Rehabilitation of Equine Tendonitis and Desmitis

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Tendon and Ligaments

Anatomy

Pieces and Parts

- 60-70% water
- Dry matter is mostly collagen Type I
- Compared to tendons, ligaments have
  - lower percentage of collagen
  - higher percentage of proteoglycans and water
  - less organized collagen fibers
  - Lower # of fibroblasts

http://www.qualitycarept.com/Injuries-Conditions/Ankle/Ankle-Anatomy/a~47/article.html
The “Glue”

- Vessels, nerves and lymphatics run in the endotenon which is an extension of the epitelen/paratenon
- Covered by connective tissue, paratenon or tendon sheath
  - fluid provides nutrients & lubrication
- Retinaculum

Function

- Tendon
  - Connect muscle to bone
    - transmit forces
  - Function as springs (elasticity)
    - modulate forces when moving, providing stability with out extra work
    - highly efficient at storing and recovering energy
- Ligaments
  - Bone to bone
  - Mechanical reinforcement

Healing

- Inflammatory phase
  - Occurs at 1-7 days
  - Influx of neutrophils and macrophages
  - Production of type III collagen
  - Growth factors involved
    - TGF-β1
    - IGF
    - PDGF
    - BMPs -12 and -13
    - bFGF
Healing

• Proliferation phase
  – occurs at 7-21 days
  – gradually replaced by type I collagen
  – tendons and ligaments are weakest at day 5-21

• Remodeling phase
  – occurs at >14 days

• Maturation phase
  – up to 18 months

Factors that impair healing

• Intra-articular/tendon sheath
  – Extra-articular ligaments have a greater capacity to heal compared with intra-articular ligaments

• Increasing age

• Immobilization
  – Reduces strength of both intact and repaired ligament

• NSAIDS

• Decreased growth factors

• Decreased expression of genes involved with tendon and ligament healing

Factors that improve healing

• Extra-articular/sheath

• Compromised immune response

• Mesenchymal stem cells

• Growth factors

• Scaffolds to help primary ligament healing (instead of reconstruction)

• Neuropeptides
**Scarring**

- Tendons and ligaments heal with scar tissue that
  - Reduces ultimate strength
  - Causes adhesions

**Primary Sites Seen**

- Proximal Rear Suspensory Ligament
- Superficial Digital Flexor Tendon
- Proximal Front Suspensory Ligament
- Inferior Check Ligament
- Deep Digital Flexor Tendon

**Tendon/Ligament Problems**

- Developmental
- Acquired
  - Tendinitis/Desmitis
  - Traumatic division of flexor/extensor tendons or ligaments
  - Acquired contracture
  - Septic tendinitis
  - Tenosynovitis
Tendinitis/Desmitis

• Inflammation of the tendon/ligament, commonly with disruption of some fibers
• Causes
  – Overextension → breaking of fibers → hemorrhage & edema within tendon/ligament → swelling and pressure → further damage of fibers
• Most commonly involves SDF and Suspensory ligaments

Tendinitis/Desmitis

• Diagnosis
  – Clinical Signs
  – Lameness Exam
  – Ultrasound
    • Evaluate for fiber disruption
    • Not as useful for early tendinitis
    • Underestimates damage
    • Monitor healing
  – MRI
    • Gold Standard

Tendinitis/Desmitis

• Healing process
  – Slow due to poor blood supply and constant tension
  – New collagen fibers replace the torn fibers
    • More fibrous (not as elastic)
    • Laid in a crisscross pattern, not lengthwise (weaker)
    • Results in weaker tendon more prone to re-injury
**Tendinitis/Desmitis**

- **Treatment**
  - Mild cases
    - Anti-inflammatory
    - Support bandage
    - Stall rest (gradual return to exercise)
    - Shoeing
  - Moderate to severe cases
    - Conservative – not likely to be successful in athletic horses
    - Surgery
    - Biologic Medicine
    - Rehabilitation

- **Surgery**
  - SDF – superior check ligament desmotomy
  - DDF – inferior check ligament desmotomy
  - Tendon/Ligament splitting – several small incisions in tendon/ligament
    - Drains blood and fluid → relieves pressure
    - Collagen feels in more quickly with “deflated” tendon
    - Improves blood supply via mild inflammation
  - Rear PSD
    - Neurectomy
    - Fasciotomy

**Biologic Medicine**

- Bone Marrow Concentrate
- Platelet Rich Plasma (PRP)
- Stem Cells
- Scaffolds/Braces
Bone Marrow Concentrate

- Straight bone marrow can be used but has fat and bone spicules that may result in poor healing
- Centrifuged so regenerative cells, growth factors and platelets are separated for injection

Platelet Rich Plasma

- Platelets play a prominent and likely determinant role in wound healing
- Platelets are activated by exposure to damaged tissue and initiation of the clotting cascade
- Degranulation of the α-granules release numerous growth factors
- Initial burst of growth factor release
  - 95% of pre-synthesized factors are released in the first hour
  - Platelets continue to synthesize and release factors for an additional 5-10 days

PRP Mode of Action

- Platelet-rich plasma contains a 3- to 5-fold increase in growth factor concentrations
- Platelet-rich plasma, with a platelet concentration of at least 1,000,000 platelets/μl in 5 mls of plasma, is associated with the enhancement of healing
PRP Mode of Action

• Cytokines play important roles in cell proliferation, chemotaxis, cell differentiation, and angiogenesis
• Bioactive factors are also contained in the dense granules in platelets
  – Dense granules contain serotonin, histamine, dopamine, calcium, and adenosine
  – These non-growth factors have fundamental effects on the biologic aspects of wound healing

PRP Formulation

• Platelet-rich plasma can only be made from anticoagulated blood
• Usually use unclotted for soft tissue injection
  – Act of injection activates the platelets
• Bovine thrombin can be used to activate the clotting mechanism and form a gel
  – Used on wounds and in bone defects

Stem Cell Therapy

• Stem cells are characterized by their ability to self-renew and to differentiate into multiple different cell types and tissues
• Stem cells are generally considered as being embryonic or non-embryonic in origin
• The available stem cell treatments for horses are autologous or allogeneic and use adult mesenchymal tissue-derived stem cells (MSC)
Mode of Action

• Stem cells, or more aptly named progenitor cells, are applied to an injured tissue where they engraft, differentiate into the tissue-specific fibroblast(?), which in turn produces the appropriate wound matrix
  – Over simplification
  – More complex
  – May supply growth factors or simple to serve to recruit other reparative cells

Stem Cell Source

• Most are from autogenous source
  – Allogeneic is becoming more prevalent
  – All stem cells are not created equal
• Current options in stem cell treatments center on donor connective tissue type and level of isolation and expansion
• Bone marrow aspirate and fat currently appear to be the most practical at this point in time

Bone Marrow

• There are currently three techniques available to acquire bone marrow (BM) stem cells
  – One uses direct injection of the heterogeneous mixed-cell population in a BM aspirate
  – Another uses centrifugation with the aim of increasing the number of stem cells in each injection
  – Third relies on a cultured cell population derived from BM
Bone Marrow

• Direct Injection
  – Low numbers of stem cells
  – Contains fat and bone spicules
• Bone Marrow Concentrate
  – Generate a 12-fold concentrate of stem cells
• Ex Vivo Expansion
  – Takes 2-4 weeks
  – More than 10 x 10^6 cells are available

Fat Derived Stem Cells

• Adipose-derived MSC’s (A-MSC’s) exhibited a similar degree of multipotentiality to BM-MSC’s
  – Available technique uses a mixture of cells derived from the adipose tissue (Vascular Stromal Fraction)
  – Advantage of supplying large numbers of different cells in a short period (48 hours)
• Stem cells from fat are now being expanded ex-vivo
  – Takes 2-4 weeks
  – Homogenous cell population
Other Sources

• Autogenous
  – Peripheral blood
  – Umbilical blood (stored)
  – Skin
• Allogenic
  – Embryonic
  – Bone marrow
  – Any other tissue by induction
  – Fully characterized

Scaffolds/Braces

• NovoBrace®
  – Chemically made internal brace formed by injection of a crosslinking agent directly into the tendon or ligament
    • Adds mechanical support to the injury
    • Flexible brace prevents further propagation of the lesion
      – Injected above, below and into lesion
    – Can be combined with other therapies
• Nanofiber technology
  – Can be used as a bridge
  – Can be impregnated with stem cells

Therapy Summary

• Combination of acute therapy and long-term rehabilitation
• Goals of therapy
  – Reduce inflammation
  – Maintain blood flow
  – Decrease formation of scar tissue
• Long term commitment (Gillis, AAEP Proceedings 1997)
  – Minimum of 6 months restricted athletic activity
  – Successful cases require 8-9 months of rest and rehabilitation to return to full former function
  – *Not certain this still applies
Tendon and Ligament Rehabilitation

Rehabilitation Options

- Contralateral limb support
- Cold therapy
- Heat therapy
- Low level laser
- Therapeutic ultrasound
- Electrical stimulation
- PEM Therapy
- Whole Body Vibration
- Hyperbaric oxygen therapy (HBOT)
- Extracorporeal shockwave therapy (ESWT)
- UW treadmill
- Therapeutic exercise
- Nutritional Support

Contralateral limb support

- Horse Swing Lifter
  - Allows horse to move around.
  - Provides up to 300kg of resistance/lift
  - Can be locked so horse cannot lay down
- SoftRides®
- Other digital supports
Cold therapy

- Indications
  - Acute injury
  - Inflammation
  - Cellulitis
  - Muscle spasms

- Techniques
  - Cold compression
  - Turbulator boot
  - Ice
  - Ice water circulation
  - Cold Salt Water

Cold Therapy

- Temperatures between 35° and 50°F
- Post-surgical
  - Dry cold – no compression
  - 2-3 sessions daily for 30 min each
- Bowed tendons, desmitis
  - Cold compression in acute phase
  - 30-min sessions every 2 hrs for 1st 24 - 48 hrs
  - After 2 days cold therapy sessions 1-4 times/day for up to 2 weeks
    - Sessions 30-45 minutes each
- Re-evaluate before going on to next steps of tx

Heat therapy

- Indications
  - Improve range of motion
  - Pain relief
  - Chronic stage of healing
  - For healing tendon injuries
    - Can be performed prior to exercise for added stretch

- Techniques
  - Therapeutic US
  - Microwave HT
    - Not validated in equine
Low Level Laser Therapy

- Pain relief
- Decreases inflammation
- Improves healing

Protocol
- Class 4 laser
- 10W/cm²
- Daily

Therapeutic Ultrasound

- Protocol
  - Set unit at either 1.1 or 3.3 MHz depending on depth of tissues
  - 1.1 MHz for most tendons
  - Constant motion of sound head is imperative to avoid overheating damage to tissues
  - 15 – 20 min sessions
  - Lots of gel for conductivity
  - Continuous/pulsed depending on stage

Electrical Techniques

- Indications
  - Pain relief
  - Muscle spasm
  - Muscle re-education
  - Re-innervation
  - Increase strength

- Techniques
  - TENS
  - E-Stim
  - Microwave HT
Electrical Stimulation

- **TENS**
  - Set stimulation to degree that the patient is comfortable
  - Can be used multiple times daily

- **E-Stim**
  - Acute pain/spasm
    - Interferential
    - 80-150 Hz
    - Continuous cycle
    - 30 minutes
  - Chronic pain/spasm
    - Premod
    - 1-10 Hz
    - 5-5 cycle-time
    - 30-45 min up to twice daily
    - Visibly contracting

- **Interferential**
  - 80-150 Hz
  - Continuous cycle
  - 30 minutes

- **Premod**
  - 1-10 Hz
  - 5-5 cycle-time
  - 30-45 min up to twice daily
  - Visibly contracting

Electrical Stimulation

- **E-Stim**
  - Strengthening muscle
    - Russian
    - 30-50 Hz
    - 20-30% duty cycle
    - 10-20 min, 2-3 x weekly
  - Edema reduction
    - Premod
    - Continuous cycle
    - 10-30 minutes
    - Twitching/slight contractions

- **Russian**
  - 30-50 Hz
  - 20-30% duty cycle
  - 10-20 min, 2-3 x weekly
  - Twitching/slight contractions

Electrical stimulation

- **Pad placements**
  - 2-4 pads
  - Over area of pain
  - Acupuncture/acupressure points
  - Over nerves leading to and from target area
  - Crisscross or in-line
  - Dermatomes
Electrical Stimulation

- Contraindications
  - Infection
  - Neoplasia
  - Pregnancy
  - Pacemakers
  - High intensity around heart

Pulsed ElectroMagnetic

- Can be used 15 -20 min per treatment time 2x daily
- Best for bone healing
- May have analgesic effect

Whole Body Vibration

- Different types of waveforms available
- Mechanical stimulus
- Possible effects
  - Improve or maintain bone density
  - Increase blood flow
  - Improve neuromuscular function
- Treat 2-3 x/day for weeks to months
Hyperbaric Oxygen Therapy

- Increases delivery of oxygen to tissues by as much as 15X normal levels
- Goal: increase the amount of oxygen delivered to diseased tissue

How it works
- Increases oxygen levels in diseased tissues
- Improves and speeds healing
- Reduces inflammation and swelling
- **Increase levels of circulating stem cells

Primary and Complementary therapy

Indications: any condition or disease in which the circulation to the diseased tissue has been compromised

Indications
- Infection
- Stem cells
- Tendon ruptures
- Fractures
- Tendonitis
- Desmitis
- Myositis
- Septic arthritis
- Neurologic diseases (EPM)
Hyperbaric Oxygen Therapy

• Treatment periods
  – Injuries, such as cellulitis, tendon tears/ruptures, and others are treated 5-7 days/week for at least 2 weeks
• Re-evaluation is necessary at least weekly to check progress

Hyperbaric Oxygen Therapy

• Hazardous materials checklist for chamber
  – Velcro
  – Petroleum-based products
  – Shod horses
  – Grooming oils/hoof products
  – Nylon
  – Any kind of metal except brass
  – Low flash points (alcohol)
  – Electronic monitoring devices
  – Anything that has potential to spark
• If you are unsure about a product entering the chamber, check MSDS (material safety data sheet)
• NO FEVERS!!

Hyperbaric Oxygen Therapy

• Horses may or may not need sedation
• Close any open catheters
• Pressure level
  – Initial depth of 2.0 ATM for 45 min
  – Consecutive dives to 2.5 ATM for 60 min at pressure with 100% oxygen
Extracorporeal shock wave

• Indications
  – Bone-tendon injuries
  – Suspensory desmitis
  – Skin injuries
  – Non-union fxs
  – Kissing spines
  – Avulsion fxs

• Bone & soft tissue junction

Extracorporeal shock wave

• Trodes
  – Come in sizes of 5, 20, 35 and 80mm
  – Depth varies w/ Trode size with the 5mm being most shallow

• Procedure
  – Energy levels allow further customization for individual patient
  – Treatment lasts ~10-15 minutes with the horse lightly sedated
  – Horses have been found to have periods of analgesia post shock wave

Extracorporeal Shockwave Therapy

http://www.pulsevet.com/
Underwater treadmill

- Low-impact mobilization and strengthening
- Tailored to the individual
- May do therapeutic ultrasound prior to exercise

Underwater treadmill

- Horses must become accustomed to the treadmill
  - 1st day (or more days), horses are trained to get on/off
  - May need sedation initially
  - Horses start at a slow walk of ~2-3 mph for average sized horse for short duration ~5 minutes
  - Subsequent sessions gradually increase time and speed
- Re-evaluation should be done at least weekly

Underwater treadmill

- For rehabilitation
  - Maintenance rate is a moderate walk for 30 minutes
  - Number of sessions vary with progress but typically number 15-20
- Final notes
  - Appropriate warm-up and cool-down period mandatory
  - Don’t forget water temperature for comfort
UT UW Treadmill Program

• Acclimation period (1-2 days)
  – Walk in and walk out of underwater treadmill
  – Walk in, turn on treadmill, stop treadmill, walk out
  – May use sedation during acclimation if needed

UT UW Treadmill Program

• Begin rehabilitation program (Days 3-7)
  – Speed – walk at 2-3 mph
  – Warm up – 5 minutes
  – Duration - 5 minutes
  – Cool down – 5 minutes
  – Frequency - Once per day
  – Rinse and dry off

• Outcome measures
  – Walking comfortably for 15 minutes duration @ 2-3 mph
    • If successful proceed to next level

UT UW Treadmill Program

• Week 2
  – Increase duration of walk up to 10 minutes (20 total)
    – May increase speed

• Week 3
  – Increase duration of walk up to 15 minutes (25 total)

• Week 4
  – Increase duration of walk up to 20 minutes (30 total)

• Week 5
  – Maximum exercise intensity of 5 mph for 20 minutes (30 total)
    – May introduce cross-training activities (trot sets)

• Warm up and cool down for each session
  – At least 5 minutes each at 2 mph
Work Under Saddle

To be done a minimum of 3 days per week but not to exceed 5 days per week.
First 3 weeks tack walking. Start at 30 min, and add 5 min/week. US before starting trot.

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Starting Week 7 following ultrasound exam

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Starting Week 11 – US Exam. No restrictions; gradual start back to normal work over a 2-3 week period.

Nutrition

- Important for healing
- Must be tailored to the individual
  - Base diet
    - Ad lib fresh water
    - 2% of BW of good quality grass hay, fed in Nibble Bags™ or Hay Bags™
    - Plain salt
    - Add concentrate, ration balancer or supplement based on individual
- Essential amino acids, antioxidants, Omega FA

UT Typical Plan

- SX, Biologic therapy, etc
- Days -2 – 14: HBOT, hand walking. Cold for 3-5 days, therapeutic laser, Whole body vibration
- Days 14-28: hand walking, therapeutic US, repeat biologic therapy, WBV
- Re-evaluate
- Days 30 –60: Underwater treadmill 3-5 days per week, free walker 2-3 times per day, WBV
  - Therapeutic ultrasound/hyperthermia prior to treadmill
- Re-evaluate
- Discharge for riding program
Proximal Front Suspensory
FD Stem Cells + HBOT

Proximal Rear Suspensory
Neurectomy, & FD Stem Cells 2/13/08 followed by HBOT & UW Treadmill

Rear DDF
FD Stem Cells + HBOT