



## PAIN & REHAB 2-DAY VIRTUAL SEMINAR

### TOPICS INCLUDE:

- Evidence Based Practice
- Pain Education
- Youth Resistance Training
- Low Back Pain
- Shoulder, Hip & ACL Lectures

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January 30th & 31st, 2021

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# 2 - Day Virtual Seminar Outline



## **Two Day Pain and Rehabilitation Webinar Agenda and Course Description**

The Barbell Medicine Pain & Rehab seminar is dedicated to helping attendees understand and implement scientific principles into clinical practice in order to provide evidence-based care to their patients dealing with pain and the rehab process.

This seminar is appropriate for clinicians, coaches, and trainers who wish to increase their knowledge base about pain, rehab, and case specific exercise prescriptions.

The seminar will be lecture based, involving audio/visual presentations followed by question and answer periods.

After completion of this 2-day seminar, attendees will have a broad understanding of the current best scientific evidence regarding the topics and how to apply such knowledge to clinical practice.

### **Lecture Topics Include:**

- Evidence Based Practice
- Pain Education
- Hip Pain
- Shoulder Pain
- Low Back Pain
- Youth Resistance Training, and
- ACL Rehab

Every lecture will include a question and answer session where Drs. Ray and Miles will spend time answering all your questions.



## **Day 1**

**8:00-8:15: Instructor introductions and review of course objectives**

**8:15-10:30: Updates in evidence base practice and critical thinking - Derek Miles, PT**

**10:30-10:45: Break with Q&A**

**10:45-12:30: Pain - Exploring the Human Experience: - Michael Ray, D.C.**

**12:30-1:30: Lunch**

**1:00-3:00: Considerations for Youth Resistance Training in Rehab - Derek Miles PT**

**3:00-3:15: Break with Q&A**

**3:15-4:45: The Shoulder - Simplifying Management With The Basics - Michael Ray, D.C.**

**4:45-5:15: Q&A**

## **Day 2**

**8:00-8:15: Address any questions from Day 1**

**8:15-10:15: Simplifying the hip - Derek Miles, PT**

**10:15-10:30: Break with Q&A**

**10:30-12:30: Low Back Pain: Guiding the Path- Michael Ray, D.C.**

**12:30-1:30: Lunch**

**1:30-3:00: RTP After ACL Reconstruction, How We Can Do Better - Derek Miles, PT**

**3:00-3:15: Break**

**3:15-4:30: Q&A**



## **Course Objectives**

### **Evidence Based Medicine**

- The attendee will be able to articulate the role of uncertainty in probabilistic thinking.
- The attendee will understand the role pre-test probability plays in interpreting statistical results in research.
- The attendee will demonstrate an understanding of the standing ovation model and the role it plays in treatment adoption.

### **Pain - Exploring the Human Experience**

- Participants will understand the evolution and history of pain in the scientific literature as it relates to clinical practice.
- Participants will discuss the change in definitions for pain based on perspective over the last 5 decades.
- Participants will understand how to discuss pain better with patients, accounting for the human experience versus tissue specific vernacular.

### **Youth Resistance Training**

- Participants will review current recommendations for physical activity guidelines in the youth population
- Attendees will develop an understanding of the Long-Term Athletic Development Model as it relates to age specific training goals
- Participants will understand how tissue specific adaptations occur related different training modalities
- Participants will be able to design a basic training program contingent upon an athlete's stage of development and goals of training

### **The Shoulder**

- Participants will review 4 common shoulder issues: scapular dyskinesis, subacromial impingement, internal impingement, and rotator cuff tears
- Attendees will develop an understanding of common radiological findings in the context of shoulder cases
- Clinicians will master evidence based management for the above reviewed topics, inclusive of exercise therapy





## **Simplifying the Hip**

- Clinicians will review current recommendations for diagnostic terminology for common hip symptoms
- Participants will be able to discuss the current treatment paradigms for those common diagnoses inclusive of tendinopathy, muscle injuries, femoroacetabular impingement, and osteoarthritis.
- Clinicians will discuss current evidence for increasing functional capacity in athletes with reported hip pain

## **Low Back Pain**

- Clinicians will be able to define low back pain with the parameters that relate to current non-specific terminology
- Participants will recognize the prevalence of low back pain and resulting disability.
- Participants will examine the base rates of biological lumbar findings and their relation to symptom presentation.
- Participants will be able to analyze & evaluate psychological and sociological correlates to low back pain.
- Clinicians will master an evidence-based approach to the management of low back pain.

## **Return to Sport After ACL Reconstruction**

- The attendee will be able to articulate modifiable and non-modifiable risk factors for risk reduction with ACL injuries inclusive of the role resistance training plays in overall player health.
- The attendee will be able to perform return to sport testing inclusive of dynamometer testing to calculate limb symmetry indexes.
- The attendee will be able to use patient reported return to sport outcomes such as the Tampa Scale of Kinesiophobia, ACL-Return to Sport Index, and IKDC.
- The attendee will understand how the scoring should interplay with return to sport discussions.
- The attendee will be able to program a weekly split for an athlete to encompass the various facets of training that need addressed in a well-developed program.



## Speaker Bios

**Michael Ray MS, D.C.** - Dr. Ray is a chiropractor based out of Harrisonburg, VA. He owns and operate Shenandoah Valley Performance Clinic and specializes in the rehabilitation of neuromusculoskeletal issues, associated pain, and dysfunction. He enjoys helping athletes from various backgrounds return to their desired level of activity. His primary goals for working with clients, educate about their situation and collaboratively design a game-plan to move them from where they are at to where they want to be.

**Derek Miles PT, DPT** - Derek is a residency trained physical therapist currently working at Cincinnati Children's Hospital. He spent three years at Stanford Children's Hospital as the Advanced Clinical Specialist in the rehabilitation department. Prior, he worked at the University of Florida for 10 years in sports medicine, treating a variety of athletic injuries from overuse to post-operative. He is involved in the peer reviewed process for academic journals and has spoken at national level conferences within the physical therapy profession on topics from utilization of resistance training in the rehabilitation of endurance athletes to post operative hip progressions. When he is not in the gym or treating, he can typically found reading, cooking, or brewing beer.



## Evidence Based Medicine

### Objectives

- The attendee will be able to articulate the role of uncertainty in probabilistic thinking.
- The attendee will understand the role pre-test probability plays in interpreting statistical results in research.
- The attendee will demonstrate an understanding of the standing ovation model and the role it plays in treatment adoption.

### Historical Context

- There are some bold claims made by clinicians on their ability to cure low back pain, prevent ACL tears, and a myriad of other injuries. None of these claims has resulted in a decrease in the incidence of low back pain or injuries in the literature.
- Clinicians like to blame constructs like adhesions or trigger points that lack good empirical evidence for their justification. This is no different than medical professionals in the past blaming disease on miasma or bad humours. We tend to look back on clinicians from 20 years ago and laugh in amazement at how wrong they were. If we're going to do that, we need to ask what clinicians 20 years from now will be laughing at us about.

### The Evidence Hierarchy and Rehab Decision Making

- The pyramid of evidence may rank meta-analysis and randomized controlled trials higher but each type of evidence is not above reproach. Meta-analysis, systematic reviews, and RCTs are all subject to interpretation. As doctoral level professionals it rests upon us to be able to interpret them properly.
- Interpretation should be viewed as a spectrum of certainty, not a dichotomy. Evidence is not yes/no but rather different degrees of maybe. The more we learn, the better we can zero in on the likelihood of being correct, but even then, we are interacting in a dirty system where all variables can never be known.



- We should use probabilistic thinking in order to make decisions and the more information we possess, the better we can calculate probability. That being said, we are always predisposed to overestimate benefits and underestimate harms. (Hoffman)
- Weber's law-the size of a just noticeable difference is a constant proportion of the original stimulus value. i.e. it is easy to tell the difference between 10 and 20 dots but not easy between 1010 and 1020 even though the difference is the same. When looking at outcomes we need to be mindful of the magnitude of differences and if they do actually matter.
- Goodhart's law- When a measure becomes a target, it ceases to become a good measure. If we know we are aiming for an "outcome" It may not be as good of one. This can be seen with hop tests, the FMS, or even the fact that studies using pain as a primary outcome tend to show a difference in pain but not function and studies using function as a primary outcome tend to show a difference in function but not pain.

## Interpretation of the Evidence

- Type I Error is the probability of accepting the experimental hypothesis when it is in fact false. This is a *false positive*. Commonly discussed via p-values with an arbitrary 0.05 value set for significance. This does not mean there is a 5% chance of false positive as it is predicated upon priors. A p-value of 0.05 with a 50/50 pre-test probability will find significant results only 71% of the time. (Nuzzo)
- Type II Error is the probability of rejecting the null when it is false. This is a *false negative*. The major problem is that many studies do not conduct power analysis so it is difficult to infer what the probability of the results being true actually are.
- In a perfect world with proper accounting for type I and type II error this would still mean that of 1000 published studies, approximately 80 would have true positive findings, 45 would be false positives, and due to the lower rate of publication for negative findings 30 true negatives. Over 1/3 of positive findings would not *really* be positive.
- We will always interpret results based upon our own priors. We are more likely to dig through a meta-analysis that shows something we disagree with than agree. This is neither good nor bad, but it must be accounted for in our own interpretation of the data.
- We should reflect on when we get positive results in clinic to check if our decision-making progress was correct. When there is a high rate of natural history resolving symptoms, it is easy to fool ourselves into thinking our treatments work.





## Standing Ovation Model

- The key is to consider what it would take for us to adopt a treatment, diagnosis, or procedure. That standing ovation model allows us to think about this through the quality of the evidence, the threshold it would take to make us adopt, and the error in the system.
- Error in the model is determined by the diversity and novice nature of the audience as well as the complexity of the performance. It states that a higher level of novice audience members and a more complex performance makes it easier for something to be adopted. We see this on a regular basis with new certifications and polysyllabic language causing drastic shifts in treatment paradigms.
- There is also the influence of the theater in which we view the show where variables such as where we went to school, where we saw the information, and what our interaction is will influence our adoption. If where we went to school highly promotes an intervention, we will be more likely to adopt it.
- We are also heavily influenced by our peers. If our friends adopt a treatment, we are more likely to as well. The Solomon Asch studies are some of the greatest examples of this where individuals went along with the crowd's decision making even though they knew the decision was wrong.
- Not everyone is as susceptible to going along with peers. This is seen in placebo studies where even if the majority receive the effect, there is a small cohort who did not. This tends to fall into approximately 25% of individuals.

## Certainty

- We should not turn questions into dichotomies as it becomes much harder to shift from right to wrong than from "highly likely" to "less likely." We are better served asking what percentage we believe something to be true. New evidence should cause perturbations to that estimation.
- We only get better at determining what is good evidence with practice. That practice should include reading things with which we disagree and applying the "why" of our disagreements to the things with which we believe to be true.
- There will always be factors in play of which we are unaware. This should offer humility to clinicians and make them wary of individuals proclaiming with absolute certainty that something works.



## Pain – Exploring the Human Experience

### Objectives

- Discuss history of pain in the scientific literature.
- Discuss definitions for pain based on perspective.
- Describe roles for professionals in pain experience.

### History

- 1974 – Creation of International Association for the Study of Pain. Led to the creation of a taxonomy regarding pain and the first proposed universal definition: *“An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”*
  - a. This definition was followed by Williams and Craig 2016 – *“Pain is a distressing experience associated with actual or potential tissue damage with sensory, emotional, cognitive, and social components.”*
- Cohen 2018 – *“Pain is a mutually recognizable somatic experience that reflects a person’s apprehension of threat to their bodily or existential integrity.”* Since the proposal of these new definitions, the IASP has since suggest a new unofficial definition pending approval – *“An aversive sensory and emotional experience typically caused by, or resembling that caused by, actual or potential tissue injury.”* It has yet to be determined if a universal definition for pain is clinically necessary, and in fact there may be some detriments by trying to force an idea of “normal” onto a patient dealing with pain.
- Healthcare models – there are two prevalent healthcare models for addressing the patient experiencing pain: Biomedical vs BioPsychoSocial.
- **Biomedical Model**
  - a. The biomedical model operates under the guise of duality with mind separate from the body.
  - b. The clinician becomes tasked as a mechanic to seek out alterations from textbook norm and correct them to attenuate or resolve pain for the patient.
  - c. Much of the biomedical model is based on the idea of nociception being strongly coupled to pain i.e. pain as a direct result of tissue damage with severity/intensity of pain as a 1:1 to amount of tissue damage.
  - d. Often, if the clinician is unable to find an underlying “problem” to correct the patient’s pain, then they are labeled as having a psychogenic issue. Much of the biomedical approach to pain unnecessarily stigmatizes the patient and leads to unnecessary worry, misdirected problem solving, disability, distress, and hyper-focus to pain.



- **BioPsychoSocial Model**
  - a. In the 1970s George Engel proposed the BioPsychoSocial (BPS) model to build on the success of the biomedical model by expanding the lens to psychology and sociology influencing the lived patient experience.
  - b. The BPS model was later adapted to pain but often creates more arbitrary lines by siloing biology, psychology, and sociology.
- **Emergent BioPsychoSocial Model**
  - a. Instead we should view pain as an individualistic, emergent process -contextually dependent, and stipulated on past experiences, beliefs, and learned behaviors - all guided through social learning.
- Phenomenology and Pain – Stilwell et al introduced an enactive approach to pain to move beyond the BPS model, stating: "...pain does not reside in a mysterious immaterial mind, nor is it entirely to be found in the blood, brain, or other bodily tissues. Instead, it is a relational and emergent process of sense-making through a lived body that is inseparable from the world that we shape and that shapes us."
- The enactive approach to pain involves **5Es: Embodied, Embedded, Enacted, Emotive, and Extended.**

## Semantics

- Definition: *"the branch of linguistics & logic concerned with meaning; the meaning of a word, phrase, sentence or text."*
- The language we use influences the pain experience.
  - We need to be careful in how we explain pain to patients; moving away from body as machine, live wires, damage, and weaponry metaphors.
- Different terminology for the same condition can influence patient expectations for treatment interventions.
  - Example: Spinal Degenerative Disc Disease vs Non-specific (multifactorial) low back pain. Our words also have an iatrogenic effect to increase severity/intensity of symptoms (Ex: nocebo).
  - To quote Neilson 2016, *"Pain is what we say it is over time." "Pain is also the context in which we feel pain, and that context need not be a clinicoapocalyptic one of damage, weaponry or live wires."*



### Patient Perspective

- Often, those experiencing persistent pain describe the experience as isolating, personified, overwhelming, and as physical sensations but some also report coping well with pain. Munday 2019 states – *"This dependence on metaphor may suggest something of the nebulous, subjective nature of pain, but also of the desire to communicate it to others and to make the invisible visible."*

### Provider's Role

- Being a guide - With a new understanding of pain, the question becomes what role do you play when helping someone dealing with pain. A 5 pronged approach is presented:
  - a. Educate – about the meaning of pain as it relates to the individual's experience. Create therapeutic alliance to reframe beliefs around pain and how best to cope. Set expectations by providing reassurance, discussing likely clinical course/prognosis, and how to best move forward from where they are at to where they want to be. Be cognizant of the placebo and nocebo effect during clinical interactions.
  - b. Decrease fear and kinesiophobia - fear is defined as, "The anticipatory emotional response to imminent threat, and adaptive learning takes place rapidly, either through direct experience, observation, or verbal instructions." Often people are fearful of the meaning of pain or of experiencing pain. Kinesiophobia is defined as, ""...an excessive, irrational and debilitating fear to carry out a physical movement, due to a feeling of vulnerability to a painful injury or reinjury." In many scenarios, it is ok to allow people to exercise with pain and research demonstrates a small initial benefit for doing so; likely related to instilling the mindset of acceptance of pain rather than being controlled by pain, reducing the mentality of "hurt equals harm", mitigating kinesiophobia, fear-avoidance, catastrophizing, and building self-efficacy.
  - c. Minimize catastrophizing, defined as, "Broadly conceived as an exaggerated negative "mental set" brought to bear during actual or anticipated pain experience." Catastrophizing consists of 3 components: rumination, magnification, and learned helplessness.
  - d. Instill self-efficacy: "Belief in one's ability to accomplish a task and succeed." Pain is a threat to social self by fundamentally challenging: autonomy, sense of belonging, and justice/fairness. Reinforce patient self-care behaviors, enhance patient beliefs in their ability to control pain, and build self-efficacy and autonomy. We can use regression to the mean to help reinforce patient self-care behaviors, enhance patient beliefs in their ability to control pain, and build self-efficacy and autonomy.



- Exercise can be analgesic for pain BUT we dosage is largely an unknown (Frequency, Intensity, Time, and Duration). These variables can be manipulated for specific adaptation to imposed demand.
  - a. Finding a tolerable entry point to activity with which to build from is a major part of the process. Eliciting buy-in the process will be non-linear, with highs and lows, is an important part of getting the person to embrace the process.

## Youth Resistance Training

### Objectives:

- Review current recommendations for physical activity guidelines in the youth population
- Develop an understanding of the Long-Term Athletic Development Model as it relates to age specific training goals
- Discuss tissue specific adaptations to different training modalities
- Design a basic training program contingent upon an athlete's stage of development and goals of training

### Recommendations

- ACSM recommends 2-3x/week of strengthening activity with only 18.6 % of individuals meeting this criteria. (Dankel 2016)
- The American Academy of Pediatrics Position Statement supports resistance training, states it is an essential component of training, and regular participation earlier in life correlates with participation later in life.
- Dogmatic recommendations that athletes need 10,000 hours of participation are not supported in the literature. The original Eriksson study was conducted on violin players, not athletes. Even in this literature, musicians who slept more than their peers were more likely to be successful.

### Specialization

- Currently over 75% of families in the US have at least one child participating in organized sport. (Amin). 12% of children under the age of 7 participate in organized sport, up from 9% in the previous decade. (Malina) 60 million youth between the ages of 6 and 18 participate in organized sport as of 2013. (DiFiori)





- Current recommendations according the Post are that athletes who are participating in more than 8 months of organized sport/year, more hours of participation per week than years old, or greater than 16 total hours of organized sport/week are at *increased risk* of injury.
- Multiple *ideal* variables such as jump height and pitch velocity have been correlated with increased risk of injury. (Olsen, Visnes)
- Specialization has also led to increased risk of psychological burnout consisting of exhaustion, cynicism, and feelings of inadequacy. (Sorkilla) Athletes striving for perfection are also at an increased risk of burnout. (Madigan)

### Long Term Athletic Development Model

- The Long Term Athletic Development Model (LTAD) breaks goals for training into Early Childhood, Late Childhood, Adolescents and Adults. Each category advocates for the use of different training modalities with early sports specialization not emerging until adolescence.
- Free weight training is advocated as early as late childhood (middle school age) which falls into what is considered the window of optimum trainability. Waiting until high school to begin resistance training is not the best way to begin establishing a strong athletic base.
- Female athletes seem to benefit from resistance training even more (O'Kane) but this could be due to them starting out more untrained than their male counterparts. With the increased risk of injuries such as ACL tears in females, resistance training is likely even more warranted.
- Training needs to be consistent over time and not sporadic if gains are to be seen. Short spanned "camps" may elicit immediate increases in strength, but this will not be maintained unless the stress to the system continues.

### Individual Tissue Adaptation

- Muscle, tendon, and bone adapt at different rates to different stress. Bone adaptation particular appears to be particularly important in adolescence. (Bonnet) Athletes participating in repetitive sports such as running and swimming were much more likely have bone mineral densities lower than their multi-direction sport peers. (Nichols)
- Direct muscle adaptation studies are difficult to perform in youth due to ethics reasons with biopsy. From other data, it appears that muscle follows the same pattern as bone with a good deal of adaptation occurring during middle school age.



- Youth tend to have more compliant tendons than older individuals but this is still contingent upon the sports that athletes. Overall tendon turnout is slow and there is some evidence that this could contribute to common pediatric conditions such as apophysitis.
- Tendon in particular adapts to heavy, slow loading (Bohm) but this does not include plyometric training. (Foure, Bohm, Houghton)
- Resistance training has also been shown to help with adolescent obesity, but dosing of exercise appears to be the most influential variable on effect. (McGuian, Schranz)

### **Training Modality Selection**

- Core is a poorly defined term and likely should not be used to determine exercise prescription. There is no good evidence that "core" training (whatever the hell that is) is superior to other forms of training.
- Balance training appears to be highly task specific. This does not mean that it should not be performed, but rather there needs to be a wide variety of tasks that are practiced under the balance umbrella. (Kummel, Behm)
- Plyometric training does have some evidence for efficacy but it should constitute a small part of an overall training session. (Johnson)
- All of these variables may be better grouped as either neuromuscular or skills training. Neuromuscular training in general has been shown to reduce the risk of injury by 30-40% but training needed to be greater than 23 weeks. (Emery, Faude)
- Eccentric training seems to have a place in risk reduction via the Nordic hamstring exercise and work on change of direction. Most resistance training exercises include an eccentric component but eccentrics would also be included in agility drills.
- Resistance training has shown the same decreases in injury risk but in the same regard, it needs to be often. The current recommendations from Lesinski are greater than 23 weeks/year, 5 sets of 6-8 reps at RPE 8 with 3-4 minutes rest in between sets.
- Gains of 10% in strength have been correlated with a 4% reduction in risk of injury. Overall, training should include a mix of skills and resistance training in order to facilitate the most well rounded athletic development. (Lauersen)

### **Take Home Message**

Training should consist of a large mix of skill training encompassing a wide variety of tasks. Beginning around middle school age, resistance training is indicated for the youth population and should serve as a fundamental pillar of training. Overall, athletes should participate in a heavy dose of skills training, and skills dose of heavy training, and sport specific in ideally a variety of sports.



## The Shoulder – Simplifying Management With The Basics

### Objectives

- Define and discuss 4 common shoulder “issues”:
  - Scapular Dyskinesis
  - External (Subacromial) Impingement
  - Internal Impingement
  - Rotator Cuff Tears

### Scapular Dyskinesis

- Definition: deviation from “*normal*” scapulohumeral kinematics
  - lacks evidential support as meaningful narrative in the management of an atraumatic shoulder pain case.
- Key points
  - The suggested 2:1 ratio of 2 degrees of humeral elevation to 1 degree of scapular upward rotation as normal scapular kinematics is an outdated narrative and instead the spectrum is much broader at 1:1 – 6:1.
  - The variability in scapular kinematics is based on how the measurement is taken, plane of elevation, external lading, speed of motion, pain, fatigue, etc. Often clinicians visibly observe scapular kinematics in an attempt to explain shoulder pain. The narrative is provided of scapular dyskinesis which is related to an “*unstable*” scapula due to “*weak*” musculature.
  - According to Wassinger 2015, scapular visual assessment lacks validity with an accuracy no better than a coin flip at 49.5% and reliability poor to fair.
  - Wright 2013 demonstrated physical exams for the scapula also lack validity. Even if we wanted to follow this line of thinking, scapular dyskinesis does not appear correlated to shoulder pain or shoulder impingement syndrome (SIS).
  - Although we can intervene with exercise at the scapula level and gain improvement (decreased pain and improved function), it has little to do with specific exercises altering scapular movement and more to do with doing something is better than nothing.



## External Impingement

- Definition: aka subacromial impingement is an outdated narrative from the 1970s that originated by Dr. Charles Neer.
  - 100 cadaver scapulae were examined, which *"revealed alterations attributable to mechanical impingement."*
  - From Neer 1972 - *"At about 80 degrees of abduction, the critical area of the supraspinatus tendon passes beneath the acromioclavicular joint and this joint tilts with overhead elevation of the arm. With the joint in this position, it is logical to assume that excrescences on the undersurface of the anterior margin of the acromion may impinge on the cuff. Arthrograms seem to substantiate this point."*
- Key points
  - Cuff 2017 demonstrates how damaging this narrative of subacromial impingement can be to a patient's understanding of their pain (biomechanistic) and expectations for treatment (surgical) to gain resolution of symptoms.
  - Dierks 2014 proposes we shift our language to more generalized terms such as *"rotator cuff related shoulder pain"*.
    - I'm a biased fan of general activity related shoulder pain.
    - The hope is to minimize hyper-focusing on a biological tissue pain *"driver"* that necessitates a specific intervention.
    - These terms would replace: bursitis, tendinosis calcarea, supraspinatus tendinopathy, partial rotator cuff tear, biceps tendinitis, or cuff tendon degeneration.
  - In regards to assessment for atraumatic shoulder pain, we lack valid orthopedic tests to assess a particular underlying issue. Often a positive shoulder orthopedic test leads to further investigation with imaging (x-ray/MRI).
    - However, we have sufficient evidence to question this approach given we have the same findings in asymptomatic populations (no pain and no dysfunction) – See Teunis 2014, Tran 2018, and Barreto 2019.
  - Dierks 2014 outlines 3 factors which alter prognosis of a case: duration of symptoms (> 3 months) is associated with poorer outcomes, middle-aged (45-54 years) is associated with poorer outcomes, and psychosocial factors. The primary modifiable risk factor from above are psychosocial factors.



- Chester 2018 states, *"Psychological factors were consistently associated with patient-rated outcome, whereas clinical examination findings associated with a specific structural diagnosis were not."*
- Additionally, Steuri 2017 found - *"Exercise, especially shoulder-specific exercises, should be prescribed for all patients with shoulder impingement."*
- In regards to surgery – Beard 2017 and Paavola 2018 both found surgical intervention based on the narrative of subacromial impingement syndrome lacks efficacy.
  - Paavola 2018 states - *"The results of this randomised, placebo surgery controlled trial show that arthroscopic subacromial decompression provides no clinically relevant benefit over diagnostic arthroscopy in patients with shoulder impingement syndrome. The findings do not support the current practice of performing subacromial decompression in patients with shoulder impingement syndrome."*
- Overall, whether performing the actual surgery or "fake" surgery (sham i.e. pretending to do the surgery) similar outcomes are achieved which seriously questions the efficacy of this intervention. We also must consider the risks that come with an unnecessary surgical intervention.

## Internal Impingement

- Definition: Seen in overhead and throwing sports – baseball, racket sports, volleyball, water polo, etc. Historically pathologized BUT perhaps a sport-specific adaptation.
  - Biomechanics - greater tuberosity of the humerus is thought to come into contact with the posterior-superior glenoid rim.
  - Purpose - limits excessive external rotation of the shoulder. Often the thought process is this leads to *"internal impingement"* of the labrum and rotator cuff, between the humeral greater tuberosity and glenoid rim.
  - Clinical presentation – activity related diffuse posterior shoulder pain. Positive *"posterior impingement sign"*: posterior shoulder pain during passive late-cocking phase position.
- Key Points:
  - Imaging often ordered in search of biological "problems".
    - However, Spiegl 2014 states - *"Owing to the large body of evidence suggesting various factors that may be involved with the development of symptomatic internal impingement and its corresponding pathologic lesions, it is most likely a complex, multifactorial process that has yet to be completely elucidated."*





- We also have evidence that common radiological findings in this cohort also occur in asymptomatic people (See Pennock 2018, Del Grande 2016, Lee 2017 Johansson 2014 and Fredericson 2009).
- Connor 2003 questions if imaging findings place this cohort at increased risk of future symptoms.
  - Took baseline images and follow-up 5 years later – *"None of the athletes interviewed 5 years later had any subjective symptoms or had required any evaluation or treatment for shoulder-related problems during the study period."* Schär 2018 demonstrates some findings on imaging may have a natural history – *"Our data suggest that findings of the throwing shoulder like partial rotator cuff tears, bony cysts and ganglions do not progress after retirement, and sometimes they resolve."*
- So what matters the most with this population:
  - Move away from overly biomedical reductionist narratives
  - Mitigate Early Sport Specialization
  - Focus on LOAD & FATIGUE Management
  - Psychosocial Coping Skills
  - Include Resistance Training (modulated based on competition season)

## Rotator Cuff Tears

- Teunis 2014 finding increased prevalence of rotator cuff issues throughout life (< 20 years old at 9.7% → 62% in those > 80 years old).
  - a. Teunis 2014 states – *"Whereas many surgeons favor a 'wear and tear' theory, it is also possible, and in our opinion more likely, that the rotator cuff is subject to an inherent degenerative process similar to thinning and graying of the hair."*
- A false dichotomy of traumatic vs degenerative or non-traumatic has been created as it relates to rotator cuff tears. This dichotomy often dictates elected treatment/management (conservative vs surgery).



- a. *According to Littlewood 2018– “200% increase in surgical rates in USA/Europe in recent years.”*
  - b. *However, we lack evidence to support this increase.*
  - c. *Ryösä 2017 compared surgical vs conservative management for rotator cuff tears and stated - “There was no clinically significant difference between surgery and active physiotherapy in 1- year follow-up in improving Constant score or reducing pain caused by rotator cuff tear.”*
  - d. *Khatri 2018 examined the natural history of rotator cuff tears by comparing non-op treatment, acromioplasty alone, or surgical repair - “We show that patients with symptomatic full-thickness rotator cuff tears demonstrate a consistent and considerable response to treatment, even with nonoperative management. The largest improvement occurs in the first 12 months, after which the response stabilizes.”*
- Another common narrative for validating surgical intervention is the concern of tear progression.
  - a. However, Kwong 2019 demonstrated although tears progress in both asymptomatic and symptomatic shoulders, it's minimal and not statistically significant.
  - b. Boorman 2018 found non- operative treatment to be acceptable and sufficient management of many cases presenting with rotator cuff tears (even up to 5 years) – *“Nonoperative treatment is an effective and lasting option for many patients with a chronic, full-thickness rotator cuff tear ...While some clinicians may argue that nonoperative treatment delays inevitable surgical repair, our study shows that patients can do very well over time, no matter whether treated operatively or nonoperatively.”*
- Injections
  - a. Cook 2018 demonstrated that corticosteroid injections may have an initial, small benefit (less than 8 weeks) however we lack sufficient data to adequately weight risks against these small benefits. The authors state – *“Future research is needed that compares injections of CS, local anaesthetic, saline injections, needle only (for the mechanical effect), other products (eg, hyaluronate sodium) an advice only group, true placebo and a control group (to map natural history).”*



- Exercise
  - a. Jeanfavre 2018 found – *“There is substantial evidence to support the use of exercise therapy as first line management, especially in individuals >60 years of age with chronic, degenerative FTT.”*
    - As it relates to psychosocial factors - Coronado 2018 found *“...psychosocial factors, namely emotional or mental health, are associated to a weak to moderate degree with initial function or disability and pain in patients seeking operative treatment for rotator cuff tears, whereas expectation was the only factor associated with postoperative patient-reported outcomes.”* We also have evidence from George 2009, Lentz 2009, and Menendez 2015 in addressing psychosocial factors for this patient cohort.

### Further Reading:

- [Scapular Dyskinesia:](#)
- [External \(Subacromial\) Impingement:](#)
- [Internal Impingement](#)
- [Rotator Cuff Tears](#)

## The Hip

### Objectives

- Review current recommendations for diagnostic terminology for common hip symptoms
- Discuss current treatment paradigms for those common diagnoses
- Discuss current evidence for increasing functional capacity in athletes with reported hip pain



1-Normal hip morphology is a highly variable spectrum with both range of motion and strength possessing wide norms. Even something as simple as hip rotation range of motion varies with some individuals possessing more internal rotation, some equal, and some more external range of motion. (Kouyoumdijan *et al*)

2-There is a tendency to prefer specific diagnoses for hip related pathology but position statements such as the Doha agreement advocate for broader terminology that we will break down into management of tendinopathies, impingement, muscle injuries, "arthritis," and unicorns. (Weir *et al*)

### **Tendinopathy**

1-Tendinopathies related to the hip (hamstring, gluteal, hip flexor, and quadriceps) do not have well validated treatment paradigms so instead we are forced to rely on heuristics from Achilles and patellar tendinopathy and will adopt the current terminology from Jill Cook's group on asymptomatic, reactive, degenerative, and reactive on degenerative.

2-Absolute rest is contraindicated for tendinopathy as it perpetuates less than ideal adaptation. The ultimate question then becomes where we start with training which under current evidence advocates for starting with isometric training. The evidence for its utilization however is low and based on low level studies primarily for the patellar tendon.

3-The gold standard for tendinopathy treatment is the Alfredson's protocol but this was based on 15 recreational runners with an average age of 44. It is difficult to extrapolate this to a broader athletic population. This has led to a movement towards *heavy slow resistance*

*training* (Kongsgaard, Beyer)

4-Contingent upon athlete goals, as symptoms improve there should be a phase of energy storage training. This would be considered plyometric or change of direction training dependent upon the demands of the sport in which an athlete participates.

### **Muscle Injuries**

1- Colloquially referred to as "strains," muscle injuries as a spectrum from delayed onset muscle soreness to complete muscle ruptures. "Strain" is the biomechanical cause, not the injury. (Mueller-Wohlfahrt 2013)

2- This is an area where imaging is more likely warranted in the pediatric population as there is a higher probability of avulsion fractures. In the adult population, imaging has not been shown to add much in terms of management or prediction of time to return to sport. (Jacobsen, Wangenstein, van Heumen).



- 3- There appears to be a correlation with risk of muscle injury and timing in season as many occur within the first 6 weeks of participation. (Elliot)
- 4- A primary goal of rehab is to address any limb symmetry index that persists with athletes returning to sport <85% having a 2.4-4x increased risk of reinjury. (Fousekis, Bourne)
- 5- There is good evidence for ways with which to address strength deficits utilizing eccentric based training through the Nordic Hamstring Curl, Reverse Nordic Hamstring Curl, and Copenhagen adductor exercises. A host of other exercises also could be utilized so long as an appropriate strength measurement outcome measure (not MMT) is used to determine outcomes.
- 6- Return to Sport Clearance should be a shared decision making process where an athlete has addressed any residual strength deficits, participated in sprinting, and deceleration drills, and been cleared by the entire medical team. (van der Horst)

### **Impingement**

- 1- There is a high base rate of cam, pincer, and mixed morphology in the asymptomatic athletic population. The Warwick consensus statement advocates for the use of this vernacular over words like "deformity, abnormality, or lesion."
- 2- There has been a dramatic increase in utilization of arthroscopic management over the past 15 years without the same justification of outcomes for the surgery. (Montgomery, Sing) Jacobs *et al*/demonstrated a higher correlation with mental health scores than any pathology when looking at hip arthroscopy.
- 3- Currently 87% of professional athletes return to sport after hip arthroscopy but only 57% of normal individuals return to their prior level of play, (Jack, Ishøi)
- 4- Individuals with FAI syndrome were weaker with lower extremity strength than matched controls. It appears that strength once again is a variable that can be highly targeted during rehab. (Diamond, Casartelli)





## Arthritis

- 1- There is a high prevalence of radiographic OA present in the asymptomatic population with the Framingham studies demonstrating the base rate 19.6% while only 4.2% of individuals were symptomatic. The explanation that joints are "bone on bone" does no one any favors when it comes to decreasing pain and increasing function in these individuals.
- 2- There is a paucity of exercise related studies directly related to the treatment of hip OA but we can use knee studies as a proxy. Here, Bartholdy, in their analysis determined a strength gain of 30-40% was necessary to decrease pain and increase function. While this could be seen as a large gain, it can also demonstrate the overall weakness present in the lower extremities of these individuals.
- 3- Exercise programs can focus on aerobic, resistance or neuromuscular components of training and be successful. The evidence suggests a minimum of 2x/week (same as ACSM guidelines) and longer duration programs have demonstrated increased efficacy.
- 4- Borde et al recommends 2-3x/week with RPE > 5 and 2-3 minutes rest between sets as an ideal dosage for resistance training. Basically, there is a high likelihood we are underdosing exercise to this population.

## Closing

1. We are likely far inferior in dosing of exercises to hip patients.
2. We likely let a diagnosis scare us into being too conservative in our care.



## Low Back Pain - Guiding the Path

1. This lecture focuses on the following objectives:
  - a. *Define low back pain.*
  - b. *Recognize the prevalence of low back pain and resulting disability.*
  - c. *Examine the base rates of biological lumbar findings and their relation to symptom presentation.*
  - d. *Analyze & evaluate psychological and sociological correlates to low back pain.*
  - e. *Master an evidence-based approach to the management of low back pain.*
2. *"Low back pain is a symptom not a disease..."* Defined by location - between lower ribs and inferior aspect of glutes. May be associated with lower extremity (leg) symptoms. Globally - leading cause of Years Lived with Disability (YLD). Global point-prevalence was 7.3% in 2015 = 540 million people dealing with this issue at any one time. Natural History - In general, people will notice marked reductions in pain and disability within the initial six weeks of onset. However, many still report symptoms at 3 months, 6 months, and 12 months after onset. The best estimate of the 1-year recurrence rate is 33%. The only prognostic factor supported by the existing evidence is a history of previous episodes of LBP. Parreira 2018 further examined risk factors for low backpain and sciatica and found – "Our results showed that exposure to a range of factors pertaining to the individual, poor general health; physical stress and psychological stress significantly increased the risk of [low back pain] and sciatica."
3. Low back pain is a prevalent and debilitating problem, what are we going to do about it? Our approach is often dictated at some level by the lens we use to view the person experiencing low back pain: biomedical vs BioPsychoSocial. The majority (90%) of low back pain is considered non-specific aka multifactorial. This means there is no diagnosable underlying pathology that can be causally related to pain perception. This is a good thing and means we should generally avoid catastrophizing (unnecessarily worrying) about the "cause". Only 1-4% of low back pain cases are due to underlying pathology necessitating a timely diagnosis and intervention. These cases include: fracture, malignancy, infection, and cauda equina syndrome. The Choosing Wisely campaign (and multiple professional organizations) strongly recommend against early imaging for acute onset low back pain with/without radicular/radiculopathy symptoms. Exceptions warranting clinician consideration for ordering imaging (not an absolute):
  - a. Personal history of Cancer / Unintentional Weight Loss
  - b. Clinical history raising suspicion for fracture
  - c. Progressive neurological symptoms / Cauda Equina Syndrome
  - d. Suspected infection



Additionally, one may become suspicious of axial spondyloarthropathies BUT keep in mind the prevalence rate is VERY low. Axial spondyloarthritis (axSpA) is an umbrella phrase for chronic inflammatory issues affecting the axial spine.

Such disorders include: Ankylosing Spondylitis, Psoriatic arthritis, Reactive arthritis, and Inflammatory bowel-related arthritides (Crohn's and Ulcerative Colitis). The prevalence of axSpA is low, between 0.32% and 1.4%. Why does ordering unnecessary imaging matter in this context? Because there are negative side-effects to consider. Darlow 2017 demonstrates how clinicians misinterpret radiological findings and the meaning of such findings in the context of the patient's pain experience. This leads to unhelpful advice → further investigations → interventions. This clinical approach can lead to the patient also misinterpreting the radiological findings → catastrophizing → fear avoidance → low expectation for recovery. We also can't forget the unnecessary exposure to radiation for unnecessary imaging. According to Lemmers 2019 - "...imaging in patients with low back pain does increase costs and healthcare utilization. There are indications that it also leads to higher absence from work. This is unwarranted for both patients and society since we know that imaging in low back pain has no health benefit." Imaging for low back pain does NOT improve outcomes and exponentially increases

4. However, many clinicians will consult patients who have undergone unnecessary imaging. Therefore it helps to know the base rates of lumbar imaging findings to help "normalize" the conversation and reframe our understanding of the correlation or lack thereof to such imaging findings and the person experiencing low back pain. Brinjikji 2015 found – *"Imaging findings of spine degeneration are present in high proportions of asymptomatic individuals, increasing with age. Many imaging-based degenerative features are likely part of normal aging and unassociated with pain. These imaging findings must be interpreted in the context of the patient's clinical condition."* However, we have an additional article from 2015 by Brinjikiji that found – *"Meta-analysis demonstrates that MR imaging evidence of disc bulge, degeneration, extrusion, protrusion, Modic 1 changes, and spondylolysis are more prevalent in adults 50 years of age or younger with back pain compared with asymptomatic individuals."* So rather than say these findings don't matter, instead we should ask how much do they matter in the management of low back pain cases excluding the above discussed unicorn cases. Even if we wanted to go the route of lumbar disc herniation being a problem, we have evidence discs heal:



- a. Macki 2014 – “Sequestrations have the highest likelihood to radiographically regress in the shortest time frame (mean= 9.27 months with serial MRIs) in comparison to the remaining four subtypes of LDH.”
- b. Chiu 2015 - *“The probability of spontaneous regression was 96% for disc sequestrations, 70% for extrusions, 41% for focal protrusions, and 13% for disc bulges. (P <0.001, Table 2)”*
- c. Zhong 2017 - *“Our meta-analysis showed that the overall incidence of spontaneous resorption after LDH was 66.66% (95% CI 55.12% –78.21%)...”*

#### Lumbar Spinal Stenosis:

Ishimoto 2013 found – *“In conclusion, the present study evaluated the prevalence of radiographic LSS and clarified its association with clinical symptoms in a population-based cohort. Many participants had radiographic LSS, but few had clinical symptoms. The prevalence of clinical symptoms increased with increasing severity of radiographic LSS.”* Burgstaller 2016 found – *“Despite a thorough analysis of the data we were not able to prove any correlation between radiological findings (MRI) and the severity of pain. There is a need for innovative ‘methods/techniques’ to learn more about the causal relationship between radiological findings and the patients’ pain related complaints.”*

Modic Changes - Defined – *“...endplate related signal changes in the vertebrae.”* These were once thought to have a stronger correlation to low back symptoms, however, new research is contradicting this stance. Herlin 2018 found:

- a. The associations between Modic changes and both outcomes of low back pain and activity limitation are inconsistent.
- b. No difference in low back pain intensity or level of activity limitation found between patients with and without Modic changes.
- c. Results question the conclusions from previously published reviews that Modic changes may constitute a specific clinically relevant subgroup among people with low back pain.

Muhareb 2019 examined a cohort of 204 LBP patients with baseline MRI followed for 13 years. Authors found modic changes present in 40% of persistent LBP patients. Oddly – *“Patients with MCs had less disability and sick leave at 13- year follow-up compared to LBP patients without MCs.”*



Osteoarthritis – Kalichman 2008 was community-based study of 188 participants and found high prevalence of FJ OA, 59.6% in males & 66.7% in females. Prevalence also increased with age. Authors concluded – *"In this community- based population, individuals with FJ OA at any spinal level showed no association with LBP."* Sacroiliac Joint Osteoarthritis - Eno 2015 evaluated 373 CT scans (746 S/I joints) for degenerative changes in asymptomatic adults. Prevalence of S/I joint degeneration was 65.1%, Substantial degeneration observed in 30.5% of asymptomatic subjects. Authors state - *"The prevalence steadily increased with age, with 91% of subjects in the ninth decade of life displaying degenerative changes."* *"Radiographic evidence of sacroiliac joint degeneration is highly prevalent in the asymptomatic population and is associated with age. Caution must be exercised when attributing lower back or pelvic girdle pain to sacroiliac joint degeneration seen on imaging."*

Spondylolysis and Spondylolisthesis – Kalichman 2009 - 21 of 188 participants demonstrated spondylolysis on CT. Prevalence of degenerative spondylolisthesis increased from 5th – 8th decade. No significant association identified between spondylolysis, isthmic spondylolisthesis, or degenerative spondylolisthesis and occurrence of LBP. Andrade 2015 - No strong or consistent association between spondylolysis/isthmic spondylolisthesis and low back pain. Natural History - Beutler 2003 - Prospective study initiated in 1955 of 500 first-grade children, 45- year follow-up. Progresses slowed with each decade, no subject reached 40% slip. No association of slip progression and low back pain.

Scoliosis - Screening for Adolescent Idiopathic Scoliosis: US Preventative Services Task Force Recommendation statement - "Therefore, the USPSTF concludes that the current evidence is insufficient and that the balance of benefits and harms of screening for adolescent idiopathic scoliosis cannot be determined." Probably means, we should not universally screen everyone for scoliosis.

Weinstein 2003 article titled, "Health and Function of Patients with Untreated Idiopathic Scoliosis, A 50-Year Natural history Study" found, "Untreated adults with LIS [Late-onset idiopathic scoliosis] are productive and functional at a high level at 50-year follow-up. Untreated LIS causes little physical impairment other than back pain and cosmetic concerns."





Muscle characteristics and low back pain – From Suri 2015 – *“Few lumbar muscle characteristics have limited evidence for an association with future LBP and physical performance outcomes, and the vast majority have limited evidence for having no association with such outcomes.”*

Chen 2018 found the following predictors for long-term low back pain:

- a. Lower socioeconomic status
- b. Higher pain intensity
- c. Greater consequences and longer duration of pain
- d. Emotional response
- e. Personal Control / Passive Behavioral Coping

Education and Low Back Pain – O’Keeffe 2019 discusses components of education for those dealing with low back pain:

- a. Listen and Connect
- b. Reassure
- c. MythBusters (*“Compassionate confrontation of misinformation”*)
- d. Explore Movement & Life

Words Matter – Darlow 2013 discusses the enduring impact of what clinician’s say to those dealing with low back pain and how these narratives influence beliefs/behaviors. Demonstrated in this quote – *“Basically all I’ve kind of been told to do by physios is to work on my core...I’ve been tested by various different physios, and Pilates, and I’m apparently ridiculously weak. I had an abortion because I didn’t think I could have a baby. I didn’t think I could handle it carrying it, and having extra weight on my stomach (CLBP11).”*

Setchell 2017 examines individuals’ explanations for their low back pain and where these narratives originated. Several themes emerged:

- a. Body as machine (structuralist)
- b. Low Back Pain as permanent/immutable (structuralist)
- c. Low Back Pain is very negative (catastrophizing)

The majority of participants (n = 116, 89%) identified healthcare professionals as the recurrent source of their beliefs regarding persistent and low back pain. Additionally, participants identified the internet as the second source of their understanding about low back pain (n = 31, 24%). Ferreira 2019 examined the credibility of internet website for disseminating evidence based information / guidelines regarding low back pain. Primary finding – *“Websites from government agencies, consumer organizations, hospitals, nongovernmental organizations, professional associations, and universities demonstrated low credibility standards, provided mostly inaccurate information, and lacked comprehensiveness across all types of LBP. Our findings highlight the need for these organizations to reformulate their treatment recommendations to reflect current evidence in the management of LBP.”*



Our target for clinical practice should not be zero pain or even to reduce severity/intensity of pain BUT instead aid those who are suffering. Lee 2016 (Zero Pain Is Not the Goal) – *"In short, patients place greater emphasis on the how (whether they are receiving care that is compassionate, coordinated, and focused on optimizing their outcomes) than the what (whether their pain is completely controlled). Zero pain is not the goal. The reduction of suffering is—and that is something more complex than analgesia alone."* Ballantyne 2015 (Intensity of Chronic Pain – The Wrong Metric?) – *"Suffering may be related as much to the meaning of pain as to its intensity. Persistent helplessness and hopelessness may be the root causes of suffering for patients with chronic pain yet be reflected in a report of high pain intensity."*

What health information needs are perceived by people with low back pain? From Lim 2019:

- a. General information on low back pain: Clear and detailed explanation of the nature of LBP (unpredictable, intermittent and fluctuating course).
- b. Diagnosis and cause or etiology of low back pain: Validation and legitimization of their experience. Frame as multifactorial. Be mindful of relaying body as machine.
- c. Perceived Needs for Imaging: EDUCATE
- d. Prognosis, including future disability and effect on work capacity: Natural History. Favorable prognosis (likely outcomes). Benign nature. Work capacity (being active with lbp).
- e. Information about precipitation of flares: Deconstruct fears (movement/activity). Instill self-efficacy for flare-management.
- f. General Information about LBP Management: Role of physiotherapy/osteopathy/postural advice/exercise. Which physical activities beneficial / not beneficial to avoid flare-ups. Improve coping. Maintaining independence. INDIVIDUALIZED INFORMATION.

## Return to Sport Criteria for ACL Rehab

### Objectives

- The attendee will be able to articulate modifiable and non-modifiable risk factors for risk reduction with ACL injuries inclusive of the role resistance training plays in overall player health.
- The attendee will be able to perform return to sport testing inclusive of dynamometer testing to calculate limb symmetry indexes.
- The attendee will be able to use patient reported return to sport outcomes such as the Tampa Scale of Kinesiophobia, ACL-Return to Sport Index, and IKDC. The attendee will understand how the scoring should interplay with return to sport discussions.
- The attendee will be able to program a weekly split for an athlete to encompass the various facets of training that need addressed in a well developed program.



## What is out of our control?

- ACL tears happen fast with peak strain reported in 0.04 seconds. This is far faster than we can react to visual, auditory, or tactile stimulus. (Shin, Withrow)
- Every year there are 100-250k ACL tears in the US, with the majority being primarily non-contact. Females are 2.7-4.3x more likely to suffer a tear.
- While 83% of athletes return to sport (Lai), the retear rate in athletes <25 is 23% (Wiggins) and only 55% of normal athletes return to competitive sport. (Arderon). However, 84% of patients expect to return to preinjury level after sport. (Webster)
- Prior to ever saying hello to a therapist there will likely have been a discussion of graft selection with no graft proving superior but allografts having an established higher retear rate according to the MOON cohort.
- Other non-modifiable risk factors include BMI, female sex, femoral notch index, knee recurvatum, mental status, general joint laxity, and ACL tensile strength.
- One of the biggest variables influencing current return to sport discussion is re-ligamentization. The current evidence points towards this taking approximately 9 months, directly influencing current return to sport timelines.

## What is in our control?

- We can influence patient psychology, conditioning and biomechanics. If we are not accounting for all of these variables in designing a program, we are doing a disservice to our athletes.
- Patient expectations should be addressed early in regards to weight bearing status, swelling, return to sport, and overall trajectory of rehab. We need to work on athlete confidence, motivation, optimism, and helping them to reestablish their identity as an athlete early on. (Everheart)
- The goal is not to re-establish normal but to find the new normal as contact forces between the tibia and femur have changed (Beynon, Frobell). There is ample evidence that early resistance training does not place an appreciable strain on the ACL (Escamilla) but even then we must consider that tissue adapts to the stress placed upon it. No stress is rarely the answer.



- The goal should be progressive loading with a focus on a limb symmetry index >90%. This should be accomplished by programming increased volume as well as intensity in the later stages of rehab. Athletes should be performing work outside of clinic with a goal of matching at least their prior training load in late phase rehab. If there is a discrepancy between the load you are dosing and what they will need for return to sport, change that.
- **Quantitative outcome measures** should be used beyond just time since surgery. Metrics of strength (biodex, isometrics), hop testing, and sport specific drills all should play a role in decision making. Currently the majority of clinicians consider a "strength" test MMT which is insufficient for picking up LSI. (Greenburg) The same can be said for surgeons who reported a 70% usage of MMT for assessing strength. (Greenburg)
- We're at a point where just over half of athletes pass their hop tests at 12 weeks and only 28% of passed strength tests. Only 13% of athletes passed all tests at 12 weeks.(Toole) This is on us. We know what our metrics are, we are supposed to be "movement specialists." We should be programming to meet our client's needs, not the one on one time we spend with them in clinic.
- The rehab process is additive, with range of motion and expectations being an early focus then strength training, followed by deceleration and jump training in later phases. Because one area may be the current focus, does not mean that prior steps are neglected.

## Gold Standards

- For strength testing it is an isokinetic dynamometer. Isometric dynamometers and 1RM tests can serve as proxies but under no circumstances should MMT be used.
- For motor control a biomechanics lab is the gold standard but hop testing and 2D video can serve as appropriate measures.
- For psych testing the Tampa Scale of Kinesiophobia is the standard but increasing evidence supports the ACL-RSI



## Two Day Rehabilitation Course Literature Review

### Pain Science, Guiding the Path

- Barsky AJ. The Iatrogenic Potential of the Physician's Words JAMA. 2017; 318(24):2425-.
- Beecher, H K. "Pain in Men Wounded in Battle." Annals of surgery vol. 123,1 (1946): 96-105.
- Beeckman M, Hughes S, Kissi A, Simons LE, Goubert L. How an Understanding of Our Ability to Adhere to Verbal Rules Can Increase Insight Into (Mal)adaptive Functioning in Chronic Pain. J Pain. 2019; 20(10):1141-1154.
- Bhalla M, Proffitt DR. Visual-motor recalibration in geographical slant perception. J Exp Psychol Hum Percept Perform. 1999; 25(4):1076-96.
- Bourke J. WHAT IS PAIN? A HISTORY THE PROTHERO LECTURE. Trans R Hist Soc. 2013;23:155-173. doi:10.1017/S0080440113000078
- CARLEN, P. L., WALL, P. D., NADVORNA, H., & STEINBACH, T. (1978). Phantom limbs and related phenomena in recent traumatic amputations. Neurology, 28(3), 211-211. doi:10.1212/wnl.28.3.211
- Cohen M, Quintner J, Buchanan D, Nielsen M, Guy L. Stigmatization of Patients with Chronic Pain: The Extinction of Empathy Pain Med. 2011; 12(11):1637-1643.
- Cohen M, Quintner J, van Rysewyk S. Reconsidering the International Association for the Study of Pain definition of pain PAIN Reports. 2018; 3(2):e634-.
- Craig KD, Stanford EA, Fairbairn NS, Chambers CT. Emergent pain language communication competence in infants and children . 2006; 58(1):52-.
- Durnez W, Van Damme S. Let it be? Pain control attempts critically amplify attention to somatosensory input Psychological Research. 2015; 81(1):309-320.
- Eccleston C, Crombez G. Pain demands attention: a cognitive-affective model of the interruptive function of pain. Psychol Bull. 1999; 125(3):356-66.
- Editorial The need of a taxonomy Pain. 1979; 6(3):247-252.
- Engel G. The need for a new medical model: a challenge for biomedicine Science. 1977; 196(4286):129-136.
- Engel GL. The clinical application of the biopsychosocial model. Am J Psychiatry. 1980;137(5):535-544. doi:10.1176/ajp.137.5.535
- Franck L, Noble G, Liossi C. From tears to words: the development of language to express pain in young children with everyday minor illnesses and injuries . 2010; 36(4):524-533.



- Geurts JW, Willems PC, Lockwood C, van Kleef M, Kleijnen J, Dirksen C. Patient expectations for management of chronic non-cancer pain: A systematic review *Health Expect.* 2017; 20(6):1201-1217.
- Holiday R. *The Obstacle Is the Way: the Ancient Art of Turning Adversity to Advantage.* London: Profile Books; 2015.
- Kaptchuk TJ, Hemond CC, Miller FG. Placebos in chronic pain: evidence, theory, ethics, and use in clinical practice *BMJ.* 2020.
- Karos K, Williams ACC, Meulders A, Vlaeyen JWS. Pain as a threat to the social self: a motivational account. *Pain.* 2018; 159(9):1690-1695.
- Latham, P. M. "General Remarks On The Practice Of Medicine." *The British Medical Journal*, vol. 1, no. 78, 1862, pp. 677-680. JSTOR, [www.jstor.org/stable/25198912](http://www.jstor.org/stable/25198912). Accessed 13 Feb. 2020.
- Law LF, Sluka KA. How does physical activity modulate pain? *PAIN.* 2017; 158(3):369-370.
- Losin EAR, Anderson SR, Wager TD. Feelings of Clinician-Patient Similarity and Trust Influence Pain: Evidence From Simulated Clinical Interactions. *J Pain.* 2017; 18(7):787-799.
- Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. *Br J Sports Med.* 2019; 53(9):554-559.
- Madden VJ, Kamerman PR, Bellan V, et al. Was That Painful or Nonpainful? The Sensation and Pain Rating Scale Performs Well in the Experimental Context. *The journal of pain : official journal of the American Pain Society.* 2019; 20(4):472.e1-472.e12.
- Martin DJ, Garske JP, Davis MK. Relation of the therapeutic alliance with outcome and other variables: a meta-analytic review. *Journal of consulting and clinical psychology.* 2000; 68(3):438-50.
- Martinez-Calderon J, Zamora-Campos C, Navarro-Ledesma S, Luque-Suarez A. The Role of Self-Efficacy on the Prognosis of Chronic Musculoskeletal Pain: A Systematic Review. *J Pain.* 2018; 19(1):10-34.
- Melzack R, Wall PD, Ty TC. Acute pain in an emergency clinic: Latency of onset and descriptor patterns related to different injuries *Pain.* 1982; 14(1):33-43.
- Melzack R. From the gate to the neuromatrix. *Pain.* 1999; Suppl 6:S121-6.
- Moseley GL. Reconceptualising pain according to modern pain science *Physical Therapy Reviews.* 2013; 12(3):169-178.
- Munday I, Kneebone I, Newton-John T. The language of chronic pain. *Disabil Rehabil.* 2019.
- Naugle KM, Ohlman T, Naugle KE, Riley ZA, Keith NR. Physical activity behavior predicts endogenous pain modulation in older adults *PAIN.* 2017; 158(3):383-390.





- Neilson S. Pain as metaphor: metaphor and medicine. *Med Humanit.* 2016; 42(1):3-10. [PDF]
- Nickel B, Barratt A, Copp T, et al Words do matter: a systematic review on how different terminology for the same condition influences management preferences *BMJ Open* 2017;7:e014129. doi: 10.1136/bmjopen-2016-014129
- Ongaro G, Kaptchuk TJ. Symptom perception, placebo effects, and the Bayesian brain *PAIN.* 2019; 160(1):1-4.
- Peerdeman K, van Laarhoven A, Bartels D, Peters M, Evers A. Placebo-like analgesia via response imagery *Eur J Pain.* 2017; 21(8):1366-1377.
- Peerdeman KJ, van Laarhoven AI, Keij SM, et al. Relieving patients' pain with expectation interventions: a meta-analysis. *Pain.* 2016; 157(6):1179-91.
- Polaski AM, Phelps AL, Kostek MC, Szucs KA, Kolber BJ. Exercise-induced hypoalgesia: A meta-analysis of exercise dosing for the treatment of chronic pain. *PLoS One.* 2019; 14(1):e0210418.
- Raja SN, Carr DB, Cohen M, et al. The revised International Association for the Study of Pain definition of pain . 2020; Publish Ahead of Print.
- Smith BE, Hendrick P, Smith TO, et al. Should exercises be painful in the management of chronic musculoskeletal pain? A systematic review and meta-analysis. *Br J Sports Med.* 2017; 51(23):1679-1687. [PDF]
- Stefanucci JK, Geuss MN. Big People, Little World: The Body Influences Size Perception *Perception.* 2009; 38(12):1782-1795.
- Stefanucci JK, Proffitt DR, Clore GL, Parekh N. Skating down a Steeper Slope: Fear Influences the Perception of Geographical Slant Perception. 2008; 37(2):321-323.
- Stilwell P, Harman K. An enactive approach to pain: beyond the biopsychosocial model *Phenom Cogn Sci.* 2019; 18(4):637-665.
- Sullivan MJ, Thorn B, Haythornthwaite JA, et al. Theoretical perspectives on the relation between catastrophizing and pain. *Clin J Pain.* 2001; 17(1):52-64.
- Sullivan MJL. Toward a Biopsychomotor Conceptualization of Pain *The Clinical Journal of Pain.* 2008; 24(4):281-290.
- Testa M, Rossetini G. Enhance placebo, avoid nocebo: How contextual factors affect physiotherapy outcomes *Manual Therapy.* 2016; 24:65-74.
- van Dieën JH, Flor H, Hodges PW. Low-Back Pain Patients Learn to Adapt Motor Behavior With Adverse Secondary Consequences. *Exerc Sport Sci Rev.* 2017; 45(4):223-229.
- Vlaeyen JW, Crombez G, Linton SJ. The fear-avoidance model of pain *PAIN.* 2016; 157(8):1588-1589.
- Wall PD. On the relation of injury to pain. The John J. Bonica lecture. *Pain.* 1979; 6(3):253-64.
- Whitney CW, Von Korff M. Regression to the mean in treated versus untreated chronic pain. *Pain.* 1992; 50(3):281-5.



- Williams AC, Craig KD. Updating the definition of pain. *Pain*. 2016; 157(11):2420-2423.
- Wittgenstein, Ludwig, and Peter M. S. Hacker. *Philosophische Untersuchungen = Philosophical Investigations*. Wiley-Blackwell, 2010.

## Youth Resistance Training

- Lai CCH, Ardern CL, Feller JA, Webster KE. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: a systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. *Br J Sports Med*. 2018;52(2):128-138.
- Dankel SJ, Loenneke JP, Loprinzi PD. Dose-dependent association between muscle-strengthening activities and all-cause mortality: Prospective cohort study among a national sample of adults in the USA. *Arch Cardiovasc Dis*. 2016;109(11):626-633. doi:10.1016/j.acvd.2016.04.005
- Hollis JL, Williams AJ, Sutherland R, et al. A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in elementary school physical education lessons. *Prev Med*. 2016;86:34-54. doi:10.1016/j.ypmed.2015.11.018
- Varma VR, Dey D, Leroux A, et al. Re-evaluating the effect of age on physical activity over the lifespan. *Prev Med*. 2017;101:102-108. doi:10.1016/j.ypmed.2017.05.030
- Strength Training by Children and Adolescents Council on Sports Medicine and Fitness. *Pediatrics* Apr 2008, 121 (4) 835-840; DOI: 10.1542/peds.2007-3790
- Lloyd RS, Faigenbaum AD, Stone MH, et al/ Position statement on youth resistance training: the 2014 International Consensus *British Journal of Sports Medicine* 2014;**48**:498-505.
- Adirim TA, Cheng TL. Overview of injuries in the young athlete. *Sports Med*. 2003;33(1):75-81. doi:10.2165/00007256-200333010-00006
- DiFiori JP, Benjamin HJ, Brenner JS, et al
- Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine *British Journal of Sports Medicine* 2014;**48**:287-288.
- Holt JB, Stearns PH, Bastrom TP, Dennis MM, Dwek JR, Pennock AT. The Curse of the All-Star Team: A Single-Season Prospective Shoulder MRI Study of Little League Baseball Players. *J Pediatr Orthop*. 2020;40(1):e19-e24. doi:10.1097/BPO.0000000000001391
- Padaki AS, Ahmad CS, Hodgins JL, Kovacevic D, Lynch TS, Popkin CA. Quantifying Parental Influence on Youth Athlete Specialization: A Survey of Athletes' Parents. *Orthop J Sports Med*. 2017;5(9):2325967117729147. Published 2017 Sep 21. doi:10.1177/2325967117729147



- Madigan DJ, Stoeber J, Forsdyke D, Dayson M, Passfield L. Perfectionism predicts injury in junior athletes: Preliminary evidence from a prospective study. *J Sports Sci.* 2018;36(5):545-550. doi:10.1080/02640414.2017.1322709
- Gornitzky AL, Lott A, Yellin JL, Fabricant PD, Lawrence JT, Ganley TJ. Sport-Specific Yearly Risk and Incidence of Anterior Cruciate Ligament Tears in High School Athletes: A Systematic Review and Meta-analysis. *Am J Sports Med.* 2016;44(10):2716-2723. doi:10.1177/0363546515617742
- Specker B, Thiex NW, Sudhagani RG. Does Exercise Influence Pediatric Bone? A Systematic Review. *Clin Orthop Relat Res.* 2015;473(11):3658-3672. doi:10.1007/s11999-015-4467-7
- Duplanty AA, Levitt DE, Hill DW, McFarlin BK, DiMarco NM, Vingren JL. Resistance Training Is Associated With Higher Bone Mineral Density Among Young Adult Male Distance Runners Independent of Physiological Factors. *J Strength Cond Res.* 2018;32(6):1594-1600. doi:10.1519/JSC.0000000000002504
- Kubo K, Kanehisa H, Kawakami Y, Fukunaga T. Growth changes in the elastic properties of human tendon structures. *Int J Sports Med.* 2001;22(2):138-143. doi:10.1055/s-2001-11337
- Bohm S, Mersmann F, Arampatzis A. Human tendon adaptation in response to mechanical loading: a systematic review and meta-analysis of exercise intervention studies on healthy adults. *Sports Med Open.* 2015;1(1):7. doi:10.1186/s40798-015-0009-9
- Mersmann F, Bohm S, Arampatzis A. Imbalances in the Development of Muscle and Tendon as Risk Factor for Tendinopathies in Youth Athletes: A Review of Current Evidence and Concepts of Prevention. *Front Physiol.* 2017;8:987. Published 2017 Dec 1. doi:10.3389/fphys.2017.00987
- Wirth K, Hartmann H, Mickel C, Szilvas E, Keiner M, Sander A. Core Stability in Athletes: A Critical Analysis of Current Guidelines. *Sports Med.* 2017;47(3):401-414. doi:10.1007/s40279-016-0597-7
- Kümmel J, Kramer A, Giboin LS, Gruber M. Specificity of Balance Training in Healthy Individuals: A Systematic Review and Meta-Analysis. *Sports Med.* 2016;46(9):1261-1271. doi:10.1007/s40279-016-0515-z
- Johnson BA, Salzberg CL, Stevenson DA. A systematic review: plyometric training programs for young children. *J Strength Cond Res.* 2011;25(9):2623-2633. doi:10.1519/JSC.0b013e318204caa0
- Barengo NC, Meneses-Echávez JF, Ramírez-Vélez R, Cohen DD, Tovar G, Bautista JE. The impact of the FIFA 11+ training program on injury prevention in football players: a systematic review. *Int J Environ Res Public Health.* 2014;11(11):11986-12000. Published 2014 Nov 19. doi:10.3390/ijerph111111986



- Faude O, Rössler R, Petushek EJ, Roth R, Zahner L, Donath L. Neuromuscular Adaptations to Multimodal Injury Prevention Programs in Youth Sports: A Systematic Review with Meta-Analysis of Randomized Controlled Trials. *Front Physiol.* 2017;8:791. Published 2017 Oct 12. doi:10.3389/fphys.2017.00791
- Teixeira E, Duarte JA. Skeletal Muscle Loading Changes its Regenerative Capacity. *Sports Med.* 2016;46(6):783-792. doi:10.1007/s40279-015-0462-0
- Lesinski M, Prieske O, Granacher U. Effects and dose-response relationships of resistance training on physical performance in youth athletes: a systematic review and meta-analysis. *Br J Sports Med.* 2016;50(13):781-795. doi:10.1136/bjsports-2015-095497
- Behm DG, Young JD, Whitten JHD, et al. Effectiveness of Traditional Strength vs. Power Training on Muscle Strength, Power and Speed with Youth: A Systematic Review and Meta-Analysis. *Front Physiol.* 2017;8:423. Published 2017 Jun 30. doi:10.3389/fphys.2017.00423
- Lauenstein JB, Andersen TE, Andersen LB
- Strength training as superior, dose-dependent and safe prevention of acute and overuse sports injuries: a systematic review, qualitative analysis and meta-analysis *British Journal of Sports Medicine* 2018;**52**:1557-1563.
- Petersen J, Thorborg K, Nielsen MB, Budtz-Jørgensen E, Hölmich P. Preventive effect of eccentric training on acute hamstring injuries in men's soccer: a cluster-randomized controlled trial. *Am J Sports Med.* 2011;39(11):2296-2303. doi:10.1177/0363546511419277
- Harper DJ, Kiely J. Damaging nature of decelerations: Do we adequately prepare players?. *BMJ Open Sport Exerc Med.* 2018;4(1):e000379. Published 2018 Aug 6. doi:10.1136/bmjsem-2018-000379

## Low Back Pain - Guiding the Path

- Andrade NS, Ashton CM, Wray NP, Brown C, Bartanusz V. Systematic review of observational studies reveals no association between low back pain and lumbar spondylolysis with or without isthmic spondylolisthesis *Eur Spine J.* 2015; 24(6):1289-1295.
- Ballantyne JC, Sullivan MD. Intensity of Chronic Pain – The Wrong Metric? *N Engl J Med.* 2015; 373(22):2098-2099.



- Beutler WJ, Fredrickson BE, Murtland A, Sweeney CA, Grant WD, Baker D. The natural history of spondylolysis and spondylolisthesis: 45-year follow-up evaluation. *Spine (Phila Pa 1976)*. 2003; 28(10):1027-35; discussion 1035.
- Brinjikji W, Diehn F, Jarvik J, et al. MRI Findings of Disc Degeneration are More Prevalent in Adults with Low Back Pain than in Asymptomatic Controls: A Systematic Review and Meta-Analysis *AJNR Am J Neuroradiol*. 2015; 36(12):2394-2399.
- Brinjikji W, Luetmer P, Comstock B, et al. Systematic Literature Review of Imaging Features of Spinal Degeneration in Asymptomatic Populations *AJNR Am J Neuroradiol*. 2015; 36(4):811-816.
- Burgstaller JM, Schöffler PJ, Buhmann JM, et al. Is There an Association Between Pain and Magnetic Resonance Imaging Parameters in Patients With Lumbar Spinal Stenosis? *Spine (Phila Pa 1976)*. 2016; 41(17):E1053-62.
- Chen Y, Campbell P, Strauss VY, Foster NE, Jordan KP, Dunn KM. Trajectories and predictors of the long-term course of low back pain *PAIN*. 2018; 159(2):252-260.
- Chiarotto A, Terwee CB, Ostelo RW. Choosing the right outcome measurement instruments for patients with low back pain *Best Practice & Research Clinical Rheumatology*. 2016; 30(6):1003-1020.
- Chiu C, Chuang T, Chang K, Wu C, Lin P, Hsu W. The probability of spontaneous regression of lumbar herniated disc: a systematic review *Clin Rehabil*. 2014; 29(2):184-195.
- da Silva T, Mills K, Brown BT, Herbert RD, Maher CG, Hancock MJ. Risk of Recurrence of Low Back Pain: A Systematic Review. *J Orthop Sports Phys Ther*. 2017; 47(5):305-313.
- Darlow B, Dowell A, Baxter GD, Mathieson F, Perry M, Dean S. The Enduring Impact of What Clinicians Say to People With Low Back Pain *The Annals of Family Medicine*. 2013; 11(6):527-534.
- Darlow B, Forster BB, O'Sullivan K, O'Sullivan P. It is time to stop causing harm with inappropriate imaging for low back pain *Br J Sports Med*. 2017; 51(5):414-415.
- Downie A, Hancock M, Jenkins H, et al. How common is imaging for low back pain in primary and emergency care? Systematic review and meta-analysis of over 4 million imaging requests across 21 years. *Br J Sports Med*. 2020; 54(11):642-651.



- Eno JT, Boone CR, Bellino MJ, Bishop JA. The Prevalence of Sacroiliac Joint Degeneration in Asymptomatic Adults The Journal of Bone and Joint Surgery-American Volume. 2015; 97(11):932-936.
- Ferreira G, Traeger AC, Machado G, O'Keeffe M, Maher CG. Credibility, Accuracy, and Comprehensiveness of Internet-Based Information About Low Back Pain: A Systematic Review J Med Internet Res. 2019; 21(5):e13357-.
- Ferreira PH, Beckenkamp P, Maher CG, Hopper JL, Ferreira ML. Nature or nurture in low back pain? Results of a systematic review of studies based on twin samples. Eur J Pain. 2013; 17(7):957-71.
- Grossman DC, Curry SJ, Owens DK, et al. Screening for Adolescent Idiopathic Scoliosis JAMA. 2018; 319(2):165-.
- Hartvigsen J, Hancock MJ, Kongsted A, et al. What low back pain is and why we need to pay attention The Lancet. 2018; 391(10137):2356-2367.
- Herlin C, Kjaer P, Espeland A, et al. Modic changes-Their associations with low back pain and activity limitation: A systematic literature review and meta- analysis. PLoS One. 2018; 13(8):e0200677. [PDF]
- Ishimoto Y, Yoshimura N, Muraki S, et al. Associations between radiographic lumbar spinal stenosis and clinical symptoms in the general population: the Wakayama Spine Study Osteoarthritis and Cartilage. 2013; 21(6):783-788.
- Itz CJ, Geurts JW, van Kleef M, Nelemans P. Clinical course of non-specific low back pain: a systematic review of prospective cohort studies set in primary care. Eur J Pain. 2013; 17(1):5-15.
- Jarvik JG, Gold LS, Comstock BA, et al. Association of early imaging for back pain with clinical outcomes in older adults. JAMA. 2015; 313(11):1143-53.
- Kalichman L, Kim DH, Li L, Guermazi A, Berkin V, Hunter DJ. Spondylolysis and Spondylolisthesis Spine. 2009; 34(2):199-205.
- Kalichman L, Li L, Kim DH, et al. Facet Joint Osteoarthritis and Low Back Pain in the Community-Based Population Spine. 2008; 33(23):2560-2565.
- Koes BW, van Tulder MW, Thomas S. Diagnosis and treatment of low back pain BMJ. 2006; 332(7555):1430-1434.
- Krishnamurthy I, Othman R, Baxter GD, Mani R. Risk factors for the development of low back pain: an overview of systematic reviews of longitudinal studies Physical Therapy Reviews. 2018; 23(3):162-177.
- Lee TH. Zero Pain Is Not the Goal JAMA. 2016; 315(15):1575-.
- Lemmers, G.P.G., van Lankveld, W., Westert, G.P. et al. Imaging versus no imaging for low back pain: a systematic review, measuring costs, healthcare utilization and absence from work. Eur Spine J 28, 937–950 (2019).  
<https://doi.org/10.1007/s00586-019-05918-1>





- Lim YZ, Chou L, Au RT, et al. People with low back pain want clear, consistent and personalised information on prognosis, treatment options and self- management strategies: a systematic review *Journal of Physiotherapy*. 2019; 65(3):124-135.
- Lutz GK, Butzlaff M, Schultz-Venrath U. Looking Back on Back Pain: Trial and Error of Diagnoses in the 20th Century Spine. 2003; 28(16):1899-1905.
- Macki M, Hernandez-Hermann M, Bydon M, Gokaslan A, McGovern K, Bydon A. Spontaneous regression of sequestered lumbar disc herniations: Literature review *Clinical Neurology and Neurosurgery*. 2014; 120:136-141.
- McCabe E, Jadaan D, Munigangaiah S, Basavaraju N, McCabe JP. Do medical students believe the back pain myths? A cross-sectional study. *BMC Med Educ*. 2019; 19(1):235.
- Menezes Costa LdC, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LOP. The prognosis of acute and persistent low-back pain: a meta-analysis *Canadian Medical Association Journal*. 2012; 184(11):E613-E624.
- O'Keefe M, O'Sullivan PB, O'Sullivan K. Education can 'change the world': Can clinical education change the trajectory of individuals with back pain? *Br J Sports Med*. 2019; 53(22):1385-1386.
- Parreira P, Maher CG, Steffens D, Hancock MJ, Ferreira ML. Risk factors for low back pain and sciatica: an umbrella review. *Spine J*. 2018; 18(9):1715-1721.
- Premkumar A, Godfrey W, Gottschalk MB, Boden SD. Red Flags for Low Back Pain Are Not Always Really Red: A Prospective Evaluation of the Clinical Utility of Commonly Used Screening Questions for Low Back Pain. *J Bone Joint Surg Am*. 2018; 100(5):368-374.
- Setchell J, Costa N, Ferreira M, Hodges PW. What decreases low back pain? A qualitative study of patient perspectives. *Scand J Pain*. 2019; 19(3):597-603.
- Setchell, J., Costa, N., Ferreira, M. et al. Individuals' explanations for their persistent or recurrent low back pain: a cross-sectional survey. *BMC Musculoskelet Disord* 18, 466 (2017). <https://doi.org/10.1186/s12891-017-1831-7>
- Sieper J, Poddubnyy D. Axial spondyloarthritis *The Lancet*. 2017; 390(10089):73-84.
- Steffens D, Hancock M, Maher C, Williams C, Jensen T, Latimer J. Does magnetic resonance imaging predict future low back pain? A systematic review *EJP*. 2014; 18(6):755-765.
- Stochkendahl, M.J., Kjaer, P., Hartvigsen, J. et al. National Clinical Guidelines for non-surgical treatment of patients with recent onset low back pain or lumbar radiculopathy. *Eur Spine J* 27, 60–75 (2018). <https://doi.org/10.1007/s00586-5099-2>



- Sullivan MJ, Thibault P, Savard A, Catchlove R, Kozey J, Stanish WD. The influence of communication goals and physical demands on different dimensions of pain behavior Pain. 2006; 125(3):270-277.
- Suri P, Fry AL, Gellhorn AC. Do Muscle Characteristics on Lumbar Spine Magnetic Resonance Imaging or Computed Tomography Predict Future Low Back Pain, Physical Function, or Performance? A Systematic Review PM&R. 2015; 7(12):1269-1281.
- Udbj PM, Bendix T, Ohrt-Nissen S, et al. Modic Changes Are Not Associated With Long-term Pain and Disability: A Cohort Study With 13-year Follow-up. Spine (Phila Pa 1976). 2019; 44(17):1186-1192.
- Vos T, Abajobir AA, Abate KH, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016 The Lancet. 2017; 390(10100):1211-1259.
- Weinstein SL, Dolan LA, Spratt KF, Peterson KK, Spoonamore MJ, Ponseti IV. Health and function of patients with untreated idiopathic scoliosis: a 50-year natural history study. JAMA. 2003; 289(5):559-67.
- Zhong M, Liu JT, Jiang H, et al. Incidence of Spontaneous Resorption of Lumbar Disc Herniation: A Meta-Analysis. Pain Physician. 2017; 20(1):E45-E52.

## Return to Sport After ACL reconstruction

- Lai CCH, Ardern CL, Feller JA, Webster KE. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: a systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. *Br J Sports Med*. 2018;52(2):128-138.
- Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *Br J Sports Med*. 2014;48(21):1543-1552.
- Hollis JL, Williams AJ, Sutherland R, et al. A systematic review and meta- analysis of moderate-to-vigorous physical activity levels in elementary school physical education lessons. *Prev Med*. 2016;86:34-54. doi:10.1016/j.ypmed.2015.11.018
- Webster KE, Feller JA. Expectations for Return to Preinjury Sport Before and After Anterior Cruciate Ligament Reconstruction. *Am J Sports Med*. 2019;47(3):578-583. doi:10.1177/0363546518819454



- Everhart JS, Best TM, Flanigan DC. Psychological predictors of anterior cruciate ligament reconstruction outcomes: a systematic review. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(3):752-762. doi:10.1007/s00167-013-2699-1
- Beynon BD, Vacek PM, Sturnick DR, et al. Geometric profile of the tibial plateau cartilage surface is associated with the risk of non-contact anterior cruciate ligament injury. *J Orthop Res.* 2014;32(1):61-68. doi:10.1002/jor.22434
- Escamilla RF, Macleod TD, Wilk KE, Paulos L, Andrews JR. Anterior cruciate ligament strain and tensile forces for weight-bearing and non-weight-bearing exercises: a guide to exercise selection. *J Orthop Sports Phys Ther.* 2012;42(3):208-220. doi:10.2519/jospt.2012.3768
- Kyritsis P, Bahr R, Landreau P, Miladi R, Witvrouw E. Likelihood of ACL graft rupture: not meeting six clinical discharge criteria before return to sport is associated with a four times greater risk of rupture. *Br J Sports Med.* 2016;50(15):946-951. doi:10.1136/bjsports-2015-095908
- Capin JJ, Khandha A, Zarzycki R, Manal K, Buchanan TS, Snyder-Mackler L. Gait mechanics and second ACL rupture: Implications for delaying return-to- sport. *J Orthop Res.* 2017;35(9):1894-1901. doi:10.1002/jor.23476
- Burgi CR, Peters S, Arden CL, et al/Which criteria are used to clear patients to return to sport after primary ACL reconstruction? A scoping review *British Journal of Sports Medicine* 2019;**53**:1154-1161
- Greenberg EM, Greenberg ET, Albaugh J, Storey E, Ganley TJ. Rehabilitation Practice Patterns Following Anterior Cruciate Ligament Reconstruction: A Survey of Physical Therapists. *J Orthop Sports Phys Ther.* 2018;48(10):801-811. doi:10.2519/jospt.2018.8264
- Greenberg EM, Greenberg ET, Albaugh J, Storey E, Ganley TJ. Anterior Cruciate Ligament Reconstruction Rehabilitation Clinical Practice Patterns: A Survey of the PRiSM Society. *Orthop J Sports Med.* 2019;7(4):2325967119839041. Published 2019 Apr 23. doi:10.1177/232596711983904
- Toole AR, Ithurburn MP, Rauh MJ, Hewett TE, Paterno MV, Schmitt LC. Young Athletes Cleared for Sports Participation After Anterior Cruciate Ligament Reconstruction: How Many Actually Meet Recommended Return-to-Sport Criterion Cutoffs?. *J Orthop Sports Phys Ther.* 2017;47(11):825-833. doi:10.2519/jospt.2017.7227
- Grindem H, Snyder-Mackler L, Moksnes H, et al Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study *British Journal of Sports Medicine* 2016;50:804-808.
- Hamlin MJ, Wilkes D, Elliot CA, Lizamore CA, Kathiravel Y. Monitoring Training Loads and Perceived Stress in Young Elite University Athletes. *Front Physiol.* 2019;10:34. Published 2019 Jan 29. doi:10.3389/fphys.2019.00034



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