IJBPAS, July, 2022, 11(7): 3171-3182

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

LOCAL INJECTION OF PLATELET RICH PLASMA AND CORTICOSTEROIDS IN THE TREATMENT OF LATERAL EPICONDYLITIS OF HUMERUS: A RANDOMISED CONTROL TRIAL

SINGH A[1], SATAPATHY D[2], SWAIN K[1*], MOHAN S[3], REDDY S[3], ZION N[3] AND CHEKURI J[3]

1: Senior Resident, Department of Orthopaedics, IMS and SUM Hospital, Bhubaneswar, Odisha

2: Assistant Professor, Department of Orthopaedics, IMS and SUM Hospital, Bhubaneswar, Odisha

3: Post Graduate Trainee, Department of Orthopaedics, IMS and SUM Hospital, Bhubaneswar, Odisha

***Corresponding Author: Dr. Kashinath Swain: E Mail: kasinathswain87@gmail.com**

Received 16th June 2020; Revised 24th July 2020; Accepted 22nd Nov. 2021; Available online 1st July 2022

https://doi.org/10.31032/IJBPAS/2022/11.7.6219

ABSTRACT

Back ground- Lateral epicondylitis is a commonly encountered entity caused by repetitive movements involving extensor tendons. Microscopic examination appears similar to angio-fibroblastic hyperplasia. Corticosteroid injection has a short duration of action, yet local it is the gold standard for the management of lateral epicondylitis. It was hypothesised that PRP injection locally in long-standing tendinopathies can bring about increase in growth factor expression, cell proliferation, angiogenesis, increase the recruitment of cells that repair and increases tensile strength of tendons.

Material and Method- Patients were included in the study after 2 months of conservative trail on anti-inflammatory, analgesics and a tennis elbow brace. Patients were randomized into two groups. Group I was given 2ml of freshly prepared platelet rich plasma with 2% of 1ml xylocaine and group II received 40mg methylprednisolone with 1ml 2% xylocaine. 101 and 112 patients respectively from group I and II were considered.

Results- The mean VAS scores of patients in Group I and II before the procedure were 8.02 and 8.10 respectively, while at 2 weeks- 3.84 and 1.92 respectively and at 1 year- 2.58 and 5.60 respectively. The mean DASH scores of patientsig Group I and II before the procedure were 71.3 and 73.0 respectively, while at 2 weeks- 65.2 and 29.2 respectively and at 1 year- 33.1 and 68.6 respectively. There were similar trends seen with Mayo elbow performance scores and Grip strength.

Conclusion- Although corticosteroid injections show better short term results but in the long term follow up their effect weans off while PRP continues to show its effect and gives long lasting relief to the patients.

Keywords: Corticosteroids, Platelet Rich Plasma, Epicondylitis, Humerus

INTRODUCTION

Lateral epicondylitis is a commonly encountered entity in orthopaedics outpatient department with an incidence of 4-7 per 1000. It is mostly seen in the age group of 35-50 years **[1-3]**. It is commonly caused by repetitive movements involving extensor tendons like overexertion of wrist and finger extensors. It caused decline in quality of life and imparts disability while performing day to day activities. It's hypothesised that the overloading and over exertion in the common extensor tendon leads to tears in it. These tears in turn elicit an abnormal microvascular response.

Usually these patients present to the clinic with the history of pain over the dorsal muscles of forearm aggravated on gripping or resistive action at the wrist and pain over olecranon while carrying weight. The degree of pain varies from infrequent throbbing pain to severe agony. However if extensor movements at wrist are passive then it's devoid of pain **[2]**. Typically clinical examination of lateral epicondyle shows direct and indirect tenderness. Also there can be tenderness over ventral aspect of humeral epicondyles **[4]**. Microscopic examination often displayed immature tissues which appears similar to angio-fibroblastic hyperplasia **[5]**. Yet there's no substantial knowledge about patho-physiology of lateral epicondylitis **[6]**. However histopathological examination from long standing cases of lateral epicondylitis showed features suggestive of malfunction of physiological tendon repair mechanism associated with angio-fibroblastic degeneration and not of an acute inflammatory origin **[7]**.

So the pathogenesis of elbow tendinosis is an amalgamation of mechanical overloading, and deranged microvascular responses **[8-9]**. Hence lateral epicondylitis belongs not under the acute inflammatory condition category, but under degenerative condition category **[3,**

10]. In a clinical setting diagnosing a lateral epicondylitis is an elementary task. But on the other hand when it comes to deciding the most favourable treatment strategy, there's still no concordance **[11]**. Age old and well accepted management strategy for lateral epicondylitis is steroid injection locally. However it provides only short term pain relief **[123]**. Novel management options include local injection of Platelet Rich Plasma (PRP), autologous blood, prolotherapy and extracorporeal shockwave therapy **[13-15]**.

Literature mentions several strategies for the treatment of epicondylitis including nonsteroidal anti-inflammatory drugs, physiotherapy, local anaesthetics, autologous blood constituents **[16-18]**. Other modalities suggested for managing elbow tendinosis are rest, bracing, physical therapy, iontophoresis, extracorporeal shock wave therapy, and botulism toxin **[6]**. Injections of corticosteroids or whole blood, and various types of surgical procedures have also been recommended **[17]**. With the myriad of options at hand we've now started to cross examine several novel strategies of management. For instance one of the studies reported that outcomes of corticosteroid injection and local anaesthetic injection were similar **[19]**.

Corticosteroid injection has a short duration of action (2-6 weeks). Yet local corticosteroid injection is the gold stands for the management of lateral epicondylitis **[18]**. Various reports show promising results for Autologous PRP injected into tissues to amplify healing in wounds, bones and tendons **[20]**. The most valuable factor for this promising results is the high concentration local of platelet derived growth factors can enhance tissue healing.

Platelet rich plasma is basically just Platelet concentrate obtained by centrifuging patient own blood. It was hypothesised that PRP injection locally in long-standing tendinopathies can bring about increase in growth factor expression, cell proliferation, angiogenesis, increase the recruitment of cells that repair and increases tensile strength of tendons. With keeping the pathogenesis of lateral epicondylitis in mind, PRP with high content of a concoction of growth factors could be an efficacious strategy. However studies on PRP injection for lateral epicondylitis has provided inconclusive results **[21-23]**.

Hence, this study was conducted with an aim to explore the efficacy of PRP in patients of tennis elbow. The main goal of our study was to compare the outcomes of local infiltration of platelet rich plasma versus corticosteroids in terms of pain relief, grip strength and functional improvement. We believe that supplementing the natural healing process

with PRP would yield good results in the treatment of epicondylitis as compared to local corticosteroids in the long run. In this study, we compared the short-term and long-term results of corticosteroid injection and autologous PRP injection in patients of elbow epicondylitis randomly selected for treatment modality.

MATERIALS AND METHODS

The study was performed on two hundred sixty adult population of both the genders who have attended the orthopaedic outpatient department from January 2019 to October 2020 after signing a written consent from all the participants in the study. The ethical committee clearance was obtained before commencement of the study. Patient aged more than 18 years were considered for the study who complained of lateral epicondylar pain which was increased and elicited on extension of the wrist against resistance. Patients were included in the study after 2 months of conservative trail on anti-inflammatory, analgesics and a tennis elbow brace. Exclusion criteria included patients of acute elbow trauma, previous elbow surgeries, elbow arthritis, nerve entrapment syndromes, patient receiving thromboprophylaxis and bleeding diathesis. all pain and anti-inflammatory medications were stopped 1 week prior to local injection. Complete physical and local examination were done followed by Investigations including complete hemogram, random blood sugar, elbow Xray was done for all patients. Patients were randomized into two groups of one hundred and thirty each (group I: receiving platelet rich plasma, group II: receiving corticosteroid). Group I was given 2ml of freshly prepared platelet rich plasma with 2% of 1ml xylocaine and group II received 40mg methylprednisolone with 1ml 2% xylocaine. Twenty nine patients from group I and eighteen patients from group II were lost to follow-up and 101 and 112 patients respectively from group I and II were considered.

Platelet rich plasma preparation: Patient was kept in a beach chair position and 25ml of blood was collected from the opposite arm from the medial cubital vein with a double barrelled syringe. The syringe was kept in a centrifuge opposite to counterbalance and centrifuged at a speed of 2500rpm for 15 minutes. A 9001:2000 ISO certified R-23 centrifuge was used for the purpose of platelet concentration. The plasma part of the blood was drawn with the inner barrel of the double barrelled syringe and the rest of the blood was discarded. The affected elbow was painted and draped and anesthetized with 1 ml of 2% xylocaine injection given locally 2ml of freshly prepared platelet rich plasma was administered with a 22G needle on the point of most tenderness on the lateral

epicondyle of the elbow using the peppering technique. **Figure 1** shows PRP bag and is administration to a patient. Patient was instructed to take rest and avoid strenuous activities for following 3 days and was advice to use only paracetamol 500mg for having pain post injection. The results were compared to local steroid injection group of patients by comparing VAS score, Mayo elbow performance score, assessing grip strength with a hand held dynamometer and DASH score.

Figure 1: A) PRP bag (after centrigugation of patient's blood). B) Loaded syringe with PRP. C) Patients points out the most painful region over lateral epicondyle. D) Administration of PRP

Post procedure protocol: Immediately after the injection patient were asked to lie in supine position for 10 minutes. Patients were asked to limit the movement of the arm for next 24 hours followed by wrist flexion and extension stretching exercises were advised. Patients were only allowed to take paracetamol tablets in case of increased pain. Normal actives were allowed after 2 weeks of the procedure. Patients were reviewed at 2weeks 4 weeks, 12 weeks,6 months and 1 year after the procedure. Visual analogue scores and grip strength was assessed with a hand held dynamometer and DASH score was calculated at each follow up.These recordings were done by a post graduate resident who did not know about which treatment group the patient belongs.

RESULTS

Patients who were available for follow up of a minimum of 12 months were considered for this study. At the end of study period, we had a total of 213 cases; 101 in Group 1 (PRP) and 112 in Group 2 (Steroid). A total of 130 patients were

enrolled in each group but few were lost to follow up and therefore, not considered for the study. There were 132 (62%) males and 81 (38%) females. 87 (41%) patients were between >20–40 years, 85 (40%) patients were in the age group of >40–≤60 years, while 41 (19%) patients were more than 60 years. The right side was involved in 160 (75%) patients, while 53 (25%) had their left side involved. **Table 1** shows the demography among two groups.

The mean VAS scores of patients before the procedure were 8.02 and 8.10 in group I and II respectively. The mean VAS scores of patients at 2 weeks were 3.84 and 1.92 in group I and II respectively. At 1 year follow up the mean scores of group I and II were 2.58 and 5.60 respectively. VAS scores at various time periods during our study are given in **Table 2**. Similarly, the mean DASH scores of patients before the procedure were 71.3 and 73.0 in group I and II respectively. The mean DASH scores of patients at 2 weeks were 65.2 and 29.2 in group I and II respectively. At 1 year follow up the mean scores of group I and II were 33.1 and 68.6 respectively. DASH scores at various time periods during our study are given in **Table 3**.

The mean Mayo elbow performance scores of patients before the procedure were 65.31 and 64.44 in group I and II respectively. The mean Mayo elbow performance scores of patients at 2 weeks were 76.45 and 81.20 in group I and II respectively. At 1 year follow up the mean scores of group I and II were 80.14 and 74.03 respectively. Mayo elbow performance scores at various time periods during our study are given in **Table 4**. Similarly, the mean Grip strength (Kg) of patients before the procedure were 22.6 and 22.4 in group I and II respectively. The mean Grip strength of patients at 2 weeks were23.7 and 29.2 in group I and II respectively. At 1 year follow up the mean scores of group I and II were 28.2 and 24.0 respectively.

Grip strength at various time periods during our study are given in **Table 5**. The only complication that we encountered was post-injection transient exacerbation of pain which was self-limiting. It was seen in 12 cases of PRP and 3 cases of steroid injection.

Table 1: Demography among the two study groups

	Group I	Group II
Enrolled patients	130	130
Lost to follow up	29	18
Final Number of patients	101	112
Male: Female	60:41	72:40
Pt. with comorbidities	36	41
Age 20-40 years	39	48
Age 40-60 years	42	43
Age >60 years	20	21

Table 2: Mean VAS scores of patients of both groups at various time intervals

	Group I	Group II
Preoperative	8.02	8.10
2 weeks	3.84	1.92
4 weeks	3.06	2.00
12 weeks	2.54	2.91
6 months	2.49	5.01
1 year	2.58	5.60

Table 3: Mean DASH scores of patients of both groups at various time intervals

	Group I	Group II
Preoperative	71.3	73.0
2 weeks	65.2	29.2
4 weeks	61.6	29.9
12 weeks	40.4	51.4
6 months	32.7	61.3
1 year	33.1	68.6

Table 4: Mean Mayo elbow performance scores of patients of both groups at various time intervals.

	Group I	Group II
Preoperative	65.3	64.44
2 weeks	76.45	81.20
4 weeks	77.2	80.6
12 weeks	80.6	78.6
6 months	80.0	76.5
1 year	80.14	74.03

Table 5: Mean Grip strength (Kg) of patients of both groups at various time intervals.

	Group I	Group II
Preoperative	22.6	22.4
2 weeks	23.7	29.2
4 weeks	23.9	29.0
12 weeks	29.4	25.3
6 months	28.4	24.4
1 year	28.2	24.0

DISCUSSION

Lateral epicondylitis, the widespread issue with a myriad of management choices. Among the multitude of treatment choices, the widely accepted non invasive management strategies are rest, physical therapy, and bracing. 87% of positive responses were recorded with the above treatment modality **[24]**. A randomised controlled examination collated three treatment modality outcomes for lateral epicondylitis such as local corticosteroid injection, physical therapy, and wait and watch policy by Smidt *et al*. Which showed ephemeral positive response with corticosteroid injection. However over the long haul they found that steroids caused irreversible micro anatomical changes in the tendon which lead to notable retrogression in patients managed with corticosteroids injection **[25]**.

A systematic analysis of corticosteroid injections efficacy in management of lateral epicondylitis and perceived that there's no evidence based guidelines on the optimal timing, dosage, injection techniques and injection volume. And he also reconfirmed that corticosteroid

injections were safe and effective but the positive outcomes were short lived **[26]**. On the flip side another study concluded that injecting steroids superficially lead to subcutaneous atrophy and administering corticosteroids within the tendon gave rise to irreversible pernicious micro anatomical changes in the tendon. In Spite of which corticosteroids injection is extensively used **[27]**.

On the diverse list of management strategies for lateral epicondylitis even invasive methods were yielding promising results. There is 60%-70% positive outcome after surgically detaching the common extensor origin laterally **[5, 28]**. Clinically though the patients tend to look for rapid healing options for their lateral epicondylitis yet they are rarely interested in surgical management. Another non-invasive widespread management strategy for the above is physiotherapy. A contemporary meta-analysis of physiotherapy detected that there's inadequate evidence to infer that physiotherapy is of any lasting positive impact **[25, 29]**. Furthermore studies have even revealed inconsistent evidence regarding the use of corticosteroids **[19, 30]**.

Recently focus has been shifted to an autologous product PRP derived from patients' own blood, which contains 3-5 times higher levels of growth factors and proteins that catalyse the curing activity on the cellular level **[20]**. PRP is showing impressive results in stimulating healing in chronic ulcers, tendinitis and bone too. The mechanism of action of PRP in tendon injury is that it enhances revascularization and healing at a cellular level **[31]**. In Vitro studies by Klein *et al* **[32]** theorised that the PRP with its transforming growth factor beta stimulated the fibroblasts nesting in the tendon sheath to produce more type I collagen. Possibly the same cascade happens on injecting PRP for lateral epicondylitis. Other mechanics which were theorised to enhance healing in tendon injury site is that PRP injection might assemble stem cells from bone marrow to the site of injection or alter the micro vascular habitat conducive to tendon healing. Much about the mechanism of action of PRP is yet to be deduced.

Another study shows 79% positive outcome after administering whole blood to treat lateral epicondylitis. Of which 32 % required several injections to get a good response. They hypothesised that their success is due to the fact that blood possesses cellular and humoral mediators which brings about the healing cascade **[17]**. A study found noteworthy alleviation of symptoms after 2 months in 60% patients managed with buffered PRP opposed to patients managed with a local anaesthetic injection which showed only

16% response **[21]**. A non-randomised examination was conducted by Hechtman *et al* in which they injected PRP in elbows of 31 individuals who were diagnosed to have lateral epicondylitis and failed to respond to non-invasive treatments previously. The goal set by Hechtman to be accomplished for treatment success was at least 25% deduction in worst pain score in at least 1 follow up and no more intervention within a year. And they encountered 90%success **[21, 22]**.

We are at the beginning of evolution of biologic treatment modalities in Orthopaedics. Bone morphogenic proteins and other growth factors are being comprehensively analyzed in vitro. These vital cytokines are now evaluated in vivo **[32]**. Marx *et al* reconfirmed the enhanced efficacy of using PRP along with the auto grafts he used and he found that the PRP-enhanced auto grafts were 50% more dense than using just autografts at 6 months follow up in a mandibular bone defect model **[33]**. Recently gathered data showed that PRP enhanced allograft on comparison to allograft alone had an increased shear strength and energy absorption **[34]**. This randomized study was considered to assess the efficacy of autologous PRP in management of lateral epicondylitis. Using PRP was safe and easy. Corticosteroid group was superior only in the commencement and then worsened, whereas the PRP group showed steady improvement over time. Our current study showed significantly better outcomes in treatment of lateral epicondylitis, and we believe the reason for which is that this modality of management addresses the pathophysiology of elbow epicondylitis which was failed to address in traditional nonsurgical modalities.

CONCLUSION

Although corticosteroid injections show better short term results but in the long term follow up their effect weans off while PRP continues to show its effect and gives long lasting relief to the patients.

REFERENCE

[1] Hamilton PG. The prevalence of humeral epicondylitis: a survey in general practice. J R Coll Gen Pract. 1986; 36(291): 464–5.

[2] Gruchow HW, Pelletier D. An epidemiologic study of tennis elbow. Am J Sports Med. 1979;7(4):234–8.

[3] Sharma MK, Kumar R. Tennis Elbow Managed by Corticosteroid and Platelet Rich Plasma (PRP): A Prospective Comparative Study. 2018;4(April 2016):1–5.

[4] Yadav R, Kothari SY, Borah D. Comparison of local injection of platelet rich plasma and corticosteroids in the treatment of lateral epicondylitis of humerus. J

Clin Diagnostic Res. 2015; 9(7): RC05–7.

[5] Geoffroy P, Yaffe MJ, Rohan I. Diagnosing and treating lateral epicondylitis [Internet]. Vol. 40, Canadian Family Physician. College of Family Physicians of Canada; 1994 [cited 2020 Nov 10]. p. 73–8. Available from: /pmc/articles/PMC2379994/?report=abstract

[6] Nirschl RP, Pettrone FA. Tennis elbow. The surgical treatment of lateral epicondylitis. J Bone Jt Surg - Ser A. 1979; 61(6): 832–9.

[7] Bennett JB. Lateral and medial epicondylitis. Hand Clin. 1994; 10(1): 157–63.

[8] Smith RW, Papadopolous E, Mani R, Cawley MID. Abnormal microvascular responses in lateral epicondylitis. Rheumatology. 1994; 33(12): 1166–8.

[9] Wang JHC, Iosifidis MI, Fu FH. Biomechanical basis for tendinopathy [Internet]. Vol. 443, Clinical Orthopaedics and Related Research. Lippincott Williams and Wilkins; 2006 [cited 2020 Nov 10]. p. 320–32. Available from: https://pubmed.ncbi.nlm.nih.gov/16462458/

[10] Price R, Sinclair H, Heinrich I, Gibson T. Local injection treatment of tennis elbow-hydrocortisone, triamcinolone and lignocaine compared. Rheumatology. 1991; 30(1): 39–44.

[11] Labelle H, Guibert R, Joncas J, Newman N, Fallaha M, Rivard CH. Lack of scientific evidence for the treatment of lateral epicondylitis of the elbow: An attempted meta-analysis. J Bone Jt Surg - Ser B. 1992; 74(5): 646–51.

[12] Tonks JH, Pai SK, Murali SR. Steroid injection therapy is the best conservative treatment for lateral epicondylitis: A prospective randomised controlled trial. Int J Clin Pract. 2007; 61(2): 240–6.

[13] Smith MA, Smith WT. Emerging techniques in orthopaedics: Platelet-rich plasma. Orthop Nurs. 2011; 30(4): 260–3.

[14] Behrens SB, Deren ME, Matson AP, Bruce B, Green A. A review of modern management of lateral epicondylitis. Phys Sportsmed. 2012; 40(2).

[15] Childress MA, Beutler A. Management of Chronic Tendon Injuries [Internet]. Vol. 87, American Family Physician. 2013 Apr [cited 2020 Nov 10]. Available from: www.aafp.org/afp.

[16] Coonrad RW, Hooper WR. Tennis elbow: Its course, natural history, conservative and surgical management. J Bone Jt Surg - Ser A. 1973; 55(6): 1177–82.

[17] Edwards SG, Calandruccio JH. Autologous blood injections for refractory lateral epicondylitis. J Hand Surg Am. 2003; 28(2): 272–8.

[18] Smidt N, Windt DAWM Van Der, Assendelft WJJ, Devillé WLJM, Bos IBCK. Corticosteroid Injections Tennis ellbogen. Lancet. 2002; 359(23): 657–62.

[19] Altay T, Günal I, Öztürk H. Local Injection Treatment for. 2002; (398): 127–30.

[20] Foster TE, Puskas BL, Mandelbaum BR, Gerhardt MB, Rodeo SA. Platelet-rich plasma: From basic science to clinical applications. Am J Sports Med. 2009; 37(11): 2259–72.

[21] Mishra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. Am J Sports Med. 2006; 34(11): 1774–8.

[22] Mishra A, Collado H, Fredericson M. Platelet-Rich Plasma Compared with Corticosteroid Injection for Chronic Lateral Elbow Tendinosis. PM R [Internet]. 2009; 1(4): 366–70. Available from: http://dx.doi.org/10.1016/j.pmrj.2009.02.010

[23] Raeissadat SA, Rayegani SM, Hassanabadi H, Rahimi R, Sedighipour L, Rostami K. Is platelet-rich plasma superior to whole blood in the management of chronic tennis elbow: One year randomized clinical trial. BMC Sports Sci Med Rehabil. 2014; 6(1): 1–10.

[24] Peerbooms JC, Sluimer J, Bruijn DJ, Gosens T. Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial: Platelet-rich plasma versus corticosteroid injection with a 1-year follow-up. Am J Sports Med. 2010; 38(2): 255–62.

[25] Smidt N, Assendelft WJJ, Van der Windt DAWM, Hay EM, Buchbinder R, Bouter LM. Corticosteroid injections for lateral epicondylitis: A systematic review. Pain. 2002; 96(1–2): 23–40.

[26] Assendelft WJJ, Hay EM, Adshead R, Bouter LM. Corticosteroid injections for lateral epicondylitis: A systematic overview. Br J Gen Pract

[Internet]. 1996 [cited 2021 Jun 3]; 46(405): 209–16. Available from: https://pubmed.ncbi.nlm.nih.gov/8703521/

[27] Leach RE, Miller JK. Lateral and medical epicondylitis of the elbow. Clin Sports Med [Internet]. 1987 [cited 2021 Jun 3]; 6(2): 259–72. Available from: https://pubmed.ncbi.nlm.nih.gov/10708988/

[28] Verhaar J, Walenkamp G, Kester A, Van Mameren H, Van der Linden T. Lateral extensor release for tennis elbow. A prospective long-term follow- up study. J Bone Jt Surg - Ser A. 1993; 75(7): 1034–43.

[29] Smidt N, Assendelft WJJ, Arola H, Malmivaara A, Green S, Buchbinder R, *et al*. Effectiveness of physiotherapy, for lateral epicondylitis: A systematic review. Ann Med. 2003; 35(1): 51–62.

[30] Newcomer KL, Laskowski ER, Idank DM, McLean TJ, Egan KS. Corticosteroid injection in early treatment of lateral epicondylitis. Clin J Sport Med. 2001; 11(4): 214–22.

[31] Kon E, Filardo G, Delcogliano M, Presti M Lo, Russo A, Bondi A, *et al*. Platelet-rich plasma: New clinical application. A pilot study for treatment of jumper's knee. Injury. 2009; 40(6): 598–603.

[32] Einhorn TA. Clinical applications of recombinant human BMPs: Early experience and future development. J Bone Jt Surg - Ser A. 2003; 85(SUPPL. 3): 82–8.

[33] Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR. Platelet-rich plasma: Growth factor enhancement for bone grafts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998; 85(6): 638–46.

[34] Jensen TB, Sraballe K. PRP and FFB graft in dogs Jensen2004. 2004; 22: 653–8.