Blood and Beyond!!!
New Advances in Sports Medicine

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Introduction / Disclaimer

- Been performing:
  - Autologous Blood injection since 1999
  - Platelet-Rich Plasma (a.k.a. PRP) Injections since 2006
  - Percutaneous Tenotomies since 2012.
  - Dry Needling, since 2013.
  - Limited ECHO, since 2014.
- Principle Investigator in longitudinal outcome study (self-funded) for Percutsneous Tenotomy.
- No financial relationships with any biotechnology firm in relation to PRP, ABI, or Percutaneous tenotomy.
- Patients mentioned in this lecture have given permission to use their likeness for educational purposes
Overview

PRP/ABI
• What are platelets & PRP
• Basic Science
  • Platelet function
  • Initiate healing
  • Growth Factors
• Difference between PRP, ABI, ACS, etc
• Platelet Basic Science
Preparation Procedures
Role of PRP:
• Potential Adverse effects
• Post-injection Recommendations

• PERCUTANEOUS U/S GUIDED TENOTOMY
  • Description
  • Indications/ Contraindications
  • Procedure

• DRY NEEDLING
  • Indication/ Contraindication
  • Treatment

• UNIQUE USE OF ULTRASOUND
  • Limited echocardiography
  • Vocal Cord imaging
Terminology

- **PRP**: Platelet-Rich Plasma
- **PEP**: Platelet-Enriched Plasma
- **PRGF**: Plasma-Rich in Growth Factors
- **ACS**: Autologous Conditioned Serum (blood is withdrawn from pt, incubated for 6 hours @ 37°C, re-injected cell-free into injured area.)
- **ABI**: Autologous Blood Injection (untreated blood withdrawn from pt and injected into injured area)
FIRST, there autologous blood injections (ABI)

- During the 1990’s, 2cc-10cc of autologous blood was withdrawn from athlete.
- This blood would be the injected into muscle strains, joints, chronic injuries
  - Started with veterinarians
  - Then, Maxifacial & Plastic Surgeons
  - Then, Russian and Chinese Sports Medicine docs in elite athletes
Autologous Blood Injections (ABI)

- **PROS:** Showed some improved healing, cheap, easy to perform
- **CONS:** hematoma, painful.
- Not a lot of peer-reviewed evidence to support, most anecdotal


Then- Autologous Conditioned Serum (ACS)

• The rationale was to:
  • remove cells (mostly RBCS and most WBCs) via centrifuge
  • Keep serum WARM (37 degree) at or just above body temp, to keep healing factors from denaturing
  • Incubate for around 6 hours
  • **PROS**: less painful, some improved outcomes, retained platelets/GF
  • **CONS**: labor and time intensive, lack of peer-reviewed support
So what’s all the HYPE with Platelets

- **Hines Ward 2009**
  - (Pittsburgh Steelers)
  - Knee injury 2 weeks before Super Bowl in 2009
  - Had PRP injection
  - Played in Super Bowl 1 week later

- **Takashi Saito 2009**
  - (L.A. Dodgers)
  - Pitcher with UCL injury
  - Received PRP
  - Was able to pitch in 2008 Playoffs

• [Link](http://www.youtube.com/watch?v=rCDrsw3e_U0)
What are Platelets?

- Formed from megakaryocytes
- Megakaryocyte (MK) will give rise to approximately 4,000 platelets which live an average of 9-12 days.
- The peripheral blood platelet count ranges from 150 - 450 x 10^12/L.
- 2/3 of platelets circulate, while 1/3 are in the splenic pool or other extravascular locations.
- In the steady state:
  - Platelet production = platelet destruction
  - Daily production is 30,000 - 40,000 /uL.
Platelet-Rich Plasma Injections

Indiana University School of Medicine
Mini-Medical School Series

Mark Lavallee, MD, CSCS, FACSM
Stephen Simons, MD, FACSM

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Platelets
RBCs
What are on Platelets which make them SPECIAL?

- Platelets contain granules that have bioactive proteins responsible for hemostasis and healing:
  - **Alpha granules** contain:
    - Platelet Derived Growth Factor (PDGF)
    - Vascular Endothelial Growth Factor (VEGF)
    - Transforming Growth Factor-B1 (TGFB)
    - Insulin Like Growth Factor-1 (IGF-1)
    - platelet factor 4,
    - Factors V & XIII and fibrinogen.
  - **Dense bodies** contain serotonin, nucleotides (ADP) and calcium.
- Platelets release their granular contents upon activation.
- Platelets activate upon exposure to:
  - Calcium
  - Thrombin
  - Tendon derived collagen
What is PRP?

• **PRP** is defined as a sample of autologous blood with concentrations of platelets above baseline values.
• Clinically active PRP typically contains over 1 million platelets per microliter.
• A part of the medical frontier known as “orthobiologics.”

Why PRP?

• Platelets do more than just clot!
• Platelets release bioactive factors that:
  • Attract macrophages;
  • Attract mesenchymal stem cells;
  • Promote removal of necrotic tissue;
  • Stimulate angiogenesis;
  • Enhance tissue regeneration and healing.
• Autologous blood eliminates concerns about disease transmission, is easy and cheap!
Platelets ATTRACTION stem cells!!

How Many Platelets Is Enough?

Dose-Dependent Mitogenic Effects of Platelet Releasate on hMSC’s

Conclusions:
- Platelet Concentrate and VEGF stimulate chemotactic migration of hMSC’s in a dose-dependent manner.
- Platelet Concentrate stimulates proliferation of hMSC’s in a dose-dependent manner.

Mitogenic Stimulation of Human Mesenchymal Stem Cells by Platelet Releasate Suggests a Mechanism for Enhancement of Bone Repair by Platelet Concentrate, Poster AAOS Meeting 2002

Haynesworth, SE; Kadiyala, S; Liang, L; Bruder, S P; DePuy AcroMed, DePuy Orthopedics, and Case Western Reserve University.
Peripheral Blood

- PLTs: 0%
- RBC: 6%
- WBC: 94%
What is PRP?

- PRP is defined as a sample of autologous blood with concentrations of platelets above baseline values.
- Clinically active PRP typically contains over 1 million platelets per microliter.
- A part of the medical frontier known as "orthobiologics."
Indications for PRP

- Tendinosis/tears
- Ligamentosis/laxity/tears
- Muscle tears
- Osteoarthritis/arthropathy
- Cartilage injury (OCD)
- Joint effusions
- Wound healing
- Fracture non-unions
- Stress fractures
Contraindications for PRP

- Anti-platelet / anti-inflammatory medication
  - Coumadin, ASA, NSAIDS, heparin, etc
  - High dose fish oil
- Bovine Thrombin Allergy
- Bleeding / clotting disorder
- Anemia / low platelet count
- ?cigarette smoking?
- ?Auto-immune disease?
  - RA, gout, SLE
  - PRP does help resolve synovial proliferation!
- ~Nutritional / Hormonal deficiency
### Potential PRP Injection Applications/Sites

#### Spine
- Sacroiliac joints
- Iliolumbar ligaments
- Facet joints (C-T-L)
- Costotransverse (rib) joints
- Spinal ligaments

#### Elbows
- Epicondylitis – medial & lateral
- Ulnar collateral ligament
- Distal biceps tendon – part. tear
- Osteoarthritis

#### Shoulder
- Rotator cuff tears/tendinosis
- Biceps tendinosis
- Chronic glenohumeral lig. sprains
- AC & GH joint arthritis
- Labral tears & degeneration

#### Wrist/Hand
- Chronic thumb UCL sprain
- First CMC / MCP osteoarthritis
- Tenosynovitis / tendinosis
- Wrist or distal RU osteoarthritis
## Potential PRP Injection Applications/Sites

### Hip/Pelvis
- Hip osteoarthritis
- Hamstring origin/ischial tuberosity
- Symphysis pubis / pubalgia
- Adductor / gluteal tendinosis

### Knee
- Patellar tendinosis
- Quadriceps tendinosis & tears
- Collateral / cruciate ligament tears
- Meniscal tears
- Osteoarthritis
- Patellofemoral
- Post ACL repair
- Pes bursitis / tendinosis
- Proximal tibfib joint laxity / OA

### Ankle/Foot
- Achilles tendinosis
- Peroneal tendinosis & tear
- Tibialis posterior tears & tendinosis
- Plantar fasciitis
- Osteochondral defect talus
- Sinus tarsi syndrome
- Ankle ligament tears and laxity
- Bunions
- Osteoarthritis ankle, foot, toes
- Sesamoids
PRP Preparation

- A: 30-60 ml of a patient’s blood is taken.
- B: It is then placed into a special sterile single-use kit and placed into a centrifuge.
- C: Once successful spin, platelet-rich plasma is withdrawn from the kit and placed into a via or syringe.
- D: A syringe with about 3-6 ml of PRP is injected into the injured area.
Most PRP is injected using Ultrasound Guidance.

Hip: Greater Trochanteric Bursa Injection
Tendinopathy
Results When Normal Healing Fails
Post Injection Recommendations

• In review of ALL the available literature:
  • No census stands on treatment after PRP
    • Most allow exercise 2-5 days after injections
    • Many encourage Rest, ice and limb elevation for 48 hours
  • Fenestration or percutaneous tenotomy has been used with PRP to treat tendonosis, which confounds rehab process b/c of microtrauma has elongating rest/rehab cycle.
Potential Adverse Effects

- In review of the literature for adverse reactions
  - (esp. Oral & Maxillofacial surgery which pioneered PRP in early 1990’s)
- **VERY LITTLE ADVERSE EFFECTS**
- **ORAL, DENTAL, ENT**
  - Wang-Saugusa et al, Arch orthop Trauma Surg, 2010:
    - no adverse events with 800+ patients
  - Anitua et al, J Periodontal, 2010:
    - no adverse events in 8 year follow-up due to PRP.
- **MUSCLE, TENDON, CARTILAGE**
  - Articles I reviewed for this lecture: only adverse reactions mentioned were 2 for mild pain, 1 for mild effusion
Potential Adverse Effects

- Theoretically:
  - Don’t use PRP in pts with low or abnormal platelet fxn, anemia, hypofibrinogenemia, hemodynamic instability, septicemia
  - Sensitivity to bovine thrombin for activation may cause a hypersensitivity reaction in a rare individual.
  - Development of antibodies against clotting Factors V and IX leading to life-threatening coagulopathies have been noted in those exposed to bovine thrombin (only 7 cases in literature, none associated with PRP)
  - Risk of infection/sepsis is present whenever the skin is punctured, but this is not unique to PRP.
PRP illegal in sport or not?

- World Anti-Doping Agency (WADA)
- Prohibited Substance List: 2010
  - A substance is considered for the list when
    - 2 of 3 are met:
      - Potential for performance enhancement
      - Risks to health
      - Violates the spirit of sport
    - WADA had PRP on their banned list in 2010 but in January 2011 it removed
    - WADA left other recombinant growth factors (i.e. epogen, hGh, etc) on the list.
PRP Peer-Reviewed Literature

• Studies placed into following groups:
  • Muscle Injury
    • Animal & Human studies
  • Tendon Injury/ Tendinosis
    • Animal and Human Studies
  • Cartilage injury (OCDs)
    • Animal & Human Studies
  • Nerve Injuries
  • Intra-articular/ DJD
My SM Fellows in Castle Dungeon in Bad Wimpfen, Germany 2016
So What is next for treatment of chronic tendonosis or ligament injury?

• Ultrasound Guided Percutaneous Tenotomy or Focused Aspiration of Scar Tissue
Over 10M Chronic Tendonosis Patients / Year

Over 9000 treated pts since Feb 2012 … (FDA approved July 2012)

**Shoulder**
Over-use workers/athletes
est. 2 million pts/year

**Elbow**
tennis + golfers elbow
est. 2.0 million pts/yr

**Skin**

**Tendon**

**Plantar Fascia**
25% “foot” visits
est. 3 million pts/year

**Scarf Tissue**

**Knee**
basketball, volleyball
est 0.5 million pts/yr

**Achilles**
10% of runners
est. 3 million pts/yr
Chronic Tendinopathy
Treatment by Ultrasound

Ultrasonic probe

3 functions

- Optimized ultrasonic frequency - breaks-down diseased tissue - spares healthy tissue
- Continuous irrigation - emulsifies tissue; cools probe
- Aspiration of target tissue
Chronic Tendinopathy
Treatment by Ultrasound

Technique - Treatment

Safety characteristics = 4

- Visualize pathology
- Effective only with necrotic tissue
- Energy sphere ~ 1mm (cavitation)
- Energy module shuts off
  - irrigation ceases
  - aspiration ceases
Chronic Tendinopathy
Treatment by Ultrasound

Clinical Experience

Visual Analogue Scale (VAS)

Improvement

US - 4.5
PRP - 3.8

Baseline (VAS)  Early (VAS)  1 Month VAS Pain Score  3 Month VAS Pain Score  6 Month VAS Pain Score
Chronic Lateral Epicondylosis

Betadine prep

Post-Lidocaine

Lidocaine

#11 Blade scalpel
Chronic Lateral Epicondylitis

- #11 Blade scalpel
- Micro-TX probe
- Steri-strip
- ACE wrap
Chronic Patellar Tendinosis
FAST Probe in Patella Tendon
Cost-Effective and Well-Tolerated

• No restrictions before procedure
• **Total procedure time from cleaning of skin to placing band-aid is less than 20 min.**
• No pain or discomfort during procedure
• **Permitted to go home afterwards +/- PT**
• Covered by some insurances (unlike PRP)
• **Can be performed in:**
  • Clinic setting (cheaper)
  • Out-patient surgical setting (more revenue)
• Can be used with PRP

• **Post-procedure ...**
  • Over-the-counter pain meds and ice as needed
  • Refrain from heavy lifting or in boot for 2 weeks
  • Return to full activity in 4 to 6 weeks
PRP / TENEX Peer-Reviewed Literature

- PRP Studies placed into following groups:
  - Muscle Injury
    - Animal & Human studies
  - Tendon Injury/ Tendinosis
    - Animal and Human Studies
  - Cartilage injury (OCDs)
    - Animal & Human Studies
  - Nerve Injuries
  - Intra-articular/ DJD
- TENEX research (Lavallee/Wennell-12 month prospective study studying VAS Pain and Function)
  169 patients enrolled, study end 2/2017
DRY NEEDLING

• Uses acupuncture solid needle (30 g)
  • Length: 30mm, 40mm, 60mm
• Fenestration of tissue by direct palpation
• Not ultrasound guided
• Skin cleansed with ETOH
• Only 1-6 needles used at time
• NOTE: inform increased pain for 24-36 hrs
DRY NEEDLING

- **Length of Procedure**: 5 minutes
- **Payment**: not billable
- **Cost**: Box of 200 needles is $14

USAW Athlete, Jenny Arthur, 2016 Rio Olympian getting “needling” before Worlds!
Dry Needling

- **Indications**
  - ACUTE- trigger points
  - Specific muscle spasm
  - CHRONIC-myotendinous junction
  - Tendinoses

- **Contraindications**
  - Cellulitis
  - Tumor/space occupying lesion
  - Cystic structure
DRY NEEDLING is NOT ACUPUNCTURE

- **ACUPUNCTURE**
  - Needs 1,400 hours of training for certificate
  - Eastern Medicine involving meridians or “lines of Chi”
    - Chi=energy
  - Needle is generally NOT placed where pain is felt.
USE of ULTRASOUND IN SPORTS MEDICINE

- MSK / NEURO diagnostic image
- Interventional
  - Injection
  - Compartment Pressure testing
- Limited ECHO for PPE/ HCM
- Vocal Cord Imaging
- Ocular Imaging
- Fracture Care Assessment

Limited Echocardiography

Left Parasternal Sagittal view.

Gian Corrado et al, Use of limited view Echo in screening Collegiate Athletes, J Ultrasound Med, 2014
Vocal Cord Imaging

- Helpful for:
  - VC Paralysis
  - VC “Screamer’s Nodes”
  - VC Dysfunction
    - Seen in runners, often confused with EIB or Asthma.
Ocular Imaging w/ U/S

- Indications
  - EOM entrapment
  - “floaters”
  - Retinal detachment
  - Non-Penetrating Foreign Body

- Contraindications
  - Open Ocular Trauma/ Globe rupture
  - Ocular Infection
  - Penetrating Foreign Body
Fracture Site Assessment with U/S

• Can see periosteal disruption on U/S when x-rays WNL and high suspicion (i.e. scaphoid)

• Helpful to grade amount of callous formation
In Office Carpel Tunnel Release?

- SONEX HEALTH
- U/S guided percutaneous release of flexor retinaculum
Summary

• PRP seems to show some **promise** as a treatment either by itself or with other treatments (i.e. surgery, percutaneous tenotomy, etc) for treatment of injuries to Muscles, Tendons, Ligaments, Nerves, and Cartilage.

• Much more animal and level 1 evidence based human research needs to be done to proved its **short- and long-term efficacy** in the realm of BOTH PRP and TENEX for acute and chronic injuries to muscles, tendons, ligaments, articular cartilage and nerves.

• Studies to date show **PRP and TENEX** as having little adverse reactions. More studies are needed

• Consider **DRY NEEDLING** for some MSK conditions

• Consider learning to use **ULTRASOUND** in your practice
Thank you!

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