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Research Article

Assessment the Effectiveness Balloon-Assisted Maxillary Sinus Floor Elevation and Traditional Sinus Floor Elevation in the Posterior Maxillary Area

Gagik Hakobyan[1*], Asdghig Boyadjian[2], Ashot Jilavyan[2], Vilen Seyranyan[2], Ani Khachatryan[2] and Sona Gevorgyan[2]

[1]Head of Department of Oral and Maxillofacial Surgery, Yerevan State Medical University, Armenia

[2]Assistant professor of Department of Oral and Maxillofacial Surgery, Yerevan State Medical University, Armenia

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Corresponding author:
Gagik Hakobyan,
Head of Department of Oral and Maxillofacial Surgery, Yerevan State Medical University, Armenia, Tel: (+37410)271146;
Email: prom_hg@yahoo.com

ABSTRACT

Background: The posterior maxillary area sometimes has insufficient bone mass for dental implants. The augmentation of the sinus floor allows the implant to be placed in the posterior of the upper jaw.

Purpose: The aim of this study was to compare the effectiveness antral balloon-assisted maxillary sinus elevation and traditional sinus floor elevation followed by bone graft and delayed implant placement the posterior maxillary area.

Material and methods: A total of 68 patients, (aged 27 to 56 years, 32 women and 36 men), without any systemic diseases, with unilateral/bilateral missing teeth and atrophy of the posterior maxillary area, who required an enlargement of the sinus prior to implant placement, whom the location of the sinus floor from the crest was 3-5mm, width ≥5 mm were included in the study between 2018 and 2021. Patients underwent a thorough clinical examination according to the generally accepted scheme. All patients were selected after meticulous evaluation of their medical histories and dental examinations, including OPG and dental Computed Tomography (CT) scans.

Results: The sinus lift using balloon technique was performed successfully in patients 1 group, with no complications. In 9 patients 2 group, perforation of the sinus membrane occurred during the operation, sinusitis in 4 patients, graft failure in 3 patients. Regardless of the approach used, both approaches showed significant increases in bone mass gain. Though not statistically significant difference, balloon-assisted procedure showed more mean bone gain (8.4 mm) compared to osteotome-assisted procedure (8.1 mm). The mean amount of Marginal Bone Loss (MBL) in patients 1 group 3 years follow-up was 0.86 mm in patients 2 group showed significantly less marginal bone loss 1,16mm. The implant survival rate 3 years follow-up was in patients 1 group was 97.62%, in patients 2 groups was 95.2%.

Conclusions: Research has shown that the balloon sinus lifting offers predictable, safe and effective results, and eliminates the complications associated with traditional side window techniques. However, further controlled clinical trials are needed to evaluate the efficacy and safety of these technique for their appropriate implementation in the field of oral implanotology.

INTRODUCTION

Conventional removable dentures have multiple drawbacks like lack of stability, minimal retention, discomfort while chewing and compromised aesthetic outcome. Dental implants will resolve the problems associated with conventional dentures. Sufficient alveolar bone to for placement 10 mm long and a diameter of 3.5-4 mm implants has traditionally been considered the minimum requirement to allow bone placement of the implant. Due to the extraction of teeth into the segment molar and pneumatization of the maxillary sinus, the vertical height of the bone in the posterior edentulous upper jaw decreases thus limiting the installation of dental implants [1]. Bone density greatly affects primary implant stability and success, since implants in areas of lower bone quality are associated with a high failure rate [2]. It is important to place implants in locations with good primary stability, which cannot be acquired in regions with low bone density. Posterior maxilla often presents type III or type IV bone quality according to Lekholm and Zarb's classification [3]. Increased pneumatization of the maxillary sinus and the quality of the III or IV types of bone in the posterior part of the upper jaw-all this emphasizes the need for additional procedures that increase the quality and quantity of bone [4,5]. One solution in these clinical cases is to use shorter implants, which sometimes leads to an unfavorable crown-to-root ratio. Maxillary sinus augmentation has become the most common surgical procedure that involves detaching the Schneider membrane from the floor of the maxillary sinus, creating a space filled with a bone graft to facilitate vertical bone augmentation in the maxillary sinus cavity, allowing future dental implants to be restored [6]. Boyne and James in 1980 proposed a conventional sinus augmentation procedure that involves direct visualization and manipulation of the Schneider membrane through a lateral window osteotomy (modified Caldwell-Luc approach) [7]. Although these procedures often ensured high implant survival and stability of bone tissue levels over time [8]. However they were not always well accepted by patients due to their high cost, increased postoperative morbidity, high risk of infection (fistula with pus or abscess, often caused by infection of the graft material) and a long healing time. In addition to being an invasive surgical procedure, it also presents with post-operative conditions such as bleeding, edema, and membrane perforation [9-11]. H. Tatum in 1986 Transcrestal Sinus Floor Elevation (TSFE) was performed by lifting the sinus floor via sequential crestal bone preparations [12]. Later, in 1994, summers introduced the osteotomy sinus floor elevation, which is a minimally invasive technique to localize the elevation of the maxillary sinus through the alveolar ridge [13]. This approach is supposed to offer more patient comfort, more primary stability, and less morbidity. However, this method has been shown to be effective only when the crest height exceeds 6 mm. Perforation of the sinus membrane will result in deposition or interruption of the sinus lift procedure. Various modifications have been proposed to prevent complications associated with the summers sinus floor elevation method [14]. Over the past decade, many authors have developed minimally invasive sinus lift techniques to overcome the postoperative complications associated with traditional sinus lift procedures. Muronoi et al. for the first time it was proposed to enlarge the maxillary sinus floor using a balloon [15]. The technique of balloon lift of the antral membrane was introduced through the lateral approach [16]. Thereafter, a technique was described for minimally invasive balloon elevation of the antral membrane using a transcrestal approach, which included the use of a balloon device through a 3 mm osteotomy [17-19]. Approach to the antrum through the lateral window and elevation of the Shneidar membrane with an antral balloon is the method that has shown the lowest of membrane perforation. It elevates the membrane easily and makes the antral floor accessible for augmentation with grafting materials. The development of minimally invasive sinus lift surgery includes progress in endoscopy, development of intraoperative navigation for maxillofacial surgery. Decision making includes diagnostic and therapeutic indications, patient preferences and values, and cost considerations. After the sinus membrane lifting a variety of bone grafting materials can be used [20-22]. Since different techniques sinus lifting were evaluated in different trials, for implant failures and complications. Based on relevance question in focus in this study is the antral membrane balloon elevation technique effective in the terms of sinus augmentation success rate, survival rate of dental implants, bone gain, and complication rate compared with the traditional sinus floor elevation technique. The aim of this study was to compare the effectiveness antral balloon-assisted maxillary sinus elevation

and traditional sinus floor elevation followed by bone graft and delayed implant placement the posterior maxillary area.

MATERIAL AND METHODS

A total of 68 patients, (aged 27 to 56 years, 32 women and 36 men), without any systemic diseases, with unilateral/bilateral missing teeth and atrophy of the posterior maxillary area, who required an enlargement of the sinus prior to implant placement, were included in the study between 2018 and 2021. All patients presented functional and esthetic complaints. Written informed consent was obtained from all patients explaining the possible side effects of the procedure.

Indications of the technique in the study

The study included patients in whom the location of the sinus floor from the crest was 3–5 mm, width ≥5 mm (from the floor of the sinus to the crest of the bone, as determined radio graphically), a minimum follow-up period of 1-year loading.

Contraindications of the technique in the study

Contraindications included any systemic condition that could interfere with physiological wound healing, orofacial cancer, radiation / chemotherapy to the head and neck area, Advanced medical conditions, patients who consumed oral bisphosphonates for more than three years, excessive smoking, alcohol or substance consumption, psychological problems. Local contraindications of sinus lift surgery included untreated active periodontal disease, maxillary sinus infections and pathological lesions, chronic sinusitis, alveolar scar possibility, odontogenic infections, allergic rhinitis. Patients underwent a thorough clinical examination according to the generally accepted scheme. All patients were selected after meticulous evaluation of their medical histories and dental examinations, including OPG and dental Computed Tomography (CT) scans (Figure 1). The initial height of the bone from the alveolar ridge to the sinus floor, the width of the ridge and the mesiodistal diameter of the edentulous area were measured using CT. To assess the volume of new bone and to monitor maxillary sinus re-pneumatization, CT scans were taken, These tests were conducted after the functional loading of implants and repeated after 1,2,3 years. Patients were divided into 2 groups, group distribution was performed randomly. In 36 patients of 1 group, implantation was performed after lateral approach antral balloon technique for sinus elevation followed by bone graft and delayed implant placement the posterior maxillary area. In 32 patients of 2 group, implantation was performed after traditional sinus augmentation procedure (Boyne and James method) a that involves direct visualization and manipulation of the Schneider membrane through a lateral window osteotomy followed by bone graft and delayed implant placement the posterior maxillary segment. Patients were started on prophylactic antibiotic treatment 24 hours before surgery.

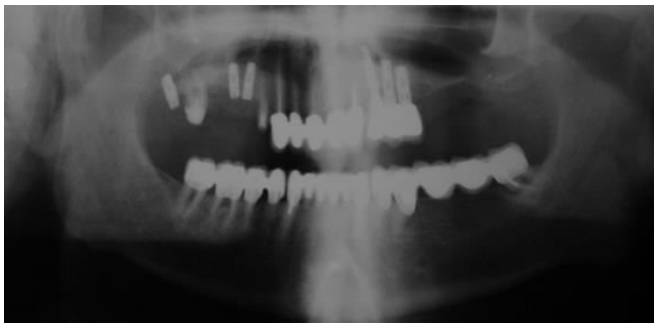

Figure: 1 Preoperative radiograph.

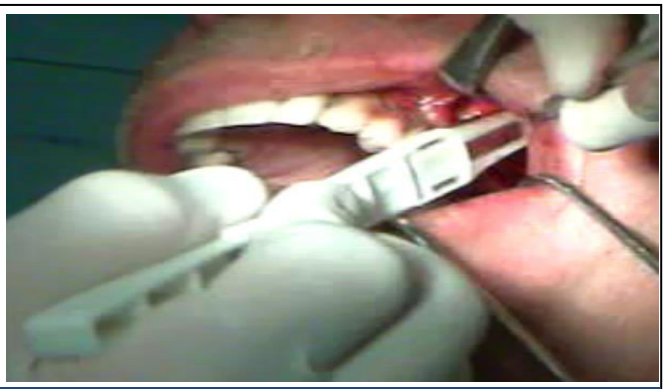

Figure 2: Bone scraper is used to collect autogenous bone from site of the operaration.

In patients 1 group after local anesthesia was injected into the edentulous ridge, after reflecting a mucoperiosteal flap bone scraper is used to collect autogenous bone from site of the operation (Figure 2). Opening a window on lateral wall of the maxillary sinus by round diamond bur and separating the Shneider membrane from the bony walls of maxillary sinus (Figure 3). Balloon-assisted maxillary sinus floor elevation was carried out using a Zimmer balloon (Zimmer, USA) (Figure 4). Insertion of Zimmer balloon (Zimmer, USA) in between the sinus membrane and the bony walls to detach the remaining part of the sinus membrane from its bony walls (Figure 5). The balloon was then slowly inflated with saline (1 cm3 of saline corresponds to 6 mm membrane elevation) until the desired elevation (usually ≥11 mm) was achieved. The balloon was

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then slowly deflated and removed. Mixing the autogeneos bone which is collected from the site of the operation by a scraper with Cerasorb® (Curasan, German) cristals along with the patient's blood Platelet-Rich fibrin (Figure 6). Bone graft material and Platelet-Rich fibrin were inserted into the sinus under the antral membrane, placement of Resodont® (Resorba Wundversorgung GmbH & Co.KG,Germany), resorpable membrane to cover the lateral wall of the sinus and separate it from the mucuperiosteal flap after which the flap was repositioned and sutured using 3-0 silk sutures (Figure 7,8,9). Radiographs were taken to assess the degree of sinus floor elevation in the surgical site after the procedure (Figure 10). The augmentation evaluated by CT scans. Patients were advised to strictly follow the postoperative instructions. Post-operative patient reactions including swelling, discoloration, discomfort, hematomas. Implant placement was initiated 6 months post-operatively and reviewed at frequent intervals. Loading of the implants was carried out after 6 months. After removing the cover screw, healing plugs were installed and after 10 days the prosthetic stage of treatment was started (Figure 11,12,13). All patients were evaluated radio-graphically after prosthetics (Figure 14) and 6th month, 1, 2, 3 years after prosthetics. The crestal bone height was maintained and verified by subsequent radiographs. In 32 patients of group 2 sinus lift procedure was performed using the traditional lateral approach method using bone graft material Resodont® and Platelet-Rich fibrin.

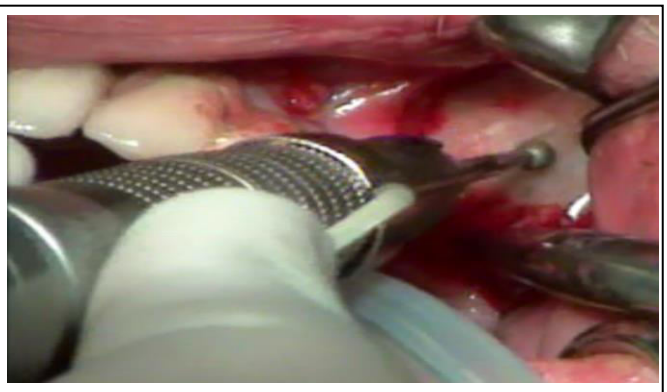

Figure 3: Opening a window on lateral wall of the maxillary sinus by round diamond bur.

Midcrestal incision is made in the mesiodistal direction along the length of the alveolar crest and anterior- and posterior-releasing incisions are made. A full-thickness mucoperiosteal flap with a trapezoid base is elevated while maintaining periosteal integrity. The superoiorinferior and anteroposterior borders of the lateral window are determined by the sinus volume, which is preoperatively examined by CT.

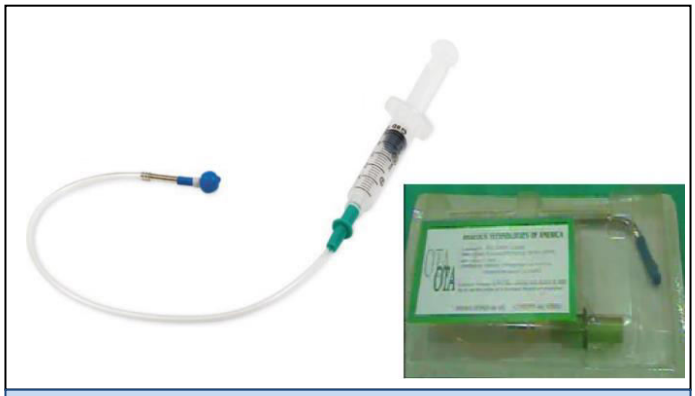

Figure 4: Zimmer balloon used in balloon sinus lift surgery (Zimmer, USA).

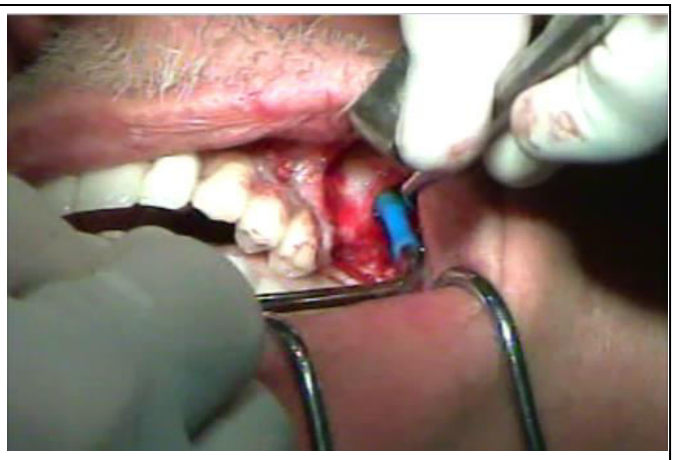

Figure 5: Insertion of Zimmer balloon in between the sinus membrane and the bony walls and inflating it with saline solution to detach the remaining part of the sinus membrane from its bony walls.

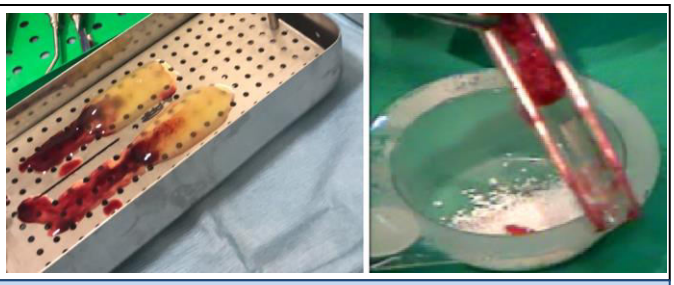

Figure 6: the autogeneos with Cerasorb® (Curasan,German) cristals along with the patient's blood Platelet-Rich fibrin.

The shape of the osteotomy window rectangular or oval and outlined with a size of 10×20 mm. The size of the window can increase or decrease, according to the size of the planned augmentation for implant placement. The inferior border of the bony window should be 2-5 mm superior to the sinus floor.

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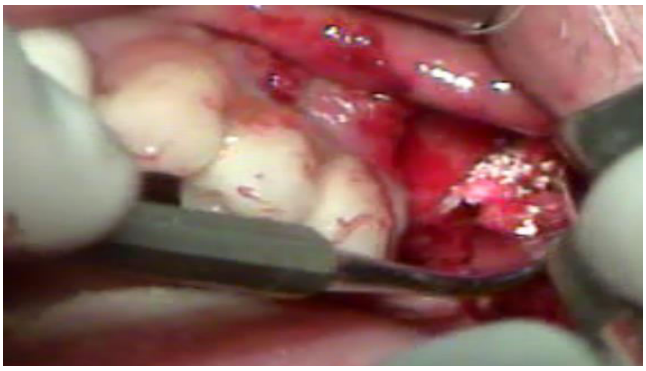

Figure 7: Augmentation of the sinus with bone graft and Platelet-Rich fibrin.

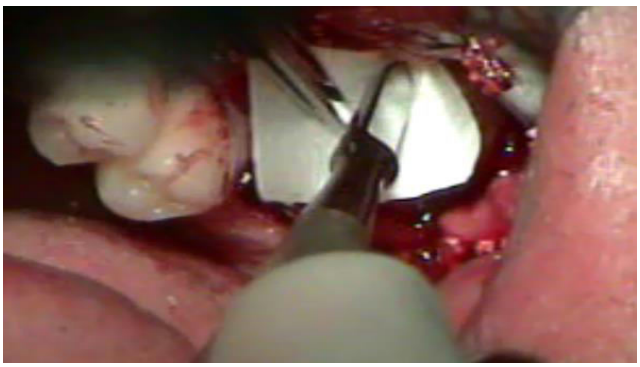

Figure 8: Resorpable Resodont® membrane to cover the lateral wall of the sinus and separate it from the mucuperiosteal flap.

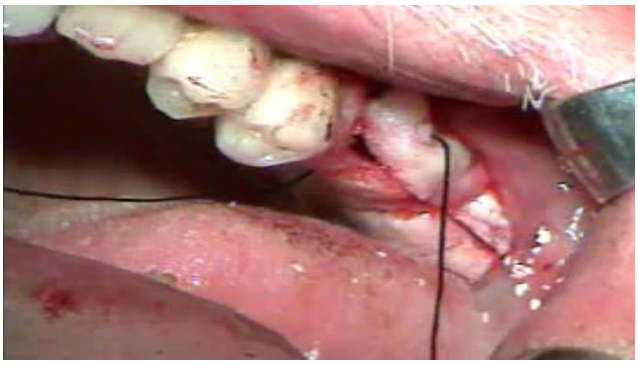

Figure 9: Suturing of the flap.

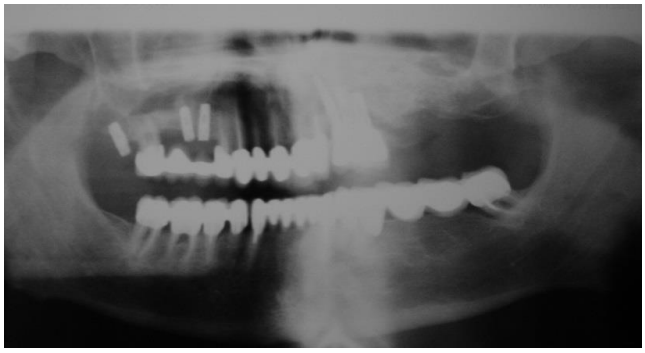

Figure 10: Postoperative radiograph.

The elevation sinus membrane performed using broad-based freers or curettes. The prepared graft material Resodont® and Platelet-Rich fibrin is placed by pieces into the drilled hole, followed by a 6-month wait. After the bone is placed in the sinus, Resorpable Resodont® membrane to cover the lateral wall of the sinus and the mucoperiosteal flap is positioned and primary closure is achieved. Patients instructed about sinus precautions, which are avoiding anything that can cause sudden pressure changes in the sinus, such as nose blowing with nostrils pinched closed and sneezing with a closed mouth. A total of 118 implants were installed in patients 1 group and 96 implants were installed in patients 2 group. An implant was considered to have failed (clinical or absolute failure) if it had any of the following conditions: pain on function, mobility, radiographic bone loss $> 1/2$ the length of the implant, uncontrolled exudate, or was no longer in the mouth. Postsurgical change in Marginal Bone Loss (MBL) was assess by digital x-ray were taken immediately (base line for comparison), 1, 2, 3 years after prosthesis loading. Statistics were used to calculate and analyze the mean marginal bone loss of implants.

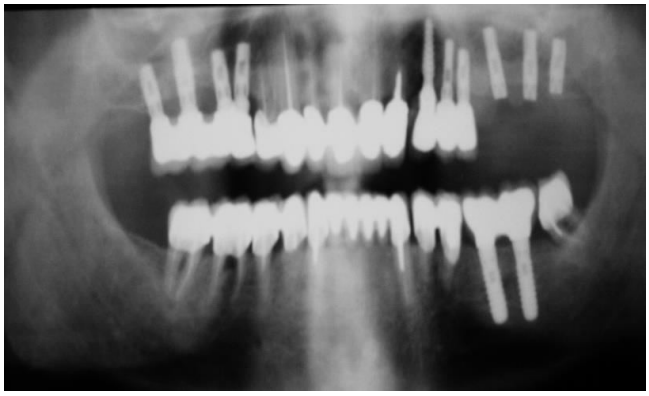

Figure 11: Radiograph after implant placement.

Statistical analyses

Statistical analyses were performed using SPSS software ver. 22.0 (IBM, Armonk, NY, USA), and MedCalc program for Windows. To test the significance of variations in the BOP, PPD, MBL, the t-test was used. The minimum level of statistical significance was set at a value of less than 0.05.

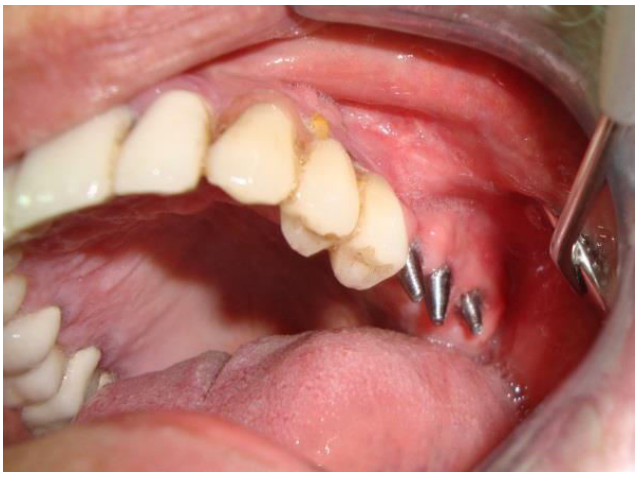

Figure 13: Intraoral view with abutments before fixation of the prosthetic construction.

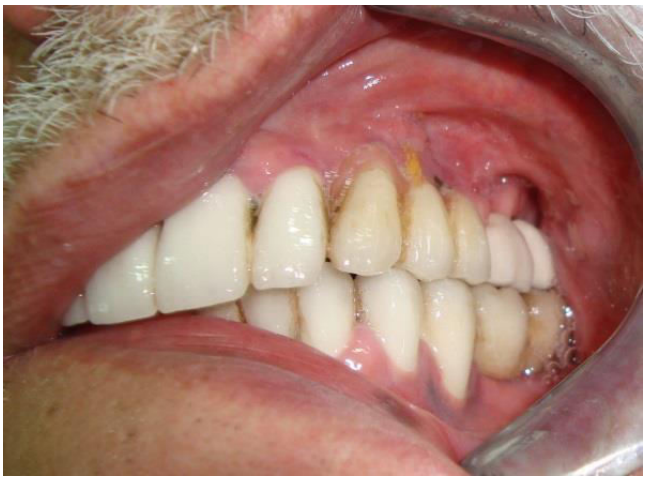

Figure 13: Final restoration with metal ceramic bridge.

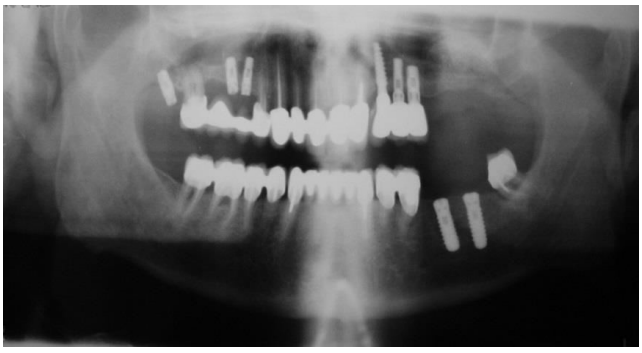

Figure 14: Final postoperative radiograph with restorations.

RESULTS

The sinus lift using balloon technique was performed successfully in patients 1group, with no complications.

In 9 patients 2 group, perforation of the sinus membrane occurred during the operation, sinusitis in 4 patients, graft failure in 3 patients. Regardless of the approach used, both approaches showed significant increases in bone mass gain. Though not statistically significant difference, balloon-assisted procedure showed more mean bone gain (8.4 mm) compared to osteotome-assisted procedure (8.1 mm). The mean amount of Marginal Bone Loss (MBL) in patients 1 group 3 years follow-up was 0.86 mm in patients 2 group showed significantly less marginal bone loss 1,16mm. In our study, delayed implant placement was performed due to insufficient initial bone height, as well as to ensure sufficient graft maturation. The implant survival rate 3 years follow-up was in patients 1 group was 97.62%, in patients 2 groups was 95.2%.

Table 1: The sinus lift complications in1 and 2 groups.

Complications	1 group	2 group
perforation of the sinus membrane	0	9
sinusitis	0	4
graft failure	0	3

Table 2: Bone mass gain after sinus lift procedures in1 and 2 groups.

Bone mass gain.	mm
1 group	8,4mm
2 group	8,1mm

Table 3: Mean of marginal bone loss (MBL) in patients 1and 2 groups 3 years follow-up.

Mean marginal bone loss (MBL)	mm
1 group	0,86mm
2 group	1,16mm

DISCUSSIONS

Insufficient bone volume is a common problem encountered in the rehabilitation of the edentulous posterior maxillae with implant supported prostheses. Alveolar bone quantity and quality are the most important parameters primarily affecting the success of implant treatment. The choice of the method of rehabilitation with an implant for upper jaw atrophy is of decisive importance. Sinus lift procedures increase bone volume by augmenting the sinus cavity with autogenous bone and/or biomaterials [13,23,24]. However, sinus floor elevation surgery is generally associated with higher costs, more complex surgical procedures, and a high prevalence of complications such as infection, sinus membrane perforation and graft failure [25,26]. Various techniques have been proposed to overcome

this complication. Outcomes of this procedure may be affected by simultaneous versus delayed implant placement, selection of graft material, and the surface characteristics of the implants. Numerous articles have been published in this field regarding different grafting materials and modification to the classic technique. Minimally invasive balloon antral membrane lift is a surgical technique developed as a less invasive alternative to a lateral window approach that includes sinus lift using the sinus balloon followed by standard implant placement [27,28]. To further simplify sinus lifting procedures and enhance their predictability and success, additional modifications technique, have been introduced during the past 10 years [29]. Numerous articles have been published in this field regarding different modification to the classic technique as transcrestal approach, lateral window approach, piezosurgery, hydrodynamic ultrasonic approach, balloon elevation technique, osteotomy technique and nasal suction technique with their success rate. Which method to give preference when choosing the method of sinus lifting is important for the prevention of complications of surgery and is actual topic for research in the field of oral implantology [13,30-34]. The present study was undertaken to comparison the safety and efficacy of a balloon sinus lift technique and traditional sinus lift. To compare the efficacy of balloon sinus lift and traditional sinus lift technique, two groups of patients were formed. In patients of 1 group, lateral approach antral balloon technique for sinus elevation followed, in of 2 group traditional sinus lift procedure followed. The study used anorganic mineral and autogenous bone for the bone augmentation technique, a collagen membrane to protect the sinus window, and a staged approach for implant placement. Bone scraper was used to collect autogenous bone from the side of the operation before opening of the window and mixed with bone graft material Resodont® with along with patient's blood Platelet-Rich fibrin and covered by resorpable membrane Resodont®. In our study, delayed implant placement was performed due to insufficient initial bone height and to ensure sufficient graft maturation. Compared to traditional sinus lift and balloon antral sinus lift have the advantage of being a high survival solution, they are less expensive, require less surgical time compared to traditional sinus lift surgery, and thus increase patient satisfaction. By incorporating efficient and efficacious materials such as anorganic bone grafting material and PRP, the balloon sinus lift technique offers an effective approach for minimally invasive sinus lifts, preventing sinus membrane perforation, reducing patient trauma, and improving implant osseointegration into grafted alveolar bone. Balloon antral sinus lift present an alternative traditional sinus lift with high survival rate and fewer complications and improving implant osseointegration into grafted alveolar bone. The process should be refined in order to reduce the percentage of mucosa perforation.

CONCLUSION

Research has shown that the balloon sinus lifting offers predictable, safe and effective results, and eliminates the complications associated with traditional side window techniques. Further controlled clinical trials are needed to evaluate the efficacy and safety of these techniques for their appropriate implementation in the field of oral implanotology.

Conflict of interest and financial disclosure

The author declares that he has no conflict of interest and there was no external source of funding for the present study. None of the authors have any relevant financial relationship(s) with a commercial interest.

Funding

The work was not funded.

Consent statement

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Ethics approval

The study was reviewed and approved by the Ethics Committee of the Yerevan State Medical University after M. Heratsi (protocol N16, 5.10.17) and by those of the World Medical Association and the Helsinki Declaration.

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