Update on PRP use in Orthopedic Medicine

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Regen4life.com

This book is meant to be a hand book for our potential patients. It will guide them through the 2 paradigms of MSK health care, the old orthopedic paradigm and the new Regenerative Interventional Orthopedic Medicine paradigm. It helps explain the options and differences between different kinds of treatments, those that are effective and those that may not be.

There is also a chapter for the Physician. It critically reviews the latest literature in the field of Regenerative Injection Treatments as well as explains how someone can seek out training to get started treating their patients with this new treatment paradigm. There is also an extensive reading list and there are over 130 medical references in this book.

"Hal Webster's blown his cerebral cortex."
PRP Efficacy

- “Studies have also shown that clinical efficacy of a PRP prep w/2-3X baseline has no more potential to heal than PPP”
- To heal what tissue?
- Did the PRP prep have increased WBC concentration or was it reduced?
- Did they flood the tissue with full dose anesthetic or not?

PM&R Journal

- A Call for A Standard Classification System for Future Biologic Research:
- The Rationale for New PRP Nomenclature
- Kenneth Mautner MD, et al,
- Publication Pending PM&R 2015

PLT Concentration

- Do more platelets matter?
- Is there an inhibitory effect if the platelet count is too high?
- What is the optimal platelet count?
Platelet Concentration

- Is it absolute PLT concentration or the presence or absence of leukocytes that has the most impact on healing?

- Mishra et al, came up with a classification of PRP used in clinical medicine and research labs

<table>
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<th>Type</th>
<th>WBC</th>
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<tr>
<td>1</td>
<td>Increased over baseline</td>
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<tr>
<td>2</td>
<td>Increased over baseline</td>
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</tr>
<tr>
<td>3</td>
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<td>A.</td>
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<tr>
<td>B.</td>
<td>Platelets &lt; 5X baseline</td>
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</tbody>
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Dohan Ehrenfest 2009 PRP/PRF Classification System

- System used more for surgical fields
- PRP separated into 2 types
- P-PRP: 1st spin creates of buffy coat (BC) and pipette off bottom ½ of plasma down to part of BC Low PLT and No Leuk
- L-PRP: 1st spin creates BC and BC plus a some amt of blood and plasma taken from BC layer- Harvest, et al.
**Dohan Ehrenfest 2009 PRP/PRF Classification System**

- PRF (Platelet Rich Fibrin) separated into two types
- P-PRF - Anitua system-
- L-PRF - Choukroun's simple bedside system includes Leukocytes and Fibrinogen - Just spin uncoagulated blood and clot that forms is the L-PRF

**Anitua’s PRGF**

- Single spin - 460XG
- Creates BC
- 5cc Tubes
- 1st cc Platelet poor GF discarded
- 2nd cc Platelet Rich collected
- BC not touched
- Therefore - low Plts 2-3X
- No Leukocytes

**PAW Classification System**

- DeLong 2012 - PAW PRP System
- PRP Classified by platelet concentration
  - P1-4 - <baseline to >1.2M
- Activation Status - +/- exogenous
- White Cell Status and if White cells present - Neutrophils above or below baseline
Mazzocca et al, looked at human muscle, bone and tendon cultures and compared different PRP preparations to whole blood, culture medium and serum. The PRP concentration and leukocyte concentration had a significant impact on tissue growth.
PLT Concentration

- Torricelli, Filardo, et al, found time to healing was significantly reduced in horse tendon healing treated with PRP with concentrations above 750K/ mcl but a plateau effect was seen above 1.5M/ mcl.

- Jo et al, showed R/C Tenocytes could be stimulated with increased healing effect with higher concentration of Platelets up to 2M Plts/ mcl.

Boswell et all 2014

- Boswell et all, showed making a PRP with an ave 2X baseline plts with reduced leukocytes helped horse tendons in culture manifest favorable growth factors known for healing tendons and reduced growth factors known to increase inflammation and catabolize tendon matrix.
Tenocyte Healing

• Anitua et al, 2009 concluded that “once stimulated to a certain point the fibroblast-tenocyte cell line cannot produce collagen at a higher rate”.
• This supports the hypothesis that PRP does not help a tendon heal faster, it simply helps a poor healing structure to heal where otherwise the risk of failed healing is very high.

Platelet Concentration

What About Stem Cells

• Stem Cells need growth factors to be told what to do, otherwise they don’t heal anything.
• Is a higher PRP Concentration advantageous to grow a MSCs in Culture?
Platelet Concentration

Low Platelet Concentration
- In Vivo O/A studies
- 1 Published with low plt concentration
- Halpern used Cascade for O/A of knee
  - 1 tx gave significant relief for mild to moderate Dz
- Harmon and Mautner
- Used both low and high density PRP to tx different tendons. No difference in outcomes

Tennis Elbow PRP vs Surgery
- Ford 2014- Compared LD P-PRP (Arthrex) single tx to Operative debridement
- 28-PRP vs 50 Surgery
- Followed 48 wks PRP vs 52 weeks Surgery
- Pain Relief 89% PRP vs 84% Surgery
So What is Optimal Plt Concentration?
• Still Unsure of tissue specific recommendations?
• PRP-LD- RL seems to work in Tendons, Joints and may be better for muscle as well. FordHarmon and Halpern
• PRP-DS High Density PRP with RL and Reduced RBCs works better than PRP-LD-RL in my experience for tendons and joints-data?
• 4-8X- range I try to reach with PRP-DS-RL.

What about Activating Plts?
• Studies are mixed.
• Scherer-showed PRP w/out activation promotes > healing response in wound study
• Activation probably not needed for tendons and joints routinely, Filardo.
• For larger tears or focal cartilage lesions may make sense to activate and gel PRP to keep it on location.

Activation
• If PRP is over-activated with Thrombin, the fibrin will form into a bivalent network that is unstable. In comparison, if the PRP is activated in a more physiologic manner, a stable tetramolecular network will form which enhances the adherence of cells and growth factors
PRP Lysates and Releasates

• Activating PRP and reprocessing creates a releasate with no cell bodies but all GFs suspended in Plasma
• Very potent anti-inflammatory effects
• Suppresses IL-1B induced inflammation by elevating IL-1 receptor antagonist (23,000X higher than IL-1B in PRP)

Platelet Releasates

• Xuetao, et al in Arthritis Research Therapy 2014 reviewed the biology of PRP
• Very clear in new data
  – MMP and IL-6 and IL-1B which are high in O/A and responsible for catablozing hyaline cartilage can be controlled with use of PRPr and P-PRP
  – And inversely- LR-PRP can increase these GF levels in joints and probably should not be used!

What about PH of PRP?

• Buffering of PRP pH using Na Bicarb to isotonic has been studied.
• May make it less painful as PRP with ACD is acidic
• Studies show doesn’t matter in joints
• Tendons- natural healing process starts in acidic environment and then turns alkaline
• Tendons- don’t buffer
What About Local Anesthetics?

• Studies are mixed in vitro.
• Lidocaine and Bupivicaine at full strength are toxic to chondrocytes, synoviocytes and tenocytes as well as muscle and stem cells.
• No in vivo studies, but most in-vivo studies use anesthetics in tendons and don’t use anesthetics in O/A studies and both outcomes are still good.
• Can we improve outcomes w/ or w/out?

Anesthetic Recommendations

• OK to use in low concentration.
  – Ropivicaine at 0.2% is safe for all tissues
  – Lidocaine- drop dose down to 0.2% for all tissues except stem cells, drop it down to 0.1%
  – Marcaine above 0.25% is unsafe for all tissues. Some in-vitro studies show below 0.25% OK in some tissues except stem cells
  – Procaine- No studies on tissue safety

What about WBC in PRP?

• Research needed to compare PRP-LP to PRP HP study arms head to head.
• New Research suggests- Neutrophils and therefore WBCs should be as low as possible
• Neutrophils are high in MMPs, TNF alpha and Interlukin-1B, IL-6 which are all responsible for bad things in healing.
WBCs in PRP

• Recommendation - Lymphocyte poor probably best for joints and acute and chronic tendon injuries.

• But, Most Tendon research done with PRP-HP w/ Leukocyte Rich systems and shows good efficacy, DeVos, Rodeo.

Neutrophil Depleted WBC Enriched Pure PRP

• Yoshida and Murray showed an anabolic effect of Neutrophil depleted Mononuclear cell enriched PRP in ACL fibroblasts.

• Dbl Spin Suspension PRP systems or simple lab based system can make a Pure-PRP with depleted neutrophils and concentrate the rest of the mononuclear WBC population in the PRP but little data exists to examine effect yet…

What About RBCs?

PRP – RBCs show better MSC culture growth in vitro.
RBCs Recommendation

• RBC poor PRP best for joints - iron catabolizes hyaline cartilage.

• Hemophilia Model - blood is toxic to hyaline cartilage

• Tendons - probably OK either way, Connel and Creany whole blood in CLE, James whole blood in patella tendon.

RBCs in PRP

• RBCs increase morbidity in tendons unnecessarily, but outcomes overall are still good with both.

• Whole blood vs RBC rich PRP in CLE saw good effect in both groups, but, sig more Whole Blood Txed pts converted to surgery

What’s Next?

• Bioactive Scaffolds
Rabago, Patterson, et al published a landmark RCT of Knee O/A in Annals of FM 7/2013
900 screened. 90 enrolled. Randomized to Prolotherapy, NSS injections or HEP
3 mandatory Tx sessions, 2 optional 4 wks apart.
9, 26 and 52 wk F/U
52 Wk WOMAC Prolo increased by 15 pts or 24%, NSS and HEP increased by 8 pts.
Minimum Meaningfull Increase with WOMAC- 12 pts
Level 1A evidence for RIT for Knee O/A
What About Stem Cells

- Kim, et al. Published a prospective case series on 75 knees broken down by K-L grade of Knee O/A.
- Txed with BMC, Adipose Fat Graft and PRP 16cc injected into each knee joint. Ouch!
- VAS scores decreased from average from 7 to 4 to 3.5 to 3.3 over a F/U period of 3, 6 and 12 months.
- Gr IV K-L knees (8)- dec from 8 to 5 over F/U

PRP Chronic Lat Epic

- Mishra-20 Patients w/ LE of 15 months duration
- 15 Tx w/ 2-3 cc of PRP using peppering tech 5X
- 5 Tx w/ Bupivicaine
  - PRP- 590% inc in pts comp to whole blood and 3.3 million/tx
- Results- From Single Tx
  - Tx Grp-60% Improvement at 8 wks, 16% in Control. P=.001
  - 3/5 in Control group lost to F/U
  - 6 Month F/U-Tx Group Improved 81% P=.0001
  - 24 Month F/U- 93% Improvement in Tx Group P=.0001
  - Level 2 evidence Cohort Study w/ Intent. to Tx issue w/ control

Mishra, et al

- Mishra et al
- 240 patients with CLE randomized to receive 1 tx w/PNT with Bupivicaine injection vs PNT with Biomet PRP
  - Followed for 12 or 24 weeks. Control group- 60% did well and met assessment criteria
  - Experimental group- 83% did well
  - First study to answer the question in PRP research- is it just the needle that provides the stimulus to heal?
Mishra Multicenter RCT

• Problems with Mishra Study
• Study design was originally supposed to be 12 weeks and Sponsor and FDA asked for longer follow up.
• 96 subjects were enrolled in 12 wk study
• 136 subjects were enrolled in 24 wk study
• Only 24 wk analysis showed separation of study groups

PRP for CLE

• Gosens and Peerbooms reported an RCT study with 100 patients followed for 1 yr
• They compared a single CSI vs PRP tx for chronic LE
• Results- PRP tx group at 2 yrs f/u 68% improvement and CSI control experienced 15% improvement

PRP for RC Tear

• Kesikburun et al. 40 pts-11 with Partial RC tears and 29 with tendinosis received either PRP injections or NSS. MRI study confirmed Dx
• Both groups received S/A Bursa Inj of 2% lido and had to have at least 50% pain relief for incl
• Both groups- 3 wks of supervised PT after 2 days of rest and then 3 more wks of HEP
• Followed for 1 yr. No Stat diff in outcomes
**PRP RC RCT 2013**

- Outcome - Both groups did very well with all measures inc the WORC, SPADI and Neers Impingement Sign. WORC 30-80%
- At 1 year no stats difference, but at 6 months there was wider separation and outcome points came together betw 6 mo and 1 yr.
- Proves once again as in de Vos Achilles RCT- NSS & PNT w/ HEP are not good controls, they are active tx groups.

**RCT PRP for Patella Tendinopathy**

- Dragoo, et al- compared dry needling (DN) to DN plus PRP-HD Leuk rich to patella tendons in 23 patients.
- Initial 12 wk end point showed PRP effect> DN alone
- VISA scores improved in PRP group by 25 pts and 5 pts in DN group


**RCT PRP for Patella Tendinopathy**

- 3 in DN group allowed to cross over at 12 wks to PRP group
- However. Btw 12 and 26 wks PRP improvement effect decreased and DN group continued to improve.
- DN Pts improved by 33 pts >26wks and PRP Pts net improvement was only 29 pts
- Why did the PRP effect drop off betw 12 and 26 weeks? Dragoo, et al, AJSM, 2014;42(3)610-18
**PRP for Achilles Tendinopathy**

- DBPC RCT study
- 54 patients randomized to either PRP or saline injxs; both + eccentric exercise
- One injection session each
- No sig difference in outcomes @ 6, 12, 24 weeks


**Achilles PRP Study cont.**

- Major flaw of study: The only non-operative co-treatment given to both study groups, eccentric exercises, is a major evidence based treatment to show efficacy in treating achilles tendinopathy.

- That's like concluding gummy bears have no additional effect compared to a sugar pill placebo when treating strep throat and both groups were also given penicillin.

**Blood vs PRP**

- Creaney, RCT on PRP vs Blood showed there was no statistical difference betwn patients w/ chronic LE at various time points over 1 year.

- McConnell- 2006 showed blood is a very effective tx for chronic LE his case series of >35 patients w/ 1 yr f/u
Dry Needling and Blood

- James et al, prospective case series on 47 patella tendons with refractory patella tendinosis.
- 2 txs 4 weeks apart. Numb with Bupivicane and then 1 minute of dry needling followed by 3cc of whole blood injection under US guide.
- Post Tx Eccentric Rehab HEP and PT visits
- VISA score pre-tx 40 improved to 74 post –tx

PRP Cases

- 21 YOM Div 1-FB- High ankle sprain
- US showed gr 3 ant tib/fib, gr 2 post tib/fib and PTFL
- Diff w/ push off, (+) Kleiger, (-) diastasis, swelling
- Played 1 wk after injury w/ great disability
- RIT wk 2 and 3 and then wk 4 had PRP
- Never missed a game

- HS Quarterback- SLAP in June
- Needs surgery to play senior yr, but will miss season
- PRP X1 in July
- Rehab 3 wks and plays pre-season. Feels no pain- but loose w/ less velocity
- 2 RIT’s to capsule 2 wks apart
- Never missed a game won awards and scholarship to D2 program

High Ankle Sprain
**PRP Stimulates HA Release**

- Synovial cells isolated from 10 OA patients and cultured in serum-free media
- Exposed to either a platelet-poor preparation or PRGF for 72 h
- PRGF significantly enhanced HA secretion compared with platelet-poor preparations, \( (P < 0.05) \); An increased HGF production was observed \( (P < 0.05) \)


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**PRP Enhances Tendon Repair - Cell Culture Study**

- Human tenocytes cultured x 14d
- Exposed to PRP or PPP
- (PRP 2.55x baseline)
- PRP > PPP stimulated cell proliferation and total collagen production

de Mos et al. *AJSM* 2008, 36;1141

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**PRP Stimulates Articular Chondrocyte Proliferation**

- Adult porcine chondrocytes cultured in presence of 10% PRP, 10% PPP or 10% fetal bovine serum (FBS) x 3 days
- Proteoglycans and collagen syntheses by PRP-treated chondrocytes markedly higher than chondrocytes treated by FBS or PPP

**Stem Cells + HA Regenerate Hyaline Cartilage**

- 10 pts w/ full-thick chondral defects
- Tx'd with drilling
- Peripheral blood stem cells harvested @ surgery & cryopreserved
- 1 week /p surgery, 5 weekly 2.5ml PBSC mixed with 2 ml HA

**Stem Cells + HA Regenerate Hyaline Cartilage**

- Sequential MRI and 2nd-look arthroscopy
- Confirmed hyaline chondrogenesis
- Ongoing remodeling @ 2-year f-u

Saw KY et al. Presented at British Orthopedic Assoc. annual convention, 2009

**Case Report- Partial S/S Tear**

- 38 yom weight lifter w/ s/s of S/S tear. MR (+)
- Failed subacromial CSI and PT
- PRP w/ U/S guided PRP
- 2 PRP Txs 4 weeks apart
- 3 months after tx back to full work outs
Case Report - PRP S/S Tear

• PRP in a tendon causes most sig morbidity for a few days to a few weeks
• Patients are given narcotic prescriptions to get through initial healing period
• Compliance is very important for a predictable recovery

Case Study Partial ACL

• 40 YOM marine mechanic dx w/ partial ACL in 12/09
• Tx consisted of PT and no surgery offered
• Had many giving way episodes
• Considered disability d/t instability
• On exam in 12/09 (+) 2 laxity w/ AD, Lachman, reverse pivot shift, Otw nl exam
• Txed w/ Q6wk PRP to joint and to ACL origin/insertion w/ blind technique X 2
• Sx of instability are gone and normal ACL exam 4/10

MRI ACL Before PRP
Blind ACL Injection Technique

MRI ACL Post 2 PRP Txs

Case Study- Patella Tendinosis

- Pre PRP on Left
- Post PRP on Right

Ultrasound performed 16 weeks after 2nd injection. The tendon was significantly less thickened and the area of hypoecogenicity was no longer visible.
**Case Study: Non-Surgical Repair of High Grade Achilles Tendon with PRP**

- 38 y/o male high-grade tear of left Achilles tendon with remainder of tendon demonstrating severe tendinopathy
- Description of Procedure (5/17/07)
  - Anesthesia: left leg popliteal block
  - Achilles tendon prepped & draped
  - 10cc of PRP prepared from 60cc of whole blood
  - 3cc PRP placed distal & proximal fragment of tendon near edges with 22g needle under US guidance
  - With complete plantar flexion the tendon’s torn edges were abutted & 4cc of PRP injected
  - 1cc of thrombin/calcium chloride was introduced from other side of tear to form a clot matrix

**Case Study: Non-Surgical Repair Achilles**

- Physical therapy started 3 weeks after injection
- 5 wk Follow-up (6/21/07): Patient stated that he is doing well, does not have pain and does not need crutches
- 7 wk Follow-up (7/2/07): MRI shows interval healing of the high-grade tear with some tendon thickening
- 9 wk Follow-up (7/16/07): Patient reports that he does not have much pain at all, no swelling/locking and ankle does not give out. Normal ROM

**PRP - Practical Considerations**

- Proper Diagnosis is Critical
- Injection Technique
  - Approach: In plane vs out of plane
  - Anesthesia: Platelet Toxicity
  - Guidance: Ultrasound
  - Activation of Platelets
- How Many Treatments
- Post-injection care & rehab
Recovery

- Realistic expectations:
- Tendons have < 15% O2 uptake of muscle and take over 100 days to synthesize the main structural proteins
- Initial, short-duration symptoms
  - Expect 2-3 months to RTP - Acute Injury
- Chronic symptoms - expect 6-9 months to RTP

Complications of PRP

- Immediate pain w/ in 60 min-d/t inflammation, swelling for a few days (can require steroids, NSAIDS)
- Allergic rxn anesthetics
- Spinal cord injury, spinal HA
- Pneumothorax
- Infection
- Nerve injury
- Temporary or permanent paralysis
- Nausea, vomiting
- Death
- Frozen Shoulder
- Tendon Rupture
- Vasovagal rxn
- No Guarantee
- Not easy to learn

Low Success Areas

- Large rotator cuff tears with retraction
- End stage 1st CMC Joint OA
- Advanced Bone on Bone O/A
- Grade 3 ACL and UCL, DRUJ
- Large unstable cartilage tears
- Knee OA with synovial proliferation
  - Takes ~5 tx’s and only lasts 1 year or so
- End stage Hallux rigidus type bunions
More Questions

• What is the minimum platelet concentration for clinical efficacy?
• What is the optimum concentration?
• Is there a concentration above which it’s deleterious?
• What is the ideal treatment frequency? 4-8 weeks
• Are platelet activators required?

“We’re like children playing with nuclear weapons”
~Sean Mulvaney, M.D.

Why Even Consider PRP?
History of PRP

• The use of autologous PRP was first used in 1987 by Ferrari et al. following an open heart surgery, to avoid excessive transfusion of homologous blood products.

Indications

- Tendinosis/tears
- Ligamentosis/laxity/tears
- Muscle Tears
- Osteoarthritis
- Cartilage injury (OCD)
- Labral, Meniscal Tears
- Wound healing
- Fracture non-unions
- Stress fractures
- Intradiscal Degeneration/ Derangement
Contra-indications

- Anti-platelet / anti-inflammatory medication
  - Coumadin, ASA, NSAIDS, heparin, etc
  - High dose fish oil, other anti-inflam supplements
- Bleeding / clotting disorder
- Thrombocytopenia - <50K
- Cigarette smoking?
- Auto-immune disease?
  - RA, gout, SLE
  - PRP does help resolve synovial proliferation!
- Nutritional / Hormonal deficiency - relative

PRP

- Normal platelet concentration = 200,000 platelets/ml.

- Studies have shown that clinical efficacy can be expected with a minimum increase of 4-5x this baseline, or 800K to 1M platelets/ microltr

- Studies have also shown that clinical efficacy of a PRP prep w/2-3X baseline has no more potential to heal than PPP

PRP Centrifuge
## PRP 6ml vs. 3ml

<table>
<thead>
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<th>Patient A Platelet Count</th>
<th>Patient B Platelet Count</th>
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<tr>
<td><strong>Baseline</strong></td>
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<td>4.27x baseline</td>
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<td>7.05x baseline</td>
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<td>1,346,000</td>
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<td>8.91x baseline</td>
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- Rao, et al. AJSM 2014 42(1) 50-8
- Yoshida & Murray Journal of Orthopedic Research 2013;31(1) 29-34

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- Creaney, et al, BrJSM. 2011. 45(12) 966-71
- Scarpone- Case Report 2008 Harvest
Origin of the term Platelet Rich Plasma

- It is the supernatant obtained following low force centrifugation of a unit of whole blood which produces a baseline platelet count
  - Volume of whole blood 180-240 mls
  - Plt Count 235-310 X 10^6/ul

PRP Defined

- What we must produce for therapy in Regenerative Medicine is a concentrated platelet product (CPP)
- 4-5X Baseline

MSKUS Texts & References

- Clark, Thomas.
- Bianchi & Martinoli. “Ultrasound of the Musculoskeletal System.”
- American Institute of Ultrasound in Medicine (AIUM.org)
- Mautner, Ken- TOBI Conference
PRP Definition
• Murphy et al- published in Transfusion 05
  – World wide standard for prep of plt transfusion is the Buffy Coat Method
  – Plt concentrates contain 5% of the baseline RBC mass
  – Plts must maintain the fct and viability throughout a 5 day storage cycle
• Giusti- Platelet Gel Angiogenesis Study
  – Optimal level of Plt concentration for Angiogenesis was 1.5 X 10^6. For ave. Plt count- 4-5X Baseline
  – <1.5X10^6 and >3X10^6 showed less angiogenesis

History of PRP
20+ year hx of use
• Orthopedics
• Sports medicine
• Dentistry
• ENT
• Neurosurgery
• Ophthalmology
• Urology
• Wound healing
• Cosmetic
• Cardiothoracic Surgery
• Maxillofacial Surgery

Blood Components
• 93% RBCs
• 6% Platelets
• 1% WBCs
• Goal of PRP prep = decreasing RBC to 5%, and increasing platelets to 94% to stimulate repair
Centrifugal Blood Separation

Platelets

- Platelets = small discoid blood cells made in bone marrow
- Lifespan of 7–10 days.
- Contain two types of granules.
- The alpha granules contain the growth factors released in the healing process.
- Granules release the growth factors, which stimulate the inflammatory healing cascade
Platelets, cont.

• Platelet-derived growth factor (PDGF)
  – Stimulates cell replication
  – Promotes angiogenesis
  – Promotes epithelialization
  – Promotes granulation tissue formation
• Transforming growth factor (TGF)
  – Promotes formation of extracellular matrix
  – Regulates bone cell metabolism

Platelets, Cont.

• Vascular endothelial growth factor (VEGF)
  – Promotes angiogenesis
• Epidermal growth factor (EGF)
  – Promotes cell differentiation and stimulates re-epithelialisation, angiogenesis and collagenase activity
• Fibroblast growth factor (FGF)
  – Promotes proliferation of endothelial cells and fibroblasts
  – Stimulates angiogenesis
Epidemiology

• Soft tissue injuries, including tendon and ligament trauma, represent 45% of all musculoskeletal injuries in the USA.


PRP Concentration

Introduction

• According to the World Health Organization (WHO), musculoskeletal injuries are the most common cause of severe long-term pain and physical disability, and affect hundreds of millions of people around the world.*