Comparative Study of Alveolar Bone Height and Implant Survival Rate Between Autogenous Bone Mixed with Platelet Rich Plasma Versus Venous Blood for Maxillary Sinus Lift Augmentation Procedure

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Abstract

Aim and Objectives The aim of this study was to evaluate changes in alveolar bone height by means of radiographic examination and Straumann implant survival rate following maxillary sinus lift augmentation using autogenous bone in combination with platelet rich plasma (PRP) versus venous blood (VB).

Methods Fifty patients requiring sinus lift augmentation procedure included in the study were divided into two groups ($n = 25$). During the procedure the sub antral sinus cavity was augmented using autogenous bone taken from mandibular ramus area and mixed with PRP in one group and autogenous bone mixed with VB in the other group. Orthopantomograms were taken preoperatively, immediate, at 6 months and 1 year postoperatively. Height of alveolar bone at the site of sinus augmentation was measured on the radiographs. One hundred and twenty-one Straumann dental implants were placed after healing period.

Results Age of the patients in the study groups ranged from 36 to 69 years. Differences in mean values of bone height measurements recorded in the PRP series revealed significant differences among the three subgroups ($P = 0.001$). Significant differences were noted between immediate postop and 6 month ($P < 0.01$), immediate postop and year ($P < 0.01$). In the VB series also significant differences were revealed among the three subgroups ($P = 0.0280$). Significant differences were noted between immediate postop and 6 month ($P < 0.05$). Comparison of results of subgroups of the two series at the three intervals revealed significant differences at 'immediate postop' values ($P = 0.0002$) and 'sixmon' values ($P = 0.0435$). Differences between 'year' values were not significant. Two implants were lost in PRP group.

Conclusion The results of this limited study reveals that both groups recorded a good increase in the alveolar bone height after sinus augmentation and showed no significant differences between these groups when compared to each other at 1 year postoperatively. When both sub groups compared with immediate postop to year, PRP group showed significant difference and blood group showed no significant difference.

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Introduction

Implant placement in the posterior maxilla is always a challenge to the surgeon due to pneumatization of the sinus with age and also due to poor quality of the bone. Success of implant osseointegration always depends on the quality and quantity of bone. The solution offered to counter this

Table 1 PRP group statistical data at all intervals

	Preoperative	Imm-post op	P-six month	P-one year
Mean	4.76	18.73	17.15	17.28
SEM	0.24	0.23	0.34	0.32
SD	1.19	1.15	1.68	1.61

Table 2 Venous blood group statistical data at all intervals

	Pre-operative	Imm-post op	P-six month	P-one year
Mean	4.84	17.13	16.31	16.71
SEM	0.23	0.27	0.17	0.15
SD	1.16	1.37	0.83	0.73

problem and for placing dental implants is the raising and augmentation of the maxillary sinus floor, and it is referred to as sinus floor augmentation which was first described by Tatum [1].

A variety of materials have been utilized for maxillary sinus augmentation ranging from bone substitute materials to autogenous bone. Many authors recommend autogenous bone [2, 3] where as some authors recommend heterografts [4–6] and further some others prefer xenografts [7, 8] and synthetic [9, 10] bone substitutes. Some studies by various authors even showed mixing the bone grafts with platelet rich plasma (PRP) [11] and venous blood (VB) [12]. Since PRP and VB is developed from autologous blood, it is safe and free from transmissible diseases. PRP [13–15] is a source of several growth factors, particularly platelet derived growth factor (PDGF), transforming growth factor, vascular endothelial growth factor, insulin like growth factor, epidermal growth factor and other growth factors (Table 1).

The aim of the study was to evaluate changes in alveolar bone height by means of radiographic examination and implant survival rate following maxillary sinus lift augmentation using autogenous bone in combination with PRP and VB.

Materials and Methods

Fifty patients requiring sinus lift augmentation procedure included in the study were divided into two groups ($n = 25$). During the procedure the sinus cavity was augmented using autogenous bone mixed with PRP in one group and autogenous bone mixed with VB in the other group. Mean age in the PRP group was 51.2 (ranging from 36 to 67 years) and in the VB group it was 55.1 (ranging from 38 to 69 years). In the PRP group there were 21 females and 4 males and in the VB group there were 14 females and 11 males (Table 2).

Pre-operative evaluation included detailed medical, clinical history and radiological examination. All the orthopantomogram radiographs showed inadequate alveolar bone height in the posterior maxilla. Pre-operatively the height of the alveolar bone ranged from 1 to 5 mm and the mean alveolar bone height in PRP group was 4.76 mm and in VB group it was 4.84 mm.

Surgical Procedure

The sinus lift operation for bone augmentation of the posterior maxillae can help to correct the problem of insufficient bone by raising the sinus floor and developing bone for the placement of dental implants (Table 3).

The sinus lift surgical procedures were done under intravenous sedation. A crestal (or) palatal incision was placed and mucoperiosteal flap raised and buccal surface of the maxillary sinus was exposed. A 2 cm wide window was made on the lateral wall of the sinus, bone plate was separated from the Schneiderian membrane (Table 4).

After Schneiderian membrane was elevated using sinus lift instruments, resorbable collagen membrane was placed below the Schneiderian membrane (Fig. 1) and autogenous graft material which was taken from the same side mandibular ramus area was particulated in a bone mill (Fig. 2) and made into small bone slices of 2 mm $\times$ 2 mm (Fig. 3) and mixed with PRP (Fig. 4) or with VB (Fig. 5). The autogenous bone mixed with 8 ml of PRP was then packed into the space between the elevated Schneiderian membrane along the collagen membrane and the bony wall and sinus floor for the patients in PRP group.

For the patients in VB group, the autogenous bone was mixed with 8 ml of the VB sampled from the vein of the patients' arm and then used to fill the space formed after elevating the Schneiderian membrane. Resorbable collagen membrane was used to cover the prepared window (Fig. 6). Mucoperiosteal flap was repositioned and the wound was closed using non-resorbable suture material. After a healing period of 4–6 months the implant placement procedure was done.

Patient Evaluation and Follow Up

All the patients in the study were evaluated clinically and radiographically preoperative, immediate postoperative, 6 months and 1 year postoperatively. Clinical assessment was done for any infection, wound dehiscence, sequestration, loss of graft and loss of implants. Alveolar bone height was measured preoperatively, immediate, 6 months and 1 year postoperatively on the orthopantomogram radiograph. The alveolar bone height was measured at three places on the sinus i.e. in the mesial side, central part and in the distal side of the maxillary sinus before and after sinus

Table 3 Comparison of statistical data between PRP and VB groups

	Pre operative mean	SEM	Immediate post op mean	SEM	6 month post op mean	SEM	1 year post op mean	SEM
PRP group	4.76	0.24	18.73	0.23	17.15	0.34	17.28	0.32
VB group	4.84	0.23	17.13	0.27	16.31	0.17	16.71	0.15

Table 4 Data showing no of Straumann dental implants placed

	Implants placed	Implants lost
PRP group	58	2
VB group	63	0
Total	121	2

Fig. 1 Resorbable collagen membrane placed below sinus membrane **Fig. 2** Bone graft in bone miller

augmentation. The outline of the maxillary sinus before and after sinus augmentation was reproduced on the tracing paper from the orthopantomogram radiograph and

Fig. 3 Bone graft made into slices **Fig. 4** Bone graft mixed with PRP

measurements were recorded. All the measurements were added and average of the total was taken as the standard value for the alveolar bone height.

Results

In both groups 14 procedures were carried out on the left side and 11 on right side. Pre-operatively the mean of the alveolar bone height in the PRP group was 4.76 mm and in the VB group it was 4.84 mm. In PRP group 58 Straumann implants were placed, and in VB group 63 Straumann implants were placed after a healing period of 4–6 months

Fig. 5 Bone graft mixed with venous blood

Fig. 6 Resorbable collagen membrane was used to cover the prepared sinus cavity

after sinus augmentation procedure. Two Straumann implants were lost in the PRP group.

Statistical Analysis

Kruskal–Wallis (non parametric one-way ANOVA) test was conducted to detect differences among the results of the three subgroups of PRP and VB groups in relation to values obtained for the alveolar bone height at immediate postoperative, 6 month and 1 year postoperative periods.

Significant differences were confirmed when the Kruskal–Wallis statistic (KW) was high and the P value approximate from Chi square distribution was <0.05 .

When there was a significant difference among the three subgroups as above, Dunn's post test was carried out to compare the differences among each pair of columns. Significant P value was considered to be <0.05 .

Results obtained for the relevant subgroups in PRP and VB were compared using Mann–Whitney test. Significant P value was considered to be <0.05 .

ANOVA test comparing the three subgroups (immediate post-operative, 6 months and 1 year post-operative) of PRP group revealed significant differences ($P = 0.001$, KW statistic = 13.87).

Dunn's posttest comparing subgroups (immediate post-operative, 6 months and 1 year post-operative) of PRP revealed significant differences between immediate postop and 6 month ($P < 0.01$), immediate postop and year ($P < 0.01$). Differences between 6 month and year are not significant.

ANOVA test comparing the three subgroups(immediate post-operative, 6 months and 1 year post-operative) of VB group revealed significant differences ($P = 0.0280$, KW statistic = 7.152).

Dunn's posttest comparing subgroups(immediate post-operative, 6 months and 1 year post-operative) of VB group reveals significant differences between immediate postop and 6 month ($P < 0.05$).

Differences between immediate postop and year and also 6 month and year are not significant in VB group.

Mann–Whitney test revealed significant differences between immediate postop subgroups of PRP and VB groups ($P = 0.0002$).

Mann–Whitney test revealed significant differences between 6 month subgroups of PRP and VB groups ($P = 0.0435$).

Mann–Whitney test revealed differences between year subgroups of PRP and VB groups as not significant.

Discussion

In 1994, Tayapongsak et al. [16] introduced the idea of adding autologous fibrin adhesive to cancellous bone during mandibular reconstruction. Marx et al. [17] have shown that the use of PRP concentrate was a source of autologous growth factors and led to an increase in the bone formation and density after autologous bone grafting.

Kim et al. [18], suggested the use of PRP in treatment of bone defects around implants and showed good results in accelerating the osseointegration of titanium implants. In 2001, Yildirim et al. [19] evaluated the bone formation following maxillary sinus augmentation using bovine substitute material bio-oss in combination with VB by means of histologic and histomorphometric examination of human biopsies and histomorphometric examination of human biopsies and the analysis showed 14.7 % newly formed bone and 29.1 % of the surface of the bio-oss granulate was in direct contact with newly formed bone. Study by Lundgren et al. [20] indicated that bone grafts or bone substitutes may not be needed to achieve augmentation of the maxillary sinus floor. McCarthy et al. [21] conducted a study and evaluated that sinus augmentation

procedure using autogenous bone grafting can increase bone volume to allow implant placement where there is insufficient bone and infection during the healing of the grafted site which reduces the success of subsequent implant osseointegration. A clinical study by Thor et al. [22] showed that high implant survival rate was achieved after 1 year of loading in the maxillae following autogenous bone grafting whether or not PRP was used, with less bone resorption on PRP side.

Raghobear et al. [23] in 2005 showed that the PRP had no beneficial effect on wound healing and bone remodeling of autogenous bone grafts used for augmentation of the maxillary sinus floor. Choukroun et al. [24] showed that sinus floor augmentation with FDBA and platelet-rich fibrin leads to a reduction of healing time prior to implant placement.

In the present study Krusal–Wallis test was used to compare the results of the three sub groups of PRP and VB groups at immediate post-operative, 6 months and 1 year post-operatively. Mann–Whitney test was used to compare between PRP and VB groups.

In the PRP group, mean value of immediate post-operative data was 18.73 mm, mean value of 6 months post-operative was 17.15 mm and 1 year post-operative data showed the mean value to be 17.28 mm.

In the VB group the mean value of immediate post-operative data was 17.13 mm, 6 months post-operative mean value was 16.31 mm and 1 year post-operative data showed the mean value to be 16.71 mm.

Thus this study shows that there is slight graft resorption in both the PRP and VB groups when immediate post-operative data was compared to 6 months data where as when compared to 1 year data PRP group data showed slightly significant difference, but VB group showed no significant difference when immediate data was compared to 1 year data, thus indicating further studies are needed to assess the use of VB as an alternative to PRP.

The advantages of using the autogenous bone mixed with VB are (1) not a time consuming procedure (2) no anticoagulants used (3) reduces the cost (4) no specific device required, (5) can be used in all countries, (6) no chance of infection.

But when these two groups compared among themselves, they show no significant difference after 1 year, showing good clinical benefits in both groups. Implant survival rate in the PRP group was 96.6 % and in the VB group it was 100 %. Two Straumann implants were lost in the PRP group with a failure rate of 3.4 %.

Conclusions

The results of this limited study reveals that both groups recorded a good increase in the alveolar bone height after

sinus augmentation and showed no significant differences between the groups when compared to each other at 1 year post-operatively.

Thus the study shows that autogenous bone mixed with PRP or VB produces similar long term clinical results with autologous bone mixed with VB having slight advantage.

Even though there are studies which are providing evidence that the use of autologous PRP does accelerate soft and hard tissue healing in at least limited number of applications further controlled clinical studies with larger sample sizes are needed to evaluate the influence of different parameters on treatment outcome. In addition, defined clinical protocols in combination with long term clinical documentation are needed to identify the clinical benefits for the use of VB in combination with autogenous bone grafts for maxillary sinus augmentation procedures.

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