Assessment of the effectiveness of platelet rich fibrin in the treatment of Schneiderian membrane perforation

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Abstract

Background: The objective of this study is to evaluate the effect of Platelet rich fibrin (PRF) treatment of maxillary sinus membrane perforation on bone formation and new vascular supply and the success of dental implant survival rate.

Methods: The dataset for this retrospective study consists of patients who received sinus augmentation using the lateral wall technique. A total of 16 patients (20 sinuses) the patients without sinus membrane perforation (10 maxiller sinus area with sinus floor augmentation) and with Schneiderian perforation (10 maxiller sinus area repairing with PRF and augmented sinus floor area) were included in this study. The bone height was measured by comparing the preoperative and postoperative dental CBCT scans. Histological sections were evaluated for possible vasculogenesis augmented sinuses area.

Results: In both groups, it was observed that the possible vasculogenesis augmented sinuses area increased. Implant survival rates in both groups found that one hundred percent and any bone loss around implants were not observed. An apparent increase in alveolar bone height was observed and measured in CBCT scans.

Conclusions: PRF can be considered as an alternative material for repairing sinus perforations because it is fully autogenous and easy manipulated.

KEYWORDS
dental implants, peri-implantitis, peri-implantitis treatment

1 | INTRODUCTION

When there is atrophy of the edentulous ridge there is insufficient bone volume for dental implant placement. Severely atrophic posterior maxilla have been successfully treated with prosthetic rehabilitation, including various sinus augmentation techniques and installation of dental implants.1-6 Direct maxillary sinus lift procedures have been performed with different surgical approaches (transcrestal technique, lateral window technique, balloon sinus lifting) and various graft materials (autogenous bone grafts, alloplasts, allografts, and xenografts), leading to new bone formation around the implant.1-4

If less than 4 mm of residual bone remains in the posterior maxilla, a two-stage operation is recommended for implant installation.5 The most commonly used technique is a lateral approach to augmentation of the maxillary sinus floor, which was first introduced by Tatum.6 Tetsch and colleagues7 followed 983 patients with 2 190 implants over a period of 176 months, showing an implant survival rate of 97.1% when using the lateral sinus floor elevation and osteotomy technique. Maxillary sinus floor elevation has become a routine treatment over the last two decades.8 Sinus augmentation procedures are safe with a minimal risk of complications, but some complications may still occur. A sinus membrane perforation during an osteotomy is major risk that can occur when burs are used. Membrane elevation using manual elevators can also cause several complications.9,10 The most common complication seems to be a Schneiderian membrane perforation, which occurs 7-58% rate of during surgeries.11 Schneiderian membrane perforations are strongly linked to the development of postoperative complications such as iatrogenic sinus infections, edema, bleeding, wound dehiscence, loss of bone graft material, increased implant failure rate and a disruption of normal sinus physiologic function.11,12
When the perforation dimension is large, the perforation needs to be closed to prevent disintegration of graft material in the antral cavity, as well as bacterial colonization. Treatment of Schneiderian membrane perforations when they are different sizes for example range in size from 2 mm to 1.5 cm perforations can be closed completely. In this condition, the sinus floor is usually closed by using a collagenous membrane, fibrin adhesive, oxidized regenerated cellulose and a block grafts. Perforations of Schneiderian membranes were repaired by many researchers. In many studies, commonly used collagen membranes for treatment of membrane perforation. Although several techniques have been suggested, no proven method has been proposed for repairing sinus membrane perforations. The classification of membrane perforations was previously described by size and degree of separation of the soft and hard tissues. A class 1 perforation is less than 2 mm in diameter and does not need additional special treatment. If the membrane perforation is 2 mm to 5 mm perforation can be closed with Folding Technique. In this technique that has been proposed, fold the membrane above the sinus membrane. After folding the membrane that can be placed the bone grafting material and implant. In the class 3 perforation (greater than 5 mm) it is more suitable the use delayed membrane sandwich technique. While class 1, 2, and 3, perforations can be repaired during the surgical procedure, class 4 and 5 perforations are extraction complications or failed sinus lift procedures and treatment procedures require the “membrane sandwich technique” after the natural healing time.

According to another aspect of the definition of sinus membrane perforation treatment, there are 2 methods. One of this called Loma Linda Pouch, consists in covering the whole sinus with a collagen membrane and the graft material is positioned in the center of the membrane, modified method, a collagen membrane located only on the surface of the Schneiderian membrane. This technique can be immediately performed when the space is discovered and the clinician will not need to postpone the bone grafting or placement of implants.

Platelet rich fibrin (PRF) is a second-generation mesh made of concentrated autologous platelets consisting of leukocytes and cytokines. It activates the vascular system and angiogenesis, releasing growth factors involved in soft and hard tissue healing. According to the positive effect on soft and hard tissue healing, PRF can be used for its antihemorrhagic effects. These effects are important in reducing edema after surgery.

When the collagen membrane and PRF are compared, PRF has natural adhesive property. It has high resistance due to the fibrin network in PRF and this feature can prevent graft particles from escaping into the sinus membrane.

Cone beam computed tomography (CBCT) images allow for identifying the location, anatomy and pathology of the maxillary sinus and provide three-dimensional visualization of bone dimensions and morphology.

The Schneiderian membrane is build up by a pseudostratified columnar ciliated epithelium and a well vascularized lamina propria and microvessels. Vascularity is an important parameter used in the assessment of healing and regeneration. There are small number of studies, which indicate that angiogenesis is seemingly responsible for remodeling the microvascular bed of the Schneiderian membrane during healing and regenerative processes. In more recent study they showed that evidence of vasculogenesis in the maxillary sinus mucosa.

The objective of this retrospective study is to evaluate the effect of PRF treatment of sinus membrane perforation on bone formation and new vascular supply and the success of dental implant survival rate.

2 | MATERIALS AND METHODS

In this study, a clinical case dataset was obtained from the archive of the Department of Periodontology at Necmettin Erbakan University Faculty of Dentistry. The dataset for this retrospective study consists of patients who received sinus augmentation using the lateral wall technique from 2014 to 2016. CBCT was taken before sinus augmentation and implant surgery. Each of the patients in this study had to have < 4 mm of crestal bone present below the sinus floor (Figure 1). A total of 16 patients (20 sinuses, 10 males, and 6 females, mean age: 55) were selected. Patients without Schneiderian membrane perforation (10 maxiller sinus area with sinus floor augmentation) and with Schneiderian membrane perforation (10 maxiller sinus area repairing with PRF and augmented sinus floor area) were included in this study. Patients with chronic sinusitis, bronchitis or asthma, major systemic illnesses (ie, diabetes mellitus, cancer, HIV, bone metabolic diseases or disorders that compromise wound healing, radiation or immunosuppressive therapy) or pregnant were excluded from the study. All patients completed a written consent form before the surgery. Sinus augmentation was performed with local anesthesia, following the lateral wall protocol. Before the surgery, for PRF preparation, blood samples were collected from the antecubital vein. Samples were collected in 9 mL glass-coated plastic tubes that did not include an added anticoagulation agent (Vacutainer, Becton Dickinson). The samples were immediately centrifuged at 2 700 rpm for 12 minutes with a table centrifuge (PC-02, Process, Nice, France). The clot was transferred to the PRF box and compressed so that PRF membranes could be obtained.

The buccal mucoperiosteal flap was raised and an osteotomy was prepared with Piezo surgery instrumentation (EMS Electro Medical Systems, Nyon, Sweden) on the lateral wall of the sinus. Schneiderian membrane perforations were noted during manual instrumentation of the membrane (Figure 2), then PRF membranes were placed directly
onto the perforation of the membrane (Figure 3). Ten perforations were noted in this study. All the perforations were classified as small-to-medium size, < 10 mm in diameter.29

After repairing the sinus membrane perforation, both the perforation and non-perforation areas, the sinus augmentation was continued with heterologous cortical bone graft material (Apatos, Osteobiol, Bologna, Italy). The lateral access window was covered with a barrier consisting of a collagen membrane (Osteobiol, Bologna, Italy). Primary closure was achieved in all cases using 4–0 Vicryl sutures. A postsurgical regimen of pain medication (flurbiprofen 2*1), antibiotics (amoxicillin 1 g 2*1), and rinse (0.12% chlorhexidine gluconate 2*1), for 2 weeks was prescribed. Implant placement surgeries were performed 24–32 weeks after the sinus augmentation surgeries. When implants were being placed, a trephine core sample (3 mm in length and 3 mm in diameter) was retrieved from the implant cavity. A histomorphometric analysis was performed on the bone core samples in the Laboratory of Pathology to determine bone formation. Tissue samples were fixed in 10% formalin solution for 24 hours and washed in tap water for 15 minutes, then decalcified in 20% formic acid solution for 72 hours. The tissues were embedded in paraffin blocks, sliced into 5 μm thick specimens, and stained with CD34+ (Figures 4A and 4B). Histological examinations were conducted with a Zeiss Axiovert 200 microscope (Carl Zeiss inverted microscope for transmitted light and epifluorescence, Germany) that was connected to a computer. Photomicrographs were taken under UV light with the same microscope. Vasculogenesis were analyzed.

For radiographic analysis, preoperative (before sinus augmentation) and postoperative (before implant insertion) dental CBCT scans (J. Morita’s 3D, Kyoto, Japan) were performed to evaluate the available maxillary alveolar bone height, as well as any possible existing sinus pathology (Figures 5A and 5B). Software programs of CBCT (J. Morita’s 3D, Kyoto, Japan) were used to calculate the existing preoperative residual bone height and new postoperative bone height in millimeters. The measurement of the postoperative elevated membrane was obtained using the adjacent tooth as a standard reference point. The bone height was measured by comparing the preoperative and postoperative dental CBCT scans. A gain of bone height was presented in millimeters. Total of 30 dental implants placed in the augmented sinuses, area and after 6–12 months the survival rates were evaluated.
implants were not observed. In both groups, it was observed that the possible vasculogenesis in the sinus floor. The newly formed bone was clearly seen around the lateral bone height (mm) or percentage (%). Data are expressed as mean values of bone height (mm) or percentage (%) ± standard deviation (SD).

3 | RESULTS

A total of 15 dental implants were placed in augmented sinuses with perforated Schneiderian membranes, while 20 dental implants were placed in nonperforated augmented sinuses. No implant failure was noted in either group. The implant success rate in both groups was 100%.

In all cases, new bone formation was detectable on the maxillary sinus floor. The newly formed bone was clearly seen around the lateral and apical side of the dental implants. On CBCT scans, no bone formation differences were seen between nonperforated and perforated sites. Additionally, ongoing marginal bone loss around the implants was not noted. The preoperative residual bone height varied from 0 mm to 4 mm and the average apical bone height was 2.41 ± 1.1 mm in both groups. Six to 8 months after surgery, no signs of infection in the maxillary sinus were observed. An apparent increase in alveolar bone height was observed in CBCT scans (Figure 6A,B). The average bone height, 6–8 months post-surgery, was 11.18 ± 1.2 mm and 10.12 ± 1.4 mm in nonperforated augmented sinuses areas and perforated augmented sinuses area, respectively. These differences were not statistically significant. We observed possible vasculogenesis in both groups. Vasculogenesis is a vital important parameter used in the evaluation of healing. In both groups, it was observed that the possible vasculogenesis in the nonperforated augmented sinuses area and perforated augmented sinuses area increased. In this study, implant survival rates in both groups found that one hundred percent and any bone loss around implants were not observed.

4 | DISCUSSION

A sinus augmentation procedure is an easy and safe procedure with minimal risk of complications. However, one of the possible complications that can occur during surgery is perforation of the Schneiderian membrane. The osteotomy for lateral window sinus access usually performed using the piezosurgery. The advantage of piezosurgery to cut the bone window decreasing the risk of Schneiderian membrane perforation. Whereas piezosurgery ten membrane perforations were observed in some studies. Similarly in the recent study therefore the piezoelectric device was shown to be slower when compared with the conventional instruments; on the other, a higher number of membrane perforations were noted with the piezosurgery. These similar with this study but our findings were not in agreement with many study that previously reported data.

A small perforation may be insignificant, but large perforations should be repaired. Although several techniques have been suggested, no proven method has been proposed for repairing sinus membrane perforations.

One of these techniques, known as “Loma Linda Pouch,” consists in covering the whole sinus with a collagen membrane and the graft material is positioned in the center of the membrane. However, in this technic, a membrane and the biomaterial is created that totally isolates from the blood supply coming from the walls of the sinus. Another technique, known as the modified method, a collagen membrane located only on the surface of the Schneiderian membrane, thanks to this method the blood supply from the bone can suitable for the vascularization and the integration of the graft into this virtual space. In this study we preferred that the modified method with PRF membrane. We have seen new bone formation and vascularization in these perforation areas. Proussaefs and colleagues used collagen membrane in their split-mouth study and they founded that significantly more bone formation (34.40%) than perforated sites (12.80%). Additionally they reported that implant survival rate higher in nonperforated area. These results have not similar to this study. Results of this study showed that bone formation and implant survival rate were similar in both group. No statistically significant differences were found for clinical parameters between the two groups. Also the bone thickness at the lateral window area were similar in both groups. In a clinical trial by Ferreira and colleagues, the Schneiderian membrane perforations that occurred during sinus lifting operations were repaired using collagen membranes. They showed that successful results at the end of the study. On the contrary Choi and colleagues compared with the autologous fibrin glue and collagen membrane in the treatment of
perforations of the maxillary sinus membrane in their split mouth animal study. They were reported that fibrin glue area showed newly formed continuous epithelium however, perforation treated with the collagen membrane exhibited extensive fibrosis, inflammatory infiltration, and absent epithelium. We preferred to use PRF for treatment of sinus membrane perforations in this study. Because; PRF is completely autogenous and is an inexpensive bioactive material. Activated platelets slowly release a wide range of proteins and growth factors including; bone morphogenetic proteins (BMPs), platelet-derived growth factors (PDGFs), insulin-like growth factors (IGFs), vascular endothelial growth factors (VEGF), transforming growth factor beta 1 (TGF-β1) and transforming growth factor beta 2 (TGF-β2). These play key roles in bone healing, controlling inflammatory response and infectious processes. Additionally, the application of PRF is very easy and safe, having positive effects on angiogenesis and wound healing and it stabilizes the graft material and protects the wound.

The vascular regenerative potential of the Schneiderian membrane is dependent on both extrinsic and intrinsic, this condition supported by vasculogenesis and angiogenesis. More recent study showed that evidence of adult vasculogenesis in the maxillary sinus mucosa, with CD31+ and CD34+ cells, these indicated that as highly angiogenic and vasculogenic potential. Similarly we observed possible vasculogenesis and new blood vessels in both groups associated with CD34+

5 | CONCLUSIONS

We compared the success of dental implants within a non-perforated membrane group and perforated membrane group. We did not find any differences between the 2 groups. Both groups had similar bone gain, possible vasculogenesis, and dental implant survival rate.

Although there are many studies in the literature about sinus floor augmentation with PRF, there is no study evaluating the clinical efficacy of PRF when used to repair sinus membrane perforations. This study aims to fill the gap in the literature. PRF can be considered as an alternative material for repairing sinus perforations because it is fully autogenous, easy manipulated and shows anti-inflammatory effects. Limitations of this study the lack of number of cases and lack of evaluation with different histological staining of bone formation. Clinical studies are needed to confirm this results.

CONFLICT OF INTEREST

We have no conflict of interest relevant to the content of the submission. We have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

REFERENCES


