Analysis of Short-term Success Rate and Healing Patterns of Implantium® Implant

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I. Introduction

Recently, tooth loss has been occurring more frequently alongside the increase in the aging population.[1,2] Tooth loss may be due to various reasons, possibly leading to functional, aesthetic, and social issues. Therefore, the recovery of lost teeth has become a very important part in dental treatment.

Specifically, the recovery of lost teeth using implant has been performed using stable operation methods. For one, implant has a number of advantages compared to the crown, bridge, or removable prosthesis.[3-7] Since the concept of modern implant based on the osseointegration between bone and titanium was established in the 1960s by Branemark et al,[8] implants have been used mainly to stabilize the prosthesis for edentulous patients permanently. It has also been used successfully in operations, offering long-term stability for the prosthetic recovery of partially edentulous patients.[9,10,11] The development of implant enabled doctors to prioritize the treatment using implant not only for the recovery of partially edentulous jaw but also for the recovery of a single tooth. Even the immediately loaded implant treatment -- which provides temporary prosthesis on the day of the operation following the insertion of the implant without the waiting period -- became common practice.[12-14]

The primary factor in predicting the success of implant treatment is the operator's skill and quantity and density of false keel. Atwood[15] evaluated the emerging changes in bone quantity following tooth loss. On the other hand, in 1985, Lekholm and Zarb[16] classified the type of residual jaw vis-à-vis implant grafting into 5 stages. Moreover, many studies reported that the use of short implants accompanied by massive resorption in the implant position would increase the failure rate.[17] Bone density also decreases following tooth loss, thereby influencing the success of implant as well.[18] Many systems are introduced to improve the success rate of the implant. Similarly, many studies are conducted by introducing changes to the design and surface of the implant. In particular, many studies reported that an implant whose rough surface was treated using various methods was more effective in case of inferior bone quality compared to the implant with mechanically ground smooth surface.[19,20]

Considering the shape of the implant, the use of the self-tapping implant improved initial stabilization and eventually increased the success rate. Based on recent studies, the use of the tapered implant in case of low bone density can improve bone density through internal condensation.[21] Compared to the straight-

walled implant, the use of the tapered implant is even easier in case of anatomical restrictions such as narrow alveolar ridge or concavity of such. Occlusal pressure is also distributed to the peripheral bone structure more evenly.[22]

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The recently developed Implantium® implant features an SLA surface subjected to hydrochloric-sulfuric acid etching and large grit sandblasting -- which is advantageous for osseointegration – for larger surface area and increased roughness of the fixture. Its internal connection and conical sealing design distribute pressure to the peripheral bones of the fixture evenly for minimum bone resorption. Moreover, the synchronized micro thread enables excellent initial fixation strength, renders appropriate strength to the marginal compact bone, increases bone density, and minimizes the resorption of marginal bones during the healing process. This study sought to analyze the clinical results of the Implantium® implant system applied to the edentulous region of the jaw to examine the success rate and healing patterns of marginal bones.

II. Research Target and Methodology (method)

A.Research Subject

This study examined 164 implants grafted onto 52 patients from among those undergoing implant operation using the Implantium® implant system at the Department of Periodontology, College of Dentistry, Yonsei University between October 2004 and October 2005.

B. Implants Grafted

Implantium® implants with various diameters -- 3.4 mm to 3.8 mm, 4.3 mm, and 4.8 mm -- and various lengths (from 8 mm to 12 mm) were used.

C. Methods

Using the patient's chart, the 1) Patient Type and Implant Distribution, 2) Condition of Bone in the Surgery Area, 3) Diameter and Length of Grafted Implants, and 4) Quantity of Previous Bone After the Grafting Operation Involving Maxillary Sinus Elevation and Guided Bone Generation were evaluated. The success rate was then examined for the implants investigated in each case.

Oral cavity examination and radiological examination were performed on all patients; their medical history and smoking habits were also investigated. Patients with absolutely uncontrollable contraindications were not subjected to implant operation; instead, other methods were recommended for the recovery of lost teeth.

In addition, the cause and period of extraction were examined through interviews to determine the pattern of tooth loss vis-à-vis age and gender.

For the bone condition in the surgery area, bone quality and quantity were evaluated and recorded during the operation according to the classification of Lekholm and Zarb. The implants used in the operation were then evaluated based on records of their length and diameter.

III. Results

1. Patient Type and Implant Distribution

1-1. Distribution of Patient's Age and Gender

A total of 19 male patients (36.5%) and 33 female patients (63.5%) were considered for the study. In terms of the number of implants used, the results were pretty close. In particular, a total of 76 implants were used for the male patients, whereas 88 implants were placed on the female patients. Approximately 3.2 implants were used for 1 patient on the average. The number of patients in their teens and 20s and the number of implants used both fell below the average. In contrast, the figures were quite high for patients in their 50s (Table 1).

Table 1. Distribution of implants according to patients' age and gender

Age (year)	Male		Female		Total (%)	
	Implants	Patients	Implants	Patients	Implants	Patients
<20	0	0	1	1	1(0.6)	1(1.9)
20-29	12	2	3	1	15(9.2)	3(5.8)
30-39	23	3	6	5	29(17.7)	8(15.4)
40-49	13	6	20	7	33(20.1)	13(25.0)
50-59	24	6	48	15	72(43.9)	21(40.4)
60-69	4	2	7	3	11(6.7)	5(9.6)
>70	0	0	3	1	3(1.8)	1(1.9)
Total	76	19	88	33	164(100.0)	52(100.0)

1-2 Location and Distribution of Implants Used

Among the 164 implants, 75 were grafted onto the maxilla; 89 were used in the mandible, 19 (12%), in the anterior, and 145 (88%), in the posterior. The use of implants tended to cluster <?>around the 1st molars on each side. (Tables 2, 3).

Table 2. Localization of the 164 implants inserted

0	10	14	6	1	2	2	0	1	2	1	5	10	13	8	0
18	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
48	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
1	13	20	6	2	3	2	1	2	1	2	3	5	12	16	0

* WHO site classification

Table 3. Distribution of implants

	Anterior* (%)	Posterior (%)	Total (%)
Maxilla	8(5)	67(41)	75(45.7)
Mandible	11(7)	78(47)	89(54.3)
Total	19(12)	145(88)	164(100.0)

*Anterior maxilla in the 13-23 area, Mandible in the 34-44 area

2. Bone Condition in the Surgery Area

The following shows the result of analyzing bone quality and quantity in patients undergoing the implant operation. Overall, type III was found to be the most common, followed by type II and type IV. Type I was found to be the least common.

Type III bone was mostly found in the maxilla, type II bone, in the anterior, and type IV bone, in the posterior. In particular, most of the bones in the maxilla posterior were type IV; in contrast, the mandibular posterior occasionally had type IV bones in case healing of extraction was not completed (Table 4).

Table 4. Distribution of bone quality

	Type I (%)	Type II	Type III (%)	Type IV (%)	Total(%)
Max. Ant.	0(0.0)	2(1.2)	4(2.4)	2(1.2)	8(5)
Max. Post.	3(1.8)	11(6.7)	27(16.5)	26(16.1)	67(41)
Man. Ant.	4(2.4)	4(2.4)	3(1.8)	0(0.0)	11(7)
Man. Post.	6(3.6)	34(20.7)	27(16.5)	11(6.7)	78(47)
Total	13(7.8)	51(31)	61(37.2)	39(24)	164(100.0)

The distribution of bone quantity based on the classification of Lekholm and Zarb showed Type C bone taking up the largest ratio, followed by Type B, Type D, and Type A. The maxilla had thrice more type D bone than the mandible. Broad resorption of Type E bone was not observed, however (Table 5).

Table 5. Distribution of bone quantity

	A	B	C	D	E	Total (%)
Maxilla	4(2.4)	15(9.2)	47(28.8)	9(5.5)	0(0.0)	75(46)
Mandible	1(0.6)	31(18.9)	54(32.9)	3(1.8)	0(0.0)	89(54)
Total	5(3.0)	46(28.1)	111(61.7)	12(7.3)	0(0.0)	164(100.0)

*Classification by Lekolm and Zarb

3. Diameter and Length of Grafted Implants

3-1 Length of Grafted Implants

Implantium® implants of varying lengths (from 8 mm to 10 mm, 12 mm, and 14 mm) were used; implants shorter than 8 mm or longer than 14 mm were excluded. Most implants were 10 mm or 12 mm long, with a number of 8 mm implants grafted onto the 2nd molar in the mandibular posterior. This was because grafting depth was restricted owing to the path of the inferior alveolar canal and internal oblique line (Table 6).

Table 6. Distribution of implant length

Length (mm)	Maxilla		Mandible		Total (%)
	Anterior	Posterior	Anterior	Posterior	
8 mm	0	0	0	22	22(13.4)
10 mm	4	39	1	31	75(45.7)
12 mm	3	27	9	25	64(39.0)
14 mm	1	1	1	0	3(1.9)
Total	8	67	11	78	164(100.0)

3-2 Diameter of Grafted Implants

The diameters of the implants used ranged from 3.4 mm (narrow) to 3.8 mm and 4.3 mm (regular) and 4.8 mm (wide). The narrow form was mostly grafted onto the maxilla and mandibular anterior, whereas the wide form was mostly used in the posterior. A total of 7 narrow implants were grafted onto the maxilla and mandibular posterior owing to the resorption of the residual ridge.

Table 7. Distribution of implant diameter

	Maxilla		Mandible		Total (%)
	Anterior	Posterior	Anterior	Posterior	
Narrow	4	4	3	3	14(8.5)
Regular	4	38	7	31	80(48.8)
Wide	0	25	1	44	70(42.7)
Total	8	67	11	78	164(100.0)

4. Grafting Operation Involving Maxillary Sinus Elevation and Guided Bone Generation

Among the 164 implants, 30 required additional methods other than ordinary implant operation such as bone graft, membrane, ridge splitting, and maxillary sinus elevation due to insufficient bone volume (Table 8).

The length of the implant was restricted by the position of the maxillary sinus in the maxilla. In fact, bone quality was expected to deteriorate over time due to the resorption of the residual ridge and expansion of the maxillary sinus. The operation required other methods such as maxillary sinus elevation -- which lifts the sinus floor -- and osteotome techniques designed to address the problem of limited bone volume. Various bone materials such as autogenous bones collected from the surgery area and neighboring part, allografts including ICB, xenografts of Bio-oss®, and Macroporous Biphasic Calcium Phosphate® were also used. Non-resorptive Gore-tex membrane and resorptive Collagen membrane were used during the operation.

Table 8. Number of advanced techniques on the recipient site

	Number
GBR*	13
Sinus graft (window opening)	5
Sinus graft (BAOSFE*)	8
Ridge splitting	4
Total	30

*GBR: Guided bone regeneration

*BAOSFE: Bone-added osteotome sinus floor elevation

5. Success Rate of Implant

A total of 164 implants were grafted onto 52 patients. The patients were then examined for 15.2 months on the average, with 2 implants failing during the period of clinical and radiological examination. A success rate of 98.8% was recorded. The failed implants were surgically removed. One of the 2 implants removed had regular diameter and dimension of 3.8 x 10 mm; the other implant measured 4.3 x 10 mm. Both implants were removed from #17 and #12 approximately 8 months and 1 month after grafting, respectively, owing to the failed osseointegration. The implant placed on #12 was grafted onto the narrow alveolar ridge of a patient with cleft lip and palate. The radiological analysis using the Starpacs® system of INFINITT showed marginal bone resorption of 0.28 mm on the average during the average treatment period of 15.2 months. No implant showed marginal bone resorption of more than 1 mm within 1 year of grafting.

IV. Discussions

The implant treatment introduced based on the concept of titanium osseointegration is a method boasting of high predictability, providing maximum satisfaction to both patient and doctor. Currently, many implants with different advantages for different types are available. Such advantages must be fully considered when making treatment plans.

Implantium® implant features an SLA surface subjected to etching and sandblasting processes. In terms of design, it has root form body, internal connection, and conical sealing connecting to the abutment. For the top, it adopted a tapered structure with synchronized micro thread to enhance initial fixation strength, render appropriate strength to the marginal compact bone, and increase bone density.

In this study, a total of 164 implants were grafted onto 52 patients. Similar to the distribution of periodontitis patients, people in their 50s made up 40% of the patient group. A total of 75 implants were grafted onto the maxilla, 89, onto the mandible, 19, onto the anterior, and 145, onto the posterior. Considering the position of the tooth, majority of the implants (59) were grafted onto the 1st molar. This is because the 1st molar is engaged in the largest number of occlusal activities when it contracts periodontal diseases or dental caries; thus often leading to tooth loss. This study examined the condition of the bones in the region included in the implant operation in terms of bone quality and bone quantity. Type III bone quality was observed in most cases (37.2% of the total), followed by Type II (31.0%) and Type IV (24.0%). Type I bone quality was the least common (7.8% of all cases). By bone quantity, Type C was noted in most cases (61.7%), followed by Type B (28.1%), Type D (7.3%), Type A (3.0%), and Type E (0.0%). Note that these results were consistent with those presented in the report by Park et al. in 2004.[23] In terms of the surgery part, the maxilla was mostly made up of Type III and Type IV bones. The maxilla had disadvantages in terms of implant operation compared to the mandible; in fact, reports showed that implant operation on the region with weak bone quality such as Type IV and insufficient false keel had low success rate.[24,25,26] In other words, the mandible has better bone quality and quantity for operation than the maxilla. This finding was consistent with that of other studies.

In the operation using Implantium implants, implants of varying diameters (3.4 mm ~ 4.8 mm) and lengths (8 mm ~ 14 mm) were grafted onto the patients according to the false keel and position of teeth to be implanted. Most implants used were 10-12 mm long. Note that implants with the appropriate length can now be grafted, thanks to the advancement of grafting techniques. With the advancement of surface treatment techniques, however, implants 15 mm long or more are no longer used. In terms of the diameter of the implant, the regular implant was the most commonly used in general, followed by the wide implant in the posterior and narrow implant in the anterior. This is because the diameter of the implant is restricted by the buccolingual thickness of the false keel. Moreover, the doctor chooses the implant whose diameter is close to that of the natural tooth in the position to be grafted to reconstruct the emergence profile when producing the prosthesis. Regular implant was used many times in the posterior because

most doctors tended to secure the stability of the prosthesis by choosing a regular implant and splitting it rather than performing additional bone grafting in the posterior not only when grafting implants in the premolar region but also when grafting a number of implants. A total of 13 implants were grafted during the maxillary sinus elevation performed in the posterior due to the insufficiency of false keel, with another 13 implants grafted through guided bone generation (GBR).

In this study, a total of 164 Implantium implants were grafted during the 15.2 months' treatment on the average. Two implants were removed, thereby making the success rate 98.8%. The removed implants had been grafted onto #17 and #12; they had regular diameter and length of 10 mm. In particular, the implant on #12 was removed 1 month after grafting; the patient with cleft lip and palate had narrow alveolar ridge. Although dehiscence or fenestration was not likely to occur, osseointegration was believed to have failed due to the resorption of the narrow bony housing during the bone remodeling process after grafting.

The average resorption of marginal bone during the resuommoning period was found to be 0.28 mm. In 1997, Palmer et al.[27] reported marginal bone resorption of 0.53 mm in the Astra implant whose micro threaded conical neck was similar to Implantium for 1 year after grafting. The Implantium implant exhibits minimal marginal bone resorption because its SLA surface has an advantage in terms of osseointegration. Likewise, the internal connection and conical sealing design evenly distribute stress to the peripheral bones of the fixture; hence the minimal bone resorption. According to the study of Hansson[28] et al on the finite element method, the conical abutment distributes occlusal pressure even to the bones at the back to prevent the pressure from being concentrated on the marginal bone and reduce marginal bone resorption such that even greater occlusal pressure can be withstood. This was consistent with reports showing less resorption of marginal bone in the Implantium implant or similar Astra implant system compared to the flat top implant system.[29] Moreover, the synchronized micro thread is considered more advantageous because it enhances initial fixation strength, renders appropriate strength to the marginal compact bone, and increases bone density.

The result of the treatment suggests the need for long treatment period. Likewise, the factors that can determine the prognosis in each case must be clearly defined. This study evaluated the newly introduced Implantium system for a relatively short period of time. The factors for determining the success rate were also limited to clinical and radiological factors. Therefore, more in-depth studies on implant treatment, causes of and factors contributing to failure, and prognostic factors must be conducted by evaluating the implant system for a long period of time based on the continuous resummoning of patients and through periodic examination to improve the success rate of implant, a more important part in dental treatment.

V Conclusion

The success rate of 164 Implantium implants grafted onto 52 patients for a resummoning period of 15.2 months on the average was 98.8%; the resorption of marginal bone for the same period was 0.28 mm. Although more evaluations accumulated over a long period of time are required together with additional studies, the results of this study suggest that Implantium® implant can yield excellent treatment results in various cases.

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Abstract

Analysis of Short-term Success Rate and Healing Patterns of Implantium® Implant

Gyung-Joon Chae[1], Sung-Min Chung[2], Ui-Won Jung[1], Kyoo-Sung Cho[1], Jung-Kyu Chai[1], Chong-Kwan Kim[1], Seong-Ho Choi[1], and Chang-Sung Kim[1]

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This study analyzed the distribution of patients who had Implantium® implant placed at Yonsei University Dental Hospital as well as the types of implant site for about 1-year recall check and the success rate. Specifically, a total of 164 implants were placed on 52 patients. The following conclusions were drawn:

1. Patients in their 40s and 50s made up 65% of all implant cases; the average number of implants was 4 for males and 2.7 for females. A total of 75 implants were used on the maxilla, whereas 89 were placed on the mandible. On the other hand, 19 implants were used in the anterior region, and 145 implants, in the posterior region.
2. Bone quality for the implant site was mostly Type Ⅲ (37.2%); bone quantity was Type C (61.7%).
3. Majority of the implants used had length of 10, 1 2 mm (85%) and regular diameter (48.8%).
4. A total of 30 implants were placed using advanced techniques, e.g., GBR, window opening, and osteotome technique.
5. Two implants were removed prior to prosthodontic treatment owing to osseointegraton failure. A success rate of 98.8% was recorded in the 15.2-month follow-up period, with marginal bone loss of 0.28 mm.

The results provided basic data on patient type, implant distribution, bone condition, and survival rate. Based on the results of this study, Implantium® implant can be said to be applicable to various clinical situations.

Keywords : Implantium® implant, success rate.
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