

Efficacy of Blood and Its Products-boon for Oral Surgeons: Review

Wamiq Musheer Fareed¹,
Parul Tandon²,
Esam Ahmad Z¹,
Giath Gazal¹,
Ahmed Hussain Khan³,
Tazeen Zaidi⁴,
Tahseen Fatima³ and
Ibrahim Saleh Falraddadi⁵

Abstract

A set of scientific researches has focused its attention on discussing the possibility that platelet derivatives are not only coherent for haemostasis, but also have gained popularity in the field of tissue healing. Products obtained from whole blood as a result of centrifugation have wide applications in this field. Various materials are commercially available that are used locally to achieve haemostasis; however platelets and fibrinogen are the natural blood components that exist as a source in coagulation process. Platelets carry platelet-derived growth factors which, when introduced into an injured region, may stimulate a healing response through the recruitment of stem cells, increased vascularization and the production of collagen enhancing both soft and hard tissue healing. Injection of collected venous blood could be a scaffold for new bone formation which is helpful in restricting mouth opening in TMJ subluxation. Injections are inexpensive, simple to acquire, accord minimal trauma with minimal risk for allergic reactions. The purpose of this paper is to provide collective information regarding the various centrifuged products obtained from blood and their application in different ways.

Keywords: Platelet rich plasma; Fibrinogen; Fibrin glue; Platelets; Platelet rich fibrin

Received: December 26, 2016; **Accepted:** January 21, 2017; **Published:** January 27, 2017

Introduction

The regenerative process in humans by employing autogenous blood is an enhancement in the field of surgery. With-drawl of the whole blood can be maximally utilized once it is centrifuged; to obtain a high concentration of platelets in less amount of plasma for various processes in oral surgery Platelets holds a significant role in healing process. Apart from its well-known role in hemostasis, it also plays its part in regeneration of tissues by releasing of active proteins from the α -granules which results in injury to tissues which in turn releases cytokines and growth factors stimulating the proliferation of cells [1].

Other than this, fibrinogen rich products as a result of centrifugation of whole blood proved to be a useful tool for oral surgeons. It comprises of 0.2% by volume of whole blood, which converts to an insoluble fibrin meshwork in the presence of thrombin [2]. There has always been a demand by surgeons for natural substances that would assist in arrest of bleeding and perfect closure of wound margins. These biologic substances benefits both the surgeon as well as patient by reduction in surgical time, elimination of foreign body reaction, removal of evacuation drains, approximation of flaps with reduced tension,

- 1 College of Dentistry, Department of Oral and Maxillofacial Surgery, Taibah University, Madina Al Munawwarah, Saudi Arabia
- 2 Department of Oral and Maxillofacial Surgery, Rama Dental College, Kanpur, Uttar Pradesh, India
- 3 Anwar Dental Hospital and Maxillofacial Centre, India
- 4 Pedodontist in Mahi Dental Clinic and Pediatric Centre, Lucknow, India
- 5 Jordan University of Science and Technology, Saudi Arabia

Corresponding author:
Dr. Wamiq Musheer Fareed

✉ wmfareed@gmail.com

College of Dentistry, Department of Oral and Maxillofacial Surgery, Taibah University, Madina Al Munawwarah, Saudi Arabia.

Tel: 000966550152401

Citation: Fareed WM, Tandon P, Ahmad Z E, et al. Efficacy of Blood and Its Products-boon for Oral Surgeons: Review. J Univer Surg. 2017, 5:1.

and shorter recovery period. This paper endeavors detailed review on various centrifuged blood products, methods of obtaining and their clinical usage in various aspects of Oral Surgery.

Review

Blood is a complex tissue based on its derivation from mesenchyme cells and its structure (**Figure 1**).

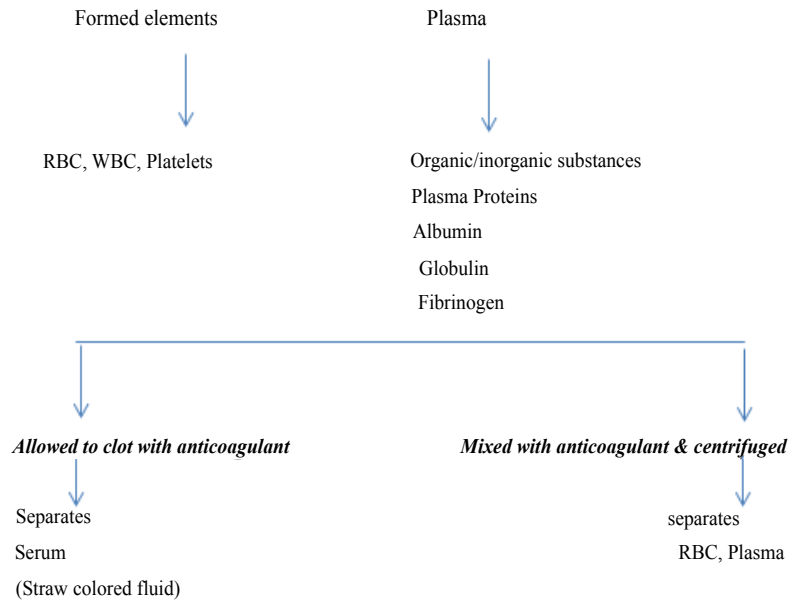


Figure 1 Components of blood.

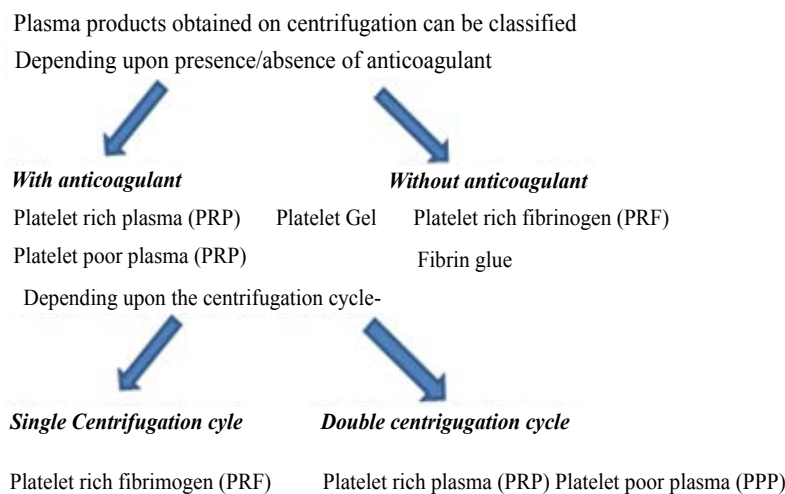


Figure 2 Plasma products.

Plasma products obtained on centrifugation can be classified as (Figure 2).

Method of Preparation of centrifuged products:

Platelet rich plasma (PRP): Platelet rich plasma (PRP) is defined as an amount of plasma in a volume of blood sample having a platelet concentration above baseline [3]. The volume of platelets generated by centrifugation ranges from 2 times to 8.5 times that of normal plasma [4]. Ideally, normal human platelet counts in the blood range from 150,000/ L to 350,000/ L (Figure 3).

Platelet rich fibrin (PRF): It was developed by Choukroun in 2001 [5] who introduced a new class of platelet concentrates which can be obtained without complex processing and blood handling (Figure 4).

Absence of anticoagulant causes the activation of platelets

in the blood sample and thus the coagulation cycle. Thus the conduct should be fast to achieve a clinically usable PRF clot [6] as the chances of failure increases if the duration required to collect blood and launch centrifugation is overly long, failure will occur: The fibrin will polymerize in a diffuse way in the tube and only a small blood clot without consistency will be obtained. Slow fibrin polymerization during PRF processing leads to the intrinsic incorporation of platelet cytokines in the fibrin meshes. They implied that PRF, unlike the other platelet concentrates, would be able to progressively release cytokines during fibrin matrix remodelling [7]. The slow polymerization during PRF preparation seems to generate a fibrin network very similar to the natural one and such a network leads to a more efficient cell migration and proliferation [8]. The PRF serves as a fibrin matrix [9], conducts an important mechanical role by supporting the graft particles as well as promotes cellular migration facilitating,

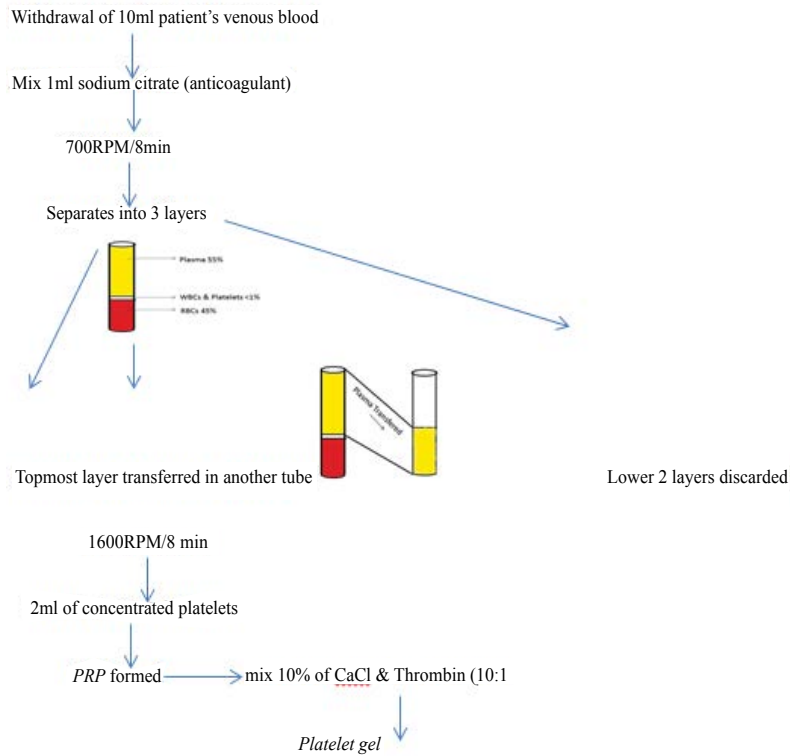


Figure 3 Preparation of platelet rich plasma.

Withdrawal of 10ml of patient venous blood

Centrifuge at 3000RPM/10 min

PRF formed

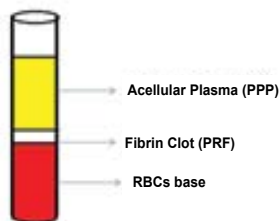


Figure 4 Preparation of platelet rich fibrin.

slow polymerization and more potent migration and proliferation of cells, a commendatory healing is obtained with PRF.

Importance of platelet rich centrifuged blood products

1. In response to tissue injury, platelets gets activated resulting in the formation of platelet plug with subsequent hemostasis.
2. Wound healing is initiated by the release of alpha granules in platelets that contains growth factors (Platelet derived growth factor, platelet factor 4, angiopoietins and thrombospondin 1 which promotes proliferation and differentiation at cellular level.
3. 90% of the growth factors are released during the first hour of wound healing followed by gradual and continuous secretion for the remaining 7 days of their viability [14].
4. Growth factors released from platelets also participate in collagen synthesis, providing a scaffold for migration of osteoblasts [15].
5. Quantity of platelets in any wound determines the quality of healing and platelet rich blood products increases that initial number. The PRP and PRF being rich in platelets have an effective use in soft and hard tissue wound healing.

neo-angiogenesis [10], responsible for the viability of the graft [11-13]. It is a simplified, cost effective process which does not require blood handling and usage of anticoagulants. Because of

Clinical implications of platelet rich blood products

These products can be used in Soft tissue regeneration or hard tissue regeneration.

Soft tissue regeneration

Skin and mucosal abrasions: All the platelet rich blood products are effectively used for soft tissue regeneration in the field of dentistry. Face being a highly aesthetic zone, the complexities in healing after any intervention poses a great challenge to the surgeon. Scar formation is one of the most undesirable outcomes of the healing process. Early primary closure helps minimize the scar, but in cases where there is skin loss, it is not always achievable.

Any wound gets covered with a blood clot which is a focal point of initiating healing. A natural blood clot contains 5% of platelets, 95% of red blood cells, <1% of WBC, and large amount of fibrin strands. A PRP clot contains 95% of platelets, 4% of RBC and 1% of WBC. This increased concentration of platelets can be utilized for the purpose of regeneration. PRF is preferred in soft tissue regeneration over PRP as an additional benefit of fibrin membrane that collects platelet concentrate is obtained.

Although cytokines holds an importance, presence of fibrin meshwork of PRF enacts as the determining element responsible for its potential [16]. The PRF membranes assists in wound repair neither by primary intention nor by pure secondary intention, thus termed as modified secondary intention healing [17]. Platelet gels can also be used as a reliable and potent healing tool in the management of skin and mucosal ulcers [18]. Hom et al. [19] performed a study based on the healing efficacy of autologous platelet gel (APG) on fresh skin wounds and concluded that APG not only enhances wound closure but also increases the wound healing velocity.

Periodontal defects regeneration: Platelet rich products display an effective effect in the regeneration of periodontium. Satisfactory results have been obtained by its use in cases of gingival recession and loss of clinical attachment level [20, 21]. It has been proposed by Garg et al. [22] that the restorable barrier membrane materials are infused with PRP as degranulation of platelets will take place within 1 week thus the presence of resorbable barrier will restrict epithelial migration.

Platelet rich fibrin is also widely used in root coverage procedures [23] in mandibular anteriors in combination with flaps. It helps in re-establishing the continuity and integrity of the zone of keratinized gingiva and protects the surgical site, promoting soft tissue healing. Jankovic et al. [24] compared the use of PRF with connective tissue grafts in cases of gingival recession and documented better postoperative results in relation to healing and comfort of patient.

Augmentation of facial tissues: Platelet rich products along with the adipose tissues are used for the 3-dimensional augmentation of face. Adipocyte grafts can alone be used for this purpose, but the incorporation of these products to the fat mass allows for improved graft vascularization [25,26].

Hard tissue regeneration

A wide range of bone grafts is available which are in constant use from last few decades. Independent use of blood products or in combination with bone grafts has been reported in various literatures to be a great success in terms of hard tissue regeneration. Various conditions include periodontal intrabony defects [27], mandibular fractures [28]. Extraction sockets [29], maxillary sinus augmentation [30,31], ridge augmentation [32], restoration of mandibular continuity along with autologous iliac crest bone [33], and in treatment of periapical defects [34]. Anand et al. [35] proposed the use of layering the implant surface with PRP as it improves the treatment outcomes in cases where immediate loading is required. PRP when coated on an implant surface forms a surface which bears potential biological activity. In 2006, Anitua showed that the osseointegration of implants was enhanced by coating the implant surface with PRP prior to insertion into the alveolus [36].

The use of PRP has also been proposed in the treatment of cartilage degeneration of TMJ in early stages of osteoarthritis [37]. Other than these, PRP has been effectively used as an adjunct to the medicinal treatment of various osseous pathologies like osteoporosis, bone metastasis, associated with solid tumors and multiple myeloma, malignant hypercalcemia) where drugs like bisphosphonates (BPs) are indicated however this drug holds a major disadvantage of causing osteonecrosis [38,39]. The incorporation of PRP in such conditions helps in rejuvenation of bone by the help of its growth factors [40].

Platelet gels has also shown successful reconstructive result in the post-resection cases of jaws, alveolar clefts and established fistulas within maxillofacial region [41]. James et al. [13] reported his work on 15 patients who were treated for alveolar ridge and sinus augmentation by using FDBA along with PRP gel formed by autologous thrombin and concluded by histological and radiographic reports that there was sufficient formation of bone around the implants.

Platelet deficient products

Platelet poor plasma-(PPP): The fraction of plasma containing less than 10, 000/ μ l of platelets is known as platelet poor plasma (PPP) [42]. PPP being rich in fibrinogen is advantageous to use as a sealant for hemostasis.

Fibrin glues-Variou commercially prepared adhesives are available that avoids the use of conventional sutures, however, biological glues prepared from the patient's own blood are considered to be the best choice as the risk of contamination is minimized. The same effects can be achieved by Platelet gels and thus can be used alternatively.

Sealants/hemostats: Application of fibrin glue as sealant can be used in patients requiring face-lift for the elimination of wrinkles, rhinoplasty, scar correction, blepharoplasty, and microvascular surgeries for anastomosis as well as in skin grafting. The adhesive nature of the gel permits good flap approximation, haemostasis and a more accurate closure in comparison to primary closure alone. Being an excellent haemostatic agent it is popular among surgeons as it limits the need of cauterization decreasing the chances of injuring adjacent nerves.

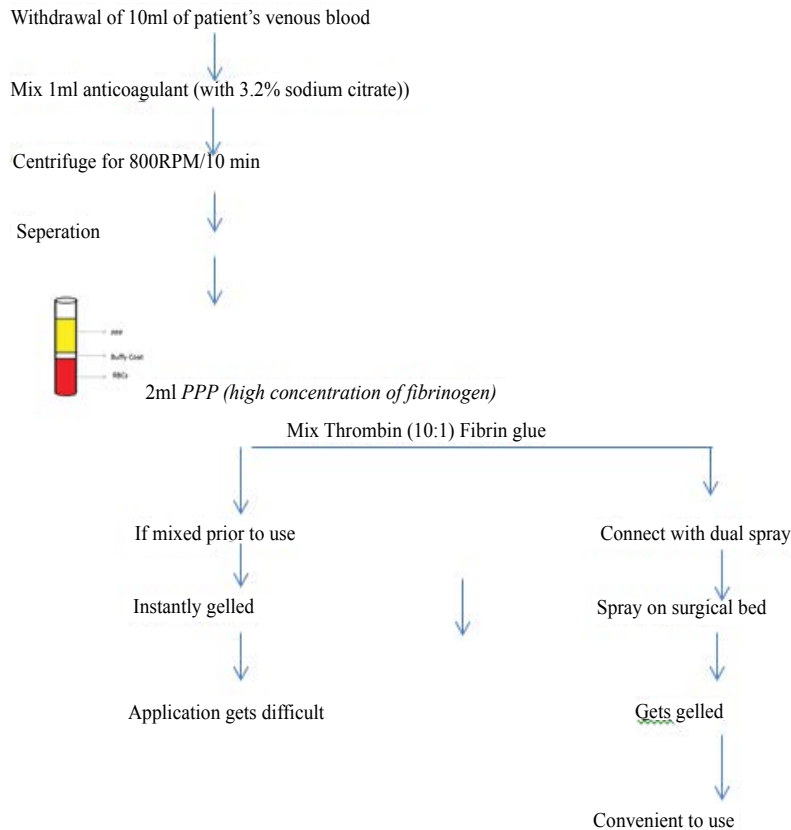


Figure 5 Platelet deficient products.

As autologous fibrin glue imitates the conversion of fibrinogen to fibrin [43], it can be used to arrest haemorrhage in spite of presence of coagulation disorders. While fibrin glues helps to achieve haemostasis and adherence of the flaps [44] autologous platelet gel offers an additional aid of tissue healing, by the presence of high concentrations of growth factors and cytokines in it [45] (Figure 5).

Patients on anticoagulant therapy are at risk of haemorrhage following oral surgical operations and the usefulness of the

autologous fibrin glues and platelet gels are useful in order to control haemostasis [46]. As this product prohibits the discontinuation of anticoagulants a few days before the surgical operation, thus reducing the hospital stay and risk of thromboembolism.

Conclusion

Autologous blood products have shown encouraging success in the field of oral surgery by stimulating and promoting healing.

References

- 1 Tsay RC, Jennifer Vo, Andrea Burke, Eisig SB, Lu HH, et al. (2005) Differential growth factor retention by platelet rich plasma. *J Oral Maxillofac Surg* 63: 521-528.
- 2 Landesberg R, Burke A, Katz DPR (2005) Activation of platelet rich plasma using Thrombin Receptor Agonist Peptide. *J Oral Maxillofac Surg* 63: 529-535.
- 3 Marx RE (2001) Platelet rich plasma (PRP): What is PRP and what is not PRP? *Implant Dent* 10: 225 -228.
- 4 Pietrzak WS, Eppley BL (2005) Platelet rich plasma: biology and new technology. *J Craniofacial Surgery* 16: 1043-1054.
- 5 Choukroun J, Diss A, Simonpieri A, Girard MO, Schoeffler C, et al. (2006) Platelet-rich fibrin (PRF): A second-generation platelet concentrates. Part IV: Clinical effects on tissue healing. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: e56.
- 6 Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, et al. (2006). Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part III: leucocyte activation: a new feature for platelet concentrates. *Oral Surg Oral Med. Oral Pathol Oral Radiol Endod* 101: e51-55.
- 7 Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, et al. (2006) Platelet-rich fibrin (PRF): A second-generation platelet concentrate. Part II: Platelet related biologic features. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: E45-50.
- 8 Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, et al. (2006) Platelet rich fibrin (PRF): A second generation platelet concentrate. Part I: Technological concepts and evolution. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: e37-44.
- 9 Wang HL, Boyapati L (2006) "PASS" principles for predictable bone regeneration. See comment in PubMed Commons below *Implant Dent* 15: 8-17.
- 10 Mosesson MW, Siebenlist KR, Meh DA (2001) The structure and biological features of fibrinogen and fibrin. *Ann NY Acad Sci* 936: 11-30.
- 11 Simonpieri A, Del Corso M, Sammartino G, Ehrenfest DM (2009) The Relevance of Choukroun's Platelet-Rich Fibrin and Metronidazole during Complex Maxillary Rehabilitations Using Bone Allograft. Part II: Implant Surgery, Prosthodontics, and Survival. *Implant Dent* 18:220-229.
- 12 Simonpieri A, Del Corso M, Sammartino G, Ehrenfest DM (2009) The Relevance of Choukroun's Platelet-Rich Fibrin and Metronidazole during Complex Maxillary Rehabilitations Using Bone Allograft. Part I: M A New Grafting Protocol. *Implant Dent.* 18: 102-111.
- 13 Man D, Plosker H, Winland-Brown JE (2001) The use of autologous platelet-rich plasma (platelet gel) and autologous platelet-poor plasma (fibrin glue) in cosmetic surgery plastic & reconstructive surgery 107: 229-237.
- 14 Smith RG, Gassmann CJ, Campbell MS (2007) Platelet-rich plasma: Properties and clinical applications. *The J of Lancaster Gen Hospital* 2: 2.
- 15 Kaur P, Puneet, Dahiya V (2011) Platelet-rich plasma: A novel bioengineering concept. *Trends Biomater. Artif. Organs* 25: 86-90.
- 16 Lundquist R, Dziegiel MH, Agren MS (2008) Bioactivity and stability of endogenous fibrogenic factors in platelet-rich fibrin. *Wound Repair Regen* 16: 356-363.
- 17 Chirag DB, Uma MR, Yogesh KK, Makarand BK (2013) Use of platelet rich fibrin over skin wounds: modified secondary intention healing. *J Cutan Aesthetic Surg* 6: 35-37.
- 18 Picardi A, Lanti A, Cudillo L, Cerretti R, Dentamaro T, et al. (2010) Platelet gel for treatment of mucocutaneous lesions related to graft-versus-host disease after allogenic hematopoietic stem cell transplant. *Transfusion* 50: 501-506.
- 19 Hom DB, Linzie BM, Huang TC (2007) The healing effects of autologous platelet gel on acute human skin wounds. *Arch Facial Plast Surg* 9: 174-183.
- 20 Jankovic S, Aleksic Z, Klokkevold P, Lekovic V, Dimitrijevic B, et al. (2012) Use of platelet-rich fibrin membrane following treatment of gingival recession. A randomized clinical trial. *Int J Periodontics Restorative Dent* 32: e41-e50.
- 21 Martínez-Zapata MJ, Martí-Carvajal A, Solà I, Bolibar I, Angel Expósito J, et al. (2009) Efficacy and safety of the use of autologous plasma rich in platelets for tissue regeneration: a systematic review. *Transfusion* 49: 44-56.
- 22 Garg AK, Gargene D, Peace I (2000) Using platelet-rich plasma to develop an autologous membrane for growth factor delivery in dental implant therapy. *Dental Implant* 11: 41-43.
- 23 Anilkumar K, Geetha A, Umasudhakar T, Ramakrishnan R, Vijayalakshmi (2009) Platelet-rich-fibrin: A novel root coverage approach. *J. Indian Soc Periodontol* 13: 50-54.
- 24 Keyhan SO, Hemmat S, Badri AA, Abdeshahzadeh A, Khiabani K (2013) Use of platelet-rich fibrin and platelet- rich plasma in combination with fat graft: Which is more effective during facial liposuction? *J Oral Maxillofac Surg* 71: 610-621.
- 25 Choukroun JI, Braccini F, Diss A, Giordano G, Doglioli P, et al. (2007) Influence of platelet rich fibrin (PRF) on proliferation of human preadipocytes and tympanic keratinocytes: A new opportunity in facial liposuction (Coleman's technique) and tympanoplasty? *Rev Laryngeal Otol Rhinol (Bord)* 128: 27.
- 26 Braccini F, Dohan DM (2007) The relevance of Choukroun's platelet rich fibrin (PRF) during facial aesthetic liposuction (Coleman's technique): Preliminary results. *Rev Laryngol Otol Rhinol (Bord)* 128: 255.
- 27 Weibrich G, Hansen T, Kleis W, Buch R, Hitzler WE (2004) Effect of platelet concentration in platelet-rich plasma on peri-implant bone regeneration. *Bone* 34: 665-671.
- 28 Daif ET (2013) Effect of autologous platelet-rich plasma on bone regeneration in mandibular fractures. *Dent Traumatol* 29: 399-403.
- 29 Rutkowski JL, Johnson DA, Radio NM, Fennell JW (2010) Platelet rich plasma to facilitate wound healing following tooth extraction. *J Oral Implantol* 36: 11-23.
- 30 Poeschl PW, Ziya-Ghazvini F, Schicho K, Buchta C, Moser D, et al. (2012) Application of platelet-rich plasma for enhanced bone regeneration in grafted sinus. *J Oral Maxillofac Surg* 70: 657-664.
- 31 Butterfield KJ, Bennett J, Gronowicz G, Adams D (2005) Effect of Platelet Rich Plasma with autogenous bone graft for maxillary sinus augmentation in a rabbit model. *J Oral Maxillofac Surg* 63: 370-376.
- 32 Shanaman R, Filstein MR, Danesh-Meyer MJ (2001) Localized ridge augmentation using GBR & Platelet rich plasma: Case reports. *Int J Periodontics Restorative Dent* 21: 345-355.
- 33 Kocyigit ID, Tuz HH, Alp YE, Atil F, Tekin U (2012) Correction of postsurgical alveolar ridge defect with vertical alveolar distraction of the on lay block graft. *J Craniofacial Surg* 23: 1550-1552.
- 34 Jayalaxmi KB, Agarwal S, Singh MP, Vishwanath BT, Krishna A, et al. (2012) Platelet rich fibrin with Tricalcium Phosphate-A novel approach for bone augmentation in chronic periapical lesion. A case report. *Case Rep dent* 9: 52-58.

- 35 Anand U, Mehta DS (2012) Evaluation of immediately loaded dental implants bio activated with platelet-rich plasma placed in the mandibular posterior region: a clinico-radiographic study. *J Indian Soc Periodontology* 16: 89-95.
- 36 Anitua EA (2006) Enhancement of osseointegration by generating a dynamic implant surface. *J Oral Implantol* 32: 72-76.
- 37 Sharma SM, Thakar D (2014) The clinical efficacy of autologous concentrated platelets in treatment of TMJ disorders - a pilot study. *Nujhs* 4.
- 38 Markiewicz MR, Margarone JE, Campbell JH, Aguirre A (2005) Bisphosphonate-associated osteonecrosis of the jaws: a review of current knowledge. *J Am Dent Assoc* 136: 1669-1674.
- 39 Yin G, Bai Y, Luo E (2011) Angiogenic suppression of osteoclasts may play a role in developing bisphosphonate-related osteonecrosis of the jaw. *Med Hypotheses* 76: 347-349.
- 40 Curi MM, Cossolin GS, Koga DH, Araújo SR, Feher O (2007) Treatment of avascular osteonecrosis of the jaw in cancer patients with a history of bisphosphonate therapy by combining bone resection and autologous platelet-rich plasma: report of 3 cases. *J Oral Maxillofac Surg* 65: 349-355.
- 41 Bocanegra-Pérez S, Vicente-Barrero M, Knezevic M, Castellano-Navarro JM, Rodríguez-Bocanegra E, et al. (2012) Use of platelet-rich plasma in the treatment of bisphosphonate-related osteonecrosis of the jaw. *Int J Oral Maxillofac Surg* 41: 1410-1415.
- 42 Kassolis JD, Rosen PS, Reynolds MA (2000) Alveolar ridge and sinus augmentation utilizing platelet rich plasma in combination with freeze dried bone allograft: Case series. *J Periodontol* 71: 1654-1661.
- 43 (2000) Collection, transport, and processing of blood specimens for coagulation testing and general performance of coagulation assays: Approved guidelines. (3rd edn). National Committee for Clinical Laboratory Standards, Wayne, Pennsylvania.
- 44 Clark RA (2001) Fibrin and wound healing. *Ann NY Acad Sci* 936: 355-367.
- 45 Tawes RL Jr, Sydorak GR, DuVall TB (1994) Autologous fibrin glue: The last step in operative hemostasis. *Am. J. Surg* 168: 120.
- 46 Whitman DH, Berry RL, Green DM (1997) Platelet Gel: An autologous alternative to fibrin glue with application in oral and maxillofacial surgery *oral maxillofacial surg* 55: 1294-1299.
- 47 Della Valle A, Sammartino G, Marenzi G, Tia M, Espedito di Lauro A, et al. (2003) Prevention of postoperative bleeding in anticoagulated patients undergoing oral surgery: Use of platelet rich-plasma gel. *Oral Maxillofacial Surg* 61: 1275-127.