Implant Survival after Lateral Window Sinus Augmentation with Plasma Rich in Growth Factors (PRGF): A Retrospective Case Series

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Introduction

Implant therapy in the posterior maxilla can present a challenge to clinicians, especially in patients with pneumatized sinuses. Pneumatization is a physiologic process that occurs in the maxillary sinus causing it to increase in volume.[13] The pneumatized sinus results in decreased alveolar ridge height that can limit the available bone for implant placement. Lateral window sinus augmentation is a common procedure done to facilitate implant placement whenever adequate bone volume is unavailable. Boyne, in 1980, introduced the sinus augmentation procedure to augment ridge volume, by placing graft material between the sinus membrane and the residual alveolar ridge.[1]

Sinus augmentation procedures can allow surgeons to place implants with high survival rates. In a systematic review by Corbella in 2013, while comparing different techniques of sinus augmentation and implant survival, it was found that with short implants (mean length 8mm), the implant survival rate varied from 86.5% to 98.2% with up to 5 years follow-up. For the osteotome technique, the survival rate varied from 95.4% to 100% after 3-year follow-up. Sinuses augmented through lateral technique had implant survival rate varied from 75.57% to 100%.[14] In a systematic review by Wallace in 2012, it was found that the utilization of bone replacement grafts, rough-surfaced implants, and barrier membranes result in the most positive outcomes when considering implant survival. Furthermore, the utilization of piezoelectric surgery, rather than rotary diamond burs, for lateral window preparation and membrane separation

leads to a dramatic reduction in the occurrence of the intraoperative complications of bleeding and membrane perforation.[12]

Lateral window sinus augmentations can have different complications at different stages of treatment that can negatively affect surgical outcomes. In a retrospective study by Moreno in 2014, perforation of the Schneiderian membrane was the most common intraoperative complication at a rate of 25.7%. Several different methods have been proposed to treat these complications, from leaving them untreated to suturing the Schneiderian membrane, repairing with resorbable membranes, and using glues obtained from autologous fibrin gel. The most frequent postoperative complication was wound infection at 7.1%, followed by postoperative sinusitis at 3.9%; others include: abscess, partial exposure of the simultaneous onlay graft, and loss of the graft. Postoperative infections are often resolved by systemic antibiotics and aerosol sprays. 5.4% of the implants had complications such as loss of implant at 2.5%, peri-implantitis, bone loss, mucositis, mobility, fracture, and local periapical infections.[14]

Platelet concentrates, such as Plasma Rich in Growth Factors (PRGF) by Anitua and Platelet Rich Fibrin (PRF) by Choukroun and Dohan, have been used in dentistry to enhance bone regeneration, improve soft tissue healing, accelerate vascularization of the graft, and reduce post-operative morbidity.[16,17] Plasma Rich in Growth Factors (PRGF) has been used in lateral window sinus augmentation procedures with various bone graft materials to improve the healing process. Khouly in 2017, found that there was a 90% implant survival in sinuses augmented using xenograft (BioOss) with PRGF over an average of 7.2 years. Factors that affected implant survival were residual crestal bone height and implant length.[2] In Del Fabbro's study in 2013, the patients that

had deproteinized bovine bone matrix as a grafting material mixed with autologous plasma rich in growth factors reported significantly less pain, swelling, and hematoma, and improved functional activities with respect to the control group that had deproteinized bone matrix alone.[15]

Operator experience is also a factor that may influence the success of sinus augmentation procedures and implant placement. More experienced clinicians would tend to have higher rates of success and survival than novice clinicians. According to Brayer in 1989, more experienced operators could be expected to render more effective soft surface debridement.[18] Studies with high sinus lift and implant success could be due to the experience of clinicians like Fugazotto having 97.7% successful sinus lifts with 97% implant success after 73 months in function.[19] There are currently no published articles with the success rate of implant placement after sinus augmentation by surgeons at the residency level. However, according to Vidal in 2010, it was found that immediate implants placed by novice operators had a 100% success rate after 1 year follow up.[3]

The aim of the present retrospective study was to assess implant survival after lateral window sinus augmentations using PRGF in combination with various bone graft materials in a periodontics residency clinic.

Methods and Materials

Study Design

This study was a retrospective chart review, with the study protocol reviewed and approved by the Institutional Review Board of the Louisiana State University Health

Sciences Center – New Orleans (Approval number # 9727). Sixty-one patients included in the study, were treated in the Department of Periodontics at LSUHSC School of Dentistry from July 1st 2010 to June 30th 2016. All patients received maxillary sinus augmentation through lateral approach with the use of PRGF and dental implant placement at least 6 months post sinus augmentation. All surgeries were performed by periodontics residents under the instruction of board-certified periodontists.

Inclusion criteria

Patients' charts that met the following inclusion criteria were included in the study: (1) Lateral Window Sinus Augmentation with PRGF used in combination with bone grafting materials; (3) CBCT scan available before and after sinus augmentation (4) dental implants placed at least 6 months after sinus augmentation and followed up for at least 3 months after stage 2 surgery.

Radiographic Procedure

The CBCT images were obtained with an iCat Next Generation XYZ Slice View Tomograph (Imaging Sciences International LLC, Hatfield, PA) with a voxel size of 0.4 mm. Operating parameters were set at 5.0mA and 120 kV, and the exposure time was 4-8.9 seconds. For all CBCT images, a limited field of view (FOV) of 4x4 cm, 8x8 cm,10x16 cm was selected CBCT images were evaluated in axial, sagittal and coronal planes on the iCatVision™ software, version 1.8.1.10 (Imaging Sciences International LLC, Hatfield, PA) by an examiner (M.F.) not directly involved in treatment and follow-

up of the patients. CBCT images were analyzed using a 13-inch MacBook Pro with Retina display with a resolution of 1,440x900 (Apple Inc)

The following demographic parameters were extracted from each patient file for further evaluation: sex, age (at the time of sinus augmentation surgery), side (right/left) of the sinus assessed and smoking (Yes/No) at the time of treatment. Surgery related parameters included (i) type of graft material mixed with PRGF, (ii) type of implant placed (brand, length, width), (iii) implant stability measured with implant stability quotient (ISQ) at the time of implant placement and stage 2 surgery, (iv) sinus membrane perforation at the time of surgery (Yes/No) and (v) post-operative complications including sinus graft infection and sinusitis.

CBCT analysis included the assessment of the following variables

a) Residual bone height (RBH): Distance between alveolar bone crest and inferior border of the sinus was measured at the area of the least amount of residual bone (x) and at the tick distance before (x-0.4mm) and after (x+0.4mm)
b) Thickness of the sinus membrane: Distance between inferior border of the sinus and mucosal surface on the planned area of sinus augmentation.
c) Presence or absence of septa
d) Presence or absence of posterior superior alveolar artery
e) Morphology of sinus membrane was evaluated and classified according to criteria modified from Soikkonen and Ainamo *(ref.):* (1) healthy sinus membrane with no thickening (<2mm); (2) flat: shallow thickening without well-defined outlines; (3) semispherical: thickening with well-defined outlines rising in an angle of > 30

degrees from the floor of the walls of the sinus; (4) mucocele-like: complete opacification of the sinus; (5) mixed-flat and semispherical thickening.[20]

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Implant success

Periapical radiographs that were taken at time of implant placement, uncovery, restoration placement and 12 month recalls were also reviewed. Misch criteria for success was used to assess implant outcomes at follow-ups measuring for radiographic bone loss: I. Success (optimum health): <2 mm radiographic bone loss from initial surgery; II. Satisfactory survival: 2–4 mm radiographic bone loss; III. Compromised survival: Radiographic bone loss >4 mm (less than 1/2 of implant body); IV. Failure: Radiographic bone loss >1/2 length of implant. [4]

Chart Review

PRGF Preparation

The PRGF preparation protocol used during the sinus augmentation procedure includes peripheral blood taken from patients by venipuncture before surgery and placed directly into 9ml blood-collecting tubes® (Biotechnology Institute [BTI], Vitoria,

Spain) that contain 3.8% (wt/vol) sodium citrate as anticoagulant. Liquid PRGF was prepared by centrifugation (PRGF System®, BTI, Vitoria, Spain) at 580g for 8 minutes at room temperature. The 1mL plasma fraction located just above the red cell fraction, but not including the buffy coat, was collected and deposited in a glass dish (BTI). In order to initiate clotting and the formation of a three-dimensional fibrin matrix for the continuous release of growth factors and proteins, PRGF activator® (BTI) (calcium chloride) was added to the liquid PRGF preparation (50mL PRGF activator per milliliter of preparation). In order to prepare the autologous fibrin membrane, the 2 mL of plasma fraction located at the top of the tubes was transferred to a glass bowl (BTI). After adding PRGF activator, it was incubated at 37°C for 40 to 45 minutes, allowing the formation of a biocompatible fibrin with excellent elastic and homeostatic properties.[8]

Lateral Window Sinus Augmentation

A Full Thickness flap is reflected. The window preparation is made using a piezoelectric unit (Piezotome 2, Acteon, Mérignac, France). The membrane is lifted using hand instruments. The graft material used during surgeries to fill the cavity was a mixture of 1.5 to 2.5g of bovine anorganic bone (Bio-Oss®, Geistlich Biomaterials, Wolhusen, Switzerland) or 1 to 2cc of mineralized cancellous bone allograft (Puros (Zimmer Dental, Carlsbad, CA) or a combination of both graft materials with activated liquid PRGF. A collagen membrane is placed over the window followed by a PRGF membrane. Flap is sutured with simple interrupted resorbable sutures.

Results

A total of 61 patients, 24 men, and 37 women, with a mean age of 59.58 ± 10.75 years old, ranging from 31 to 84 years, received 79 lateral window sinus augmentations and 102 implants. The average residual ridge height before grafting was 4.51 ± 1.88mm and the average residual height after grafting was 15.73 ± 3.60mm. Septae were noted in the CBCT scans in 13 (16.46%) cases. The posterior superior alveolar artery was noted in the CBCT scan in 5 (6.33%) of cases.

Mucosal thickening of > 2 mm was classified as pathologic according to the criteria of Cagici.[21] In Figure 1, the morphology of the sinus membrane was detected to be: healthy sinus membrane, no thickening in 51 (64.56%) cases; flat: shallow thickening without well-defined outlines in 21 (26.58%) cases, semispheric: thickening with well-defined outlines rising in an angle of > 30 degrees from the floor of the walls of the sinus in 6 (7.59%) cases, and mixed-flat and semipherical thickening in 1 (1.27%) case (Table 1).

During lateral window sinus augmentations, the graft materials used were: xenografts in 45 (56.96%) cases, allografts in 24 (30.38%) cases, and a combination of xenograft and allograft in 10 (12.66%) cases (Table2). Perforations of the sinus were noted in 26 (32.91%) of the cases.

There were 102 rough surface implants placed after lateral window sinus augmentation using PRGF. Figure 2 illustrates the different implant systems that were used and the number of implants of each placed: Straumann Bone Level, 7 (6.82%); Zimmer-Biomet Tapered Screw-Vent, 68 (66.67%); Nobel Replace Tapered, 10 (9.8%); Astra Osseospeed EV, 7 (6.82%); 3i Tapered Certain, 4 (3.92%); and Biohorizons tapered, 6 (5.88%) (Table 3).

The implant lengths recorded were divided into 3 groups: <10mm 7 (6.82%), 10-12mm 79 (77.45%), and >12mm 16 (15.69%) (Table 4). The implant widths recorded were divided into 3 groups: <4mm 22 (25.49%), 4-4.9mm 66 (64.7%), ≥5mm 10 (9.8%) (Table 5). There were no implant failures recorded. The Misch[4] Success criteria was used to record implant success at follow up: I. Success (optimum heath), 101 (99.02%); II. Satisfactory survival, 1 (0.98%).

The ISQ recorded at implant placement and uncovery was available for 56 (54.9%) implants. The ISQ reading dropped between placement and uncovery for 15 (14.7%) implants. In Figure 3, the average ISQ reading at placement was 73.75 ± 6.82 and the average ISQ reading at uncovery was 77.48 ± 6.1.

Discussion

Currently, this study is the only retrospective study that has reported implant survival in patients receiving PRGF in conjunction with maxillary sinus augmentation by periodontics residents. There were significant improvements in implant survival with implant length, implant width, and residual bone height after lateral window sinus augmentation. The sinus augmentation results and implant survival may be attributed to staging of the surgeries; firstly, augmentation was done and then implants in 2 stages.

The study had some notable limitations. The author had to rely on documentation of notes in axium. If the recordings in axium were incorrect, then this may affect the results obtained for the study. The angulations of radiographs were not standardized for measurements. The amount of blood collected from each patient for the PRGF may have been different.

Of the 102 implants in this study, 0 were lost, with an overall success of 99.02% and survival rate of 100% during the follow-up period. This result is the same to that previously reported which showed 100% implant survival with a mean follow-up of 33 months after sinus floor augmentation surgery using PRGF.[5] The use of PRGF provides important advantages for sinus augmentations including reduced tissue inflammation after surgery, increased bone formation, and promoted vascularization of bone tissue and higher values of bone density. [5,6,7] Anitua in 2012, reports that radiographic evaluation of bone density using the Hounsfield scale also revealed significantly higher values for cases in which PRGF was used as compared to those grafted with anorganic bovine bone alone.[8] The same study showed no difference in implant survival regardless of implant length, implant width, residual ridge height, and sinus perforation. The implants were placed in a two-stage approach. Felice in 2014, found that 1-stage lateral window sinus lift with simultaneous implant placement or 2-stage procedure with implant placement delayed by 4 months with bone stubstitute had no significant differences with regard to implant survival. However, patients with residual ridge of 1-3mm in a 1-stage sinus lift may have a slightly higher chance of implant failure.[11]

Sinus augmentations were performed with piezoelectric surgical devices in this study. This method is used to reduce sinus perforations and has been regarded useful for these procedures.[9] There were 26 sinus perforations observed in 79 sinuses that underwent surgery, resulting in an overall rate of 32.91%. This finding is much higher than other studies using piezoelectric surgery to perform lateral window sinus augmentation.[9,10] This could be related to the inexperience of the periodontics residents using this piezoelectric unit.

Conclusions

Implants placed after sinus augmentation using PRGF and bone grafts have a survival rate of 100%. The inexperience of the surgeon did not affect results compared to other studies with more experienced surgeons. Prospective randomized clinical trial, however, is needed to confirm the findings in this study.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in this article.

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