

Platelet Rich Plasma, Is It Of Use In Human Intrabony Periodontal Defects?

Dr.Syed Wali Peeran, Dr. Fatma Mojtaba Alsaid

ABSTRACT: - Platelet-rich plasma is an autologous concentration of platelets. Scientific data has shown that this tissue-engineering tool, platelet rich plasma can enhance wound healing. Its use in periodontal surgeries is relatively recent. This paper tries to sketch a complete picture describing the use of platelet-rich plasma in human periodontal intrabony defects.

Key words: - Intrabony defects, Periodontology Platelet rich plasma, tissue engineering.

INTRODUCTION:

Platelet-rich plasma an autologous concentration of human platelets is a small volume of plasma which has a platelet concentration above baseline.¹ It contains a considerable increased amount of growth factors especially platelet derived growth factor and transforming growth factor.² The use of platelet rich plasma began embedded in sound biological belief that it could enhance the wound healing mechanisms. With promising results in vivo, animal studies platelet-rich plasma is considered as an innovative tissue engineering strategy in boosting the periodontal wound healing and periodontal regeneration.^{[3],[4],[5],[6]} After almost a decade of its use in periodontics we in this paper revisit and review the benefits of its use in human periodontal intrabony defects. . The search strategy of relevant articles included using hand searching which included examining relevant published or incomplete journals or electronic databases (PUBMED) up to 31st December 2012. The searching key words in PUBMED included Platelet-rich plasma (PRP)/ intrabony defects/Periodontal therapy and their synonyms, the articles of relevance were sorted and then taken into consideration.

PERIODONTAL INTRABONY DEFECT AND PLATELET-RICH PLASMA:

Lekovic et al (2002) using split mouth design in twenty one patients with interproximal bony defects compared the use of platelet rich plasma, bovine porous bone mineral and guided tissue regeneration with platelet rich plasma and bovine porous bone. Re-entry surgeries were carried at 6 months post treatment. Both the combinations proved to be effective in treating intra bony defects and showed no statistical difference.⁷

Camargo et al (2002) using split mouth design in eighteen patients with interproximal bony defects studied the use of platelet rich plasma, bovine porous bone mineral and guided tissue regeneration with guided tissue regeneration absorbable lactic acid membrane. Re-entry surgeries were carried at 6 months post treatment. The amount of defect fill observed was 4.78+/-1.26 mm on buccal and 4.66+/-1.32 mm on lingual sites of the combination group where as 2.31+/- 0.76 mm on the buccal and 2.26+/-0.81 mm on the lingual sites of guided tissue regeneration membrane group. It suggests that platelet rich plasma and bovine porous bone mineral had an added regenerative effect to the guided tissue regeneration in promoting the resolution of the intra bony defects with severe periodontitis.⁸

Hanna, Trejo and Weltman (2004) studied in thirteen patients with bilateral two wall intrabony defects with loss of attachment of 6 mm or more using double-masked, randomized, split mouth clinical trial the comparison of platelet rich plasma and bovine derived xenograft with bovine derived xenograft. The results showed significant difference between the two treatment modalities. The addition of platelet rich plasma significantly improved the clinical periodontal response.⁹

Okuda et al (2005) compared the use of platelet rich plasma and hydroxyapatite with a mixture of hydroxyapatite and saline in seventy healthy non-smokers each with an interproximal intrabony defects. Evaluation at 12 months showed that all clinical parameters improved in both the treatment groups, but combination of platelet rich plasma and hydroxyapatite showed significantly more favourable clinical improvement in intrabony periodontal defects.¹⁰

Ouyang and Qiao (2006) evaluated the effectiveness of platelet rich plasma as an adjunct in the treatment of intrabony defects. Ten periodontitis patients with seventeen intrabony defects were selected nine of the intrabony defects were randomly treated with platelet rich plasma and bovine porous bone mineral while the rest were treated with bovine porous bone mineral alone. At one year post surgery, group treated with platelet rich plasma and bovine porous bone mineral showed statistically significant improvement in probing depth reduction, clinical attachment gain, bone probing reduction and defect fill when compared to the control group. Digital subtraction radiography also showed greater radiographic gains in the alveolar bone mass

- Dr. Syed Wali Peeran, Assistant Professor, Department of Periodontology and oral Implantology, Faculty of Dentistry, Sebha University, Sebha, Libya. 00218-928940337 e-mail: doctorsyedwali@yahoo.in
- Dr. Fatma Mojtaba Alsaid, Faculty of Dentistry, Sebha University, Sebha, Libya.
- Email: doctorfatmaalsaid@gmail.com

treated with platelet rich plasma and bovine porous bone mineral than in the control group.¹¹

Czuryszkiewicz-Cyran and Banach (2006) treated twenty six patients with seventy two periodontal infrabony pockets with a combination of autogenous bone graft and platelet rich plasma. 12 months post treatment results showed a reduction in pocket depth, tooth mobility along with a mean attachment level regeneration of 3.47 mm. They concluded that the autogenous bone with added platelet rich plasma resulted in significant clinical improvement and eliminates the convenient environment for the sub gingival bacterial plaque.¹²

Ilgenli et al (2007) compared the clinical and radiographic outcomes of demineralized free-dried bone allograft and Platelet rich plasma with Platelet rich plasma in infrabony defects. Eighteen months post treatment results indicated that demineralized free-dried bone allograft and Platelet rich plasma combination exhibited more favourable gains in both clinical and radiographic parameters than Platelet-rich plasma alone.¹³

Papli and Chen (2007) treated five cases with bilateral infrabony pockets, each with Autologous platelet concentrate or bioabsorbable guided tissue regeneration membrane. Autologous platelet concentrate achieved similar clinical attachment level gain and pocket depth reduction over a 52 week period as the guided tissue regeneration.¹⁴

Döri et al (2007) in thirty patients with at least one advanced intrabony defect compared the use of natural bone mineral, platelet rich plasma and guided tissue regeneration collagen membrane combination with natural bone mineral and guided tissue regeneration collagen membrane combination. Though both the treatment modalities gave significant clinical gains platelet rich plasma failed to improve the results obtained with natural bone mineral and guided tissue regeneration collagen membrane combination.¹⁵

Berkman et al (2007) studied combined use of platelet-rich plasma and β -Tri calcium phosphate bone grafting with or without guided tissue regeneration in the random treatment of thirty anterior interproximal defects in twenty five patients. Evaluation at the end of twelve months revealed that all options were effective in the treatment of anterior interproximal intrabony defects. The results also suggested that platelet-rich plasma added no clinical benefit to β -Tri calcium phosphate bone graft material used alone or in combination with guided tissue regeneration.¹⁶

In a study by **Döri et al (2007)** in twenty four patients with at least one intrabony defect were treated randomly with either a combination of platelet-rich plasma, anorganic bovine bone mineral and guided tissue regeneration membrane or anorganic bovine bone mineral and guided tissue regeneration membrane failed to show added clinical benefits for addition of platelet rich plasma.¹⁷

Demir et al (2007) evaluated the effect of bioactive glass graft material with or without platelet rich plasma on the clinical healing of intrabony defects. The two treatment

modalities showed no statistically significant difference. The results showed that using platelet rich plasma with bioactive glass bone graft gave no added benefit in clinical parameters.¹⁸

Yilmaz et al (2007) reported marked improvement in clinical, radiographic and 12 months re-entry results in wide intrabony periodontal defects of a 32 year old generalized aggressive periodontitis patient when treated with combined platelet rich plasma and bovine derived xenograft.¹⁹

Döri et al (2008) in twenty six patients with at least one advanced intrabony defect compared clinically the treatment of deep intrabony defects with either enamel matrix derivative, natural bone mineral and platelet rich plasma or enamel matrix derivative and natural bone mineral. Both the treatment modalities showed statistically significant improvement in clinical parameters but the use of Platelet rich plasma failed to enhance the results obtained with enamel matrix derivative, natural bone mineral combination.²⁰

Döri et al (2008) in twenty eight patients with at least one intrabony defect compared clinically the treatment of deep intrabony defects with either platelet rich plasma, beta-tri calcium phosphate and guided tissue regeneration membrane or beta-tri calcium phosphate and guided tissue regeneration membrane. Both the treatment modalities showed statistically significant improvement in clinical parameters but the use of Platelet rich plasma failed to enhance the results obtained with beta-tri calcium phosphate and guided tissue regeneration membrane combination statistically.²¹

Piemontese et al (2008) treated sixty interproximal intrabony defects in sixty healthy subjects randomly assigning them to platelet rich plasma, demineralized freeze dried bone allograft combination or demineralized freeze dried bone allograft with saline. 12-month evaluation of clinical measurements showed treatment with platelet rich plasma, demineralized freeze dried bone allograft combination led to a significant improvement when compared to demineralized freeze dried bone allograft.²²

Yamamiya et al (2008) in thirty intrabony osseous defects in thirty healthy subjects compared the clinical response of human cultured periosteum sheets in combination with platelet-rich plasma and porous hydroxyapatite granules to a mixture of platelet-rich plasma and hydroxyapatite. 12 month post treatment showed a significantly more favourable clinical improvement in infrabony periodontal defects treated with human cultured periosteum sheets in combination with platelet-rich plasma and porous hydroxyapatite granules to a mixture of platelet-rich plasma and hydroxyapatite.²³

Harnack et al (2009) evaluated the additional effect of platelet-rich plasma in attachment gain. Twenty-two patients with contralateral intrabony defects were randomly treated with either a combination of beta Tri calcium phosphate with platelet-rich plasma or with beta Tri calcium phosphate alone. Platelet rich plasma did not improve the

results achieved with beta Tri calcium phosphate alone in the treatment of intrabony defects.²⁴

Pradeep et al (2009) compared the effectiveness of platelet rich plasma plus anorganic bovine-derived matrix and peptide 15 versus autologous platelet rich plasma in treating intrabony defects using split mouth design in 28 patients. A combination of rich plasma plus anorganic bovine-derived matrix and peptide 15 was more effective than platelet rich plasma alone in treatment of intrabony defects.²⁵

In a similar study by **Camargo et al (2009)** evaluating the additional benefits provided by incorporation of platelet-rich plasma into a combination of bovine porous bone mineral and guided tissue regeneration in the treatment of intrabony defects, Platelet rich plasma did not significantly augment the effects combination.²⁶

In a study by **Döri et al (2009)** thirty patients displaying one intrabony defect were randomly treated with platelet rich plasma and anorganic bovine bone mineral or anorganic bovine bone mineral alone. Results at 1 year post surgery showed significant improvement with both the treatment modalities in clinical parameters but platelet rich plasma failed to improve the results obtained with anorganic bovine bone mineral alone.²⁷

Yilmaz et al (2009) studied the effectiveness of platelet rich plasma and bovine derived xenograft combination in the treatment of 85 deep intrabony defects of 3 mm or more depth in twenty patients. One year post treatment showed significant favorable improvement in deep intrabony periodontal defects.²⁸

Sammartino et al (2009) investigated the clinical effect of resorbable collagen membrane associated with platelet rich plasma on bone regeneration after surgical extraction of the mandibular third molars in comparison with platelet rich plasma alone. They found the clinical results for both the treatment modalities were similar. But histologically the association of association of platelet rich plasma to the collagen membrane showed earlier signs of maturation.²⁹

Markou et al (2009) conducted a randomized, double-masked, controlled clinical trail in twenty-four patients with proximal periodontal endosseous defects to compare the effectiveness of autologous platelet-rich plasma alone to platelet-rich plasma with demineralised freeze dried bone allograft. 6-months post surgical results demonstrated that both platelet rich plasma and platelet rich plasma with demineralised freeze dried bone allograft combination resulted in significant clinical and radiographic improvement and the addition of demineralised freeze dried bone allograft to platelet rich plasma did not enhance the treatment outcome.³⁰

Parimala and Mehta (2010) compared the efficacy of bovine porous bone mineral with or without platelet rich plasma in twenty eight identical bilateral periodontal intrabony defects selected from fourteen chronic periodontitis patients. Nine months clinical, radiographic and intrasurgical measurements showed more favorable

clinical outcome for the combination therapy than bovine porous bone mineral alone, though the difference between the groups was statistically nonsignificant.³¹

Markou et al (2010) reported three deep periodontal intraosseous defects successfully treated with a combination of platelet rich plasma and demineralized freeze dried bone allograft combination.³²

Yilmaz et al (2011) assessed the healing outcomes of intrabony defects after treatment with platelet-rich plasma versus platelet-poor plasma combined with bovine-derived xenograft using a split-mouth design in 79 intrabony defects in 20 patients. 12 months post surgical results were similar for both treatment modalities.³³

Rodrigues et al (2011) evaluated the efficacy of platelet-rich plasma alone or in combination with bovine anorganic bone mineral in treatment of intrabony defects. Platelet rich plasma and platelet rich plasma with bovine anorganic bone mineral resulted in significant clinical improvement of the defects.³⁴

Saini et al (2011) compared the efficacy of autologous platelet-rich plasma in combination with β -tricalcium phosphate versus β -tricalcium phosphate alone in treating intrabony defects using a split-mouth design in twenty patients. Post operative results showed combination of platelet rich plasma and β -Tri calcium phosphate led to a significantly more favourable clinical and radiographic improvement in infrabony periodontal defects.³⁵

Kaushick et al (2011) compared the clinical effectiveness of platelet rich plasma and hydroxyapatite-Tricalcium phosphate bone graft combination versus hydroxyapatite-tricalcium phosphate bone graft in ten patients with chronic periodontitis. 6 months post treatment recordings showed significantly higher reduction in probing pocket depth, higher gain in attachment levels and higher amount of radio-density in the intrabony defects treated with Platelet rich plasma and hydroxyapatite-Tricalcium phosphate bone graft combination.³⁶

Ozdemir and Okte (2012) studied the efficacy of beta-tricalcium phosphate graft versus platelet rich plasma and Tricalcium phosphate bone graft combination in fourteen patients with atleast two similar three-walled defects. At 6 month post healing period both the treatment modalities were effective in treatment of three walled intrabony defects and no additional statistically significant benefits were found with platelet rich plasma.³⁷

Pradeep et al (2012) compared the efficiency of platelet rich fibrin and platelet-rich plasma in treatment of 3-wall intrabony defects in chronic periodontitis patients and found the 9 months post operative pocket depth reduction, clinical attachment level gain and bone fill at treated sites to be similar.³⁸

Hassan et al (2012) compared the effectiveness of torus mandibularis bone chips alone and when combined with autogenous platelet rich plasma in treating periodontal intrabony defects. The use of mandibular tori as

autogenous bone graft combined with platelet-rich plasma showed a significant improvement in the clinical outcome of periodontal therapy than mandibular tori alone.³⁹

Menezes and Rao (2012) in a long term clinical evaluation compared the efficacy of platelet-rich plasma and hydroxyapatite bone graft combination with a mixture of hydroxyapatite with saline using a split mouth technique in sixty patients with chronic periodontitis. 4 year post treatment results indicated that platelet-rich plasma and hydroxyapatite bone graft combination showed statistically significant changes when compared to the control group. The 4 year post treatment results for platelet-rich plasma and hydroxyapatite bone graft combination vs hydroxyapatite saline mixture were as follows respectively, probing depth reduction, $5.4 \pm 0.49\text{mm}$ vs $4.0 \pm 0.45\text{mm}$ ($p < .001$); clinical attachment gain, $5.4 \pm 1.2\text{mm}$ vs $3.1 \pm 1.1\text{mm}$ ($p < .001$); defect fill, $3.2 \pm 0.8\text{mm}$ vs $2.1 \pm 0.6\text{mm}$ ($p < .001$). Treatment with a combination of of platelet-rich plasma and hydroxyapatite bone graft combination compared with hydroxyapatite with saline led to a significantly more favourable long term clinical improvement in intrasosseous periodontal defects.⁴⁰

CONCLUSION: Both positive and negative outcomes have been reported with the use of platelet-rich plasma and its various combinations with other periodontal regeneration materials. The various study designs employed, the differences in surgical procedures carried out and assessment variables such as clinical and radiographic parameters recorded and techniques used make it hard for en bloc evaluation of the data available. The available scientific data indicates platelet-rich plasma to be of benefit in treatment of human periodontal intrabony defects, but further long term clinical research is necessary to help understand precisely how platelet rich plasma helps in periodontal regeneration, and to help and guide clinicians choose the appropriate technique of harnessing the platelet rich plasma and the combination of regenerative procedures in relation to the human periodontal intrabony defects.

REFERENCES:

- [1]. R.E.Marx. Platelet-Rich Plasma (PRP): What is PRP and WHAT is not PRP? *Implant Dentistry*. 10(4).2001.
- [2]. RE.Marx, ER.Carlson, RM.Eichstaedt, SR.Schimmele, JE.Strauss and KR.Georgeff. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.*; 85(6):638-46.1998.
- [3]. K.Okuda, T.Kawase, M.Momose, M.Murata, Y.Saito, H.Suzuki, LF.Wolff and H.Yoshie. Platelet-rich plasma contains high levels of platelet-derived growth factor and transforming growth factor-beta and modulates the proliferation of periodontally related cells in vitro. *J Periodontol* ; 74(6):849-57.2003.
- [4]. EA.Pepelassi, CE.Markopoulou, XE.Dereka, AA.Mamalis, IA.Vrotsos and M.Koutsilieris. Platelet-rich plasma effect on periodontally affected human gingival fibroblasts: an in vitro study. *J Int Acad Periodontol.*; 11(1):160-8.2009
- [5]. H.El-Sharkawy, A.Kantarci, J.Deady, H.Hasturk, H.Liu, M.Alshahat and TE.Van Dyke. Platelet-rich plasma: growth factors and pro- and anti-inflammatory properties. *J Periodontol*; 78(4):661-9.2007.
- [6]. MQ.Kurikchy, NH.AI-Rawi, RS.Ayoub and SS.Mohammed. Histological evaluation of bone healing using organic bovine bone in combination with platelet-rich plasma (an experimental study on rabbits). *Clin Oral Investig*.10.1007/s00784-012-0751-z.2012.
- [7]. V Lekovic, PM.Camargo, M.Weinlaender, N.Vasilic and EB.Kenney. Comparison of Platelet-rich plasma, bovine porous bone mineral, and guided tissue regeneration versus platelet-rich plasma and bovine porous bone mineral in the treatment of intrabony defects: a reentry study. *J Periodontol*. 73(2):198-205: 2002.
- [8]. PM.Camargo, V.Lekovic, M.Weinlaender, N.Vasilic, M.Madzarevic and EB.Kenney. Platelet-rich plasma and bovine porous bone mineral combined with guided tissue regeneration in the treatment of intrabony defects in humans. *J Periodontal Res*.37 (4):300-6:2002.
- [9]. R.Hanna, PM.Trejo and RL.Weltman. Treatment of intrabony defects with bovine-derived xenograft alone and in combination with platelet-rich plasma: a randomized clinical trial. *J Periodontol* 75(12):1668-77.2004.
- [10]. K.Okuda, H.Tai, K.Tanabe, H.Suzuki, T.Sato, T.Kawase, Y.Saito, LF.Wolff and H.Yoshiex. Platelet-rich plasma combined a porous hydroxyapatite graft for the treatment of intrabony periodontal defects in humans: a comparative controlled clinical study. *J Periodontol*: 76(6):1287-1292.2005.
- [11]. XY.Ouyang and J.Qiao. Effect of platelet-rich plasma in the treatment of periodontal intrabony defects in humans. *Chin Med J (Engl)*. 20; 119 (18):1511-21.
- [12]. J.Czuryzkiewicz-Cyrana and J.Banach. Autologous bone and platelet rich plasma (PRP) in the treatment of intrabony defects. *Adv Med Sci* ;51(1):26-30.2006
- [13]. T.Ilgenli, N.Dündar and B.I.Kal. Demineralized freeze-dried bone allograft and platelet-rich plasma vs platelet-rich plasma alone in infrabony defects: a clinical and radiographic evaluation. *Clin Oral Investig*. 11(1):51-9.2007.
- [14]. R.Papli and S.Chen. Surgical treatment of intrabony defects with autologous platelet concentrate or

- bioabsorbable barrier membrane: a prospective case series. *J Periodontol*; 78(1):185-93.2007.
- [15]. F.Döri, T.Huszár, D.Nikolidakis, NB.Arweiler, I.Gera and A.Sculean. Effect of platelet-rich plasma on the healing of intra-bony defects treated with a natural bone mineral and a collagen membrane. *J Clin Periodontol*; 34(3):254-61.2007.
- [16]. ZY.Berkman, O.Turner, T.Sbasioglu and A.Kantarci. Combined use of platelet-rich plasma and bone grafting with or without guided tissue regeneration in the treatment of anterior interproximal defects. *J Periodontol* ; 78(5):801-9.2007.
- [17]. F.Döri, T.Huszar, D.Nikolidakis, NB.Arweiler, I.Gera and A.Sculean. Effect of platelet rich plasma on the healing of intrabony defects with an anorganic bovine bone mineral and expanded polytetrafluoroethylene membranes. *J Periodontol*.78(6):938-90.2007.
- [18]. B.Demir, D.Sengün and A.Berberoğlu. Clinical evaluation of platelet-rich plasma and bioactive glass in the treatment of intra-bony defects. *J Clin Periodontol*; 34(8):709-15. 2007.
- [19]. S.Yilmaz, G.Cakar, B.E.Kuru and B.Yildirim. Platelet-rich plasma in combination with bovine derived xenograft in the treatment of generalized aggressive periodontitis: a case report with re-entry. *Platelets*; 18(7):535-9.2007.
- [20]. F.Döri, D.Nikolidakis, T.Húszár, N.B.Arweiler, I.Gera and A.Sculean. Effect of platelet-rich plasma on the healing of intrabony defects treated with an enamel matrix protein derivative and a natural bone mineral. *J Clin Periodontol* ; 35(1):44-50.2008.
- [21]. F.Döri, T.Húszár, D.Nikolidakis, D.Tihanyi, A.Horváth, NB.Arweiler, I.Gera and A.Sculean. Effect of platelet-rich plasma on the healing of intrabony defects treated with Beta tricalcium phosphate and expanded polytetrafluoroethylene membranes. *J Periodontol* ; 79(4):660-9.2008.
- [22]. M.Piemontese, S.D.Aspriello, C.Rubini, L.Ferrante and M.Procaccini. Treatment of periodontal intrabony defects with demineralized freeze-dried bone allograft in combination with platelet-rich plasma: a comparative clinical trial. *J Periodontol*. 79(5):802-10:2008.
- [23]. K.Yamamiya, K.Okuda, T.Kawase, K.Hata ,L.F.Wolf and H.Yoshie. Tissue-engineered cultured periosteum used with platelet-rich plasma and hydroxyapatite in treating human osseous defects. *J Periodontol*.79 (5):811-8.2008.
- [24]. L.Harnack, R.H.Boedeker, I.Kurtulus, S.Boehm, J.Gonzales and J.Meyle. Use of platelet-rich plasma in periodontal surgery-a prospective randomized double blind clinical trial. *Clin Oral Investig*; 13(2):179-87.2009.
- [25]. A.R.Pradeep, SK.Shetty, G.Garg and S.Pai. Clinical effectiveness of autologous platelet-rich plasma and Peptide-enhanced bone graft in the treatment of intrabony defects. *J Periodontol*. 80(1):62-71.2009.
- [26]. PM.Camargo, V.Lekovic, M.Weinlaender, T.Divnic-Resnik, M.Pavlovic and EB.Kenney. A surgical reentry study on the influence of platelet-rich plasma in enhancing the regenerative effects of bovine porous bone mineral and guided tissue regeneration in the treatment of intrabony defects in humans. *J Periodontol*. 80(6):915-23. 2009.
- [27]. F.Döri, V.Kovács, NB.Arweiler, T.Huszár, I.Gera, D.Nikolidakis and A.Sculean. Effect of platelet-rich plasma on the healing of intrabony defects treated with an anorganic bovine bone mineral: a pilot study. *J Periodontol* .80(10):1599-605 .2009.
- [28]. S.Yilmaz, G.Cakar, B.Kuru, S.Dirikan and B.Yildirim. Platelet-rich plasma in combination with bovine derived xenograft in the treatment of deep intrabony periodontal defects: a report of 20 consecutively treated patients. *Platelets*; 20(6):432-40.2009.
- [29]. G.Sammartino, M.Tia, E.Gentile, G.Marenzi and PP.Claudio. Platelet-rich plasma and resorbable membrane for prevention of periodontal defects after deeply impacted lower third molar extraction. *J Oral Maxillofacial Surg*; 67(11):2369-73.2009.
- [30]. N.Markou, E.Pepelassi, H.Vavouraki, HC.Stamatakis, G.Nikolopoulos, I.Vrotsos and K.Tsiklakis. Treatment of periodontal endosseous defects with platelet-rich plasma alone or in combination with demineralized freeze-dried bone allograft: a comparative clinical trial. *J Periodontol*. 80(12):1911-9.2009.
- [31]. M.Parimala and DS.Mehta. Comparative evaluation of bovine porous bone mineral. *J Indian Soc Periodontol*; 14(2):126-31.2010.
- [32]. N.Markou, E.Pepelassi, S.Kotsovilis, I.Vrotsos, H.Vavouraki and HC.Stamatakis. The use of platelet-rich plasma combined with demineralized freeze-dried bone allograft in the treatment of periodontal endosseous defects: a report of two clinical cases. *J Am Dent Assoc*. 141(8):967-78.2010.
- [33]. S.Yilmaz, C.Kabadayi, SD.Ipci, G.Cakar, B.Kuru. Treatment of intrabony periodontal defects with platelet-rich plasma versus platelet-poor plasma combined with a bovine-derived xenograft: a controlled clinical trial. *J Periodontol*; 82(6):837-44. 2011.

- [34]. SV.Rodrigues, AB.Acharya and SL.Thakur. An evaluation of platelet-rich plasma without thrombin activation with or without anorganic bone mineral in the treatment of human periodontal intrabony defects. *Platelets* 22(5):353-60.2011.
- [35]. N.Saini, P.Sikri and H.Gupta. Evaluation of the relative efficacy of autologous platelet-rich plasma in combination with β -tricalcium phosphate alloplast versus an alloplast alone in the treatment of human periodontal infrabony defects: a clinical and radiological study. *Indian J Dent Res*; 22(1):107-15.2011.
- [36]. BT.Kaushick, ND.Jayakumar, O.Padmalaatha and S.Varghese. Treatment of human periodontal intrabony with hydroxyapatite+ β tricalcium phosphate bone graft alone and in combination with platelet rich plasma: a randomized clinical trial. *Indian J Dent Res*; 22(4):505-10.2011.
- [37]. B.Ozdemir and E.Okte. Treatment of intrabony defects with beta-tricalcium phosphate alone and in combination with platelet-rich plasma. *J Biomed Mater Res B Appl Biomater*. 100(4):976-83 .2012.
- [38]. AR.Pradeep, NS.Rao, E.Agarwal, P.Bajaj, M.Kumari and SB.Naik. Comparative evaluation of autologous platelet-rich fibrin and platelet-rich plasma in the treatment of 3-wall intrabony defects in chronic periodontitis: a randomized controlled clinical trial. *J.Periodontol*. 83(12):1499-507.2012.
- [39]. KS.Hassan, AS.Alagl and A.Abdel-Hady. Torus mandibularis bone chips combined with platelet rich plasma gel for treatment of intrabony osseous defects: clinical and radiographic evaluation. *Int J Oral Maxillofacial Surg*.41 (12):1519-26. 2012.
- [40]. LM. Menezes and J. Rao. Long-term clinical evaluation of platelet-rich plasma in the treatment of human periodontal intraosseous defects: A comparative clinical trial. *Quintessence Int*. 43(7):571-82.2012.