Sports Medicine & the Athlete

"-itis" versus "-osis"

Can you get there from here

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Disclaimers/Disclosures

- Nothing to disclose
- No monetary remuneration
- No off-label use
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Learning Objectives

- Distinguish between types of tendinopathies
- Understand the pathophysiology of enthesopathy
- Apply knowledge gained to practice in the field

Risk versus Reward

- Success is predicated on a precarious physiologic and psychological balance easily tipped by the slightest touch of adrenaline
- Failure is manifested by under-preparation coupled with compromised conditioning imperceptibly mixed with the intangible "X-factor" of chance

Triumph

You can't succeed unless you're willing to fail

- Success
  - Individual
    - Preparation
      - Physical
      - Emotional
      - psychological
  - Group
    - Cooperation
    - support
    - Sacrifice
- Failure
  - Individual
    - Preparation
      - Physical
      - Emotional
      - psychological
  - Group
    - Cooperation
    - Support
    - sacrifice

Accomplish the task

Failure

- Mechanisms
  - Psychological
  - Emotional
  - physical
- Mechanisms
  - Physical
    - Anatomical
      - functional
        - Structural
          - Mechanical
            - elemental

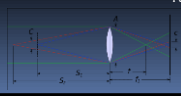
Focus on a concept

- Identify an injury profile that we can:
  - *Understand*
  - *Define*
  - *Deconstruct*
  - *Reconstruct*

- All for the singular purpose of:
  - *Effecting positive change…*

Bright idea

- Common things are common
  - Seemingly…
    - Routine
    - Mundane
    - Anticipate positive outcome
- Difficult things are difficult
  - Sometimes…
    - Challenging
    - Provocative
    - Compromised results



ENTHESOPATHY

TENDONOPATHY

- Tendonitis
  - Reactivity with inflammatory response
  - Acute (or chronic) overload
  - Intrinsic or extrinsic factors
- Tendonosis
  - Damage at cellular level
  - Microtears in connective tissue leading to increase in repair cells
  - Chronic degeneration without inflammation

ACHILLES

- Greek hero of the Trojan war
- Mother nymph *Thetis*, father *Peleus* king of the Myrmidons
- *Thetis* attempted to make *Achilles* immortal by dipping him in the river Styx, but left vulnerable by the part she held him by : his heel
- Killed by *Paris* at end of Trojan war who shot him in the heel with an arrow

Achilles' heel: point of weakness

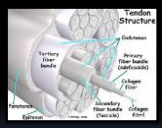
TENDONITIS

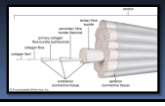
- Acute inflammatory response to load
  - Hallmarks
    - Pain
    - Swelling
    - Stiffness
    - Warmth
    - Limited ROM

TENDONITIS

Normal structure

- MACROSCOPIC
- MICROSCOPIC

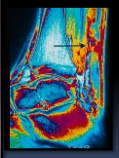
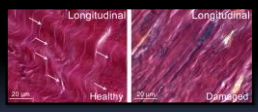




TENDONITIS

ABNORMAL STRUCTURE

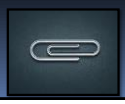
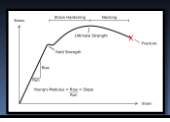
- MACROSCOPIC
- MICROSCOPIC

MECHANISM OF INJURY

LOAD TO FAILURE

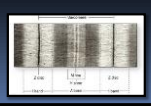
- CYCLIC LOADING
  - FORCE COUPLES
  - VELOCITY OF MOTION
  - INTENSITY OF MOTION
  - AMBIENT PARAMETERS
    - TEMPERATURE
    - STIFFNESS
- REPETITION
  - FLEXION
  - EXTENSION
  - TENSION
  - COMPRESSION
  - STRESS/STRAIN CURVE

MECHANISM OF INJURY

FORCE AND LENGTH (MUSCLE PHYSIOLOGY)

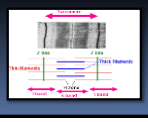
- ISOMETRIC
  - GENERATE TENSION WITHOUT CHANGING LENGTH
    - TENSE A MUSCLE TO HOLD IN POSITION
- ISOTONIC
  - CONSTANT TENSION WITH CHANGE IN LENGTH
- ISOKINETIC
  - CONSTANT VELOCITY WHILE FORCE CHANGES



Mechanism of Injury

Force and Length (Muscle Physiology)

- Concentric
  - *Isotonic*
  - Length shortens as it contracts
- Eccentric
  - *Isotonic*
  - Loading while lengthening



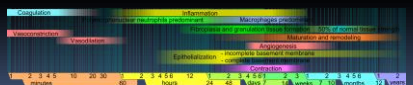
Mechanism of Injury

Acute **Chronic**

Phased Healing Response

Spectrum

- Hemostasis
- Proliferation
- Inflammation
- Maturation



Phased Healing Response

- Hemostasis
  - Hematoma stimulates platelet aggregation, activating fibrin with stasis of injury site…
- Inflammation
  - White blood cell phagocytose debris and necrotic material…
  - Platelet-derived-growth-factors (PDGF's) released, stimulating migration and division of cells…

Phased Healing Response

- Proliferation
  - Angiogenesis
  - Collagen deposition
  - Granulation tissue
  - Contraction
- Maturation
  - Remodeling
  - Realignment
  - Tissue strengthening

Transition

TENDONOSIS

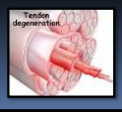
- Chronic degenerative change without inflammation
  - Hallmarks
    - Pain
    - Limited ROM
    - Recalcitrant recovery

"The Chronic"

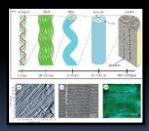
TENDINOSIS

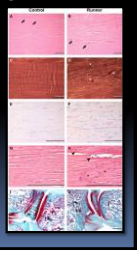
Normal/abnormal structure

- Macroscopic



- Microscopic





Mechanism of Injury

Load to failure

- Cyclic loading
  - Abnormal tissue subjected to normal stress/strain load
  - Altered response and recovery
- Repetition
  - Compromised tissue characteristics leads to progressive structural malfunction
  - Compensatory recruitment of surrounding structures

Phased healing response

spectrum

- Hemostasis ?
- *Non-inflammatory cellular response*
- Proliferation ?
- Maturation ?

- Microtears in connective tissue at the cellular level

Healing response

mechanism

- Inflammatory
  - Vascular component
    - Vasodilation
    - Membrane permeability
    - Plasma cascade system
    - Plasma-derived mediators
  - Cellular component
    - Leukocyte extravasation
    - Cell-derived mediators
- Non-inflammatory
  - Degenerative changes in collagenous matrix
  - Disorganized hypercellularity
  - Hypervascularity
  - Lack of inflammatory cellular response

Healing response

Non-inflammatory

- Blocks "normal" reparative process
  - Inhibits functional reorganization of tissue from *microscopic* to *macroscopic* regeneration
  - "abnormal" tissue with compromised response to normal tissue recovery

Can we effect change?

Modulate or enhance the cycle

- Proactive
  - Attempt to "pre-treat" a condition that does not yet exist
- Reactive
  - "Damage control" approach in response to an insult

Propose a combination of both

What works

Proactive

- Muscle-tendon unit
  - Stretch: optimize mechanical advantage
  - Strength: maximize power through arc of motion
  - Condition: prepare for physical challenge

Reactive

- Muscle-tendon unit
  - Control zone of injury to limit extent of damage
    - Support/protect
    - Modalities
    - Rehabilitate

What doesn't work

Incomplete rehabilitation

- Restricted ROM
- Persistent pain
- Swelling
- Stiffness
- Muscle atrophy
- Compromised proprioception
- Inadequate/unreasonable timeframe
- Inappropriate "ramp-up" of return to play criteria

MODALITIES

Tendonitis → **Tendonosis**

- Basic
  - *RICE*
  - Thermotherapy
  - Cryotherapy
- Advanced
  - Ultrasound
  - Iontophoresis
  - Phonophoresis
  - Active release therapy (ART)
  - Graston technique
  - Muscle energy

On the horizon

"In your hands"

- Foundation techniques that are effective but "more of the same"

"Almost there"

- Realistic techniques based on scientific principles that view things from an advanced perspective

MODALITIES

State of the art

- Eccentric loading
  - Lengthening muscle/tendon contractions under load
  - Optimize excursion of functional unit over anatomic distance

Rowe V, Hemmings S, Barton C, Malliaras P, Maffulli N, Morrissey D (November 2012). "Conservative management of midportion Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning". Sports Med 42 (11): 941–67.

MODALITIES

STATE OF THE ART

- SOFT TISSUE MOBILIZATION

AUGMENTED SOFT TISSUE MOBILIZATION (ASTM) IS A FORM OF MANUAL THERAPY THAT HAS BEEN SHOWN IN STUDIES ON RATS TO SPEED THE HEALING OF TENDONS BY INCREASING FIBROBLAST ACTIVITY.

CRAIG J. DAVIDSON ET. AL., "RAT TENDON MORPHOLOGIC AND FUNCTIONAL CHANGES RESULTING FROM SOFT TISSUE MOBILIZATION", *MEDICINE & SCIENCE IN SPORTS & EXERCISE*, MAR. 1997, VOL. 29, NO. 3, PP. 313-319.

GALE M. GEHLSEN, "FIBROBLAST RESPONSES TO VARIATION IN SOFT TISSUE MOBILIZATION PRESSURE", *MEDICINE & SCIENCE IN SPORTS & EXERCISE*, APR. 1999, VOL. 31, NO. 4, PP. 531-535.

MODALITIES

STATE OF THE ART

- SHOCK WAVE THERAPY

IN RAT SUBJECTS, SWT INCREASED LEVELS OF HEALING HORMONES AND PROTEINS LEADING TO INCREASED CELL PROLIFERATION AND TISSUE REGENERATION IN TENDONS.

CHEN Y.J, WANG C.J, YANG K.D, KUO Y.R, HUANG H.C, HUANG Y.T, SUN Y.C, WANG F.S (2004). "EXTRACORPOREAL SHOCK WAVES PROMOTE HEALING OF COLLAGENASE-INDUCED ACHILLES TENDINOSIS AND INCREASE TGF-BETA1 AND IGF-I EXPRESSION". J ORTHOP RES 22 (4): 854–61.

MODALITIES

STATE OF THE ART

- VITAMIN E

VITAMIN E HAS BEEN FOUND TO INCREASE THE ACTIVITY OF FIBROBLASTS, LEADING TO INCREASED COLLAGEN FIBRILS AND SYNTHESIS, WHICH SEEMS TO SPEED UP THE REGENERATION AND INCREASE THE REGENERATIVE CAPACITY OF TENDONS.

GONZALEZ, SANTANDER R, PLASENCIA AHRIBA MA, MARTINEZ CUADRADO G, GONZALEZ-SANTANDER MARTINEZ M & MONTEAGUDO DE LA ROSA M. (1990). "EFFECTS OF "IN SITU" VITAMIN E ON FIBROBLAST DIFFERENTIATION AND ON COLLAGEN FIBRIL DEVELOPMENT IN THE REGENERATING TENDON". THE INTERNATIONAL JOURNAL OF DEVELOPMENTAL BIOLOGY (UNIVERSITY OF THE BASQUE COUNTRY PRESS) 1 (SUPPLEMENTAL): 181–2.

MODALITIES

STATE OF THE ART

- NITRIC OXIDE

NITRIC OXIDE (NO) APPEARS TO PLAY A ROLE IN TENDON HEALING AND INHIBITION OF ITS SYNTHESIS IMPAIRS TENDON HEALING. THE USE OF A NITRIC OXIDE DELIVERY SYSTEM (GLYCERYL TRINITRATE PATCHES) APPLIED OVER THE AREA OF MAXIMAL TENDERNESS WAS TESTED IN THREE CLINICAL TRIALS FOR THE TREATMENT OF TENDINOPATHIES AND WAS FOUND TO SIGNIFICANTLY REDUCE PAIN AND INCREASE RANGE OF MOTION AND STRENGTH.

XIA, W.; SZOMOR Z.; WANG Y.; MURRELL G.A. (2008). "NITRIC OXIDE ENHANCES COLLAGEN SYNTHESIS IN CULTURED HUMAN TENDON CELLS". JOURNAL OF ORTHOPAEDIC RESEARCH (WILEY) 24 (2): 159–72.

MURRELL GA (2007). "USING NITRIC OXIDE TO TREAT TENDINOPATHY". BR J SPORTS MED 41 (4): 227–31.

MODALITIES

STATE OF THE ART

- AUTOLOGOUS TENOCYTE INJECTION
  - THE AUTOLOGOUS TENOCYTES WERE SORTED AND PURIFIED BY REAL-TIME POLYMERASE CHAIN REACTION, AND AMPLIFIED BY FLOW CYTOMETRY. THE TENOCYTES WERE THEN INJECTED INTO THE INJURED TENDINOPATHY SITE, WHICH WAS THE ORIGIN OF THE EXTENSOR CARPI RADIALIS BREVIS TENDON, UNDER THE GUIDANCE OF AN ULTRASOUND. AFTER THE AUTOLOGOUS TENOCYTE INJECTION TREATMENT, PATIENTS WITH CHRONIC LATERAL EPICONDYLITIS SHOWED IMPROVED CLINICAL FUNCTION AND STRUCTURAL REPAIR AT THE ORIGIN OF THE COMMON EXTENSOR TENDON.

WANG, A.; BREIDAHL, W.; MACKIE, K. E.; LIN, Z.; QIN, A.; CHEN, J.; ZHENG, M. H. (2013). "AUTOLOGOUS TENOCYTE INJECTION FOR THE TREATMENT OF SEVERE, CHRONIC RESISTANT LATERAL EPICONDYLITIS: A PILOT STUDY". THE AMERICAN JOURNAL OF SPORTS MEDICINE 41 (12): 2925–2932.

MODALITIES

STATE OF THE ART

- ULTRASONIC PERCUTANEOUS TENOTOMY

PERCUTANEOUS ULTRASONIC TENOTOMY PROVIDED CONTINUED PAIN RELIEF AND FUNCTIONAL IMPROVEMENT FOR RECALCITRANT TENNIS ELBOW AT A 3-YEAR FOLLOW-UP.

SENG, C.; MOHAN, P. C.; KOH, S. B. J.; HOWE, T. S.; LIM, Y. G.; LEE, B. P.; MORREY, B. F. (2015). "ULTRASONIC PERCUTANEOUS TENOTOMY FOR RECALCITRANT LATERAL ELBOW TENDINOPATHY: SUSTAINABILITY AND SONOGRAPHIC PROGRESSION AT 3 YEARS". THE AMERICAN JOURNAL OF SPORTS MEDICINE 44 (2): 504–510.

MODALITIES

State of the art

- Acoustoelastography ultrasound

Acoustoelastography: ultrasound technique that relates ultrasonic wave amplitude changes to the mechanical properties of a tendon.

ultrasound-based model that can be used evaluate tendon function.

September 2010 New Products". Journal of Orthopaedic & Sports Physical Therapy 40 (9): 598–601. 2010.

MODALITIES

State of the art

- Nonbulbar dermal sheath cells

clinical trial using fibroblasts isolated from nonbulbar dermal sheath cells of hair follicles. The tendon treatment will be tested in approximately 28 subjects. Nonbulbar dermal sheath cells used because they produce more type I collagen than fibroblasts that are derived from adipose tissue. Type I collagen is the primary collagen in tendons. Nonbulbar dermal sheath cells will be replicated, then reintroduced into wounded tendons with ultrasound.

Safety and Efficacy of RCT-01 in Men and Women With Unilateral, Chronic Achilles Tendinosis (ReaCT) In: ClinicalTrials.gov [Internet]. Last updated: March 12, 2015.

Ilic, Dusko (2013). "Industry Update: Latest developments in stem cell research and regenerative medicine". Regenerative Medicine 8 (5): 535–542.

MODALITIES

State of the art

- Tendon bioengineering

The future of non-surgical care for tendinosis is likely bioengineering. Ligament reconstruction is possible using mesenchymal stem cells and a silk scaffold. These same stem cells were capable of seeding repair of damaged animal tendons.

Fan H, Liu H, Wong E.J, Toh SL, Goh JC (August 2008). "In vivo study of anterior cruciate ligament regeneration using mesenchymal stem cells and silk scaffold"

Long JH, Qi M, Huang XY, Lei SR, Ren LC (June 2005). "[Repair of rabbit tendon by autologous bone marrow mesenchymal stem cells]". Zhonghua Shao Shang Za Zhi (in Chinese) 21 (3): 210–2.

MODALITIES

State of the art

- Micro-RNA injection

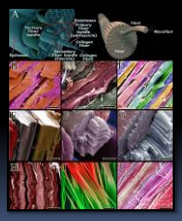
A trial will put injections of microRNA – small molecules that help regulate gene expression – into the tendon to decrease the production of type 3 collagen and switch to type-1.

Millar NL, Gilchrist DS, Akbar M, Reilly JH, Kerr SC, Campbell AL, et al. (2015). "MicroRNA29a regulates IL-33-mediated tissue remodelling in tendon disease."

Damage done…

Compromised tissue

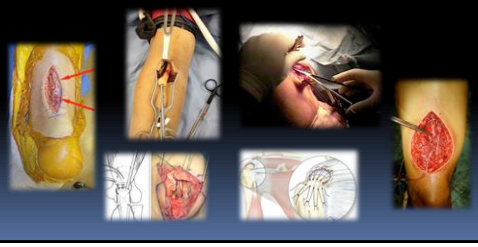
- Can we take that altered environment and *reorganize*, *reorient*, *regenerate* the macro & micro structure to enable "normal" function…



ENDSTAGE

rupture

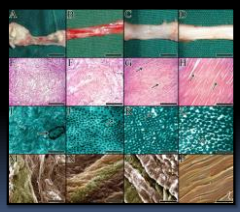
- Surgical option



…DAMAGE UNDONE

Functional unit

- Ability to apply techniques *at the cellular level* that may enable the seemingly impossible to become possible…



SUCCESS

Return of function

MAYBE

These studies are showing promise

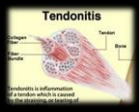
- Improved understanding of micro-structural elements
- Identifying what we can actually enhance

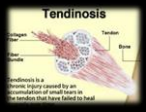
Real-time & routine application of principles

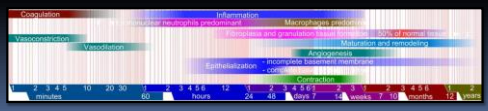
- Applicable to on-the-field or training room environment
- Knowledge base for user competency

CONTINUUM

- WE CAN GET THERE FROM HERE
- WE JUST NEED A LITTLE DIRECTION







TAKE AWAY

THE FUNCTIONAL UNIT

RISK VERSUS REWARD

- THE VICTOR
- THE GOAT


THANK YOU