Lateral Sinus Augmentation Using L-PRF and Xenograft: Radiographic and Histomorphometry Analysis.

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List of Abbreviations:

PRP = Platelet Rich Plasma

PRF = Platelet Rich Fibrin

L-PRF = Leucocyte and Platelet Rich Fibrin

A-PRF = Advanced Platelet Rich Fibrin

i-PRF = injectable Platelet Rich Fibrin

T-PRF = Titanium Platelet Rich Fibrin

CGF = Concentrated Growth Factors

PRGF = Plasma Rich in Growth Factors

PDGF = Platelet Derived Growth Factors

VEGF = Vascular Endothelial Growth Factors

IGF = Insulin like Growth Factors

TGF = Transforming Growth Factors

FGF = Fibroblast Growth Factors

BMP = Bone Morphogenic Protein

CBCT = Cone Beam Computed Tomography

DFDBA = Demineralized freeze bone allograft

BPBM = Bovine porous bone mineral

BHG = Bone Height Gain

POSEIDO = (Periodontology, Oral Surgery, Esthetic and Implant Dentistry Organization)

Hounsfield unit = HU

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Acknowledgment

Introduction

Edentulism in the posterior maxilla can present with compounding variables that make it a difficult region to restore with implants. Pneumatization of the sinus floor is typically accounted for during surgical treatment planning, but other factors such as horizontal ridge deficiency and vertical defects may be overlooked (**Karacayli et al., 2015).**

The maxillary sinus elevation technique is a main surgical procedure that permits to augment sufficient bone volume in the posterior maxilla to place implants (**Paridah et al., 2016).**

There are different techniques for sinus augmentation; the factors that contribute to the survival rate of sinus augmentation and dental implant placement are still the subject of discussion. The most used sinus floor elevation techniques are a) Lateral antrostomy as a one or two-step procedure as direct method. b) Osteotome technique with a crestal approach as indirect method. Osteotome technique can be recommended when more than 6 mm of residual bone height is present, and an increase of 3-4 mm is expected. In case of more advanced resorption direct method through lateral antrostomy must be performed. Both sinus elevation techniques did not seem to affect the implant success rate **(Pal et al. 2012).**

At the end of the 1960s, Linkow first referred to the possibility of introducing blade implants into the maxillary sinus, by partially lifting the Schneider membrane without tearing it. **Tatum et al. (1986)**

proposed to raise the sinus membrane by performing a modified Caldwell-Luc technique, then called the ‘inverted lateral window,’ introducing, as graft, autologous bone taken from the rib. This technique was first published by **Boyne** and **James (1980)**, who reported 14 cases of autologous graft (iliac crest) with simultaneous insertion of blade implants **(Linkow et al., 1997).**

There is currently no single protocol to follow when planning this type of surgical operation: some variables such as the crestal height, the separation between the walls and the sinus pneumatization, the state of the membrane or the type of residual bone in the crest, affect the surgical indication and the techniques that must be adopted **(Chipaila et al., 2014).**

A lateral sinus lift is one of the most widely used augmentation procedures. It enables to make an implant in the dorsal parts of the maxilla, where the bone often has poor quality and is reduced by the extended maxillary sinus. When considering that the minimum safe length of the implant is 10 mm, the bone at the site of the first premolar is deficient in one-fourth (25%) of patients. The bone is insufficient in more than half of patients at the level of the second premolar, and in 80 to 90% of patients at the level of molars **(Šimůnek et al., 2007).**

The different classifications of treatment modalities of the posterior maxilla introduce a new system that incorporates all factors critical for implant success. The ABC classification is a simple system to guide clinicians in proper implant treatment of the posterior maxilla where Class A represents abundant bone with > or = 10 mm bone height below the sinus floor and > or = 5 mm bone width, allowing proper implant placement. Class B indicates barely sufficient bone with 6 to 9 mm bone height below the sinus floor, and this can be further subclassified into division h (horizontal defect; < 5 mm bone width), division v (vertical defect; > 3 mm away from cementoenamel junction), and division c (combined horizontal and vertical deficiency). Class C indicates compromised bone with < or = 5 mm bone height below the sinus floor, and this can also be subclassified like Class B. **(Wang and Katranji, 2008).**

Sinus lift technique provides satisfactory and predictable clinical results. However, it requires lengthy healing time, delaying rehabilitation treatment, which brings discomfort to the patients. L-PRF is a second-generation platelet concentrate that stimulates and accelerates tissue repair **(Boyne et al., 1980).**

L-PRF as grafting material develops new bone of better quality (histologically), but in a smaller amount (radiologically) than the bone obtained from the association of L-PRF and an allograft. The use of LPRF as a unique filling material in sinus procedures could be a valuable treatment option **(Bölükba et al., 2013).**

Graftless sinus augmentation technique seems to be very predictable thanks to the osteoconductive principles on which it is based, and in association with the proper management of peri-implant soft tissue, so as to increase the amount of keratinized tissue, which could represent the new gold standard for this type of rehabilitation in the future **(Chipaila et al., 2014).**

The objective of this preliminary study is to compare the effect of L-PRF as sole grafting material in maxillary sinus augmentation with xenograft and mixed xenograft with L-PRF and evaluate its capability in new bone formation.

Review of Literature

Hard tissue defects resulting from trauma, infection, or tooth loss often lead to unfavorable anatomy of maxillary and mandibular alveolar processes. Dental implant placement in the edentulous posterior maxilla can present difficulties because of a horizontal or vertical alveolar ridge deficiency, unfavorable bone quality, or increased pneumatization of the maxillary sinus (**Karacayli et al., 2015).**

Implant placement in the posterior maxilla was a challenging procedure when vertical deficiencies occurred. The maxillary sinus elevation technique is a main surgical procedure that permits to augment sufficient bone volume in the posterior maxilla in order to place implants (**Paridah et al., 2016).**

Oral rehabilitation with implant-supported prosthesis has shown improved masticatory function and oral specific health-related quality of life compared to removable dentures. However, placement of implants in the posterior part of the maxilla is frequently compromised or impossible due to atrophy of the alveolar process, poor bone quality, and maxillary sinus pneumatization. Therefore, vertical alveolar ridge augmentation is often necessary before or in conjunction with the installation of implants. Various surgical approaches comprising elevation of the Schneiderian membrane have been proposed in order to achieve the required vertical height of the alveolar process for the installation of implants with a sufficient length including maxillary sinus floor augmentation with the lateral window technique, osteotome-mediated sinus floor elevation and sinus membrane elevation without the use of graft material. However, the treatment of choice for the most appropriate surgical intervention for oral rehabilitation of the atrophic posterior maxillary ridge with implants is influenced by the vertical height of the residual alveolar bone, local intra-sinus anatomy, and the number of teeth to be replaced . **(Starch-Jensen et al., 2017)**

To increase the amount of bone in the posterior maxilla, the sinus lift procedure, or sub antral augmentation, was presented initially in 1977 and subsequently published in 1980 **(Boyne et al., 1980)**.

Different types of bone grafts had been used for sinus augmentation, such as autogenous, allograft; xenograft and alloplastic grafts had a separate action on the bone being osteogenic, osteoinductive, or osteoconductive capabilities **(Roberts and Rosenbaum 2012).**

There are four characteristics an ideal bone graft material should offer including osteointegration; to chemically bond to bone surface without an intervening layer of fibrous tissue, osteoconduction; to support growth of bone over its surface, osteoinduction; to induce differentiation of pluripotential stem cells from surrounding tissue to an osteoblastic phenotype and osteogenesis; to form new bone by osteoblastic cells present within the graft material **(Moore et al., 2001).**

Autogenous bone grafts were considered 'gold standard' graft taken from both extra- and intraoral sources. It had been used in periodontal therapy, around a dental implant, socket augmentation, and guided bone regeneration due to its osteogenic potential, possessing all four characteristics although few mature osteoblasts survive adequate numbers of precursor cells survive after transplantation explaining its osteogenic potential **(Gultekin et al., 2016).**

Some histological evaluations of autogenous intraoral grafts reported new connective tissue attachment following autogenous grafts. Others reported the presence of long junctional epithelium between the regenerated alveolar bone and root surface **(Goldstein et al., 2001).** A systematic review comparing autogenous bone to open flap debridement revealed a higher clinical attachment level gain for the grafted group **(Reynolds et al., 2004).**

Allogenic bone grafts are present in several types of commercial tissue banks. It includes iliac cancellous bone and marrow, freeze bone allograft and demineralized freeze bone allograft (DFDBA) which is considered osteoinduction since it has the capacity to induce the formation of new bone and to stimulate maturation of the undifferentiated mesenchymal cells to pre-osteoblasts and osteoblast forming cells **(Schwartz et al., 1996).** The freeze-drying process destroys cells but maintains its cellular morphology and chemical integrity **(Malinin and Temple, 2007).**

It was suggested that the demineralization of lyophilizing bone would allow the exposure of bone morphogenetic proteins and polypeptides that induce pluripotential stem cells to differentiate into osteoblasts **(Urist., 1983)**. However, it has been found that this osteoinductive capacity depends on the donor characteristics, especially the age and the degree of demineralization that rely on the bone bank **(Kukreja et al., 2014).**

A xenograft is a graft taken from a non-human. It also referred to as an organic bone, since during its processing, all cells and proteinaceous