EDUCATION SESSION

Orthopedic Section

Regenerative Injections: Still Quackery? PT Research and Rehab Pearls

Annette M. Zaharoff, M.D.
Medical Director/Owner of The Non-Surgical Center of Texas
Julie B. Barnett PT, DPT, MTC
Director of PT at The Non-Surgical Center of Texas
Associate Professor at The Health Science Center of San Antonio
Physical Therapy Department

Disclosure

- No relevant financial relationship exists

Learning Objectives

- Define regenerative injections for tendon and joint healing as well as elaborate upon the distinction between elements used in clinical practice
- Define terminology used within regenerative medicine to include prolotherapy, platelet rich plasms, (PRP), stem cell injection and others
- Identify the injectable elements used with prolotherapy with indications and contra-indications associated with each
- Discuss the relevant outcome measures used in clinical practice to guide decision making with rehabilitation

Medicine Today

- Advanced care
- Manage symptoms or cure disease
- Short term effects and no long term solutions

Regenerative Medicine

- Long term solutions
- Replace or regenerate human cells, tissues, or organs to restore or establish normal function

Regenerative Medicine

- Degenerative
  - Heart, lungs, eyes, ears, bones, joints, metabolism…….
- Regenerative
  - Assist body's potential to heal and repair

Clinical Application of Biologics

- "The first great advancement in sports medicine was arthroscopy; the second is going to be this!"
  - James R. Andrews, M.D.

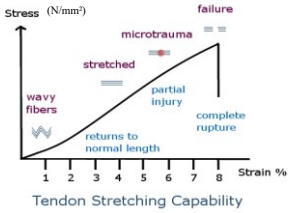
Musculoskeletal Medicine

- MSK injuries leading cause of disability and pain
- Increasing prevalence
- Increase healthcare costs
- Decrease productivity and quality of life

Scope of the Problem

- MSK Pain
  - $950 billion per year
  - >50% chronic conditions over 50 y.o.
- TKR/THR in U.S.
  - 7 million current
  - 1 million per year
  - $40,000-60,000 per surgery
  - Complications

Acute Injuries and Healing



Tendon Stretching Capability

Chronic Injuries

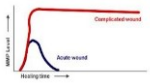
- Gradual process
- Initially asymptomatic
- Overuse injury
  - Tissue microtrauma and breakdown precedes pain
  - Creep and deformation occur without time to heal
- OA: Ineffective catabolic checks and balances

Tendinosis vs. "-itis"

- Inadequate cycle of inflammation, scarring, hypoxia, neovessels, failed healing
- Jozsa and Kannus: 97% of spontaneously ruptured tendons exhibit degenerative changes

Insufficient Healing

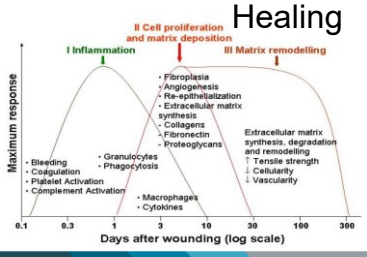
- Delayed Healing and Repair
  - Age, protein deficiency, low vitamin C, smoking
  - NSAID's, steroids
  - Poor blood supply, excessive motion
- Connective tissue insufficiency
  - Decrease tensile strength, increased laxity
  - Constant firing of mechanoreceptors
  - Pain



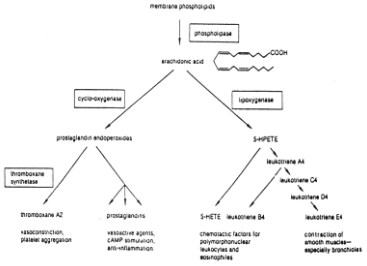
Connective Tissue Healing

- Sequential cascade, systematic process
- Phases
  - Inflammation
  - Proliferation
  - Remodeling
- Regulation by various cells in different phases

Inflammation is Necessary for Healing



Phase 1: Inflammatory, Vascular Response



Inflammatory Phase

- Platelet aggregation
- Clot formation and platelets release signals to start repair
- Debris removed, circulation increases, new cells attracted
- 48-72 hours

Phase 2: Proliferative, Tissue Reconstruction, Repair

- Inflammatory cells attract new cell growth and blood vessels
- New collagen synthesis
  - 2 days to 6 weeks
  - Maturation begins by 3 weeks

Phase 3: Remodeling, Functional Restoration

- Collagen
- Increase size and tensile strength
  - Reorganizes along lines of tension, crosslinks
- 3 weeks to 1-2 years

Remodeling

- Ligament tensile strength 50% normal at 6 months
- Ligament tensile strength 100% after 1-3 yrs.

Standard of Care ?? for Musculoskeletal Injuries

The Modern Definition (*Hall v. Hilburn; McCourt v. Abernathy; Johnston v. St. Francis Medical Center*)
That which a minimally competent physician in the same field would do under similar circumstances (2011)

- NSAID's and corticosteroids
- Most frequent pharmacologic substance prescribed for tendinopathy
- Inhibits inflammation

Standard Treatment Options

Arthroscopy
Joint Injections
Physical therapy
Oral NSAID
Diet and Exercise
Activity Modification

Injections Therapies

Stem cells + PRP
Stem cells
Platelet Rich Plasma
Viscosupplementation
Steroids
JOINT INJECTIONS

Regenerative Medicine

- Prolotherapy
- Platelet Rich Plasma
  - Growth factors
- Stem cells
  - Cells for new tissue/organ growth

Why are we still debating if orthobiologics works?

- Need to define what we are injecting
  - Platelet concentration
  - MSC concentration
  - Leukocyte count
  - RBC +/ RBC –
  - Autologous/ allogenic
- Need to define the procedure
  - US guidance
  - Needle tenotomy performed ?
    - How many needle passes ?

Why are we still debating if orthobiologics works?

- Rehabilitation methods
  - Need to be studied/ validated
  - Immobilization
  - Timing of eccentrics
- May need to separate out different body parts

Biologic Treatment Goals

- Tendinopathy
  - Degenerative tissue- ineffective healing cascade
- Osteoarthritis
  - Increased catabolic activity, cartilage destruction
- Pro- or anti-inflammatory or neither?

Indications for Regenerative Injections

- Repair soft tissue/joint injuries or laxity
  - Acute, chronic
  - Any accessible ligament, tendon, joint including spine
- Shorten rehabilitation time
- Prevent surgery
- Enhance post-surgical healing

Absolute Contraindications

- Acute infection or inflammatory disease
- Active cancer site
- Acute non-reduced subluxations, dislocations, fractures
- Allergies to injectants
- Prosthetic joint injection

Absolute Contraindications

- Platelet dysfunction
- Critical thrombocytopenia
- Hypofibrinogenemia,
- Hemodynamic instability
- Septicemia
- Pregnancy (PRP, Stem cell)

Relative Contraindications

- NSAID < 48hr, corticosteroid < 2 wks
- Recent fever or illness
- Skin rash
- Cancer (hemapoetic or bone)
- HgB <10g/dl, Platelets < 100,000 µL
- Anticoagulated w/ high INR (>3)
  - Clin Rheum 2013 Dec; 32

Risks of Injection Therapy

- Relatively safe procedure
  - Similar to risks of other injection procedures
  - Infection 1:50,000
  - Needle induced trauma (U/S guidance during procedure as needed
  - Allergic reactions (medication only)
- Post injection soreness

Pre-Injection Preparation

- No NSAID's or corticosteroids
- Tylenol or Rx pain medications prn
- Consent forms
- Supportive equipment prn
- Transportation

Post-Injection Protocols

- Post-injection soreness
  - 2 to 5 days
- Phases
- Length of time
- Restrictions
- Rehabilitation

Prolotherapy Injections

- Non-surgical
- Injection of substances into damaged tissue (muscle, ligament, tendon, cartilage)
  - stimulates proliferation and healing
  - decreases pain and improves function

Prolotherapy Treatment

- Hyperosmolar Dextrose (12-25%)
  - 50% D, normal saline, 1% lidocaine
- Osmotic gradient initiates local injury and **aseptic** inflammatory response
- Multiple injections into enthesis, joints and damaged tissues to increase ligament/tendon strength

Enthesis

- Zone of insertion of connective tissue to bone
  - Superficial fibers attach to periosteum
  - Deep fibers penetrate bone
  - "Weakness is in the weld" George S. Hackett, M.D.

Prolotherapy Actions

- Mechanisms
  - Inflammation stimulates fibroblast formation to repair connective tissue
  - Vascular: decrease neovessels
  - Neurologic function: Articular ligaments are rich in nerve endings. Weakness causes pain and alteration in motion, structure and function.
  - Reconstructing tensegrity

Prolotherapy

- Photomicroscopy shows collagenous connective tissue
- Identical material and geometric alignment of collagen fibers of normal connective tissues

Effectiveness: Research

- Evidence based publications about prolotherapy support the following:
  - Microscopic and macroscopic changes in local structures occur with prolotherapy injections supporting regeneration
  - Measurable mechanical improvement occurs in local structures
  - Decrease pain and increase function have been shown to occur in animal and human studies

Rabago D., Patterson, JJ et al,

Dextrose prolotherapy for knee osteoarthritis: a randomized controlled trial.
Ann Fam Med. 2013; 11(3):229-37 (ISSN: 1544-1717)
Rabago D; Patterson JJ; Mundt M; Kijowski R; Grettie J; Segal NA; Zgierska A

- Decrease pain and disability
- Dextrose prolotherapy is statistically superior to blinded saline injections and at-home exercises for function at 24 and 52 weeks, and trends to superior pain relief at 52 weeks.

Conclusions

- Dextrose prolo is statistically superior to blinded saline injections and at-home exercises for function at 24 and 52 weeks, and trends to superior pain relief, at 52 weeks.
- Improvement exceeds minimal clinical improvement on the WOMAC for knee OA
- Safe and satisfying to patients

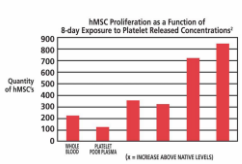
Prolotherapy for Tennis Elbow
Scarpone M. et al, CJSM; 2008

- Pain relief for lateral epicondylosis with intratendinous injections of prolotherapy solutions
- Decreased pain, increased strength, increased function

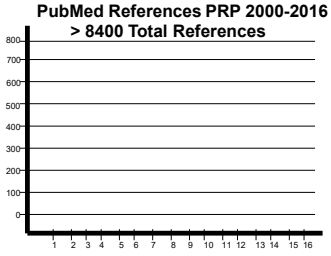
Platelet Rich Plasma

- >4x baseline concentrations
- Autologous growth factors
  - Cell proliferation, tissue growth, angiogenesis
- Cytokines
  - Intercellular interactions
- Chemokines
  - Attract stem cells and macrophages

Healing Cascade



Relationship of differing platelet concentrations and human mesenchymal stem cell (hMSC) migration and proliferation. From: Haynesworth, Stephen et al. American Academy of Orthopedic Surgery, March 2001



Does PRP Work?

PubMed Article Search: 6,047

Peerbooms, AJSM 2010
Kon, KSSTA 2010
Radice, Arthroscopy 2010
Wang-Saegusa, AOTS 2011
Thanasas, AJSM 2011
Gosens, AJSM 2011

Silva, KSSTA 2009
DeVos, JAMA 2010
Creaney, BJSM 2010
DeJonge , AJSM 2011
Schepull, AJSM 2011

50 % ? **50 % ?**

PRP Research

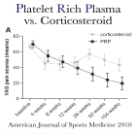
- Level 1 Evidence for PRP use
  - Lateral epicondylosis
  - Patellar tendinopathy
  - OA
  - ?Muscle regeneration
- Overall safety of PRP demonstrated

PRP Research

- Mishra AK, et al: Efficacy of platelet-rich plasma for chronic tennis elbow: A double-blind, prospective, multicenter, controlled trial of 230 patients. *Am J Sports Med* 2014;42(2):463-471.
- Alsousou J, et al: Effect of platelet-rich plasma on healing tissues in acute ruptured Achilles tendon. *Lancet* 2015;385;S19.

PRP Research

- PRP vs cortisone or HA
  - AJSM 2010-Gosens et al; PRP vs cortisone: Chronic lateral epicondylitis
  - Foot Ankle Int. 2014-Monto RR. PRP vs cortisone: Chronic plantar fasciitis
  - Arthroscopy 2011-Kon et al; PRP vs HA: Knee OA



PRP Research

- **The Effectiveness of Platelet-Rich Plasma in the Treatment of Tendinopathy: A Meta-analysis of Randomized Controlled Clinical Trials.**
  - Fitzpatrick A, et al. Am J Sports Med. 2016 Jun 6
- **Efficacy of Intra-articular Platelet-Rich Plasma Injections in Knee Osteoarthritis: A Systematic Review (Level 1)**
  - Meheux C J, et al. Arthroscopy 2016 Mar; 32(3):494-505
- **Platelet rich plasma versus corticosteroid injection for plantar fasciitis: A comparative study.**
  - Jain K, et al. Foot 2015 Dec;25(4):235-7.
- **Efficacy of Platelet-Rich Plasma versus Hyaluronic Acid for treatment of Knee Osteoarthritis: A systematic review and meta-analysis**
  - Hassan Niroomand S, et al. Am J Sports Med 2016 Jun6

Specific Formulation per Indication

- Platelets
  - Growth factors
  - WBC's
  - RBC's
  - Activation
- Indications
  - Tendinopathy
  - OA
  - Acute injuries

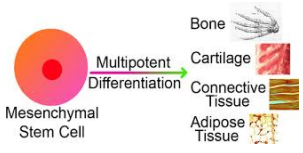
Stem Cells

- Stem cells
  - Cells for new tissue/organ growth
- Pluripotent
  - Embryonic
  - Induced (iPS)
- Multipotent
  - Adult

Adult Multipotent Stem Cells

- Allogenic
  - Placenta
  - Umbilical cord
- Autologous
  - Bone marrow
  - Peripheral blood
  - Adipose

Stem Cell Differentiation

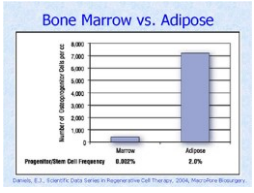


Bone Marrow

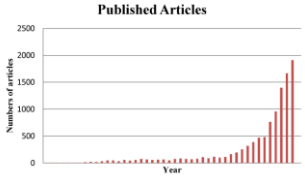
- Well established biotherapy
- Painful to harvest
- Donor site morbidities
- Reduced number and activity with age
- Less MSC yield
  - 30,000 NC/G of tissue

Adipose Stem Cells (ASC)

- Easy to harvest
- Minimal donor site morbidity
- Less decrease in number and activity with age
- Higher cell counts
  - 1,000,000 NC/G of tissue
  - 500x greater than BMAC
- Stromovascular fraction (SVF)
- Abundant source



Stem Cell Research 1964-2012



Stem Cell Research

- BMAC w/ HA post meniscectomy
  - Randomized, double blind, control
  - Increase meniscal volume and decrease pain
  - JBJS, 2014 Vangness et al
- Stem cells for the treatment of musculoskeletal pain
  - Luminita L, et al. World L Stem Cells. 2015 Jan 26; 7(1):96-105

Stem Cell Studies

- BMAC w/ HA post meniscectomy
  - Randomized, double blind, control
  - Increase meniscal volume and decrease pain
  - JBJS, 2014 Vangness et al
- Fat pad derived MSC s/p AKS
  - Decrease pain, increase cartilage growth
  - Arthroscopy, 2013 Koh et al

PRP + MSC's

- PRP + ASC Synergy
  - Enhances stem cell and fibroblast proliferation
  - Inflammation
  - Anti-microbial
  - Angiogenic

PRP + Stem Cells

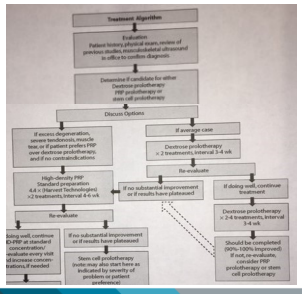
- ADSC w/ PRP s/p AKS
  - 87% improved w/ 2nd look arthroscopy
  - Knee Surg Sport Trauma, 2013 Koh et al

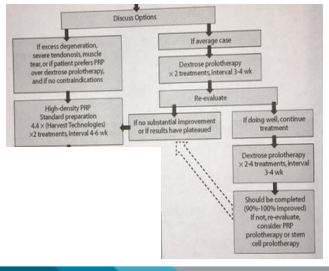
PRP + Stem Cells

- Disease modifying?
- Optimal source and administration
- Optimal dose, frequency, timing, # of injections
- Surgical correction of deformity in addition to MSC treatment

Treatment Course

- Prolotherapy
  - Average trial: 3-6 injections
  - Frequency: every 2-6 weeks
- Platelet Rich Plasma
  - Average trial: 1-3 injections
  - Frequency: every 6 weeks
- Stem Cells
  - Average trial: 1-2 injections
  - Frequency: every 3 months


Treatment Algorithm
Evaluation
Determine if candidate for either Dextrose prolotherapy, PRP prolotherapy or stem cell prolotherapy
Discuss Options
If excess degeneration, severe tendinosis, muscle tear, or if patient prefers PRP over dextrose prolotherapy, and if no contraindications
If average case
Dextrose prolotherapy × 2 treatments, interval 3-4 wk
Re-evaluate
High-density PRP Standard preparation 4-6 × (Harvest Technologies) ×2 treatments, interval 4-6 wk
If no substantial improvement or if results have plateaued
If doing well, continue treatment
Dextrose prolotherapy × 2-4 treatments, interval 3-4 wk
Re-evaluate
If no substantial improvement or if results have plateaued
Should be completed (90%-100% Improved) If not, re-evaluate, consider PRP prolotherapy or stem cell prolotherapy
Stem cell prolotherapy (note: may also start here as indicated by severity of problem or patient preference)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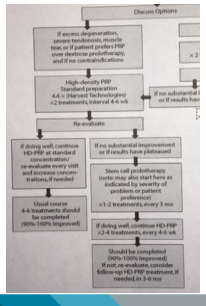

Discuss Options
If excess degeneration, severe tendinosis, muscle tear, or if patient prefers PRP over dextrose prolotherapy, and if no contraindications
High-density PRP Standard preparation 4-6 × (Harvest Technologies) ×2 treatments, interval 4-6 wk
Re-evaluate
If doing well, continue HD-PRP at standard concentration/ re-evaluate every visit and increase concentrations, if needed
If no substantial improvement or if results have plateaued
Stem cell prolotherapy (note: may also start here as indicated by severity of problem or patient preference) ×1-2 treatments, every 3 mo
Usual course 4-6 treatments should be completed (90%-100% Improved)
If doing well, continue HD-PRP ×2-4 treatments, every 4-6 wk
Should be completed (90%-100% Improved) If not, re-evaluate, consider follow-up HD-PRP treatment, if needed, in 3-6 mo

Post-Injection Protocols

- Post-injection soreness
  - 2 to 5 days
- Phases
- Length of time
- Restrictions
- Rehabilitation

Rehabilitation Protocols Post-Injection

- Kaux, et al., 2014
- Peck, Mautner 2015
- Finoff et al., 2011
- M. van Ark et al., 2012
- UW Health, Sports Rehabilitation, 2014

Rehabilitation Protocols Post-Injection

Similarities

- Avoid NSAI
  period
- Early mobili
- Progressive
  program
- 12 weeks to
  activities

[redacted]

nces

- of cryotherapy
- ng of mobilization
- itial weight bearing
- ng of eccentrics

Optimal Therapy Post Regenerative Injection

- Ice?
- NSAID?
- Immobilization?
- ROM?
- Stretching?
- Strengthening?
- Full activities?

Post Injection Rehabilitation

- Inflammatory phase (24-48 hrs)
  - No ice
  - No NSAID's (2-4 weeks)
- Proliferative phase (day 4-week 6)
  - ROM when painfree
  - Stretching (physiologic motion)
  - Strengthening (<3/10 level pain with PRE's)

Post Injection Rehabilitation

- Strengthening (<3/10 level pain)
  - 2-4 weeks: Isometrics→Isotonics (concentrics)
  - 4-6 weeks: Concentrics→Eccentrics
  - 6+ weeks: Eccentrics→HSR
  - 6-12 weeks: CKC→Plyometrics →Sports specific training
  - 12 weeks: Return to full activities
  - Vary timeline to individual needs

Basics of Joint Rehabilitation

- Phase 1 (protection/joint activation)
  - 0-7 days
  - Protective weight bearing status
  - ↓pain/effusion
  - maintain normal ROM
  - avoid muscle atrophy

Basics of Joint Rehabilitation

- Phase 2 (progress joint loading and functional restoration)
  - 7-21 days
  - Controlled stimulus to promote cartilage healing
  - Correct biomechanical deficits
  - Restore normal strength
  - Proprioceptive/balance activities (2 leg→1 leg)

Basics of Joint Rehabilitation

- Phase 3 (activity restoration)
  - 21+ days
  - Progress aerobic activities per pain/swelling
  - Loading program varies with area of body and sport demand
  - Begin sport specific training

Future Solutions

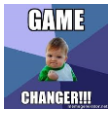
- Preparation
  - Centrifuge, Cells, Activation, Anticoagulants
- Growth factor quantities
- Injury environment
  - Pain and injury biomarkers
- Combined treatments
- Genomics/Exposome
  - Dr. Nathan Price, Institute for Systems Biology

Conclusions

- Regenerative injections may offer effective long term, non-surgical treatment options for MSK injuries, when indicated
- Cost effective with *effective outcomes vs. surgery*
- Great potential in MSK medicine

Progression of Scientific Truth

- Initially it is *ridiculed*
- Next, it is *violently opposed*
- Then finally, it is accepted as *self evident*



Thank you
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APTA CSM APTA Combined Sections Meeting

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- Discuss the relevant outcome measures used in clinical practice to guide decision making with rehabilitation

APTA CSM APTA Combined Sections Meeting

Content Slides

- Include a course outline, address the major points of the presentation.
- Include diagrams or graphic images (in black and white) or guiding questions, as appropriate. If the presentation includes more than one speaker, summarize each speaker's presentation points.
- Electronic files of articles may be included if you are the author and they have been published by APTA; otherwise, you are responsible for obtaining copyright permission. Identify copyrighted materials by using a reference number within the body of the text or providing information directly under a chart or diagram.
- Include time for learning assessment (discussion, polling, small group work, etc…)

Decision Making Algorithm

- Which injection?
  - Prolotherapy
  - Platelet Rich Plasma (PRP)
  - Adipose Stem Cell

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Orthopedic Injection Options:

- Corticosteroid injections
- Hyaluronic Acid injection (HA)
- Regenerative injection therapy (RIT)

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02/18/2017

Orthopedic Injections

Corticosteroid +'s:

- Fast acting
- Analgesic/pain relief
- Anti-inflammatory
- 1-2 months duration typical
- Can repeat 3x/year
- Covered by insurance **Corticosteroid –'s:**

02/18/2017

- Effects wear off with time typically
- Can damage connective tissue
- Sleep disturbances
- Weight gain
- Irritability

Orthopedic Injections

Hyaluronic Acid +'s:

- Fast acting
- Lubricant to joint
- Pain relief
- Aprx 6 month duration
- Can repeat 3x (18 months)
- Covered by insurance

Hyaluronic Acid –'s:

- Effects wear off with time
- Not curative/reparative

Orthopedic Injections

Regenerative +'s:

- Analgesic pain relief
- Regenerative goal for connective tissues
- Can repeat monthly for 3-6 months
- Cash based service for facility

Regenerative –'s:

- Cost to patient
- Slow acting: 1-3 months max per injection so can take 6+ months maximum outcome results
- Multiple injections and can be painful

Expectations with Regenerative Injections

02/18/2017

- Alternative option if patient is not a safe medical candidate for surgery
  - Age, smoker, diabetic, multiple co-morbidities, lack of family support before/during/after a surgical procedure
- Alternative option to exhaust non-surgical options for patients not wanting to undergo surgical procedure
  - Time off work, expense, lack of family support before/during/after a surgical procedure
- Safe option to strengthen natural tissue in conjunction with prescriptive rehabilitation guidelines

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Expectations with Regenerative Injections

• Decrease pain • Increase function: retest with outcome instrument • Decrease use of assistive device • Normalization of ROM • Progression of prescription exercise program

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Pre Regenerative Injection Therapy

- Establish outcomes measures:
  - Evaluation standards: Visual Analogue Scale (VAS), ROM, MMT, palpation, subjective data, SF-36

Pre Regenerative Injection Therapy (RIT)

- Patient education about diagnosis/care of the environment
- Supportive Equipment: tape, shoes, braces, ergonomics until patient has independence
- Assistive Devices: assessment of current/short term future need

02/18/2

- Spine: Oswestry, Neck Disability Index
- UE: Disabilities of the Arm, Shoulder, Hand (DASH), quick DASH
- LE: WOMAC, Timed Up & Go (TUG), BERG, Tinetti, walking speed, 6 min walk test

Pre Regenerative Injection Therapy (RIT)

• Stretches: prescriptive for diagnosis • Strengthening: phases I, II, III for load to connective tissue

- UE: Shoulder joint by side to progression to overhead as improvements tracked
- LE: open kinetic chain to progression to closed kinetic chain as improvements tracked

Rehab Goals AFTER Regenerative Injections

- Rehabilitation team: understand structural cell biology and time frames for rebuilding
- NSAID: do not use for prescriptive time to allow inflammatory cells to assist in healing

Pre Regenerative Injection Therapy

- Cardio: low impact even in LE for 1-3 months; walk not jog
- Sport/higher work demands: progressive resistive exercise per VAS and outcome measures

- Ice vs heat indications/discussion:
- Activity limitation: short term
- Assistive Devices: short term for LE

Same day-2 weeks post RIT #1

• NSAID: none. Tylenol is allowed for prn pain
• Ice • Assistive device prn 1-2 weeks; DC asap
• Stretching: per rehab protocol • Strengthening: none • Cardio: none

4-6 weeks post RIT

• Follow up with physician • Decide on sequential injection or • Progression of rehab protocol with increased graduated load

RIT #2 - #3 etc

- Must follow same protocol to protect the tissue
- 1st-2nd weeks of controlled tissue load
- 3rd- 4th weeks of graduated rehab protocol load added

After RIT #1:

No further RIT

- Progress rehab
  - Stretches: continue
  - Strengthening: progress 10 - 20%
  - Cardio: increase low impact 10-20%

Proceed with RIT #2

- Resume protocol of RIT #1
  - NSAID: none
  - Tylenol if needed for pain
  - Ice
  - Assistive Device if needed
  - Stretches only
  - Follow protocol as before

RIT completed

• After all RIT completed • # injections could be from 1-6 injections and could be 1-6 months + • Rehabilitation protocol is progressed incrementally at each injection phase if symptoms are improving

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Rehab after RIT completed

- Stretches: per protocol and safe for diagnosis
- Strengthening: progressed
  - Repetitions increased to 50-60 total per exercise
  - Add 1-2 lb. light weights with same repetitions
  - Increase therabands from yellow to red or blue with same repetitions

Rehab after RIT completed

- Cardio: establish 20 -30 min of low impact base
- Walk/Jog protocol: 20 min duration only
  - 4 min walk/1 min jog: repeat 4 sets (20 min)
  - 3 min walk/2 min jog
  - 2 min walk/3 min jog
  - 1 min walk/4 min jog
  - After 20 min jog then increase in 2' increments weekly
  - Do not increase speed or hills during this time

02/18/2

– Advance controlled closed chain exercises

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RESEARCH

• Tendons: Achilles and forearm • Cartilage: knee osteoarthritis • Spine: ligaments primarily; disc not as successful

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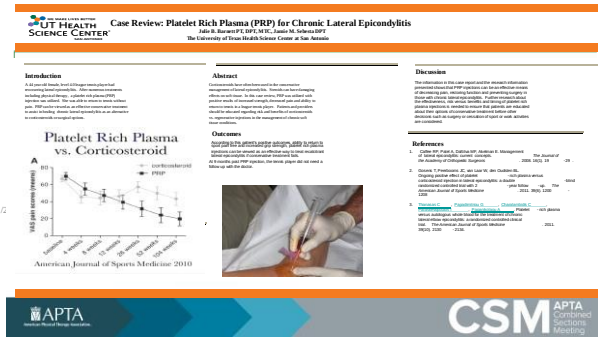
RESEARCH

- FOREARM:



RESEARCH

- KNEE OA

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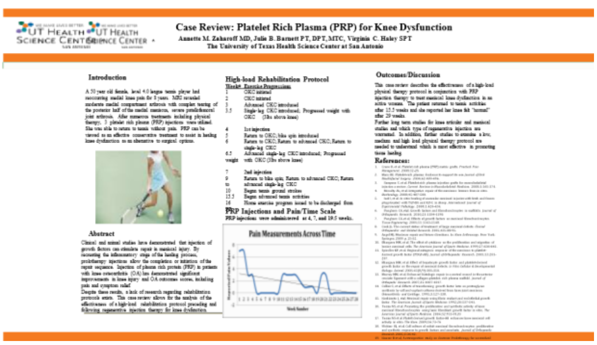
APTA CSM APTA Combined Sections Meeting



Conclusions

- Tremendous potential for "biologic augmentation" to improve healing and regeneration of cartilage, meniscus, and tendon
- Learn from embryologic development
- **Overall goal: recapitulation of molecular signals that can lead to tissue regeneration**
- Tissue regeneration will provide new approaches for tissue replacement and may ultimately improve management of common orthopedic injuries

Level V Evidence

- Personal Observation/Anecdotal
  - My 2nd plantar plate cartilage tear in foot
    - Left foot: 2006
      - Rehab + tendon transfer with limitations
    - Right foot: 2016
      - Rehab + 1 prolotherapy: no pain/no limitations

02/18/2

APTA CSM APTA Combined Sections Meeting

Future

- Regenerative Medicine is transforming all areas of medicine - not just orthopedics. • Future conferences will be divided by specializations
- Further research needed before drinking the Kool-Aid

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