Original Article

Comparison of Peri-Implant Bone Loss and Survival of Maxillary Intrasinus and Extrasinus Implants After 2 Years

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Abstract:

Objective: Low quality of the bone and insufficient bone due to the size of the sinus and resorption of the alveolar ridge decrease the long-term survival of implants in the posterior maxilla compared to other regions of the jaws. Surgical procedures to increase bone volume make it possible to place implants longer than 8 mm. In this situation sinus elevation makes it possible to place implants. We intend to evaluate peri-implant bone loss and survival of implants placed in elevated sinuses after 2 years and to compare with implants placed in the native posterior maxilla.

Materials and Methods: Twenty-five implants placed in sinuses that had been reconstructed with Bio-Oss and healed after 9 months were compared with 30 implants placed in the posterior maxilla without any surgery. The groups were compared using probing pocket depth, bleeding on probing, Plaque Index and bone loss immediately after implant placement surgery and 2 years postoperatively. The criterion for implant survival was presence or absence of the implant in the oral cavity, which was recorded in relevant forms in both groups.

Results: Three implants were lost; one in control and two in grafted sinuses. No significant differences were observed in the survival rates. In general, the mean bone loss around intrasinus and extrasinus implants was not significantly different. In the same context, no differences were observed between bleeding on probing, Plaque Index and probing pocket depths of two groups (P=0.397, P=0.637 and P=0.224, respectively).

Conclusion: The survival and bone loss around intrasinus and extrasinus implants are similar.

Key Words: Bio-Oss; Alveolar Bone Loss; Dental implants; maxillary sinus; survival rate

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INTRODUCTION

In many patients, the posterior maxilla poses problems for the placement of dental implants as a result of the presence of maxillary sinuses. The maxillary sinus expands laterally and inferiorly and it may even extend to the canine eminence after tooth loss.

As a result, bone height is decreased in this area. Subsequent to periodontal disease, tooth loss and maxillary sinus expansion, there is

usually less than 10 mm of bone remaining between the alveolar ridge and the floor of the maxillary sinus. This small amount of bone is usually associated with insufficient bone density and great force in the region, endangering the long-term prognosis of many endosteal implant systems. A sinus elevation procedure may be undertaken to reconstruct bone at the sinus floor to increase the survival of dental implants. Several techniques have been proposed for reconstruction of the posterior maxilla.

In the late 1960s, Linkow [1] reported that the maxillary sinus membrane may be displaced slightly to provide room for the placement of blade implants inside the sinus in the posterior maxilla. This technique requires at least 7 mm of vertical bone height under the sinus.

Barone [2] used onlayautogenous bone taken from the illiac to provide sufficient bone height to support implants and increase bone height in the posterior maxilla. Tatum [3] introduced a modified Caldwell-Luc technique for maxillary sinus floor grafts. In this technique, the alveolar crest of the maxilla is incised and used to lift the maxillary sinus membrane. Then the bone graft is placed in the area that was previously occupied by the inferior third of the maxillary sinus. Endosteal implants are placed inside this grafted area after approximately 6 months of healing. This technique was developed for simultaneous placement of the implant.

Various materials that have been used to graft the sinus cavity are listed in Table 1.

Autogenous bone grafts have been the primary material of choice by dental practitioners all over the world since surgical techniques for sinus floor elevation were introduced. Although autogenous material is the most acceptable biomaterial for osseous grafts, its use has some disadvantages, including the need for a second surgical procedure.

In addition, postoperative pain at the donor site may be severe, depending on its location and the amount of grafting material needed.

Application of xenografts to increase bone height and volume in posterior maxillary defects has been proved highly effective. Anorganic bovine bone matrix, either alone or in combination with autogenous materials is the material of choice by the majority of physicians who perform sinus graft surgeries. Froum and Wallace [4] examined 5,267 implants after at least 1 year of loading.

The study included 34 lateral window accesses and 11 xenografts, alone or in combination with autogenous bone or in combination with platelet-rich plasma.

The study showed that the survival of implants placed in xenografts was the same as that placed in autogenous bone from a statistical viewpoint.

In another systematic study by Del Fabbro et al [5], the survival rates of 6,913 implants in 2,046 patients assessed for 12 to 25 months in 39 eligible studies were evaluated.

The mean survival rate was 87.7% for implants placed in 100% autogenousgrafts and

Table 1. Materials used in sinus elevation procedures

Autograft	Bone harvested from iliac crest, tibia, mandibular ramus and mandibular symphysis
Allograft	Freeze-dried demineralized bone
Alloplast	Resorbable hydroxyapatite, nonresorbable hydroxyapatite and resorbable glass
Xenoplast	Bio-Oss, osteograft and inorganic bovine bone

for implants placed in sinuses that had been reconstructed with a combination of xenograft and autogenous bone the survival rate was 94.9%.

A survival rate of 85% was reported for sinuses reconstructed with pure xenografts. Based on the results of this study [5], it may be concluded that xenografts are as efficacious as autogenous bone. Xenografts are osteoconductive rather than osteoinductive; therefore, the osseous walls of the sinus need to provide blood vessels, cells and growth factors that encourage bone formation. To achieve the best results, the sinus membrane should be elevated from the floor and the medial segment so that the whole graft may receive blood vessels and the greatest number of particles are in contact with the osseous walls. In addition, autogenous bone provides growth factors, so that bone formation is induced during bone turnover. Because xenografts do not include growth factors, they need a longer healing period so that viable bone may be formed.

The success of sinus grafting procedures is evaluated by following the therapeutic objectives and feedback from the patient. The aims of sinus lifting procedures include formation of viable bone in areas in which no bone is present and the survival of implants placed in the reconstructed bone. The latter should be evaluated through prospective clinical studies.

Papa et al [6] evaluated 50 patients who had undergone sinus elevations between 1995 and 1998. Different grafting materials, including xenografts, autografts and allografts were used during the period. Postoperative evaluation consisted of radiographic examination and histologic evaluation at 6 and 12 months, respectively. In radiographic examinations, the amount of the bone formed was assessed and in the histologic evaluation, the quality of the bone formed was evaluated. The evaluations revealed that xenograft particles and HA of autogenous bonehad the greatest and lowest resorption and replacement by bone, respectively.

Landi et al [7] used demineralized freeze-dried bone allograft (DFDBA) and hydroxyapatite instead of autogenous bone to graft sinuses. The healing period varied from 6 to 13 months before implant placement, during which an osseous sample was taken from each patient for histologic and histomorphometric evaluation. Woven and lamellar bone was observed in all samples, with a mean volume of 27.92% of lamellar bone. Newly formed bone was proportional to the duration of the healing period; the bone formed after 6 months was 5.36%, which increased to 43.67% after 12 months. DFDBA particles were visible in the specimens surrounded by inflammatory agents taken at 6 months. The particles decreased in size over time and no particles were visible after 12 and 13 months.

Scarano et al [8] carried out a study on 94 patients who had undergone sinus lifting procedures to compare nine different graft materials in an attempt to solve the problem of implant placement in the posterior maxilla. A total of 362 implants were placed in reconstructed sinuses. Six months after the implants were loaded, all of them were in satisfactory condition and the patients had no complaints. Radiographic evaluation revealed compact bone around the implants. Four years later, only seven implants had failed and histologic evaluations showed that vital bone had replaced the graft particles.

Olson et al [9] conducted a study on patients with a mean age of 56 years to evaluate the survival of implants placed in maxillary sinuses. The materials studied were allografts such as DFDBA, alloplasts such as HA, xenografts and a combination of these materials. One hundred twenty implants were placed in 45 grafted sinuses. Thirty-eight months after the implants were loaded, only three of the implants failed, These failures occurred in patients who had a history of smoking. The survival rate of the implants placed in elevated

sinuses was higher than that of the implants placed in sinuses which had not undergone surgery.

Simunek et al [10] performed a histomorphologic study on 24 patients with a mean age of 47 years to evaluate the effect of alloplastic graft materials, such as hydroxyapatite in sinus lifting procedures. Forty-five titanium implants were placed and the patients were re-examined at 6, 9, 12, and 15-month intervals after sinus grafting. In addition, samples were taken from the patients for histomorphologic evaluations. The results showed complete resorption of graft materials and replacement with viable bone. The histomorphologic evaluation carried out in the study represented an appropriate and noninvasive technique for correlation with implant survival rates.

Andreana et al [11] carried out a study in six patients who had undergone sinus lifting procedures to evaluate the efficacy of the use of calcium sulfate alone or in combination with DFDBA in sinus grafting procedures. Clinical examinations showed long-term survival of implants placed in the grafted sinuses and histologic evaluations of bone biopsies obtained 6 to 24 months after surgery showed new bone formation.

Maiorana et al [12] compared peri-implant bone loss and implant survival with the use of HA versus a xenograft in sinus lifting procedures and found no significant differences in peri-implant bone loss or successful osseointegration after 4 years. They reported a success rate of 97% in the treatment of 34 patients with 36 reconstructed sinuses and 37 implants with one failed implant. The average marginal bone loss for both HA and xenograft was 1 mm.

Valentini and Abensur [13] studied 59 patients who received 178 cylindrical implants in 78 reconstructed sinuses to evaluate implant survival. They reported a success rate of 94.5% over a mean period of 6.5 years. Survival of implants in xenograft-reconstructed sinuses was 96.8%, which was comparable to the success rate of 90% in sinuses reconstructed with a combination of xenograft and allograft bone (DFDBA). Hallman et al [14] evaluated the effects of different graft materials on implant survival. They reported an overall survival rate of 91% for 111 implants placed in 36 elevated sinuses at least 1 year subsequent to loading. Survival rates for sinuses reconstructed with autogenous bone alone and autogenous bone with bovine bone at a 20:80 ratio were 82.4% and 94.4%, respectively. In addition, implant survival was reported to be 96% in sinuses reconstructed with 100% Bio-Oss.

The aim of the present study was to evaluate the survival of implants placed in reconstructed maxillary sinuses and to determine the extent of bone loss around implants placed in such sinuses. These factors were then compared with implants placed in the intact posterior maxilla.

MATERIALS AND METHODS

This case control study was carried out in the Department of Implantology in the Faculty of Dentistry, Tehran University of Medical Sciences after approval by the Ethical Research Committee of the Tehran University School of Dentistry. Eligible subjects who needed dental implants in the posterior maxilla including the first and second premolar and first and second molar regions, had a less than 5 mm original distance between the alveolar crest and the sinus floor, had sinus surgery performed with the lateral window technique and Bio-Oss material, had a time interval of 9 months since sinus elevation, had at least 24 months passed after the implant placement were enrolled in the study. Patients who had Class II or III occlusal relationships, bruxism and/or clenching habits and those who had immunosuppressive systemic conditions such as diabetes mellitus, pregnancy and smoking habit were excluded from the study.Dental implants placed in reconstructed maxillary sinus-

es with the lateral window technique and Bio-Oss graft material were compared with dental implants placed in the posterior maxilla without any other surgeries. For each subject, probing pocket depth (PPD) at six spots around the implants, bleeding on probing (BOP), Plaque Index (PI, presence or absence of plaque around implants) and bone loss on panoramic radiographs immediately after implant surgery and after at least 2 years were recorded for both the test and control groups. The implant survival criterion consisted of presence or absence of the implant in the oral cavity determined by clinical examination. In order to calculate the type and amount of bone loss, the two radiographic views were compared as follows. Since the implant length was declared, it was possible to determine the radiographic magnification for each radiographic view.Magnification was calculated by dividing the implant length on the radiograph by the actual implant length.

$$\text{Radiographic magnification} = \frac{\text{Implant length on the radiograph}}{\text{Actual implant length}}$$

Then, the bone height around each implant was measured on the radiograph from the most inferior spot of the bone around it; subsequently, divided by the magnification calculated for the implant on the same radiograph. This calculation was carried out separately for each implant on both radiographs.

$$\text{Actual bone height} = \frac{\text{Bone height around the implant on the radiograph}}{\text{Magnification of the implant on the same radiograph}}$$

The difference between the two bone heights calculated on the two radiographs representing the bone loss between the two time intervals was recorded for each implant. In case of bone loss, its type was determined and recorded.

Data were analyzed by descriptive statistical tests (chi-square test) and analysis of variance using SPSS software.

RESULTS

A total of 25 dental implants placed in reconstructed maxillary sinuses with the lateral window technique and Bio-Oss graft material and 30 dental implants placed in the posterior maxilla without any other surgeries were compared. The means and standard deviations of PPD (probing pocket depth), BL (bone loss) and LT (loading time) in both groups are listed in Table 2.Distribution of implants under study between the two groups is; in intrasinus implants 4 implants placed in the second premolar region, 17 in the first molar and 4 in the second molar region. In extrasinus implants, there were 12 implants inserted in the first premolar region, eight placed in the second premolar region, eight in the first molar and 12 positioned in the second molar region.One of the 30 extra sinus implants placed in this study failed and was extruded. In the intrasinus group, two of the 25 inserted implants failed and were extruded. The chi-square test did not reveal any significant deference between the two groups (P=0.448).

According to BOP index, 18 implants of the intrasinus group were marked as 0 and five of them were marked as 1. On the other hand, in the extrasinus group, 20 implants were marked as 0 and nine were marked as 1.

The chi-square test did not show any significant deference between the two groups (P=0.397).According to PI, 19 implants of the intrasinus group were marked as 0 and four of them were marked as 1, but in the extrasinus group, 24 implants were marked as 0 and five as 1.The chi-square test did not reveal any significant deference between the two groups (P=0.637).

DISCUSSION

The use of dental implants in the posterior maxilla is often limited due to the maxillary sinuses. To overcome the problem, open and

closed sinus elevation procedures have been recommended using various materials to ossify the sinus cavity. In the present study, 25 implants placed in sinuses reconstructed with Bio-Oss were compared with 30 implants placed in the posterior maxilla without sinus grafting. The results may be evaluated from various viewpoints.

The survival rates of the implants were not significantly different between the two groups after 2 years.

The survival rate of implants placed in the reconstructed sinuses was 92% after 2 years; whereas, the survival rate of the implants placed in intact maxillae was 96.7%. In a similar study by Hallman [14], a survival rate of 91% was reported for 111 implants placed in 36 elevated sinuses, which had been loaded for at least a year. In the present study, the mean bone loss around the implants placed in elevated sinuses was less than 1 mm after 2 years (P = 0.981). In a similar study performed by Maiorana et al [12] in 2005, 1 mm of bone loss was reported around 37 implants placed in 26 reconstructed sinuses in a 4-year follow-up.

In a study carried out by Simunek et al [10], the success rate of intrasinus implants was evaluated by histology and histomorphometry and resorption of graft materials and replacement with viable bone was reported.

In the present study, of the 25 implants placed in reconstructed sinuses, only two had failed after 2 years.

In a similar study by Olson et al [9] on the survival rate of 120 implants placed in 45 reconstructed sinuses, only three implants had failed after 38 months.

The similarities between the results of the present study and those of other studies indicate that sinus elevation with the lateral window technique may be used reliably for osseous reconstruction. In addition, the use of Bio-Oss graft material alone can be an appropriate alternative to autogenous grafts on the condition that there is at least an interval of 9 months after the graft procedure prior to implant placement.

Mean values for bone loss around implants placed in reconstructed sinuses and outside the sinuses were 0.641 mm and 0.643 mm, respectively, demonstrating no statistically significant difference. In the present study, there were no significant differences in BOP, PI and PPD around implants placed inside and outside the sinuses (P = .397, P = .637, and P = .314, respectively).

Table 2. Means and Standard Deviations of PPD, BL and LT in Both Groups

		Frequency (No.)	Mean	Standard Deviation	P
PPD	Extra-sinus implants	29	1.88	0.38	0.314
	Intra-sinus implants	23	2.07	0.7001	
BL	Extra-sinus implants	29	0.64	0.69	0.981
	Intra-sinus implants	23	0.64	0.52	
LT	Extra-sinus implants	30	40.06	20.88	0.024
	Intra-sinus implants	25	28.16	16.33	

PPD = Probing Pocket Depth; BL = Bone Loss; LT = Loading Time

Problems and Limitations

The most important problem in the present study was the difficult access to patients due to changes in addresses and phone numbers.

CONCLUSION

Based on the results of the present study, it may be concluded that sinus lifting by window technique provides good prognosis for preparing bone needed for implant insertion surgery procedure. In addition, the results of this study indicate that Bio-Oss grafting material itself induces bone regeneration. Therefore, there is no need to use the patient's outogenous bone and the second surgery procedure. This is really important for patient comfort and prohibition of invasive procedures.

The point in using Bio-Oss grafting material is that it takes 9 months for osseogenesis in the sinus and patients should be aware of this fact. Moreover, this technique provides the opportunity of using dental implants for patients with inadequate bone in the post maxillary region.

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