<Original Article>

Short-term, Multi-center Prospective Clinical Study of Short Implants Measuring Less Than 7mm

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• Abstract

Objective : This prospective study sought to verify the stability of three types of short implants measuring 7mm or less.

Materials and methods : Implants measuring 7mm or less were placed in patients at multicenter dental clinics in Korea, China, Taiwan, and Singapore. Initial stability, intraoperative and postoperative complications, crestal bone loss, and survival rate of the implant were prospectively evaluated.

Results : The primary stability of a 6-mm implant was lower than that of a 7-mm implant. The marginal bone loss of short implants measuring less than 7mm was minimal. Complications such as wound dehiscence, implant mobility, and peri-implant mucositis developed, and these were associated with initial implant failure. The short-term survival rate of 6-mm implant was 93.7%, and that of 7-mm implant, 96.6%.

Conclusion : Short implant for the mandible with insufficient height for the residual ridge can be selectively used. Poor primary stability and wound dehiscence can cause osseointegration failure and alveolar bone loss.

• Key word : short implant, 7mm or less

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I. Introduction

Long-term edentulous state causes vertical or horizontal bone loss that limits the necessary implant length for sufficient stability, increases the possibility of violating the anatomical structures, and results in inappropriate implant-crown ratio. In particular, residual bone recession is 4 times faster for the vertical height of the mandibular anterior portion compared to the maxilla, with the anterior part of the mandible showing even greater tendency for resorption compared to the posterior part. The posterior part of the mandible exhibits a more distinct vertical rather than horizontal resorption pattern. As such, special attention must be given to the insufficient vertical bone volume of this area.[1] To address this matter, various surgical approaches such as bone grafting, bone augmentation, and inferior alveolar nerve transfer have been proposed. Still, the possibility of failure clearly increases in such cases, and the huge surgical trauma results in increased complications during healing, alveolar bone resorption, and soft tissue recession.[1] Therefore, short implants that minimize the possibility of complications and burden of surgical procedures have been drawing interest recently. In particular, when high stability can be predicted, short implants may be a valuable treatment option for mandibular posterior implants given insufficient bone volume.

Reports have shown that disadvantageous crown/implant ratio (C/I ratio) may be caused by short implants, resulting in increased possibility of mechanical complication; there are various opinions concerning the relationship between the C/I ratio and alveolar bone resorption. Rangert, et al[2,3] state that a disadvantageous crown/implant ratio (C/I ratio) causes non-axial loading that inevitably results in alveolar bone resorption. On the other hand, Blanes, et al[4] reported statistical analysis results revealing that a larger C/I ratio causes less alveolar bone resorption. According to Rokni, et al[5] and Tawii, et al[6], when occlusion is maximally centered near the implant axis, the C/I ratio does not affect alveolar bone resorption.

Generally, crown-to-root ratio is a clinical index that is used to evaluate the prognosis of abutment teeth when selecting abutment teeth among natural teeth for partial dentures[7]. When the alveolar bone level is lowered toward the tooth apex, the lever arm above the alveolar bone elongates; thus increasing the possibility of adverse lateral forces. The best prognosis can be expected when this ratio is 0.5; it should be at least 1 to be appropriate for an abutment[8]. Nonetheless, there is still no consensus on the clinical guideline for the implant C/I ratio.

Recently, short implants with surface processing and improved designs have been showing relatively satisfactory clinical results in the mandible; high long-term success rates for short implants measuring 6~8.5mm of the Branemark and ITI implant system have also been reported[9,10].

The authors investigated the initial failure rate of short implants foregoing invasive surgical procedures - which have been placed in patients at medical institutes in Korea, China, Taiwan, and Singapore - to evaluate the short-term prognosis of 6mm and 7mm Osstem GS II implants of the mandibular posterior area.

II. Materials and methods

7mm long Osstem GS II and SS II implants that had been placed during the period January 2008 ~ June 2009 at Bundang Seoul National University Hospital, Apsun Dental Hospital, Dental Hospital of Chosun University, and Jeju Yena Dental Clinic of Korea and 6mm long Osstem implants that had been placed at dental clinics in China, Taiwan, and Singapore were studied. The following were the inclusion criteria for patient selection:

(1) Patient with sound general health and those with controlled medical conditions

(2) Patients with insufficient residual alveolar bone height above the mental foramen and inferior alveolar nerve canal in the edentulous mandibular second premolar and first and second molar area

(3) Patients with residual alveolar bone height to the inferior alveolar nerve canal measuring less than 10mm

(4) Bucco-lingual alveolar bone width of at least 6mm

(5) Cases with advanced vertical alveolar bone resorption with predicted implant length: crown length ratio of over 1:2 were excluded from this study.

(6) Smoking behavior was not considered in this study.

The treatment procedure consisted of pretreatment clinical and radiographic examination to determine the implant placement position and size selection; implant placement was done under local anesthesia. Placement procedures were based on the manufacturer's manual; 7mm long implant of Osstem GS II and SS II systems and 6mm long implant of Osstem US II, SS II, and GS II systems were

used. A submerged or a nonsubmerged type was done depending on the operator's preferences. Primary stability was measured right after implant placement with Osstell mentor. BioOss bone graft material was used for guided bony regeneration, and BioGide was selected when a membrane was necessary. Antibiotics and non-steroidal, anti-inflammatory analgesics were prescribed for a week after the surgery, and chlorhexidine gargling 3 times a day was prescribed.

The sutures were removed 1 week later, and the second surgery or 1st impression taking for prosthodontic treatment was performed 2~3 months later. Periapical and panoramic radiographs were taken right after surgery, after the second surgery, after the completion of prosthetic procedures, and 1 year after prosthetic functioning. Postoperative complications, failure of early osseointegration, and crestal bone loss around the implant after 1 year of functioning were measured.

1) Early stability

Early stability has been proposed as an effective evaluation method to predict the level of osseointegration[1]. The Osstell® mentor (Integration Diagnostics, Sävedalen, Sweden) was used during the first surgery in this study to measure early stability.

2) Marginal bone resorption

Marginal bone level change was measured using periapical x-rays at the final recall check following prosthesis setting compared to the level right after implant placement. The magnification rate was considered based on the implant length of each implant placed, and the mean value was calculated after measuring the resorption amount of the mesial and distal sides.

3) Complication

The perioperative and postoperative complications were investigated.

4) Success and survival rate

The standard criteria for success at the final recall check included the absence of clinical findings such as mobility, pain, adjacent soft tissue inflammation, and radiographic radiolucency; among such cases, those with bone loss of less than 1.5mm after prosthesis setting and bone loss of less than 0.2mm each year after prosthesis loading were considered successful. When the implant and upper prosthesis remained at the final recall check regardless of the surrounding condition, the case was considered a survival. When the implant was removed for any reason, the case was considered a failure.

III. Results

A total of 43 6-mm implants were placed in 28 patients at medical institutes in China, Taiwan, and Singapore. The mean age of the patients was 52.6 ±14.3 years, with the group consisting of 10 men and 18 women. A total of 88 7-mm implants were placed in 53 patients at a multicenter dental clinic in Korea. The mean age of the patients was 52.8 ±9.8 years, and the group consisted of 20 men (28 implants) and 33 women (60 implants). The follow-up period was 6~9 months after prosthesis functioning for the 6mm implants and 7.9 ±6.9 months on the average for the 7mm implants.

1) Primary stability

A total of 12 US II, 14 SS II, and 17 GS II implants were placed, but implant stability was measured only for the GS II system. Primary stability for 6mm Osstem GS II implants was a minimum of 40 to a maximum of 68 ISQ value with mean of 49.4 ±8.7 ISQ. The mean value for the 7mm implant was 69.3 ±17.1 ISQ (Table 1).

Table 1. Primary stability of short implants

Types		Number	Primary Stability
6-mm	US II	12	
	SS II	14	
	GS II	17	49.4
7-mm	SS II	54	71.0
	GS II	34	68.2

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Table 2. Amount of marginal bone resorption

Types	F/U period (month)	Bone loss
6-mm	9	0.23
7-mm	7.9	0.36

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2) Marginal bone resorption (Table 2)

The mean amount of marginal bone resorption for the 6mm implant based on a periapical radiograph taken 9 months after prosthesis setting was 0.23 $\pm$0.69mm.

The resorption value was 0.36 $\pm$0.66mm for the 7mm implants after an average duration of 7.9 $\pm$6.9 months.

3) Complications (Table 3)

Postoperative complications that occurred after implant placement included 4 cases of cover screw exposure caused by wound dehiscence, 1 case of implant mobility, and 3 cases of implant removal due to early failure. The failure areas were GS II at the #35 position of a 65-year old male patient, SS II at the #36 position of a 48-year old female patient, and US II system at the #36 position of a 62-year old male patient.

A total of 54 7-mm GS II implants and 34 SS II implants were placed, with 3 GS II implants failing. Cover screw exposure caused by wound dehiscence occurred in 3 cases, all which resulted in failure. Mucositis surrounding the implant occurred in 2 cases but were treated successfully with curettage and laser treatment.

The failure areas were at the #47 position of a 49-year old female patient, #37 position of a 50-year old female patient, and #36 position of a 54-year old female patient. All failures were caused by cover screw exposure and alveolar bone loss following wound dehiscence.

4) Success and survival rate

The short-term implant survival rate was 93% for the 6-mm implants and 96.6% for the 7-mm implants.

IV. Discussion

There is still controversy concerning the prognosis of short implants. Herrmann, et al (2005)[11] reported that 78.2% of 7-mm implants recorded low survival rate and concluded that a close relationship exists between short implants and high failure rates.

Weng, et al (2003)[12] reported that 60% of the failed implants were shorter than 10mm, with the cumulative success rate of short implants significantly lower compared to the total success rate of implants. On the other hand, some reported that the failure rate of short implants was similar to that of other implants; since the alveolar crest area bears the most loading, once initial healing has taken place, implant length cannot be a critical factor for success[13].

Palo Maló, et al (2007)[9] actually placed 408 short Brånemark implants and reported a high 5-year survival rate of 96.2% from 131 7-mm implants and 97.1% from 277 8.5-mm implants. Moreover, Romeo, et al (2006)[10] reported that the cumulative survival rate for 14 years was 97.9% for the short implant and 97.1% for the standard implant. There was also no statistically significant difference in the five-year success rate and survival rate when analyzed for the short implant and the standard implant with both TPS and SLA surface processing. This suggests that the prognosis of short implants has been improved due to the upgrades of surgical procedures, implant surface processing, and design.

Table 3. Types of complications

Implant length	Complications	Number of Cases
6mm	Wound dehiscence	4
	Implant mobility	1
7mm	Wound dehiscence	3
	Peri-implant mucositis	2

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Although the observation period was rather short, 6-mm implants recorded a 93% survival rate in this study, and 7-mm implants, 96.6%.

Osstell® mentor was used to measure primary stability in this study. Osstell® mentor (Biolin Medical) is a device using resonance frequency that is affected by the stiffness and effective marginal length of the bone-implant interface. A "normal" case shows a mean value of around 70 ISQ, and the clinically measurable range is 40~45 to 85~90[4]. Piero Balleri, et al[5] reported that successful cases of osseointegration recorded an average ISQ of 69 ranging from 57 to 82 when measured 1 year after functioning. Implants placed in the mandible showed a stabler value compared to the maxilla, and there was no significant difference between the anterior and posterior areas. Moreover, stability was similarly high for both short and long implants[16,17]. Specifically, 6-mm implants recorded 49.4 ±8.7 ISQ, and 7-mm implants posted 69.3 ±17.1 ISQ in this study. Romeo, et al[10] compared 111 8-mm implants and 154 10-mm implants of 129 patients for 3 ~ 14 years and reported that the mean amount of bone resorption at the final recall check was 1.6mm for 8-mm implants and 1.7mm for 10-mm implants. There was no statistical difference in bone resorption amount between short and standard implants. In this study, the mean amount of bone loss for the 6-mm implant 9 months after prosthesis setting was 0.23 ± 0.69mm, and the average resorption value was 0.36 ± 0.66mm for 7mm implants after a duration of 7.9 ±6.9 months.

The statement that implant length alone cannot determine the stress dispersion degree to the alveolar bone is gaining ground. According to Misch[18], as implant length increases, the total area also increases, but the occlusal force delivered to the apical area is weak; it cannot lower the stress applied to the alveolar crest area. Thus, he stressed that the functional surface area should be considered, not the absolute total surface area. In other words, the factor affecting alveolar bone resorption is implant diameter or screw design, not implant length. All the implants used in this study had an RBM surface; US II, SS II, and GS II design implants were variably applied. Alveolar bone loss was not severe.

Complications following the placement of short implants in clinical studies included temporary sensory anomaly, cover screw exposure caused by wound dehiscence, peri-implant mucositis, screw loosening, and prosthesis damage[5-9]. Complications that occurred in this study included wound dehiscence, implant mobility, and peri-implant mucositis; three cases of osseointegration failure each were recorded for the 6-mm and 7-mm implants.

The short observation period after prosthesis functioning was one limitation of this study, but prosthetic complications did not occur. Another limitation of this study was that in spite of the small case number of 6-mm implants, a variety of US II, GS II, and SS II implants were placed, and data from overseas research institutes was incomplete. Further studies with reinforced material including cases of over 1-year prosthetic functioning shall be conducted and presented in the future.

V. Summary

1. The primary stability of 6-mm implants was slightly lower than 7-mm implants.
2. Marginal bone loss was minimal for both 6- and 7-mm implant systems.
3. Postoperative complications such as wound dehiscence, implant mobility, and peri-implant mucositis occurred, and these were related to the failure of early implant osseointegration.
4. The short-term implant survival rate was 93% for 6-mm implants and 96.6% for 7-mm implants.

Implants shorter than 7mm may be selectively used for the mandibular posterior area with insufficient vertical bone height. Still, care should be taken since they may result in poor primary stability or complications that cause increased alveolar bone loss and failure of implant osseointegration, such as wound dehiscence.

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