

Sinus floor elevation with simultaneous placement of INNO™ implants: a 1-year radiographic evaluation

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Purpose: This study evaluated the clinical results of submerged INNO implants placed at the time of the sinus floor elevation procedure at sites where native bone height was less than 4 mm. Changes in graft height were also assessed using radiographs for 1 year after the implant procedure.

Methods: The sinus floor elevation procedure with rhBMP-2 bone graft was performed on 4 patients with atrophic posterior maxillas with simultaneous placement of 7 submerged INNO implants. Panoramic radiographs were obtained from each patient as follows: before surgery, immediately after implant placement, 6 months after surgery, and after 1 year. Clinical and radiographic examinations were performed at every visit. Radiographic changes in graft height were calculated with respect to the implant's known length and the original sinus height.

Results: All implants were stable functionally, as well as clinically and radiographically, during the follow-up. Most of the radiographic reduction in the grafted bone height occurred in the first 6 months; reduction after 6 months was slight.

Conclusions: The simultaneous placement of submerged INNO implants using sinus floor elevation procedure with rhBMP-2 is a feasible treatment option for patients with severe atrophic posterior maxillas.

Key Words: Dental implantation, Maxillary sinus, Radiography.

INTRODUCTION

The placement of implants in the posterior maxilla is limited occasionally by insufficient bone volume as a result of alveolar atrophy or pneumatization of the maxillary sinus. This clinical problem can be resolved by sinus augmentation using surgical procedures such as onlay augmentation of the alveolar crest [1,2], Le Fort I osteotomy with an interpositional bone graft[3,4], lateral-approach sinus augmentation [5-7], or osteotome sinus augmentation [8-11]. In 1994, Summers introduced a less invasive sinus floor elevation procedure employing simultaneous grafting and the immediate placement of implants [8]. Using the Summers osteotome kit [8,9], which was specifically designed for this procedure, the pre-existing crestal bone is displaced toward the sinus floor as the osteotomes are inserted. Various graft materials and implants can be used in this surgical procedure. However, a

minimum native bone height is required to get initial stability of the implant, and at least 5 mm of alveolar ridge height under the sinus is recommended for an implant that is 10 mm or longer [9]. Clinical case reports and studies on the sinus floor elevation procedure with simultaneous placement of implants show a relatively high survival rate in non-submerged sand blasted with large grit and acid etched (SLA) implants (94-98%) [10-15], but implant survival rates drop significantly when native bone height is 4 mm or less. Therefore, there are only a few clinical case reports involving sites with less than 4 mm of native bone height.

This report evaluates the clinical results of submerged INNO implants placed at the time of the sinus floor elevation procedure at sites where native bone height was less than 4 mm. Changes in graft height were also assessed using radiographs for 1 year after the implant procedure.

MATERIALS AND METHODS

Patients

Four consecutive patients (2 women and 2 men, mean age of 61) with severe atrophy of the alveolar process in the posterior maxilla were treated at Seoul dental clinic. The patients showed no signs or symptoms of sinus or intraoral disease. All four patients underwent the sinus floor elevation procedure with simultaneous placement of a total of 7 INNO implants (Cowellmedi, Pusan, Korea) (Table 1).

Surgical techniques

All patients' medical histories were reviewed at an initial examination in order to rule out any local or systemic diseases that might contraindicate the surgical procedures. The patients received oral hygiene instructions and whole-mouth scaling prior to the surgery.

The sinus floor elevation procedure was performed using a Sinus lift kit, (Cowellmedi, Pusan, Korea). Briefly, an incision was made under local anesthesia of lidocaine 2% with 1:80,000 epinephrine (Kwangmyung Pharmaceutical, Seoul, Korea) at the edentulous area to be treated. After the crestal incision was made, full-thickness buccal and palatal flaps were reflected. Site preparation was begun using the point drills. 2.2 mm and 27 mm twist drilling was used to reach the cancellous bone, stopping 1 mm below the floor of the sinus. The

remained bone of preparation site was removed using 3.2 mm spreader drill and widened with 3.6 mm sinus lift drill or tap drill for the diameter 4 mm implant, and 4.6 mm sinus lift drill or tap drill for the diameter 5 mm implant. The elevated space was filled with synthetic bone with rhBMP-2 (Cowellmedi, Pusan, Korea) using osteotome (Fig. 1). Finally, INNO implants were placed into the osteotomy site. Primary stability was achieved for all implants. Primary closure was achieved using monofilament suture material.

Postoperatively, patients were instructed to rinse their mouth twice a day with a 0.12% chlorhexidine solution, Hexamedin (Bukwang Pharmaceutical Co., Seoul, Korea) for 2 weeks after surgery. Antibiotics were prescribed for 7 days, and sutures were removed after 10 days. After a mean healing period of 7 months, all patients were rehabilitated with fixed crowns or bridges.

Follow-up

After inserting the implants, the patients received follow-up care at 1 and 2 weeks, at 3, and 6 months, and every 12 months thereafter. Clinical and radiological evaluations were performed using standardized radiographs according to the following schedule: prior to surgery, immediately after surgery, 6 months after surgery, and then every year after surgery.

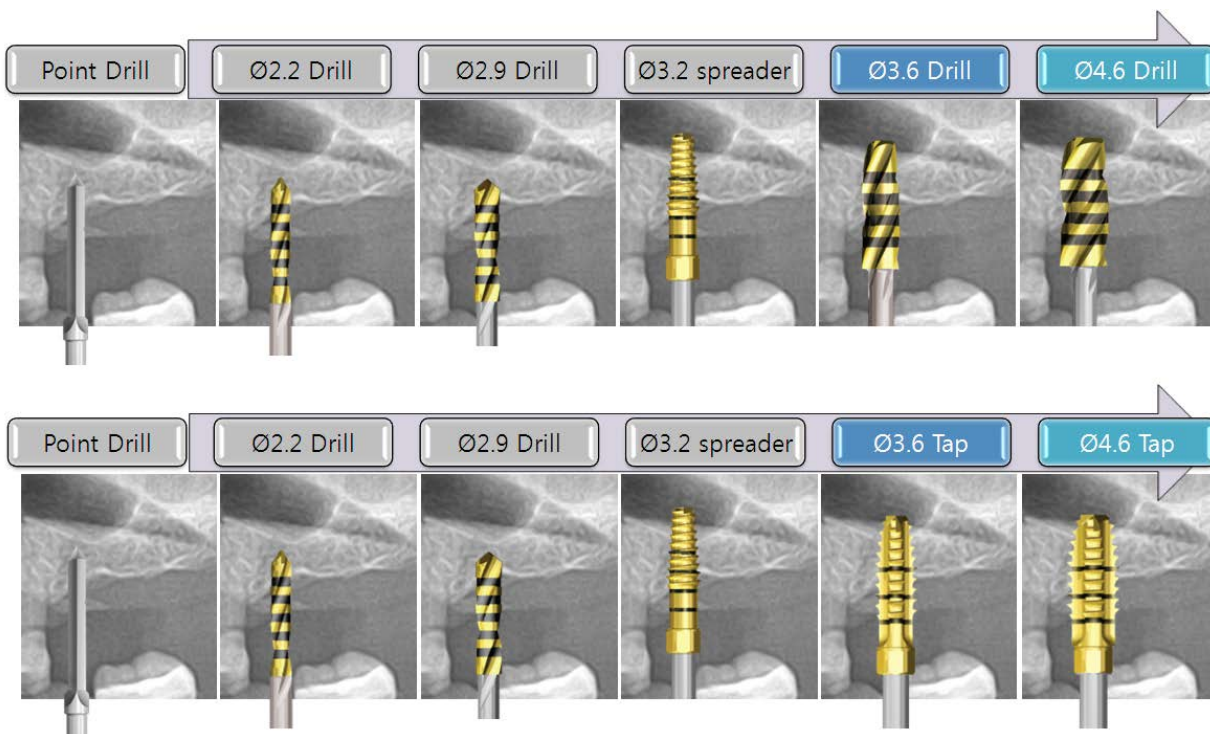


Figure 1 Drill sequence of sinus lift kit. Upper sequence of sinus lift drill, Low sequence of sinus lift tap drill

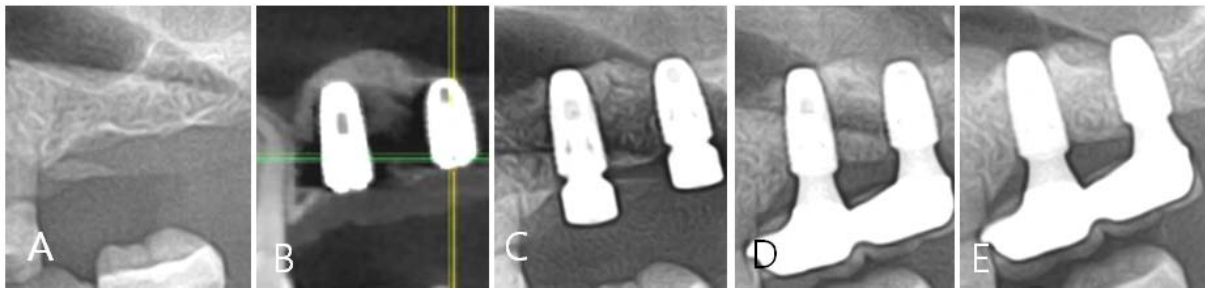


Figure 2 Panoramic X-ray at every visit during 1 year. (A) At preoperative visit (B) At postsurgery (C) 6 months after surgery. (D) restoration placement on 7 months (E) 13 months after surgery

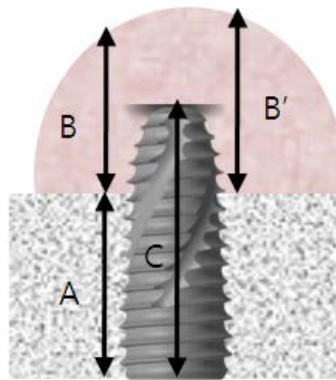


Figure 3 Schematic drawing of the measured parameters. (A) Native bone height: the distance from the alveolar crest to the floor of the maxillary sinus at the implant site, which was calculated as the mean of the mesial and distal native bone heights. Grafted bone height: the distance from the floor of the maxillary sinus to the border of the grafted bone at the implant site, which was calculated as the mean of the mesial (B) and distal (B_) grafted bone heights. (C) The implant height: the distance from the apex to the head of the fixture.

Patient no.	Site tooth no.	Bone quality	Implant		NBH (mm)	GBH0 (mm)	GBH6 (mm)	GBH12 (mm)
			D (mm)	L (mm)				
1	27	D2	4.0	10	3.6	8.6	6.4	6.4
2	18	D3	4.0	10	4.0	8.0	6.8	6.6
3	16	D2	5.0	10	3.1	9.9	7.4	7.3
	17	D2	5.0	8	4.0	9.0	7.0	6.9
4	16	D3	4.0	10	3.3	9.0	6.7	6.7
	17	D3	4.0	10	2.1	9.2	7.9	7.9
	18	D3	4.0	10	3.7	6.9	6.7	6.3
Mean					3.4	8.6	7.0	6.9

Table 1. Radiographic measurements for each patient

The mean total reduction in grafted bone height was 1.9 mm. Reduction was greatest during the 6 months (1.6 mm). Subscript numbers indicate the number of months elapsed since the surgery. D: diameter, L: length, NBH: native bone height, GBH: grafted bone height.

Radiographic analysis of the grafted bone height

Radiographic examinations were performed at every visit (Figure 2). Radiographic changes in graft height were calculated with respect to the implant's known length and the original sinus height with Easydent viewer version 4.5 software (Vatec, Anseong, Korea) (Figure 3).

RESULTS

Radiographic examination showed that the sinus floor was elevated immediately after surgery in all patients. Table 1 shows the radiographic measurements for each patient. The mean native bone height was 3.4 mm. The average gain in the grafted bone height of the implants was 8.6 mm (range, 6.9-9.9 mm). The grafted bone area was easily distinguished from the sinus floor on the radiographs. Clinical and radiographic examination during the initial healing period showed normal healing in all patients. At 6 months, radiographic evaluation showed the maturation of the grafted bone, including increased density and sinus floor remodeling. Although the change in grafted bone height varied from patient to patient, there were marked differences in bone height immediately after the surgery versus 6 months after surgery. The mean reduction in grafted bone height, which was gradual, was 1.6 mm (85% of the mean total reduction) during the 6 months. In contrast, subsequent grafted bone height reduction was minimal: After 6 months, the mean bone height was further reduced by 0.3 mm (15% of the mean total reduction). In case of patient no.4, significant radiographic remodeling of grafted bone occurred also during the 6 months. And the mean reduction was minimal between 6 and 1 year. Thus, the total mean reduction in the grafted bone height was 1.9 mm in 1 year after surgery. All implants were functionally stable, and crestal bone remodeling was minimal.

DISCUSSION

This report evaluated the clinical results of INNO implants placed simultaneously in sites with less than 4 mm of native bone height using the sinus floor elevation procedure. Using radiographs, this report also assessed changes in the grafted bone height during the short-term (1-year) healing period. All implants were maintained successfully for over 1 years. The results suggested that simultaneous placement of INNO implants using the sinus floor elevation procedure is a feasible treatment option for patients with atrophic posterior maxillas. There was some variation in results among patients, depending on the

follow-up time, inclusion criteria, surgical and prosthetic techniques, and other factors; however, the sinus floor elevation procedure with simultaneous placement of an implant shows a predictable survival rate ranging from 95-100% [6,10,11]. The 1-step approach using the sinus floor elevation procedure has the advantage of being less invasive, and this technique can enhance the bone quality of the implant site from type III or IV to type II. Reducing the surgical and healing times can be achieved because coordinated consolidation of the graft around the implants during the healing period is expected. Moreover, little difference has been reported between the survival rate of implants placed at the time of grafting versus those placed after a delay [16]. Differences in implant design and surface characteristics may influence the survival rate of different types of implants [11]. The superiority of SLA surface implants in conjunction with the osteotome sinus floor elevation technique has been documented in many studies [17,18]. Regarding the extent of bone retention, some studies have reported that the SLA surface is superior to a machined-surface implant [19,20]. Moreover, the survival rate of SLA-surface implants in the sinus augmented maxilla is markedly higher than that of the machined surface implants [21].

The survival rate of implants is also influenced by the quality and quantity of the native bone [11,12,22]. In particular, the survival rate is clearly reduced when the native bone height in an implant site is 4 mm or less [11]: It is difficult to achieve primary stability of the implant, and there is a higher possibility that the Schneiderian membrane will tear [23]. However, this is somewhat controversial. Peleg et al. [24] evaluated the efficacy of augmentation of the maxillary sinus using a lateral approach with simultaneous placement of hydroxyapatite surface implants in patients with 3-5 mm of residual bone height.

In this report, the height of the grafted bone was reduced markedly by an overall mean of 1.6 mm during the course of the short-term healing period, i.e. the 6 months. During the long-term healing period, i.e. over 1 years, the height of the grafted bone was reduced by an overall mean of 1.9 mm. Dimensional changes in the height of augmented grafts in the sinus have been documented in clinical and radiographic studies [25,26]. At the Sinus consensus conference in 1996, there was a report on 100 patients and 145 sinus-grafting sites that were evaluated using panoramic radiographs over a 3-year period. All graft materials resulted in a radiographic reduction ranging from 0.79-2.09 mm. However, it was not determined whether this reduction in graft height occurred in the initial healing period or was part of an ongoing healing process. Hallman et al. analyzed 30 maxillary sinuses in 20 patients who were grafted with a mixture of autogenous bone and bovine hydroxyapatite, and reported that a small (<10%) but statistically significant

dimensional reduction was observed 12 months after surgery and after 1 year of loading [27]. Other studies on the reduction of sinus grafts using X-rays have also been performed; most of these studies show agreement with the results of this report in that that shrinkage of the grafted materials and reduction in grafted bone height were observed during the initial healing period after the sinus floor elevation procedure were performed [28-29].

While small, this report suggests that simultaneous placement of INNO implants using the sinus floor elevation procedure is a feasible treatment option for patients with severely atrophic posterior maxillas.

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