

“Assessment and Treatment of Mechanical Low Back Pain in Active Populations”

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ATSNJ Student Program

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Presentation Overview:

- ▶ **Review an MSK-based history and orthopedic assessment protocol.**
- ▶ **Explore the use of directional preference testing & provocative testing.**
- ▶ **Explore sign &/or symptom patterns.**
- ▶ **We will be moving quickly....**

Disclosure:

- ▶ I have no conflicts to disclose in connection with the information covered in this seminar.
- ▶ I have no affiliations and receive no compensation from any of the systems or devices discussed during this presentation.
- ▶ Furthermore, the opinions expressed herein are mine, and not representative of the ATSNJ or Atlantic Health Systems.

Low Back Pain in the U.S.:

- ▶ **60%- 80% of population suffers LBP at some point. (Bigos, 1994)**
- ▶ **LBP is the most common reason for disability in people under age 45 (Andersson, 1998)**
- ▶ **Almost 1/3 of 20yo's (asympt) have disc bulges (Brinjikji, 2015)**
- ▶ **Incidence of disc anomalies rises approx. 10% for every decade older (Carragee, 2006)**

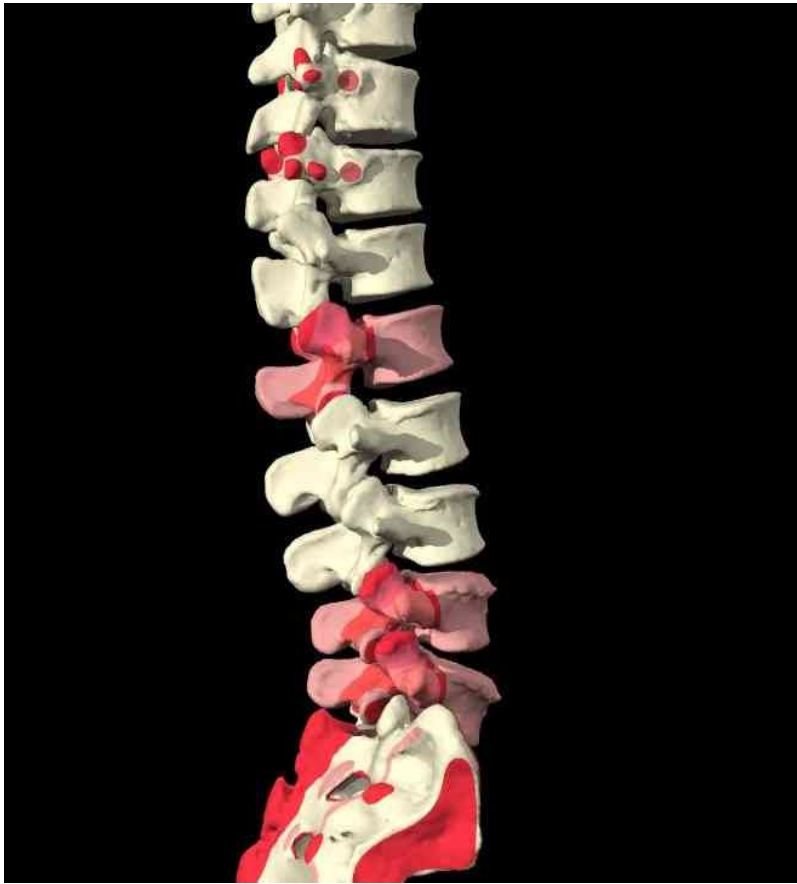
LBP and Athletics:

- ▶ **Prevalence of sympt DD in elite athletes(75%) higher than non-athletes(31%). (Takatalo 2009; Ong 2003)**
- ▶ **47% of adolescent athletes reporting to sportsmed clinic with LBP receive dx of spondylolysis (Micheli, et al. 1995)**
- ▶ **Prevalence of spondylolysis: divers-43%; wrestlers-30%; & weight lifters-23%(Rossi, et al. 1990)**



Anatomical & Biomechanical Considerations

Lumbar-Pelvic Region:



- ▶ **T12- Sacrum**
- ▶ **“Articulating Triads”**
- ▶ **2 SI joints.**
- ▶ **2 transitional zones.**
- ▶ **Numerous lig & myo-fascial complexes.**

Myo-Fascial Orchestra:

1. Local Stabilizers:

1. **Transversus Abdominis.**
2. **Multifidus.**
3. **Internal Obliques.**
4. **Intertransversarii/Rotatores.**
5. **Pelvic Floor.**
6. **Diaphragm.**

2. Global Stabilizers:

1. **Longissimus/Iliocostalis Groups.**
2. **Quadratus Lumborum.**
3. **Rectus Abdominus.**
4. **External Obliques.**
5. **Latissimus Dorsi.**
6. **Thoraco-Dorsal Fascia.**
7. **Psoas.**
8. **Gluteal Groups.**

Intervertebral Discs:

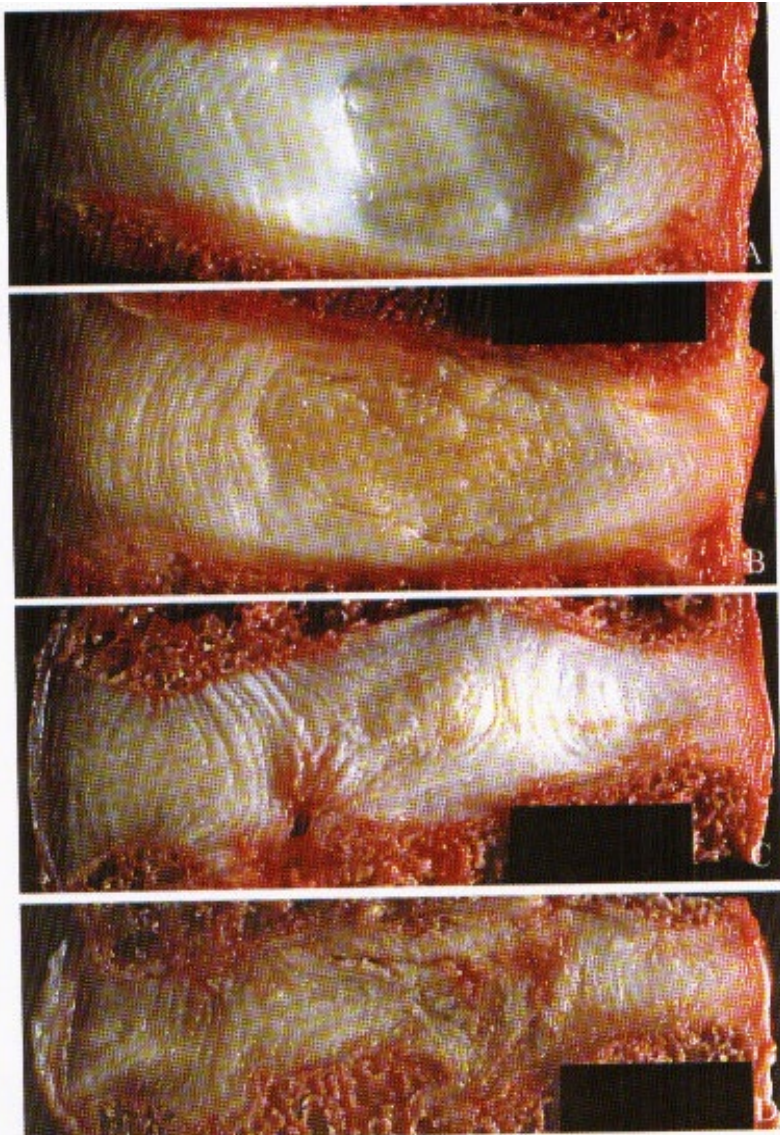
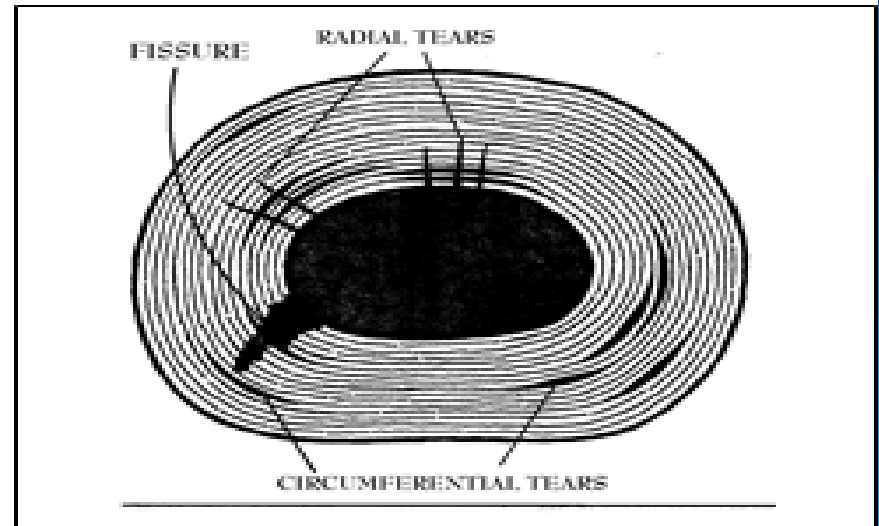
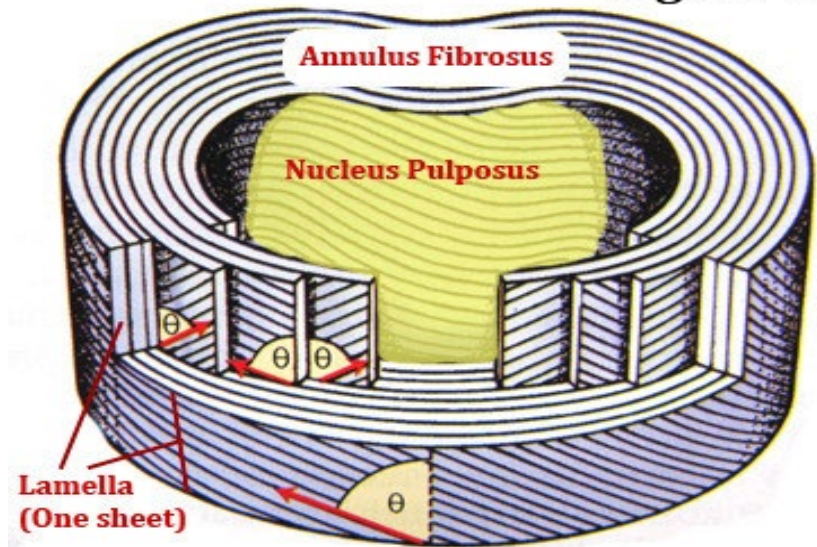


Figure 6



Challenges in Diagnosis of LBP:

- ▶ **Complex Disorder.**
- ▶ **Multi-factorial (BioPsychoSocial).**
- ▶ **Lack of any universally accepted classification system!**
- ▶ **Structural vs. Functional ?**
 - ▶ **28%- 50% of normal, asymptomatic individuals have significant structural pathology on CT/MRI studies. (Boden, 1990; Jensen, 1994; Brinjikji, 2015)**

Herzog R, Elgort DR, Flanders AE, Moley PJ. Variability in diagnostic error rates in 10 MRI centers performing lumbar spine MRI examinations on the same patient within a 3 week period. Spine J. 2017;17(4):554-561.

Subject: 63-year old female with a history of low back pain and right L5 radicular symptoms

Imaging: Received 10 MRIs at 10 Different Testing Centers over a 3 week period



Results:

- 49 distinct findings were reported related to a distinct pathology
- Only one finding was reported in 9 out of the 10 MRIs
- 32.7% of interpretive findings only appeared once across all 10 reports
- 2 exams reported a disc herniation at all five lumbar segments and one exam did not report any herniation
- Central canal stenosis was reported at 4 segments in 2 exams and not present at all in 2 other exams
- 4 exams reported nerve root involvement in 3 segments and 5 exams did not report any nerve root involvement
- No interpretive finding was reported in all 10 exams



CRISP™ Protocol:

- ▶ Developed by Dr Don Murphy and colleagues, to best integrate EBP and BPS models into clinical reasoning for LBD.
- ▶ **CRISP**= “Clinical Reasoning In Spine Pain”
- ▶ Based on the “three questions of diagnosis”
 - ▶ 1. Are there possible **Red Flags**?
 - ▶ 2. **Where** is the pain coming from?
 - ▶ 3. What is happening with this person **as a whole** that would cause this condition to develop and persist?

Question #1:

- ▶ Do the presenting symptoms reflect a visceral disorder, or a serious condition necessitating an immediate referral?

“RED FLAG”

“Red Flags”

- ▶ Age concerns?
- ▶ Recent acute trauma.
- ▶ Hx of Cancer.
- ▶ Night Pain.
- ▶ Fevers.
- ▶ Unexplained Weight Loss.
- ▶ Recent Infection.
- ▶ Cauda Equina.
- ▶ Saddle anesthesia.
- ▶ Bowel/Bladder changes.
- ▶ Failure of 4 weeks of conservative care.

Question #2:

Where is the pain coming from?

- ▶ **Discogenic**
- ▶ **Joint dysfunction**
- ▶ **Radiculopathy**
- ▶ **Myofascial**
- ▶ **Combination?**

What are the primary tissue sources of LBP???

Kuslich, 1991



**Annulus (Post 1/3)
End Plates
Nerve Roots**



**Muscle
Fascia**

Allegri, 2016
Manchikanti, 2001



**Discs (26-39%)
Facets (15-40%)
SI Joints (2-15%)**



Myofascial Tissues

So, why is spine pain different?

1. **Sclerotogenous patterns dominate**
(Vernon, 2012)
2. **Hyperconvergence** (Gillette, 1993)
3. **Greater % of WDR vs NS neurons.**
4. **Greater density of nociceptors in deep spinal tissues.**
5. **More likely to develop chronicity (NSS).**

The Examination Process

Taking a History...

- ▶ **D** = description of events
- ▶ **O** = onset of current episode?
- ▶ **P** = provoking activities...
- ▶ **P** = palliative positions...
- ▶ **Q** = quality of pain (sharp, dull...)
- ▶ **R** = radiation of pain? Where?
- ▶ **S** = site of symptoms...
- ▶ **T** = timing (constant, variable...)

Questions to ask...

1. Are there daily variations in p! intensity?
2. Does rolling over in bed cause sudden p!?
3. What was MOI?
4. Any hx of OA, OP, Cancer?
5. Is it worse in the morning?
6. Does p! increase thru day?
7. Does it radiate? Where?
8. ROS (“SMITH”)

Evaluative Processes:

1. Inspection

- ▶ Slouched
- ▶ Rigid
- ▶ Antalgic

2. Palpation (?)

3. AROM/ PROM

4. Accessory Jt. Play (?)

Neurological Evaluation (MRS):

1. Motor:

L1-3: Raise the Knee.

L2-4: Kick the Door.

L5: Toe “High Five”.

S1: Reach for Sun.

S2: Gum on my shoe?

2. Deep Tendon Reflexes:

L4- Patella Reflex.

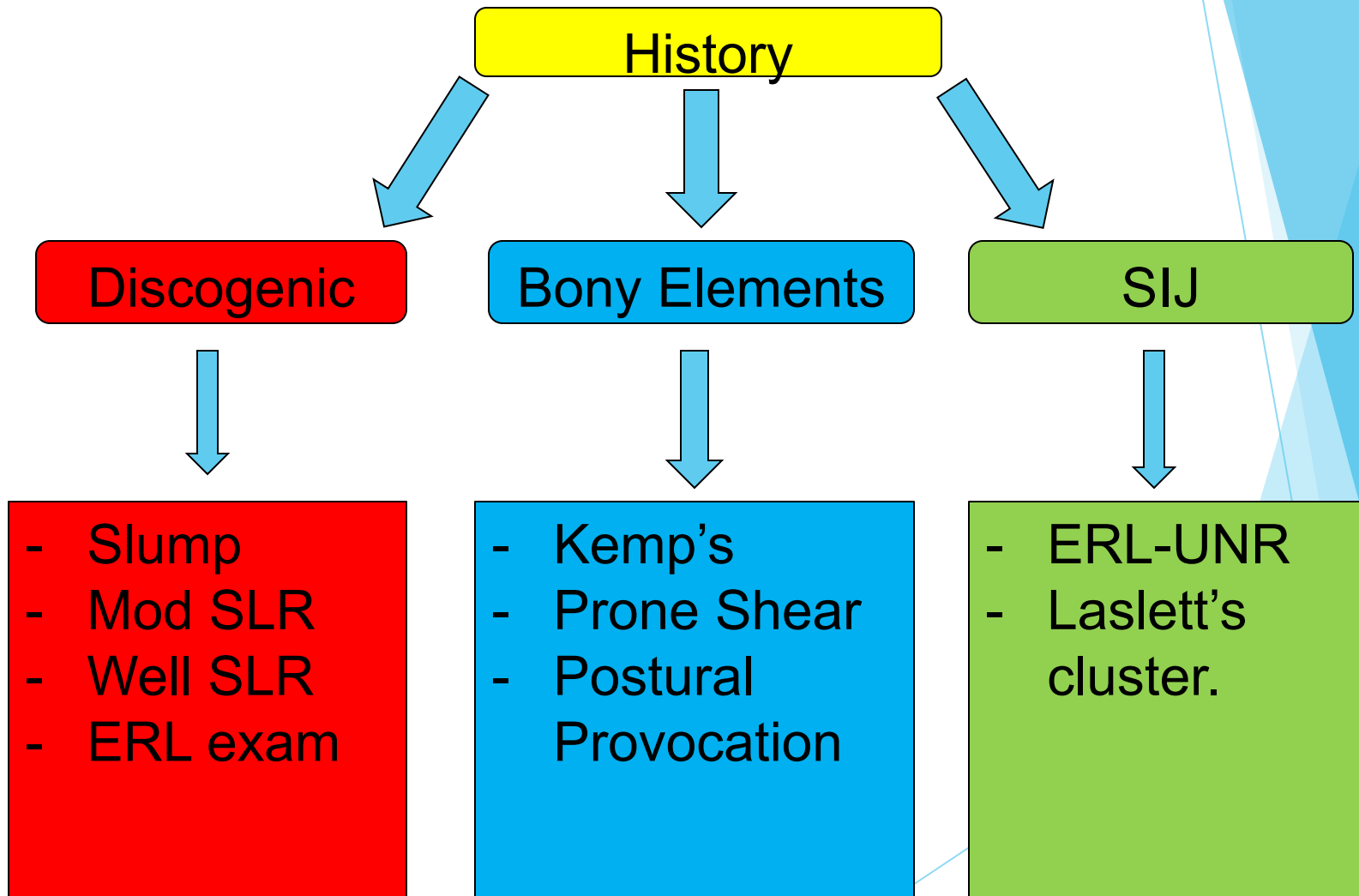
S1- Achilles Reflex.

Jendrassik
Maneuver.

3. Sensory (Dermotomes).

Orthopedic & Clinical Special Tests:

Choosing the right tests...



“Slump” Test:

- ▶ Seated Position:
 - ▶ Slump torso→extend knee→DF ankle→flex neck (overpressure).
- 3 Criteria for “+” finding (Butler, 1991; Majlesi, 2008)
 - Assymmetrical findings.
 - Same pain response as reported in IP.
 - P= radicular quality.
- +LR=1.82 -LR=0.19
(Stankovic, 1999)

CUS= 2



Modified SLR

(Vroomen 2002/ Pesonen 2021)

- ▶ Best performed sequentially.
- ▶ Same criteria as w/ slump test.

+LR=2.23 -LR=0.05

- ▶ Supine
- ▶ Head/neck & DF neutral.
- ▶ Raise to symptoms.
- ▶ Back off 10° & DF/IntRot thigh → s/s “+” finding.

CUS= 2



Prone Test: Posterior Shear Instability Test

- ▶ Pt./Athlete lies prone w/ torso on table and legs over side. Feet resting on floor.
- ▶ Palpate each level- start at sacrum. If pain noted, have athlete raise legs.
- ▶ **+** If pain relieved with active HE- probable instability.
- ▶ Fritz, 2005/ Hicks, 2005:
- ▶ +LR= 1.41 -LR= 0.69



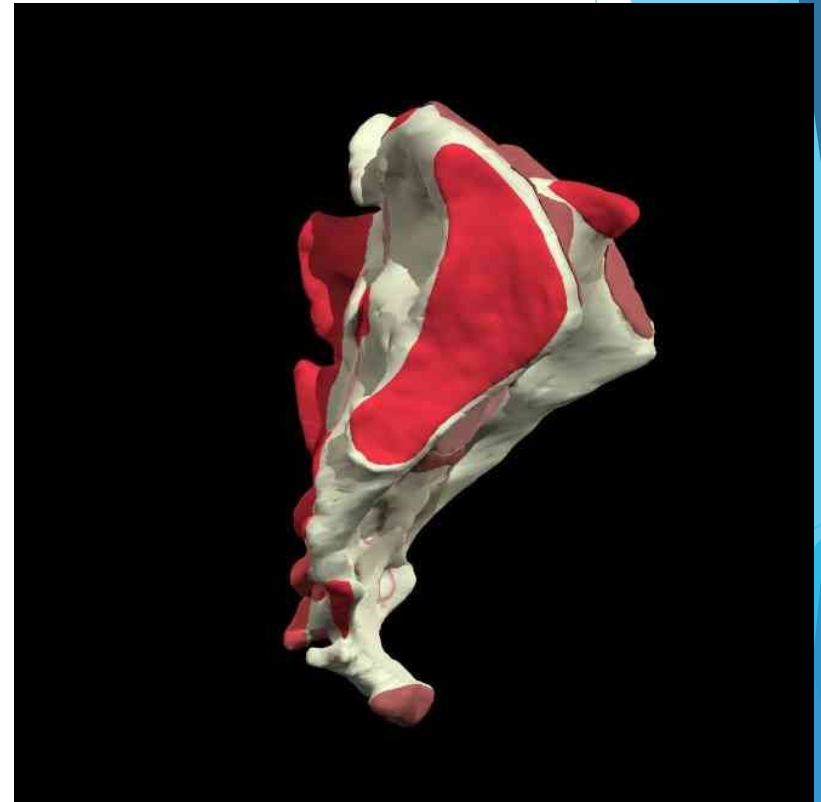
SI Joint Dysfunction (SIJD):

- ▶ **Controversial.**
- ▶ **Maigne (1996): prevalence @ 18.5% (dbl injection blocks).**
- ▶ **Relies on Form/Force Closure.**
- ▶ **Movement often < 2-3mm...**

SI Joint- Anatomy:

- ▶ Anteriorly synovial.
- ▶ Posteriorly syndesmotic.
- ▶ Sacral side-hyaline/ Iliac side-fibrocartilage.

- ▶ Multiple Ligament complexes:
 - ▶ Ventral Ligament (resists Nut.)
 - ▶ L. Dorsal Ligament (resists CN)
 - ▶ Interosseous Ligament.
 - ▶ Iliolumbar/Sacrospinous/Sacrospinotuberosus.



SI Orthopedic Testing:

- ▶ Laslett's Cluster (5): +LR= 4.16 -LR= 0.11
- ▶ Multiple formats (Robinson, 2007/ Laslett, 2005/ Cibulka, 1999/ Telli, 2018):
- ▶ **CUS= 1**
 - ▶ **Gaenslen's.**
 - ▶ **Thigh Thrust.**
 - ▶ **SI Distraction.**
 - ▶ **Sacral Thrust.**
 - ▶ **SI Compression.**

SI- Gaenslen's:

1. Patient positioned at end of plinth, painful side hanging downward.
 2. Flex opposite hip/leg past 90°.
 3. Apply several quick forceful thrusts thru both thighs (torque pelvis).
 4. Best to perform on both sides.
- ▶ **“+” finding= Pain!**

▶ **CUS= 3**



SI- Thigh Thrust:

1. Patient supine.
2. Stand opposite painful side.
3. Hip on pain side flexed to 90°.
4. Place hand under SI region to form stable bridge & apply downward pressure thru flexed leg.

“+” finding= Pain!

CUS= 2



SI Distraction Test:



1. Pt. Supine & relaxed.
 2. Examiner applies laterally directed pressure to medial ASIS areas bilaterally.
- +: SI joint lesion (anterior ligaments).**

CUS= 3

Sacral Thrust:

1. Patient prone.
 2. Apply downward pressure thru mid-sacrum, then 5-6 quick thrusts.
- ▶ “+” finding= pain.
 - ▶ Variations.
 - ▶ CUS=3



SI Compression:

1. Patient Side-lying → painful side up.
 2. Knees/Hip flexed.
 3. Apply firm downward pressure thru crest > 10sec.
- ▶ “+” finding = Pain!
 - ▶ **CUS = 3.**



Provocative & Directional Preference Testing:

Disclaimer:

- ▶ This presentation is **NOT** intended to teach clinical mastery or proficiency in all the skills necessary to adequately understand and perform the methods of Mechanical Diagnosis and Therapy (MDT- aka “McKenzie”) or Prof. Stu McGill’s Assessment program. This presentation is just intended to be an overview of the methods contained within these programs. Any attendees who seek to further understand and utilize these systems are strongly encouraged to seek out additional training and certification in these programs.
- ▶ During our practice of these maneuvers, please exercise caution and refrain from taking part if you feel you have any reason to avoid these provocative tests.

Provocative Functional Tests...

- ▶ Listening during the **HISTORY**

- ▶ Use a combination of:

 - ▶ **Motions**

 - ▶ **Postures**

 - ▶ **Loads**

Identify provocative positions, and mechanisms that increase pain and decrease capacity...

Provocative Testing

- ▶ **Standing Heel Drop:**
 - ▶ Standing- relaxed. PF & drop.
 - ▶ If pain, ab brace and repeat.
 - ▶ If brace \uparrow pn, shoulder brace and repeat.
- ▶ McGill, 2001



Provocative Testing:

- ▶ **Seated Compression:**
- ▶ Seated on chair. Feet on floor.
- ▶ Slump and pull down onto seat-
- ▶ Sit upright and pull onto seat-
- ▶ change?
- ▶ Variations...

- ▶ McGill, 2



Directional Preference Testing:

- ▶ **Is a system of analysis and treatment in which the spine is loaded in static and dynamic postures at end range.**
- ▶ **Has been shown to have consistent reliability as both an assessment and a treatment.**
- ▶ **Apeldoorn 2016; Beattie 2010; Flavell 2016; Karayannis 2012; May 2012**

Possible DP improvement patterns

- ▶ **1. Change in distribution of LE ss.**
- ▶ **2. Change in distribution of LBP.**
- ▶ **3. Change in pain intensity or frequency.**
- ▶ **4. Increase in ROM.**
- ▶ **5. Improvement in function (ADLs)**

Directional Preference Assessment:

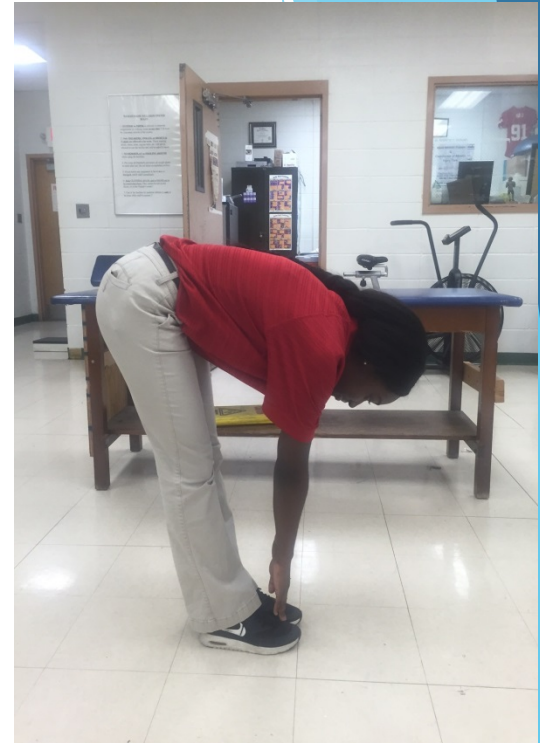
- ▶ Step 1: Use history to anticipate loading strategies.
- ▶ Step 2: Correct any fixed/antalgic shift first (advanced)
- ▶ Step 3: Explore all ranges and look for a pattern (did you explore full end-range and perform enough repetitions??)
- ▶ Step 4: Observe end range loading response in each range. Is there a DP?

DP Protocol

- ▶ Standing Forward Flexion
- ▶ Standing Extension
- ▶ Standing Side- Glide Right/Left
- ▶ Supine Knees-to-Chest
- ▶ Prone Extension Press Up

Observe for limitations in ROM and symptom pattern response (consistent pain/ only @ end range/ DP?) Perform at least 5-10reps each.

Directional Preference Protocol:



Question #3:

- ▶ **What has happened with this person as a whole that would cause the pain experience to develop and persist?**
- ▶ Apply the BPS model
- ▶ Examine Pain Phenotypes.
- ▶ Outcomes assessment.

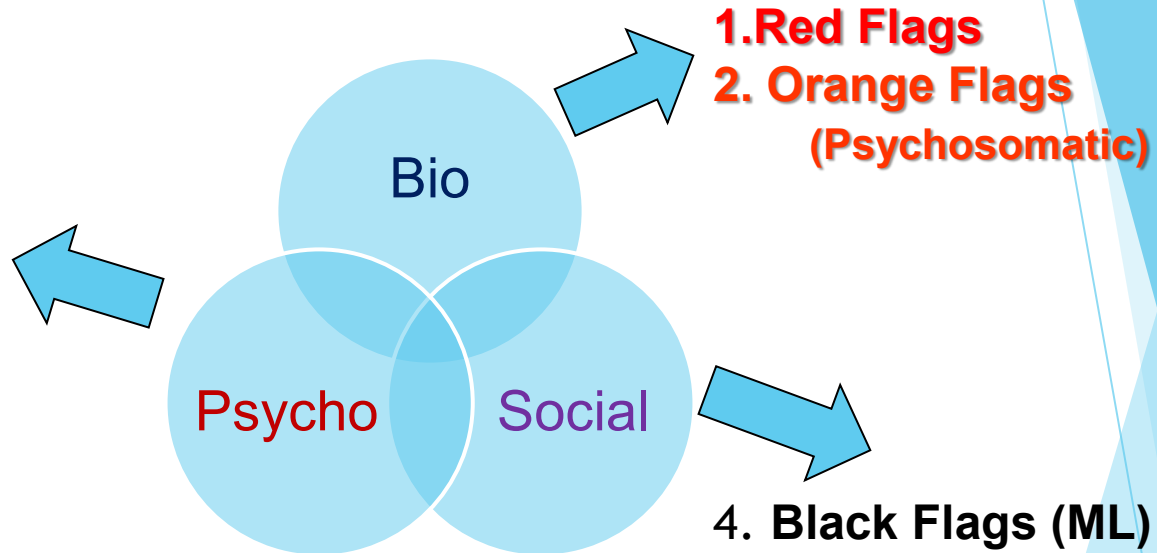
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BioPsychoSocial Model:

3. Yellow Flags

- Fear/Anxious
- Catastrophizing
- Poor Coping
- Self-Efficacy
- Depressed



1. Red Flags
2. Orange Flags
(Psychosomatic)

4. Black Flags (ML)
5. Blue Flags (Occ)

- Work
- Sports
- Family
- Substances?

In Summary...

- ▶ **The HISTORY is Key !**
- ▶ **Can you identify a loading pattern that affects symptoms.**
- ▶ **Don't rush to conclude a STRUCTURAL cause.**
- ▶ **Look for Flexibility &/or Strength asymmetry.**
- ▶ **Continue to learn !**

Additional Resources:



- ▶ Rehabilitation of the Spine- C. Liebenson (**text**)
- ▶ Low Back Disorders: Evidence Based Prevention and Rehabilitation- Stu McGill (**text**)
- ▶ McKenzie Institute International (**courses**)
- ▶ Backfitpro (**courses**)
- ▶ Mechanical Care Forum (**podcast**)

THANK YOU !



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Bibliography:

- ▶ Adams, M.; Bogduk, N; Burton, K; and Dolan, P. The Biomechanics of Back Pain. Edinburgh: Churchill-Livingstone. 2002.
- ▶ Albert, H, et al. Evaluation of clinical tests used in classification procedures in pregnancy-related pelvic joint pain. Eur Spine J. 2000; 9(2):161-166.
- ▶ Allegri M, Montella S, Salici F, et al. Mechanisms of low back pain: a guide for diagnosis and therapy. F1000Research. 2016.doi:10.12688/f1000research.8501.1
- ▶ Andersson, GB. Epidemiology of low back pain. Acta Orthop Scand. 1998; 69 (Supplement 281): 28-31.
- ▶ Aoki Y, Takahashi Y, Ohtori S, et al. Distribution and immunocytochemical characterization of dorsal root ganglion neurons innervating the lumbar intervertebral disc in rats: a review. Life Sci. 2004; 74(21):2627-2642.
- ▶ Apeldoorn A, van Helvoirt H, Meihuizen H, Tempelman H et al. The influence of centralization and directional preference on spinal control in patients with nonspecific low back pain. JOSPT. 2016; 46(4):258-269.
- ▶ Axler, C; and McGill, S. Low back loads over a variety of abdominal exercises: Searching for the safest abdominal challenge. Med and Sci in Sport & Exercise, 1997; 29 (6): 804-811.
- ▶ Beattie PF, Arnot CF, Donley JW, Noda H, Bailey L. The immediate reduction in low back pain intensity following lumbar joint mobilization and prone press-ups is associated with increased diffusion of water in the L5-S1 intervertebral disc. JOSPT. 2010; 40:256-264.
- ▶ Bigos, S., Bowyer, O, Braen, G, et al. (1994). Acute Low Back Problems in Adults. Clinical Practice Guideline. Rockville, MD. US Dept. of Health & Human Services. AHCPR.
- ▶ Boden, SD; Davis, DO; et al. Abnormal magnetic resonance scans of the lumbar spine in asymptomatic subjects. J. Bone & Joint Surgery (Am). 1990; 72(3):403-408.
- ▶ Brieg, A; Troup, JD. Biomechanical considerations in the straight-leg raise test. Cadaveric and clinical studies of the effects of medial hip rotation. Spine. 1979; 4(3):242-250.

Bibliography:

- ▶ Brinjikji W, Luetmer PH, Comstock B. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. J Neuroradiology. 2015; 36(4):811-816.
- ▶ Butler, D., Jones, M. Mobilization of the Nervous System. Melbourne: Churchill Livingstone. 1991.
- ▶ Carragee E, Alamin T, Cheng I, et al. Are first-time episodes of serious LBP associated with new MRI findings? Spine J. 2006; 6(6):624-635.
- ▶ Cibulka, MT; Koldehoff, R. Clinical usefulness of a cluster of SI joint tests in patients with and without LBP. JOSPT. 1999; 29(2):83-89.
- ▶ Cook, C; Turney, L; et al. Predictive factors in poor inter-rater reliability among physical therapists. J Man Manip Ther. 2002; 10(4):200-205.
- ▶ Cook, Chad, Hegedus, E. Orthopedic Physical Examination Tests: an evidence based approach. Upper Saddle River: Pearson/Prentice-Hall. 2008.
- ▶ Donelson, R; April, C; et al. A prospective study of centralization of lumbar and referred pain. A predictor of symptomatic discs and annular competence. Spine. 1997; 22:1115-1122.
- ▶ Dreyfuss, P; Dreyer, S; et al. Positive sacroiliac screening tests in asymptomatic adults. Spine. 1994;19(10):1138-1143.
- ▶ Dreyfuss, P; Michaelsen, M; et al. The value of medical history and physical examination in diagnosing SI joint pain. Spine. 1996; 21(22):2594-2602.
- ▶ Ebraheim, NA; Madsen,TD; et al. Dynamic changes in the contact area of SI joint. Orthopedics. 2003; 26(7):711-714.

Bibliography:

- ▶ Estridge, MN, Rouhe, SA, et al. The femoral stretching test. A valuable sign in diagnosing upper lumbar disc herniations. J Neurosurg. 1982; 57(6): 813-917.
- ▶ Feldman, DE, et al. Risk factors for the development of low back pain in adolescence. Am J Epidemiol.. 2001; 154: 30-36.
- ▶ Ferrari S, Manni T. et al. A literature review for clinical tests of lumbar instability in low back pain: validity and applicability in clinical practice. Chiro & Man Ther. 2015; 23:14
- ▶ Flavell C, Gordon S, Marshman L. Classification characteristics of a chronic low back population using a combined McKenzie and patho-anatomical assessment. Manual Therapy. 2016; 26:201-207.
- ▶ Fritz, J; Piva, S; Childs, J. Accuracy of the clinical examination to predict radiographic instability of the lumbar spine. Eur Spine J. 2005; 14(8): 743-750.
- ▶ Gatt, CJ.; Hosea, TM.; et al. Impact loading of the lumbar spine during football blocking. Am J Sports Med. 1997; 25 (3): 317-321.
- ▶ Gillette RG, Kramis RC, Roberts WJ. Characterization of spinal somatosensory neurons having receptive fields in lumbar tissues of cats. Pain. 1993; 54: 85-98.
- ▶ Hakelius, A, Hindmarsh, J. The comparative reliability of the preoperative diagnostic methods in lumbar disc surgery. Acta Orthop Scand. 1972; 43:234-238.
- ▶ Hicks, G; Fritz, HM, et al. Preliminary development of a clinical prediction rule for determining which patients with LBP will respond to a stabilization exercise program. Arch Phys Med Rehabil. 2005; 86:1753-1762.
- ▶ Hosea TM, Gatt CJ, Carthy KE. Analytical computation of rapid dynamic loading of lumbar spine. Trans Orthop Res Soc. 1989; 34:358.
- ▶ Hosea TM, Hannafin JA, Rowing injuries. Postgrad Adv Sport Med. 1989; 111:1-17.
- ▶ Iwamoto, J. et al. Relationship Between Radiographic Abnormalities of the Lumbar Spine and Incidence of Low-Back Pain in High School and College Football Players. AJSM. 32: 781-786. (2004).
- ▶ Jensen, MC, et al. Magnetic resonance imaging of the lumbar spine in people without back pain. N England Journal of Med. 1994; 2:69.

Bibliography:

- ▶ Jull, G. Treleaven, J; et al. Manual examination: Is pain provocation a major cue for spinal dysfunction? Aust J Physiother. 1994; 40:159-165.
- ▶ Karayannis NV, Jull GA, Hodges PW. Physiotherapy movement based classification approaches to low back pain: comparison of subgroups through review and developer expert survey. BMC Musculo Dis. 2012; 13:24.
- ▶ Keene, JS; Albert, MJ; Springer, SL; et al. Back injuries in college athletes. J Spinal Dis. 1986; 2:190.
- ▶ Kosteljanetz, M; Bang, F; Schmidt-Olsen, S. The clinical significance of straight leg raising in the diagnosis of prolapsed lumbar disc. Spine. 1988; 13:393-395.
- ▶ Kuslich S, Ulstrom C, Michael C. The tissue origin of low back pain and sciatica: a report of pain response to tissue stimulation during operations on the lumbar spine using local anesthesia. Orthop Clinics North Am. 1991; 22(2):181-187.
- ▶ Lam OT, Strenger DM, Chan-Fee M, Pham PT, et al. Effectiveness of the McKenzie method of mechanical diagnosis and therapy for treating low back pain: Literature review with meta-analysis. JOSPT. 2018; 48(6):476-490.
- ▶ Laslett, M; April, C; et al. Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. Man Ther. 2005;10:207-218.
- ▶ Laslett, M; Young, SB; et al. The reliability of selected pain provocation tests for SI joint pathology. Spine. 1994;19(11):1243-1249.
- ▶ Laslett, M; Oberg, B; et al. Centralization as a predictor of provocation discography results in chronic LBP, and the influence of disability and distress on diagnostic power. Spine J. 2005; 5(4):370-380.
- ▶ Levangie, PK. The association between static pelvic asymmetry and LBP. Spine. 1999; 24(12):1234-1242.
- ▶ Lee, Diane. The Pelvic Girdle. Edinburgh (U.K.): Churchill- Livingstone Publishers. 3rd ed. 2004.

Bibliography:

- ▶ Liebenson, C. (ed.): Rehabilitation of the Spine: A Patient-Centered Approach. 3rd ed. Baltimore: Wolters Kluwer. 2020.
- ▶ Luo, X., et al. Estimates and Patterns of Direct Health Care Expenditures Among Individuals With Back Pain in the United States. Spine. 2004; 29 (1): 79-86.
- ▶ Majlesi J, Togay H, et al. The sensitivity and specificity of the slump and SSLR tests in patients with lumbar disc herniation. J Clin Rheumatol. 2008;14:87:87-91.
- ▶ Manchikanti L, Singh V, Pampati V. et al. Evaluation of the relative contribution of various structures in chronic low back pain. Pain Phys. 2001;4(4):308-316.
- ▶ May S, Aina A. Centralization and directional preference: a systematic review. Manual Therapy. 2012; 17:497-506.
- ▶ May S, Rosedale R. An international survey of the comprehensiveness of the McKenzie classification system and the proportions of classifications and directional preferences in patients with spinal pain. Musculoskeletal Sci Pract. 2019; 39:10-15.
- ▶ McGill, S. Low Back Disorders: Evidence based prevention and rehabilitation. 3rd ed. 2016. Champaign: Human Kinetics.
- ▶ Micheli, LF.; Wood, R. Back pain in young athletes. Significant differences from adults in causes and patterns. Arch Pediatr Adolescent Med.1995; 149 (1): 115-118.
- ▶ Mortazavi J, Zebardast J, Mirzashahi B. Low back pain in athletes. Asian J Sports Med. 2015; 6(2):e24718.
- ▶ Murphy, DR. Clinical Reasoning in Spine Pain: Volume 1- Primary Management of Low Back Disorders Using the CRISP Protocols. Rhode Island: CRISP Education and Research LLC. 2013
- ▶ Ohtori S, Inoue G, Miyagi M, Takahashi K. Pathomechanisms of discogenic low back pain in humans and animal models. Spine J. 2015; 15(6):1347-1355.
- ▶ Ong A, Andersson J, Roche J. A pilot study of the prevalence of lumbar disc degeneration in elite athletes with lower back pain at the Sydney 2000 Olympic Games. Br J Sports Med. 2003;37:263-266.
- ▶ Otero J, Bonne F. Low back pain: prevalence of McKenzie's syndromes and directional preferences. Kinesither Rev. 2014; 14(145):36-44.
- ▶ Pesonen J, Shacklock M, et al. Extending the straight leg raise test for improved clinical evaluation of sciatica: reliability of hip internal rotation or ankle dorsiflexion. BMC Musculoskel Disorders. 2021;22:303.
- ▶ Rossi F, Dragoni S. Lumbar spondylolysis: occurrence in competitive athletes. Updated achievements in a series of 390 cases. J Sports Med Phys Fitness. 1990; 30(4):450-452.

Bibliography:

- ▶ Sedrak P, Shahbaz M, et al. Return to play after symptomatic lumbar disc herniation in elite athletes: a systematic review and meta-analysis of operative versus nonoperative treatment. Sports Health. 2021; doi:10.1177/1941738121991782.
- ▶ Shimpi A, Hatekar R, Shyam A, Sancheti P. Reliability and validity of a new clinical test for assessment of the sacroiliac joint dysfunction. Hong Kong Physiotherapy Journal. 2018; 38(1):13-22.
- ▶ Stankovic, R; Johnell, O; et al. Use of lumbar extension, slump test, physical and neurological examination in the evaluation of patients with suspected HNP: a prospective clinical study. Man Ther. 1999; 4(1):25-32.
- ▶ Sward, L.; Hellstrom, M.; et al. Back pain and radiologic changes in the thoraco-lumbar spine of athletes. Spine. 1990; 15 (2): 124-129
- ▶ Takatalo J, Karppinen J, Niinimäki J, et al. Prevalence of degenerative imaging findings in lumbar magnetic resonance imaging among young adults. Spine. 2009;34:1716-1721.
- ▶ Teichtahl AJ, Urquhart DM, Wang Y. Modic changes in the lumbar spine and their association with body composition, fat distribution and intervertebral disc height- a 3.0 T-MRI study. BMC Musculoskel Disorders. 2016; 17:92.
- ▶ Telli H, Telli S, Topal M. The validity and reliability of provocation tests in the diagnosis of sacroiliac joint dysfunction. Pain Physician. 2018. Jul;21(4):E367-E376.
- ▶ Yamauchi K, Inoue G, Koshi T, et al. Nerve growth factor of cultured medium extracted from human degenerative nucleus pulposus promotes sensory nerve growth and induces substance p in vivo. Spine. 2009; 34(21):2263-2269.
- ▶ Van Trijffel; Andereg, Q; et al. Interexaminer reliability of passive assessment of intervertebral motion in the cervical and lumbar spine: a systematic review. Man Ther. 2005; 10:256-269.
- ▶ Vernon H. What is different about spinal pain? Chiro & Man Therapies. 2012. 20:22