Local Sinus Lift for Single-Tooth Implant. I. Clinical and Radiographic Follow-Up

Karl-Erik Kahnberg, DDS, PhD;* Mats Wallström, DDS;† Lars Rasmusson, DDS, PhD[‡]

ABSTRACT

Background: For single-tooth implant replacement in the posterior maxilla, it is often necessary to do an augmentation of the alveolar process because of post-extraction resorption and include part of the maxillary sinus.

Purpose: The purpose of this study is to present a technique for a local sinus lift with autogenous bone in a one-stage procedure. Additionally, volume changes of the grafted area were evaluated radiographically up to 2 years.

Materials and Methods: Twenty patients, 12 female and 8 males, were included in the study. Single-tooth replacement was made in the second premolar area in 7 cases and in the molar area in 13 cases. Local sinus lift and implant installation were made simultaneously. Abutment connection was made after 6 months of healing.

Results: Two years of clinical and radiographic follow-ups have been made in all patients. The survival rate was 100%. The residual bone volume in the actual area was 2–5 mm preoperatively, after sinus lifting in mean 13 mm, after 1 year in mean 11.4 mm, and 2 years postoperatively in mean 10.6 mm.

Conclusions: Local sinus lift with simultaneous bone augmentation and single-tooth replacement in the posterior maxilla is a predictable method although a certain bone volume reduction around the implant was evident at the 2-year follow-up.

KEY WORDS: bone graft, implants, sinus lift

INTRODUCTION

In the posterior maxillary region behind the canine, premolars and molar teeth have a close connection to the maxillary sinus. Satisfactory bone support to allow for implant rehabilitation in the upper jaw does have a predictable high success rate.^{1,2} However, when the bone volume below the sinus cavity is reduced to between 3–5 mm, conventional implant insertion is impossible. Sinus lift procedures using autogenous bone or bone

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substitutes have reasonable favorable results.^{3–17} Sinus impaction using osteotomes is another alternative method if the bone volume allows for the technique. Usually, a residual volume of more than 5 mm is necessary. Sinus lifting for rehabilitation of larger segments such as partial edentulousness posterior of the canine is mostly carried out with the buccal window technique. The residual bone volume has to be augmented by use of either autogenous bone material, bone substitutes, or impaction of the residual bone.¹⁸⁻²⁴ In a situation where a single tooth is missing in the premolar or molar region in the maxilla, a localized resorption is frequently seen both from the coronal and sinus aspects.²¹ In these situations, a modified technique which we call local sinus lift has been developed in our clinic. The aim of this paper is to describe the method and report the result of a 2-year follow-up of the method.

MATERIAL AND METHODS

Twenty patients (12 females and 8 males) have been included in the study. The average age at the start of the study was 49 years for the males (range 38–55) and 43 for the females (range 26–60). The patients reported no

^{*}Professor, Department of Oral and Maxillofacial Surgery, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden; [†]assistant professor, Department of Oral and Maxillofacial Surgery, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden; [‡]professor, Department of Oral and Maxillofacial Surgery, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

Reprint requests: Professor Karl-Erik Kahnberg, Department of Oral and Maxillofacial Surgery, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Box 450, SE 405 30 Gothenburg, Sweden; e-mail: k-e_kahnberg@odontologi.gu.se

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history of sinus infection. Local sinus lifts were made to replace a second premolar tooth in seven cases and a molar tooth in 13 cases. Intraoral radiographs were taken preoperatively, postoperatively, 6 months, 1 year, and 2 years postoperatively using a standardized technique. The radiographs were evaluated by two independent observers for estimation of marginal bone level and amount of bone augmentation. In this clinical study, Astra Tech Osseo Speed® implants (Astra Tech AB, Mölndal, Sweden) have been used. The diameter of the fixtures varied between 4.5 mm and 5 mm depending on the width of the alveolar process. The length of the implants has also varied between 13 mm and 17 mm.

Surgical Procedure

A crestal incision was made in the edentulous area and connected with diverging relaxation incisions in the vestibule. A circular area over the sinus cavity bone was removed to the sinus membrane and the bone was collected with a Bone Trap® device (Astra Tech AB, Mölndal, Sweden) during the preparation (Figure 1, B and D). The sinus membrane was then carefully lifted and the implant installed through the crestal bone by use of the standardized preparation technique for Astra Tech fixtures using initially round burr followed by spiral drills up to 3.2 mm (see Figure 1C). The implant was allowed to penetrate into the sinus cavity about two or three times the residual bone volume (Figure 1F). The primary stability was acceptable, however, not excellent in most of the cases as judged by the surgeon during the implant installation. The sinus membrane was thus held up by the implant which acts as a tent pin for the membrane (Figure 1C). The implant was surrounded by the bony walls of the adjacent teeth and at the top of it the sinus mucosa. A cover screw was adapted and the collected bone material from the Bone Trap® was placed around the exposed part of the implant. The apical part of the fixture was completely covered with bone in all cases. The flap was then repositioned with interrupted sutures. Sutures were removed after 2 weeks and abutment connection made after 6 months followed by single crown therapy. Clinical and radiographic follow-up was then made during 2 years (Figures 1A–I and 2A–D).

Radiographic Examination

Parallel intraoral techniques were used for radiographic examinations and carried out at the Department of Oral and Maxillofacial Surgery, University of Gothenburg. Residual bone level inferior of the sinus floor was measured before patients entered the study and a vertical bone height of 2-5 mm was accepted for inclusion. A second radiograph of the area was taken immediately after the grafting procedure as a baseline. The grafted area (+implant) was then followed annually for 2 years. The radiographs were displayed on a light box and captured by a charge-coupled device camera connected to a desktop computer using a picture analysis system (NIH Image, National Institutes of Health, Bethesda, MD, USA). Contrast and light were automatically optimized. The vertical bone height was measured from the marginal crest on both sides of the implant. Thus, the implant reference point was not used for measurements of the total height as some implants were installed slightly deeper than the crest and also marginal bone resorption was seen in some cases at the 1- and 2-year follow-up visits. Care was taken to obtain a clear image of the threads on both sides of the implant for correct assessment of the vertical bone height. A mean value was calculated for each implant.

RESULTS

A total of 20 patients have been followed clinically and radiographically for 2 years. All patients have been rehabilitated with crown therapy. No implant losses have occurred which is 100% survival rate. Clinically, there were no reports of side effects or complications. The marginal gingiva is healthy in all the patients; the oral hygiene around the crowns in all patients is without remarks.

Radiographic Findings

The mean residual bone level below the sinus floor was at start 5.8 ± 1.3 mm. The augmented area was measured as an increase in vertical dimension. The total height immediately after grafting (residual bone + bone graft) was in mean 13.0 ± 1.8 mm. As a result of resorption, the total bone height decreased to a mean of 11.4 ± 3.6 mm after 1 year and to a mean of 10.6 ± 2.1 mm 2 years after grafting and implant installation. Bone resorption was mainly seen apically but in some cases also marginally. The marginal bone level from the implant neck (reference point) was in mean 0.83 ± 0.77 mm (range 0.0-1.8 mm) after 2 years. The decrease in bone height after augmentation was statistically significant after 1 year and also between years 1 and 2 (Table 1).



Figure 1 *A*, Radiograph in the region of the missing second premolar showing limited amount of bone below the maxillary sinus cavity after extraction. *B*, Local sinus lift after removal of the covering bone-plate. *C*, Clinical view after local sinus lift and placement of implant supporting the sinus membrane. *D*, Bone graft material collected with the Bone Trap[®]. *E*, Clinical view after filling the space around the implant with Bone Trap[®] graft material.



Figure 1 (*continued*) *F*, Radiograph showing implant in place with about 75% of the implant into the sinus cavity. *G*, Six months postoperative radiograph. *H*, Radiograph at 1-year follow-up. *I*, Radiograph postoperatively at 2-year follow-up. *J*, Crown restoration made.

DISCUSSION

Replacement of a single tooth is usually a choice between conventional bridge therapy and implant therapy. A three-unit bridge was the method of choice before the implant era. However, single-tooth implants prevent invasive preparation of adjacent teeth, especially if those are more or less intact. With a compromised bone situation, our method with a local sinus lift seems to be working very well. Bone filling around the implant was radiographically evident and with minor remodeling in the marginal area. The implant seems to keep the bone up to the apex of the implant although one may

Figure 2 *A*, Radiograph showing limited amount of bone in the region of a missing first molar. *B*, Implant placed after impaction of the sinus floor. *C*, One year follow-up after impaction. *D*, Two years follow-up.

observe tendency from the sinus membrane to move downwards. The average sinus augmentation height was approximately 7–8 mm, enabling the use of 13–15 mm fixtures. Whether you need that long fixtures or not is a question for further studies. In our study, all of the patients have been successfully rehabilitated with crown therapy. The minor marginal bone loss around the implants could be because of a remodeling phase after

TABLE 1 Bone Volume Measurement Preoperatively and after Sinus Lifting Procedure as well as 1 and 2 Years Postoperatively			
Bone Volume Measurement (in mean)			
Residual Bone Volume Preoperatively (mm)	Total Bone Volume of Sinus Lifting (mm)	Bone Height 1 Year Postoperatively (mm)	Bone Height 2 Years Postoperatively (mm)
5.8 ± 1.3	13.0 ± 1.8	11.4 ± 3.6	10.6 ± 2.1
Range	Range	Range	Range
3.2-8.9	9.0–15.4	5.6-13.4	5.0-13.4
	p ·	< .01	
		<i>P</i> ·	< .01

the surgical procedure. The Osseo Speed® surface and the microthread is well documented to maintain the bone level.²² It has been suggested by some authors that the mere lift of the sinus membrane could promote bone formation.^{25–27} Using the bone window as a roof could also improve the bone regeneration.²⁶ In our study, the intention has never been to completely fill up the space around the implant with bone material. Instead, the idea has been to create a space with the implant acting as a tent pin. It seems important that the adjacent bone walls have an inclination steep enough to help in the bone regeneration. The bone graft material obtained by the Bone Trap® is very limited and not by far enough for filling of the peri-implant space. The bone walls surrounding the created space may be very important for the bone anchorage in a time perspective. As we have observed, the sinus membrane is eager to taper the top of fixture already in a 2-year follow-up. Individual intrasinus pressure may have an impact for the final outcome as well as post-extraction resorption of the alveolar bone. And, as shown by the results from the radiographic measurements, there is during a 2-year period a marginal bone reduction up to between 2 and 3 mm for various reasons such as remodeling of bone tissue after surgery, intrasinus pressure, etc. As the "tent pin effect" seems to stimulate bone regeneration, it should be recommended to use long fixtures like between 13 mm and 15 mm in these cases. This has also been demonstrated in a recent long-term follow-up study by Ferrigno and colleagues²⁸ who showed a strong correlation between implant length and survival rates in the posterior maxilla. The local sinus lift procedure is in our opinion a safe and simple procedure in cases with loss of a single tooth in the premolar and molar region with close relation to the maxillary sinus.

We have also observed in the intraoral radiographs that if the anatomical situation locally is more flattened, that is, not surrounded by bone walls, the bone filling around the top of the implant is not the same as if we had steep bone walls adjacent to the implant. The idea that the sinus membrane could help in bone regeneration is not supported in our study. Logically, if there had been a bone generating capacity in the sinus membrane, there would have been no maxillary sinus space. It is of course also possible to fill the space around the part of the implant extending into the sinus cavity with bone graft material or Bio-Oss particles to prevent the sinus membrane from tapering the implant apex.²⁹ Sinus lift by use of osteotome impaction technique is of course also useful in these cases, but the risk for perforation of the sinus membrane is larger and the idea of lifting the membrane like a tent is sometimes difficult to achieve. However, promising results have recently been published.³⁰

CONCLUSIONS

Local sinus lift with simultaneous bone augmentation and single-tooth replacement in the posterior maxilla is a predictable method although a certain bone volume reduction around the implant was evident at the 2-year follow-up. However, long-term data are needed to evaluate the degree of bone graft resorption in an extended time perspective.

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