Disc Narrow ACR Approp. Criteria

Spinal nerves exit neural foramen at every level

Nerves named relative to bodies

- ✓ Lumbar/Thoracic nerves named for pedicle they pass *under*
 - ❖ L3 nerve passes *under* L3 pedicle via the L3-L4 neural foramen
- ✓ Cervical nerves named for pedicle they pass *over*
 - ❖ C7 nerve passes *over* C7 pedicle via the C6-C7 neural foramen (why?)
 - 8 Cervical Nerves

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Story of Lumbar Spine: 1) Variations of Normal

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MRI Well Shows Spinal Nerves

Central Structural Flexible
Anatomy Radiographs
1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow
5. Spondylo...
6. ACR Approp.
7. Criteria

Sagittal
Midline
Axial Reference Image

✓ Conus Medullaris
✦ End of Cord (-L1)
✓ Cauda Equina
✦ "Horse's tail"
✦ Nerves below conus

T1 Fat=bright Fluid=dark
T2 Fat Suppressed Fat=dark Fluid=bright

R,R 29yoF

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Story of the Lumbar Spine:1 Variations of Normal

MRI Well Shows Spinal Nerves

Central Structural Flexible
Anatomy Radiographs
1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow
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6. ACR Approp.
7. Criteria

Axial (parallel to discs)

T2 Fat Suppressed Fluid=bright
T2 Fluid=bright Fat=bright

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Story of the Lumbar Spine:1 Variations of Normal

MRI Well Shows Bones

Central Structural Flexible
Anatomy Radiographs
1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow
5. Spondylo...
6. ACR Approp.
7. Criteria

Sagittal
Thru NF
Axial Reference Image

✓ Bodies
✦ SP

T1: Thru NF Fat=bright
T1: Midline Fat=bright

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Story of the Lumbar Spine:1 Variations of Normal

MRI Well Shows Bone Marrow

Central Structural Flexible
Anatomy Radiographs
1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow
5. Spondylo...
6. ACR Approp.
7. Criteria

Can tell new Fxs from old

T1: Fat=Hi
Dark signal:
✓ Non-fatty

T2+Fat Sat: Fluid=Hi
Hi signal:
✓ Edema

T12, L1, L2, L3, L4, L5, S1, Fx

F,R 77yoM

L1 & L5 recent & active fractures
L2 & L3 old & quiescent fractures

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Story of the Lumbar Spine:1 Variations of Normal

MRI Well Shows Bone Marrow

Central Structural Flexible
Anatomy Radiographs
1. Labeling
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7. Criteria

T2+Fat Sup Mid-Sagittal

Not all high signal on T2 is abnormal

Normal Lumbar Venous Plexus
Common on mid-sagittal
Prominent in young

T2+Fat Sup Mid-Sagittal

R,R 29yoF

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We're Getting Ahead of Ourselves

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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

WOW: Imaging Low Back Pain

Central Structural Flexible Anatomy

0) History & Physical

- Conservative management (ACR: 6 weeks)

1) Radiographs (AP & Lateral)

- Best to show the big picture

2) MRI (without contrast)

- Well shows discs, nerves, bones

3) Refer to Spine Clinic

CT: Ordered by ER & Spine Clinic

Nuclear Medicine (Bone scan, SPECT, PET/CT)

- Ordered by specialty clinics

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Story of the Lumbar Spine:1 Variations of Normal

Radiographs: AP View

Central Structural Flexible Anatomy

Shot standing

X-ray tube

Should include:

- T12 (ribs)
- L1-L5
- S1 (top of sacrum)

AP view superimposes front on back

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Story of the Lumbar Spine:1 Variations of Normal

View

Central Structural Flexible Anatomy

Radiographs

1. Labeling

2. Body/Height

3. Alignment

4. Disc/Narrow

5. Spondylo...

6. ACR Approp.

7. Criteria

Transverse Processes

Facets

Vertebral Body

Ped

SPINOUS

Difficult to assess Disc spaces

We can still see lots of anatomy

V,S 18yoF

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Story of the Lumbar Spine:1 Variations of Normal

Radiographs: Lateral View

Central Structural Flexible Anatomy

Shot standing

X-ray tube

Should include:

- T12 (ribs)
- L1-L5
- S1 (top of sacrum)

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Story of the Lumbar Spine:1 Variations of Normal

Radiographs: Lateral View (SMoney View)

Central Structural Flexible Anatomy

Shows the Big Picture

- Well shows vertebral alignment
 - Normal Lordosis, smooth curve
 - vs spondylolisthesis
- Well shows vertebral body height
 - Parallel superior/inferior end plates
 - Slight wedging at T-L junction is common
- Shows Disc space widths
 - Wider @ Lower Levels
 - L5-S1 variable
 - L4-L5 widest
 - DDD starts L4-L5

T12 ribs

L1

L2

L3

L4

L5

S1

K,D 44yoM

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Story of the Lumbar Spine:1 Variations of Normal

How I Look at L-Spine Radiographs

Central Structural Flexible Anatomy

AP & Lateral side-by-side on PACS

1. Label the vertebrae!

- Iliac Crests @ L4-L5

UW MSK Policy: All Lumbar spines get labeled on PACS

Why the big fuss? Sometimes it's hard to count...

AP

Lateral

T12 ribs

L1

L2

L3

L4

L5

S1

J,D 20yoM

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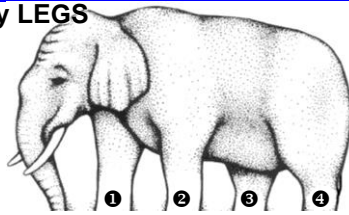
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Story of the Lumbar Spine:1 Variations of Normal

Sometimes it's hard to count...

- Central
- Structural
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How many LEGS does this elephant have?



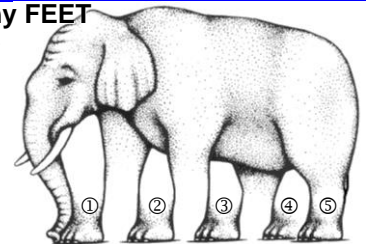
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Story of the Lumbar Spine:1 Variations of Normal

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How many FEET does this elephant have?



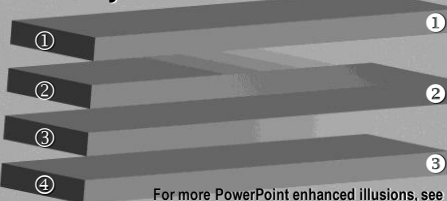
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Story of the Lumbar Spine:1 Variations of Normal

Sometimes it's hard to count...

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How many shelves are here?



For more PowerPoint enhanced illusions, see my lecture "Pitfalls of the Human Visual System"

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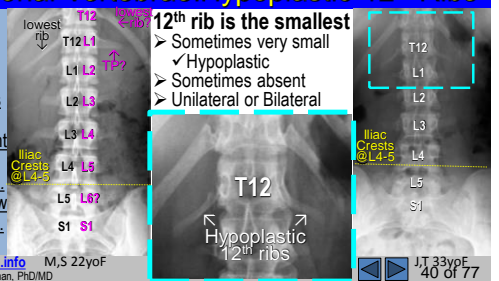
Story of the Lumbar Spine:1 Variations of Normal

Transitional Vertebrae: Hypoplastic 12th Ribs

- Central
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12th rib is the smallest

- > Sometimes very small
- ✓ Hypoplastic
- > Sometimes absent
- > Unilateral or Bilateral

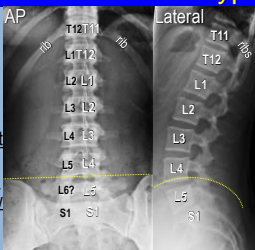


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Story of the Lumbar Spine:1 Variations of Normal

Transitional Vertebrae: Hypoplastic 12th Ribs

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Very hypoplastic 12th ribs makes it look like there are 6 lumbar vertebrae
 > Non-rib-bearing vertebrae
 Sometimes it's hard to count...

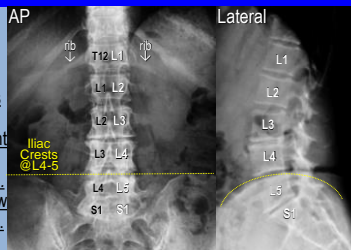
Schreibman's Rule:
 Iliac Crests @ L4-L5

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Story of the Lumbar Spine:1 Variations of Normal

Transitional Vertebrae: Lumbar Ribs

- Central
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- Criteria



Lumbar ribs makes it look like there are 4 lumbar vert.
 > Non-rib-bearing vertebrae
 Lumbar ribs are not uncommon
 > 49/559 (9%) skeletons Wash U
 1944 Lanier: Am J Phys Anthropol 2:137-146

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Story of Lumbar Spine:

1) Variations of Normal

Story of the Lumbar Spine:1

Not Everyone Has 12 Ribs

Not everyone has 10 fingers

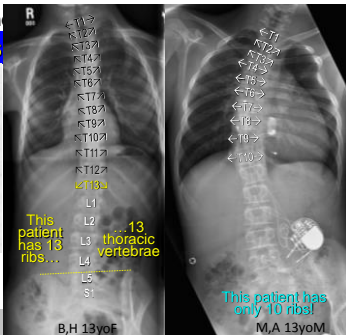
12 Fingers

4. Disc Narrow

ACR Approp. Criteria

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Story of the Lumbar Spine:1

Variations of Normal

Transitional Vertebrae: Sacralization of L5

Central Structural Flexible Anatomy Radiographs

1. Labeling

2. Body Height

3. Alignment

Spondylo...

4. Disc Narrow

ACR Approp. Criteria

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AP

Lateral

Fx of ...

No disc between L5 & S1

L5 is fused to S1!

H,S 20yoF

anatomyatlases.org

Fairly common

- > ~14%
 - 1989: 46/340 sacra (Arab and Indian)
- > 18%
 - 1936: Australian aboriginals
- > 6%
 - 1927: Japanese

> Can be bilateral...

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Story of the Lumbar Spine:1

Variations of Normal

Transitional Vertebrae: Sacralization of L5

Central Structural Flexible Anatomy Radiographs

1. Labeling

2. Body Height

3. Alignment

Spondylo...

4. Disc Narrow

ACR Approp. Criteria

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L5 is sacralized (fused) to S1 on the right...

...but not on the left

Can be unilateral

Can be fused "Complete sacralization"

S,L 43yoF

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Story of the Lumbar Spine:1

Variations of Normal

Transitional Vertebrae: Sacralization of L5

Central Structural Flexible Anatomy Radiographs

1. Labeling

2. Body Height

3. Alignment

Spondylo...

4. Disc Narrow

ACR Approp. Criteria

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Complete sacralization of L5 on the right

Partial sacralization of L5 on the left

Can be fused "Complete sacralization"

Can be an extra facet between L5-S1 "Partial sacralization"

C,D 28yoM

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Story of the Lumbar Spine:1

Variations of Normal

Transitional Vertebrae are Common

Central Structural Flexible Anatomy Radiographs

1. Labeling

2. Body Height

3. Alignment

Spondylo...

4. Disc Narrow

ACR Approp. Criteria

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Lumbar ribs (L1)

- > 9% of population

Sacralization of L5

- > ~14% of population (6-18%)

Hypoplastic 12th ribs

- > I can't find a number for this, but I'm guessing it's at least as common as sacralized L5
- ✓ Some patients have both

30-40% of population have Trans. Vert.

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Story of the Lumbar Spine:1

Variations of Normal

Final comments on labeling for Radiologists

Central Structural Flexible Anatomy Radiographs

1. Labeling

2. Body Height

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Spondylo...

4. Disc Narrow

ACR Approp. Criteria

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UW MSK Policy

- > ALL LUMBAR VERTEBRAE GET LABELED
- ✓ All: Radiographs/CTs/MRs

Easy to do on PACS

- > Single view or entire stack

As easy on AP as Lateral

- > Forces me to look at each Pedicle, Spinous Process

L1

- > Lytic pedicle
- > ✓ Expansile
- > ✓ Scoliosis
- > Hx: Pain
- > **Osteoblastoma**

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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

How I Look at L-Spine Radiographs

Central Structural Flexible Anatomy Radiographs	AP & Lateral side-by-side on PACS	AP	Lateral
1. Labeling	1. Label the vertebrae! ✓ Comment on Trans. Vert		
2. Body/Height	2. Vertebral body height ✓ Parallel end plates		
3. Alignment	✓ Pathologic fractures can occur at any level		
4. Disc/Narrow	✓ Traumatic fractures tend to occur at T-L junction		
Criteria		www.schreibman.info VV 40yoM © 2014 Ken L. Schreibman, PhD/MD 49 of 77	

Story of the Lumbar Spine:1 Variations of Normal

Lumbar vs Thoracic Radiographs

Central Structural Flexible Anatomy Radiographs	L-spine	Lumbar Radiographs	T-spine
1. Labeling		<ul style="list-style-type: none"> Cover entire L-spine ✓ From T12 – S1 ✓ Centered on L3 	
2. Body/Height		<ul style="list-style-type: none"> Cover entire T-spine ✓ From T1 – T12 ✗ Usually can't see T1 ✗ Centered on T7 	
3. Alignment		But neither optimally shows T-L junction	
4. Disc/Narrow			
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Story of the Lumbar Spine:1 Variations of Normal

Thoraco-Lumbar Radiographs

Central Structural Flexible Anatomy Radiographs	L-spine	TL junction	T-spine
1. Labeling		<ul style="list-style-type: none"> Centered at T-L junction Good for seeing fractures at T-L junction 	
2. Body/Height		<ul style="list-style-type: none"> Notice how much easier it is to see the T12 wedging 	
3. Alignment			
4. Disc/Narrow			
Criteria		www.schreibman.info VV 40yoM © 2014 Ken L. Schreibman, PhD/MD 51 of 77	

Story of the Lumbar Spine:1 Variations of Normal

Assessing Fracture Stability

Central Structural Flexible Anatomy Radiographs	Radiologists:	TL junction	
1. Labeling	Measure wedging		
2. Body/Height	<ul style="list-style-type: none"> Easy on PACS Don't measure height loss Measure focal kyphosis Cobb ∠ 		
3. Alignment	<ul style="list-style-type: none"> Superior end plate level above Inferior end plate level below 		
4. Disc/Narrow			
Criteria		www.schreibman.info VV 40yoM © 2014 Ken L. Schreibman, PhD/MD 52 of 77	

Story of the Lumbar Spine:1 Variations of Normal

Congenital/Physiologic Wedging

Central Structural Flexible Anatomy Radiographs	Vertebral bodies = basically square
1. Labeling	<ul style="list-style-type: none"> Parallel Superior / Inferior end plates T-L Junction is a Transition Zone Lumbar Lordosis / Thoracic Kyphosis L1 (or T12 or T11) can be keystone shaped
2. Body/Height	
3. Alignment	
4. Disc/Narrow	
Criteria	<ul style="list-style-type: none"> Superior & Inferior end plates slightly wedged, by the same amount
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Story of the Lumbar Spine:1 Variations of Normal

Congenital Wedging vs Fracture

Central Structural Flexible Anatomy Radiographs	<ul style="list-style-type: none"> ← Congenital wedging Keystone shaped → Traumatic wedging Right Trapezoid
1. Labeling	
2. Body/Height	<ul style="list-style-type: none"> Superior & Inferior end plates wedged by the same amount Depressed Superior end plate only
3. Alignment	
4. Disc/Narrow	
Criteria	<ul style="list-style-type: none"> History Helps: Acute onset, recent trauma Comparison with old images helps A LOT May need CT/MRI to determine if acute
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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

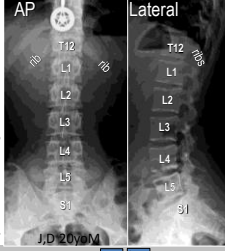
How I Look at L-Spine Radiographs

Central Structural Flexible Anatomy Radiographs

AP & Lateral side-by-side on PACS

1. Label the vertebrae!
2. Vertebral body height
3. Alignment
 - ✓ Lateral: Normal Lordosis vs Spondylolisthesis
 - ✓ AP: Straight vs Scoliosis

Scoliosis should be imaged with "Scoliosis" Radiographs



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Story of the Lumbar Spine:1 Variations of Normal

Lumbar vs Scoliosis Radiographs

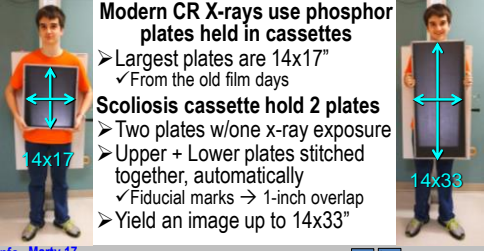
Central Structural Flexible Anatomy Radiographs

Modern CR X-rays use phosphor plates held in cassettes

- Largest plates are 14x17"
 - ✓ From the old film days

Scoliosis cassette hold 2 plates

- Two plates w/one x-ray exposure
- Upper + Lower plates stitched together, automatically
 - ✓ Fiducial marks → 1-inch overlap
- Yield an image up to 14x33"



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Story of the Lumbar Spine:1 Variations of Normal

Scoliosis Radiographs

Central Structural Flexible Anatomy Radiographs

PA view – Upper Half

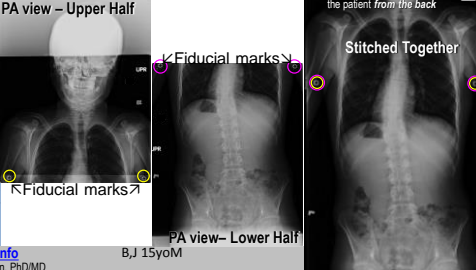
Shot standing → UPR

By convention, scoliosis PA views are displayed like you're looking at the patient from the back

Stitched Together

Fiducial marks

PA view – Lower Half



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Story of the Lumbar Spine:1 Variations of Normal

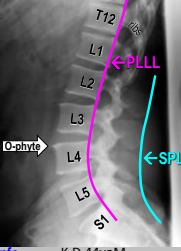
Normal Lumbar Lordosis

Central Structural Flexible Anatomy Radiographs

Smooth Curves

- Along back vertebral bodies
 - ✓ "Posterior Longitudinal Ligament Line"
 - ✓ (Fronts tend to have osteophytes)
- Along back spinous process
 - ✓ "Spinous Process Line"

Continuous Curves



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Story of the Lumbar Spine:1 Variations of Normal

Spondylolisthesis

Central Structural Flexible Anatomy Radiographs

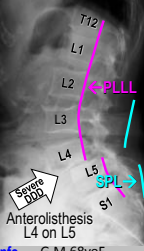
[Gr] spondylo: "vertebrae" olisthesis: "slipping"

Anterior slippage of a vertebra relative to the one below it

aka "Anterolisthesis"

3 causes of spondylolisthesis

1. DDD (most common)
 - ✓ PLLL & SPL disrupted at same level
2. Spondylolysis
3. Trauma (least common)



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Story of the Lumbar Spine:1 Variations of Normal

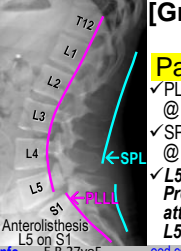
Spondylolysis

Central Structural Flexible Anatomy Radiographs

[Gr] spondylo: "vertebrae" lysis: "dissolution"

Pars Interarticularis Defect

- ✓ PLLL disrupted @ L5-S1
- ✓ SPL disrupted @ L4-L5
- ✓ L5 Spinous Process not attached to L5 Body



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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

Spondylolysis: Prevalence

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

Japan: 2,000 CTs (20-92yo) not for back pain

- **6% Spondylolysis** (M:F = 2:1)
 - ✓ 80% Bilateral
 - ✦ 75% of these had spondylolisthesis
 - ✓ 20% Unilateral
 - ✦ 8% of these had spondylolisthesis
- **90% @ L5**
- **Probably a stress fracture**
- Due to vertical shear
- Vertical shear greatest at L5 pars interarticularis

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Story of the Lumbar Spine:1 Variations of Normal

Spondylolysis: CT Gold Standard

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

Dx: Unilateral spondylolysis without spondylolisthesis

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Story of the Lumbar Spine:1 Variations of Normal

Spondylolysis: Lateral View

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

May be able to see on lateral view if there is enough spondylolisthesis to separate body from spinous process

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Story of the Lumbar Spine:1 Variations of Normal

Spondylolysis: Oblique Views

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

Shot laying on X-ray table

- Unlike standing AP & Lateral
- ✓ See scotty dog

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Story of the Lumbar Spine:1 Variations of Normal

Spondylolysis: Oblique Views

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

Oblique view

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Story of the Lumbar Spine:1 Variations of Normal

Radiographs Show the Big Picture

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. Body/Height
3. Alignment
4. Disc/Narrow

For Alignment: Get Standing Views

- For alignment of entire Lumbar spine:
 - ✓ Get Lumbar spine radiographs
- For alignment of entire Thoracic spine:
 - ✓ Get Thoracic spine radiographs
- For alignment of Thoraco-Lumbar Junction
 - ✓ Get Thoraco-Lumbar radiographs
- For alignment of ENTIRE SPINE (C+T+L)
 - ✓ Get Scoliosis radiographs

For Stability: Get Flexion/Extension

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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

Flexion/Extension Views

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. BodyHeight
3. Alignment
4. DiscNarrow
- ACR Approp. Criteria

www.schreibman.info Marty 17 I find these of limited value 67 of 77

Story of the Lumbar Spine:1 Variations of Normal

Flexion/Extension: Good ROM

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. BodyHeight
3. Alignment
4. DiscNarrow
- ACR Approp. Criteria

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Story of the Lumbar Spine:1 Variations of Normal

Flexion/Extension: Limited ROM

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. BodyHeight
3. Alignment
4. DiscNarrow
- ACR Approp. Criteria

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Story of the Lumbar Spine:1 Variations of Normal

Flexion/Extension: Spondylolysis

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. BodyHeight
3. Alignment
4. DiscNarrow
- ACR Approp. Criteria

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Story of the Lumbar Spine:1 Variations of Normal

How I Look at L-Spine Radiographs

Central Structural Flexible Anatomy Radiographs

1. Label the vertebrae!
2. Vertebral body height
3. Alignment
4. Disc Spaces
 - Wider @ Lower Levels
 - L5-S1 variable
 - L4-L5 widest
 - DDD starts L4-L5

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Story of the Lumbar Spine:1 Variations of Normal

DDD: My Grading System

Central Structural Flexible Anatomy Radiographs

1. Labeling
2. BodyHeight
3. Alignment
4. DiscNarrow
- ACR Approp. Criteria

> If I have to convince the resident the disc is narrow =MILDLY NARROWED
 > If we agree it's narrow =MODERATELY NARROWED
 > Vacuum phenomenon =SEVERLY NARROWED

Lateral\$ PACS Measurements

- L1 10.4 mm
- L2-3 > L1-2 11.3 mm
- L3-4 < L2-3 9.82 mm
- L4-5 < L3-4 9.82 mm
- L5-S1 >> 10.4 mm

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Story of Lumbar Spine: 1) Variations of Normal

Story of the Lumbar Spine:1 Variations of Normal

ACR Appropriateness Criteria

Central Structural Flexible Anatomy Radiographs
 1. Labeling
 2. Body Height
 3. Alignment
 Spondylo...
 4. Disc Narrow

American College of Radiology ACR Appropriateness Criteria®

Date of origin: 1996
 Last review date: 2011

Low Back Pain

Summary (Page 7)

- Acute uncomplicated LBP without red flags is a benign, self-limited condition that does not require imaging evaluation.
- MR has displaced CT and myelography as the initial imaging modality of choice in complicated LBP, with contrast useful for neoplasia, infection, and postoperative evaluation.
- CT is useful in patients with surgical fusion instrumentation or bone structural abnormalities, and in patients with MRI contraindications.
- Myelography/CT, discography/CT, and radioisotope bone scans are useful in selected patients for problem solving.
- Advanced imaging techniques such as SPECT/CT and PET/CT have value in selected patients but are not considered routine clinical practice at this time.

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Story of the Lumbar Spine:1 Variations of Normal

ACR Appropriateness Criteria

Central Structural Flexible Anatomy Radiographs
 1. Labeling
 2. Body Height
 3. Alignment
 Spondylo...
 4. Disc Narrow

Acute uncomplicated LBP without red flags is a benign, self-limited condition that does not require imaging eval.

12

- Trauma (cumulative)
- Unexpected wt. loss
- Osteoporosis (>50y)
- Fever, Infection (UTI)
- Diabetes
- Cancer, Immunosuppression
- IV drug use
- Prolonged steroid use
- Age > 70 years
- Focal Neuro (cauda equina)
- Duration > 6 weeks
- Prior surgery

Radiographs may be useful in any of these categories.
May be sufficient for the initial evaluation: 1, 3, 9

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Story of the Lumbar Spine:1 Variations of Normal

ACR Appropriateness Criteria

Central Structural Flexible Anatomy Radiographs
 1. Labeling
 2. Body Height
 3. Alignment
 Spondylo...
 4. Disc Narrow

MR has displaced CT and myelography as the initial imaging modality of choice in complicated LBP.

- With contrast: neoplasia, infection, **post-operative** evaluation.

CT is useful in patients with surgical fusion, bone structural abnormalities, MRI contraindications.

Other modalities are used in selected patients for problem solving but not routine clinical practice.

Nonspecific lumbar disc abnormalities are common in asymptomatic patients, readily demonstrated on MR.

Don't treat the images; treat the patient.

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Story of the Lumbar Spine:1 Variations of Normal

What to Order When (WOW)

Central Structural Flexible Anatomy Radiographs
 1. Labeling
 2. Body Height
 3. Alignment
 Spondylo...
 4. Disc Narrow

- Low back pain < 6 weeks, no red flags
 - ✓ **No imaging**
 - ✓ Conservative treatment, Physical Therapy
- LBP with red flags, including > 6 weeks
 - ✓ **Get Radiographs today in clinic**
 - ✓ **Schedule MRI**
 - ✦ Without IV Contrast (if no prior lumbar surgery)
 - ✓ Consider referral to Spine/Sports Clinic

Patients with fusions throughout spine (AS, DISH) who have pain after even minor trauma MUST get spine CT urgently for non-displaced fractures!

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Story of the Lumbar Spine:1 Variations of Normal

Any Questions?

Central Structural Flexible Anatomy Radiographs
 1. Labeling
 2. Body Height
 3. Alignment
 Spondylo...
 4. Disc Narrow



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