Acute Low Back Pain in the Athlete: Myofascial injury and Enthesopathy

Ariana Vora, MD
Staff Physiatrist at Massachusetts General Hospital Spaulding Rehabilitation Network

Disclosures/Conflict of Interest
• None

What is the pain generator?
• Potential causes of acute LBP in the athlete
  – Disc disruption/annular tear
  – Spondylolysis
  – Endplate fracture
  – Zygaphysial joint arthropathy
  – Sacroiliac joint
  – Myofascial
  – Enthesis
• We are trained to localize and target a single structural pain generator
MRI Findings accompanying annular tears

- Ultrashort echo time (TE) MRI pulse sequence images of patients with lumbar degeneration vs. normals
- High signal in annulus fibrosis AND also in:
  - Anterior and posterior longitudinal ligaments
  - Cartilaginous endplate
  - Ligamentum flavum
  - Interspinous ligaments
  - Insertions of ligaments


MRI findings accompanying annular tears

- Hypertrophied ligaments and scar tissue enhanced with contrast
- Disc degeneration does not occur in isolation
- Changes are seen in a functional unit of tension and compression elements
- Spine as integrated, interdependent, and dynamic biologic structure


Activity-specific nature of MSK pain

- Higher incidence of axial LBP in rowers and American football compared with other collegiate sports


- LBP comprises 20% of musculoskeletal complaints in Finnish soldiers


- LBP less common than knee, thigh, and ankle injury in collegiate soccer players

Transmission of mechanical force

- Mechanical force applied to extracellular matrix of muscle is transmitted to:
  - extracellular matrix of adjacent muscles
  - antagonist muscles
  - surrounding bony structures

Transmission of mechanical force: Human studies

- Force generation in a single human finger is coupled by force production in adjacent fingers

- Truncal muscles act synergistically during voluntary body sway

Biotensegrity

- Derived from tensional integrity concept described by R. Buckminster Fuller
- Functionally interdependent elements
- Architectural concept balancing tension cables and steel rods
  - Kenneth Snelson’s Needle Tower
**Biotensegrity**

- Vertebral bodies supported by a highly organized continuous tension network consisting of muscle, ligaments and fascia
- Bones act as compression rods
- Soft tissues act as tension elements
- Mechanical load encountered anywhere in the body is distributed through continuous network of fascia, ligaments and muscles suspending entire skeleton, including lumbar spine

Enthesis

- Site of tendon, ligament, joint capsule or fascia attachment to bone
- Biomechanical function: Absorb shock at junction between bone and soft tissue fibers while maintaining constant length
- Enthesis organ:
  - Functional unit of the musculoskeletal system
  - enthesis, fibrocartilage, fascia, bursa, fat pad, and adjacent trabecular bone


Enthesopathy: histology

- Thought to result from repeated mechanical overload
  - Tearing
  - Calcification
  - Fibroblast proliferation
  - Neovascularization
    - Vascular endothelial growth factor is highly expressed in degenerative tendons, barely present in healthy tendons

Sacroiliac joint

- Depending on the source, 6%-13% of axial low back pain is attributed to the sacroiliac joint
The sacroiliac joint/ligament complex

- Diarthrodial joint wedging sacrum between two iliac bones forming posterior pelvic wall
- Joint space: 1-2mm wide, lined with hyaline cartilage
- Superiorly: histologic qualities of a symphysis, attached to dense network of surrounding stabilizing ligaments
- Inferiorly: histologic qualities of synovial joint

Sacroiliac ligaments

- Interosseous fibers: thickest connection between sacrum and ilium
- Anterior and posterior sacroiliac ligaments
  - Ligaments and joint are so closely connected that the anterior sacroiliac ligament is a continuation of the anterior capsule

Innervation of sacroiliac complex

- Under debate
- Mechanoreceptors and nerve receptors identified with gold chloride staining
- Nerve fascicles with myelinated fibers, unmyelinated fibers, paciniform mechanoreceptors and nonpaciniform mechanoreceptors
  - Pain and proprioception pathways

Innervation of sacroiliac complex

- Fortin et al: Exclusive innervation from dorsal rami at S1-S4
  

- Electrical and mechanical stimulation studies: innervation by L4-S1 nerve roots with secondary contribution from gluteal nerve
  

Extra-articular sacroiliac pain

- 120 study subjects from two RCTs given intra-articular vs. combined intra-articular + peri-articular sacroiliac joint injection

- Outcome measures:
  - Positive response:
    - greater than 50% drop in VAS pain score
    - patients describing ADLs as “greatly improved”
  - Anesthetic response: VAS at one hour post-injection


Results

- Intra-articular alone:
  - 12.40% positive response in VAS and ADLs at 3 months
  - 42.5% anesthetic response rate

- Intra-articular and peri-articular:
  - 31.25% positive response in VAS and ADLs at 3 months
  - 62.5% anesthetic response rate

- Statistically significant improvement in combined injection group with respect to anesthetic response (P=.037) and pain/ADL at 3 months (P=.025)

- Significant extra-articular sacroiliac pain generators exist
Interspinous ligament

- Connects consecutive spinous processes
- Fan-shaped, middle fibers parallel to spinous processes
- Posteriorly blends with supraspinous ligament, which is continuous with thoracolumbar fascia
- Innervation: dorsal rami
- Function: Anchor transmitting anterior-posterior forces from extremities to spine via TLF and vertebral bodies

Interspinous ligament and LBP

- Experimental hypertonic saline injection to the lumbar interspinous ligament vs. lumbar erectorspinae muscles
  - Both caused acute axial LBP
  - Interspinous ligament injection recipients reported pain not affected by truncal flexion-extension movement (in contrast to erectorspinae group)
  - They often pointed to a location of pain 1-2 segments below the injection point

Iliolumbar ligament

- Restrains lumbosacral side bending, flexion and extension
- Stabilizes spine in setting of spondylolysis
  Jeong JC et al. The biomechanical functions of the iliolumbar ligament in maintaining stability at the lumbosacral junction. Spine 1987; 12:669-74
- Primarily innervated by Pacinian and Ruffini mechanoreceptors; also has plentiful free nerve endings
- Richest nerve endings at iliac wing

Iliolumbar ligament and biomechanics

- Cadaveric study using strain gauge sensors:
  - Slouching places mechanical stress on iliolumbar ligament
  - 100N Tension on erectorspinae and multifidi reverses slouch and relieves stress on iliolumbar ligament

Iliolumbar ligament and disc degeneration

- Annular fibers become less effective in absorbing mechanical forces in setting of disc degeneration
- Iliolumbar ligament may then take on additional mechanical stress and become subject to tears


Ligamentous degeneration first?

- Ligament and capsule as “epicenter” of joint inflammation
  - MRI, animal and human studies of hands, knees, and spine
  - Enthesis fibrocartilage due to ligamentous trauma, tearing and laxity may play a role in the pathophysiology of degenerative changes in adjacent joints


Muscle
Transversus abdominus

- Considered critical for lumbar strength and stability
- Origin: lowest six ribs, thoracolumbar fascia, anterior iliac crest, lateral inguinal ligament
- Connects linea alba to anterior pelvic wall
- Shares aponeurosis with internal and external obliques

Transversus abdominus activation

- EMG study: Activation pattern of trunk musculature with arm movements
  - In individuals without LBP: transversus abdominus contracted before limb movement initiated
  - Individuals with LBP: delayed transversus abdominus firing, following direction-specific patterns
- Suggests decreased motor control in setting of LBP
Multifidus anatomy

- Multiple fascicles; each originates at the most caudal aspect of its lumbar spinous process
- Attachments in fanlike projection to mammillary processes, iliac crest, and sacrum
- Fibers are continuous with deep laminae of thoracolumbar fascia, long dorsal sacroiliac ligament, and sacrotuberous ligament


Multifidus self-bracing mechanism

- Compresses intervertebral discs
- Facilitates lumbar lordosis
- Counteracts abdominal muscles during flexion
- Transfers energy from upper body to lower extremities
  - Multiple EMG studies: Multifidi activate during standing, sitting, trunk movement, lifting, and gait

LBP and multifidus deconditioning

- MR spectroscopy: Increased multifidus mean fat content in individuals with LBP vs. controls
  Mengiardi B et al. Fat content of lumbar paraspinal muscles in patients with chronic low back pain and asymptomatic volunteers: quantification with MR spectroscopy. Radiology 2006;240:786-92

- Multifidi biopsies in individuals with LBP compared with controls:
  - Higher distribution of type II fibers
  - Reduced diameter in both type I and type II fibers
LBP and decreased multifidus recruitment

- Hypertonic saline injection inducing unilateral LBP
- Visualization of multifidus muscles by ultrasound
- Bilateral multifidus recruitment with active arm lifts was diminished compared with controls


LBP and decreased multifidus recruitment

- Multifidus recovery is slow after LBP episodes
  - EMG study: Vs. controls, individuals in remission from LBP exhibited prolonged mean motor latency of short multifidus fibers when provoked by rapid arm movement


Myofascial pain syndrome

- Palpable tense bands of skeletal muscles
- Sustained sarcomere contraction
- Thought to have multiple triggers:
  - Muscle strain and overuse
  - Psychosocial stress
  - Postural habits
- “Trigger points:” Discrete, focal hyperirritable spots located on taut bands on skeletal muscle
- Peripheral sensitization phenomenon
Treatment of myofascial pain

• Address underlying structural, postural, psychological or ergonomic imbalance
• Evaluate for underlying medical conditions, such as hypothyroidism
• Trigger point release by needling
  – Effective for acute pain relief
  – Symptoms recur unless underlying problem is addressed


Muscles as pain generators

• Lidocaine and steroid facet injections in active adults aged 18-45 with axial LBP
  – Both groups received facet injection with lidocaine and steroid
  – One group also received continuous lidocaine advancing injection en route to facet
  – Pain relief measured at one week post-injection
  – Superior pain relief in recipients of continuous lidocaine advancing technique (P < 0.05)


Fascia
Fascia

• Multilayered, soft-tissue sheath
  – Divides muscles into organized groupings
  – Protects nerve and vascular structures
• Tissue continuum uniting and integrating different regions of the body

Thoracolumbar fascia

• Envelops and divides lumbar spine muscles into anterior, middle, posterior layers
• Posterior layer
  – Superficial: inferomedially directed fibers attaching at gluteus maximus, medial sacral crest, spinous processes, serratus posterior inferior aponeurosis, latissimus aponeurosis, and trapezius aponeurosis
  – Deep: inferolaterally directed fibers attaching thoracic spinous processes, rib angles, serratus posterior superior, deep neck fascia
  – Both layers converge at sacrotuberous ligament

Thoracolumbar fascia may stabilize lumbar spine and sacroiliac joint

• Transfers force between spine and extremities
• Traction applied to latissimus dorsi, gluteus maximus, erector spinae, and biceps femoris muscles displaces posterior thoracolumbar fascia


• Reduces lumbar axial displacement during flexion and extension

Histologic changes in TLF with LBP

- TLF samples taken from 24 patients undergoing their first lumbar surgery following positive discogram or facet block
- Histologic exam:
  - Aneural tissue
  - Ischemic changes
  - Similar to histology of diabetic microangiopathy


Treatment Strategies

Common acute LBP treatments

- Acetaminophen
- NSAIDs
- Topical preparations
- Modalities (heat, ice, massage, ultrasound)
- Manipulation
- Spinal injections: disc, facet
- Sacroiliac injections
**Muscle balance training**

- Correct tight hip flexors
- Strength and endurance of multifidus, transversus abdominus
- Address training errors

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**Optimization of biomechanics**

- Address postural awareness
- Address fit of gear and shoewear
- Evaluate gym and field technique
- Possible role of manual manipulation

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**Medications**

- Acetaminophen
- Topical preparations
- Antispasmodic
Injections

• Trigger point release
• Enthesis injections

Take-home points

• Look for pain generator to match history
• Consider interplay of bone, joint, ligament, muscle, fascia and enthesis in human movement and injury patterns
• When designing treatment, consider anatomical and biomechanical context LBP for each individual and sport.