

# Advances in Stem Cell and Platelet Rich Plasma Therapies



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# Disclosures:

-None

# What is all this about?



**Sports Illustrated**

# SPORTS MEDICINE'S NEW FRONTIERS

Surgeries that were once repairs are now reconstructions, enabling athletes to return to the field sooner and even better. Novel prostheses are allowing maimed soldiers to compete at the elite level of sports. Researchers of motor skills and pain tolerance, who once relied on crude measures, now study brain imagery to analyze neural activity. Many long-held axioms of sports physiology have been exposed as myths. And yet, as always with serious scientific inquiry, the journey so far has shown us how much farther there is to go—and how much more there is to learn

BY DAVID EPSTEIN  
ILLUSTRATIONS BY BRYAN CHRISTIE

**SURGERY** • PAGE 48

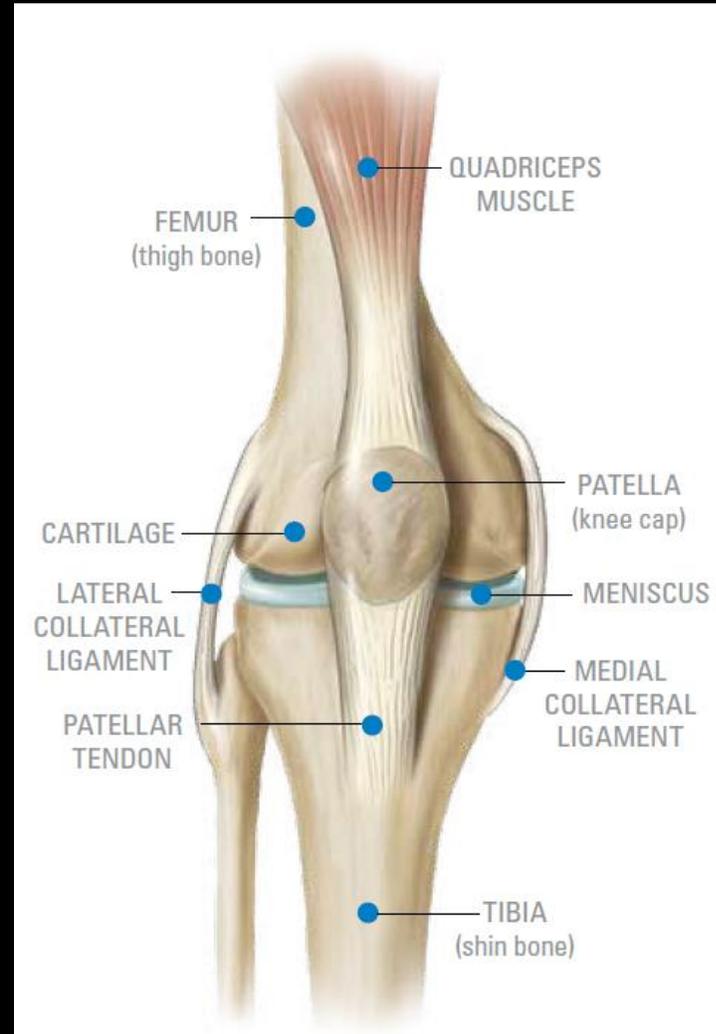
**PROSTHETICS** • PAGE 50

**MOTOR SKILLS** • PAGE 54

**PAIN** • PAGE 58

A vertical strip of four small illustrations showing anatomical and medical concepts: a hand, a prosthetic leg, a person holding a sword, and a person's head with neural activity.

- Muscles, tendons and connective tissue protect our joints and hold the various parts together.



- Once injured, tendons and ligaments do not heal easily because they naturally have poor blood supply, particularly where they connect to bone.
- As a result, the tendons and ligaments become weak and the muscles become over-taxed causing chronic pain, weakness and further damage.

## COMMON TREATMENT OPTIONS

- Rest
- Anti-inflammatory medicines
- Physical therapy
- Bracing
- Corticosteroid injections



When these treatment options are **not enough** or **do not provide long-term relief**, Platelet Rich Plasma (PRP) therapy or other regenerative medicine treatments may be an option





# In Office Options

- PRP (Platelet Rich Plasma)
- True Stem Cell Injections
  - BMAC or BMA
  - Adipose Derived stem cells
- Amniotic Fluid/ Placental derived Injections
- Other
  - Prolotherapy
  - “Ozone” Injections/ Prolozone

# Who has all the answers?

- Nobody!!
- This is an emerging area: there is a lot of promise but also a lot of shenanigans
- Complicated thought process of patient selection, discussion of data and outcomes, patient expectations.
- Best process is to explain options, give information regarding them, and let patient think about it (*and consult with Dr. Google* )



# In office Options

- PRP
  - Derived from Patient's own blood
  - Building evidence (Level 1 for Knee OA and some Tendinopathy)
  - Most evidence here, but many questions still need clarified
  - Cost is less than other options
  - Comparison data available for Steroids/Saline/HA

# In Office Options

- “Stem Cell” Injections
  - BMAC or BMA Injections
    - Concept is getting true stem cell/ MSC’s (also getting Bone marrow derived PRP)
    - Data is nascent, but some promising (yet small power) studies
    - FDA ok
    - cost
    - Time will tell as data/ trials come in
    - Combo treatment (staged) or after failure of PRP?
  - Adipose-derived stem cell injections
    - Theory is higher MSC’s derived than BMAC/BMA
    - Very limited data
    - May be FDA gray area or no-go for certain products
    - Some off-shore labs/ and/or FDA Trials for Cultured MSC’s

# In Office Options

- Amniotic Fluid/Placental Derived
  - Can be FDA gray area (typically not with Amniotic derived products)
  - Little data, but may present reasonable option in certain patients
  - No live cells....
  - There are growth factors present—application?
  - More theory than data driven practice
  - Scant Comparison data
  - Easy to perform
  - Cost less than BMAC/BMA

# Prolotherapy

- Substance injected into joint or tendon area designed to incite inflammatory response/ theoretically creating positive pain response and healing response
- Not covered by insurance
- Typically dextrose/ lidocaine/ others
- Can have a significant inflammatory response
- Limited data regarding comparison to saline injections for knee (is saline a placebo??)
- No comparison to hyaluronic acid or PRP

# “Ozone Injections”/ Prolozone

- O<sub>3</sub> initially used to disinfect/ currently used in municipal water treatment plants in the world
- Limited studies showing histological and biological evidence for effects of its use, certainly controversial in its use
- Theory is that O<sub>3</sub> inhibits inflammatory cytokines/milieu, and normalizing the cellular redox balance through the actions of cytokines
- Generated O<sub>2</sub> by “Ozone generator” in the office
- Administered as an injection to the affected area
- Lots of ?’s



# PRP: History

- First promoted by M. Ferrari in 1987 autologous transfusion component after open heart operation to avoid homologous blood product transfusion
- PRP used in maxillofacial and plastic surgery since the 1990s
- Use in sports medicine has grown mostly in the last decade given potential to enhance muscle and tendon healing/ studies showing benefit of PRP for degenerative arthritis of knee
- Safety profile as well as improved development of devices for outpatient preparation and delivery/quality of MSK ultrasound have also contributed to increased use

Platelet Rich Plasma (PRP) is defined as autologous blood with a concentration of platelets above baseline values (200,000 plt/ $\mu$ L)

Blood typically contains 6% platelets  
PRP has a significantly increased supra-physiological platelet concentration.

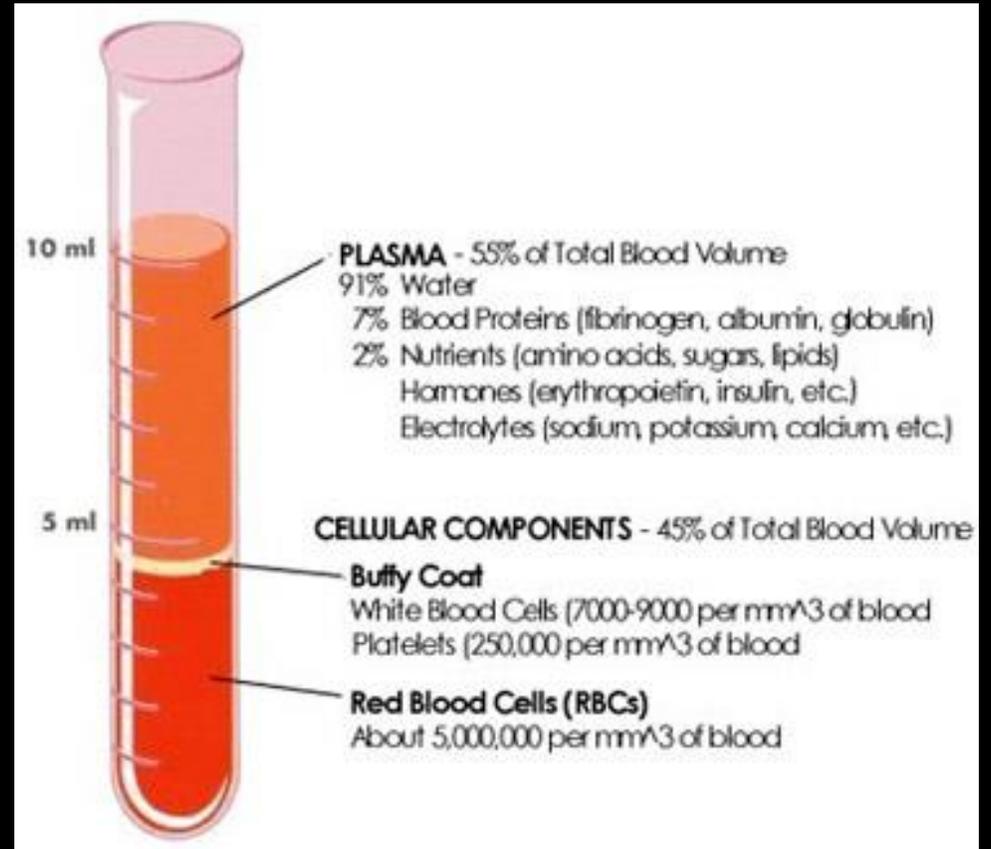
Although this level can vary depending on the method of extraction and equipment, **studies have shown that clinical benefit can be obtained if the PRP used has an increased platelet concentration of 4x greater than normal blood**



Blood contains platelets and fibrinogen, which play a crucial role in blood clotting and also carry certain growth factors that promote wound healing.<sup>1-7</sup>

PRP is derived from your own blood, which has been processed to concentrate the platelets.

When injected into the injured site, these concentrated platelets contain powerful growth factors that can jumpstart the healing of injured tendons and ligaments by stimulating tissue repair and regeneration.<sup>1-8</sup>



# Healing/ tissue repair cascade

- Hemostasis
  - Clot formation to degranulation of platelets
- Acute inflammatory phase
  - Last up to 72 hours
  - Characterized by pain, swelling, redness and increased local temperature
- Intermediate repair phase
  - 48 hrs. to 6 weeks
  - Anatomic structures restored and tissue regeneration occurs
  - Fibroblasts, angiogenesis
- Advanced remodeling phase
  - 3 weeks to 12 months
  - Collagen remodeling

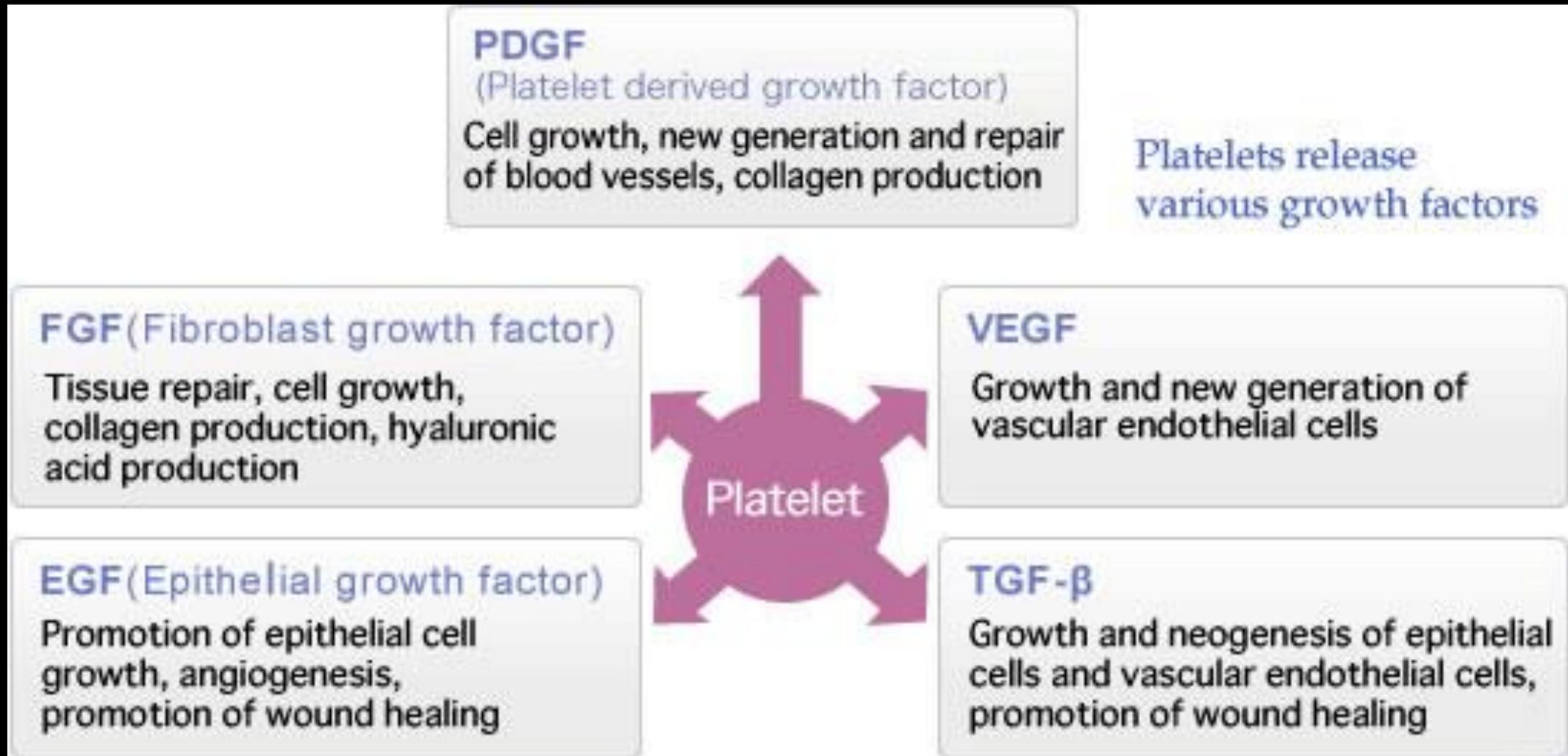
# What are platelets? What do they do?

- **Platelets** are small discoid cells with a life span of about 7-10 days.
- Granules inside platelets contain clotting and **growth factors**.
- Platelets are activated and aggregate together during the healing process.
- Once activated, platelets release the granules which contain growth factors to stimulate the inflammatory cascade and healing process

# What do Growth Factors do?

- GF mediate the processes necessary for repair of soft tissues (muscle, tendon and ligament) after acute traumatic or overuse injury
- In vitro, GF recruit reparative cells and may augment soft-tissue repair
- Animal studies have been shown GF to accelerate healing, exhibit anti-inflammatory properties and stimulate cartilage matrix metabolism

# Growth Factors in PRP



# Application to Tendon Healing

- Tendons are slow to heal and repair due to low vascularity and low energy consumption
- Growth factors can stimulate tendon repair by tenocyte activation (stimulating proliferation of tendon cells)
- Reduced scar formation/ promotion of angiogenesis/ neovascularization

# Application to muscle healing

- Studies show accelerated muscle healing/ quicker return to sport times (in aggregate but maybe not hamstring....)
- Decrease scar formation/promotion of blood flow



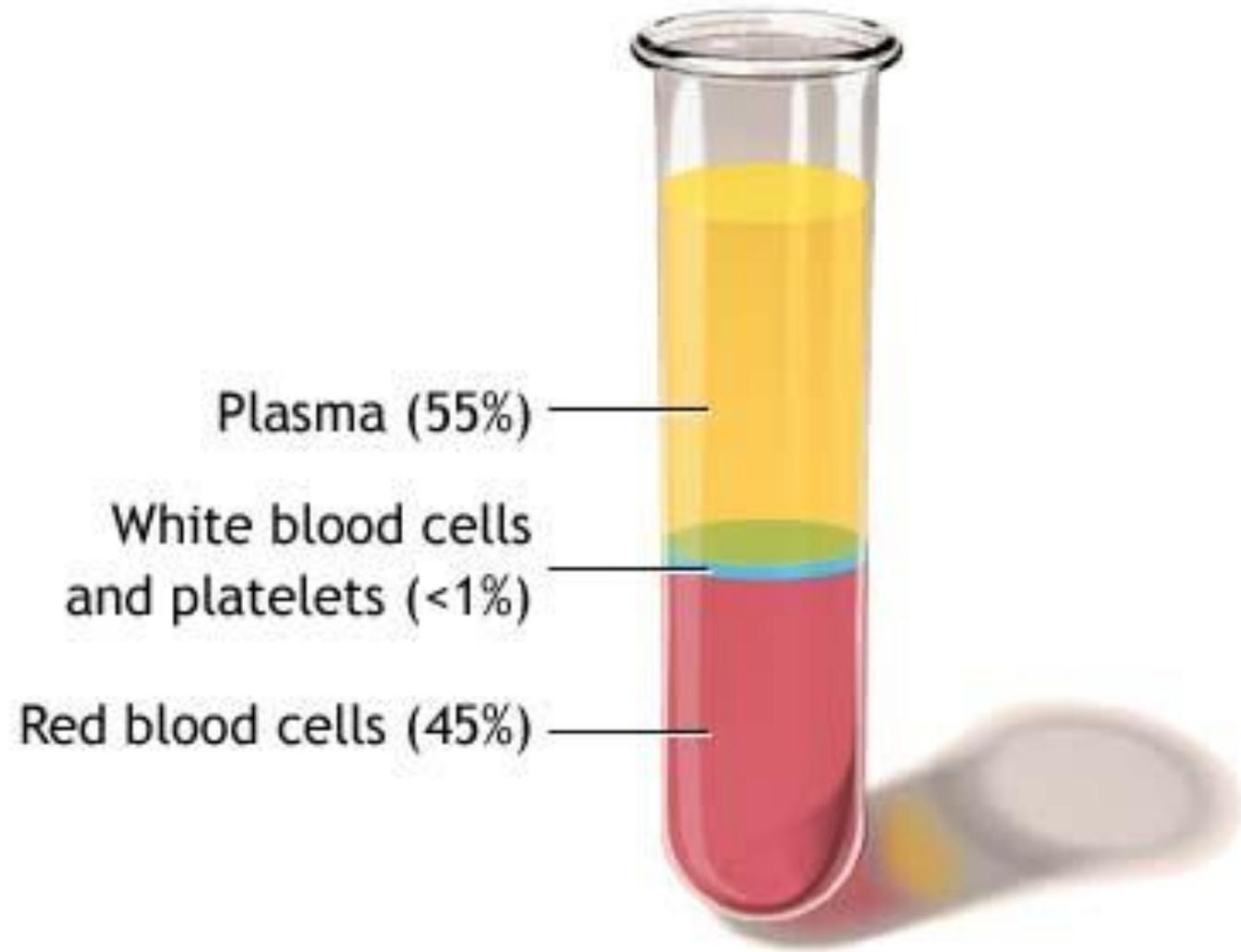
# Application to bone/degenerative conditions

- Promising results when compared to hyaluronic acid and steroid injections for knee degenerative arthritis regarding length of pain relief/return to function/functional outcome—especially for earlier stages of arthritis
- Possible benefit for cartilage defects/fractures/various MSK disorders
- Much detail and information yet to be established—regarding standard protocols, much variability in individual platelet counts/concentration systems. More studies are needed to define these questions

# PRP: how is it performed?

- A small sample of blood is taken from the patient (30-60 cc)
  - This sample is then placed into a centrifuge.
- 
- The centrifuge separates the sample into
    - red blood cells
    - the buffy coat/ platelet rich plasma
    - platelet poor plasma

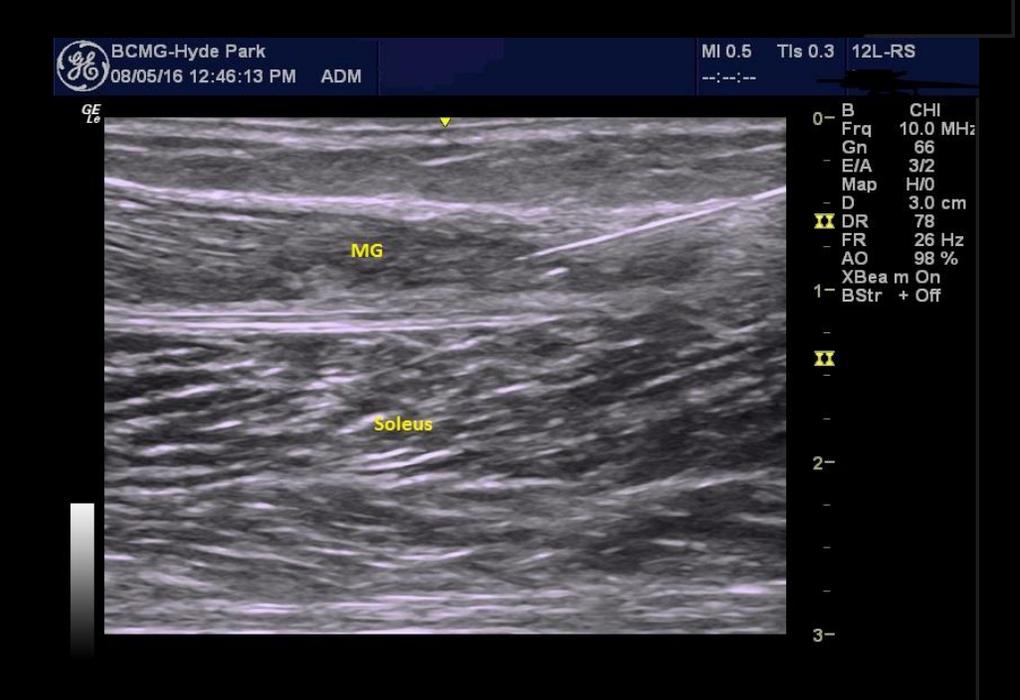
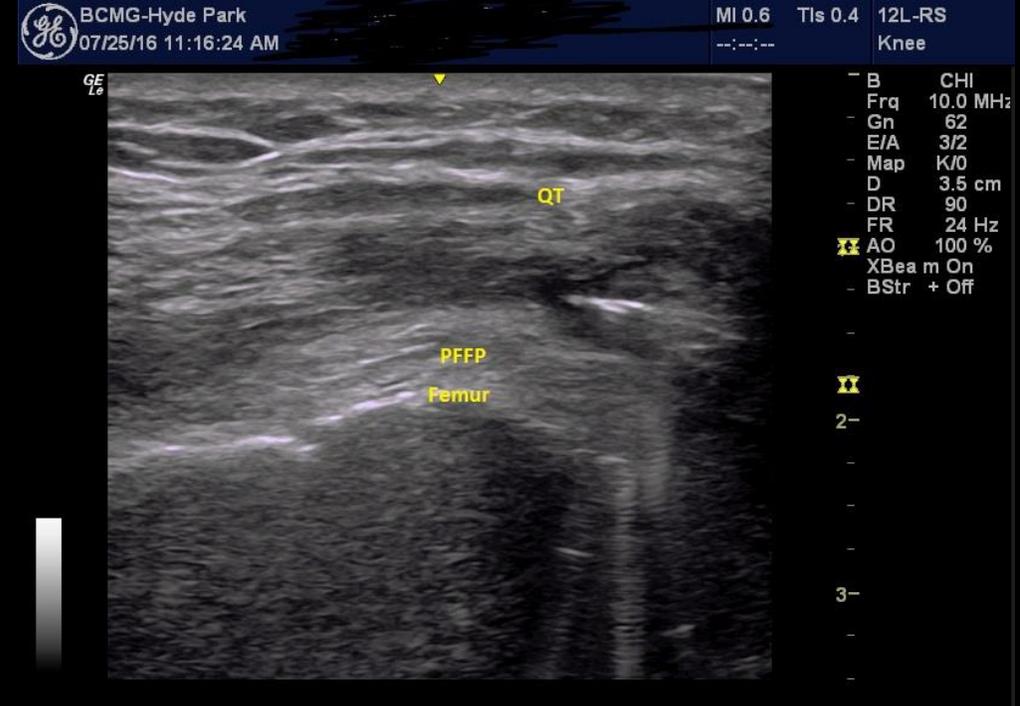
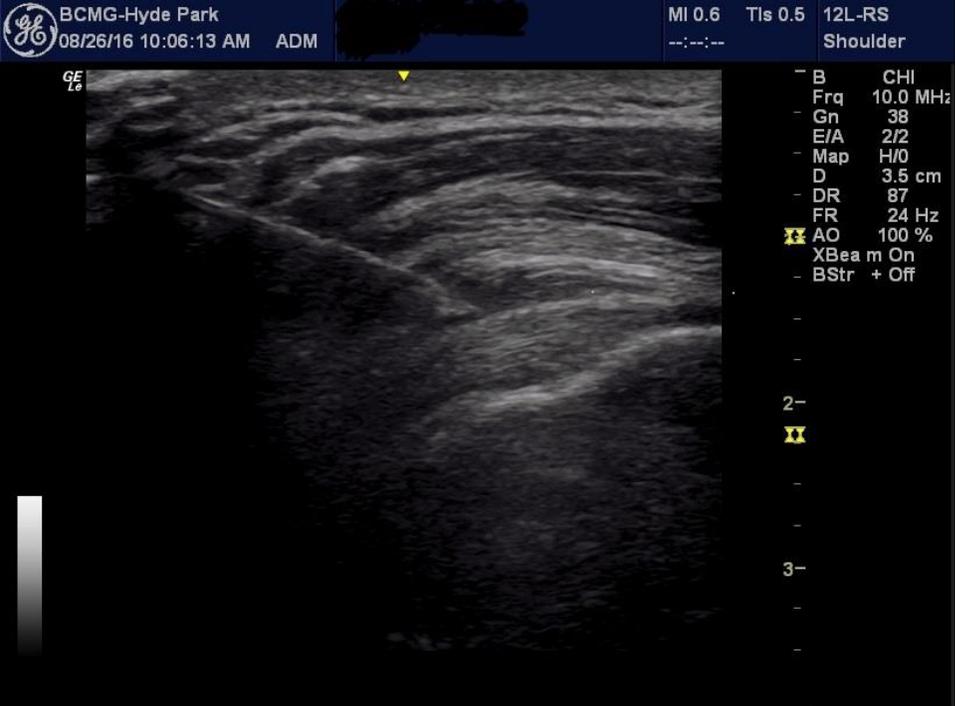




# PRP: how is it performed

- This platelet rich plasma is then injected into the targeted tissue (joint/tendon/muscle etc) preferably under MSK ultrasound visualization and guidance





# Biceps Tendinopathy: October 2017

February 2018

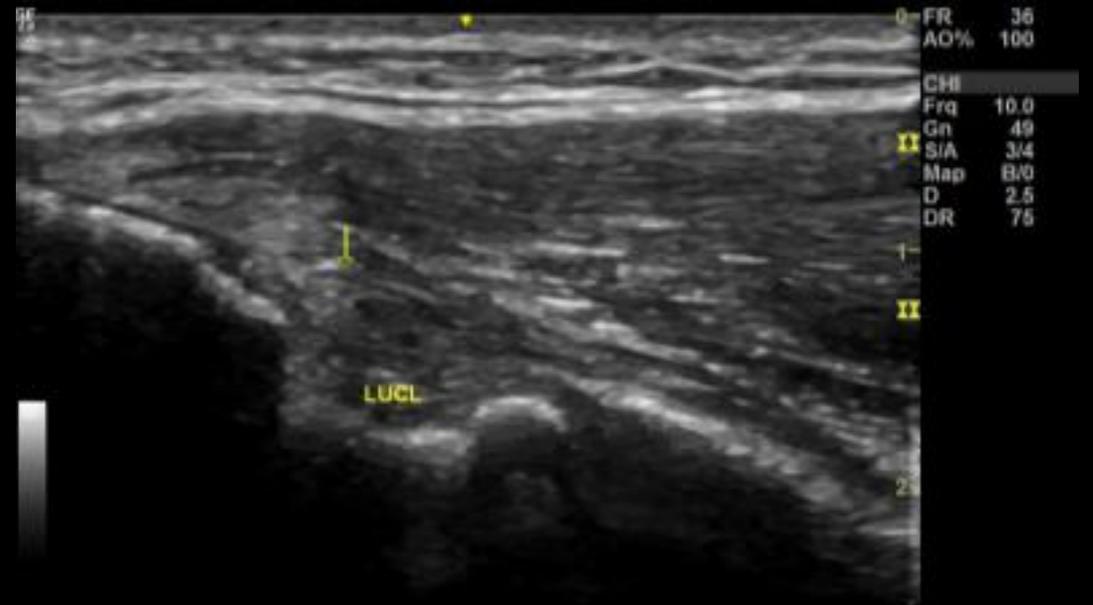
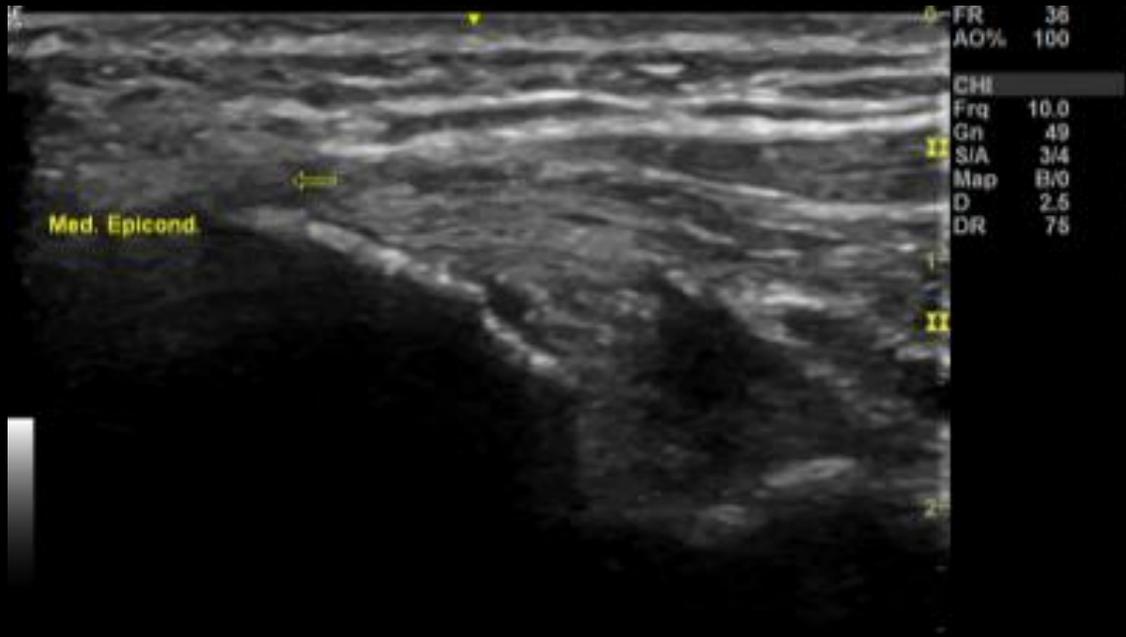


FR	33
AO%	100
CHI	
Frq	10.0
Gn	45
S/A	3/2
1-Map	B/O
D	3.5
II DR	72
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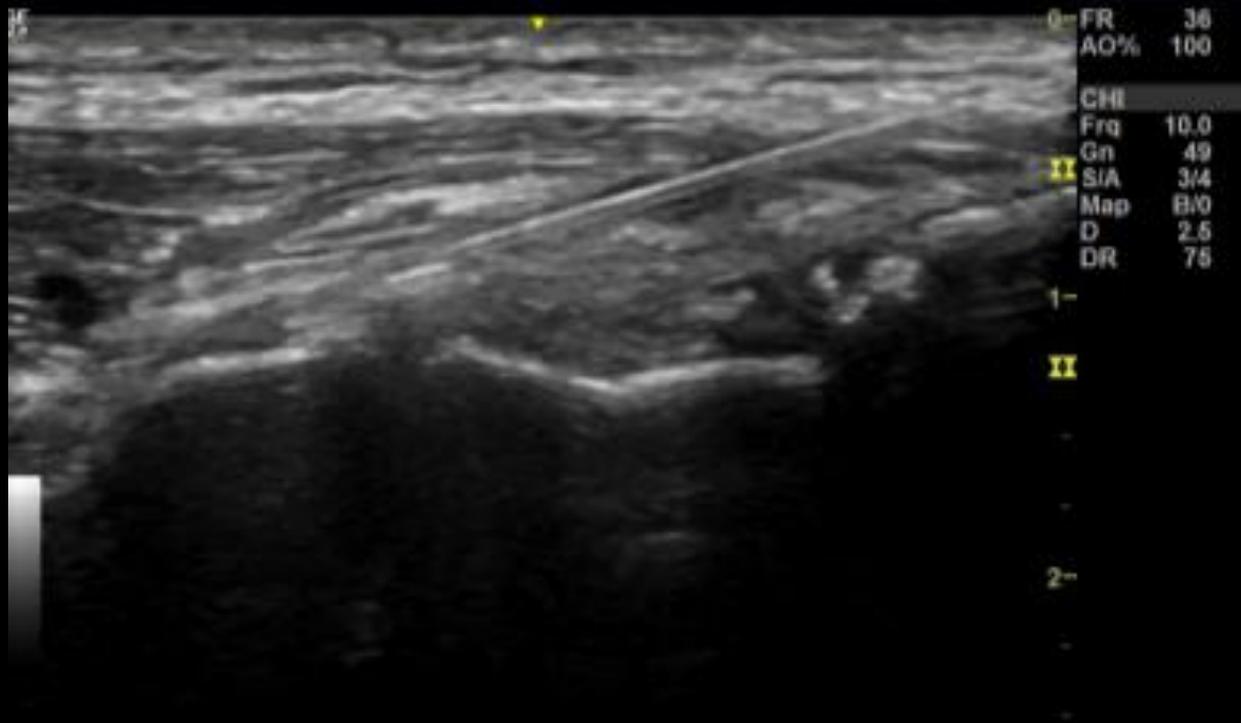


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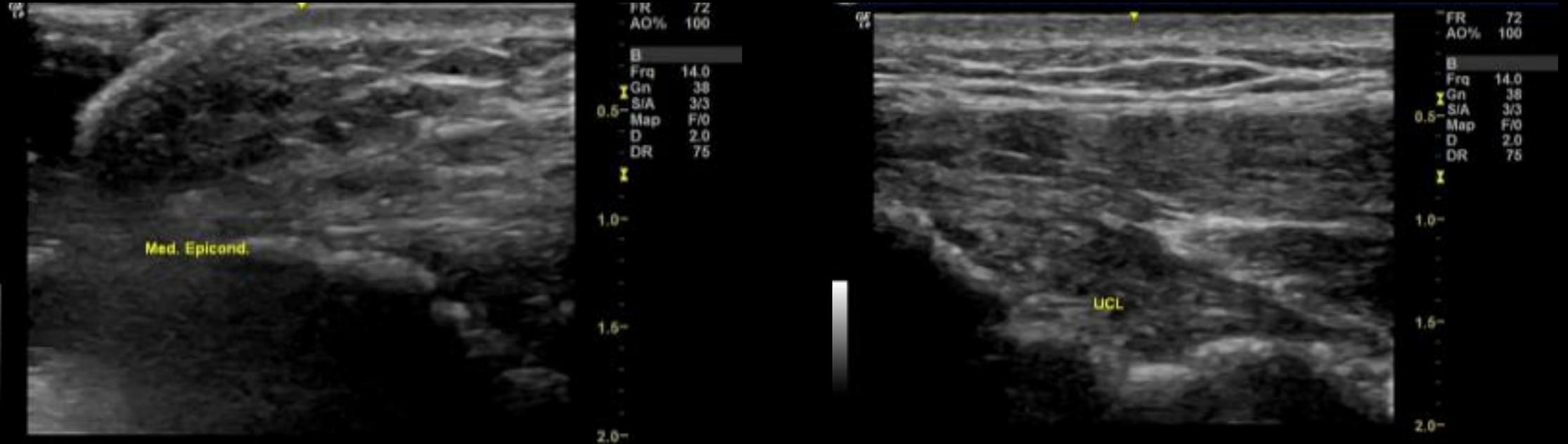
# UCL Injury: December 2017



# UCL PRP Injection: January 2018



# UCL Post PRP Injection: March 2018



# Achilles Tendon

March 2017-  
Long Axis

May 2017



Achilles Tendon  
March 2017-  
Short Axis



May 2017



- Responses to treatment vary, but most patients will need one to three injections.
- Each set of treatments may be spaced approximately one to four weeks apart.

PRP therapy may eliminate the need for more aggressive treatments such as invasive surgery or long-term medication

PRP therapy is not a quick fix.

The therapy stimulates the growth and repair of tendons and ligaments, which requires time and rehabilitation



# Current Concepts regarding PRP

- Technique (accuracy) and timing matter
- May require more than 1 Injection
- Current Trend towards
  - Leukocyte rich PRP for tendon/soft tissue
  - Leukocyte poor for joint
- Avoid other chondrotoxins or anything that may affect the activity of the PRP!! (Marcaine/ nondiluted lidocaine)

# My experience

- Started doing PRP under MSK US guidance in 2012
- Over 2200 PRP injections done to date
- 2 studies approved by BayCare IRB ongoing in process (Proximal Hamstring Tendon and Plantar Fascia)/ Plus Case report involving competitive pediatric gymnasts with recalcitrant lateral epicondylitis (X 1 year+ each)
- Tactical Precision is key: MSK US
- Some protocols are being better refined: knee degenerative arthritis—series of 3/others---
- PRP + HA Combination?
- Many patients referred by prior patients whom have had PRP in the last 4 years and very happy with functional improvement and outcome
- Have treated physicians, athletes, “weekend warriors”, and various people who could not afford to continue to have activity curtailed by their MSK problem



# My Experience:

- Clinical Journal of Sport Medicine:
- [March 2017 - Volume 27 - Issue 2 - p 193–230](#)
- doi: 10.1097/JSM.0000000000000417
- Abstracts
- **Treatment of Plantar Fascial Tendinosis With Ultrasound Guided Platelet-Rich Plasma Injection**
  - Michelle Hummel, BS, Kevin Elder, MD, and James Vogler, MD

# PRP: evidence is growing for treatment of knee degenerative arthritis and tendinopathy

- THE PHYSICIAN AND SPORTSMEDICINE, 2017 <http://dx.doi.org/10.1080/00913847.2017.1297670>
- CLINICAL FEATURE ORIGINAL RESEARCH
- Platelet rich plasma versus steroid on lateral epicondylitis: meta-analysis of randomized clinical trials
- **Conclusion:** Treatment of patients with LE by steroid could slightly relieve pain and significantly improve function of elbow in the short-term (2 to 4 weeks, 6 to 8 weeks). PRP appears to be more effective in relieving pain and improving function in the intermediate-term (12 weeks) and long-term (half year and one year). Considering the long-term effectiveness of PRP, we recommend PRP as the preferred option for LE.

# PRP: evidence is growing for treatment of knee degenerative arthritis and tendinopathy

- Am J Sports Med. 2017 Jan;45(1):226-233. doi: 10.1177/0363546516643716. Epub 2016 Jul 21.
- The Effectiveness of Platelet-Rich Plasma in the Treatment of Tendinopathy.
- **CONCLUSION:**  
There is good evidence to support the use of a single injection of LR-PRP under ultrasound guidance in tendinopathy. Both the preparation and intratendinous injection technique of PRP appear to be of great clinical significance

[Am J Sports Med.](#) 2018 Mar;46(4):933-939.

## **The Effectiveness of Platelet-Rich Plasma Injections in Gluteal Tendinopathy: A Randomized, Double-Blind Controlled Trial Comparing a Single Platelet-Rich Plasma Injection With a Single Corticosteroid Injection.**

### **CONCLUSION:**

Patients with chronic gluteal tendinopathy >4 months, diagnosed with both clinical and radiological examinations, achieved greater clinical improvement at 12 weeks when treated with a single PRP injection than those treated with a single corticosteroid injection. Registration:

ACTRN12613000677707 (Australian New Zealand Clinical Trials Registry).

[Am J Sports Med.](#) 2019 Mar 6:363546519826969. doi:

10.1177/0363546519826969. [Epub ahead of print]

Leucocyte-Rich Platelet-Rich Plasma Treatment of **Gluteus Medius and Minimus Tendinopathy**: A Double-Blind Randomized Controlled Trial With 2-Year Follow-up.

### **CONCLUSION::**

Among patients with chronic gluteal tendinopathy and a length of symptoms >15 months, a single intratendinous LR-PRP injection performed under ultrasound guidance results in greater improvement in pain and function than a single CSI. The improvement after LR-PRP injection is sustained at 2 years, whereas the improvement from a CSI is maximal at 6 weeks and not maintained beyond 24 weeks.

# EARLY INTERVENTIONS: A ROLE FOR PLATELET-RICH PLASMA IN THE TREATMENT OF EARLY KNEE OSTEOARTHRITIS?

EVIDENCE GROWS IN FAVOR OF PRP AS COST-EFFECTIVE, MINIMALLY INVASIVE TREATMENT FOR KNEE OA



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In the past, abundant anecdotal reports showing the benefits of platelet-rich plasma (PRP) in the treatment of knee osteoarthritis (OA) amassed faster than we could produce empirical data. Now, as the desire increases to use minimally invasive, cost-effective treatments prior to surgical intervention, published data are gaining ground. PRP has emerged in the literature as a cost-effective, minimally invasive way to reduce OA-associated pain and morbidity in the active aging population.

At Cleveland Clinic Florida, our patients with mild-to-moderate knee OA have shown favorable clinical outcomes with ultrasound-guided intra-articular PRP injections. In total we perform approximately 10 to 15 PRP injections per month. We have about an 80 percent success rate with an average length of pain relief of 9 to 12 months.

## PRP mechanism of action

Platelets are activated by exogenous substances (calcium chloride or thrombin), endogenous thrombin and/or intra-articular cartilage. Upon platelet activation,  $\alpha$ -granules are degranulated and secrete growth factors and anti-inflammatory cytokines, including insulin-like growth factor (IGF), platelet-derived growth factor (PDGF) and interleukin receptor antagonists. Current literature indicates these mediators inhibit cartilage degradation by regulating and promoting gene expression of tissue inhibitors of metalloproteinases (TIMP-1). This reduction in cartilage degradation makes PRP particularly useful in the treatment of osteoarthritis.

## Preparation impacts injectate efficacy

PRP is prepared by centrifuging autologous whole blood. The initial centrifugation separates the patient's blood into three layers based on specific gravity: plasma, platelets and white blood cells, and red blood cells. Some PRP systems include a second centrifugation to further concentrate the platelets and separate the platelet-rich plasma from platelet-poor plasma. Differences in container size, spin time and spin rate among PRP systems produce PRP with varying amounts of leukocytes, RBCs and platelet concentrations. These differences can alter the efficacy of the injectate.

## Comparing hyaluronic acid and PRP

In the past five years, at least 13 independent studies looked specifically at PRP and knee OA, while several recent studies have looked at the role of PRP in the healing of musculoskeletal conditions in general. Of the studies on knee OA, 11 directly compared intra-articular PRP with intra-articular hyaluronic acid (HA). Nine studies showed better symptom scores and clinical outcomes six to 12 months post-treatment in the PRP groups. In the two that showed no significant difference between PRP and HA, one study compared only leukocyte-rich PRP. The remaining two studies compared undefined PRP to saline, and leukocyte-poor PRP to saline, and both showed better outcomes in the PRP groups.

OUR PATIENTS WITH MILD-TO-MODERATE KNEE OA HAVE SHOWN FAVORABLE CLINICAL OUTCOMES WITH ULTRASOUND-GUIDED INTRA-ARTICULAR PRP INJECTIONS.

## PRP offers clinical improvements

A review of the current literature suggests that patients with knee OA have a positive response to PRP treatment. Younger, more active patients with mild OA tend to have better clinical improvements with PRP when compared to older patients with more severe OA.

PRP is a minimally invasive, cost-effective procedure with a low complication rate and a rapid recovery time. Usually, patients are able to bear weight immediately post-procedure and can return to normal activities following completion of treatment.

# Early Knee OA

- Studies directly comparing PRP to hyaluronic acid show superior pain/functional outcome with PRP as well as improved symptom scores for longer periods of time.
- Generally patients that did better were younger patients with earlier stages of knee arthritis.
- Some recent studies showing better effects/with doing series of injections(3) rather than single injection for knee arthritis



# What does the Data Say/ When might it be best option?

- Early knee Arthritis (degenerative meniscus)
  - “Meniscus Sparing” approach strongly favored in practice guidelines
- MCL
- Tendinopathies
  - Lateral/Medial Epicondylitis
  - Plantar Fasciitis
  - Achilles Tendon
  - Rotator Cuff
  - Hamstring/ Quadriceps/ Gastrocnemius
  - Gluteus tendinopathy

My Experience very favorable, however not as much data in literature

- DeQuervain's Tenosynovitis/ recalcitrant where there is tendinopathy
- Hand Flexor Tendinopathy
- Gastrocnemius tendinopathy/partial tear
- High hamstring/insertional hamstring tendinopathy
- Quadriceps injury/tendinopathy
- UCL Partial tear
  - Proximal or distal?
  - Extent of tear?
  - Timeline discussion— if unsuccessful may delay surgery/return to play

# Tough Conditions to Consider/ Not as Much data

- Ankle Arthritis
  - CMC Arthritis
  - Hallux Rigidus
  - GH Arthritis/shoulder
- 
- The key with any joint injection is that NO joint injection is going to restore motion when there is mechanical loss of space due to advanced DJD etc.
  - This option is considered in an effort to decrease pain/ improve functional status, decrease reliance on NSAIDS, also some of these patients cannot have further steroid injections--

# The Toughest

- Patellar Tendinopathy
  - What works? (!!)
  - Comprehensive approach absolutely essential, including assessing needs/timeline of patient and/or athlete
  - Technique may play a role (“Patellar Scraping” separating Patella from fat pad disrupting neovascularization)
- Hip/Labrum and Hip Arthritis
  - Neither the literature nor my own experience is great
  - Candid conversation a must in my opinion
  - ?Worth trying CSI first if patient is not planning surgery to gauge response?

# Emerging Areas

- Peripheral Nerve
  - Hydrodissection or effect of the growth factors or both?
- Spine
  - Intradiscal



# Absolute Contraindications

- Platelet dysfunction syndrome
- Critical thrombocytopenia
- Hemodynamic instability
- Septicemia
- Local infection at the site of the procedure/ or Open Skin
- Patient unwilling to accept risks

# Relative contraindications

- Consistent use of NSAIDs within 48 hours of procedure
- Corticosteroid injection at treatment site within 1 month
- Systemic use of corticosteroids within 2 weeks
- Tobacco use
- Recent fever or illness
- Cancer- especially hematopoietic or of bone
- HGB < 10 g/dl
- Platelet count < 105/ $\mu$ l

# Limitations of PRP

- Lack of standardization in the preparation of PRP (Several companies with competing products)
- No standardized number of injections, timing or known optimal volume of injection
- Many published studies have small sample numbers– sometimes without controls
- Not known whether white cells should be included or not? If included: what type of white cells?
- Important to recognize when need for surgical involvement

# Cost

- Many insurers are still slow to cover but...
  - Some patients have FSAs etc and submit to have covered
  - Some insurances sometimes cover with supporting info/notes which can be provided
  - What is cost to health of lost activity level for chronic non healing injury?
  - What is cost to health of chronic NSAIDs?
  - Some surgical treatments for chronic tendinopathy do not have great outcomes....and patients often want to avoid surgery in the first place



# True “Stem cell” Injections: BMAC

- Bone marrow aspirate taken from patient- several locations possible, often taken from hip/posterior iliac crest
- Local anesthesia used to numb up area for bone marrow aspirate which is done in office/ or O.R.
- Bone marrow aspirate placed into a centrifuge which then separates the sample
- A sample containing the stem cells is then injected into the targeted tissue/joint

# Office



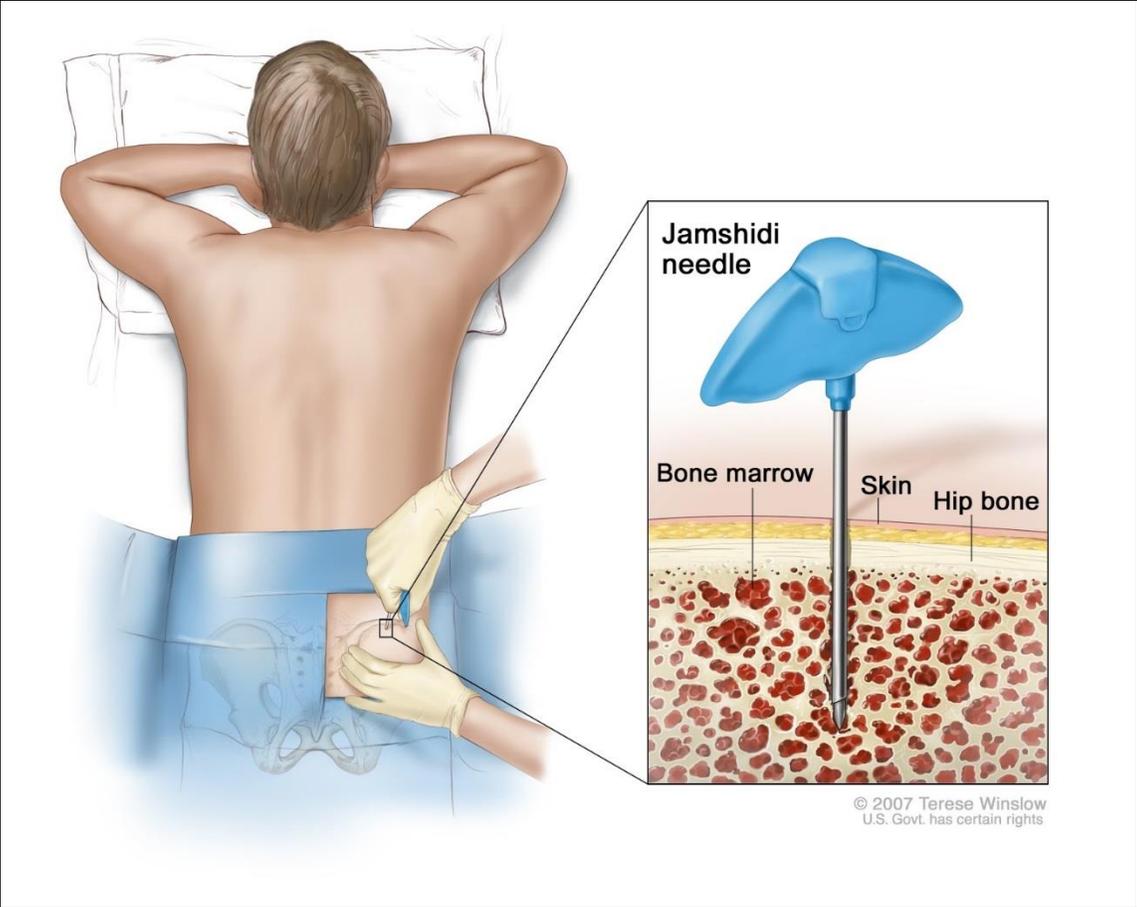
# BMAC

- Patient given mild anxiolytic to help stay calm during procedure
- Otherwise only local anesthesia used (Ropivacaine to numb skin/subcutaneous tissue and periosteum while taking sample)
- Hand driven Jamshidi needle
- Area of posterior iliac crest identified using MSK ultrasound
- Procedures/injection of bone marrow aspirate concentrate (BMAC) performed using MSK ultrasound guidance
- Total time in office approximately 2 hours





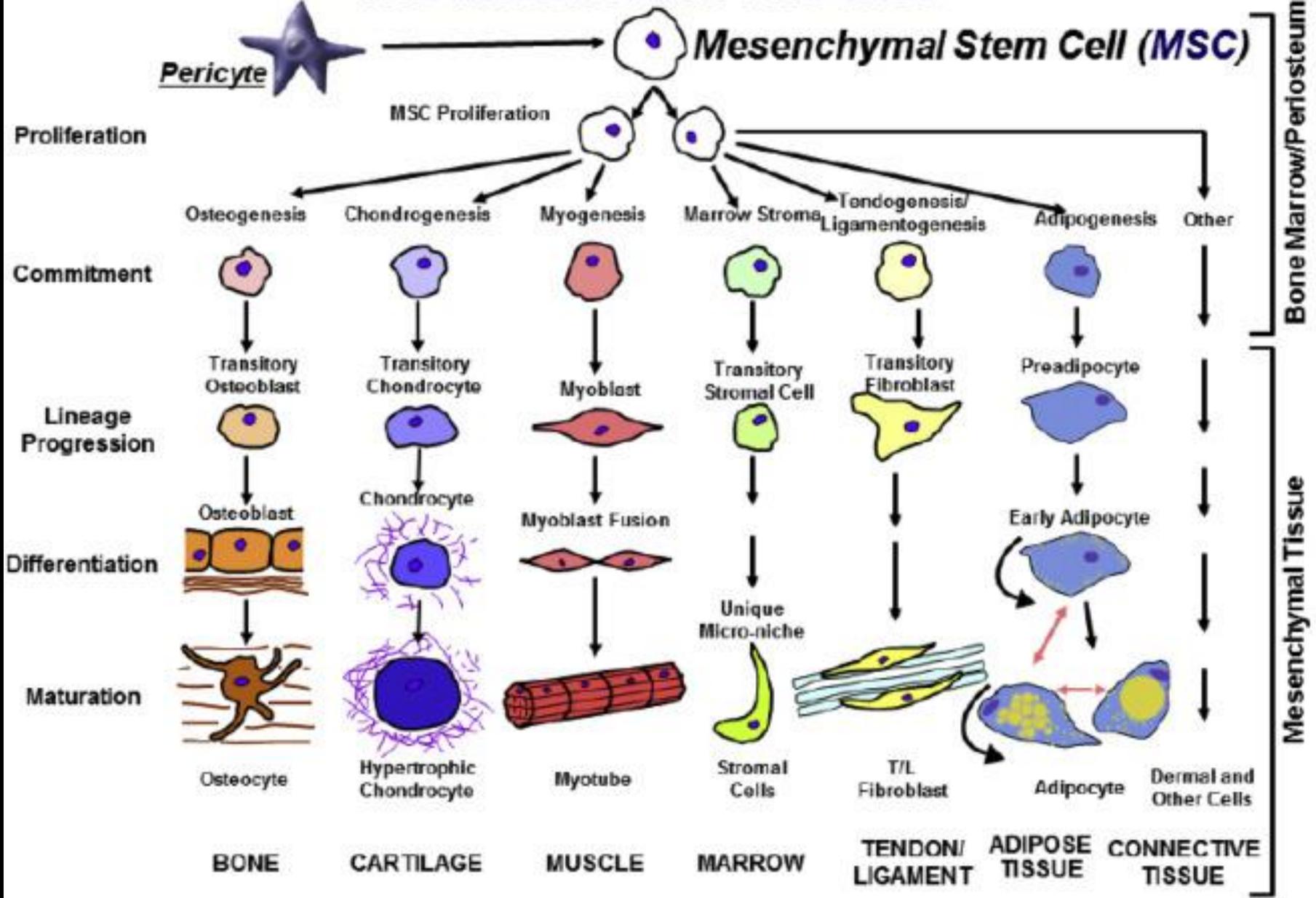
# The Procedure

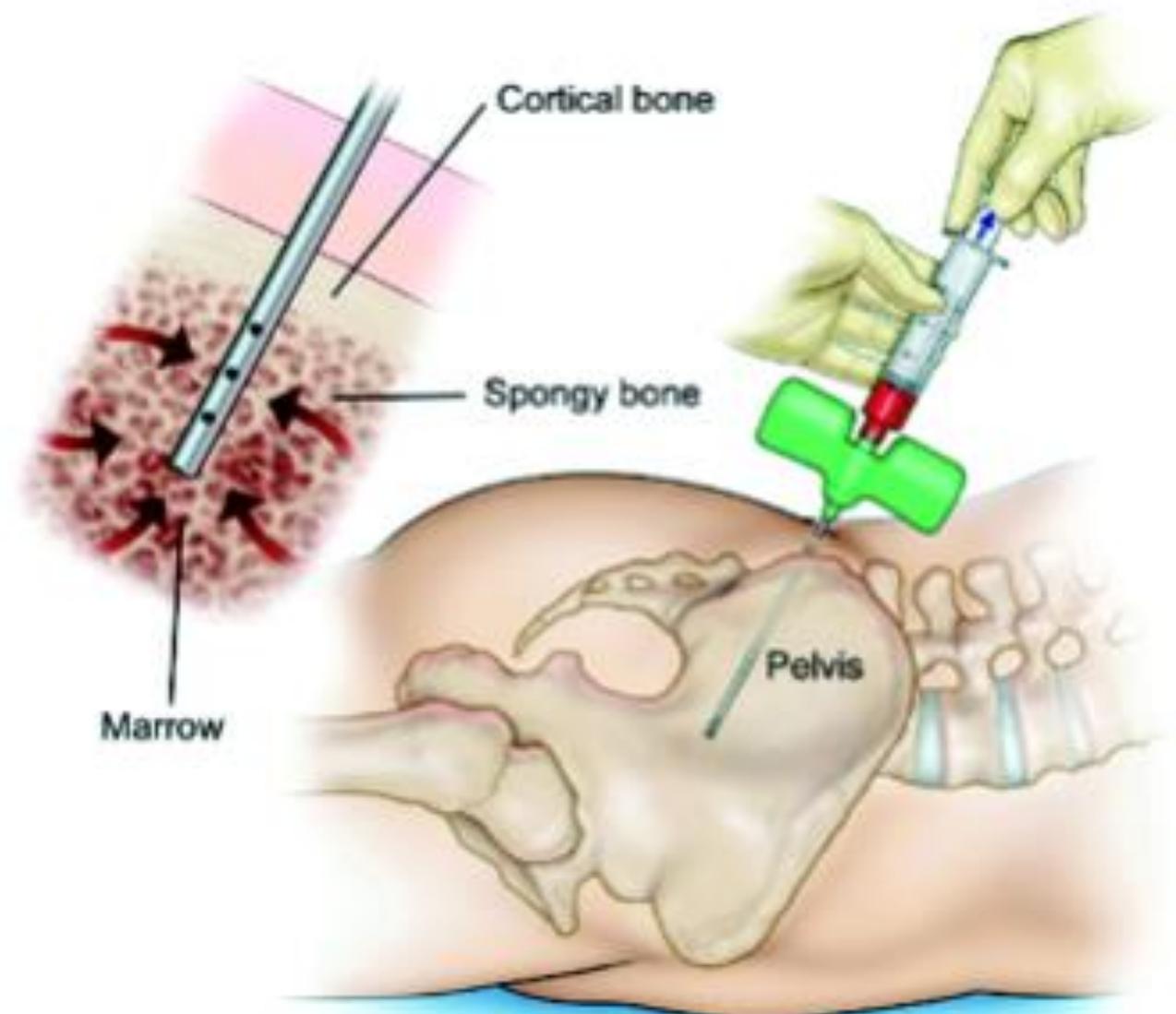


Technique/ etc.



# THE MESENGENIC PROCESS



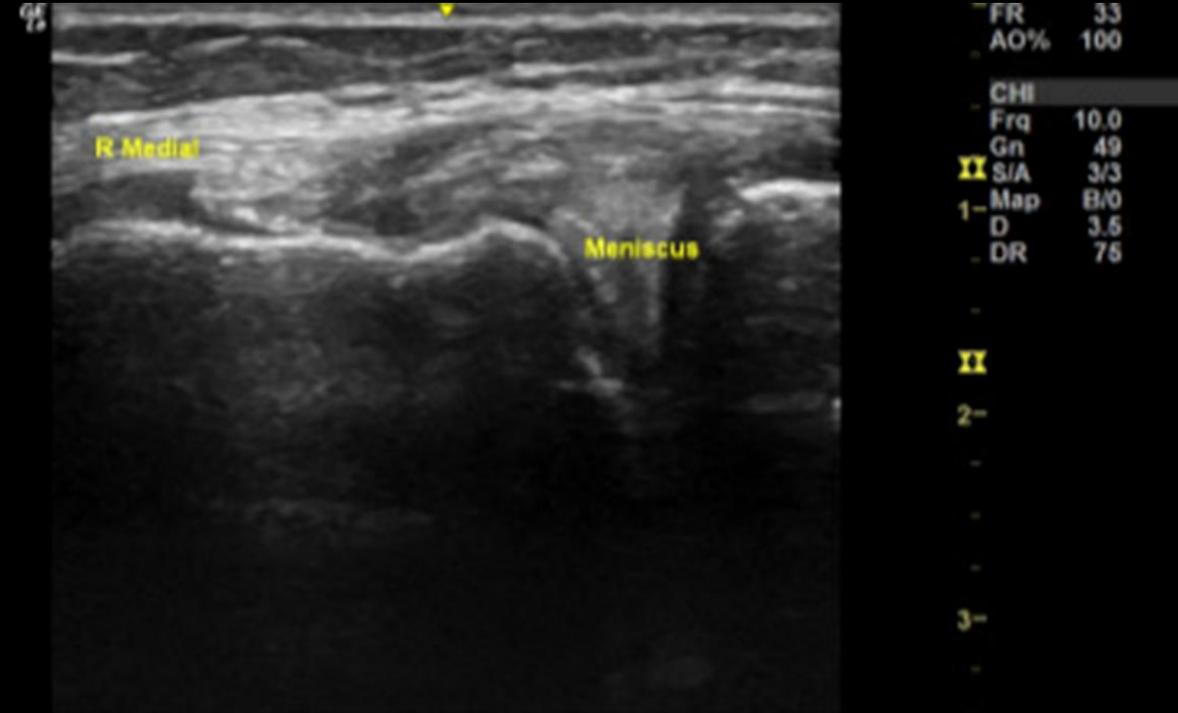
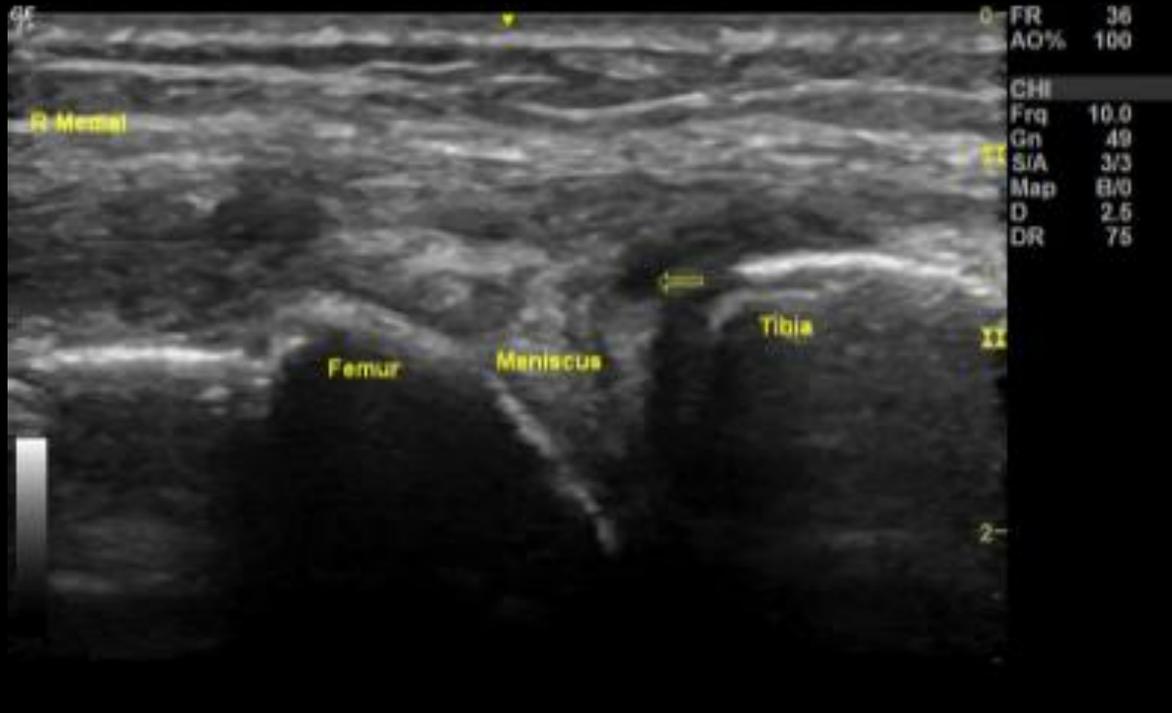


# BMAC: Theory versus reality

- Because there are higher concentration of growth factors/true stem cells- it is thought that the treatment should be more potent/ have greater effect than PRP itself
- There are studies showing very positive effects on actual cartilage regrowth etc but most of them are animal studies
- There are a few human studies so far published
- Despite the lack of data, there is a growing interest in developing protocols involving BMAC
  - Knee DJD: BMAC followed by PRP 4-8 weeks later
- Isolated case reports of meniscus regrowth followed by MRI-- as well as osteochondral/cartilage defects resolved by treatment with BMAC injections generate excitement and hope— however data is nascent, lack of trials not affected by bias/etc.

# Knee OA Pre-BMAC: February 2018

May 2018



# Is BMAC just expensive PRP?

- Cassano KSSTA 2016

- Bone marrow concentrate and platelet-rich plasma differ in cell distribution and interleukin 1 receptor antagonist protein concentration.
- 29 patients: PRP vs BMA- BMAC
- Bone marrow-derived samples were cultured to measure colony-forming units, and flow cytometry was performed to assess mesenchymal stem cell (MSC) markers.
- Catabolic cytokines and growth factors important for cartilage repair were measured using multiplex ELISA
- Colony-forming units were increased in both BMCs compared to BMA ( $p < 0.0001$ )
- TGF, VEGF higher in BMAC than PRP ( $p=0.024$ ,  $p=0.0005$ )
- IL-1ra concentrations were greater ( $p = 0.0018$ ) in BMC-A samples (13,432 pg/mL) than in PRP (588 pg/mL).

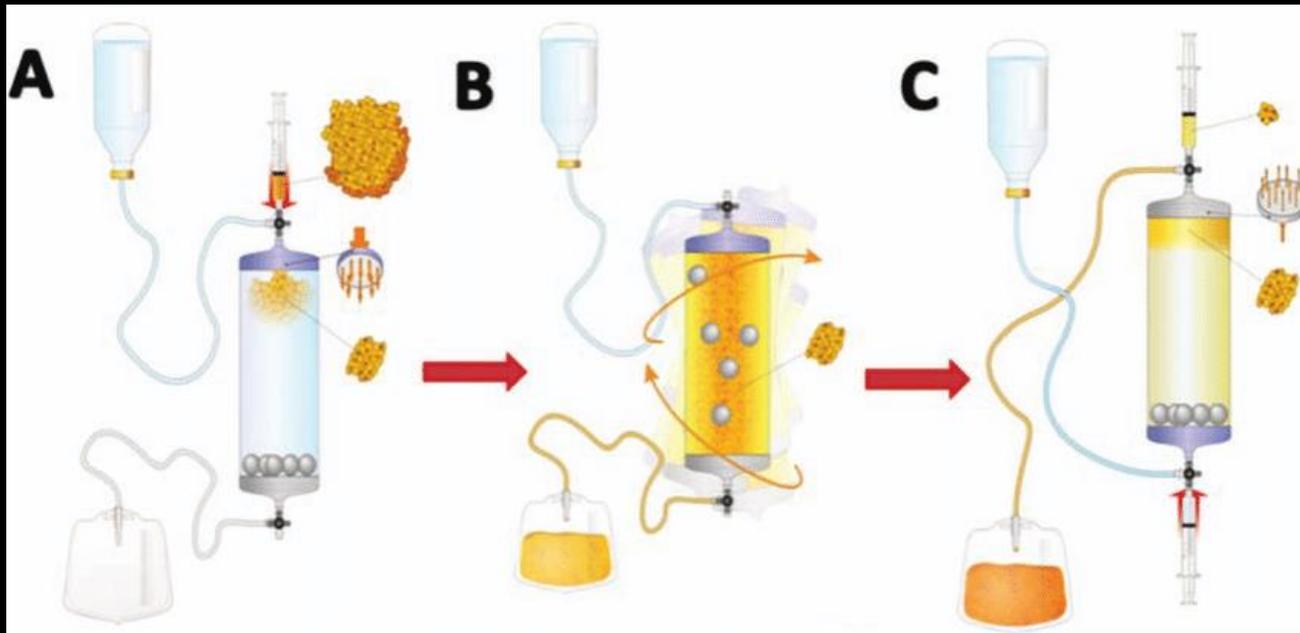
# What is this IL-1ra

- Orthokine
- IRAP
- Regenokine



# Adipose Derived Stem Cell products also exist

- Thought to generate a higher number of cells than BMAC
- Requires more tissue manipulation/Processing than BMAC
- Must be minimally manipulated, no enzymatic digestion allowed!



# Adipose-Derived Stem Cells

- Must meet FDA criteria for minimal manipulation of cells performed same day.
- Lipogems, LipoPro, AdiPReP, EmCyte, Tulip
- General Concepts
  - closed loop device for autologous adipose tissue
  - No centrifuge required
  - Progressively micro-fractures adipose tissue clusters minimizes inflammatory oily and blood residue
  - No enzymatic digestion
  - Produces injectable version of structural adipose tissue/can be injected with 22-gauge needle

# FDA Considerations

- **FDA Regulation of Human Cells, Tissues, and Cellular and Tissue-Based Products (HCT/P's) Product List**
- **HCT/P's Regulated under 21 CFR 1271.3(d)(1) and **Section 361** of the PHS Act**
- If considering a product need to see their 361 Registration.
- **If dealing with a product requiring 351 Registration: that is a whole other ball game:** Unless there is an active research trial you are officially part of and/or FDA has specifically granted you ability to work with these products and you have the 351 designation, you can't do it.

# Section 351

<https://www.fda.gov/vaccines-blood-biologics/tissue-tissue-products/fda-regulation-human-cells-tissues-and-cellular-and-tissue-based-products-hctps-product-list>

- This grouping includes products that FDA has determined do not meet all of the criteria in 21 CFR 1271.10(a) and are regulated as drugs and/or biological products.
- **CULTURED CARTILAGE CELLS**
- CULTURED NERVE CELLS
- LYMPHOCYTE IMMUNE THERAPY
- GENE THERAPY PRODUCTS
- HUMAN CLONING
- HUMAN CELLS USED IN THERAPY INVOLVING THE TRANSFER OF GENETIC MATERIAL (cell nuclei, oocyte nuclei, mitochondrial genetic material in ooplasm, genetic material contained in a genetic vector)
- **UNRELATED ALLOGENEIC HEMATOPOIETIC STEM CELLS**
- UNRELATED DONOR LYMPHOCYTES FOR INFUSION

# Florida Federal Judge Grants Summary Judgment to the FDA against US Stem Cell; Game Over except for the obligatory appeal

- “Stromal Vascular Fraction” method of obtaining Adipose derived stem cells NOT okay with FDA.
- Minimal Manipulation seems to be key for FDA
- Also Key factors FDA has published are vital with HCT/P’s—
  - Same Day
  - Autologous
  - Do NOT call that which are not stem cells “stem cells”
  - Do NOT venture into random sketch experimentation land injecting IV trying to “cure diabetes” or whatever.

# Adipose derived stem cells

- Evidence historically has lagged way behind BMAC—BMAC has the longest and greatest evidence of efficacy for orthopedic conditions
- More recent studies comparing directly to BMAC showing some equivalent benefit
- Safety appears to be very good with similar contraindications as seen with BMAC
- Same concerns re: low N studies/bias/ lack of control/ observational etc

# Stem cell injections: BMAC and adipose derived

- Cost is generally 6-10 times that of PRP
- More time consuming and technically involved
- No insurance coverage
- Generally reserved for challenging cases where there may not be other options or patient has already failed other available options
- Is there a sweet spot for BMAC?
- Effect of significant higher growth factors?
- As with PRP, safety profile from this autologous product appears to be excellent
- Data is nascent, but recent studies showing lasting functional relief >1 year, possible delayed progression to joint replacement

# Amniotic Fluid derivatives

- Several companies now producing products
- No live cells (dehydrated membrane grafts). Getting growth factors
- These are not “stem cell injections”
- Minimal data/ studies
- Cost more than PRP/ less than BMAC/BMA
- Time will tell/ ? Adjunctive treatment?
- This may be an option for patients whom have low platelets?
- Hard stick?



# Key Concepts

- Full work up: XR, MSK US, and/or MRI
- Range of Motion!
- Realistic expectations
- Skill/experience of clinician doing injection (“Surgical strike” or “Yosemite Sam”)
- Eliminate confounding variables that may negatively affect outcome
  - Holding NSAIDS, steroids: timing before and after
  - Accuracy: MSK US key
  - Ropivacaine
  - Post injection offloading/restrictions
- Talking to patient
  - These treatments do not “cure arthritis”
  - No treatment works 100% of the time
  - Be familiar with the data, and state what it says –or if there is not data
  - Expectation regarding single or multiple injections

# Summary/Pearls

- PRP is an excellent option to consider for lasting functional improvement and pain relief for patients with chronic tendinopathy injuries and/or DJD. The data for PRP has grown significantly in the last 5 years. More research is needed to continue to refine the process.
- BMAC is an exciting concept that may have important significance. Data is very nascent regarding this application but growing. There may be patients that this is the perfect treatment for or those whom have exhausted all other options. Is it better for certain joints/ areas than others?
- Amniotic Fluid derivatives are available, these are easy to administer, “prepackaged” do not require extraction, but have limited data regarding efficacy.
- These treatments should be done with consideration to exploring the whole kinetic chain/ referral to physical therapy to correct any contributing deficits
- Not for everyone: there are contraindications
- Some patients may have need for surgery (ie: complete ACL tear/ severe DJD/etc.) Each case is considered individually
- XR and diagnostic US done in office, other studies ordered as needed

# Advances in Stem Cell and Platelet Rich Plasma Therapies

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Thank You!!!!

