

Evaluation of PRP after Maxillary Sinus Membrane Elevation with simultaneous Implant Placement

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ABSTRACT: A lot of grafting materials has been used to augment subsinus area. Many of which have inherited drawbacks, so searching about simple, cheap and natural material and has an osteogenic potential was our domain. Recently, Platelet Rich Plasma was introduced. This study aimed to evaluate bone formation after maxillary sinus membrane elevation using lateral window technique and simultaneous implant placement with and without platelet rich plasma loading. **Patients and methods:** Twelve patients with moderate vertical posterior maxillary bone height (4-7mm) with acceptable inter arch space were included in this study and randomly divided into two equal groups; 6 patients each. Group A (study group) received a Platelet Rich Plasma (PRP) gel loaded around and above the implant. Group B (control group) left without PRP loading. Collagen membrane was applied to cover the lateral bone window in both groups. Bone formation and degree of mineralization was evaluated using Cone Beam Computed Tomography (CBCT) three and six months postoperatively at certain fixed reference points around the implants. **Results:** Radiographically, new bone formation around the implants was observed in both groups with statistically significant higher increase in the mean bone density after three and six months in both groups. However, Group A showed statistically significant higher mean bone density than Group B at 3 and 6 months postoperatively. **Conclusion:** Immediate implants placement in association with maxillary sinus membrane elevation only is a safe and reliable technique and associated with bone healing around the implant. However, the use of PRP promotes bone formation and increases the amount and its degree of mineralization.

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Key words: sinus lifting, sinus membrane tenting, platelet rich plasma, bone formation around implant.

1.INTRODUCTION:

Dental rehabilitation of edentulous posterior maxillary region is considered one of the most significant challenges that face the Oral and Maxillofacial surgeon, as well as, the restorative dentist, *Raja*(2009). Sufficient volume and density of the alveolar bone in edentulous posterior maxilla are prerequisites for success of endosseous implant integration, *Small et al.*(1993). Bone resorption following the extraction of posterior maxillary teeth sometimes results in severe loss of bone in vertical and/or horizontal dimensions, which may preclude the dental implants placement opportunity, *Tatum* (1977).

Following teeth loss progressive sinus pneumatization occurs leading to excavation of the alveolar process above and thus decreasing its height, *Cchanvaz*(1990). This finding is related to two phenomena; first because of the increased osteoclastic activity of the periosteum of the Schneiderian membrane, second because of the increase in positive intra-antral pressure. Consequently, the amount of bone beneath the sinus is often very limited, *Smiller et al.*(1992).

The resorption rate varies from individual to another, and finally leaves inadequate bone height for placement of endosseous implant at the end. In extreme cases, only a paper-thin bone lamella separates the maxillary sinus from the oral mucosa after long-term edentulousness, *Boyne and james*(1980).

The lateral approach using a Caldwell-Luc osteotomy is historically the first technique, where the maxillary sinus floor is grafted to provide a sufficient quantity of bone for the placement of endosteal dental implants. A current issue is the definition of the best filling material for the sinus cavity after lifting the sinus membrane. Considering the high osteogenic potential of the Schneiderian membrane and its periosteum-like behavior, the consensual approach is to consider that most materials, bone substitutes or autologous bone, are efficient in this situation, *Geurs et al.*(2001); *Jensen* (2003). Using this approach, implant placement can be performed in one or two surgical stages depending on the residual alveolar bone height. A minimum of 4 to 5mm was recommended for a one-stage surgical procedure (simultaneous implant placement), however data published since 1998 have shown that

using an appropriate implant design (tapered or microthreaded) and/or an optimal surgical technique (to reach implant stability), sinus floor augmentation with simultaneous implant placement can be performed in cases of 1 to 2mm of residual alveolar bone height with predictable results during a follow-up >10 years, *Wallace et al.,(2006)*.

Different autogenous grafting has been used to fill the space created between the superiorly repositioned sinus membrane and the floor of the sinus. However, its availability is restricted by the limited amount of intra-oral grafts, the morbidity associated with the second surgery at the donor site and the high cost for bone harvesting from extra-oral sites, *Klongnoi et al.,(2006 a and b)*. Allogeneous and alloplastic grafting materials also used to fill the space under the sinus membrane. However these are a biocompatible and osteoconductive materials that provide a scaffold for new bone formation, *Rodriguez et al., (2006)* the lack of osteo-inductive properties compared to natural autologous bone encouraged researchers to find a way for improving its performance. The addition of osteoinductive agents as (PRP) has been assayed, *Roldán et al.,(2008)*; *Schaaf et al.,(2008)*.

The first clinical trial within the field of oral and maxillofacial surgery with PRP was reported by Marx in 1998, which used PRP to improve graft incorporation in mandibular reconstruction in patients who had received cancellous bone marrow graft after tumor resection. His data strongly suggested that adding PRP to bone grafts accelerate the rate of bone formation and degree of mineralization.

PRP is a concentrated autologous source of several growth factors, particularly platelet-derived growth factor (PDGF), transforming growth factor-B (TGFB1 and TGF-B2), vascular endothelial growth factor, insulin-like growth factor, and other growth factors possibly contained within platelets. Once the clinician prepares PRP by extracting a small amount of a patient's own blood, and then sequestering and concentrating the platelets, which is a process that requires 20–30 minutes in an outpatient clinic, PRP can be used to enhance formation of a growth-factor rich membrane or a traditional membrane barrier. Its fibrinogen component also makes PRP an excellent hemostatic tool, tissue sealant, wound stabilizer, and graft condenser, through the creation of a gel-like substance that allows for sculpting and excellent adherence in defects, *Samule and lynch(1994)*; *Garg(2000)*.

Researchers have shown radiographically that adding PRP to graft material significantly accelerates the rate of bone formation and improves trabecular bone density as compared to sites treated with only autogenous graft, *Samule and lynch(1994)*; *Tozum and Demiralp(2003)*. Some evidence even suggests

that adding PRP to graft material leads to bone growth that is denser than native bone, *Marx and Garg(1999)*; *Marx(2002)*. PRP growth factors are particularly attractive for cases in which conditions typically reduce the success of bone grafts and osseointegration. These include patients with severely atrophic maxilla, patients with osteoporosis, and those with periodontal disease, and subsequently scarred and altered tissues, *Lynch et al.,(1994)*.

Plasma Rich Growth Factors jump- starts osteogenesis by releasing several growth factors at the local site. Osteoblasts can move across a greater distance by creating a scaffold system (fibrin). This will assist their movement, speed up mineralization, early consolidation and improves trabecular bone density, *Nazaroglu and Matoulas(2009)*. This study aimed to evaluate the role of PRP in bone formation around the implant projecting into maxillary sinus after Schneiderian membrane elevation.

2.PATIENTS AND METHODS:

2.1.Patients

The present study was conducted on twelve patients (all were females) with age ranged from 40-55 years seeking implantation of their lost posterior maxillary teeth, and has limited bone height below the floor of the maxillary sinus, secondary to sinus pneumatization. They were selected from outpatient clinic; Oral and Maxillofacial Surgery Department, Faculty of Oral and Dental Medicine, Cairo University.

Patients were selected on the basis of history, clinical examination and radiographic examination using panoramic radiography to fit the following inclusion criteria:

- No recent sinus surgery, severe sinus floor convolutions or prominent sinus septa.
- Acceptable inter-arch space for the future prosthesis.
- Had a ridge height at the site of implantation should be (4-7 mm).

All patients were informed about sinus lifting and implant placement procedures and they gave their approval to participate in this study with written consent. Patients were randomly divided into two groups, six patients each'

***Group A (study group):** Subjected to maxillary sinus lifting and implant placement with autogenous PRP loading.

*** Group B (Control group):** Subjected to maxillary sinus lifting and implant placement without PRP Loading.

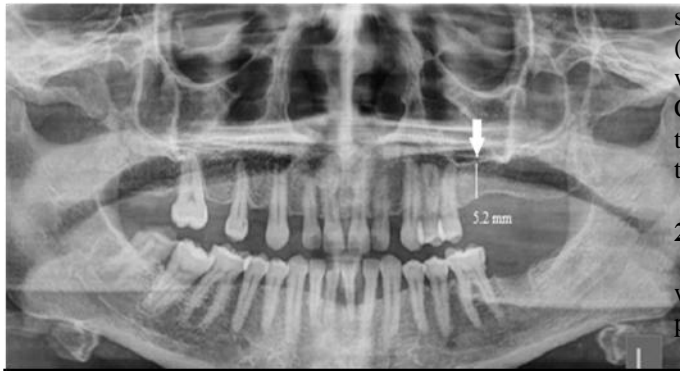


Figure (1): A photoradiograph showing sinus pneumatization

The platelet rich plasma was prepared from the patient's own blood just before surgery.

40ml of venous blood withdrawn and equally loaded to 8 tubes of 5ml previously loaded with anticoagulant citrate dextrose-A. These tubes were centrifuged for 10 minutes at 1300 rounds per minute. After the first spin the whole blood is separated into a lower red colored blood cell layer, upper straw colored layer contains the platelets poor plasma (PPP) and a platelet rich plasma (PRP) layer in the boundary layer between these two layers. The upper straw colored plasma layer (PPP) and 2 mm of top part of the red layer (PRP) is aspirated and transferred into another tube and again centrifuged for 15 minutes at 3500 rpm. This results in upper portion of clear yellow serum and the bottom dark yellow layer consisting of highly concentrated PRP. The bottom layer of PRP was aspirated (about 0.6ml from each tube) into another syringe. A mixture of 1ml of 10% calcium chloride solution and 80 units USA bovine thrombin was mixed (activator), 0.5 ml of the prepared activator was added to the freshly prepared platelet rich plasma and left for 2 minutes to complete the activation and the gel state transformation of the PRP (Each 1ml PRP require 0.1ml of the activator to be activated), Tamimi et al.,(2007).

2.2.Methods:

2.2.1.SURGICAL PROCEDURE:

A trapezoid flap was used to fully expose the alveolar ridge and the lateral wall of the maxillary sinus (Fig 2). Through the surgical stent pilot drill to make the initial hole a long which the lateral window and Schneiderian membrane lifting was done, then implant placement extending into the sinus chamber was performed (Figure 3). In GROUP (A) the space between the sinus membrane and the floor of the

sinus around the fixture was filled with the PRP gel (Fig4). In GROUP B the elevated sinus membrane was tented over the fixture without PRP loading. Collagen membrane was applied to completely cover the lateral surgical area in both groups (Figure 5), and then flap was sutured.

2.2.2. Postoperative radiographic evaluation:

Immediate postoperative panoramic radiograph was performed to ensure the proper implant positioning (Fig6)



Figure (6): A photoradiograph showing proper implant position.

CBCT (coronal & Saggital) was used to evaluate the amount of formed bone around the portion of the implant inside the sinus cavity of all cases and its density at three and six months postoperatively using intraoral radiography (IOR) software (Fig 7)

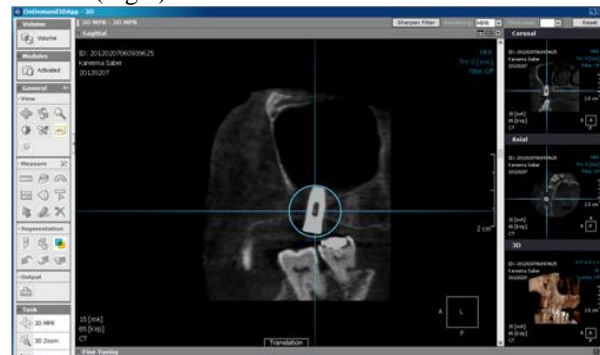


Figure (7): A photoradiograph showing sagittal section of CBCT, intraoral radiography (IOR) software used to record bone density.



Figure (2): A photograph showing the flap reflection.



Figure (3): A photograph showing the sinus membrane tented over the implant.

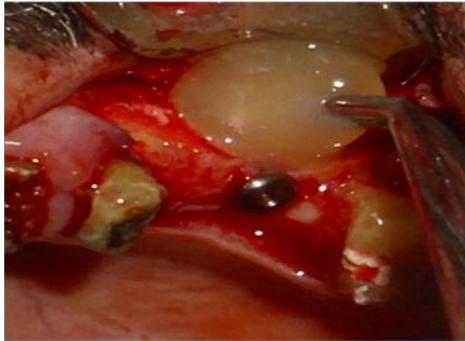


Figure (4): A photograph showing PRP application into the sinus.



Figure (5): A photograph showing collagen membrane placement.

2.2.3. Statistical analysis

Data were presented as mean and standard deviation (SD) values. Student's t-test was used to compare between mean bone density measurements in the two groups. Paired t-test was used to study the changes by time in each group. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM (IBM Corporation, NY, USA) SPSS Statistics Version 20 for Windows.

3.RESULTS:

3.1.Clinical results:

All cases showed uneventful healing except one case in group B presented immediate postoperative minor nasal bleeding which stopped shortly probably due to sinus membrane injury. One case in group A showed mucosal soft tissue infection that

was treated using antibiotic prescriptions and chlorhexitol mouth wash.

3.2.Radiographic Results:

CBCT revealed bone deposition around the implants at three and six months postoperatively which appeared as increase radio-opacity around the implant with its protruded portion inside the maxillary sinus. The bone density was measured by Houns field Units. The minimum sinus elevation gained was 4 mm and the maximum was 6.2mm with mean of 5.31 ± 0.6 mm.

However bone formation occurs around implants in both groups group A showed complete covering of the implants even above its ends (Fig 8) , but group B showed incomplete coverage of the implant ends (fig 9).

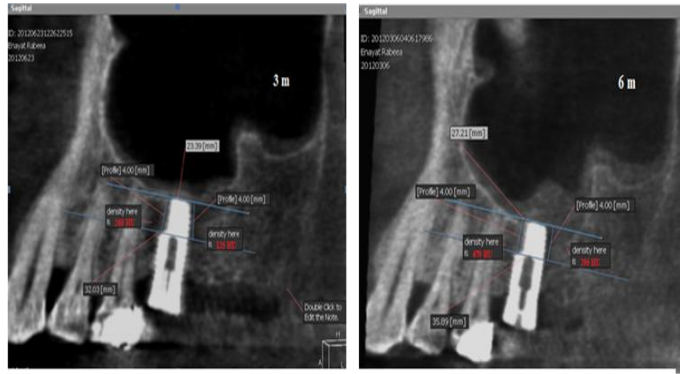


Figure (8): A photoradiograph of 3 and 6 months cone beam C.T (Sagittal view) Group A.

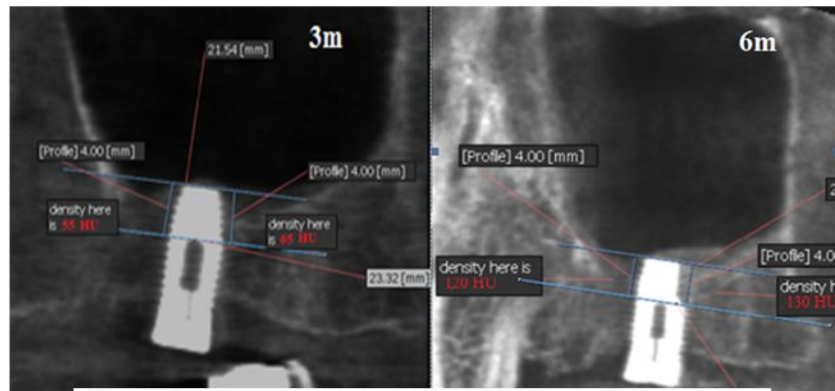


Figure (9): A photoradiograph of 3 and 6 months cone beam C.T (Sagittal view) Group B.

Comparison between bone density measurements and its percentage increases in both groups showed statistically significant higher mean bone density in group A than group B at three and six months postoperatively (tab 1).

Table (1): showing the mean, standard deviation (SD) values and results of Student’s t-test for comparison between bone density measurements in the two groups.

Group Period	Group A		Group B		P-value
	Mean±	SD±	Mean±	SD±	
3 months	247.9	31.2	112.8	16.7	<0.001*
6 months	458.7	34.1	176.7	25.4	<0.001*

*: Significant at P ≤ 0.05

Changes by time within each group: showing a statistically significant increase in the mean bone density at three and six months postoperatively in both groups (tab 2).

Table (2): Showing the mean, standard deviation (SD) values and results of paired t-test for the changes by time in the mean bone density measurements of each group.

Period Group	3months		6months		P-value
	Mean ±	SD ±	Mean ±	SD±	
Group A	247.9	31.2	458.7	34.1	<0.001*
Group B	112.8	16.7	176.7	25.4	<0.001*

*: Significant at P ≤ 0.05

4. DISSCUSSION:

The choice of the lateral window technique in this study was to allow proper visualization of Schneiderian membrane and allows proper and easier application of the gel-like PRP, this accordance with *Shulman and Jensen* (1998). For simultaneous implant placement with sinus floor elevation procedure, a minimum of 4mm of residual bone height has been recommended in order to achieve sufficient initial implant stability, which result was in agreement with *Kaneko et al.*, (2012).

The main question of this study was to fill or not to fill during sinus-lifting? During sinus-lift, the biomaterials were used as space maintainers and scaffold to promote bone regeneration in the subsinus area. The general consensus was that many biomaterials were usable in the sinus, because of the membrane, *Browaeyts et al.*, (2007). Consequently; both Summer's and lateral sinus-lift techniques can easily be performed without any material, particularly for small grafting volume, *Nedir et al.*, (2006); *Thor et al.*, (2007). However, some authors believed that when no filling is used, have shown that the true bone gain is in fact always limited and that implant apical ends might be enmeshed in the sinus connective tissue and, thus, not osseointegrated. *Sul et al.*, (2008 a and b) the results of our study agreed with this concept. However, bone formation occurs around implants filling the subsinus area, the ends of some implants in control group was not fully covered with bone. These results disagreed with other authors *Lundgren et al.*, (2005) and *Anderson et al.*, (2003) who concluded that a good survival rate was observed in the implant placed with lateral approach for maxillary sinus lift with tenting technique only.

The systematic use PRP during sinus-lift, with or without bone substitute, seems a very interesting option, particularly for the protection of the Schneiderian membrane, *Ehrenfest et al.*, (2009) Moreover, from our results we can conclude that the use of PRP as sole filling material seems able to stabilize a quite high amount and more dense bone around the implants. Indeed, in this study, the follow-up showed that peri-implant bone finally stabilized up to the implant end in PRP group (group A). This result was quite different from the non PRP group (group B) which showed that the use of PRP, as an optimized natural platelet clot, seemed to avoid the enmeshment of the implant end in a thick sinus connective tissue which agreed with *Sul et al.* (2008).

This result could be the consequence of the applications of PRP gel as membrane on the Schneiderian membrane cushioned it and prevent direct contact to the implant. Indeed, a PRP cover on the sinus membrane can potentially improve the

healing of the membrane, induce a stimulation of the periosteum, and perhaps stabilize a new bone volume at the end of the implant and this was in accordance with *Sul et al.*, (2008); *Dohan et al.* (2009 and 2010) This effects may be both related to the platelet and fibrin content of the PRP, *Clark* (2001); *Lindeboom et al.*, (2007).

Although general agreement currently exists regarding the efficacy of either autogenous bone graft or allogeneic bone substitutes in sinus lifting to enable an increase in the height of bone formation into the maxillary sinus, *Boyne and James* (1980), yet, in the present study none of these graft material was placed inside the sinus after membrane elevation and bone formation around the implant occurs, this also supported by *Thor et al.*, (2007); *Pjetursson et al.*, (2008).

However, *Esposito et al.*, (2010) stated that there was no evidence that PRP treatment improved the clinical outcome of sinus lift procedures with autogenous bone or bone substitutes. We found that after the period of 6 months, in both groups, bone was formed around the implant and filled that space created under the Schneiderian membrane. But when the comparison was done using CBCT, we found that high bone amount and density recorded in group A compared to group B. This agreed with *Pacifici et al.*, (2003); *Schaaf et al.*, (2008) who stated that PRP guaranties a better quantity and quality in terms of speed and degree of mineralization.

From a practical standpoint, the use of PRP on the Schneiderian membrane is a simple mechanical and biological protection that can be used in daily practice, whatever the filling material. Therefore, we can clearly answer the question: Filling or not filling during sinus-lift? Filling is not absolutely necessary because the natural blood clot inside the subsinus chamber is enough for bone healing; but filling at least with PRP, i.e. optimized blood clots, seems the adequate alternative to improve natural healing and to secure the surgical procedure.

Conclusion

Immediate implantation in association with sinus floor elevation without grafting materials is safe and reliable technique and associated with a good survival rate. The use PRP improves and minimizes the healing period, and increases the amount and density of newly formed bone around the whole length of the implant.

5. REFERENCES:

1-Boyne p, James RA: grafting of the maxillary sinus floor with autogenous marrow and bone. *Int J Oral Maxillofac Surg* 1980; 38:113.

- 2-Browaeys H, Bouvry P, De Bruyn H.** A literature review on biomaterials in sinus augmentation procedures. *Clin Implant Dent Relat Res.* 2007; 9: 166.
- 3-Cchanvaz M:** Maxillary sinus: anatomy, physiology, surgery and bone grafting related to implantology – eleven years of surgical experience. *J Oral implantol* 1990; 16: 199.
- 4-Clark RA.** Fibrin and wound healing. *Ann N Y Acad Sci.* 2001;936: 355
- 5-Dohan Ehrenfest DM, Diss A, Odin G.** In vitro effects of Choukroun's PRF (platelet-rich fibrin) on human gingival fibroblasts, dermal prekeratinocytes, preadipocytes and maxillofacial osteoblasts in primary cultures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009; 108: 341.
- 6-Dohan Ehrenfest DM, Doglioli P, de Peppo GM.** Choukroun'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.
- 7-Dohan Ehrenfest DM, Rasmusson L, Albrektsson T.** Classification of platelet concentrates: From pure platelet-rich plasma (P-PRP) to leucocyte- and platelet rich fibrin (L-PRF). *Trends Biotechnol.* 2009; 27: 158.
- 8-Esposito M, Grusovin MG, Rees J, Karasoulos D, Felice P, Alissa R, Worthington HV et al.** Interventions for replacing missing teeth: augmentation procedures of the maxillary sinus. *Cochrane Database Syst Rev.* 2010; 3: 397
- 9-Garg AK.** Using platelet-rich plasma to develop an autologous membrane for growth factor delivery in dental implant therapy. *Dent Implantol Update.* 2000; 11: 41
- 10-Geurs NC, Wang IC, Shulman LB, Jeffcoat MK.** Retrospective radiographic analysis of sinus graft and implant placement procedures from the Academy of Osseointegration Consensus Conference on Sinus Grafts. *Int J Periodontics Restorative Dent* 2001; 21: 517.
- 11-Jensen** Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Ann Periodontol* 2003;8: 328.
- 12-Kaneko T, Masuda I, Horie N, Shimoyama T.** New bone formation in nongrafted sinus lifting with space-maintaining management: a novel technique using a titanium bone fixation device. Department of Oral and Maxillofacial Surgery, Saitama Medical Center, Saitama Medical University, Saitama, Japan. *J Oral Maxillofac Surg.* 2012; 70:217.
- 13-(a)Klongnoi, B., Rupprecht, S., Kessler, P., Thorwarth, M., Wiltfang, J. & Schlegel, K.** Influence of platelet-rich plasma on a bioglass and autogenous bone in sinus augmentation. An explorative study. *Clinical Oral Implants Research.* 2006; 17: 312.
- 14-(b) Klongnoi, B., Rupprecht, S., Kessler, P., Zimmermann, R., Thorwarth, M., Pongsiri, S., Neukam, F. W., Wiltfang, J. & Schlegel, K. A.** Lack of beneficial effects of platelet-rich plasma on sinus augmentation using a fluorohydroxyapatite or autogenous bone: an explorative study. *Journal of Clinical Periodontology.* 2006; 33: 500.
- 15-Lindeboom JA, Mathura KR, Aartman IH, et al.** Influence of the application of platelet-enriched plasma in oral mucosal wound healing. *Clin Oral Implants Res.* 2007; 18: 133.
- 16-Lundgren S, Andersson S, Gualini F, Sennerby L.** Bone reformation with sinus membrane elevation: a new surgical technique for maxillary sinus floor augmentation. *Clin Implant Dent Relat Res.* 2004; 6:165.
- 17-Lynch SE, Trippel SB, Finkelman RD, et al.** The combination of platelet derived growth factor and insulin-like growth factor I stimulates bone repair in adult Yucatan miniature pigs. *Wound Rep Reg.* 1994; 2: 182.
- 18-Marx RE.** Clinical effects of platelet rich plasma on soft-tissue healing. Paper presented at: First Symposium on Platelet- Rich Plasma and Its Growth Factors; February 28–March 2, 2002; Lake Buena Vista, FL.
- 19-Marx RE, Garg AK.** Bone graft physiology with use of platelet-rich plasma and hyperbaric oxygen. In: Jensen OT, ed. *The Sinus Bone Graft.* Chicago, IL: Quintessence; 1999:183.
- 20-Marx RE, Carlson ER, Eichstaedt RM.** Platelet-rich plasma. Growth factor enhancement for bone grafts. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998; 85: 638.
- 21-Nazaroglou I, Matoulas E.** The effect of platelets-rich plasma on reconstruction of mandibular and maxillary bone defect: A review of recent experimental studies on human and animals. *Surgery Jurnal.* 2009 Apr (1): 1.
- 22-Nedir R, Bischof M, Vazquez L, et al.** Osteotome sinus floor elevation without grafting material: A 1-year prospective pilot study with ITI implants. *Clin Oral Implants Res.* 2006;17: 679
- 23-Raja SV:** Management of the posterior maxilla with sinus Lift: Review of Techniques. *J Oral Maxillofac Surg* 2009; 67:1730.
- 24-Pacifici L, Casella F, Ripari M.** Lifting of the maxillary sinus: complementary use of platelet rich plasma, autologous bone deproteinised bovine bone. Case report. *Minerva Stomatol.* 2003; 52:471.

- 25-**Pjetursson BE, Tan WC, Zwahlen M, Lang NP.** A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. *J Clin Periodontol.* 2008; 35:216.
- 26-**Rodriguez, A., Anastassov, G. E., Lee, H., Buchbinder, D. & Wettan, H.** Maxillary sinus augmentation with deproteinated bovine bone and platelet rich plasma with simultaneous insertion of endosseous implants. *Journal of Oral Maxillofacial Surgery* 2003; 61: 157.
- 27-**Roldán, J. C., Knueppel, H., Schmidt, C., Jepsen, S., Zimmermann, C. & Terheyden, H.** Single-stage sinus augmentation with cancellous iliac bone and anorganic bovine bone in the presence of platelet-rich plasma in the miniature pig. *Clinical Oral Implants Research* 2008; 19: 373.
- 28-**Small SA, Zinner ID, Panno FV, Shapiro HJ, Stein JJ:** Augmentation of maxillary sinus for implants: report of 27 patients. *Int J Oral Maxillofac Implants* 1993; 8:523.
- 29-**Smiller DG, Johnson PW, Misch C:** sinus lift grafts and endosseous implants. *Dent Clin North Am* 1992; 36:15.
- 30-**Samule E. lynch.** The role of growth factors in periodontal repair and regeneration. *Periodontal regeneration: current status and direction*; 1994; 8:179.
- 31-**Schaaf, H., Streckbein, P., Lendeckel, S., Heidinger, K., Go`rtz, B., Bein, G., Boedeker, R. H., Schlegel, K. A. & Howaldt, H. P.** Topical use of platelet-rich plasma to influence bone volume in maxillary augmentation: a prospective randomized trial. *Vox Sanguinis* 2008; 94: 64.
- 32-**Simultaneous implant placement in the severely atrophic posterior maxilla:** A 9-year longitudinal experience study of 2132 implants placed into 731 human sinus grafts. *Int J Oral Maxillofac Implants* 2006; 21: 94.
- 33-**Shulman LB, Jensen OT.** Sinus Graft Consensus Conference. Introduction. *Int J Oral Maxillofac Implants.* 1998; 13 suppl:5.
- 34-(a)**Sul SH, Choi BH, Li J, et al.** Histologic changes in the maxillary sinus membrane after sinus membrane elevation and the simultaneous insertion of dental implants without the use of grafting materials. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2008; 105: 1.
- 35- (b)**Sul SH, Choi BH, Li J.** Effects of sinus membrane elevation on bone formation around implants placed in the maxillary sinus cavity: An experimental study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2008;105: 684.
- 36-**Sten Anderson, Martignoni M, Miranda Burgos P, Gottlow J, Sennerby L:** Bone Reformation with Sinus Membrane Elevation: A New Surgical Technique for Maxillary Sinus Floor Augmentation. *Clin Implant Dent Relat Res* 2003; 5:88.
- 37-**Schaaf H, Streckbein P, Lendeckel S, Heidinger KS, Rehmann P, Boedeker RH, Howaldt HP.** Sinus lift augmentation using autogenous bone grafts and platelet-rich plasma: radiographic results. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2008; 5:673.
- 38-**Tatum OH:** Maxillary Sinus Elevation and Subantral augmentation, *Alabama Implant Study J.*1977; 8:67.
- 39-**Tamimi FM, Montalvo S, Tresguerres I, Blanco Jerez L.** A comparative study of 2 methods for obtaining platelet-rich plasma. *J Oral Maxillofac Surg.* 2007; 65: 1084.
- 40-**Tozum TF, Demiralp B.** Platelet-rich plasma: A promising innovation in dentistry. *J Can Dent Assoc.* 2003; 69: 664.
- 41-**Wallace SS, Froum SJ, Thor A, Sennerby L, Hirsch JM, et al.** Bone formation at the maxillary sinus floor following simultaneous elevation of the mucosal lining and implant installation without graft material: An evaluation of 20 patients treated with 44 Astra Tech implants. *J Oral Maxillofac Surg.* 2007; 65:64.