



(Place your scripture, quote or photo here, i.e.)

*“Do not be conformed to the pattern of this world,
but be transformed by the renewing of your mind
That you may be able to test and approve
what the will of God is,
his good, pleasing, and perfect will.”*

-Romans 12:2

Regenerative Medicine for the Companion Animal

Britt Carr Benson, DVM, DACVSMR, CCRT

*Diplomate of the American College of
Veterinary Sports Medicine and
Rehabilitation*

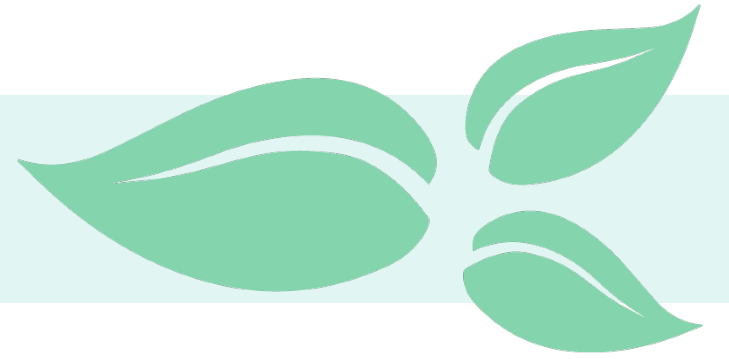
Certified Canine Rehabilitation Therapist



**CVM
Veterinary
Conference**

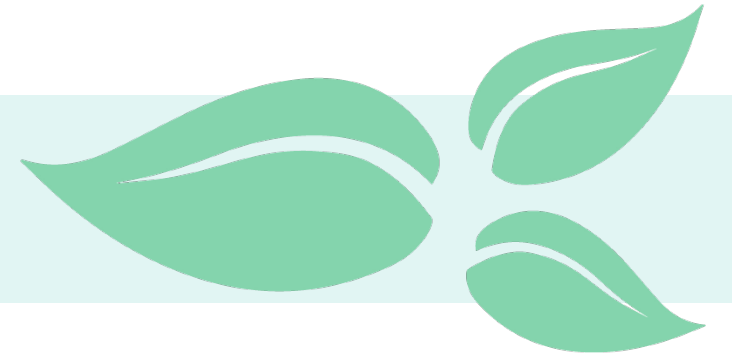


Acknowledgements



- Christian Veterinary Mission

Relevant Disclosures



- I am a consultant for Companion Animal Health



Tiger Admits to Platelet-Rich Plasma Therapy, What's That?

April 7, 2010
By LAUREN COX

Kobe in Germany for PRP treatment

Updated: October 3, 2013, 11:58 PM ET
By [Dave McMenamin](#) | [ESPNIosAngeles.com](#)



John Canzano

PRP, stem cell and Warriors G Steph Curry's quick return from knee injury

Updated Jan 09, 2019; Posted Apr 30, 2016



Kim Kardashian's \$1,500 'vampire facial' is a Hollywood hit that promises younger, firmer-looking skin

Her spa procedure is splattered all over her reality TV show, but was it played up for the cameras?

BY NICOLE LYN PESCE / NEW YORK DAILY NEWS / Published: Tuesday, March 12, 2013, 6:00 AM



TC Palm

Former NFL star Eddie George returns to Vero Beach for therapy, this time on shoulder

VERO BEACH — Stem cell and plasma therapy brought a former ... be commenting on college football on ESPN's XM Satellite Radio station a ...
Sep 20, 2020



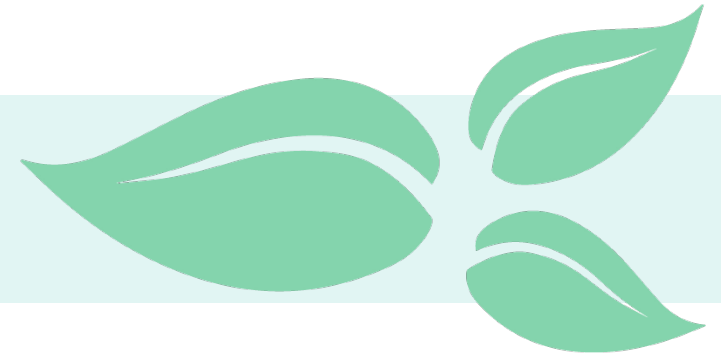
theScore.com

Report: Padres expect Lamet to be ready for spring after PRP treatment

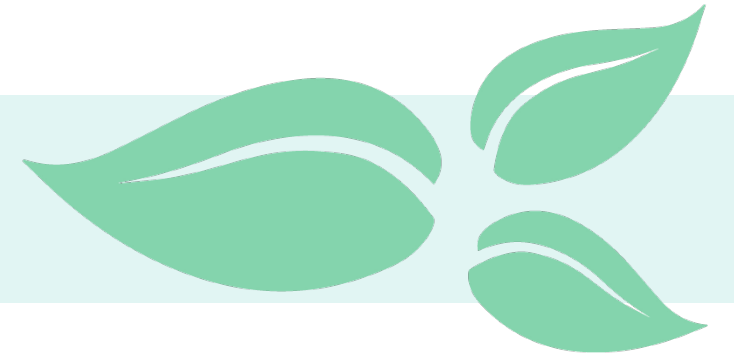
San Diego Padres right-hander Dinelson Lamet began platelet-rich plasma (PRP) therapy on his elbow Monday, sources told Kevin Acee of ...
Oct 12, 2020



Regenerative Medicine



- Increasingly popular in both human and veterinary medicine for managing osteoarthritis as well as soft tissue injuries
- Stimulate healing in traditionally poorly healing tissues such as cartilage, tendon, and ligament
- Often used to adjunct surgical, medical, and/or rehabilitation therapy
- Two most common forms in the Companion Animal:
 - Platelet Rich Plasma (PRP)
 - Stem Cell Therapy



Platelet Rich Plasma (PRP)

Platelet Rich Plasma (PRP)



- Platelet rich plasma (PRP) is an autogenous fluid concentrate composed primarily of platelets and growth factors.
- Platelets contain alpha granules that release growth factors to stimulate other cells of the body to migrate to the area of trauma, thus facilitating tissue healing.
- Growth factors:
 - Platelet-derived growth factor (PDGF)
 - Transforming growth factor- β 1 (TGF- β 1)
 - Transforming growth factor- β 2 (TGF- β 2)
 - Vascular endothelial growth factor (VEGF)
 - Basic fibroblastic growth factor (bFGF)
 - Epidermal growth factor (EGF)





Platelet Rich Plasma (PRP)

Where's the Evidence??

well SG, Cole BJ, Sundman EA, Karas V, Fortier LA. Platelet-rich plasma: a milieu of bioactive factors. *Arthroscopy*. 2012;28(3):429-439.

an Ehrenfest DM, Doglioli P, de Peppo GM, Del Corso M, Charrier JB. Platelet-rich plasma: a review of its use in the treatment of musculoskeletal injuries. *Arch Oral Biol*. 2010; 55:185-192.

ukroun's platelet-rich fibrin (PRF) stimulates in vitro proliferation and differentiation of human oral bone mesenchymal stem cell in a dose-dependent way. *Arch Oral Biol*. 2010; 55:185-192.

rdo G, Kon E, Roffi A, Di Matteo B, Merli ML, Marcacci M. Platelet rich plasma: what is it? Intra-articular? A systematic review of preclinical studies and clinical evidence on PRP for joint degeneration. *Knee Surg Sports Traumatol Arthrosc*. 2013. doi:10.1007/s00167-013-2743-1

WK, Mishra A, Rodeo SR, Fu F, Terry MA, Randelli P, Canale ST, Kelly FB. Platelet-rich plasma in orthopaedic applications: evidence-based recommendations for treatment. *J Am Acad Orthop Surg*. 2013; 21:739-748.

ellan J, Plevin S. Does it matter which platelet-rich plasma we use? *Equine Vet Educ*. 2011; 23(10):101-104.

etier MH, Malhotra A, Brighton T, Walsh WR, Underman R. Platelet function and constituents of platelet rich plasma. *Int J Sports Med*. 2008; 34: 74-80.

ndman EA, Cole BJ, Karas V, Valle CD, Tetreault MW, Mohammed HO, Fortier LA. The anti-inflammatory and matrix restorative mechanisms of platelet-rich plasma in osteoarthritis. *Am J Sports Med*. 2013; 42(1): 35-41.

ams GD, Frank RM, Fortier LA, Cole BJ. Platelet rich plasma for articular cartilage repair. *Sports Med Arthrosc Rev*. 2011; 21:213-219.

ok K, Kim JM, Kim MH, Kang SS, Kim G, Choi SH. Scintigraphic evaluation of osseointegrative response around calcium phosphate-coated titanium implants in tibia bone: effect of platelet rich plasma on bone healing in dogs. *Eur Surg Res*. 2013; 51: 138-145.

goo JL, Braun HJ, Durham JL, Ridle BA, Odegaard JI, Luong R, Arnoczky SP. Comparison of the acute inflammatory response of two commercial platelet-rich plasma systems in healthy rabbit tendon. *Am J Sports Med*. 2012; 40(6): 1274-1281.

goo JL, Wasterlain AS, Braun HJ, Nead KT. Platelet-rich plasma as a treatment for patellar tendinopathy: a double-blind, randomized controlled trial. *Am J Sports Med*. 2014; 42(5):610-618.

rdo G, Kon E, Di Martino A, Di Matteo B, Merli ML, Cenacchi A, Fornasari PM, Marcacci M. Platelet-rich plasma vs hyaluronic acid to treat knee degenerative pathology: study design and preliminary results of a randomized controlled trial. *BMC Musculoskeletal Disorders*. 2012; 13(229):

CHALLENGE

rdo G, Kon E, Buda R, Timoncini A, Di Martino A, Cenacchi A, Fornasari PM, Giannini S, Marcacci M. Platelet-rich plasma intra-articular knee injections for the treatment of degenerative cartilage lesions and osteoarthritis. *Knee Surg Sports Traumatol Arthrosc*. 2011; 19:528-535.

nklin S, Cook J. Prospective trial of autologous conditioned plasma versus hyaluronan plus corticosteroid for elbow osteoarthritis in dogs. *Can Vet J*. 2013; 54:881-884.

ng SJ, Kim JD, Cha SS. Platelet-rich plasma (PRP) injections as an effective treatment for early osteoarthritis. *Eur J Orthop Surg Traumatol*. 2013; 23: 573-580.

shbin A, Leroux T, Wasserstein D, Marks P, Theodoropoulos J, Ogilvie-Harris D, Gandi R, Takhar K, Lum G, Chahal J. The efficacy of platelet-rich plasma in the treatment of symptomatic knee osteoarthritis: a systematic review with quantitative synthesis. *Arthroscopy*. 2013; 29(12):2037-2048. DOI 10.1007/s00167-013-2743-1.

n E, Buda R, Filardo G, Di Martino A, Timoncini A, Cenacchi A, Fornasari PM, Giannini S, Marcacci M. Platelet-rich plasma: intra-articular knee injections produced favorable results on degenerative cartilage lesions. *Knee Surg Sports Traumatol Arthrosc*. 2010; 18:474-479.

n E, Mandelbaum B, Buda R, Filardo G, Delcogliano M, Timoncini A, Fornasari PM. Platelet-rich plasma intra-articular injection versus hyaluronic acid viscosupplementation as treatments for cartilage pathology: from early degeneration to osteoarthritis. *Arthroscopy*. 2011; 27(11):1490-1497.

Carrel T, Fortier L. Temporal growth factor release from platelet-rich plasma, trehalose lyophilized platelets, and bone marrow aspirate and their effect on tendon and ligament gene expression. *J Orthop Res*. 2009; 27(8):1033-1042.

Carrel TM, Minas T, Fortier LA. Optimization of leukocyte concentration in platelet-rich plasma for the treatment of tendinopathy. *J Bone Joint Surg Am*. 2012; 94: e143(1-8).

hra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. *Am J Sports Med*. 2006; 34(11):1774-1778.

el S, Shillon MS, Aggarwal S, Marwaha N, Jain A. Treatment with platelet-rich plasma is more effective than placebo for knee osteoarthritis: a prospective, double-blinded, randomized trial. *Am J Sports Med*. 2013; 41(2): 356-364.

issadat SA, Rayegani SM, Babaee M, Ghorbani E. The effect of platelet-rich plasma on pain, function, and quality of life of patients with knee osteoarthritis. *Pain Res and Treatment*. 2013; 1:1-7.

ndelli P, Arrigoni P, Ragone V, Aliprandi A, Cabitza P. Platelet rich plasma in arthroscopic rotator cuff repair: a prospective RCT study, 2-year follow-up. *J Shoulder Elbow Surg*. 2011; 20:518-528.

mpson S, Gerhardt M, Mandelbaum B. Platelet rich plasma injection grafts for musculoskeletal injuries: a review. *Curr Rev Musculoskeletal Med*. 2008; 1:165-174.

ra RF, Carmona JU, Rezende CMF. Intra-articular injections of autologous platelet concentrates in dogs with surgical repair of cranial cruciate ligament rupture. *Vet Comp Orthop Traumatol*. 2013; 26: 122-125.

ith JJ, Ross MW, Smith RKW. Anabolic effects of acellular bone marrow, platelet rich plasma, and serum on equine suspensory ligament fibroblasts in vitro. *Vet Comp Orthop Traumatol*. 2006; 19: 43-47.

iza TFB, Andrade AL, Ferreira GTNM, Sakamoto SS, Albuquerque VB, Bonfim SRM, Luvizotto MCR, Louzada MJQ. Healing and expression of growth factors (TGF-B and PDGF) in canine radial osteotomy gap containing platelet-rich plasma. *Vet Comp Orthop Traumatol*. 2012; 25: 445-452.

i Buul GM, Koevoet WLM, Kops N, Bos PK, Verhaar JAN, Weinans H, Bernsen MR, van Osch JVM. Platelet-rich plasma releasate inhibits inflammatory processes in osteoarthritic chondrocytes. *Am J Sports Med*. 2011; 39(11):2362-2370.

X, Hua W, Zhao S, Xie G, Huangfu X, Zhao J. The effect of platelet-rich plasma on patterns of gene expression in a dog model of anterior cruciate ligament reconstruction. *J of Surg Res*. 2013; 180:80-88.

X, Wang Y, Zhao C, Guo S, Liu S, Jia W, Tuan RS, Zhang C. Comparative evaluation of MSCs from bone marrow and adipose tissue seeded in PRP-derived scaffold for cartilage regeneration. *Biomaterials*. 2012; 33:7708-7018.

eckx S, Zimmerman M, Crocetti S, Suls M, Marien T, Ferguson SJ, Chiers K, Duchateau L, Franco-Obregon A, Wuertz K, Spaas JH. Regenerative therapies for equine degenerative joint disease: a preliminary study. *PLoS ONE*. 2014; 9(1):e85917.

o HS, Song IH, Park SY, Sung MC, Ahn MW, Song KE. Individual variation in growth factor concentrations in platelet-rich plasma and its influence on human mesenchymal stem cells. *Korean J Lab Med*. 2011; 31:212-218.

Bue M, Riccò S, Ramoni R, Conti V, Gnudi G, Grolli S. Equine adipose-tissue derived mesenchymal stem cells and platelet concentrates: their association in vitro and in vivo. *Vet Res Commun*. 2008; 32(S1):S51- S55.

ngk A, Zapf A, Stürmer EK, Stürmer KM, Frosch KH. Influence of platelet-rich plasma on chondrogenic differentiation and proliferation of chondrocytes and mesenchymal stem cells. *Cells Tissues Organs*. 2009; 189:317-326.

an Ehrenfest DM, Rasmusson L, Albrektsson T. Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leukocyte- and platelet-rich fibrin (L-PRF). *Trends in Biotech*. 2008; 27(3):158-167.

hra A, Tummala P, King A, Lee B, Kraus M, Tse V, Jacobs CR. Buffered platelet-rich plasma enhances mesenchymal stem cell proliferation and chondrogenic differentiation. *Tissue Eng Part C Methods*. 2009; 15:431-435.

anabel LV, Lynch ME, Van der Meulen MC, Yeager AE, Komatowski MA, Nixon AJ. Mesenchymal stem cells and insulin-like growth factor-I gene- enhanced mesenchymal stem cells improve structural aspects of healing in equine flexor digitorum superficialis tendons. *J Orthop Res*. 2009; 27(10):1392-1398.

ricelli P, Fini M, Filardo G, Tschon M, Pischetta M, Pacorini A, Kon E, Giardino R. Regenerative medicine for the treatment of musculoskeletal overuse injuries in competition horses. *Internat Orthop*. 2011; 35:1569-1576.

un HJ, Kim HJ, Chu CR, Dragoo JL. The effect of platelet-rich plasma formulations and blood products on human synoviocytes. *Am J Sports Med*. 2014; 42(5):1204-1210.

ndman EA, Cole BJ, Fortier LA. Growth factor and catabolic cytokine concentrations are influenced by the cellular composition of platelet-rich plasma. *Am J Sports Med*. 2013; 39(10): 2135-2140.

ndman EA, Boswell SG, Schnabel LV, Mohammed HO, Minas T, Fortier LA. Increasing platelet concentrations in leukocyte-reduced platelet-rich plasma decrease collagen gene synthesis in tendons. *Am J Sports Med*. 2013; 42(1): 35-41.

stillo TN, Pouliot MA, Kim HJ, Dragoo JL. Comparison of growth factor and platelet concentrations from commercial platelet-rich plasma separation systems. *Am J Sports Med*. 2011; 39(2):266-271.

of M, Gottschalk J, Ionita JC, Einspanier A, Oechtering G, Boettcher P. Concentration of platelets and growth factors in canine autologous conditioned plasma. *Vet Comp Orthop Traumatol*. 2011; 24: 285-290.

well SG, Schnabel LV, Mohammed HO, Sundman EA, Minas T, Fortier LA. Increasing platelet concentrations in leukocyte-reduced platelet-rich plasma decrease collagen gene synthesis in tendons. *Am J Sports Med*. 2013; 42(1):42-49.

allo C, Filardo G, Mariani E, Kon E, Marcacci M, Pereira Ruiz MT, Facchini A, Grigolo B. Comparison of platelet-rich plasma formulations for cartilage healing. *J Bone Joint Surg Am*. 2014; 96: 423-429.

adini A, Morena E, Fimiani M, Campoccia G, Fossombroni V, Carraro F. The effects of autologous platelet gel on inflammatory cytokine response in human peripheral blood mononuclear cells. *Platelets*. 2008; 19(4): 268-274.

shida R, Murray MM. Peripheral Blood Mononuclear Cells Enhance the Anabolic Effects of Platelet-Rich Plasma on Anterior Cruciate Ligament Fibroblasts. *J Orthop Res*. 2011; 31(1): 29-34.

nklin SP, Garner BC, Cook JL. Characteristics of canine platelet-rich plasma prepared with five commercially available systems. *Am J Vet Res*. 2015; 76(9):927-927.

r BJ, Canapp SO, Mason DM, et al. Canine platelet rich plasma systems: A multicenter prospective analysis. *Front Vet Sci*. 2015; 2:73. doi:10.3389/fvets.2015.00073

ynski CC, Stannard JP, Smith P, et al. Acute management of anterior cruciate ligament injuries using novel canine models. *J Knee Surg*. 2015; doi:10.1055/s-0035-1570144

ok JL, Smith PA, Bozynski CC, et al. Multiple injections of leukocyte-reduced platelet-rich plasma reduce pain and functional impairment in a canine model of ACL and meniscal deficiency. *J Orthop Res*. 2016; 34(1):607-615. doi:10.1002/jor.22954

X, Zhu S, Wu H, et al. Platelet-rich plasma enhances autograft vascularization and innervation in a dog model of anterior cruciate ligament reconstruction. *J Surg Res*. 2013; 183: 14-222.

X, Wu H, Zhao S, et al. The effect of platelet-rich plasma on patterns of gene expression in a dog model of anterior cruciate ligament reconstruction. *J Surg Res*. 2013; 183: 80-88.

LK, Baltzer WI, Nemanic S, et al. Single ultrasound-guided platelet-rich plasma injection for treatment of supraspinatus tendinopathy in dogs. *Can Vet J*. 2015; 96:645-645.

emi D, Fakhriou A. Leukocyte and platelet rich plasma (L-PRP) versus leukocyte and platelet rich fibrin (L-PRF) for articular cartilage repair of the knee: a comparative evaluation in an animal model. *Iran Red Crescent Med J*. 2015;17(10):e19594.

WHY NOT TRY ANYWHERE

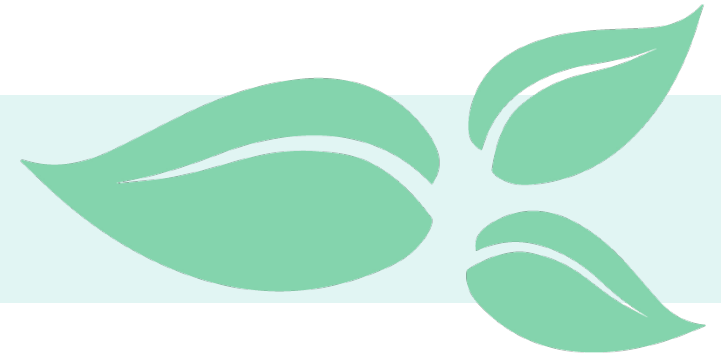
PRP Studies: ACL Model

- Bozynski et al showed that dogs with ACL injury treated with one single intra-articular injection of leukoreduced PRP had less pain, lameness, effusion, and synovial inflammatory and degradative biomarkers at 8 weeks post treatment when compared to dogs treated with rest and nonsteroidal anti-inflammatory drugs.
- Cook et al showed dogs that underwent a partial ACL transection and meniscal release in one knee and received 5 weekly leukoreduced PRP injections had significantly improved orthopedic examination findings, less synovitis and evidence of ACL repair arthroscopically, and less severe changes histopathology 6 months post treatment compared to dogs who were treated with saline.
- Xie et al showed PRP enhances autograft revascularization and reinnervation in dogs who underwent ACL reconstruction.
- Venator et al showed a single injection of PRP improved kinetics for minimally 4 weeks, possibly up to 12 weeks, in dogs with unilateral or bilateral CCL injury (non-stabilized)
- Vilar et al showed a single PRP injection improved joint kinetics and AROM for up to 12 weeks.

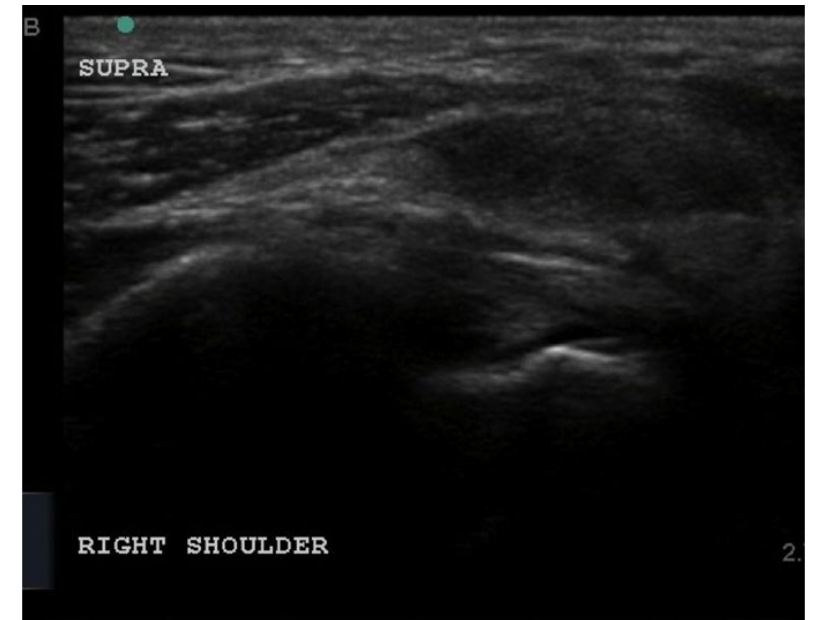


Bozynski CC, Stannard JP, Smith P, et al. *J Knee Surg*. 2015
Cook JL, Smith PA, Bozynski CC, et al. *J Orthop Res*. 2016.
Xie X, Zhao S, Wu H, et al. *J Surg Res*. 2013.
Xie X, Wu H, Zhao S, et al. *J Surg Res*. 2013.
Venator JP et al. *Vet Med (Auck)*. 2020.
Vilar JM et al. *PLoS ONE*. 2018.

PRP Studies: Tendinopathy



- Ho et al showed that in dogs with supraspinatus tendinopathy treated with a single PRP ultrasound guided injection had subjective improvement in lameness and function in 40% of dogs with improved tendon heterogeneity and in 60% of dogs with improved tendon echogenicity 6 weeks following treatment.



Ho LK, Baltzer WI, Nemanic S, et al. *Can Vet J.* 2015.

PRP Studies: Osteoarthritis



- Kazemi et al showed that in dogs with experimentally induced full thickness cartilage defects treated with either leukocyte and platelet rich plasma (L-PRP) or leukocyte and platelet rich fibrin (L-PRF) had significantly better mean macroscopic and microscopic scores compared to controls at 4 and 16 weeks post treatment.

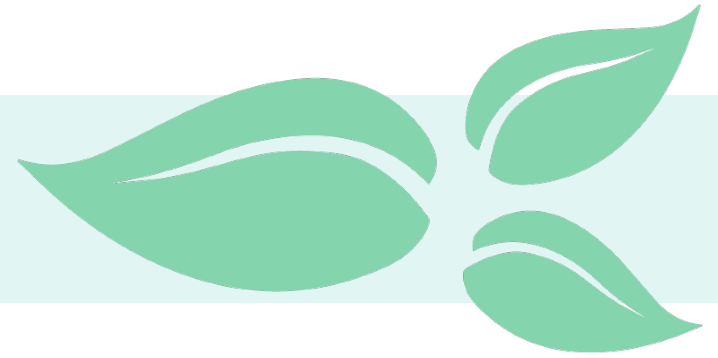
Figure 1. Macroscopic Appearance of Representative Defects from Different Treatment Groups



Note the presence of fibrous tissue in all defects at 4 weeks with a central depression, which is deeper in the control group. Later, the fibrous repair tissue was replaced by opaque white repair tissue resembling the surrounding normal cartilage, but the defect area was still distinguishable. Cystic lesion was present at the center of the repair tissue at 24 weeks in the control group.

Kazemi D, Fakhrijou A. *Iran Red Crescent Med J.*
2015. DOI:10.5812/ircmj.19594

PRP Studies: Osteoarthritis



> [Animals \(Basel\)](#). 2020 Jan 21;10(2):175. doi: 10.3390/ani10020175.

Objective Comparison between Platelet Rich Plasma Alone and in Combination with Physical Therapy in Dogs with Osteoarthritis Caused by Hip Dysplasia

Belén Cuervo ^{1 2}, Mónica Rubio ^{1 2}, Deborah Chicharro ^{1 2}, Elena Damiá ^{1 2},
Angelo Santana ³, José María Carrillo ^{1 2}, Ayla Del Romero ^{1 2}, José Manuel Vilar ⁴,
José Joaquín Cerón ^{2 5}, Joaquín Jesús Sopena ^{1 2}

- Two groups PRP or PRP + physical therapy
- Evaluated at baseline and at 30, 90, and 180 days after
- After 180 days, the PRP group showed a decrease in PVF and VI with respect to the values obtained at 90 days.
- However, the PRP + physical therapy group maintained increased values of both PVF and VI values during the 180-day study period.

PRP Studies: Osteoarthritis



> [Open Vet J. 2020 Aug;10\(2\):226-231. doi: 10.4314/ovj.v10i2.12. Epub 2020 Jun 30.](#)

Treatment of canine osteoarthritis with allogeneic platelet-rich plasma: review of five cases

José Catarino ¹, Pedro Carvalho ^{2 3}, Sara Santos ¹, Ângela Martins ^{1 4}, João Requicha ^{1 5}

- 5 dogs with OA treated with 1 IA injection of PRP
- Subjective lameness and pain scores evaluated at 30, 60, and 90 days
- All animals presented improvements at 30 and 60 days in both parameters.
- Four dogs showed a decrease of three grades of lameness after 90 days and there was complete absence of lameness in 2 days.
- Pain was reduced from severe and moderate to mild in all the dogs after 30 days, and among them, three revealed no pain after 90 days.

PRP Studies: Osteoarthritis



Vet Comp Orthop Traumatol 2018; 31(S 02): A1-A25
DOI: 10.1055/s-0038-1668217



Podium Abstracts

Georg Thieme Verlag KG Stuttgart · New York

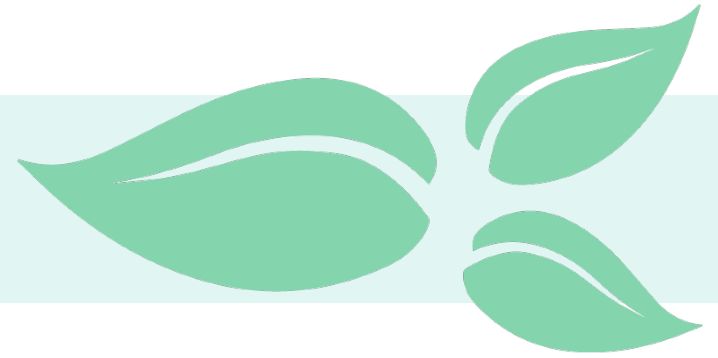
Clinical Efficacy of Platelet Rich Plasma for the Treatment of Elbow Osteoarthritis in Twenty Dogs

Brittany Jean Carr, Sherman O. Canapp Jr., Nicole Chun, Ashley Gaver



- 10 dogs with unilateral or bilateral elbow OA given a single injection of PRP
- 10 dogs in control group
- All dogs had grade II/III or III/III radiographic osteophyte grade at day 0
 - Moderate to severe elbow OA
- No significant differences in objective gait analysis, CBPI, or elbow flexion
- Concluded that a single injection of PRP may not be appropriate for moderate to severe OA and that a series of injections should be considered instead

PRP Studies: Osteoarthritis



[BMC Vet Res.](#) 2021; 17: 207.

Published online 2021 Jun 5. doi: [10.1186/s12917-021-02913-x](https://doi.org/10.1186/s12917-021-02913-x)

PMCID: PMC8180029

PMID: [34090433](https://pubmed.ncbi.nlm.nih.gov/34090433/)

Platelet-rich plasma therapy in dogs with bilateral hip osteoarthritis

[J. C. Alves](#),^{1,2} [A. Santos](#),¹ and [P. Jorge](#)¹

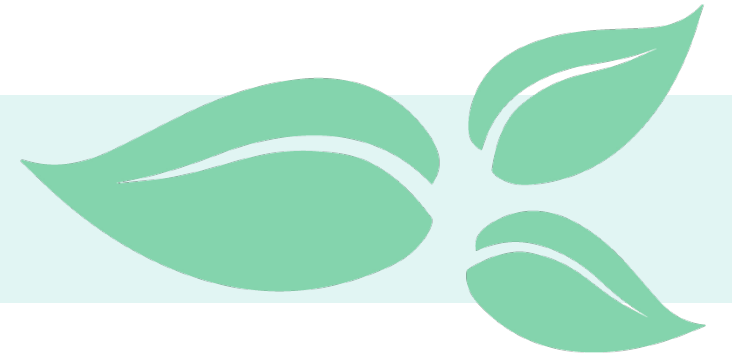
- 20 dogs with moderate and severe OA treated
- 10 treated with 2 IA injection of PRP 14 days apart
- PRP group had significantly better CPBI, HVAS, LOAD, PIS, PSS, QOL scores than control group at multiple time points, some up to 180 days

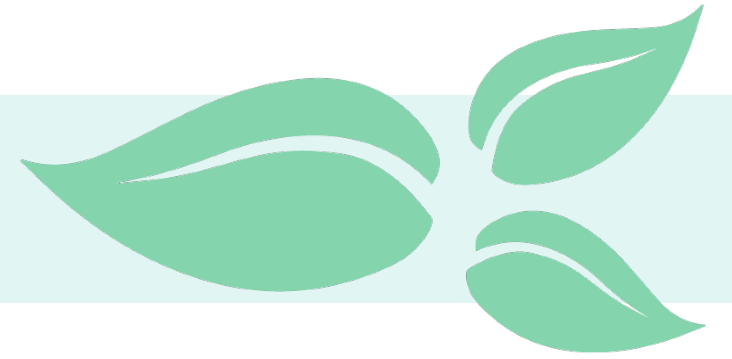
What can we gain from the research?



- PRP has been used to help manage both osteoarthritis and soft tissue injury in dogs.
- Multiple injections of PRP can be used (PRP series).
- PRP appears to be well tolerated and safe.
- PRP can easily be done in clinical setting.

Multiple Systems for PRP



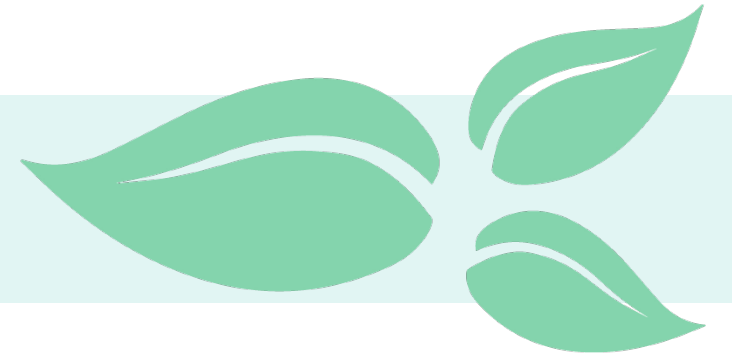


How do I choose a PRP System??

How Do I Choose a PRP System

- Good price point
- Spin or Gravity Separation
- Validated to produce the “Ideal PRP” in the species you’re using it in



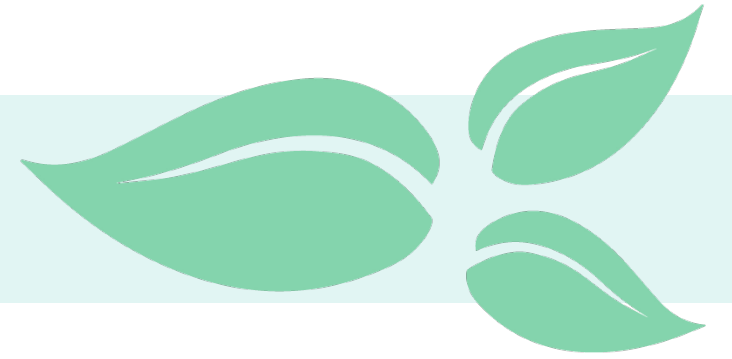


**What should the “Ideal
PRP” contain??**

The “Ideal” PRP– The Short Answer

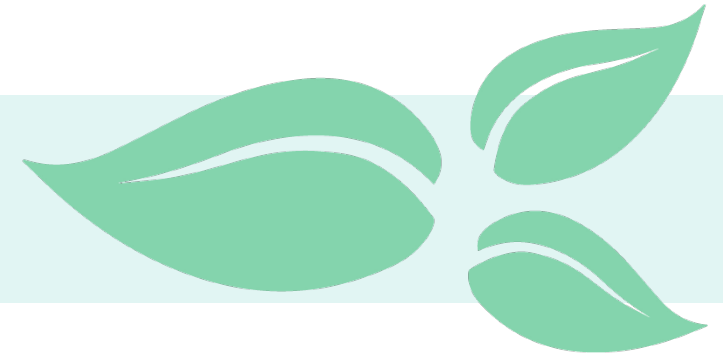
- Increased Platelet Concentration
- Minimize RBC Concentration
- +/- Neutrophils
 - Reduce Neutrophils for OA
 - +/- Neutrophils for ST injury



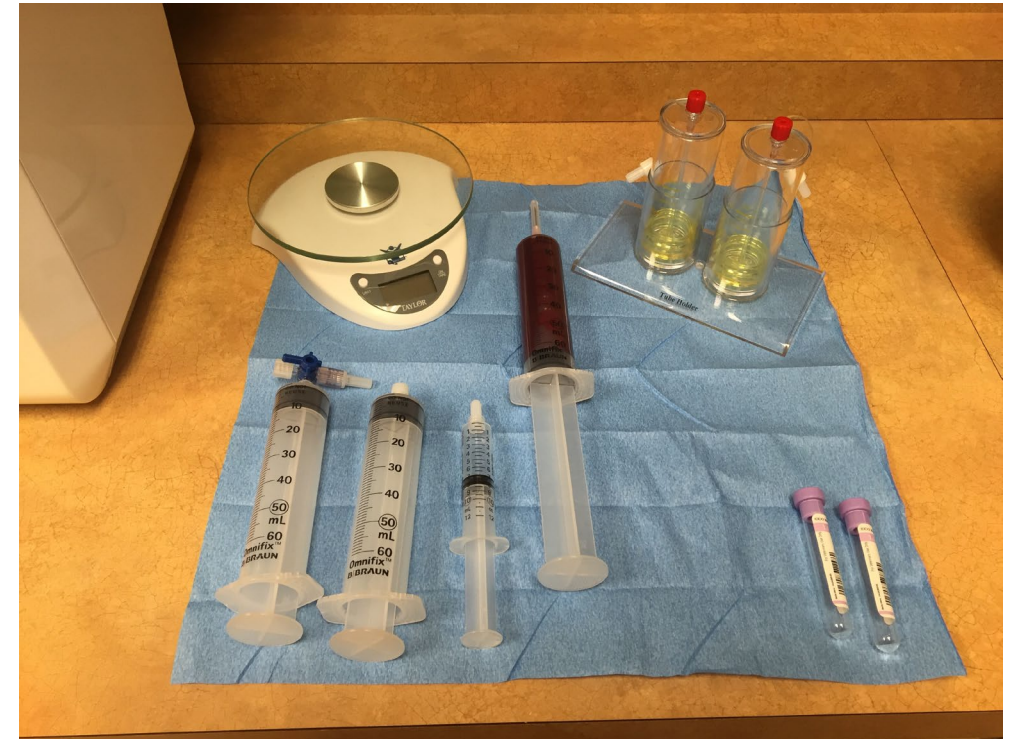


**What does PRP look like
clinically??**

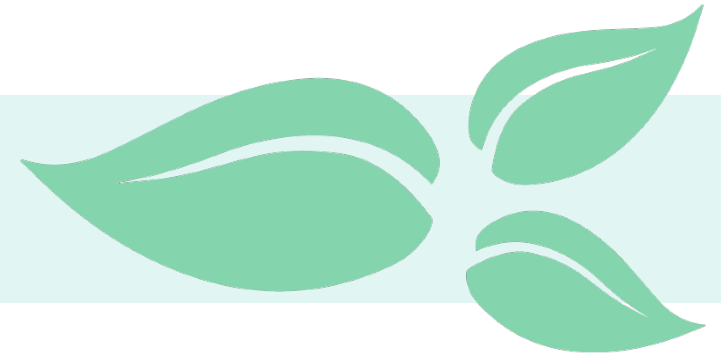
PRP Protocol



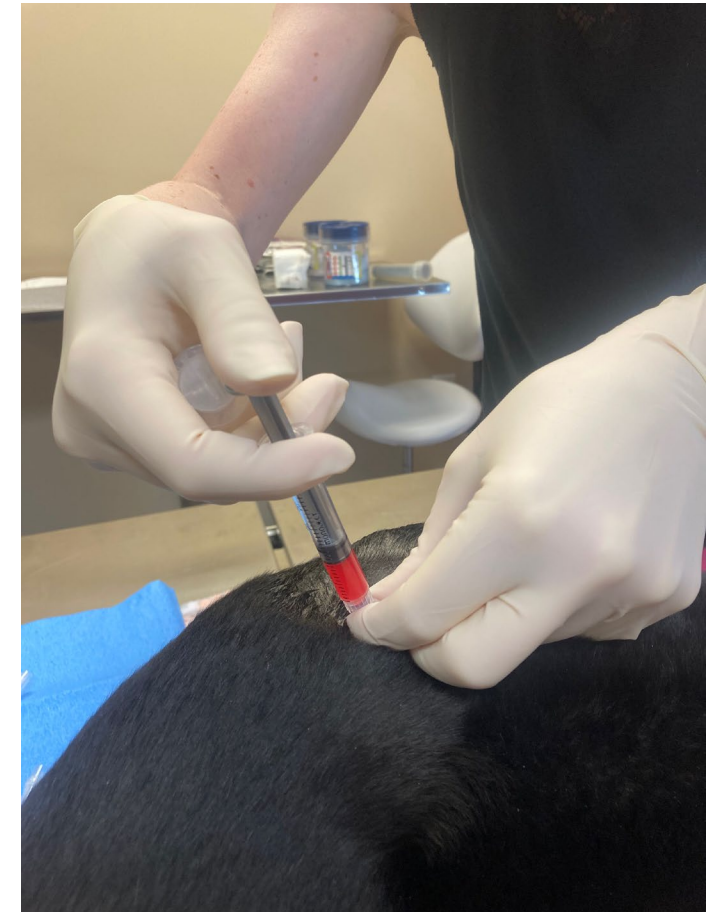
- Blood collection (10-60 mls)
- Blood is centrifuged or filtrated and PRP produced
- Increases the concentration of platelets and growth factors
- For OA PRP is injected
 - Blind IA
 - US or XR guidance
- For soft tissue injury PRP is injected under ultrasound guidance



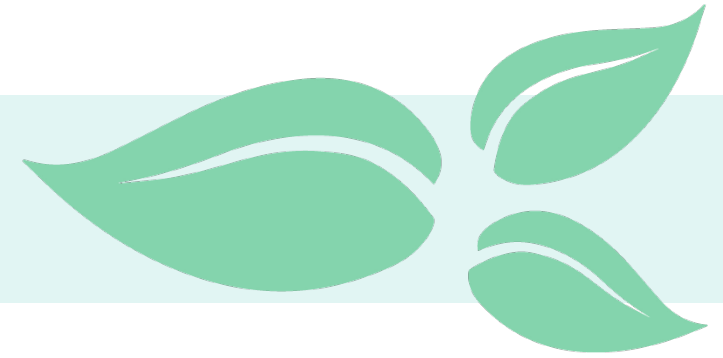
PRP Clinical Applications



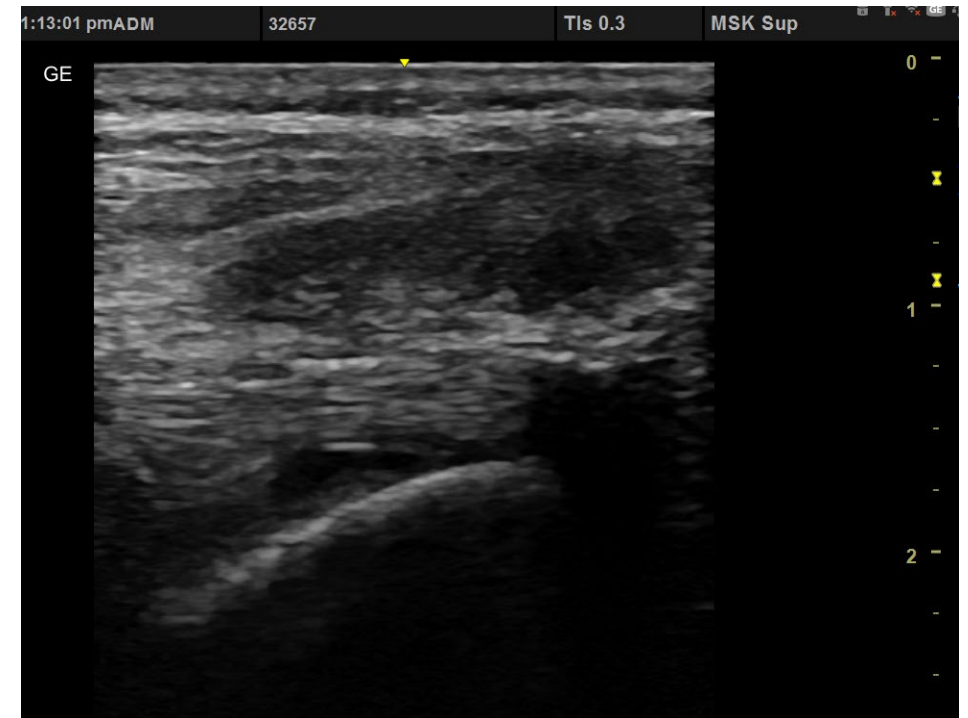
- Series of 1 to 3 injections every 2 weeks
- Usually performed under a light sedation
- IA injection or US guided
- Typically performed every 6-9 months
- Cost: \$700-\$1,000 per injection
- Recommend performed in conjunction with rehabilitation therapy



PRP Case Selection



- Osteoarthritis:
 - Mild: 1-2 injections every 2 weeks
 - Moderate: 1-2 injections every 2 weeks
 - Severe: 1-3 injections every 2 weeks
- Soft tissue injury
 - Grade 1-2/3 tendon injury
 - 1-3 injections every 2-4 weeks
 - MUST have US guidance

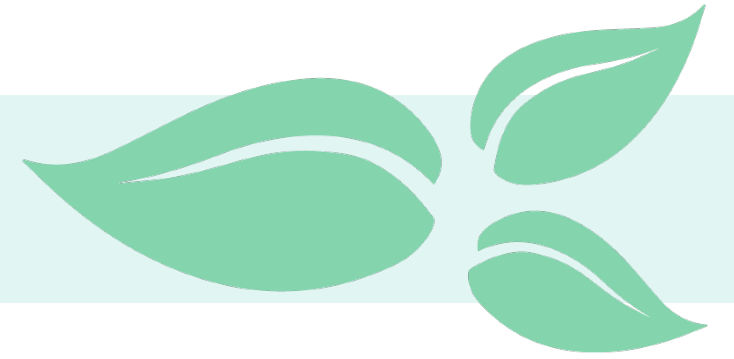


PRP Summary



- PRP has been used to help manage OA and ST injuries
- Easily done in clinical setting and incorporated into clinical practice
- Must be comfortable with administration techniques
 - Intra-articular injections
 - US Guided Injections





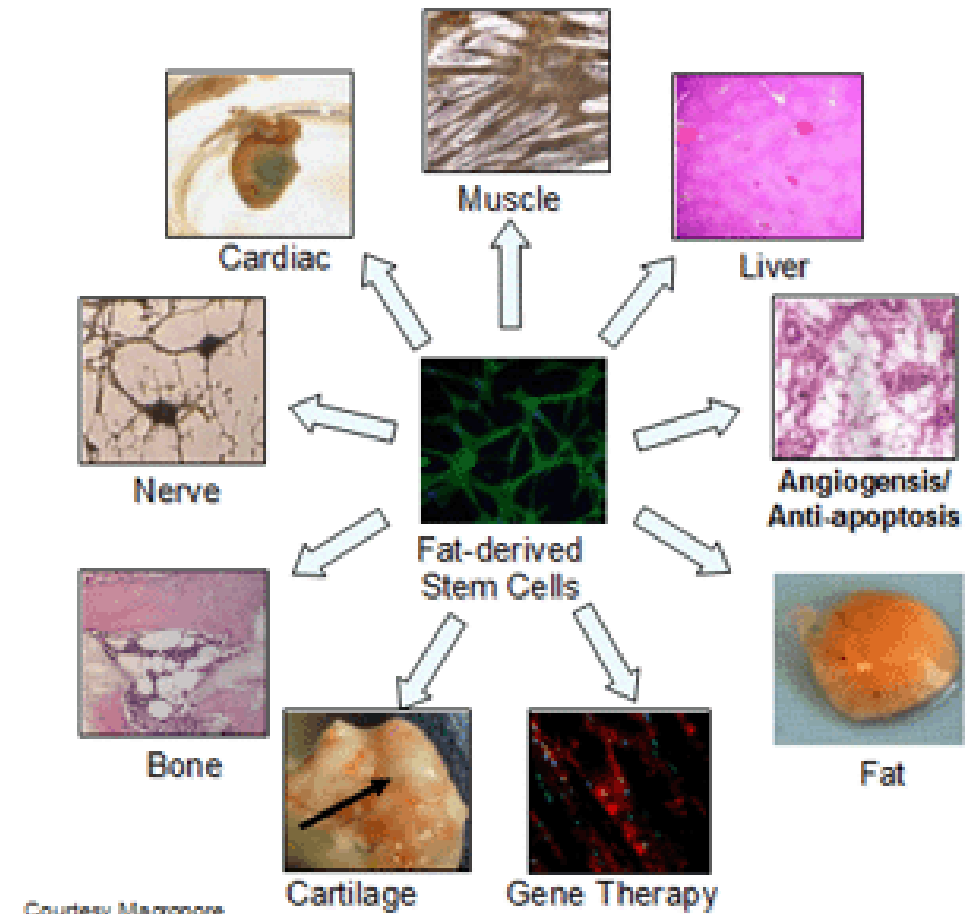
Stem Cell Therapy

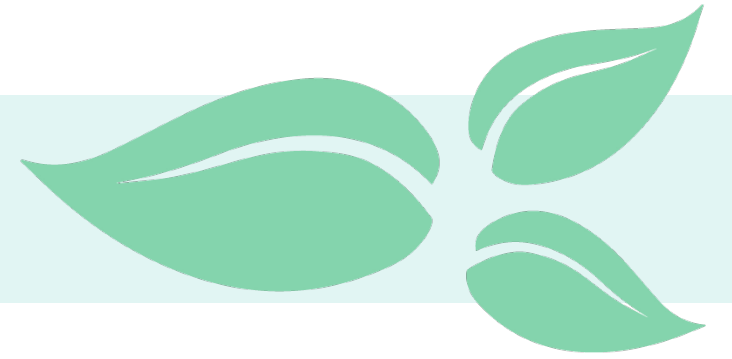
Stem Cell Therapy



Adipose tissue and Bone Marrow as a source of stem cells:

- Readily available
- Yields a high volume of cells
- Low morbidity
- Able to differentiate into all cell lines





Stem Cell Therapy

Where's the Evidence??

Kiefer K, Wucherer KL, Pluhar GE, Conzemius MG. Autologous and allogeneic stem cells as adjuvant therapy for osteoarthritis caused by spontaneous fragmented coronoid process in dogs. *VOS Symposium Proc*, 2013.

Black LL, Gaynor J, Adams C, et al. Effect of intraarticular injection of autologous adipose-derived mesenchymal stem and regenerative cells on clinical signs of chronic osteoarthritis of the elbow joint in dogs. *Vet Ther*. 2008;9(3):192-200.

Guercio A, Di Marco P, Casella S, et al. Production of canine mesenchymal stem cells from adipose tissue and their application in dogs with chronic osteoarthritis of the humeroradial joints. *Cell Biol Int*. 2012;36:189-194.

Cuervo B, Rubio M, Sopena J, et al. Hip osteoarthritis in dogs: a randomized study using mesenchymal stem cells from adipose tissue and plasma rich in growth factors. *Int J Mol Sci*. 2014;15:13437-13460.

Black LL, Gaynor J, Gahrng D, et al. Effect of adipose-derived mesenchymal stem and regenerative cells on lameness in dogs with chronic osteoarthritis of the coxofemoral joints: a randomized, double-blinded, multicenter, controlled trial. *Vet Ther*. 2007;8(4):272-284.

Vilar JM, Morales M, Santana A, et al. Controlled, blinded force platform analysis of the effect of intraarticular injection of autologous adipose-derived mesenchymal stem cells associated to PRGF-Endoret in osteoarthritic dogs. *BMC Vet Res* 2013; 9:131.

Vilar JM, Batista M, Morales M, et al. Assessment of the effect of intraarticular injection of autologous adipose derived mesenchymal stem cells in osteoarthritic dogs using a double-blinded force platform analysis. *BMC Vet Res* 2014; 10:143.

Yun S, Ku SK, Kwon YS. Adipose-derived mesenchymal stem cells and platelet-rich plasma synergistically ameliorate the surgical-induced osteoarthritis in Beagle dogs. *Journal of Orthopaedic Surgery and Research*. 2016;11:9. Doi 10.1186/s13018-016-0342-9

Tsai SY, Huang YC, Chueh LL, et al. Intra-articular transplantation of porcine adipose-derived stem cells for the treatment of canine osteoarthritis: a pilot study. *World J Transplant*. 2014;4(3):196-205.

Case JB, Palmer R, Valdes-Martinez A, et al. Gastrocnemius tendon strain in a dog treated with autologous mesenchymal stem cells and a custom orthosis. *Vet Surg* 2013; 42:355-260.

Canapp SO, Canapp DA, Ibrahim V, Carr BJ, Cox C, Barrett JG. The use of adipose derived progenitor cells and platelet rich plasma combination for the treatment of supraspinatus tendinopathy in 55 dogs: a retrospective study. *Vet Regen Med*. 2016.

Canapp SO, Cox KC, Leasure CS. The use of bone marrow aspirate concentrate and platelet rich plasma combination for the treatment of partial cranial cruciate ligament rupture. *Vet Regen Med*. 2016

Martinello T, Bronzini I, Maccatrozzo L, et al. Canine adipose-derived-mesenchymal stem cells do not lose stem features after a long-term cryopreservation. *Res Vet Sci* 2011; 91:18-24.

Carvalho AM, Badial PR, Alvarez LE, et al. Equine tendonitis therapy using mesenchymal stem cells and platelet concentrations: A randomized controlled trial. *Stem Cell Res Ther* 2013; 22(4):85.

Del Bue M, Ricco S, Ramoni R, et al. Equine adipose-tissue derived mesenchymal stem cells and platelet concentrations: Their association *in vitro* and *in vivo*. *Vet Res Commun* 2008; 32(1):S51-S55.

Chen L, Dong SW, Liu JP, et al. Synergy of tendon stem cells and platelet-rich-plasma in tendon healing. *J Orthop Res* 2012; 30(6):991-997.

Uysal CA, Tobita M, Hyakusoku H, Mizuno H. Adipose-derived stem cells enhance primary tendon repair: Biomechanical and immunohistochemical evaluation. *J Plast Reconstr Aesthet Surg* 2012; 65(12):1712-1719.

Manning CN, Schwartz AG, Liu W, et al. Controlled delivery of mesenchymal stem cells and growth factors using a nanofiber scaffold for tendon repair. *Acta Biomater* 2013; 9(6):6905-6914.

Yun JH, Han SH, Choi SH, et al. Effects of bone marrow-derived mesenchymal stem cells and platelet-rich plasma on bone regeneration for osseointegration of dental implants: Preliminary study in canine three-wall intrabony defects. *J Biomed Mater Res B Appl Biomater* 2014; 102(5):1021-1030.

Tobita M, Uysal CA, Guo X, et al. Periodontal tissue regeneration by combined implantation of adipose tissue-derived stem cells and platelet-rich plasma in a canine model. *Cryotherapy* 2013; 15(12):1517-1526.

Harting MT, Jimenez F, Xue, H, Fisher UM, Baumgartner J, Dash PK, Cox CS. Intravenous mesenchymal stem cell therapy for traumatic brain injury. *J Neurosurg* 2009;110(6):1189-1197.doi:10.3171/2008.9.JNS08158.

Arnold I, Caplan JED: Mesenchymal stem cells as trophic mediators. *J Cell Biochem*. 2006; 98:1076-1084.

Ahmad Z, Wardale J, Brooks R, et al: Exploring the application of stem cells in tendon repair and regeneration. *Arthroscopy*. 2012; 28:1018-1029.

Gao J, Caplan AI: Mesenchymal stem cells and tissue engineering for orthopaedic surgery. *Chir Organi Mov*. 2003; 88:305-316.

Guest DJ, Smith MR, Allen WR: Monitoring the fate of autologous and allogeneic mesenchymal progenitor cells injected into the superficial digital flexor tendon of horses: preliminary study. *Equine Vet J*. 2008; 40:178-181, 2008.

Izadpanah R, Trygg B, Patel B, et al: Biologic properties of mesenchymal stem cells derived from bone marrow and adipose tissue. *Journal of Cellular Biochemistry*. 2006; 99:1285-1297.

Zhang J, Wang JH: Platelet-rich plasma releasate promotes differentiation of tendon stem cells into active tenocytes. *Am J Sports Med*. 2010; 38:2477-2486.

Chen L, Dong SW, Liu JP, et al: Synergy of tendon stem cells and platelet-rich plasma in tendon healing. *J Orthop Res*. 2012; 30:991-997.

Richardson LE, Dudhia J, Clegg PD, et al: Stem cells in veterinary medicine--attempts at regenerating equine tendon after injury. *Trends Biotechnol*. 2011; 25:409-416.

Ginani F, Soares DM, Barreto MP, Barboza CA. Effect of low-level laser therapy on mesenchymal stem cell proliferation: A systemic review. *Lasers Med Sci* 2015; 30(8):2189-2194.

Canapp SO. Supraspinatus Tendinopathy in Dogs. Proceedings ACVS Symposium 2013, San Antonio, TX.

Isaac C, Gharaibeh B, Witt M, Wright VJ, Huard J. Biologic approaches to enhance rotator cuff healing after injury. *J Shoulder Elbow Surg*. 2012;21(2):181-90.

Lorbach O, Baums MH, Kostuj T, et al. Advances in biology and mechanics of rotator cuff repair. *Knee Surg Traumatol Arthrosc*. 2015;23:530-541.

Ahmad Z, Wardale J, Brooks R, et al: Exploring the application of stem cells in tendon repair and regeneration. *Arthroscopy*. 2012; 28:1018-1029.

Ho LK, Baltzer WJ, Nemanic S, Stieger-Vanegas SM. Single ultrasound-guided platelet-rich plasma injection for treatment of supraspinatus tendinopathy in dogs. *Can Vet J*. 2015;56:845-849.

Al-ani MK, Xu K, Sun Y, et al. Study of bone marrow mesenchymal and tendon-derived stem cells transplantation on the regenerating effect of Achilles tendon ruptures in rats. *Stem Cell International*. 2015;1-11.

Yuksel S, Gulec MA, Gultekin MZ. Comparison of the early-period effects of bone marrow-derived mesenchymal stem cells and platelet rich plasma on Achilles tendon ruptures in rats. *Connect Tissue Res*. 2016;PMID:27191749.

Vieira MH, Oliveira RJ, Eca LP, et al. Therapeutic potential of mesenchymal stem cells to treat Achilles tendon injuries. *Genet Mol Res*. 2014;13(4):10434-10449.

Case JB, Palmer R, Valdes-Martinez A, et al. Gastrocnemius tendon strain in a dog treated with autologous mesenchymal stem cells and a custom orthosis. *Vet Surg*. 2013;42:355-360.

Stein BE, Stroh DA, Schon LC. Outcomes of acute Achilles tendon rupture repair with bone marrow aspirate concentrate augmentation. *Int Orthop*. 2015;39(5):901-905.

Chen J, Altman GH, Karageorgiou V, Horan R, Collette A, Volloch V, Colabro T, Kaplan DL. Human bone marrow stromal cell and ligament fibroblast responses on RGD-modified silk fibers. *J Biomed Mater Res A* (2003) 67:559-570. doi: 10.1002/jbm.a.10120

Agung M, Ochi M, Yanada S, Adachi N, Izuta Y, Yamasaki T, Toda K. Mobilization of bone marrow-derived mesenchymal stem cells into the injured tissues after intraarticular injection and their contribution to tissue regeneration. *Knee Surg Sports Traumatol Arthrosc* (2006) 14:1307-14. doi: 10.1007/s00167-006-0124-8

Linon E, Spreng D, Rytz U, Forterre S. Engraftment of autologous bone marrow cells into the injured cranial cruciate ligament in dogs. *Vet J* (2014) 202:448-54. doi: 10.1016/j.tvjl.2014

Kanaya A, Deie M, Adachi N, Nishimori M, Yanada S, Ochi M. Intra-articular injection of mesenchymal stem cells in partially torn anterior cruciate ligaments in a rat model. *Arthroscopy* (2007) 23:610-7.

Oe K, Kushida T, Okamoto N, Umeda M, Nakamura T, Ikehara S, Iida H. New strategies for anterior cruciate ligament partial rupture using bone marrow transplantation in rats. *Stem Cells Dev* (2011) 20:671-9. doi: 10.1089/scd.2010.0182

Centeno CJ, Pitts J, Al-Sayegh H, Freeman MD. Anterior cruciate ligament tears treated with percutaneous injection of autologous bone marrow nucleated cells: a case series. *J Pain Res* (2015) 8:437-47. doi: 10.2147/JPR.S86244

Centeno CJ, Schultz JR, Cheever M, Freeman M, Faulkner M, Robinson S, Hanson R. Safety and complications reporting update on the re-implantation of culture-expanded mesenchymal stem cells using autologous platelet lysate technique. *Curr Stem Cell Res Ther* (2011) 6:368-78. doi: 10.2174/157488810790442796

Chen L, Dong SW, Liu JP, Tao X, Tang KL, Xu JZ. Synergy of tendon stem cells and platelet-rich plasma in tendon healing. *J Orthop Res* (2012) 30:991-7. doi: 10.1002/jor.22033

Molloy T, Wang Y, Murrell G. The roles of growth factors in tendon and ligament healing. *Sports Med* (2003) 33:381-94. doi: 10.2165/00007256-200333050-00004

Zhang J, Wang JH. Platelet-rich plasma releasate promotes differentiation of tendon stem cells into active tenocytes. *Am J Sports Med* (2010) 38:2477-86. doi: 10.1177/0363546510376750

Smith JJ, Ross MW, Smith RKW. Anabolic effects of acellular bone marrow, platelet rich plasma, and serum on equine suspensory ligament fibroblasts in vitro. *Vet Comp Orthop Traumatol* (2006) 19:43-7.

Richardson LE, Dudhia J, Clegg PD, Smith R. Stem cells in veterinary medicine--attempts at regenerating equine tendon after injury. *Trends Biotechnol* (2011) 25:409-16. doi: 10.1016/j.tibtech.2007.07.009

Nishimori N, Matsumoto T, Ota S, et al. Role of angiogenesis after muscle derived stem cell transplantation in injured medial collateral ligament. *J of Orthop Res*. 2012;30:627-633.

Saether EE, Chamberlain CS, Leiferman EM, et al. Enhanced medial collateral ligament healing using mesenchymal stem cells: dosage effects on cellular response and cytokine profile. *Stem Cell Rev*. 2014;10(1):86-96.

Saether EE, Chamberlain CS, Aktas E, et al. Primed mesenchymal stem cells alter and improve rat medial collateral ligament healing. *Stem Cell Rev and Rep*. 2016;12:42-53.

Stem Cell Therapy: Elbow OA



- Kiefer et al. reported that dogs with elbow osteoarthritis caused by spontaneous fragmented coronoid process that underwent arthroscopic fragment removal and a proximal ulnar ostectomy and received **stromal vascular fraction or allogeneic stem cells** had a more favorable outcome than those treated with surgery alone.
- Black et al. and Guercio et al. found **significant improvement in subjective lameness, pain on manipulation, and owner-assessed outcomes** in dogs with chronic osteoarthritis that were treated with adipose derived mesenchymal stem cells 1 month following treatment.
- Kriston-Pal et al. showed **significant improvement in lameness scores, arthroscopic analysis, and histopathological analysis** in dogs with elbow OA treated with adipose derived MSCs.
- Kim et al reported **significantly improved owner outcome scores** in dogs with elbow OA treated with umbilical MSCs. **No significant improvement in PVF** noted.



Kiefer K, et al. *VOS Symposium Proc*, 2013.
Black LL, et al. *Vet Ther*. 2008.
Guercio A, et al. *Cell Biol Int*. 2012.
Kriston-Pal et al. *Can Vet J*. 2017
Kim et al. *Front Vet Med*. 2019.

Stem Cell Therapy: Hip OA



- Upchurch et al found that dogs with hip osteoarthritis treated with SVF and PRP combination therapy had improved subjective lameness scores and owner-assessed outcomes.
- Cuervo et al reported that dogs with hip osteoarthritis that received a single intra-articular injection of adipose-derived cultured stem cells had significantly better pain and function scores than control patients and those that received plasma rich in growth factors (PRGF).
- Black et al conducted a randomized, double-blinded, multicenter, controlled trial and found that dogs with chronic hip osteoarthritis treated with adipose-derived stem cell therapy had significantly improved lameness scores and compiled scores for lameness, pain, and range of motion compared with control dogs.
- Vilar et al reported that dogs with hip osteoarthritis who were treated with a single intra-articular injection of adipose-derived cultured stem cells had significantly reduced lameness quantified by force plate at day 180 following treatment.
- Maki et al reported that intra-articular administration of allogeneic adipose derived MSCs was well-tolerated and improved lameness scores and reduced pain for up to 90 days.



Upchurch et al. *AJVR*. 2016
Cuervo B, et al. *Int J Mol Sci*. 2014.
Black LL, et al. *Vet Ther*. 2007.
Vilar JM, et al. *BMC Vet Res* 2013.
Vilar JM, et al. *BMC Vet Res* 2014.
Maki CB, et al. *Front Vet Med*. 2020.

Stem Cell Therapy: Stifle OA

- Yun et al showed that dogs with ACL transections who were treated with ADPC and PRP therapy had significantly more ECM synthesis and chondrocyte proliferation histologically.
- Tsai et al showed that dogs with chronic stifle osteoarthritis who were treated with porcine adipose-derived stem cells had reduced lameness quantified by force plate at 12 weeks following treatment.
- Zhang et al used MRI and US to show significantly higher improvement in cartilage neogenesis and tissue recovery in dogs treated with umbilical MSC compared to the control group. Systemic and joint fluid inflammatory response markers in the treated group also decreased.

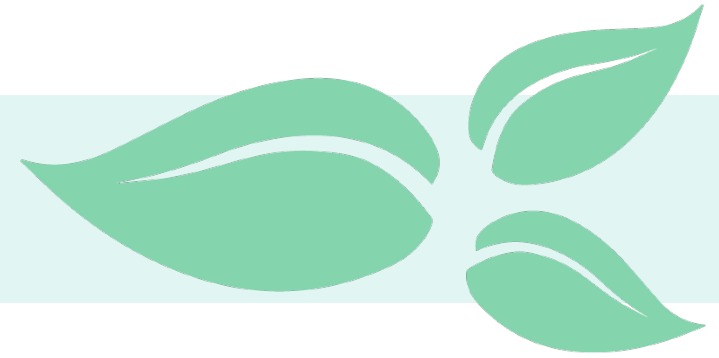


Yun S, et al. *Journal of Orthopaedic Surgery and Research*. 2016.

Tsai SY, et al. *World J Transplant*. 2014.

Zhang B, et al. *Stem Cell Int*. 2018.

Stem Cell Therapy: OA



[Front Vet Sci.](#) 2016; 3: 81.

Published online 2016 Sep 16. doi: [10.3389/fvets.2016.00081](https://doi.org/10.3389/fvets.2016.00081)

PMCID: PMC5025432

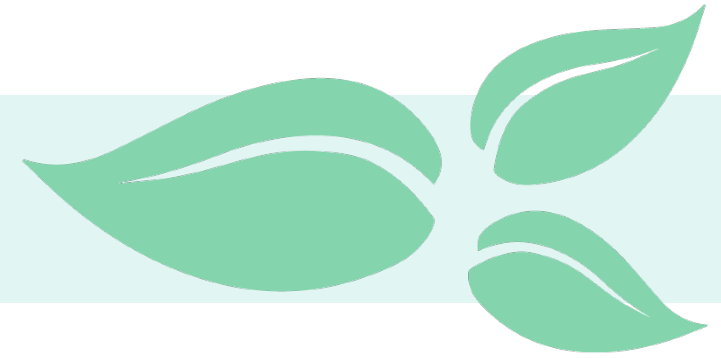
PMID: [27695698](https://pubmed.ncbi.nlm.nih.gov/27695698/)

A Prospective, Randomized, Masked, and Placebo-Controlled Efficacy Study of Intraarticular Allogeneic Adipose Stem Cells for the Treatment of Osteoarthritis in Dogs

[Robert Harman](#),^{1,*} [Kim Carlson](#),² [Jamie Gaynor](#),³ [Scott Gustafson](#),⁴ [Sarit Dhupa](#),⁵ [Keith Clement](#),⁶ [Michael Hoelzler](#),⁷
[Tim McCarthy](#),⁸ [Pamela Schwartz](#),⁹ and [Cheryl Adams](#)¹⁰

- Dogs with hip, elbow, stifle, or shoulder OA included in study
- Significant improvement in owner assessment, pain, and lameness scales.

Stem Cell Therapy: OA



[Front Vet Sci.](#) 2019; 6: 10.

Published online 2019 Feb 5. doi: [10.3389/fvets.2019.00010](https://doi.org/10.3389/fvets.2019.00010)

PMCID: PMC6371748

PMID: [30805348](https://pubmed.ncbi.nlm.nih.gov/30805348/)

Long-Term Safety and Efficacy of Single or Repeated Intra-Articular Injection of Allogeneic Neonatal Mesenchymal Stromal Cells for Managing Pain and Lameness in Moderate to Severe Canine Osteoarthritis Without Anti-inflammatory Pharmacological Support: Pilot Clinical Study

[Quentin Cabon](#),¹ [Marine Febre](#),² [Niels Gomez](#),¹ [Thibaut Cachon](#),^{1,3} [Paul Pillard](#),¹ [Claude Carozzo](#),^{1,3}

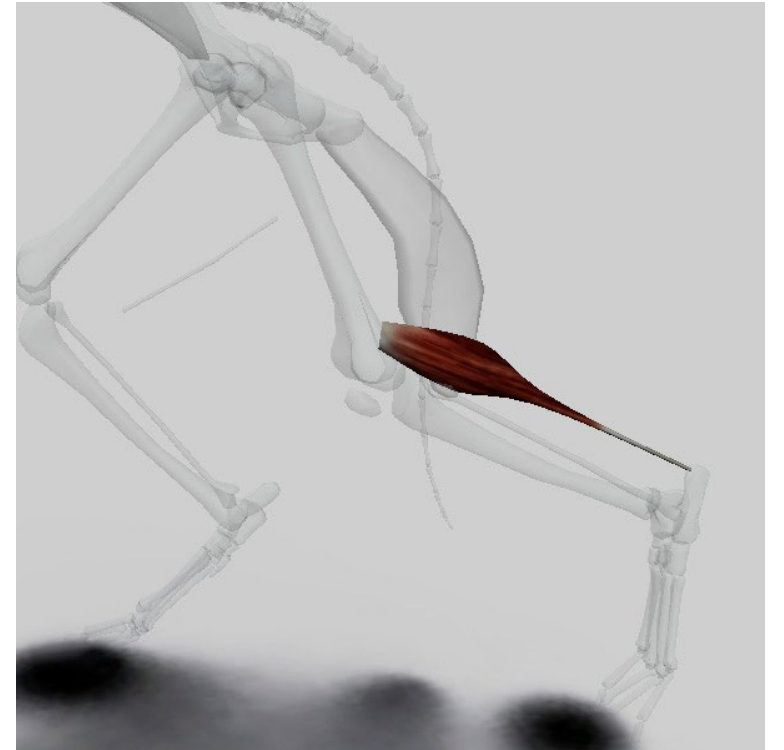
[Nathalie Saulnier](#),² [Clément Robert](#),² [Véronique Livet](#),¹ [Rodolphe Rakic](#),² [Nadia Plantier](#),² [Philippe Saas](#),⁴

[Stéphane Maddens](#),^{2,†} and [Eric Viguier](#)^{1,3,*†}

- Single or repeated intra-articular administration of neonatal MSC in dogs with moderate to severe OA is a safe procedure and effective over a 24-month period.

Stem Cell Therapy: Tendon Injury

- Case et al reported favorable results for one dog with a **gastrocnemius strain** treated with bone marrow derived mesenchymal stem cell therapy and a custom, progressive, dynamic orthosis.

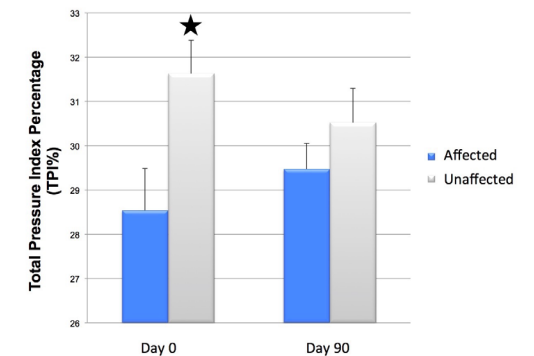


Case JB, et al. Vet Surg 2013.

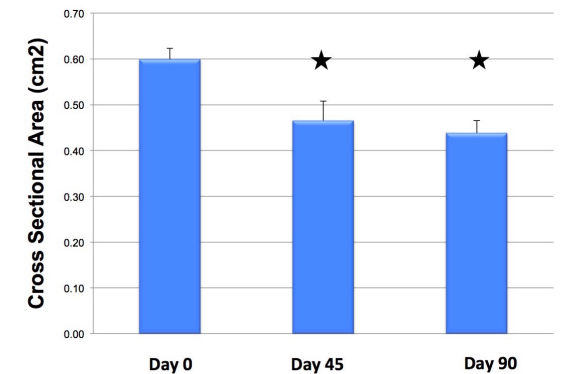
Stem Cell Therapy: Tendon Injury

- Canapp et al reviewed the cases of 55 dogs with supraspinatus tendinopathy that were treated with adipose-derived progenitor cells and platelet rich plasma.
- At 90 days following ultrasound-guided injection of ADPC-PRP, a significant increase in total pressure index percentage (TPI%) was noted in the injured (treated) forelimb and shoulder diagnostic musculoskeletal ultrasound revealed a significant reduction in tendon size (CSA) and significant improvement in fiber pattern of the affected supraspinatus tendon.

Total Pressure Index Percentage (TPI%) at Day 0 and Day 90 in the Affected and Unaffected Limb



Affected Supraspinatus Tendon Cross Sectional Area (CSA)



Stem Cell Therapy: CCL Injury



- Linon et al investigated engraftment of BMCs following IA injection in dogs with spontaneous CCL injury. This study found that BMCs engraft to the injured CCL as early as 3 days following IA injection.

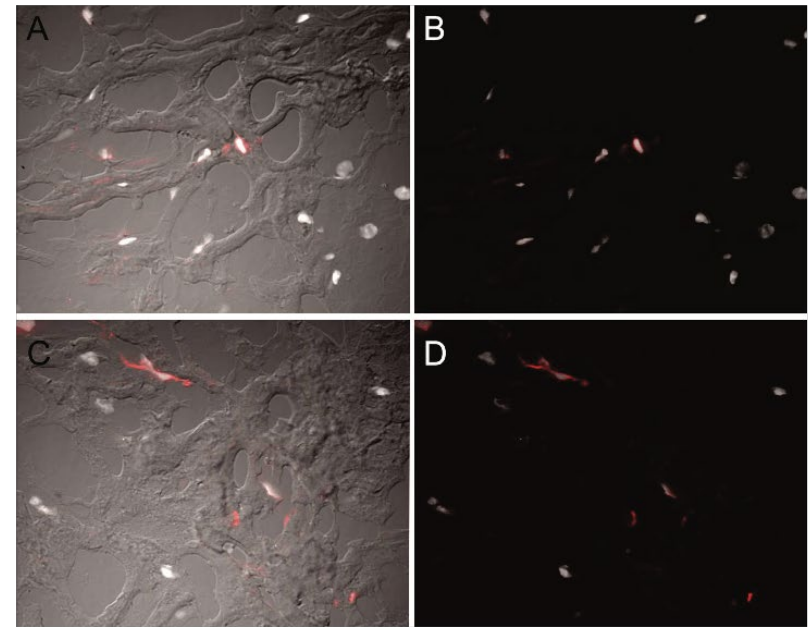


Fig. 3. Fluorescence photomicrographs showing PKH26 positive (red) and TOTO-3 positive (grey) cells (B, D); merged with tissue (A, C). In vivo specimens of torn CCLs from two dogs at day 13 after transplantation of PKH26-labelled autologous BMCs. Labelled cells were detected within the CCLs. Magnification: $\times 100$.

Linon E, et al. *The Veterinary Journal*, 2014.
<http://dx.doi.org/10.1016/j.tvjl.2014.08.031>

Stem Cell Therapy: CCL Injury

- Muir et al found autologous bone marrow derived mesenchymal cells have an **anti-inflammatory effect** over an 8-week period after IV and IA injection in dogs with a partial CCL tear

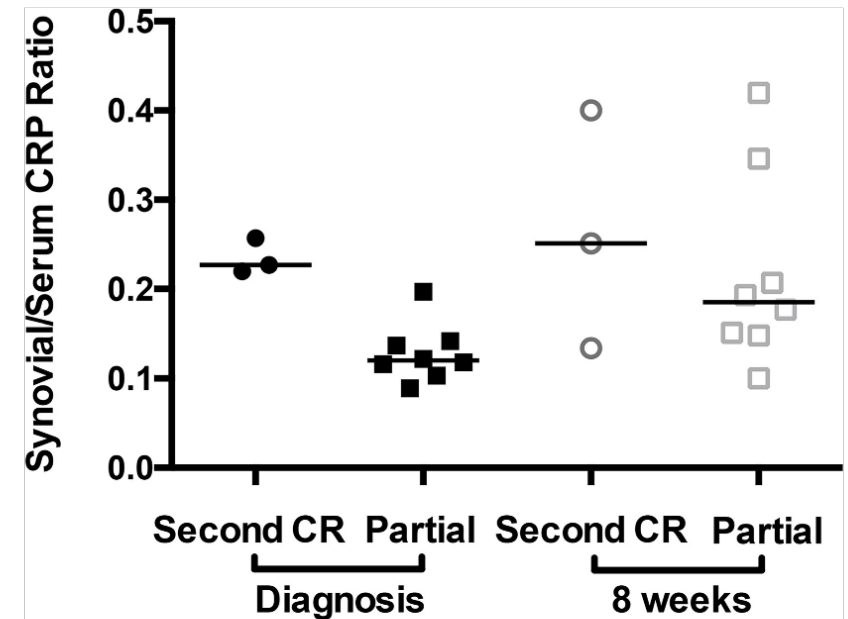


Fig 5. Synovial fluid/serum C-reactive protein (CRP) ratio in stifle joints of dogs with stable partial cruciate ligament rupture (CR) before and after treatment with bone marrow-derived mesenchymal stem cell treatment. At diagnosis, synovial fluid/serum CRP ratio was elevated in the partial CR stifles of dogs that developed a second CR (n = 3) within the study period, when compared with the dogs that did not develop a second CR (n = 8). Synovial CRP was not measured in one dog because of insufficient sample volume. Synovial fluid/serum CRP ratio values were higher at 8 weeks in the dogs that did not experience CR within the study period.

doi:10.1371/journal.pone.0159095.g005

Muir P, et al. *PLoS ONE*. 2016.
<http://doi.org/10.1371/journal.pone.0159095>

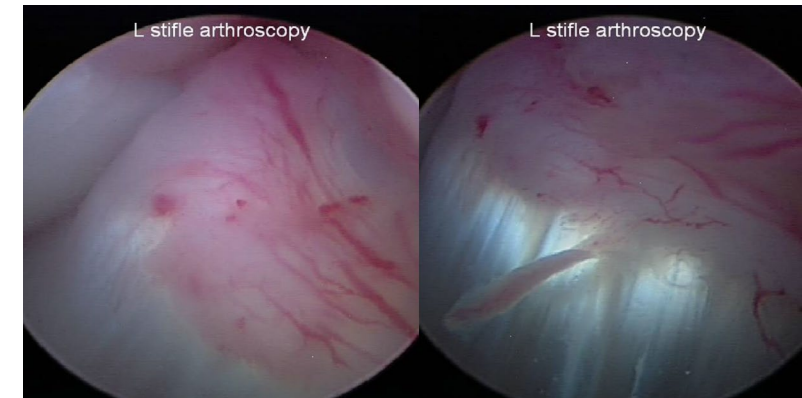
Stem Cell Therapy: CCL Injury



- Canapp et al performed a retrospective study to evaluate the use of autologous bone marrow aspirate concentrate (BMAC) or adipose derived progenitor cells (ADPC) with PRP combination for the treatment of early partial CCL tears in dogs.
- Patients:
 - Medical records of client-owned dogs were reviewed for cases diagnosed arthroscopically with an early partial ($\leq 50\%$) tear of the craniomedial band of the CCL that were treated with BMSC-PRP or ADPC-PRP
 - Patients with concomitant stifle joint problems, or orthopedic or neurologic conditions affecting the hind limbs, were excluded from analysis.

90 Day Stifle Arthroscopy (Available on 13 of the 35 dogs)

- Second look stifle arthroscopy revealed a fully regenerated CCL in 69% of dogs, significant improvement in 8%, while 23% failed.
- 9/13 dogs:
 - Fully intact CCL with normal fiber pattern
 - Marked neovascularization
 - Blood supply to the region of CCL injury: Genicular artery.



Day 0

Day 90

Canapp SO, et al. ACVS. 2016.

Stem Cell Therapy



Most commonly used:

- Bone Marrow Aspirate Concentrate (BMAC)
- Culture Expanded Bone Marrow Stem Cells (BMSC)
- Stromal Vascular Fraction (SVF)
- Culture Expanded Adipose Derived Progenitor Cells (ADPC)



Stem Cell Therapy: Which to choose??



- No study showing superiority of one vs another
- No study showing how many cells are needed for various injuries
- In house option:
 - Bone Marrow Aspirate Concentrate (BMAC)
 - +/- Stromal Vascular Fraction (SVF)
- Send out to lab:
 - Culture Expanded Bone Marrow Stem Cells (BMSC)
 - Culture Expanded Adipose Derived Progenitor Cells (ADPC)

Stem Cell-PRP Combination Therapy



Multiple studies have demonstrated synergy between Stem Cells and PRP:

Cells for Regeneration

- Tendon Matrix
- Inhibit scarring
- Improve healing

Growth factors

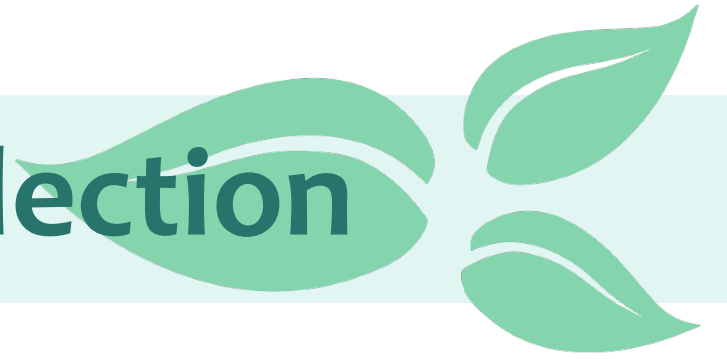
- Cell proliferation
- Trophic factors

Scaffold to provide template for cell attachment



Carvalho et al. *Stem Cell Res Ther.* 2013
Cuervo et al. *Int. J. Mol. Sci.* 2014
Ricco et al. *Int J Immunopathol Pharmacol.* 2013
Martinello et al. *J Orthop Res.* 2013
Chen et al. *J Orthop Res.* 2012
Uysal et al. *J Plast Reconstr Aesthet Surg.* 2012
Manning et al. *Acta Biomater.* 2013
Zhang et al. *Am J Sports Med.* 2010
Pandi et al. *BMC Vet Res.* 2019.

Stem Cell Therapy: Case Selection



- Osteoarthritis:
 - Moderate to severe osteoarthritis
- Soft tissue injury:
 - Grade 2/3 injury
 - Iliopsoas tendinopathy
 - Supraspinatus tendinopathy
 - Biceps tendinopathy
 - Many more...
 - Supplement surgical treatment for grade 3 injury



Stem Cell Therapy in Clinical Practice

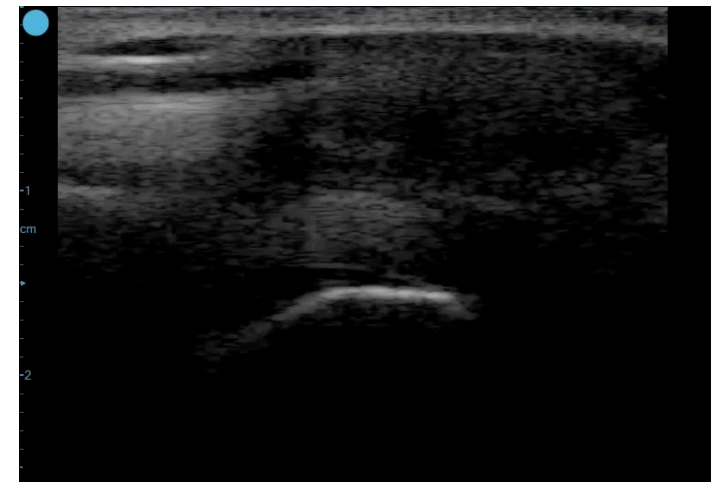
- Stem Cell/PRP Combination Therapy
- Typically a single injection
- Usually performed under anesthesia
- IA injection or US Guided soft tissue injection
- Typically performed every 12 months
- Cost: \$3,000-\$4,000 per injection*



*Cost may change if MSC are banked

Stem Cell Therapy in Clinical Practice

- Recommend performed in conjunction with rehabilitation therapy
- Confirm healing with US or second look arthroscopy
- Some clients are opting to collect adipose from the falciform ligament at the time of neuter for culturing and banking ADPC for future use



Post Regenerative Medicine Recommendations

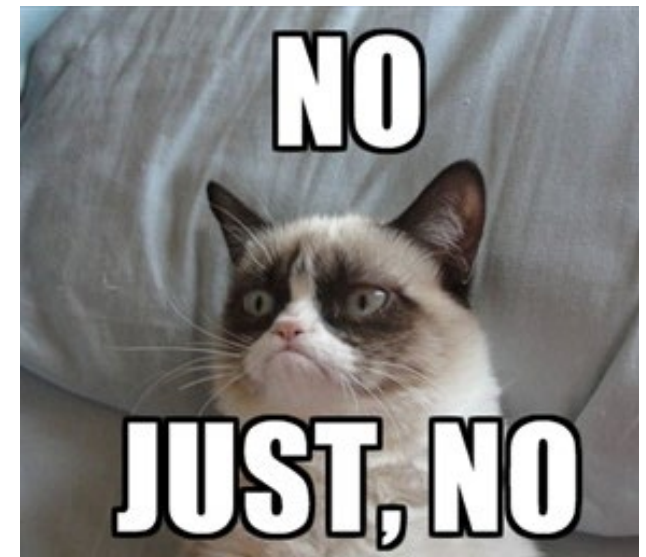


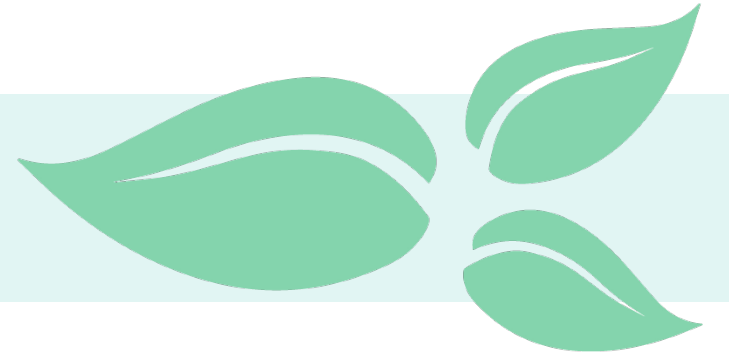
Things to do for the first 8 wks:

- Manual/massage therapy
- Class IIIb low level laser therapy
 - Ok for use on treated area
- Home exercise program

Things to stay away from for 8 wks:

- NSAIDs and steroids
- Cryotherapy
- Class IV low level laser therapy
 - If used, do not apply to treated area
- Therapeutic Ultrasound
- TENS/NMES
- Hydrotherapy

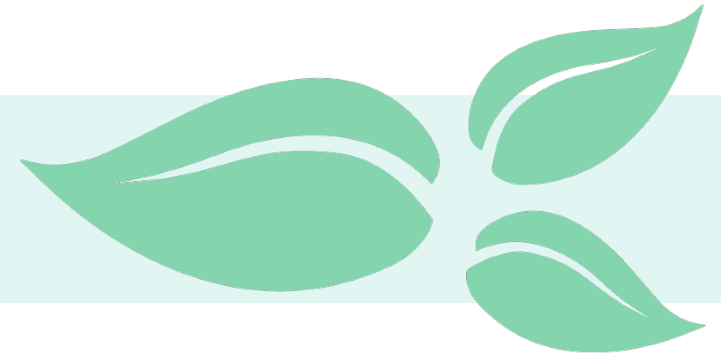




Case Study



Case Study



12 year old, female spayed Old English Sheepdog

- Presenting complaint: Difficulty getting up, lameness on walks
- Participating in weekly rehabilitation therapy and daily home exercise program
- Medications/Supplements:
 - Will not tolerate oral pain medications
 - Chinese herbs
 - Adequan twice monthly
- History of moderate bilateral hip osteoarthritis



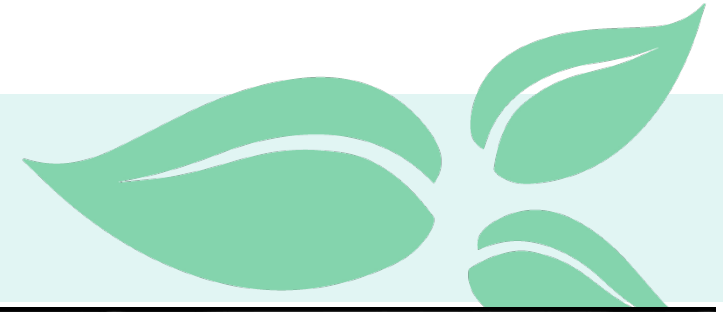
Case Study

Physical Exam Findings:

- Grade 2-3/5 bilateral hind limb lameness (worse on left)
- Decreased range of motion in both hips
 - Left Hip extension: 125 deg
 - Right Hip extension: 135 deg
- Muscle atrophy of both hind limbs:
 - Left HL: 47cm
 - Right HL: 49cm
- Bilateral iliopsoas tension upon palpation on stretch



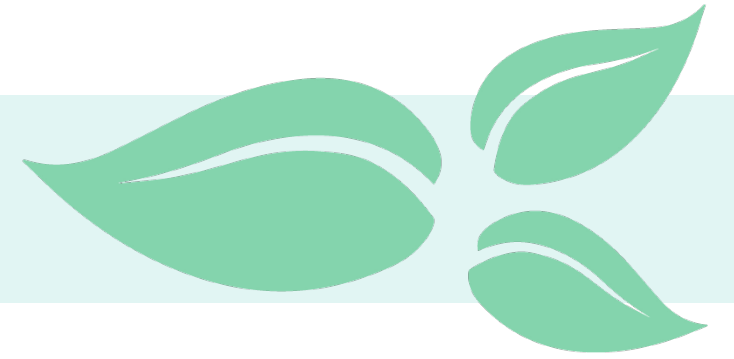
Case Study



- Initial Radiographs: Evidence of moderate bilateral hip dysplasia and osteoarthritis
- Owner elected to proceed with bilateral hip PRP IA injections and continue with once weekly rehabilitation therapy and daily home exercise program



Case Study



2 weeks post PRP

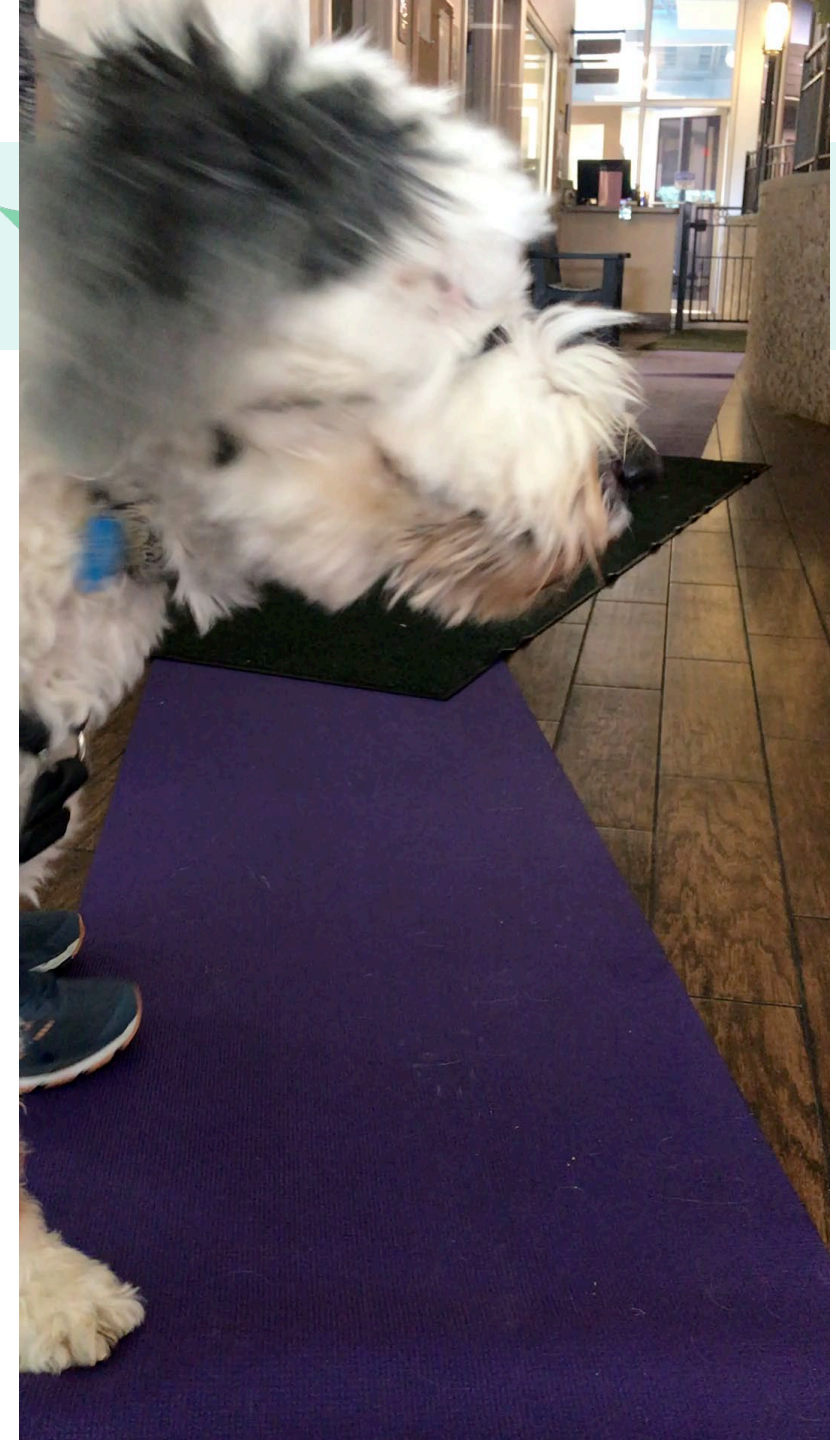
- Able to rise and move around home much easier
- Improved hip extension in left hip (130 deg)
- Improved lameness (grade 2/5 bilateral HL lameness)



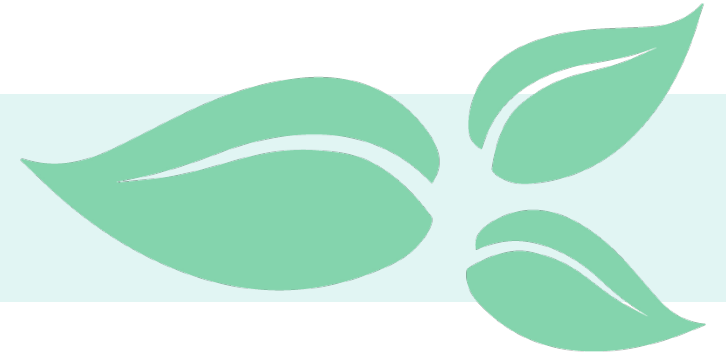
Case Study

4 weeks post PRP

- Continued improvement in moving around her home
- Improved hip extension bilaterally (140 deg)
- Improved lameness (grade 2/5 bilateral HL lameness)



Case Study



Recommendations:

- Continue weekly rehabilitation therapy and daily home exercise program
- Continue all supplements
- Recommended a recheck at 8 and 12 weeks

Follow Up:

- Patient followed up at 9 months post PRP and wanted to repeat PRP therapy



Regenerative Medicine Summary



- Appropriate patient and client selection
- Choose the appropriate product and dosing
- Guide directly to the source of tissue injury
- Part of a multimodal approach
- Follow up with objective measures

Questions?

dr.brittcarrbenson@gmail.com

