

Evidence-Based Medicine
and the Forensic Examination
Montana State Fund 17th Annual Course
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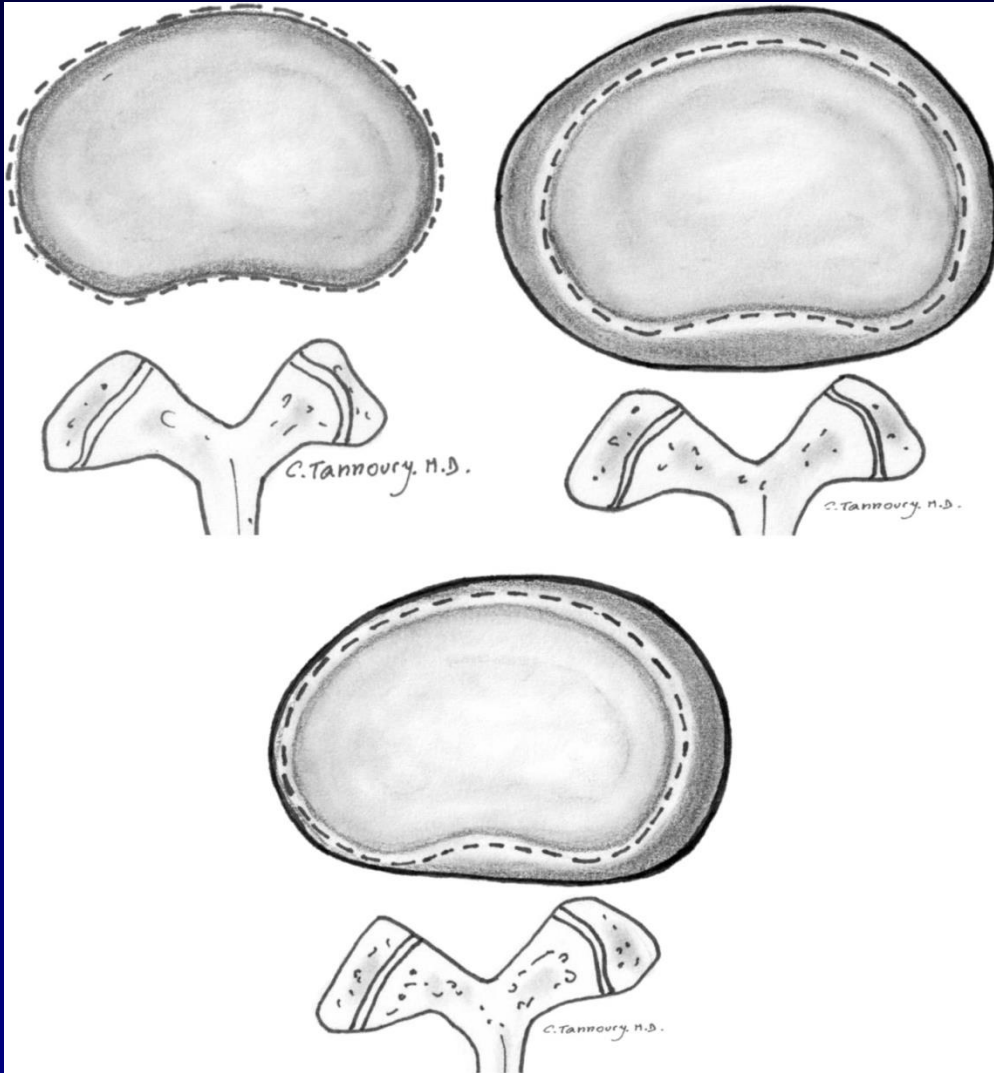
dkraemermd@gmail.com

Terminology



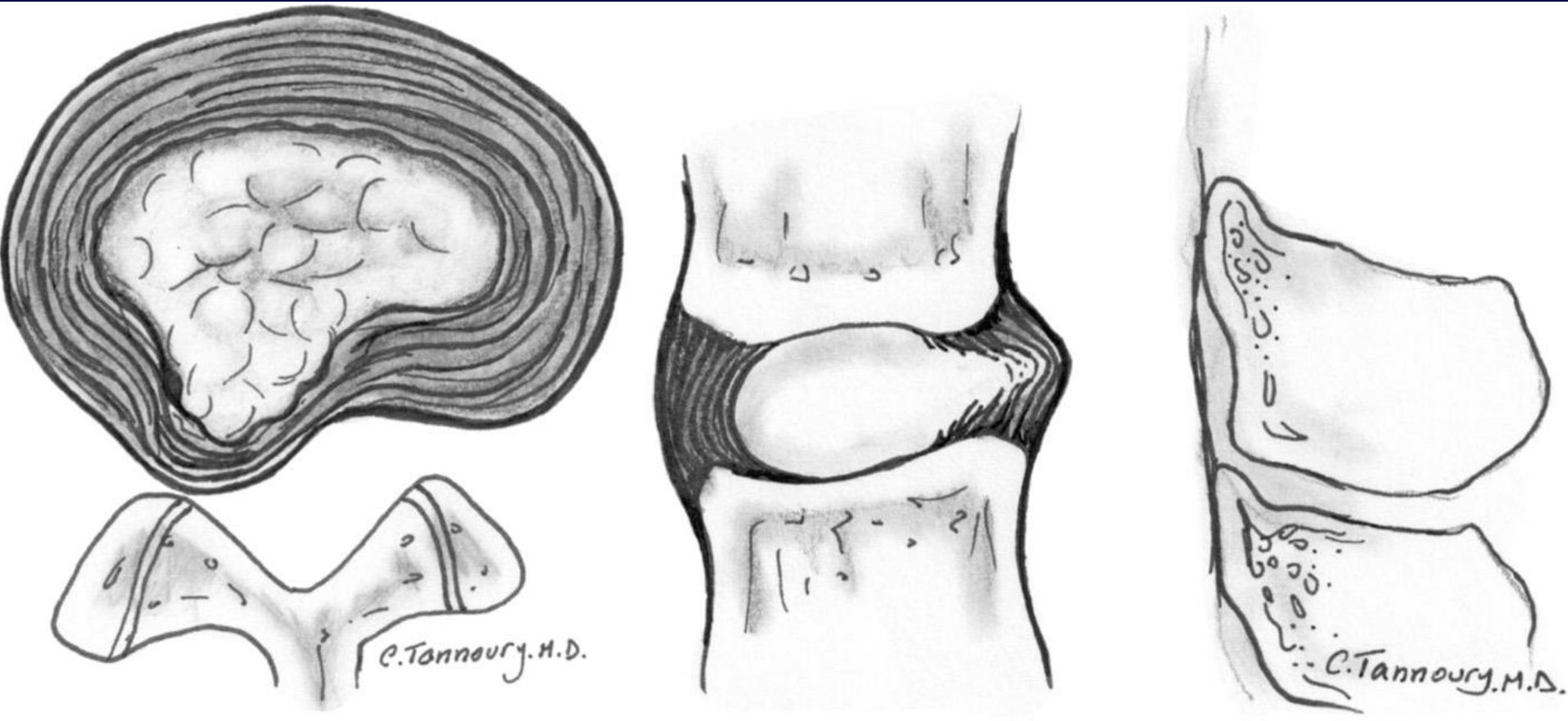
= Spondylosis

Disc bulge

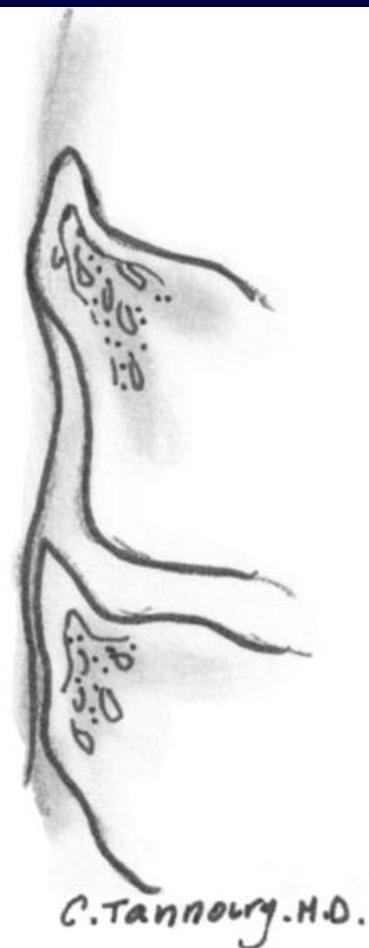
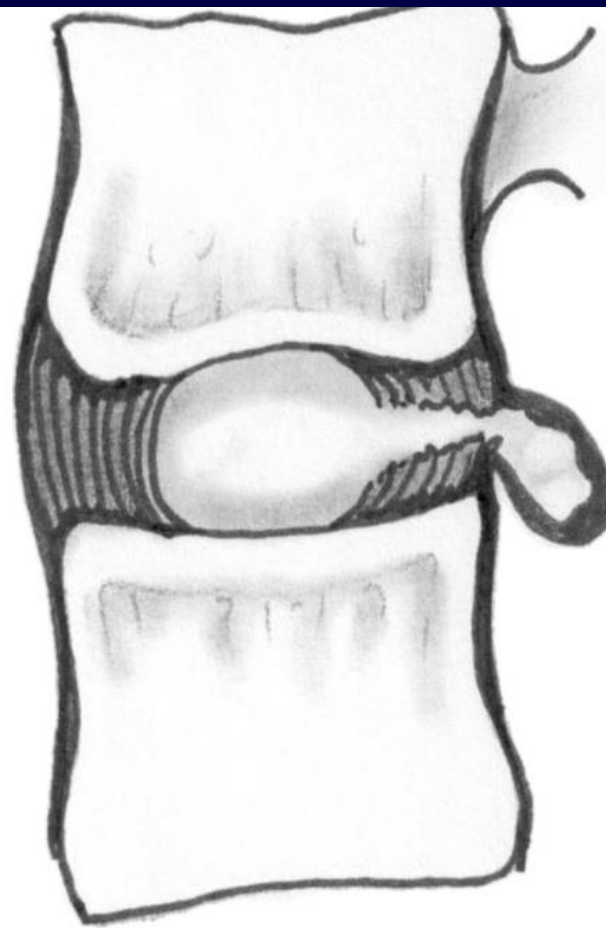
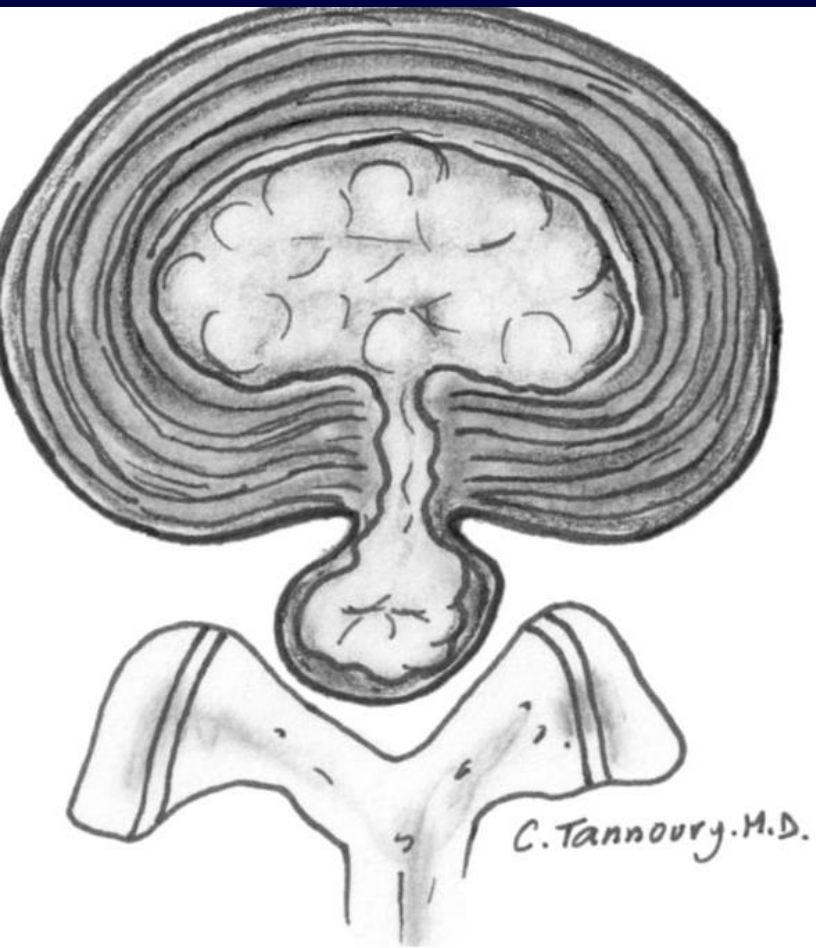


- Diffuse
- Central
- Asymmetric
- Far Lateral

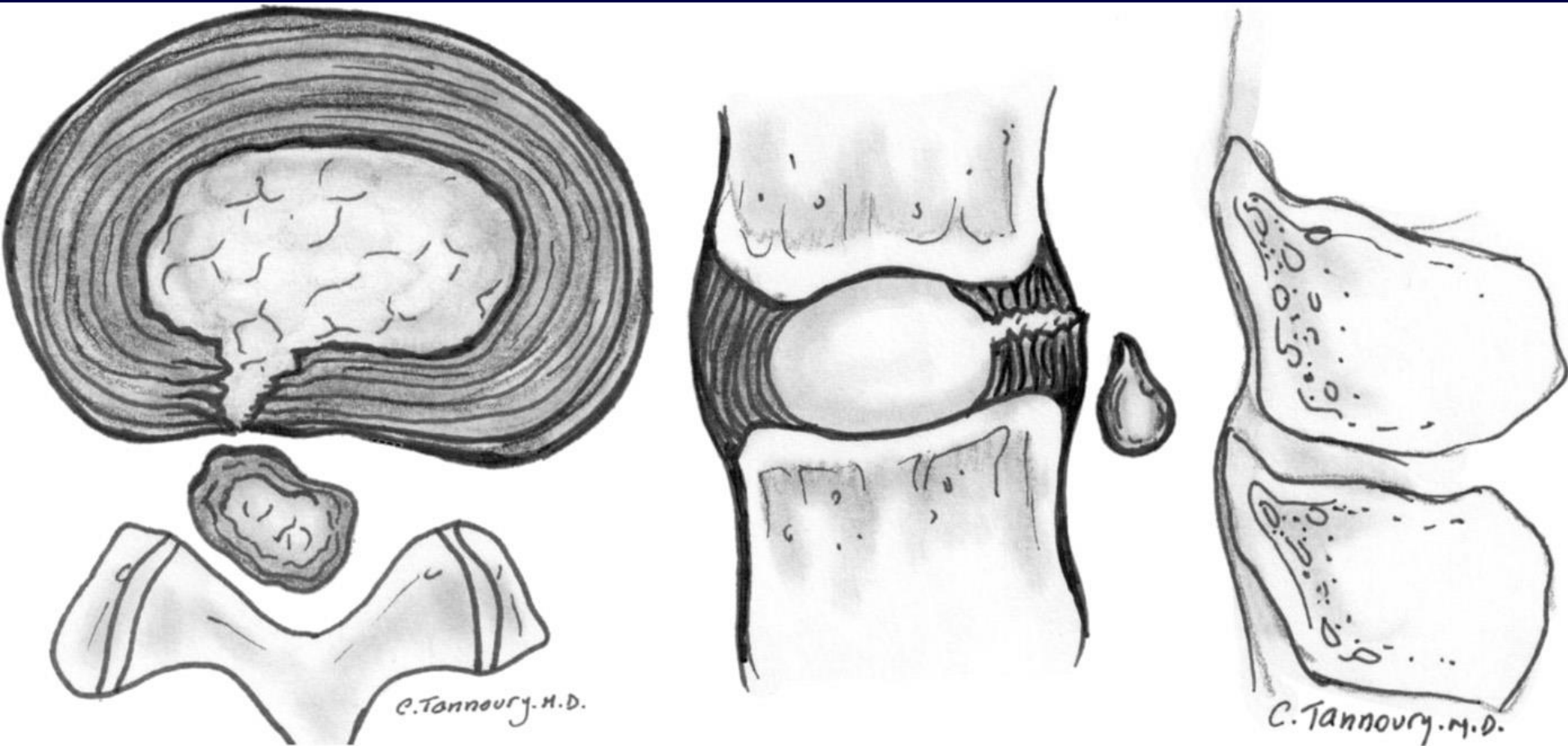
Disc Protrusion



Disc Extrusion

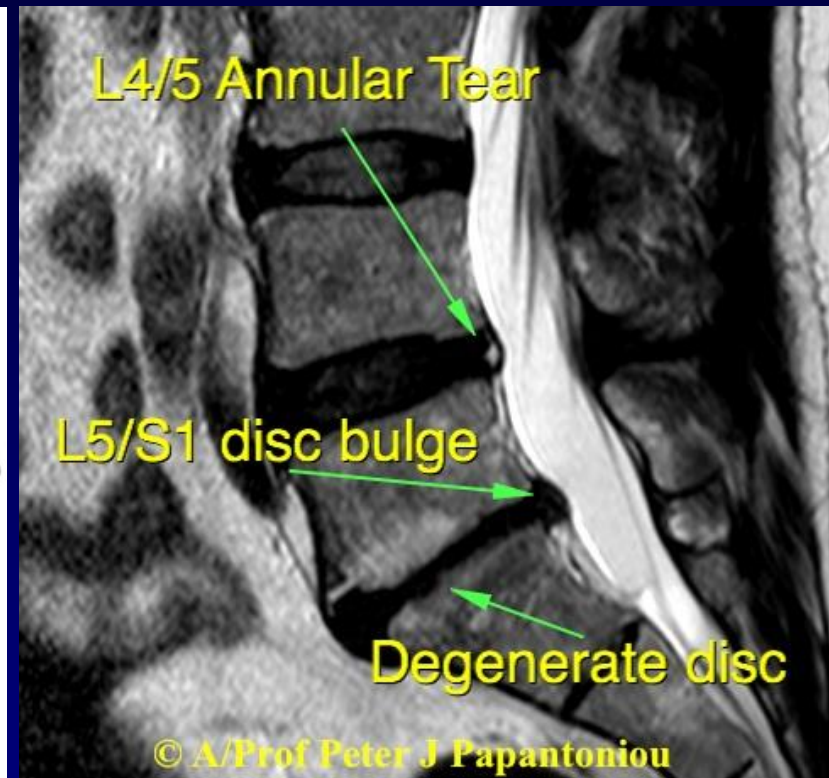
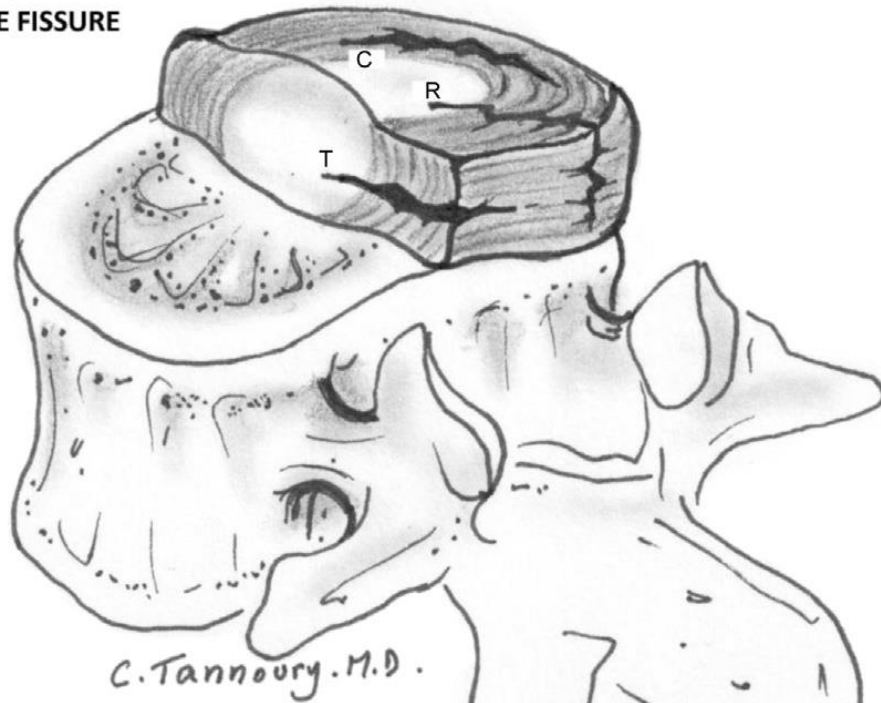


Disc Sequestration

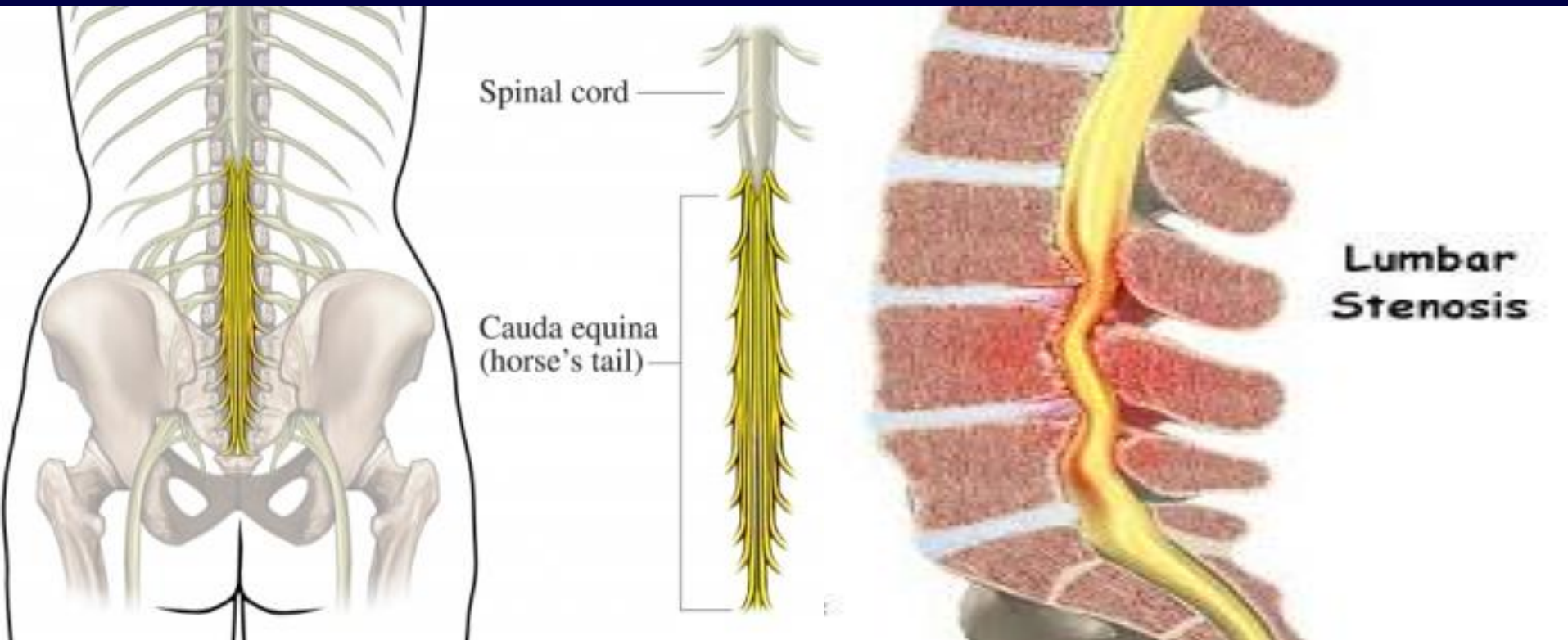


Annular Tear

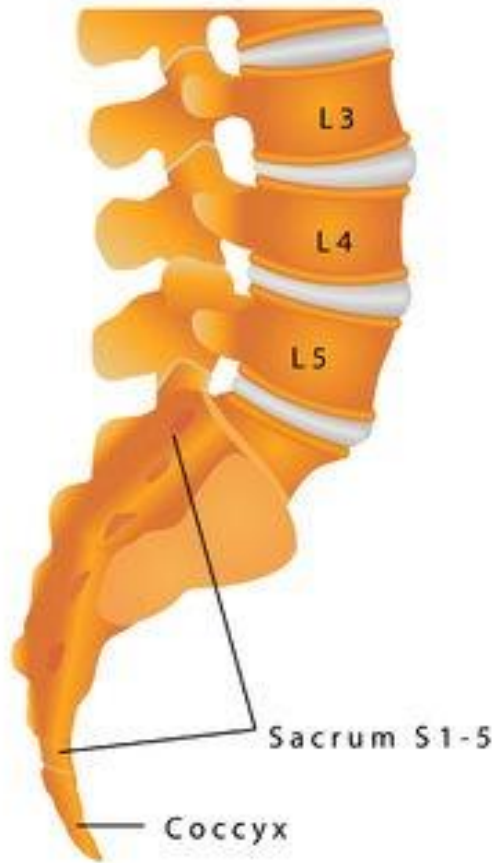
C: CONCENTRIC FISSURE
R: RADIAL FISSURE
T: TRANSVERSE FISSURE



Lumbar Stenosis



Spondylolithstesis



Pars
Interarticularis

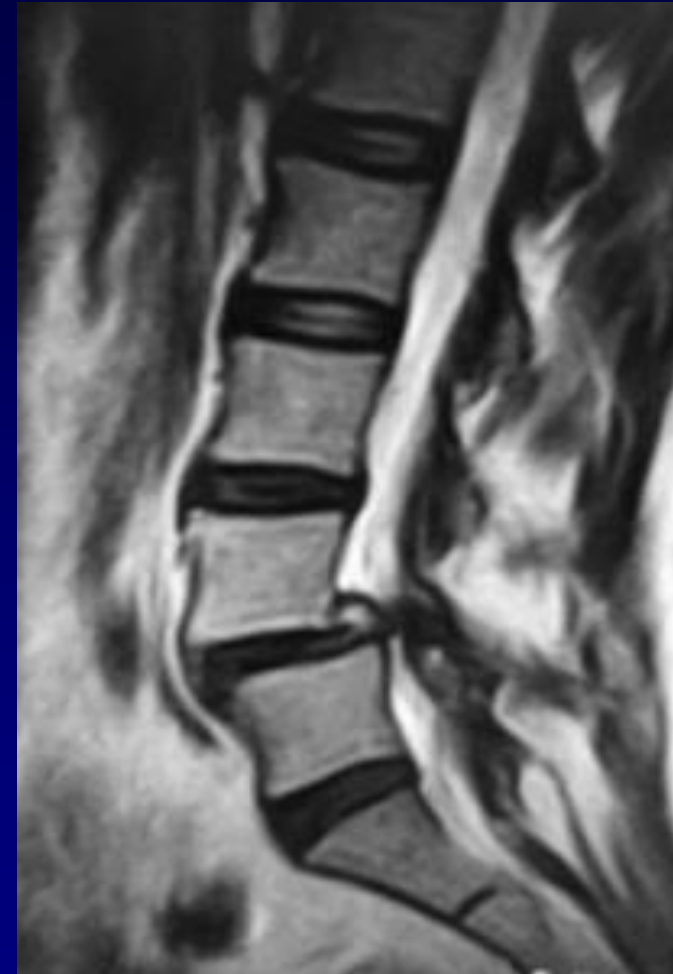


Spondylolysis

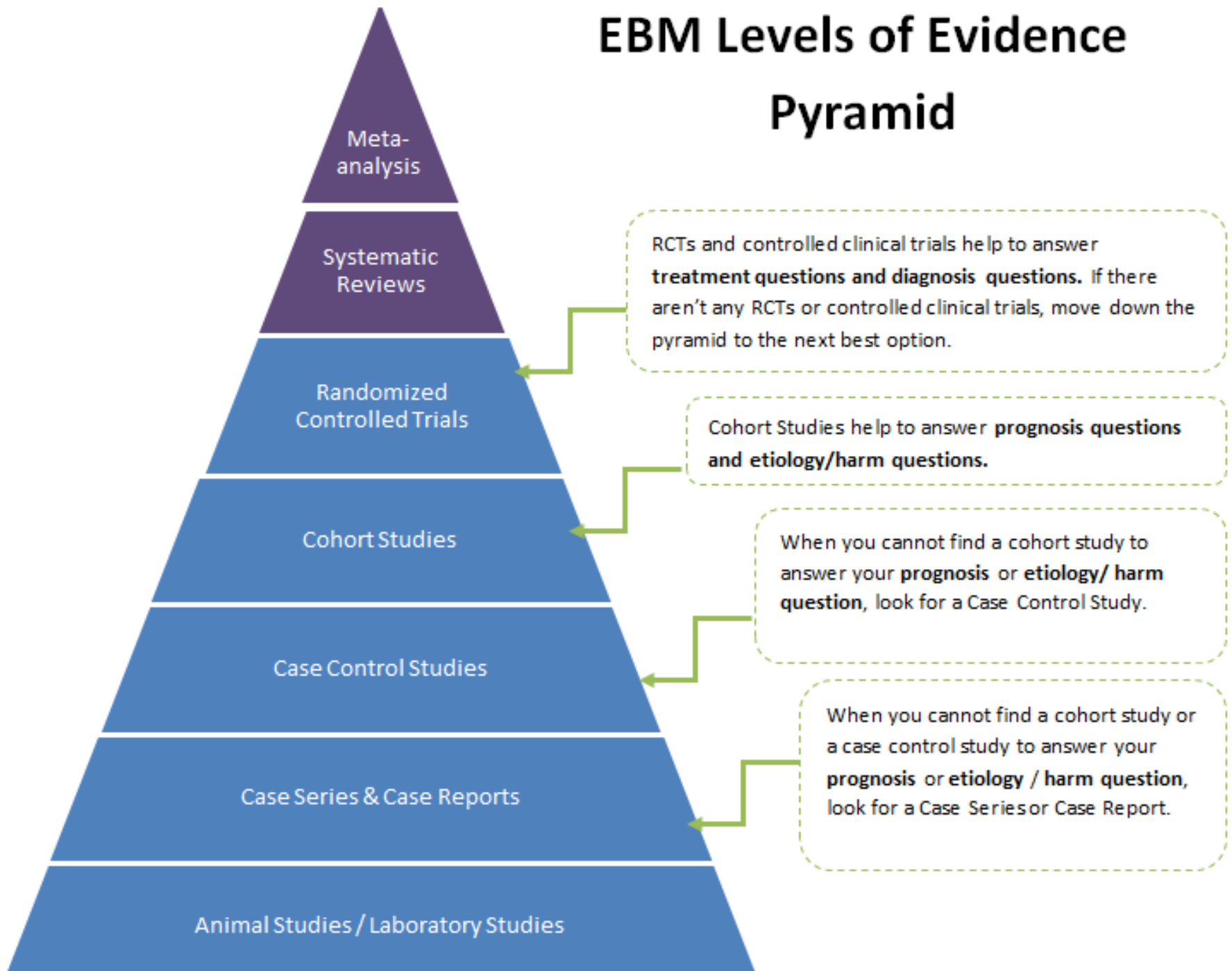


Spondylolisthesis

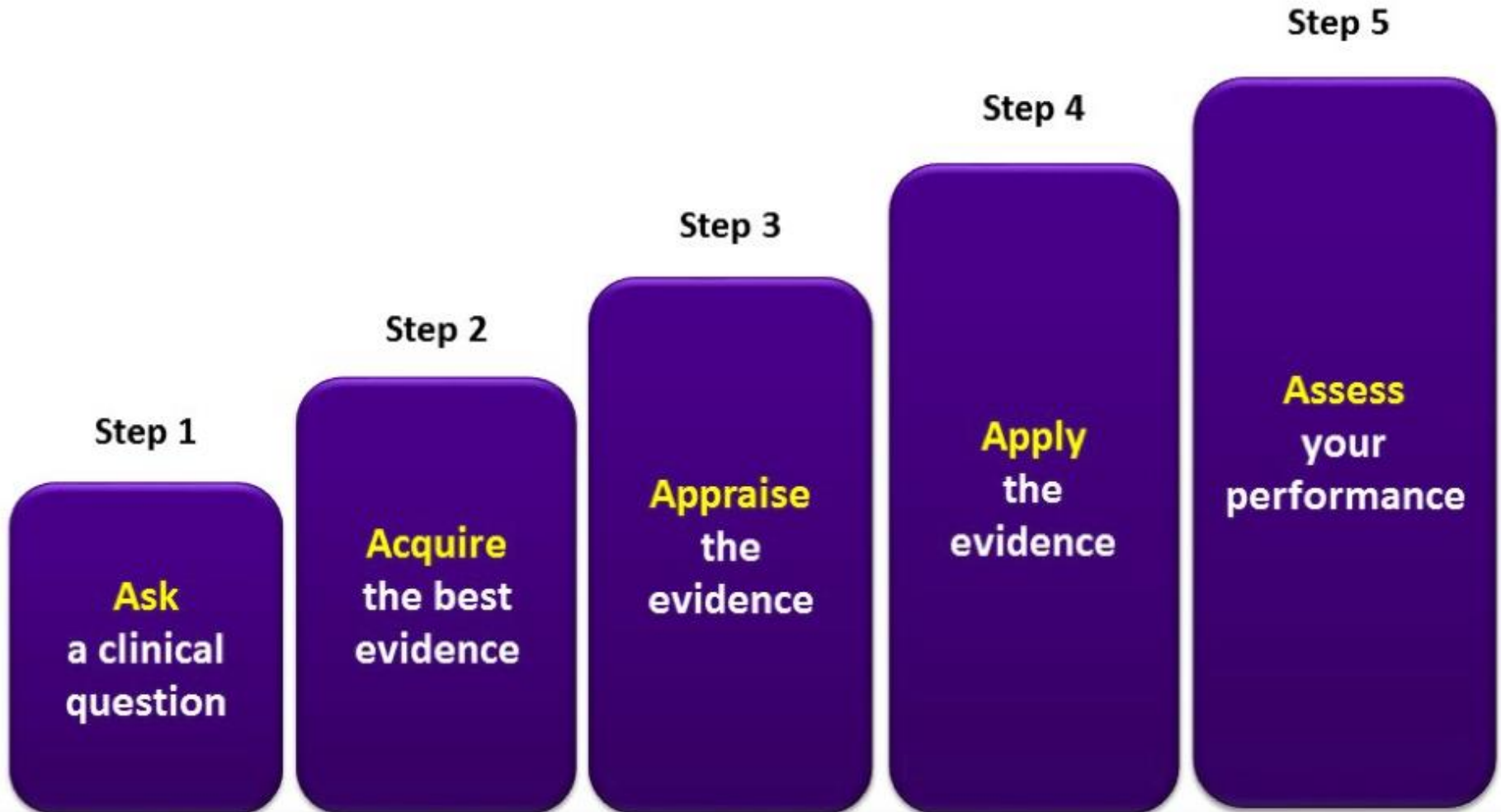
Spondylolisthesis



EBM Levels of Evidence Pyramid



The 5 Steps of Evidence-Based Medicine



Prevalence of Spondylosis by Age in asymptomatic people:

Age	Bulge	Protrusion	S-lithstesis
20	30%	29%	3%
80	84%	43%	50%

➤ Disc degeneration in 96% at age 80!

Prevalence in Asymptomatic People: Lumbar Disc Degeneration

Age	Degen	Bulge	Protrusion
20-29	37%	30%	30%
30-39	50%	40%	30%
40-49	70%	50%	35%
50-59	80%	60%	40%
> 60	90%	70%	40%

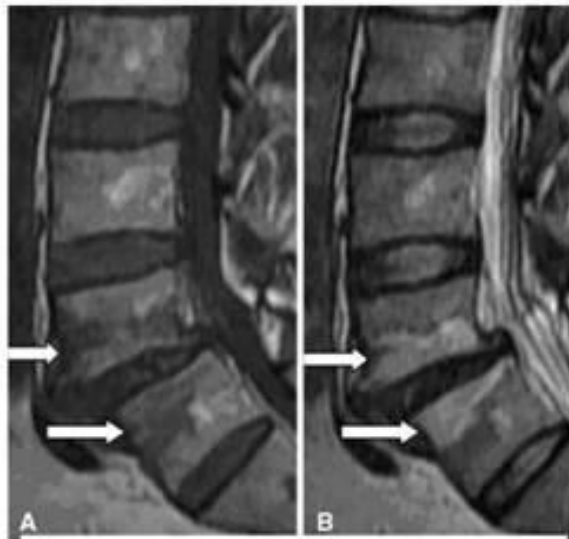
Annular Tear: 20% at age 20
30% at age 80

Prevalence in Asymptomatic People: Lumbar Disc Degeneration

Age	Degen	Bulge	Protrusion	Ann Tear
20-29	37%	30%	30%	
30-39	50%	40%	30%	20%
40-49	70%	50%	35%	
50-59	80%	60%	40%	
> 60	90%	70%	40%	30%

“So, Dr. Kraemer, you’re telling me that my 25yo...”
???Are there different disease processes???

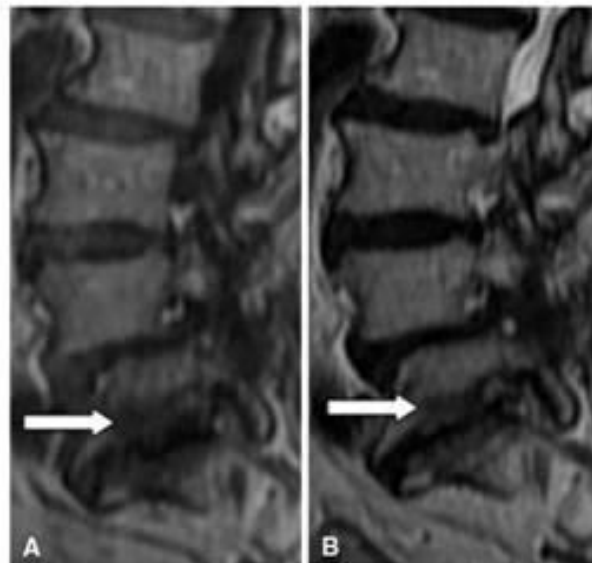
Modic Changes



MC type I (arrows): hypointense on T1WI (A) and hyperintense on T2WI (B)

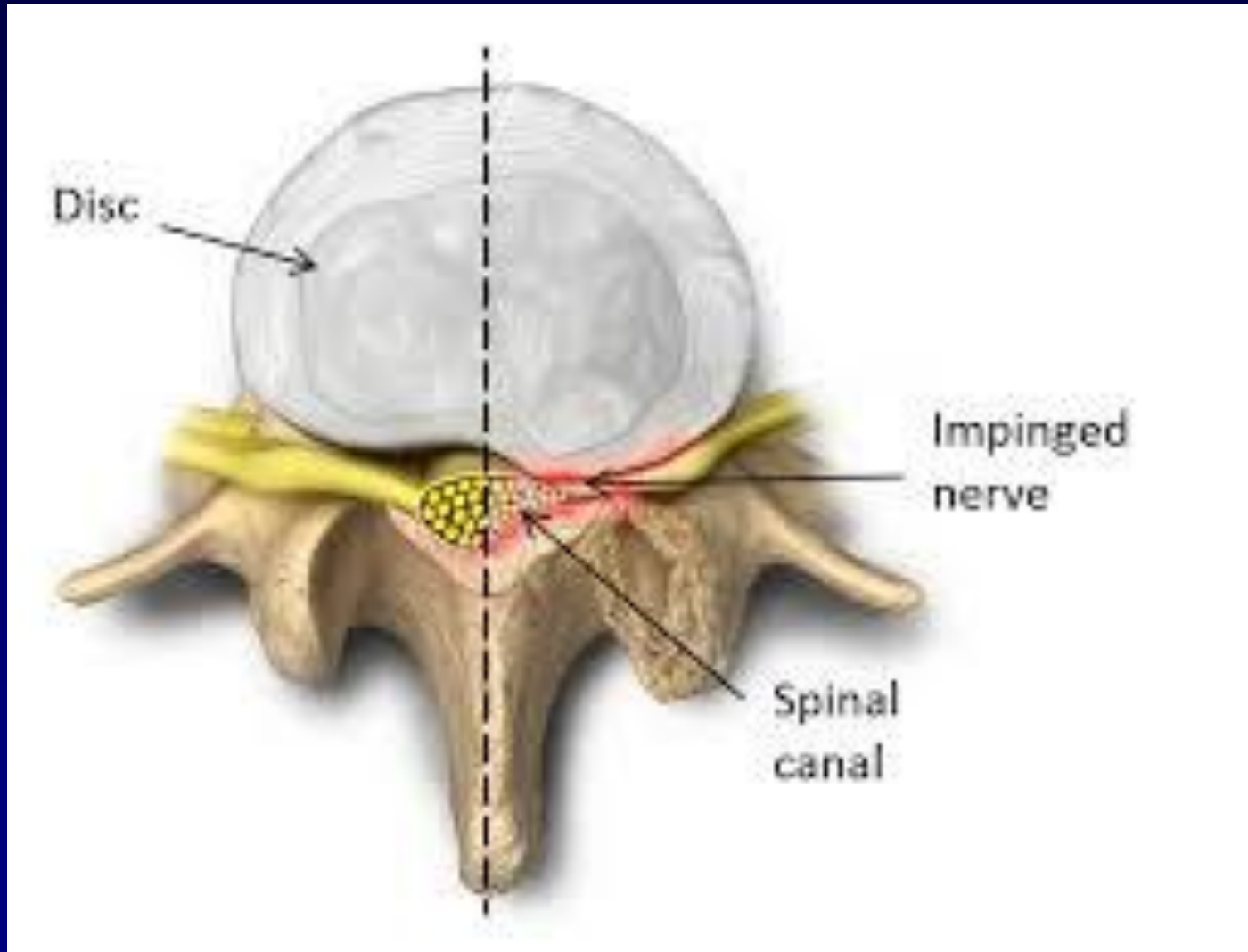


MC type II (arrows): hyperintense on T1WI (A) and isointense or hyperintense on T2WI (B)



MC type III (arrows): hypointense on T1WI (A) and hypointense on T2WI (B)

Spondylosis is degenerative!



Disc Degeneration \neq Back Pain!

Age	Disc Bulge	Disc Protrusion
40-49	50%	35%

Degeneration increases with Age,
>>> Back Pain!

People who exercise have LESS back pain:

Disc Herniation \neq Sciatica!

1 year study:

Early Surgery vs Prolonged Medical Therapy

At 1 Year:

84% favorable outcome (all patients)

Disc Herniation: 85% with Favorable Outcome

No Disc Herniation: 83% with Favorable Outcome

Same for Disc Herniation with Nerve Root Compression

Same for Post-op with or without Enhancement on Nerve

el Barzouhi, NEJM, 2013

Twin Studies



Twin Spine Study

Monozygotic Twins:

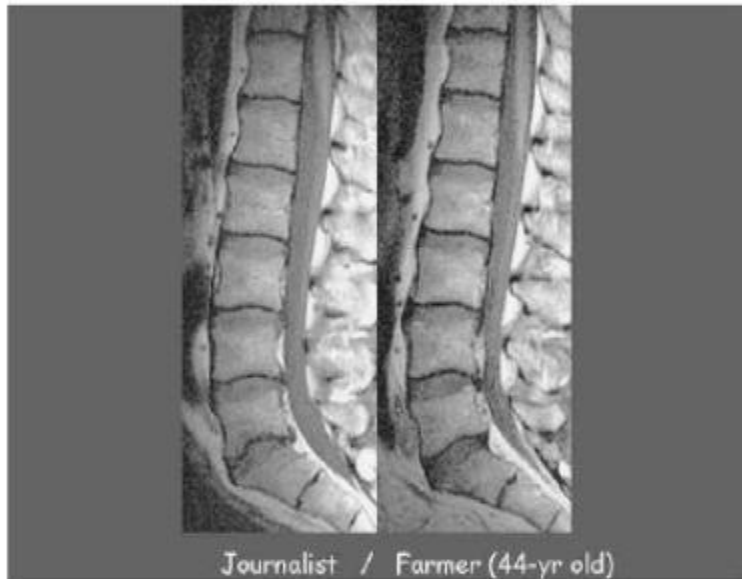
Journalist/farmer or Programmer/plumber

MRIs looked remarkably similar!!!

- | | |
|--------------------------|----------------|
| •Genetics: | Strong |
| •Work Load: | No association |
| •Leisure activities: | No association |
| •Driving/Body Vibration: | No association |
| •Smoking: | + Small |

Battié, et al, Spine 2010

Esempi di gemelli con presenza/assenza di esposizione a MMC



Twin Spine Study:
Monozygotic Twins with different occupations:
Degeneration is Genetic!

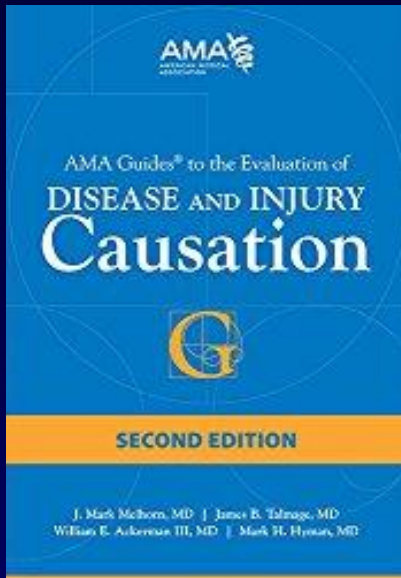
Minor Trauma

5 year study of 200 people with Neck Pain:

- 16 episodes of Major Trauma:
- 170/200 had 652 episodes of Minor Trauma:
Falls, Lifting, MVA, Sports Injuries
- **1/200 Disc Herniation: NOT assoc. with trauma!**

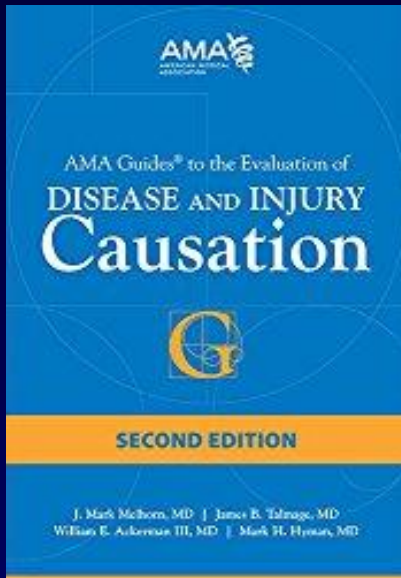
93% predictive ability for Disabling Low Back Pain :

- abnormal baseline psych profile or
- previous disputed compensation claim
- **NOT** improved by adding falls, lifting or MVA



What does the Science Say? Low Back Pain (LBP):

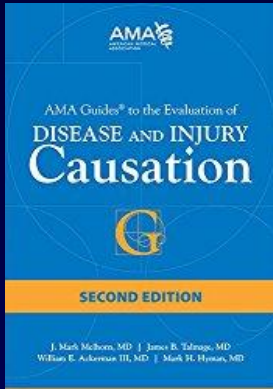
- Insufficient Evidence for **Heavy Work**
- Insufficient Evidence for **Awkward Positions**
- Insufficient Evidence for **Flexion (Bending)**
- Insufficient Evidence for **Twisting**



What does the Science Say?

Low Back Pain (LBP):

- Strong Evidence: **Sitting** is **NOT** associated LBP
- Strong Evidence that **Standing/Walking** <2 hrs/day is **NOT** associated with LBP.
- Insufficient Evidence for Standing/Walking >2h/d



What does the Science Say?

Low Back Pain (LBP):

- Strong Evidence that **Previous LBP** is a risk factor for future LBP
- Strong Evidence that **AGE** is **NOT** a factor in LBP.
- Insufficient Evidence for Smoking in LBP
- Insufficient Evidence for Obesity in LBP
- Strong Evidence that Exercise and Leisure Activities are **NOT** associated with LBP

Summary of EBM:

(Battié, Carragee, Jarvik, et al)

For the LUMBAR SPINE:

- Degenerative Changes are Common.
- Degenerative Changes = age and genetics.
- Degenerative Changes do NOT imply symptoms.
- Minor Trauma rarely causes structural changes.
- Disability is predicted by psychological status, smoking, and compensation issues.

EBM in Cervical Disease:

Can we extrapolate the Lumbar Spine literature to the Cervical Spine?

And what are the limitations of doing so?

Cervical Spondylosis; Pathology



Age Related Degeneration and Dehydration of intervertebral Disks

Decreased cartilage between adjacent vertebral bodies

Developmental laxity in the spinal supportive ligaments

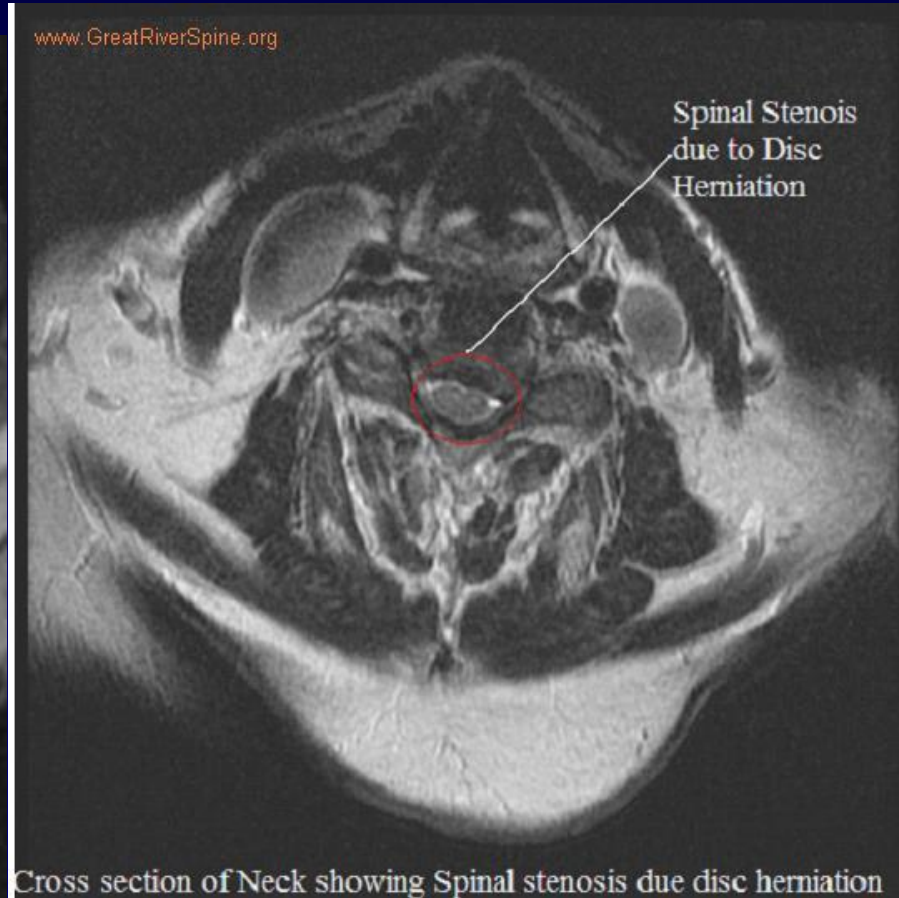
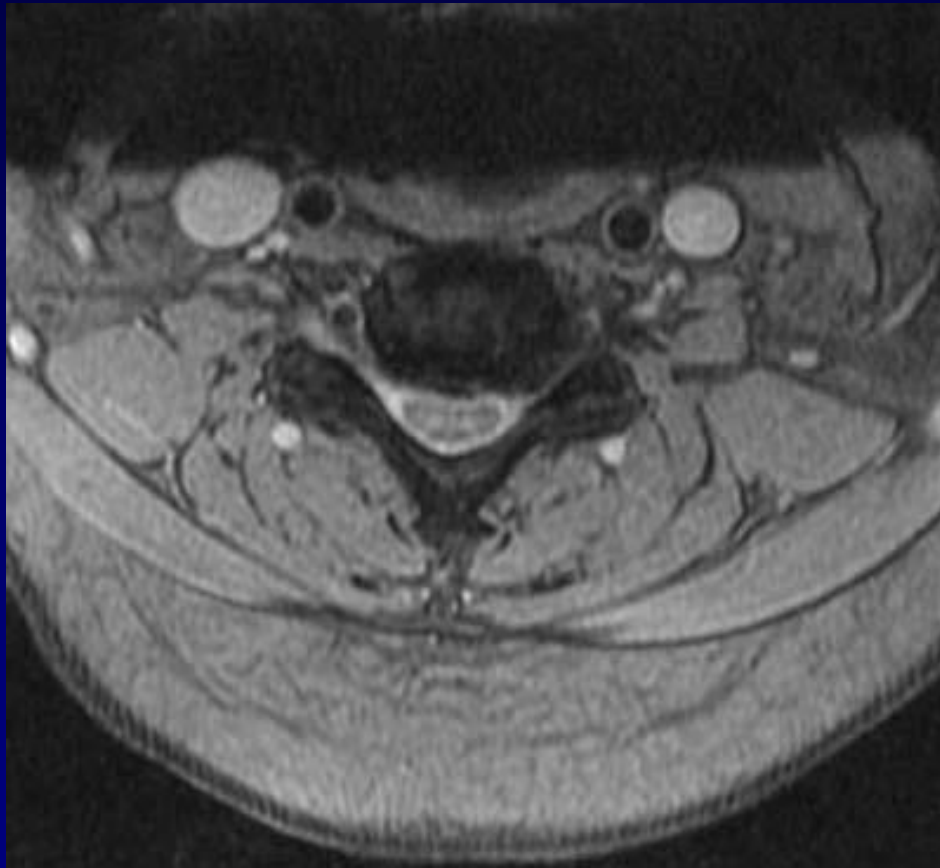
Hyper-mobility of spinal segment

Bone-on bone apposition propagates bone spur formation which narrow the cervical spinal canal and may compress the cervical nerve roots and spinal cord

Cervical Stenosis



Cervical Stenosis



Cross section of Neck showing Spinal stenosis due disc herniation

Prevalence in Asymptomatic People: Cervical Disc Degeneration

Age	Disc Bulge	Disc Protrusion
20-29	15%	10%
30-39	20%	15%
40-49	40%	20%
50-59	65%	25%
➤ 60	85%	30%

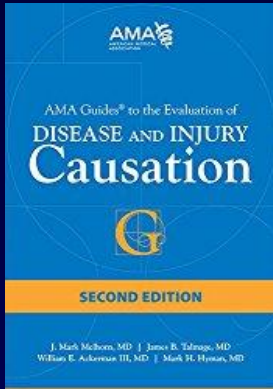
7% with spinal cord compression on MRI

Tandem Changes in the Lumbar and Cervical Spine

	Lumbar spine	Cervical spine	Tandem positive findings ^a
Decrease in signal intensity	70 (74.5 %)	76 (80.9 %)	61 (64.9 %)
Posterior disc protrusion	74 (78.7)	72 (76.6)	62 (66.0)
Anterior compression of dura	77 (81.9)	76 (80.9)	64 (68.1)
Disc space narrowing	20 (21.3)	32 (34.0)	10 (10.6)
Spinal canal stenosis	12 (12.8)	13 (13.8)	4 (4.3)
Any one of the five findings	79 (84.0)	85 (90.4)	74 (78.7)



Matsumoto, 2012

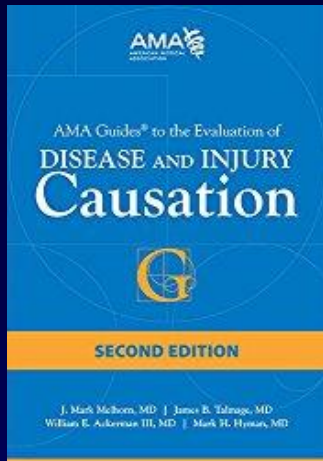


What does the Science Say?

Neck Pain

Insufficient Evidence for

- Heavy Work
- Neck Posture
- Prolonged Work in a sedentary position
- Repetitive and Precision Work



What does the Science Say?

Neck Pain

+ Evidence:

- AGE
- Female Gender
- Previous history of Neck/shoulder pain

Note: Past records are **REALLY** helpful!

Whiplash-Associated Disability (WAD)

- Only 50% symptom free at 1 year.
- Age: Younger ages have increased pain
- Worse pain at onset affects duration of symptoms
- + Neurologic findings at onset affects duration
- Frequent, early health care usage predicts poorer outcome.

Psychological Findings: Worse outcomes with:

- Post-injury psychological distress
- Passive coping style

Whiplash-Associated Disability (WAD)

No evidence

- Severity of crash affects rate of WAD
- Preexisting degenerative changes affect rate.
- Awareness of impending crash and neck position affect rate.

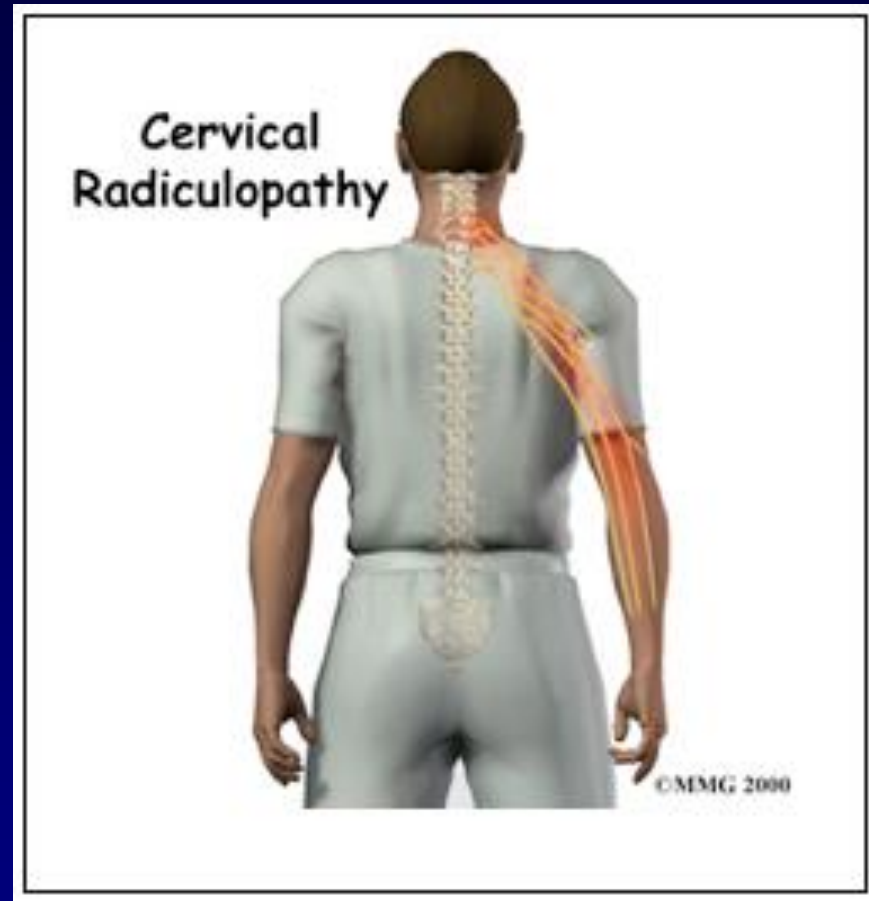
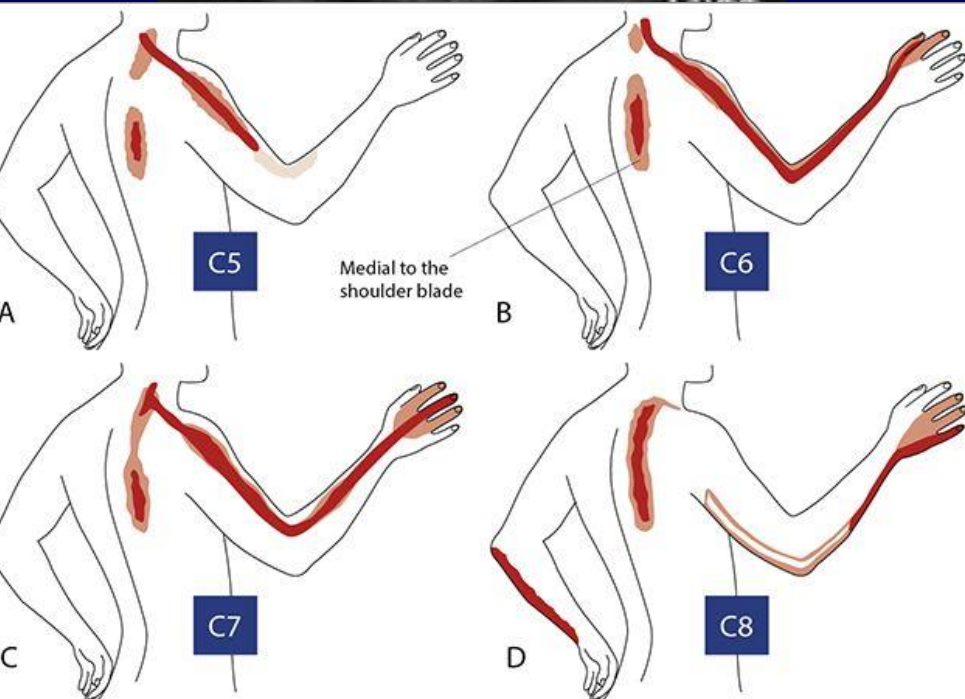
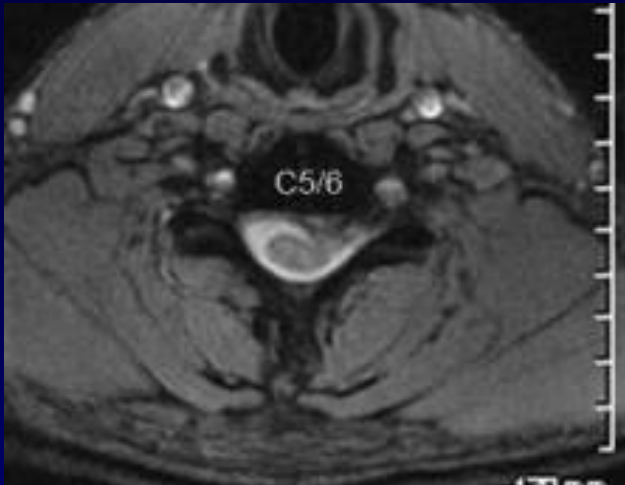
Fewer claims are made when pain/suffering compensation is eliminated.

Evidence Based Medicine:

**Objective Findings
and the**

Neurologic Examination:

Cervical Radiculopathy



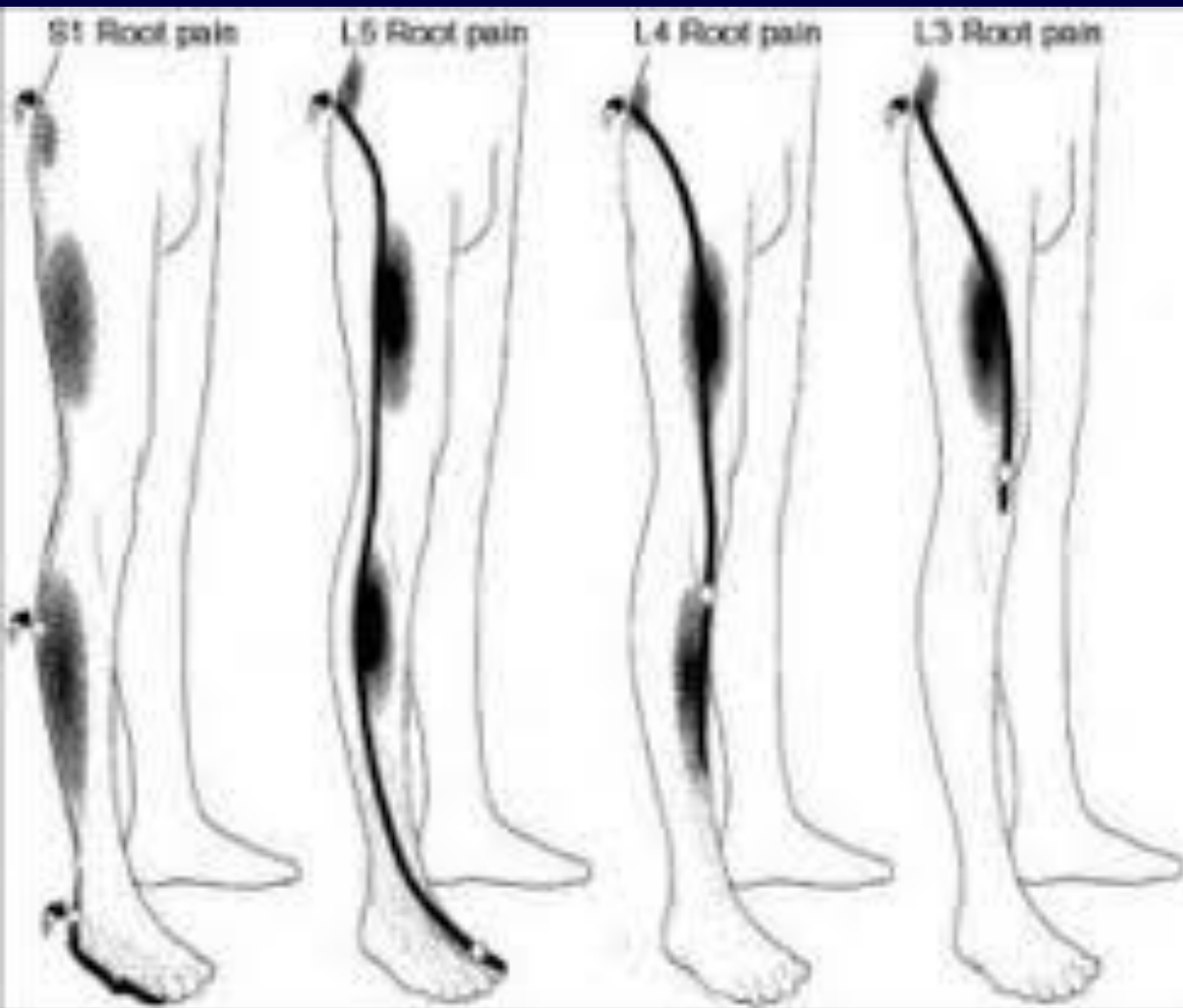
Cervical Myelopathy



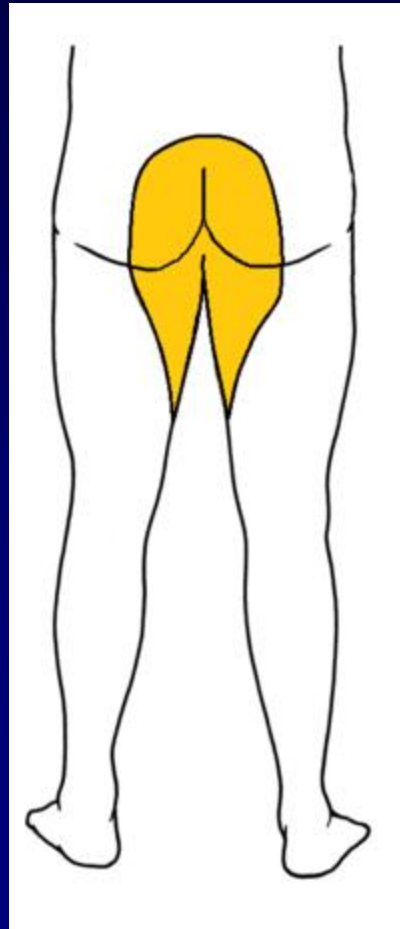
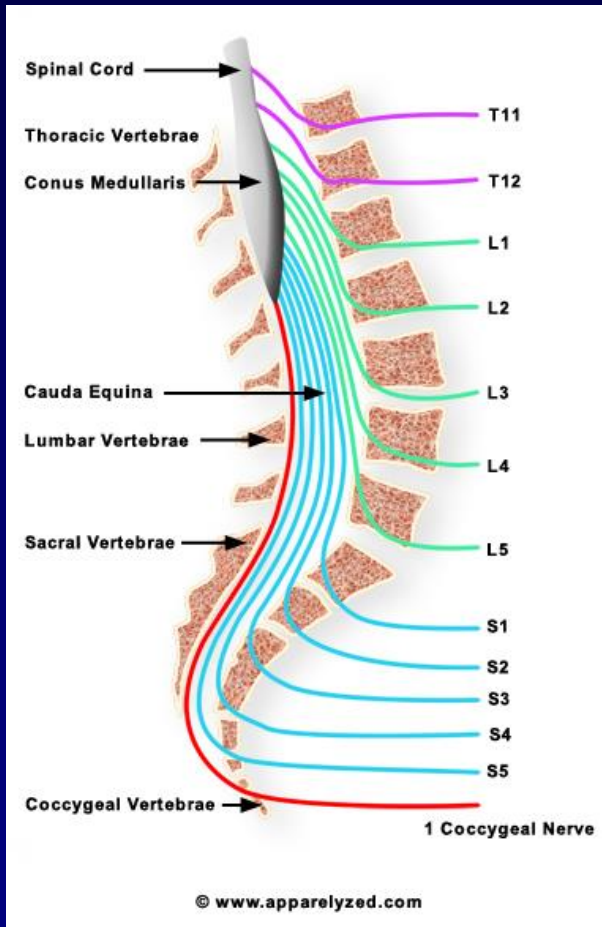
Symptoms



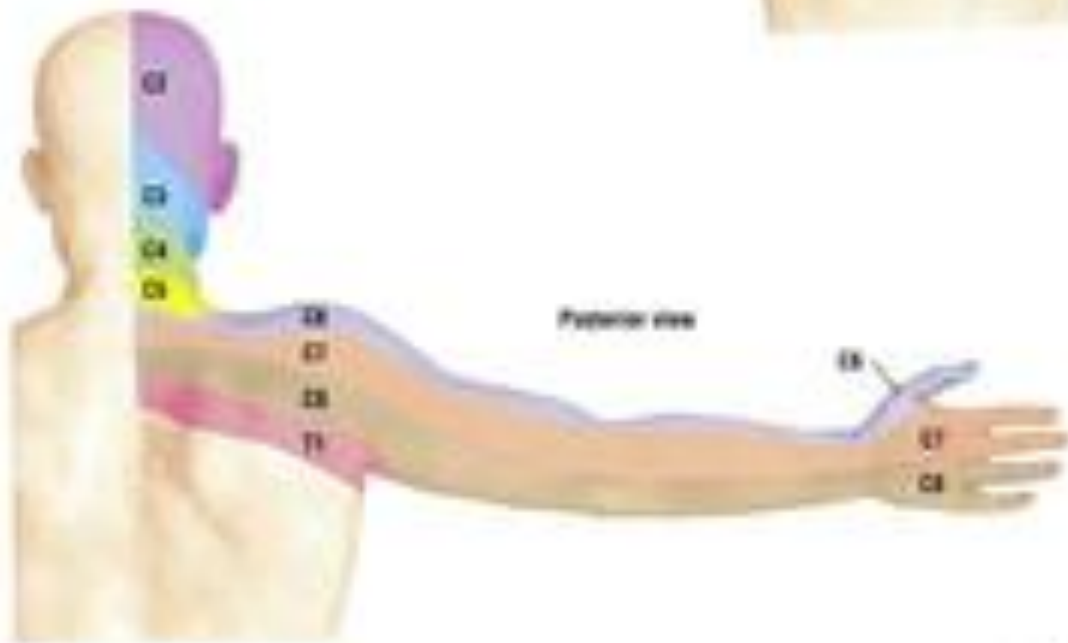
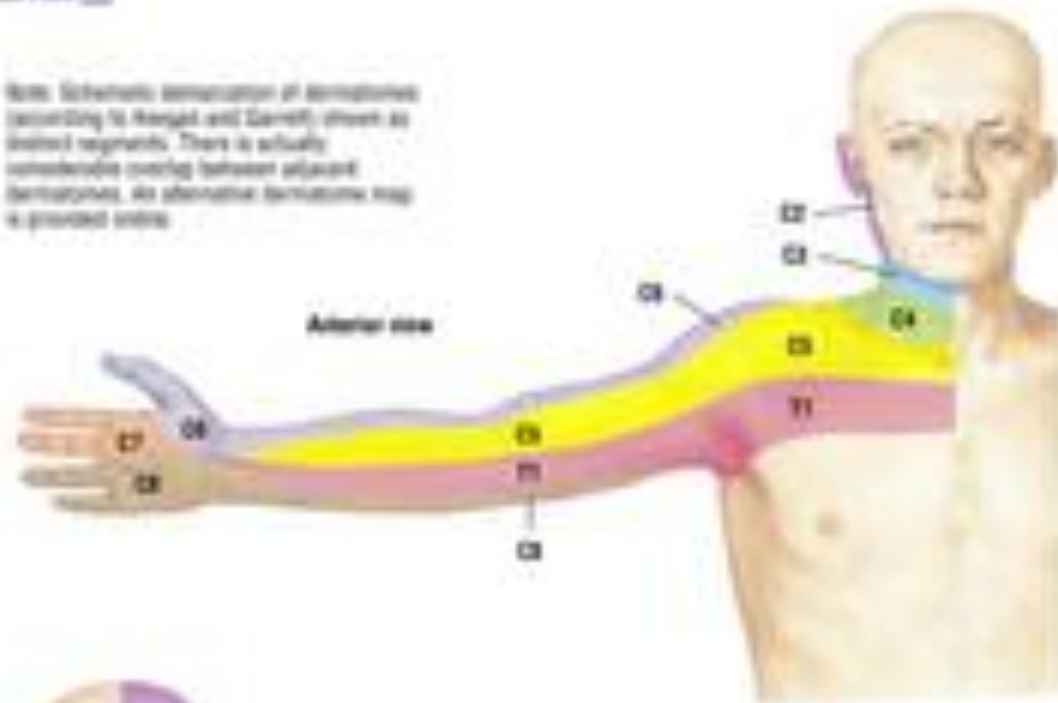
Lumbar radiculopathy



Cauda Equina Syndrome

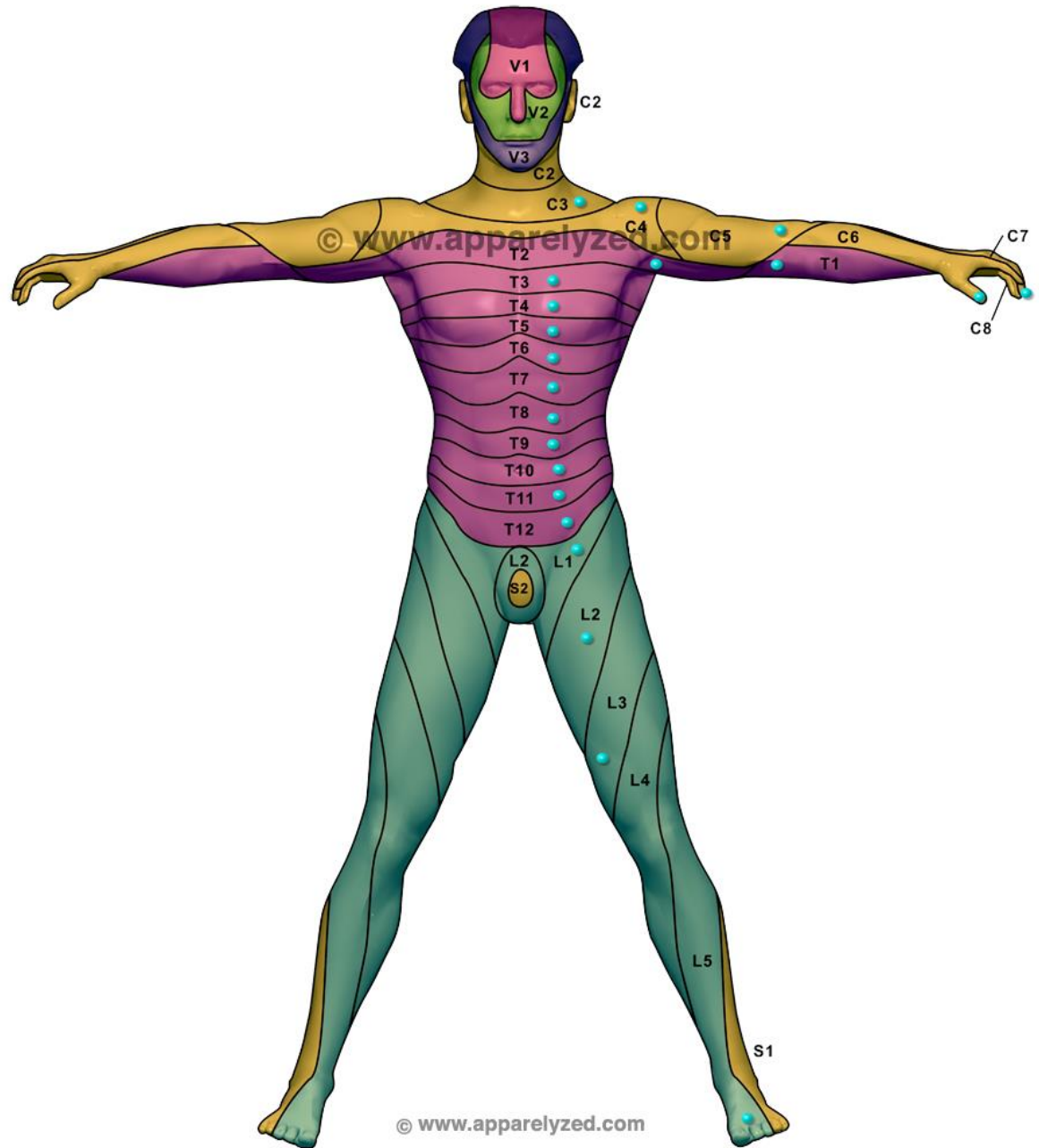


Note: Schematic representation of dermatomes according to Keegan and Garrett shown as limited segments. There is actually considerable overlap between adjacent dermatomes, an alternative dermatome map is provided below.

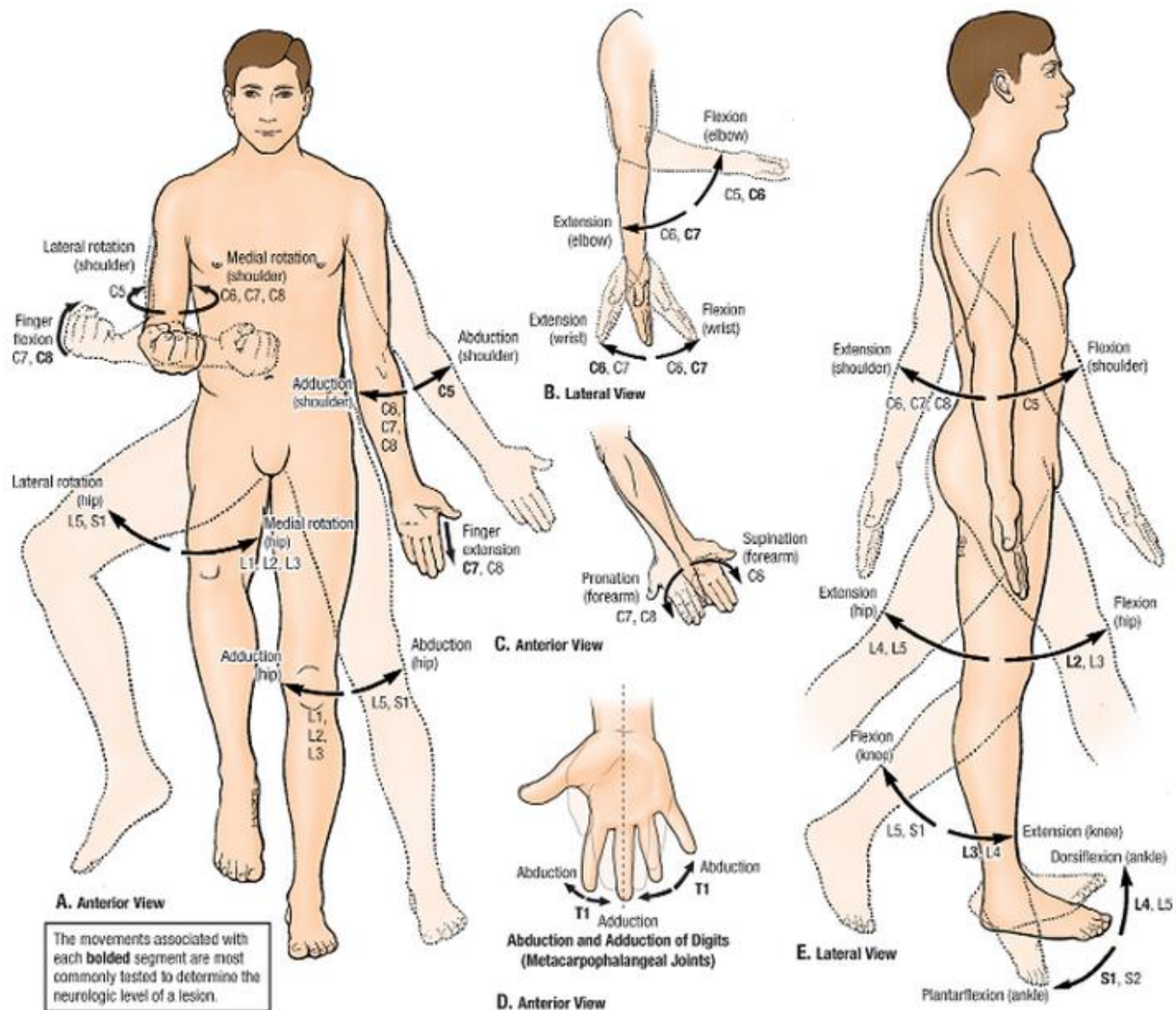


DERMATOMES

DERMATOMES



Myotomes



Motor strength

Grade 5	Normal power
Grade 4	Active movement against gravity with resistance
Grade 3	Active movement against gravity without resistance
Grade 2	Active movement with gravity eliminated
Grade 1	Only a trace or flicker of movement
Grade 0	No movement



Non-physiologic findings:

Motor Strength:

- Give-way weakness
- Ratcheting
- Cog-wheeling (not Parkinson's)

Sensory:

- Non-dermatomal (entire extremity)
- Invalid two-point discrimination
- Midline split
- Entire hand

Waddell's signs

Simulation

- Axial Loading

- Rotation

Distraction:

- Straight Leg Raising

Regional:

- Weakness

- Sensory

Overreaction:

- verbalization, facial expression, muscle tension and tremor, or collapsing

Waddell's

- Study done on White Males:
- Significance requires judgement:
- Easy to place too much significance on findings:
- Is only one part of the Exam:
- Need to combine with objective medical findings.

Report reads:

- “Axial loading, shoulder loading, en-bloc rotation and light touch are (descriptor/positive/negative)”
- “Straight leg test with distraction is tolerated to __ degrees”
- “There is tenderness to deep palpation (multiple, described)”
- Or a description of exaggerated reaction, “grimace, sighs, nonphysiologic tremor, leg collapse with little weakness”...

Montana State Guidelines

Includes Definitions

Chronic Pain Guidelines:

Pain Behaviors: “Non-verbal communications

- grimacing, groaning,
- limping, using visible pain relieving or support devices
- requisition of pain medications,

Outward manifestations of pain,
and through which a person may communicate
that pain is being experienced”

Thin Skull Rule-WA state



The “thin-skull” rule:

Provides that a wrongdoer must take his victim as he finds him.

The aggressor is responsible for **all** of the consequences that ensue.

Lighting Up- WA

Previous condition:

latent, quiescent, Asymptomatic

AND

Non-disabling

Entire impairment is attributed to the injury,
none to the pre-existing condition.

Lighting Up - WA

Preexisting condition is **NOT Lit-up IF:**

The condition was symptomatic before injury

Or

Condition was a naturally progressing condition that would have progressed to symptoms without the injury.

Lighting Up (WA)

Zavala v Twin City Foods: 2015

Knee injury vs. pre-existing arthritis:

The Court relied on:

expert witness medical testimony
to establish that the pre-existing
condition was **probably symptomatic**,
over worker's testimony that the
condition was asymptomatic.

Prevention of Low Back Pain

Effective

- Exercise Interventions

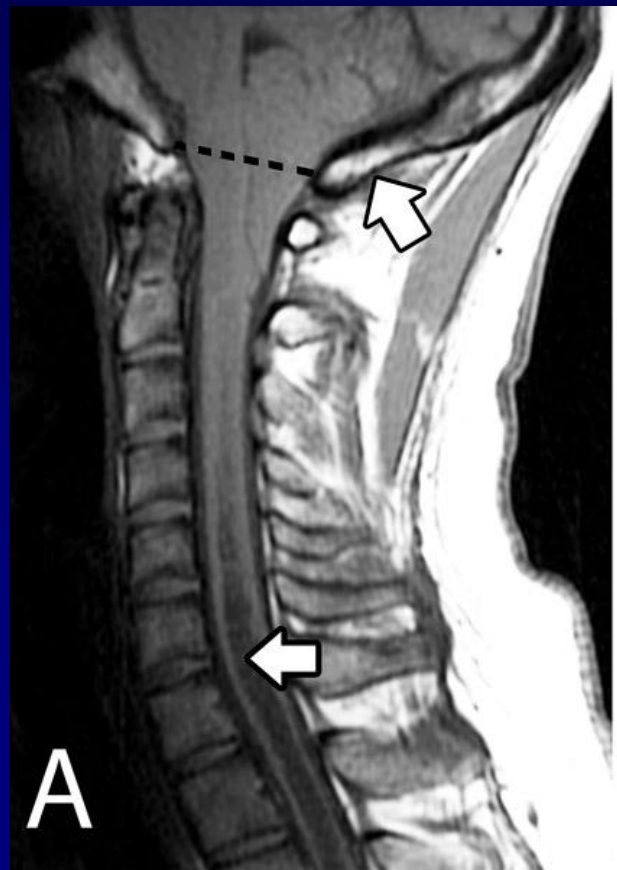
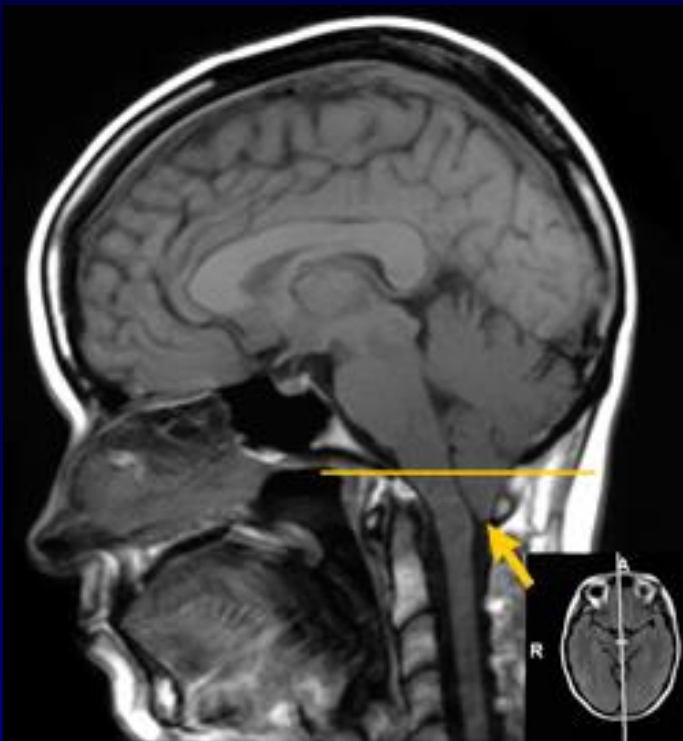
Ineffective:

- Stress management
- Shoe inserts
- Back supports
- Ergonomic/back education
- Reduced lifting programs.

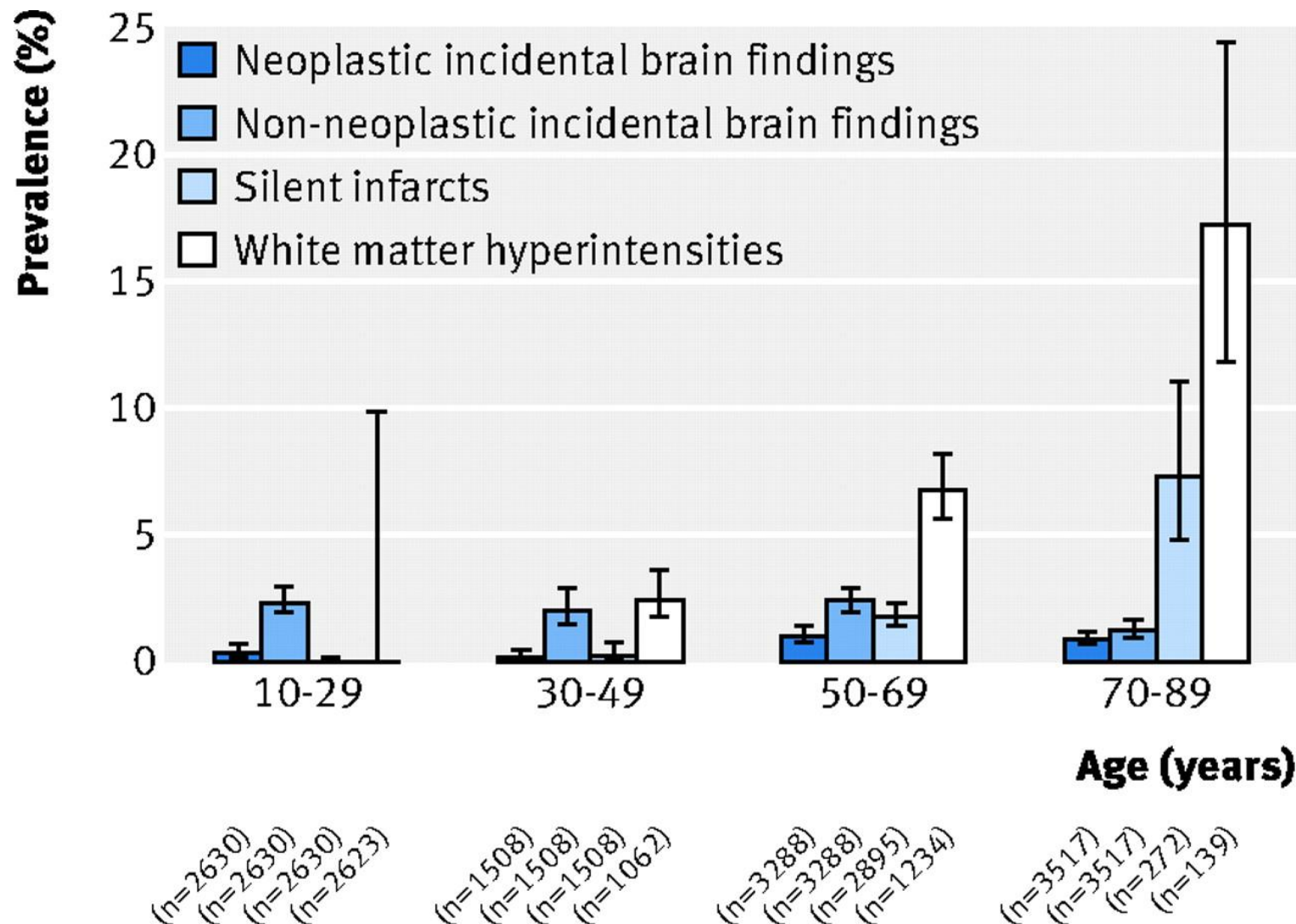
Now: What am I learning?

- 50% of fusions begin with a “strain”.
- Escalating Disability Claims
- Can IME’s be Advocates for the Claimant?
- What are Best Practices for Examiners?
- What is Cost Effective?
- Specific Challenging syndromes

Chiari I and minor trauma



Incidental Findings on Brain MRI: Prevalence with 95% confidence intervals. Overall Incidence 2.7% (1/37) --- Chiari I (1/400)



Zoe Morris et al. BMJ 2009;339:bmj.b3016

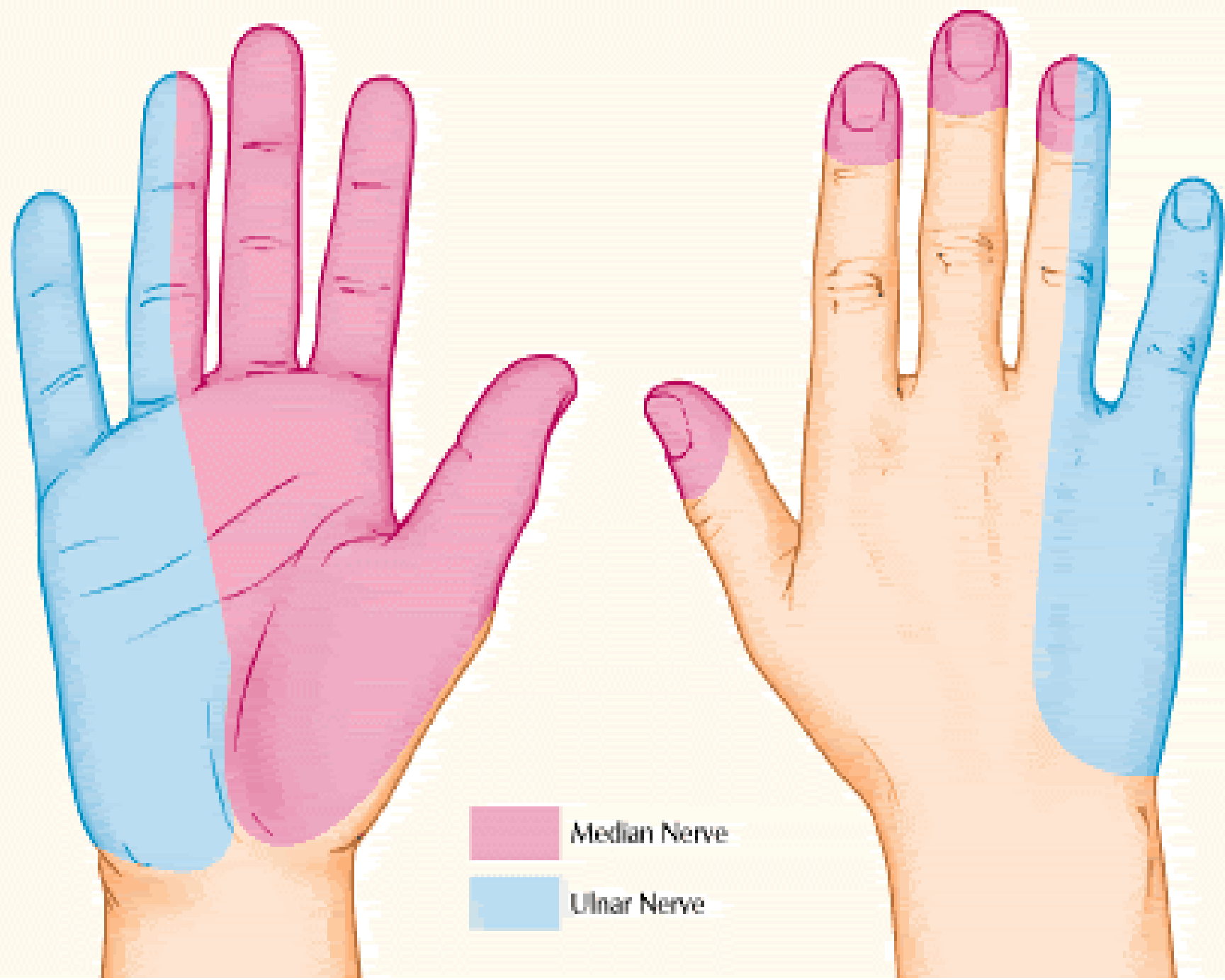


Symptomatic Chiari I after minor Trauma:

3/85 patients met criteria of:

- Initially Asymptomatic with no Neuro deficit.
- Symptoms of Concussion or Whiplash present immediately after the trauma.
- New Chiari-like symptoms in < 6 months.
- No other explanation.
- Surgery indicated with improvement or stabilized symptoms after surgery.

MJ Wan, Neurosurgery



Physical Findings of CTS



- Phalen test

- ◆ Wrists maximally flexed, may produce symptoms within 60 seconds

- Tourniquet test

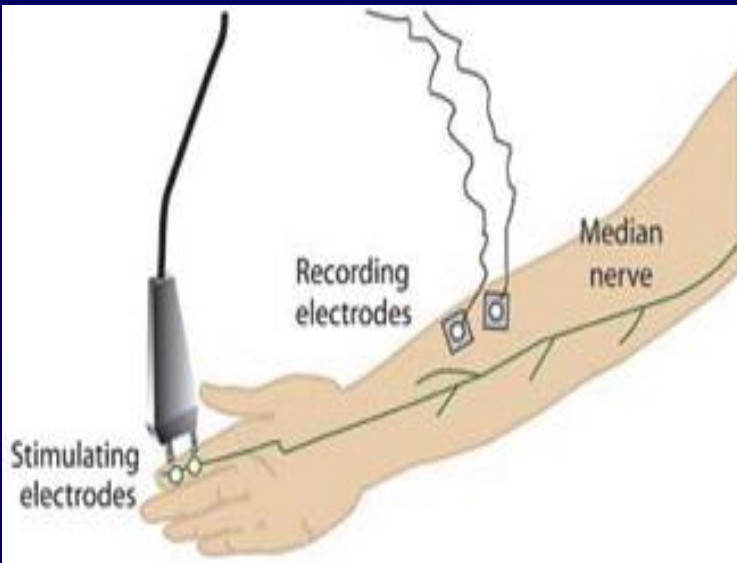
- ◆ Blood pressure cuff on arm, inflated above systolic pressure, symptoms within 60 seconds

Slide Courtesy of Charles N. Brooks, MD

Diagnosing CTS

- History & physical exam often sufficient
- However, may get nerve conduction study (NCS) when:

- ❖ Diagnosis is in doubt
- ❖ Workers' comp case
- ❖ Surgery is considered



Carpal Tunnel Syndrome:

More likely to occur in:

- Women than men (4-5 X)
- 30-60 years of age
- Obese
- Physically inactive

Carpal Tunnel Syndrome:

External forces:

- Direct pressure,
- Repetitive high force wrist and finger motion
- Vibration

Physiologic Factors:

- Obesity
- Pregnancy
- Menopause
- Kidney failure
- Thyroid disease, esp. hypothyroidism
- Trauma

Inflammation: Gout, Infection, Rheumatoid arthritis, Tenosynovitis

Neuropathic disorders: Alcohol, Diabetes, Solvent exposure

Does Keyboarding Cause CTS?

- No
- Prevalence of CTS in computer users is similar to or *lower* than the general population
- Keyboarding may be protective

Slide Courtesy of Charles N. Brooks, MD

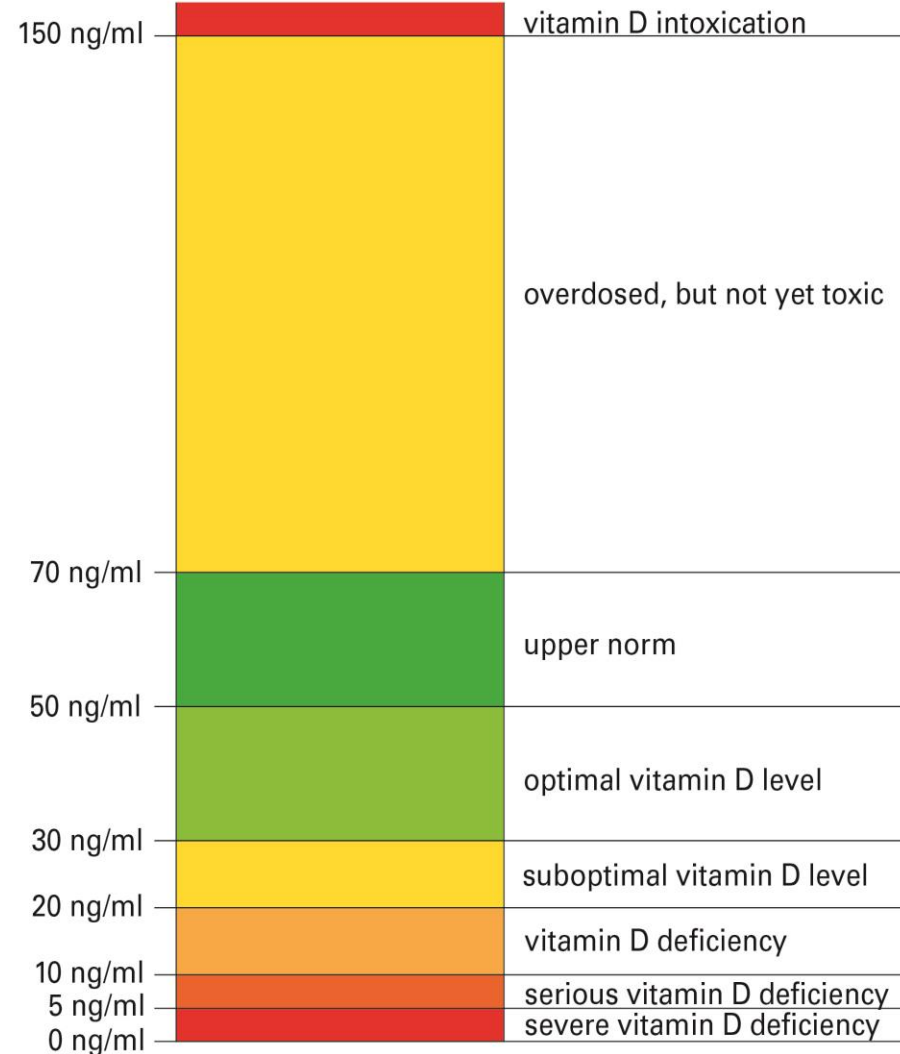
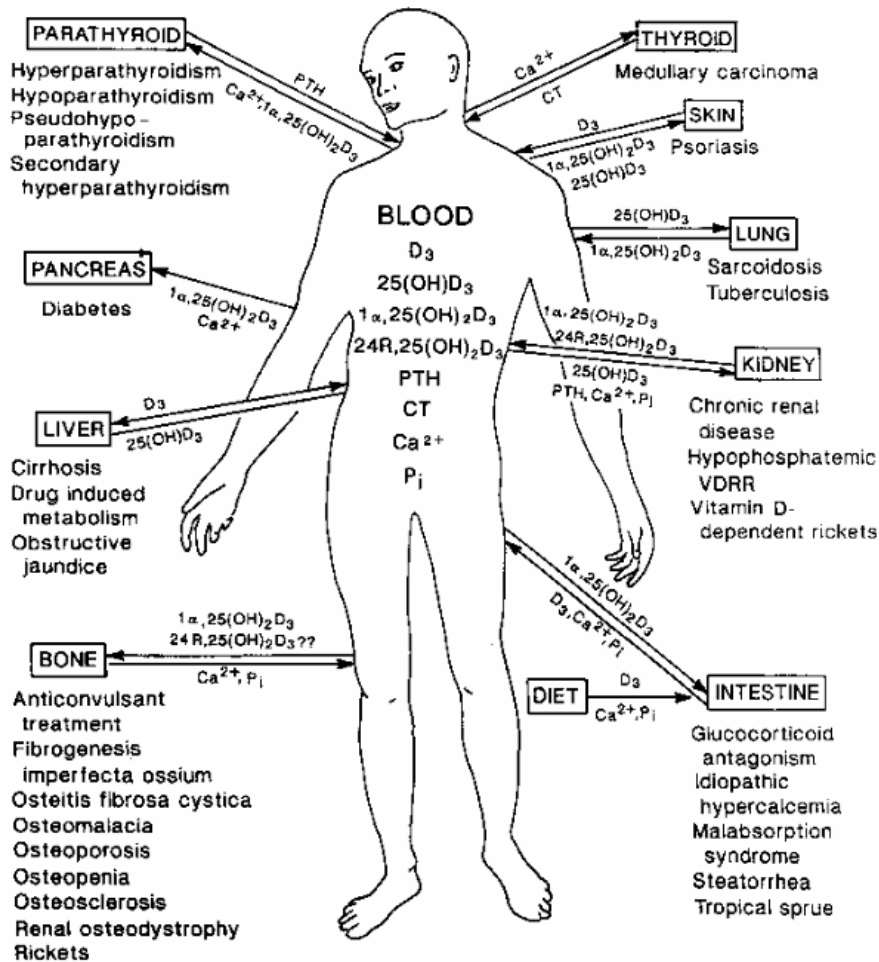
When is CTS Work Related?

- High force *and* repetition
- Vibration exposure
- Cold exposure ???

Slide Courtesy of Charles N. Brooks, MD

Vitamin D

VITAMIN D IN HUMAN DISEASE STATES

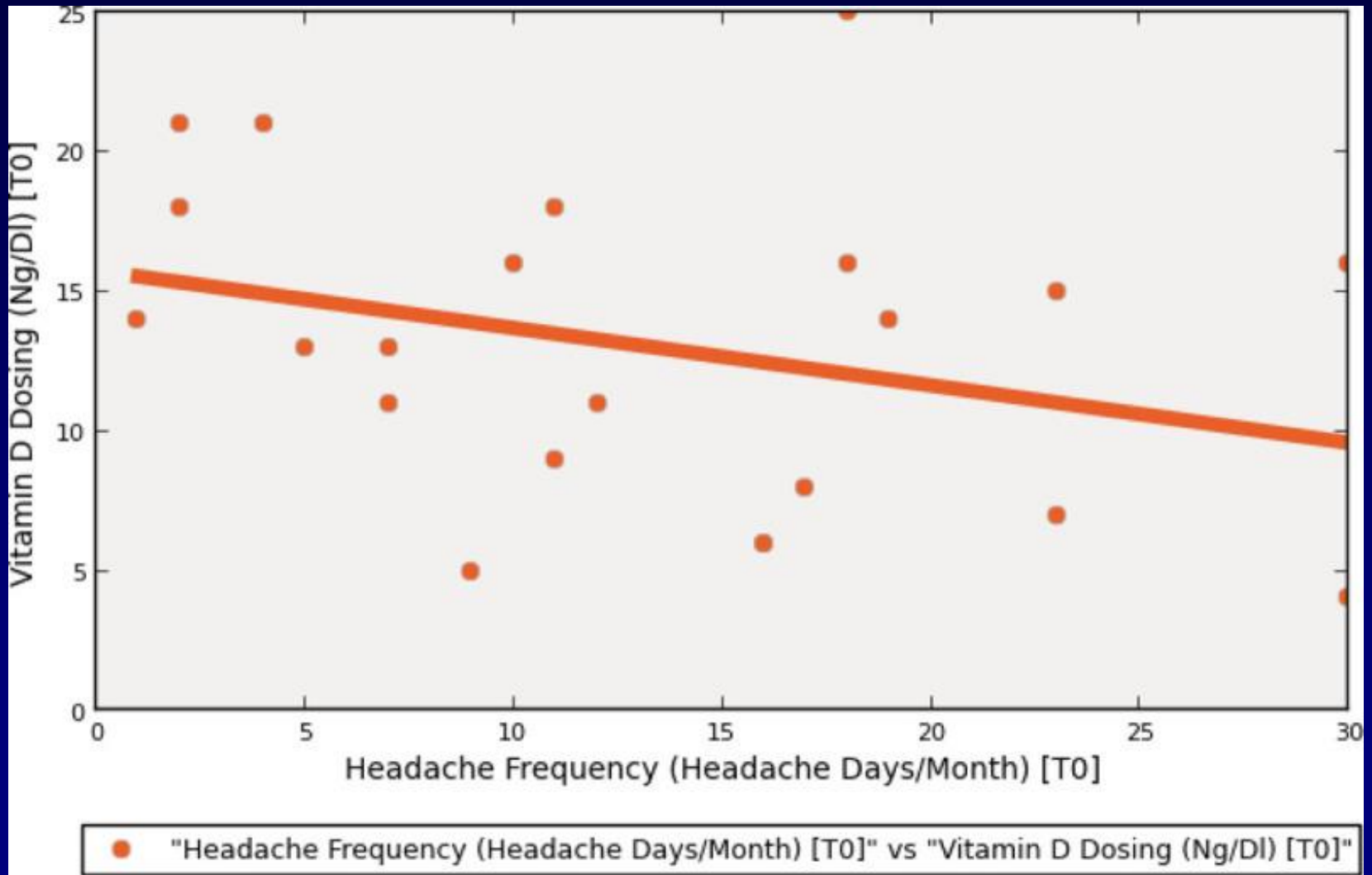




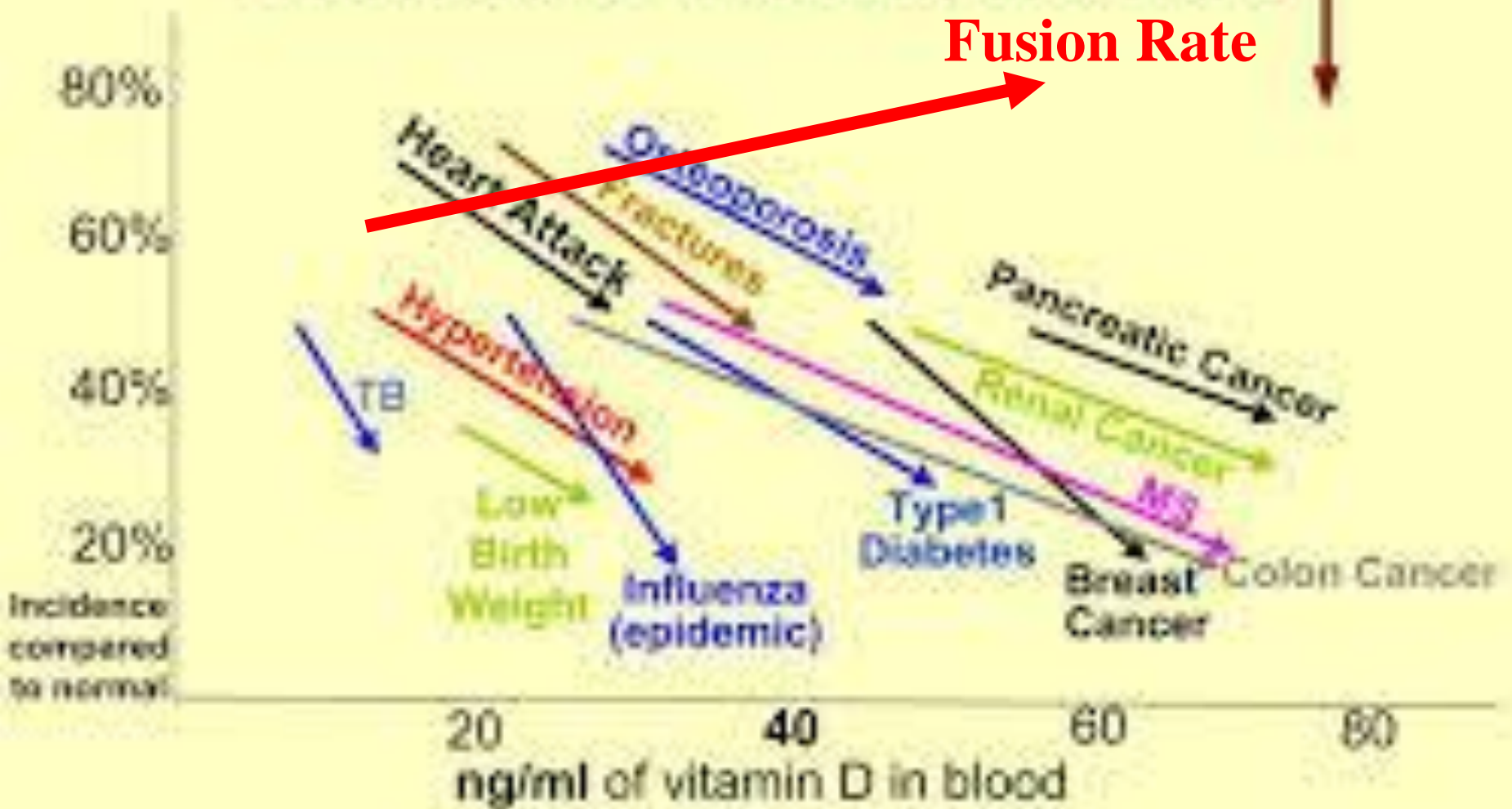
Vitamin D

- Improves Fusion Rate
- Decreases Low Back Pain
- Improves Migraine, Depression
- Improves Bone Health
- Lowers Risk of:
 - Death, Diabetes, Cancer, MS, Asthma!

Low Vitamin D levels worsen Migraine



More Vitamin D → decreases health problems



Data from Grassroots
Health June 2013

Below
30

Deficient.
Talk to your
doctor about
supplements.

**30 to
50**

Generally
inadequate for
bone and
overall health.

**50 and
above**

Adequate
(but more is
not necessarily
better).

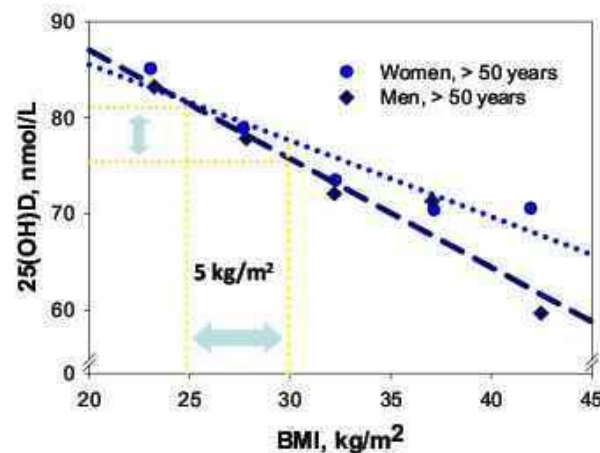
**125 and
above**

Too high
(may have
adverse
effects).

Vitamin D

Lagunova et al. Mol. Nutr. Food Res. 2010; 54: 1127–1133.

Decay in serum 25(OH)D levels with increasing BMI



25 (OH)D decrease per each 5 kg/m² BMI increase

✓ Women: 4,5 nmol/L

✓ Men: 5,5 nmol/L

✓ All: 5 nmol/L

Study	25(OH)D (±SD) (nmol/L)	Age (±SD) (years)	BMI range (kg/m ²)	Gender	25(OH)D decrease ^{a1}	p-Value
McGill <i>et al.</i>	62.2 (22.7)	47.6 (± 11.6)	28–50	Women, men	0.7 nmol/L	0.002
Rodrigues-Rodrigues	56.5	27.8 (± 4.6)	24–35	Women	1.2 nmol/L	< 0.05
Stein <i>et al.</i>	44.9 (22)	39 (12)	35–65	Women, men	1.3 nmol/L	< 0.01

Which is cost-effective?



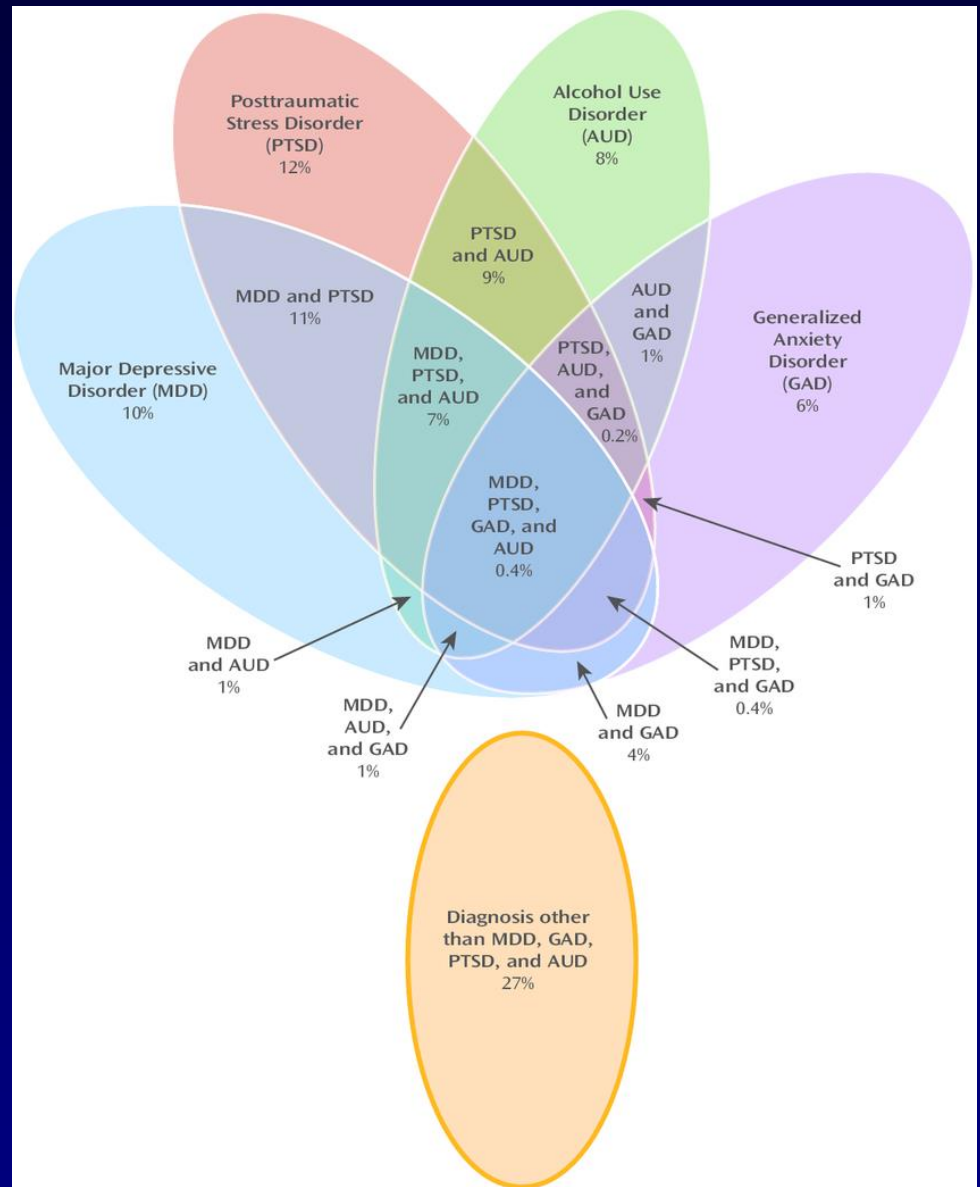
Co-Morbidity with Migraine

	F (df-btw, df-tot)	P-value	η^2
Depression	192.034 (1, 2,909)	0.000	0.062
Anxiety	120.116 (1, 2,909)	0.000	0.040
Stroke	4.015 (1, 2,909)	0.045	0.001
Epilepsy	0.607 (1, 2,909)	0.436	0.000
Hypertension	38.634 (1, 2,909)	0.000	0.013
Diabetes	7.148 (1, 2,909)	0.008	0.002
Bipolar	8.989 (1, 2,909)	0.003	0.003
IBS	73.210 (1, 2,909)	0.000	0.025
Chronic pain	107.060 (1, 2,909)	0.000	0.036
Fibromyalgia	39.812 (1, 2,909)	0.000	0.014
Thyroid disease	35.871 (1, 2,909)	0.000	0.012
Chronic fatigue	64.419 (1, 2,909)	0.000	0.022
Asthma	30.355 (1, 2,909)	0.000	0.010
COPD	6.326 (1, 2,909)	0.012	0.002
Autoimmune disorder	12.335 (1, 2,909)	0.000	0.004
Negative life event score H, M, L	107.144 (2, 2,909)	0.000	0.069
Migraine symptoms per month (n)	1028.578 (5, 2,909)	0.000	0.639

Depression

Genetics:

- Migraine,
- Depression,
- Motion Sickness,
- Alcohol



Depression Worsens Outcome after Lumbar Fusion

	Depression Group (n = 123)	Control Group (n = 2676)	P
Days absent from work AIF* (mean ± SD)	1077.4 ± 99.7	893.4 ± 333.9	<0.001
Medical costs paid by BWC AIF† (mean ± SD)	\$93,405.0 ± \$41,749.0	\$71,251.5 ± \$41,094.4	<0.001
Narcotic utilization AIF (mean ± SD)			
Days supplied	836.0 ± 690.7	567.2 ± 596.3	<0.001
Net mg of MEQs prescribed	61,587.8 ± 80,207.7	40,241.6 ± 72,055.8	<0.001
Average MEDs	66.7 ± 48.7	62.1 ± 58.1	0.388
New psychological developments within 3 yr AIF			
Depression	0 (0.0%)	430 (16.1%)	...
Anxiety	1 (0.8%)	32 (1.2%)	0.701
Adjustment reaction	0 (0.0%)	50 (1.9%)	0.126
PTSD	5 (4.1%)	14 (0.5%)	<0.001
Bipolar	0 (0.0%)	8 (0.3%)	0.544
Schizophrenia	0 (0.0%)	1 (< 0.1%)	0.830
Psychotherapy AIF			
Subjects using psychotherapy AIF	102 (82.9%)	617 (23.1%)	<0.001
Mean number of sessions	34.3 ± 37.5	5.2 ± 14.1	<0.001
Did sessions span from BIF to AIF?	78 (63.4%)	47 (1.8%)	<0.001
Postsurgical infection	0 (0.0%)	10 (0.4%)	0.497
Failed back syndrome AIF	10 (8.1%)	234 (8.7%)	0.813
Nonunion/pseudoarthrosis AIF	1 (0.8%)	33 (1.2%)	0.677
Newly awarded permanent disability‡ AIF	50 (40.7%)	1092 (40.8%)	0.972
All-cause mortality AIF	3 (2.4%)	47 (1.8%)	0.576
Subjects with additional lumbar surgery AIF	23 (18.7%)	524 (19.6%)	0.809
Mean major lumbar surgical procedures AIF	0.21 ± 0.47	0.23 ± 0.50	
Subjects with additional lumbar fusion	19 (15.4%)	400 (14.9%)	0.879
Subjects with additional decompression	13 (10.6%)	300 (11.2%)	0.825

Bold values represent statistically significant.

**AIF: After index fusion, in the context of this study, within 3 years after index fusion.*

†Net medical costs paid for by the Ohio BWC within 3 years after index fusion.

‡Permanent disability that was not awarded before fusion but was awarded AIF.

AIF indicates after index fusion; BWC, Bureau of Workers' Compensation; MEQs, morphine equivalent units; MEDs, morphine equivalent units per day; PTSD, posttraumatic stress disorder.

SPINE

Clinical Depression Is a Strong Predictor of Poor Lumbar Fusion Outcomes Among Workers' Compensation Subjects

Anderson, Joshua T.; Haas, Arnold R.; Percy, Rick; Woods, Stephen T.; Ahn, Uri M.; Ahn, Nicholas U.

Spine. 2015;40(10):748-756.

doi:
10.1097/BRS.0000000000000863

Depression worsens Patient Satisfaction Scores after fusion

	Nondepressed	Depressed	<i>P</i>
Number of patients	160	57	
Nurses <i>always</i> treated you with courtesy and respect	146/160 (91.3%)	45/57 (78.9%)	0.014*
Nurses <i>always</i> listened carefully to you	120/160 (75.0%)	44/57 (77.2%)	0.741
Nurses <i>always</i> explained things in a way you could understand	122/159 (76.7%)	38/57 (66.7%)	0.137
Doctors <i>always</i> treated you with courtesy and respect	142/160 (88.8%)	41/56 (73.2%)	0.005*
Doctors <i>always</i> listened carefully to you	131/160 (81.9%)	38/56 (67.9%)	0.029*
Doctors <i>always</i> explained things in a way you could understand	124/160 (77.5%)	39/56 (69.6%)	0.240
Your room and bathroom were <i>always</i> kept clean	124/158 (78.5%)	43/57 (75.4%)	0.636
The area around your room was <i>always</i> quiet at night	79/156 (50.6%)	31/57 (54.4%)	0.628
You <i>always</i> got help in getting to the bathroom or using a bedpan as soon as you wanted it	77/114 (67.5%)	25/41 (61.0%)	0.447
After you pressed the call button, you <i>always</i> got help as soon as you wanted it	102/151 (67.5%)	26/53 (49.1%)	0.017*
Your pain was <i>always</i> well controlled	96/156 (61.5%)	28/57 (49.1%)	0.104
The hospital staff <i>always</i> did everything they could to help you with your pain	122/156 (78.2%)	37/56 (66.1%)	0.072
Before giving you any new medicine, hospital staff <i>always</i> told you what the medicine was for	95/124 (76.6%)	32/41 (78.0%)	0.850
Before giving you any new medicine, hospital staff <i>always</i> described possible side effects in a way you could understand	59/120 (49.2%)	16/40 (40.0%)	0.314
Hospital staff talked with you about whether you would have the help you needed when you left the hospital	141/145 (97.2%)	47/52 (90.4%)	0.042*
You got information in writing about what symptoms or health problems to look out for after you left the hospital	137/143 (95.8%)	47/53 (88.7%)	0.065
Staff took your preferences and those of your family into account in deciding what your health care needs would be	86/160 (53.8%)	28/57 (49.1%)	0.548
You had a good understanding of the things you were responsible for in managing your health	100/160 (62.5%)	33/57 (57.9%)	0.540
You clearly understood the purpose for taking each of your medications	110/160 (68.8%)	32/57 (56.1%)	0.086
Rated this hospital as a 9 or 10 out of 10 overall	131/160 (81.9%)	43/57 (75.4%)	0.295
Would definitely recommend this hospital to friends and family	134/160 (83.8%)	40/57 (70.2%)	0.027*

*All *P* values <0.05 were considered statistically significant.

Treatment Implications:

- Migraine retards remission of Depression.
- Smoking Worsens pain, including Migraine.
- Depression worsens surgical outcomes.
- Depression worsens fusion outcomes.
- Exercise improves
 - depression,
 - migraine,
 - low back pain.

Treatment Implications:

How my practice is currently evolving:

- Medical Records Before and After Injury
- Objective Findings: (Physiologic and Non-Physiologic)
- Identify Concordant Findings:
- Screen for Chronic Pain, Depression & Migraine:

Treat with:

- Vitamin D to greater than 40ng/ml
- Magnesium and melatonin to improve sleep
- Encourage movement, exercise and RTW

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