Injectables, Percutaneous Tendon Fenestration and Tenotomy

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Outline

- Anesthetic agents
- Corticosteroids
- Fenestration or tenotomy
- Autologous blood products
- Miscellaneous

Anesthetic Agents: types

- Diagnostic or therapeutic joint injection
- All agents harm tissues
  - Dependent on exposure time and dose
  - Use of epinephrine

Anesthetic Agents: harm

- Human chondrocytes and synovial cells
  - 0.5% Bupivacaine + 1:1000 epinephrine: 60% cell death
  - 1% Lidocaine: induced most apoptosis (programmed cell death)
  - Epinephrine: very cytotoxic
  - 0.5% Ropivacaine: most protective

Anesthetic Agents: joint injection

- Aim for joint recess
- Determine pain generator
  - Labrum: significance of imaging findings
  - Midfoot and hindfoot: prior to fusion
- Often combined with steroids

Disclosures

- Consultant: Bioclinica
- Book Royalties: Elsevier
- Advisory Board: GE, Philips
- Unpaid consultant for both regular and sugar-free Red Bull products

Note: all images from the textbook Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.
Joint Injection

- Anterior recess
- In plane
- Transducer: parallel to femoral neck, consider curvilinear
- Needle: distal to proximal
- 97% accuracy


Glenohumeral Joint

- Posterior joint recess
  - In plane
  - Transducer: axial, lateral to medial
  - Most reliable site*

Anesthetic Agents: harm

- Tenoblasts
  - Cell death: related to exposure time and concentration
  - All agents were toxic
  - 0.2% Ropivacaine: least toxic
  - Lidocaine: most toxic regardless of concentration

Corticosteroids: types and doses

<table>
<thead>
<tr>
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Corticosteroids: contraindications

- Absolute:
  - Septic joint
  - Bacteremia
  - Intra-articular fracture
  - Joint instability
- Relative:
  - Severe juxta-articular osteoporosis
  - Coagulopathy
  - Greater than 3 injections per year or within 6 weeks

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Corticosteroids: adverse effects

- Septic arthritis: 0.01 - 0.03%
- Post-injection “flare”: 2 - 25%
  - Within hours: if more than 24 hours- aspirate
- Local tissue depigmentation, atrophy
- Facial flushing: 15%, histamine mediated
- Increased glucose level

MacManus PJ et al Radiology 2009; 252;647

- Cartilage thinning:
  - Debated in the literature
  - Knee study:
    - 8 injections 40 mg Triamcinolone
    - Over 2 years
    - Compared to saline
    - Greater cartilage loss (seen on MRI)
  - No difference in pain relief

MacManus TE et al JAMA 2017; 317;1967

Rapidly Progressive Hip Disease

- Rapid chondrolysis
- In spite of anecdotal discussions, no proven link with intra-articular steroids
- Is development of RPHD coincidental?
- Only several case reports associating intra-articular steroids and osteonecrosis

6 weeks later
Initial Radiograph

Rapidly Progressive Hip Disease

- Joints, bursae, tendon sheaths
- Decrease inflammation
- Caveats:
  - Many bursae: distended and not inflamed
  - Some tendon sheaths communicate: joints
  - Biceps brachii long head and glenohumeral joint1

Corticosteroids: synovial spaces

- Midfoot and hindfoot
- In-plane: joint recess
- Out-of-plane: joint space
- Midfoot steroid injection:
  - Improvement at 4 months
  - Less improvement if obese

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1 Protheroe D et al Foot Ankle Int 2018; 39:101

Subacromial-subdeltoid: injection

PB
PL
Talus
Calcaneus
Iliopsoas Bursa

- **Oblique-axial plane:**
  - Superior to femoral head
  - Lateral to medial
  - Inject between tendon and ilium

- **Pain relief = successful iliopsoas surgical release**

Baker Cyst

- **Aspiration**
  - Inferior to superior
  - Medial to lateral
  - Aspirate joint effusion first if present

- **Steroid injection**
  - Baker cyst injection works better than intra-articular injection

Ilium

Blankenbaker DG. Skeletal Radiol 2006; 35: 565

Corticosteroids: other sites

- Ganglion and paralabral cysts: unproven
- Morton neuromas: pain relief 3 months
- Carpal tunnel: pain relief up to 6 months
- Plantar fasciopathy: equal to saline

Baker Cyst injected

Inferior to superior

Ganglion Cyst (elbow): aspiration

1. Blankenbaker DG. Skeletal Radiol 2006; 35: 565

Morton Neurona

- **Steroid injection**
  - 3 month: pain relief
- **Alcohol injection**
  - Symptoms return at 5 yrs
- **Radiofrequency ablation**
  - 85% effective at 6 months


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


Peritendon Steroid Injections (elbow)
Steroid Injection: plantar fascia

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


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

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Tendinosis

- 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

Non-sterile technique for simulation only!

- 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 steroids
- 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


Common Extensor Tendon (Elbow)
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


Common Extensor Tendon: elbow

- Randomized controlled: 28 patients
- PRP + fenestration versus fenestration alone
- Trend for greater clinical improvement in PRP subjects at 2 months
- No difference in clinical outcome at 6 months

Stenhouse G et al. Skeletal Radiol 2013; 42:1515

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


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


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.)

Gluteus Medius

- Greater Trochanter
- Needle
- Normal

Fenestration: pelvis

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

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

Achilles Tendon

- Randomized controlled: 54 patients
- PRP versus saline injection
- No significant difference at 24 weeks and 1 year

Metaanalysis
- PRP + eccentric physical therapy compared with saline
- No difference in outcomes: clinical or ultrasound findings

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References:
1. Vos RJ et al. JAMA 2010; 303:145
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

Biceps Brachii Tendon: whole blood injection
Flexion Pronated Position
Whole Blood Injection + Fenestration

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 healing²


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

PRP: proximal patellar tendon

Pre-procedure

PRP Injection

PRP: where are we today?

- Promotes healing, does not cause harm
- Need: randomized controlled trials
- Meta-analysis:
  - No conclusive evidence to support PRP use\(^1\)
  - PRP may help knee osteoarthritis\(^2\)
  - Supports ultrasound-guided leukocyte-rich PRP for tendinopathy\(^3\)
- What about cost effectiveness?

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Hyaluronic Acid

- Intra-articular injection
- Treatment of osteoarthritis (knee)
- American Academy of Orthopaedic Surgeons: evidence for use “inconclusive”
- American College of Rheumatology: supportive
- Meta-analysis: no difference over placebo

Miscellaneous Injections

- Mesenchymal stem cells: marrow, fat, tendons
- Sclerotherapy: target neovascularity
- Prolotherapy: hyperosmolar dextrose
- High volume injection: nerves, paratenon
- Hyaluronic acid: tendon sheaths
- Human amniotic membrane
- Deer antler velvet

Take Home Points

- Anesthetic agents:
  - All harm cartilage: ropivacaine is best
- Corticosteroids
  - Effective: synovial spaces
  - Other sites, peritenon: limited utility
- Autologous blood products:
  - All seem to help without harm
  - Not sure if any better than fenestration
- Miscellaneous: many unproven


\(^{2}\) Burke CJ et al AJR 2016; 207:1

\(^{3}\) Weick JW et al JBJS 2016; 98:1429; Jevsevar D et al JBJS 2015; 97:2047
Thank You

Syllabus on line and other educational material:
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Twitter handle: @jacoban