Interventional MSK Ultrasound: Tendon Treatments and PRP

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Outline
• Tendon treatment overview
• Tendon fenestration / tenotomy
• Whole blood injection
• Prolotherapy
• Platelet-rich plasma

Tendon: injury
• Acute tensile overload
  – Usually underlying abnormal tendon
• Chronic overuse: repetitive excessive loading
  – Loss of normal tendon architecture
  – Change in tenocyte morphology
  – Altered collagen fibril distribution and neovascularity
  – Microtears
  – Resulting underuse may contribute

Galloway MT et al. JBJS 2013; 95:1620

Tendon: healing
• Inflammatory phase
  – First week after injury
    – Fibrin clot
  – Cell migration, neovascularity
• Proliferation phase
  – 1 to 4 weeks
  – Fibroblasts synthesize collagen and extracellular proteins
• Remodeling phase

Galloway MT et al. JBJS 2013; 95:1620

Tendinosis or Tendinopathy
• Terms used instead of tendinitis
• No acute inflammatory cells
  – Primarily mucoid degeneration
  – Chondroid metaplasia
• Ultrasound:
  – Hypoechoic tendon
  – Heterogeneous, ill-defined
  – Possible increased thickness


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• Not relevant to this talk

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Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.
Tendinopathy

- Degenerative, microtears, no inflammation
- Hypoechoic enlarged
- Anechoic clefts / partial tears
- Hyperemia: correlates with pain
- Eccentric physical therapy should be considered prior to any percutaneous treatment considerations


Patellar Tendon: tendinosis

Percutaneous Tendon Treatments

- Corticosteroid
- Fenestration (dry needling, tenotomy)
- Hyperosmolar dextrose, prolotherapy
- Whole blood (autologous)
- Platelet-rich plasma
- Stem cells
- Other: deer antler velvet, amniotic membrane


Peritendon Steroid Injections

- Shoulder: minimal transient pain relief\(^1\)
- Elbow: common extensor tendon
  - Pain returns worse than before injection\(^2\)
- Gluteal:
  - 72% showed improvement at 1 month\(^3\)
- Hamstring:
  - 24% had symptom relief beyond 6 months\(^4\)

2Coombes BK et al. JAMA 2013; 309:461
3Labrosse JM et al. AJR 2010; 294:292
4Zissin MH et al. AJR 2010; 195:993

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Tendon Fenestration

- Also called “dry-needling” or tenotomy
- Needle repeatedly passed through areas of tendinosis
- Disrupts area of tendinosis
- Bleeding causes release of growth factors
- Stimulates tendon healing
Fenestration: technique

- No NSAIDS x 2 weeks prior
- Ultrasound guidance: in plane
  - Long axis to tendon
- 20 or 22 gauge needle
- 20 – 30 passes until area soft
- Minimal Lidocaine: over tendon

Fenestration: technique

- Cover entire tendon abnormality
- Contact bone if at tendon abnormality
- Pull needle out of tendon to redirect
- Also redirect medial to lateral
  - Pivoting at needle entrance
  - Cone-shaped area

Fenestration: technique

- Contraindications:
  - Not delineated in literature
  - Prior steroid injection < 3 months ago
  - Bleeding disorders
  - Infection
  - Tendon tear > 50% thickness?

Post-procedure:

- No ice
- Rest for 2 weeks
  - Daily activities okay
  - Gradual return to activities
- Follow-up:
  - Referring physician, physical therapy
- No NSAIDS: 2 weeks

Percutaneous Fenestration

- 20 or 22-gauge needle
- 20 to 30 needle passes
- Continued until area covered and tendon softens

Phases of Tissue Healing

Post-procedure:

- Patellar tendon:
  - Knee brace (locked) x 2 weeks
  - First week non-weight bearing with crutches
  - Nothing?
- Achilles tendon:
  - Walking boot x 2 weeks

Fenestration: tendons

- Common extensor tendon: elbow
- Patellar tendon
- Gluteal tendons: great trochanter
- Achilles
- Other

Tendon Fenestration

- 14 tendons
- VAS score improved: 4, 12 weeks
- Patellar (5), Achilles (4)
- 1 each: gluteus medius, iliotibial tract, rectus femoris, hamstring, common extensor tendon


Common Extensor Tendon (Elbow)

- 58 patients
- Outcome: average 28 months
  - Pain level and difficulties with related activities
  - 64% excellent, 16% good, 7% fair, 13% poor
  - No adverse effects
- Follow-up study: 57 patients
  - 93% excellent or good results
  - Corticosteroid injection not needed


Patellar Tendon

Long Axis
Patellar Tendon

• 45 tendons
• 76% improved at 4 weeks, 24% no change
• Improved outcome at 4 weeks if:
  – Less pain prior to procedure
  – Well-defined area of tendinosis at US
  – No correlation with other ultrasound findings (color, size, location, etc.)


Discussion: tendon fenestration

• Studies are relatively limited to date
• Most common site:
  – Common extensor tendon (elbow)
  – Other sites have been attempted
• All studies show improvement
• Procedure well-tolerated
  – Potential risk of tendon tear

Discussion: other treatments

• Fenestration is often combined with other treatments:
  – Platelet-rich plasma or whole blood injection
  – Hyperosmolar dextrose or prolotherapy
• Common extensor tendon (elbow):
  – There is no benefit of injecting steroids during tenotomy1
  – Risk of tendon rupture

Ultrasonic Tenotomy (Tenex)

- Ultrasound phacoemulsification
  - Debride and aspirate necrotic tendon
- Irrigation
- Safe and effective
- No comparison studies
  - Outcomes, cost-effectiveness

Williams RC et al. PM R 2018; 10:313

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Whole Blood Injection

- Autologous whole venous blood
- Injected into abnormal tendon during fenestration
- Release of growth factors that will promote healing
- Refractory tendinopathy may be helped
  - Additional studies are needed

Kampa RJ et al. Int J Clinical Practice 2010; 64:1813

Whole Blood Injection: Common Extensor Tendon

Biceps Brachii Tendon: whole blood injection

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Prolotherapy

- Injection of an irritant
- Hyperosmolar dextrose or morrhuate sodium
- Unknown mechanism
  - Irritant attracts inflammatory mediators
  - Stimulate release of growth factors
  - Vascular sclerosant

Distel et al. PMR 2011; 3:S78

Achilles: hyperosmolar dextrose

Courtesy of Mark Cresswell, Vancouver

Prolotherapy

- Achilles
  - 36 patients with chronic tendinosis
  - Hyperosmolar dextrose every 6 weeks
  - Significant reduction in pain
  - Decreased vascularity in 55%


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Platelet-Rich Plasma

- Autologous venous blood
- Centrifuged
- Concentrated platelet sample
- Platelets degranulate:
  - Alpha granules: contain 95% of growth factors
  - Secrete additional growth factors (7 days)
  - Bind to cell membrane receptors: healing


PRP: what’s in the mix

- Platelet count:
  - 500K ideal (in vitro)\(^1\)
  - Tenocyte proliferation, migrations, collagen type I production
  - Less effectiveness if higher, even cell death
- White blood cells:
  - Leukocyte poor or rich concentrations
  - Poor; less catabolic cytokines, more healing\(^2\)

\(^2\)McCarron TM et al. JBJS 2012; 94:e143
PRP: Arthrex
- One of many available systems
- Double syringe system
- Leukocyte poor
- No anticoagulant needed
- Venous draw: 15 ml
- Place directly in centrifuge: 5 min
- 2 - 5 ml PRP
- Platelet concentration: 200 – 500K

PRP: how to inject
- No NSAIDS: 10 days before procedure
  - Inhibits platelet aggregation and activation
  - Platelet life span = 10 days
- Sterile technique
- 20 or 22-gauge needle
- Tendinosis: fenestrate during injection
- Tendon tear: target tendon defect

PRP: safety
- Pain: up to several days
- Risks:
  - Infection: PRP has antibacterial effects
  - Tumor:
    - Insulin-like growth factor (IGF) linked to cancer
    - IGF is not elevated in PRP preparations


Common Extensor Tendon: PRP
- 22-gauge needle
- In plane with transducer and long axis to tendon
- Fenestrate prior to or during PRP injection
- Most common: one treatment

PRP and Tendon Injection
- Common extensor tendon: elbow
  - Randomized controlled: 230 patients
  - PRP + fenestration versus fenestration alone
  - No difference in outcomes at 12 weeks
  - Significant difference in pain scores at 24 weeks: PRP group had less pain


Common Extensor Tendon
- PRP vs fenestration: 230 subjects
  - 24 weeks: PRP higher success (84% vs 68%)
- PRP, fenestration, steroid (in tendon):
  - No significant difference
- PRP vs whole blood: no difference
Common Extensor Tendon

- PRP vs steroid (+fenestration)
  - PRP significantly better at 2 years
- Metanalysis: inconclusive
- PRP is superior to steroids
- PRP is equal to lidocaine
  - Martin GI, J Ortho Surg Res 2019; 23:14

PRP and Tendon Injection

- Gluteal Tendons: greater trochanter
  - Randomized controlled: 30 patients
  - PRP versus fenestration alone
  - Significant improvement at weeks 1 and 2
  - Approximately 80% had long term improvement: up to 1 year follow-up
  - No difference between treatment groups
  - Two injections: more sustained response


PRP and Tendon Injection

- Gluteal Tendons: greater trochanter
  - Randomized controlled: 80 patients
  - PRP versus steroid injection
  - Ultrasound-guided: 5 – 6 needle passes
  - Patients with > 4 months of symptoms had greater clinical improvement with PRP at 12 weeks


PRP and Tendon Injection

- Patellar tendon
  - Randomized controlled: 23 patients
  - PRP + fenestration versus fenestration alone
  - PRP better at 12 weeks, no different at 26 weeks
  - PRP no better than saline

PRP and Tendon Injection

- **Achilles tendon**
  - Randomized controlled: 54 patients
  - PRP versus saline injection
  - No significant difference at 24 weeks\(^1\) and 1 year\(^2\)
- **Metaanalysis**
  - PRP + eccentric physical therapy compared with saline
  - No difference in outcomes: clinical or ultrasound findings\(^3\)

\(^1\)de Vos RJ et al. JAMA 2010; 303:145
\(^3\)Zhang YJ. Clin Orthop Relat Res 2018; 38:1623

PRP and Tendon Injection

- **Rotator cuff**
  - PRP not beneficial\(^1\)
- **Supraspinatus**
  - Interstitial tear
  - No difference between PRP and saline\(^2\)

\(^1\)Hurley ET et al. Arthroscopy 2019; 35:1584

PRP and Knee Osteoarthritis

- Several studies evaluating PRP, knee OA
- PRP may be slightly better than hyaluronic acid
- Benefits may decrease after 1 year
- Mild OA responds better
- No anatomic information
- Leukocyte-poor preparation is best
- Cartilage did not increase in thickness

PRP: where are we today?

- Promotes healing, does not cause harm
- Need: randomized controlled trials
- Meta-analysis:
  - No conclusive evidence to support PRP use\(^3\)
  - Supports ultrasound-guided leukocyte-rich PRP for tendinopathy (still controversial)\(^4\)
  - Supports use for knee osteoarthritis\(^5\)
- Accuracy? What about cost effectiveness?

\(^3\)Sheth U. et al. JBJS 2012; 94:298
\(^4\)Fitzpatrick J. et al. AJSM 2017; 45:238
\(^5\)Wang D. et al. JBJS Reviews 2017; 5:1

Take Home Points

- Fenestration / tenotomy:
  - Proven effective at many sites
- Other tendon treatments: same
- Platelet-rich plasma
  - Tendon: not proven better than other treatments
  - Osteoarthritis: promising
  - What about cost effectiveness?

Syllabus on line and other educational material:
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