Ultrasound-guided MSK Procedures: Advanced

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Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.

Outline:
- Calcific tendinosis
- Tendon fenestration
- Tendon injection and PRP
- Soft tissue mass biopsy

Degenerative Calcification

Calcific Tendinosis
- Hydroxyapatite deposition: metaplasia
  - Usually do not have cuff tear
- Appearance:
  - 79% hyperechoic & shadowing
  - No shadow: 7%
- Two phases:
  - Formative
  - Resorptive: painful

Farin et al. Skeletal Radiol 1996; 25:551

Tendon Calcification:
- Degenerative: thin, linear deposit
- Calcific tendinosis:
  - Formative: well-defined, dense shadow
  - Resorptive:
    - Globular, amorphous
    - Variable shadow
    - Best success with aspiration


Degenerative Calcification

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Calcific Tendinosis

**Formative**
- Defined, shadow

**Resorptive**
- Amorphous, little shadow

Calcific Tendinosis: resorptive phase

Patient #1
- Intra-osseous invasion

Patient #2:
- Intra-osseous invasion

Calcific Tendinosis: supraspinatus

Use of Tendon Anisotropy

Long axis

Calcific Tendinosis: aspiration

- Percutaneous lavage and aspiration
  - Best: rounded amorphous calcification
  - Correlate with radiography
- 3-10 cc syringes: Lidocaine
- 20 – 22 gauge needle
- Position patient: syringe is dependent

Calcific Tendinosis: lavage/aspiration

- Inject Lidocaine, then aspirate
  - Dilute calcification
  - Syringe dependent
  - Calcification will flow into needle
  - Repeat until calcification decreases
- Inject steroids into adjacent bursa
Calcific Tendinosis: lavage/aspiration

Calcific Tendinosis: results

- Calcium decrease correlates with symptom improvement
- Improvement: 91% at 1 year*
  - Calcium gone in 89%
  - Transitory recurrence at 15 weeks: 44%
  - Improved symptoms at 1 year
- No difference at 5, 10 years**

*del Crura, AJR 2007; 189:W128
**Serafini G, Radiology 2009; 252:157

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Tendon: anatomy

- Primarily: Type 1 collagen
  - Viscoelastic
  - Minor collagens
  - Proteoglycans
  - Glycoproteins
- Tendon fibroblasts or tenocytes
  - Respond to mechanical loading
  - Modulate extracellular proteins

Galloway MT et al. JBJS 2013; 95:1620
**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


**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**
- Elbow: common extensor tendon
  - Pain returns worse than before injection
- Gluteal:
  - 72% showed improvement at 1 month
- Hamstring:
  - 24% had symptom relief beyond 6 months

1Coombes BK et al. JAMA 2013; 309:461
2Labrosse JM et al. AJR 2010; 194:202
3Zissen MH et al. AJR 2010; 195:993
Steroid Injection: plantar fascia

- Into fascia:
  - 2% risk of plantar fascia rupture\(^1\)
  - Temporary pain relief: 4 weeks
  - No difference at 8, 12 weeks compared to saline\(^2\)
- Deep to fascia: 1st branch of the lateral planter nerve (Baxter’s nerve)
- Superficial to fascia:
  - Risk of fat atrophy theoretical using US guidance

\(^1\)Kim C et al. Foot Ankle Spec. 2010; 3:335
\(^2\)McMillan AM et al. BMJ 2012; 344:e3260

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

Prolotherapy

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


Achilles: hyperosmolar dextrose

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

Courtesy of Mark Cresswell, Vancouver
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

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

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

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

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, iliobial tract, rectus femoris, hamstring, common extensor tendon


Common Extensor Tendon (Elbow)

22-gauge

Patellar Tendon

Fenestration

Post-fenestration
**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.)


**Fenestration: pelvis**
- 22 tendons in 21 patients
- Gluteus medius (11), hamstring (8),
  gluteus minimus (2), tensor fascia lata (1)
- Marked or some improvement: 82%

Achilles tendon

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 tenotomy
  – Risk of tendon rupture


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

Outline:

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• Tendon injections and PRP
**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


**Platelets: growth factors**

- PDGF: platelet-derived growth factor
- VEGF: vascular endothelial growth factor
- TGF: transforming growth factor b-1
- IGF: insulin-like growth factor
- EGF: epidermal growth factor
- FGF: fibroblast growth factor
- TNF: tumor necrosis factor
- WTF: what's that factor?

**Platelet-Rich Plasma: uses**

- Historically:
  - Used in maxilla-fascial surgery: 1990's
- Other surgeries:
  - Fracture, non-union, bone fusion
- Cosmetics:
  - Alopecia, scars, wrinkles
- Tendon and ligament injuries
- Osteoarthritis


**Platelet-Rich Plasma: who cares?**

- Many high-profile athletes claim effectiveness
- Patients are requesting this treatment
- Everyone is doing it
- It works, but may not be best treatment

**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\(^2\)

\(^2\)McCarran 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: 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


PRP: injections

• Tendon
• Muscle
• Ligament
• Osteoarthritis
• Cartilage

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

Common Extensor Tendon

• PRP (72%) vs fenestration (56%)
  – Both improved
• 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 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

Gluteus Medius

Greater Trochanter
Needle
Normal

Gluteus Maximus and Minimus

- 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


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 outcomes better at 12 weeks
  - No significant difference in outcomes when greater than 26 weeks


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 Y.J. Clin Orthop Relat Res 2013; 39:1623
PRP and Tendon Injection

- Plantar fascia
  - PRP versus corticosteroid (40 patients)
  - PRP more effective and durable

Monto et al. Foot Ank Int 2014; 35:313

PRP and Knee Osteoarthritis

- Several studies evaluating PRP and knee OA
- Most studies show superior results with leukocyte-poor PRP compared with saline or hyaluronic acid
- Mild OA responds better
- No anatomic information
- One study showed same results with 1 or 2 injections

Wang D. et al. JBJS Reviews 2017; 5:1

PRP: issues

- Different PRP systems
  - Variable platelet concentrations
  - Leukocyte poor versus rich
- Studies:
  - Variable controls, often unblinded
  - Often not compared to other treatments
  - Variable follow-up time points
  - How many injections?
  - Acute versus chronic conditions?
  - Which tendon?

PRP: where are we today?

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

Sheth U. et al. JBJS 2012; 94:298
Fitzpatrick J. et al. AJSM 2017; 45:226
Wang D. et al. JBJS Reviews 2017; 5:1

Take Home Points

- Calcific tendinosis:
  - Inject before aspiration
- Tenotomy:
  - Proven effective at many sites
  - Integral part of other tendon treatments
- Platelet-rich plasma
  - What about cost effectiveness compared to tenotomy?

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