

Ultrasound-guided Tendon Treatments

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Disclosures

- Book Royalties: Elsevier
- Consultant: Bioclinica
- Medical Director: POCUSPRO
- Not relevant to this talk

Syllabus on line and other educational material:
www.jacobsonmskus.com

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Outline

- Tendon treatment overview
- Tendon fenestration / tenotomy
- Whole blood injection
- Prolotherapy
- Platelet-rich plasma
- Calcific tendinitis

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Tendon: injury

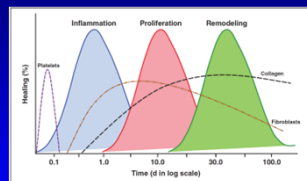
- Acute tensile overload
 - Usually underlying abnormal tendon
- Chronic overuse: repetitive excessive loading
 - Loss of normal tendon architecture
 - Change in tenocyte morphology
 - Altered collagen fibril distribution and neovascularity
 - Microtears
 - Resulting underuse may contribute

Galloway MT et al. JBJS 2013; 95:1620

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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

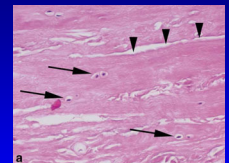


Galloway MT et al. JBJS 2013; 95:1620
Lee KS, et al. Am J Roentgenol 2011; 196:628

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Tendinosis

- Histologic term used instead of tendinitis
- No acute inflammatory cells
 - Primarily mucoid degeneration
- Inflammatory mediators do exist!
 - Precise role unknown
- Tendinopathy: non-specific term
 - Any tendon pathology



From: Hodler J, et al. JMRI; 2010. 72:811

Mosca MJ et al. BMJ Open Sport Exerc Med 2018

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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

Lopez-Vidriero et al. Am J Sports Med 2010; 26:269

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Peritendon Steroid Injections

- Shoulder: minimal transient pain relief¹
- Elbow: common extensor tendon
 - Pain returns worse than before injection²
- Gluteal:
 - 72% showed improvement at 1 month³
- Hamstring:
 - 24% had symptom relief beyond 6 months⁴

¹Mohamadi A et al. Clin Orthop Relat Res 2017; 475:232

²Coombes BK et al. JAMA 2013; 309:461

³Labrosse JM et al. AJR 2010; 194:202

⁴Zissen 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

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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



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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

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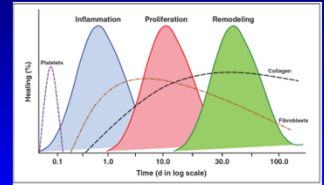
Fenestration: technique

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

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Post-procedure:

- No ice
- Achilles: walking boot
- Rest for 2 weeks
 - Daily activities okay
 - Gradual return to activities
- No NSAIDs: 2 weeks



Lee KS, et al. Am J Roentgenol 2011; 196:628

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Fenestration: tendons

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

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Tendon Fenestration

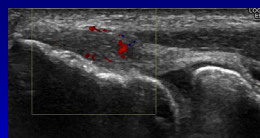
- 14 tendons
- VAS score improved: 4, 12 weeks
- Patellar (5), Achilles (4)
- 1 each: gluteus medius, iliotibial tract, rectus femoris, hamstring, common extensor tendon

Housner JA et al. J Ultrasound Med 2009; 28:1187

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Common Extensor Tendon: elbow

- 58 patients¹
- Outcome: average 28 months
 - 64% excellent, 16% good, 7% fair, 13% poor
- Follow-up study: 57 patients²
 - 93% excellent or good results
 - Corticosteroid injection not needed
- Metanalysis vs PRP: inconclusive³



22-gauge

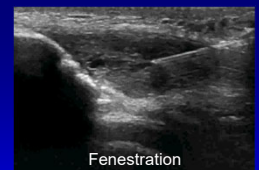
¹McShane JM et al. J Ultrasound Med 2006; 25:1281
²McShane JM et al. J Ultrasound Med 2008; 27:1137
³Krogh, Am J Sports Med 2013; 41:1435

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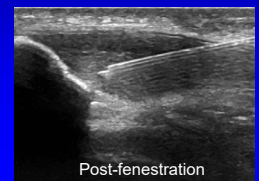
Patellar Tendon

- 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

Dragoo JL et al. Am J Sports Med 2014; 42:610



Fenestration



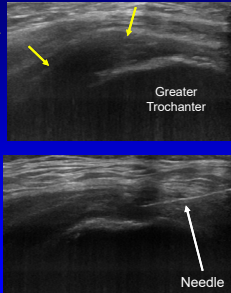
Post-fenestration

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Gluteus Maximus and Minimus

- Randomized controlled: 30 patients
 - PRP versus fenestration alone
 - Significant improvement at weeks 1 and 2
 - 80% had long term improvement: up to 1 year follow-up
 - No difference between treatment groups¹
- Two injections: more sustained response²

¹Jacobson JA et al. J Ultrasound Med 2016; 35:2413
²Fitzpatrick J et al. Am J Sports Med 2019; 47:1130



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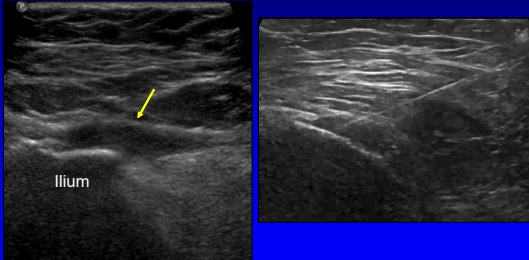
Fenestration: pelvis

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

Jacobson JA et al. J Ultrasound Med 2015; 34:2029

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Tensor Fascia Lata

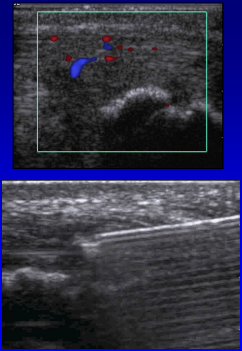


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Achilles Tendon

- Randomized controlled: 54 patients
- PRP versus saline injection
- No significant difference in outcomes
 - At 24 weeks¹
 - At 1 year²
 - *All had eccentric physical therapy

¹de Vos R.J et al. JAMA 2010; 303:145
²de Jonge S. Am J Sports Med 2011; 39:1623



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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

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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


¹McShane JM et al. J Ultrasound Med 2008; 27:1137

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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; 2015; 10:313



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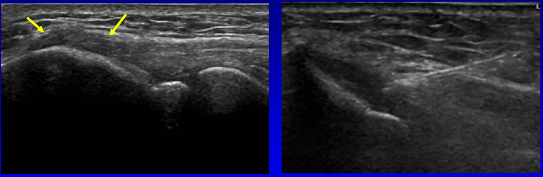
Whole Blood Injection

- 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

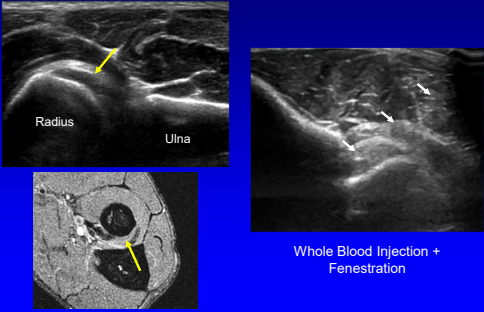
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Whole Blood Injection: Common Extensor Tendon



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Biceps Brachii Tendon: whole blood injection



Whole Blood Injection + Fenestration

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Outline

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- Whole blood injection
- **Prolotherapy**
- Platelet-rich plasma
- Calcific tendinitis

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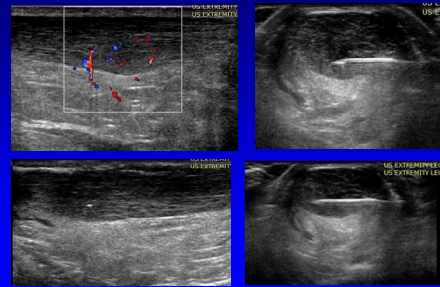
Prolotherapy

- 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

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Achilles: hyperosmolar dextrose



Courtesy of Mark Cresswell, Vancouver

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Prolotherapy

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

Maxwell et al. Am J Roentgenol 2007; 189:W215

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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

Giusti et al. BioMed Res International 2014; 26:269

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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?

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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 healing²

¹Giusti et al. BioMed Res International 2014; 26:269
²McCarrel TM et al. JBJS 2012; 94:e143

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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



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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

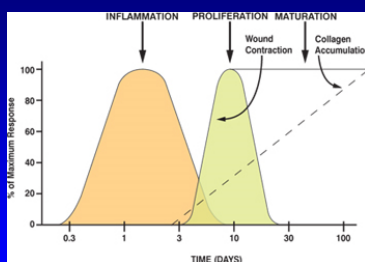
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Pre- and post-procedure:

- No NSAIDs: 10 days after procedure
- No ice after procedure
- Initial rest: 2 weeks
- Gradual return to activities
- Begin with mild stretching
- Physical therapy (eccentric)

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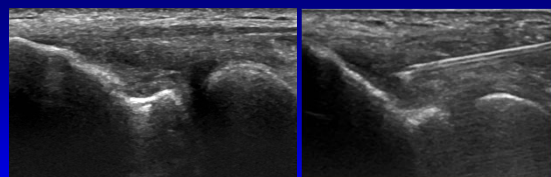
Phases of Tissue Healing



No non-steroidal anti-inflammatory drugs for 2 weeks

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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

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Common Extensor Tendon

- PRP vs fenestration: 230 subjects
 - 24 weeks: PRP higher success (84% vs 68%)
 - Mishra, Am J Sports Med 2013
- PRP, fenestration, steroid (in tendon):
 - No significant difference
 - Krogh, Am J Sports Med 2013; 41:625
- PRP vs whole blood: no difference
 - Thanasas, Am J Sports Med 2011; 39:3120

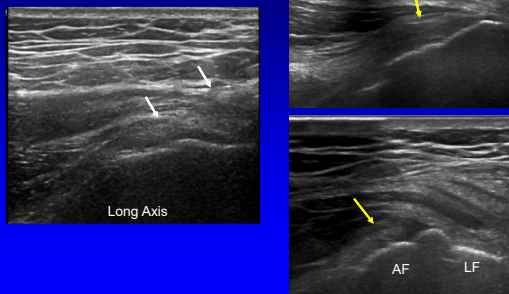
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Common Extensor Tendon

- PRP vs steroid (+fenestration)
 - PRP significantly better at 2 years
 - Gosens, Am J Sports Med 2013; 39:1200
- Metanalysis: inconclusive
 - Krogh, Am J Sports Med 2013; 41:1435
- PRP is superior to steroids
 - Xu G, Int J Surg 2019; 67:37
- PRP is equal to lidocaine
 - Martin GI, J Ortho Surg Res 2019; 23:14

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PRP: Gluteus Minimus



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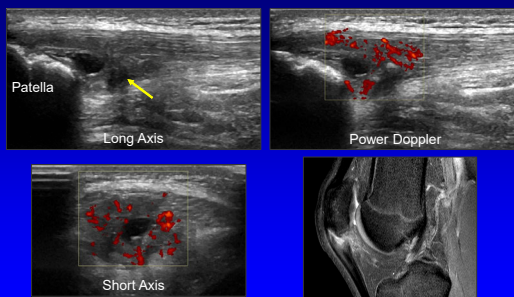
PRP and Tendon Injection

- 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 groups¹
- Two injections: more sustained response²

¹Jacobson JA et al. J Ultrasound Med 2016; 35:2413
²Fitzpatrick J et al. Am J Sports Med 2019; 47:1130

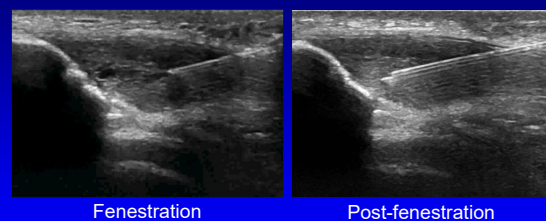
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PRP: proximal patellar tendon

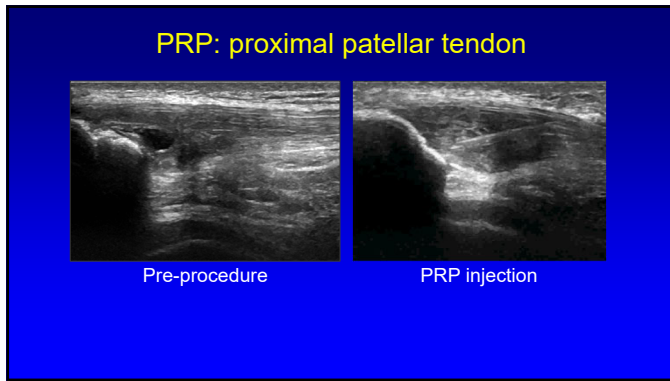


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Step #1: tendon fenestration



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PRP and Tendon Injection

- **Patellar tendon**
 - Randomized controlled: 23 patients
 - PRP + fenestration versus fenestration alone
 - PRP better at 12 weeks, no different at 26 weeks¹
 - PRP no better than saline²

¹Dragoo JL et al. Am J Sports Med 2014; 42:610
²Scott A et al. Am J Sports Med 2019; 47:1654

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PRP and Tendon Injection

- **Achilles tendon**
 - Randomized controlled: 54 patients
 - PRP versus saline injection
 - No significant difference at 24 weeks¹ and 1 year²
- **Metaanalysis**
 - PRP + eccentric physical therapy compared with saline
 - No difference in outcomes: clinical or ultrasound findings³

¹de Vos RJ et al. JAMA 2010; 303:145
²de Jonge S. Am J Sports Med 2011; 39:1623
³Zhang YJ. Clin Orthop Relat Res 2018; 39:1623

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PRP and Tendon Injection

- **Rotator cuff**
 - PRP not beneficial¹
- **Supraspinatus**
 - Interstitial tear
 - No difference between PRP and saline²

¹Hurley ET et al. Arthroscopy 2019; 35:1584
²Schwitzgubel AJ et al. Am J Sports Med 2019; ahead of epub

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PRP and Muscle Injection

- **Proximal hamstring**
- PRP versus rehabilitation only
- Randomized controlled: 28 patients
- PRP group: full recovery earlier
 - 27 days versus 42 days (average)

Hamid MS et al. Am J Sports Med 2014; in print

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Adductor Tear: PRP

- Target: tendon tear
- Efficacy uncertain

Pubis Adductor Longus Long Axis

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PRP and Muscle Injection

- Gastrocnemius: rat model
- PRP versus saline injection: 46 rats
- Followed to 14 days
- Outcome: strength and histologic analysis
- No significant difference between groups

Delos D et al. Am J Sports Med 2014; 42:2067

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PRP and Muscle Injection

- Hamstring
- PRP versus rehabilitation alone
- 10 National Football League players
- Median time: return to play
 - PRP = 20 days vs. rehabilitation = 17 days
- No significant difference between groups

Rettig AC et al. Orthopaedic J Sports Med 2013

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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

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PRP and Cartilage

- Meta-analysis: 21 papers
- Increased chondrocyte and mesenchymal stem cell proliferation
- Proteoglycan and Type II collagen deposition
- Increase chondrocyte viability
- Migration of stem cells
- Hyaline vs. fibrocartilage?

Smyth N. et al. Arthroscopy 2013; in press.

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- **Calcific tendinitis**

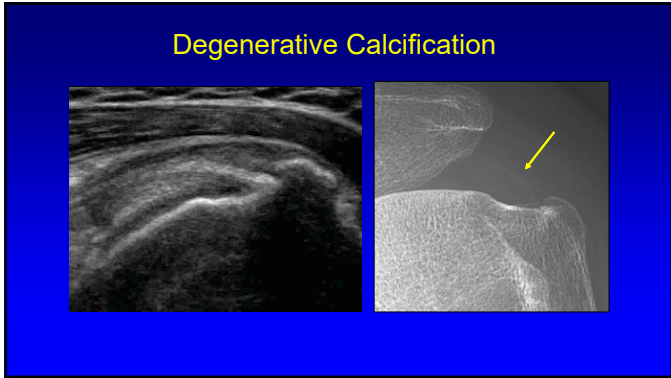
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Tendon Calcification

- Degenerative:
 - Thin, linear
 - Background of tendinosis
- Calcific tendinosis / tendinitis:
 - Globular
 - Tendon metaplasia
 - Lavage and aspiration

Uthoff. J Am Acad Ortho Surg 1997; 5:183

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Calcific Tendinosis

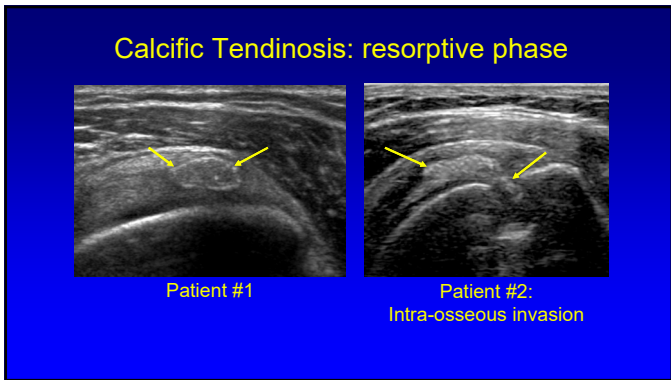
- Hydroxyapatite deposition: metaplasia
 - Usually do not have cuff tear
- Appearance:
 - 79% hyperechoic & shadowing
 - No shadow: 7%
- Two phases:
 - Formative
 - Resorptive: painful

Farin et al. Skeletal Radiol 1996; 25:551

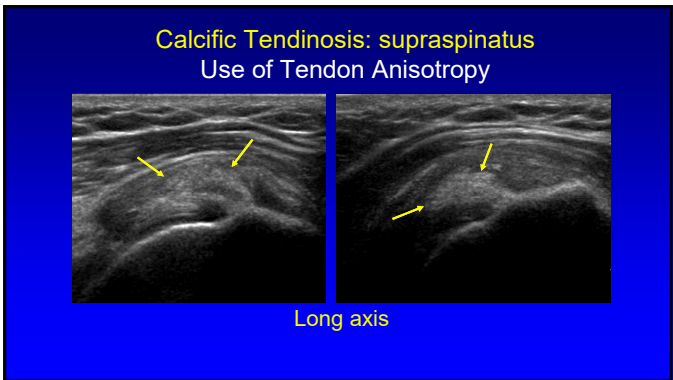
Formative
Defined, shadow

Resorptive
Amorphous, little shadow

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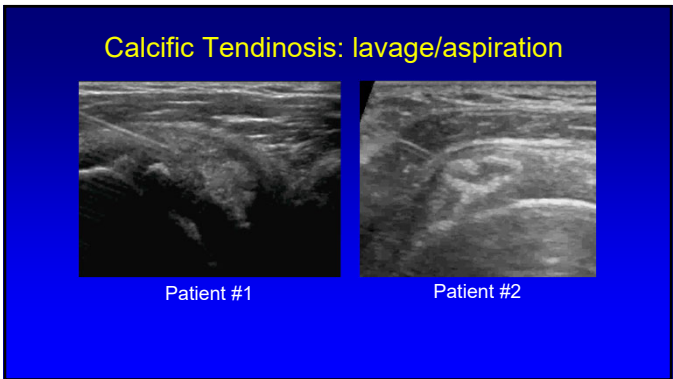


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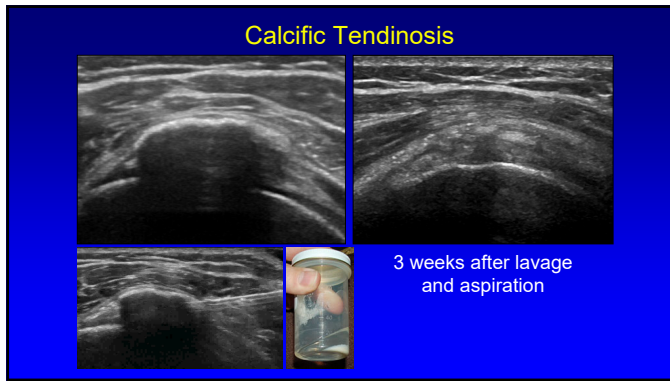
Calcific Tendinosis: lavage/aspiration

- Single puncture: 20 gauge needle
- Lavage: three 10ml syringes: lidocaine
- Shoulder: inject steroids in bursa
- Amorphous type: easier

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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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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?

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Thank you!

Syllabus on line and other educational material:
www.jacobsonmskus.com

Twitter handle: @jjacobsn

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