

A retrospective clinical study on the evaluation of the survival rate and marginal bone resorption of implant placement immediately after tooth extraction

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Purpose: The purpose of this study was to analyze the clinical results of screw retained type and locking taper type implants immediately placed in the extraction site to determine the implant survival rate and to analyze the marginal bone resorption of both types of implants during the healing process.

Materials & Methods: From January 1, 2012 to December 31, 2016, 211 implants placed immediately after tooth extraction in 158 patients at Cheongju Hankook Hospital were followed up for up to 6 years for survival rate and mesiodistal marginal bone resorption. The implants used were 96 screw retained type (AF) implants and 115 locking taper type (SF) implants from SNUCONE®.

Results: 1) Two out of 211 implants in a total of 158 patients failed, resulting in a survival rate of 99.05%. The cause of the failed implant was the lack of initial fixation power due to lack of bone quality and bone mass. 2) The marginal bone resorption was 0.44 ± 0.59 mm in the mesial marginal bone and 0.39 ± 0.71 mm in the distal marginal bone for about 4 years after the prosthesis was installed, and very good results were obtained. In detail, in AF implants, mesial bone resorption was 0.41 ± 0.58 mm, distal marginal bone resorption was 0.38 ± 0.83 mm, and in SF implants, mesial marginal bone resorption was 0.46 ± 0.59 mm, and distal marginal bone resorption was 0.39 ± 0.58 mm, there was no statistically significant difference between the two groups ($P > 0.05$).

Conclusions: Previously, there were not many papers comparing the screw retained type implant and the locking taper type implant in implants placed immediately after tooth extraction, so this study was conducted. If the initial fixation with the alveolar bone is secured when the implant is placed immediately after tooth extraction, it is thought that a high predictive treatment result can be obtained not only for screw retained type implants but also for locking taper type implants. (THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2021;13 (1):29-35)

Key words: Immediate implant placement, Marginal bone resorption, Survival rate

INTRODUCTION

Since implants were first introduced by Branemark, implants have become a predictive and universal treatment method for tooth loss¹. With remarkable advances in surface treatment, implantation equipment, and implantation methods, the time for implant placement after tooth extraction is also moving forward.

Depending on the timing of implant placement after extraction, immediate implantation is performed immediately after extraction, recent implantation is placed after 6~8 weeks to allow soft tissue to heal, delayed implantation is performed 6 months after bone grafting if the bone in the receptor is not suitable for placement, and mature implantation, which is placed after 9

months or more so that the socket is completely healed by bone². Immediate implant placement after extraction is a treatment compared to the traditional method of waiting for more than several months for bone healing of the extraction socket. Not only can the period be reduced, but it also has the advantage of reducing the number of surgeries, and has abundant healing and regeneration ability of the tooth extraction site. It is easy to select the implant position according to the position of the tooth before extraction, and in the case of the anterior region, it can be esthetically advantageous because natural interdental papilla can be secured by performing restoration immediately after extraction. Due to these many advantages, despite the burden of immediate procedure after tooth extraction, implants placed immediately after tooth ex-

Received November 9, 2021, Revised November 16, 2021, Accepted November 24, 2021
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traction are considered a good treatment option for clinicians³.

In this study, the immediate implantation technique was used, which was placed immediately after tooth extraction, and the clinical results were analyzed using AF and SF implants, the implant survival rate was investigated, and the amount of marginal bone resorption during the healing process was analyzed.

MATERIALS AND METHODS

1. Subjects

From January 1, 2012 to December 31, 2016, at Cheongju Hankook Hospital, 211 implants placed immediately after tooth extraction in 158 patients were investigated for up to 6 years of survival and mesiodistal marginal bone resorption. The implants used were AF and SF implants from SNUCONE®.

1) Age and gender distribution of patients

The patient group consisted of 78 males and 80 females, and a total of 211 implants were placed. The age distribution was 26~86 years old, 4 people in their 20s, 6 people in their 30s, 6 people in

their 40s, 36 people in their 50s, 68 people in their 60s, 36 people in their 70s, and 2 people in their 80s (Table 1, 2).

2) implant location and distribution

Of the total 211 implants, 126 were placed in the maxilla and 85 in the mandible, 65 in the anterior region, 72 in the premolar region, and 74 in the molar region (Table 3).

3) Types of implants

The implants targeted in this study are SNUCONE®'s AF implants and SF implants. AF implant is a screw type, and it has a shape that is internally connected to the abutment and has a tapered tip, so it has excellent initial fixation power, and can provide adequate strength to the dense bone in the marginal area and increase bone density. The SF implant is in the form of a locking taper and has a sloping shoulder on the top of the fixture to have resistance to marginal bone loss. Each implant and abutment design is as follows (Figure 1, 2). Of the 211 implants placed in 158 patients in this study, 96 were AF implants and 115 were

Table 1. Patient distribution according to gender

Gender	Number of patient (% of patients)	Number of implant (% of implant placed)
Male	78 (49.37%)	103 (AF40, SF63) (48.81%)
Female	80 (50.63%)	108 (AF56, SF52) (51.18%)
Total	158	211

Table 2. Patient distribution according to age

Age	Number of patient (% of patients)	Number of implant (% of implant placed)
21~30	4 (2.53%)	5 (2.37%)
31~40	6 (3.80%)	8 (3.79%)
41~50	6 (3.80%)	6 (2.84%)
51~60	36 (22.78%)	47 (22.27%)
61~70	68 (43.04%)	92 (43.60%)
71~80	36 (22.78%)	51 (24.17%)
81~90	2 (1.27%)	2 (0.95%)
Total	158	211

Table 3. Numbers of implants placed according to location in arch

	Maxilla	Mandible	Total
Anterior	48	17	65
Premolar	42	30	72
Molar	36	38	74
Total	126	85	211

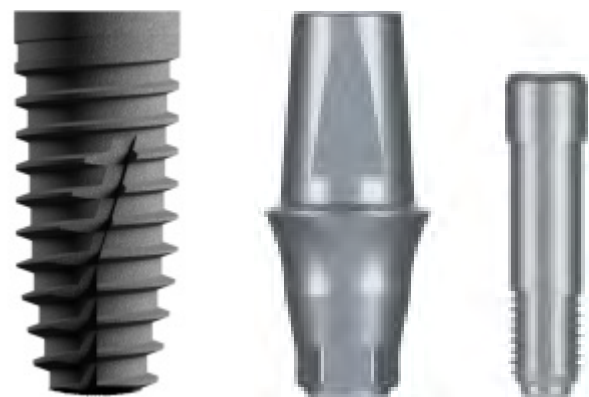


Figure 1. AF fixture and abutment (SNUCONE® Co., Korea).



Figure 2. SF fixture and abutment (SNUCONE® Co., Korea).

SF implants.

4) Implant length and diameter

Three types of implant lengths were used: 8 mm (79 pieces), 10 mm (97 pieces), and 12 mm (35 pieces). The implant diameters were 3.5 mm (6 pieces), 3.8 mm (18 pieces), 4.3 mm (100 pieces), 4.8 mm (58 pieces), 5.3 mm (19 pieces), and 5.8 mm (10 pieces) were used.

2. Methods

Implant surgery was usually performed in one or two approaches under local anesthesia. Whether or not the second operation was performed was decided by the operator according to the initial stability of the implant during surgery. All implants were AF and SF implant systems from SNUCONE®, and were placed according to the protocol using the manufacturer's dedicated drill.

After the healing period after surgery, prosthetic work was performed, and SNUCONE® products were used for all abutments used for upper prosthetic restoration. When the final prosthesis was installed, patients were asked to visit the clinic every 6 months or 1 year after installation to undergo plaque control, clinical examination, and radiographic examination.

The implant survival rate was evaluated according to the criteria for success presented by Rosen et al., and the evaluation according to the implant failure period was based on a suggestion by Rosenberg et al. in 2004. Classification according to the implanted position was divided into 6 parts: maxillary anterior, premolar, molar, mandibular anterior, premolar, and molar, and the survival rate and marginal bone resorption were compared for each part. Also, the amount of marginal bone resorption according to the type of implant was investigated. For the amount of marginal bone resorption, mesial and distal bone changes were measured based on the platform of the implant on the panorama by comparing radiographs before and after the functional load of

the implant prosthesis was applied. For statistical analysis on the amount of bone resorption, IBM SPSS Statistics program was used and Mann-Whitney test method was used.

RESULTS

1. Overall survival rate

In this study, 211 implants placed immediately after tooth extraction were followed up for up to 6 years in 158 patients. During the total follow-up period, two implants were removed, all of which failed before loading the implant prosthesis, and the survival rate was 99.05%.

2. Survival rate according to patient gender and age

In this study, the implant survival rate according to the patient's gender was 99.10% in men and 100% in women. The survival rate according to the age of the patients was 98.88% because one implant failed in the 51-60 year old patient group, and 98.18% because one implant failed in the 61 to 70 year old patient group.

3. Survival rate according to implant placement location, diameter and length

The survival rate according to the implantation location was 94.44% in the maxillary molars, and 100% in other areas (Table 4).

The survival rate according to the diameter and length of the implant is as follows. 58 implants with a diameter of 4.8 mm were placed, and one of them failed, showing a survival rate of 98.28%, and one out of 10 implants with a diameter of 5.8 mm failed, showing a 90% survival rate. As for the survival rate for the implant length, 2 out of 79 implants with a length of 8 mm failed, showing a survival rate of 97.47%.

4. Marginal bone resorption

The marginal bone resorption was 0.44 ± 0.59 mm in the mesial marginal bone and 0.39 ± 0.71 mm in the distal marginal bone

Table 4. Survival rate of implant according to implant location

Site		State		Survival rate (%)
		Placed	Failed	
Maxilla	Anterior	48 (AF27, SF21)	0	100
	Premolar	42 (AF, 14SF28)	0	100
	Molar	36 (AF, 19, SF17)	2 (SF2)	94.44
Mandible	Anterior	17 (AF8, SF9)	0	100
	Premolar	30 (AF10, SF20)	0	100
	Molar	38 (AF18, SF20)	0	100

for about 4 years after the prosthesis was installed, and very good results were obtained. In detail, the amount of marginal bone resorption in AF implants and SF implants is as follows (Table 5). The amount of marginal bone resorption between the two types of implants according to the placement location is as follows (Table 6~8).

5. Failed implant analysis

Two implants did not satisfy the survival criteria. One was a

locking taper fixture with a diameter of 4.8 mm and a length of 8 mm, implanted in #27, a male in his 50s. The other was a locking taper fixture with a diameter of 5.8 mm and a length of 8 mm that was placed on #26, a male in his 60s. All implants were placed in the position of the maxillary molars, and they were floating teeth at the time of the first visit, and due to severe bone loss, the thickness of the remaining alveolar bone below the maxillary sinus floor was less than 2 mm, so it is presumed that osseointegration failed because it was difficult to obtain initial fixation.

Table 5. Marginal bone resorption of implant according to implant type

	Bone resorption		
	Mesial (mm)	Distal (mm)	Mean (mm)
AF	0.41 ± 0.58	0.38 ± 0.83	0.40 ± 0.72
SF	0.46 ± 0.59	0.39 ± 0.58	0.43 ± 0.59
P value	0.643	0.737	0.546

Table 6. Marginal bone resorption of implant according to implant location (AF + SF)

Site		Bone resorption		
		Mesial (mm)	Distal (mm)	Mean (mm)
Maxilla	Anterior	0.44 ± 0.63	0.45 ± 0.54	0.44 ± 0.59
	Premolar	0.52 ± 0.63	0.60 ± 0.91	0.56 ± 0.78
	Molar	0.43 ± 0.49	0.30 ± 0.67	0.36 ± 0.59
Mandible	Anterior	0.43 ± 0.42	0.40 ± 0.78	0.42 ± 0.63
	Premolar	0.37 ± 0.53	0.19 ± 0.67	0.23 ± 0.61
	Molar	0.41 ± 0.65	0.30 ± 0.59	0.35 ± 0.62

Table 7. Marginal bone resorption of implant according to implant location (AF)

Site		Bone resorption		
		Mesial (mm)	Distal (mm)	Mean (mm)
Maxilla	Anterior	0.46 ± 0.63	0.43 ± 0.58	0.44 ± 0.60
	Premolar	0.46 ± 0.67	0.76 ± 1.18	0.61 ± 0.97
	Molar	0.44 ± 0.51	0.30 ± 0.83	0.37 ± 0.69
Mandible	Anterior	0.61 ± 0.46	0.46 ± 1.03	0.54 ± 0.80
	Premolar	0.37 ± 0.47	0.21 ± 0.82	0.29 ± 0.67
	Molar	0.22 ± 0.53	0.16 ± 0.58	0.19 ± 0.55

Table 8. Marginal bone resorption of implant according to implant location (SF)

Site		Bone resorption		
		Mesial (mm)	Distal (mm)	Mean (mm)
Maxilla	Anterior	0.43 ± 0.63	0.47 ± 0.48	0.45 ± 0.56
	Premolar	0.56 ± 0.61	0.51 ± 0.72	0.54 ± 0.67
	Molar	0.41 ± 0.46	0.30 ± 0.42	0.35 ± 0.45
Mandible	Anterior	0.27 ± 0.29	0.36 ± 0.46	0.31 ± 0.39
	Premolar	0.37 ± 0.56	0.19 ± 0.57	0.28 ± 0.57
	Molar	0.59 ± 0.71	0.43 ± 0.57	0.51 ± 0.64

DISCUSSIONS AND CONCLUSIONS

The advantage of implant placement immediately after tooth extraction is that it can achieve the esthetic purpose well in the anterior region while shortening the treatment period, reducing the number of surgeries, and minimizing the loss of soft and hard tissue. Since the height and width of the alveolar bone decreases rapidly after extraction, the resorption of the alveolar bone can be prevented if the implant is placed immediately after extraction. In addition, since it is placed based on the original tooth, there is an additional advantage that it can be placed in an ideal three-dimensional position. In particular, since esthetic recovery is more important than functional recovery in the maxillary anterior region, if the alveolar bone and gingival tissue before extraction are healthy, implant placement can be considered immediately after extraction to maintain them. On the other hand, disadvantages include invasion of major anatomical structures, failure to obtain initial fixation, higher risk of failure, and possible postoperative infection by activating inactive infected tissue⁴.

Since Schulte et al. first reported an immediate implant in an extraction orthodontic area in 1978, steady research has been actively conducted, and a study comparing it with delayed implantation also reports a similar survival rate. In addition, Novae et al. reported a 2-year cumulative survival rate of 100% immediately after implant placement in infected dentition, and Chen and Covani et al. In another study, the immediate implant showed a relatively low survival rate compared to the delayed implant, but there was no significant difference in marginal bone loss and implant stability. In another study, immediate implant showed a relatively low survival rate 18203compared to delayed implant, but there was no significant difference in marginal bone loss or implant stability⁵. Chen et al. reported that there was no significant difference in the short-term survival rate between immediate and delayed implant placement, and Tan et al. reported that the 2-year survival rate reached 98% with immediate implant placement. As such, a high survival rate of immediate implants has been reported through several studies. However, immediate implant placement is not possible in all cases, and several studies including the papers published by Schwartz-Arad et al. Also, Penarrocha et al. stated that immediate implantation in the area with acute apical inflammation is an absolute contraindication⁶.

In addition, since this procedure is difficult to obtain initial fixation and the amount of soft tissue is small, it is difficult to

achieve primary fusion when a complex procedure such as bone-guided regeneration is accompanied, and it is a procedure sensitive to the skill of the operator. Therefore, for immediate implant success, thorough preoperative diagnosis and treatment plan are important factors, and systemic disease, periapical disease, cause of extraction, and implant system should be evaluated before surgery, and bone resorption patterns after extraction should be predicted.

As the use of implants has become more common, many studies have been conducted on the success rate and survival rate over a long period of time⁷⁻¹⁴. It is very difficult to determine which of the success rate and the survival rate is an excellent retrospective study method for implants, but the success rate is a realistic problem that it is difficult to investigate all the success criteria.

One of the objective indicators to judge the long-term success of implants is the level of marginal bone around the implant. The measurement of marginal bone height has an important meaning as a method to evaluate the success of implants¹⁵. Looking at the results of other authors who conducted studies on marginal bone resorption, Astrand et al.¹⁶ used Branemark implants and Astra Tech implants. In a 5-year study using the abutment connection, when the amount of bone loss was measured by dividing the maxilla and the mandible 14 months after the abutment was connected, in the case of the Branemark implant, bone resorption of 1.97 ± 0.18 mm in the maxilla and 1.73 ± 0.20 mm in the mandible occurred compared to the time of implantation. In the case of Astra Tech implants, it was reported that bone resorption occurred at 1.74 ± 0.36 mm in the maxilla and 1.26 ± 0.20 mm in the mandible. Another study compared an implant placed immediately after tooth extraction with an implant placed on mature bone in 48 patients. There was no difference in direct implant-bone contact (DBC) and no bone resorption was observed, indicating clinical and radiological differences. When the screw-type implant is placed immediately after extraction, even if a barrier membrane or other regenerative material is not used, if the distance between the bone and the implant is less than 2 mm, the clinical results and osteointegration of implants in mature bone are significantly different. showed no significant difference¹⁷.

The average absorption of marginal bone analyzed through radiographic examination in this study was 0.44 ± 0.59 mm in the mesial marginal bone and 0.39 ± 0.71 mm in the distal marginal bone for about 4 years after the prosthesis was installed, resulting

in very good results. In detail, the mesial marginal bone resorption of the AF implant was 0.41 ± 0.58 mm, the distal marginal bone resorption was 0.38 ± 0.83 mm, the mesial marginal bone resorption of the SF implant was 0.46 ± 0.59 mm, and the distal marginal bone resorption was 0.39 ± 0.58 mm. There was no statistically significant difference between the two groups ($P > 0.05$). In the amount of marginal bone resorption according to the placement location, the distal maxillary premolars showed more bone resorption than the mandibular premolars ($P < 0.05$), and other Marginal bone resorption occurred more in the maxilla than in the mandible, but there was no statistically significant difference ($P > 0.05$). It is presumed that this is because the cortical bone is relatively thin compared to the mandible and the bone quality is poor. When comparing the two implants according to the placement location, the mesial marginal bone resorption in the mandibular anterior region was lower in SF, and the average marginal bone resorption in the mandibular molars was less in AF ($P < 0.05$). Although there was a difference in the amount of resorption, it is thought that it is meaningful to show good results with bone resorption within an average of 1 mm in all cases.

In addition, as a result of follow-up of a total of 211 implants, two failed, resulting in an overall survival rate of 99.75%. Two implants failed only in the maxillary posterior region with a survival rate of 98.41% in the maxilla and 100% in the mandible. All were molars accompanied by bone graft, and they occurred before loading the prosthesis. It is presumed that the maxillary molars have thinner cortical bone than the mandible or maxillary anterior teeth, and mostly consist of reticulated bone, which has disadvantageous bone quality for implant placement. Therefore, in case selection, if the thickness of the remaining alveolar bone below the maxillary sinus in the maxillary posterior region is less than 2 mm, it is difficult to obtain initial fixation power, which increases the possibility of implant failure. Immediately upon implantation, a method of securing initial fixation should be determined and a treatment plan established. Through CT, anatomical structures such as the maxillary sinus and inferior alveolar nerve are taken into consideration to confirm whether the alveolar bone mass is secured in the apical region for initial fixation. For good results of implants placed immediately after tooth extraction, accurate diagnosis and case selection before surgery are important. If sufficient bone mass cannot be secured, it is wise to change the treatment plan to a method other than implantation immediately.

During the investigation period, implants were placed immediately

after tooth extraction at a rate of about 4%, and showed a high survival rate and low marginal bone resorption for an average of 4 years after placement. In particular, the locking taper type implant placed immediately after tooth extraction showed satisfactory results. Previously, there were not many papers comparing screw retained type implants and locking taper type implants in implants placed immediately after tooth extraction, so this study was conducted. If the initial fixation force of the conjunctiva is secured, it is thought that a high predictive treatment result can be obtained not only for screw retained type implants but also for locking taper type implants.

REFERENCES

1. Branemark PI, Adell R, Breine U, Hansson BO, Lindstrom J, Ohlsson A. Intra-osseous anchorage of dental prostheses. I. Experimental studies. *Scand J Plast Reconstr Surg* 1969;3:81-100.
2. Park HJ, Kook MS, Kim SG, Kim YK, Cho YS, Choi GL, et al. Multi-center retrospective study of immediate two different rbm surfaced implant systems after extraction.
3. Rosenquist JB, Grenthe B. Immediate placement of implants into extraction sockets : Implant survival. *Int J Oral Maxillofac Implant* 1996;11:205-209.
4. Kim YK. Bone Graft in Immediate Implantation after Anterior Tooth Extraction.
5. Mello CC, Lemos CAA. Immediate implant placement into fresh extraction sockets versus delayed implants into healed sockets: a systematic review and meta-analysis. *International Journal of Oral and Maxillofacial Surgery* 2017;1162-1177.
6. Yi JY, Kim JH, Han DH. Immediate implant placement into extraction sites with periapical lesions in the esthetic zone: a case report.
7. Schnitman PA, Shulman LB. Recommendations of the consensus development conference on dental implants. *J Am Dent Assoc* 1979;98:373-377.
8. Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. *J Prosthet Dent* 1989;62:567-572.
9. Misch CE. The implant quality scale: a clinical assessment of the health-disease continuum. *Oral Health* 1998;88:15-20, 23-15; quiz 25-16.
10. Buser D, Mericske-Stern R, Dula K, Lang NP. Clinical experience with one-stage, non-submerged dental implants. *Adv Dent Res* 1999;13:153-161.
11. Zarb GA, Albrektsson T. Consensus report:towards optimized treatment outcomes for dental implants. *J Prosthet Dent* 1998;80:641-648.
12. Krennmair G, Schmidinger S, Waldenberger O. Single-tooth replacement with the Frialit-2 system: a retrospective clinical analysis of 146 implants. *Int J Oral Maxillofac Implants* 2002;17:78-85.
13. Romeo E, Lops D, Margutti E, Ghisolfi M, Chiapasco M, Vogel G. Long-term survival and success of oral implants in the treatment of

- full and partial arches: a 7-year prospective study with the ITI dental implant system. *Int J Oral Maxillofac Implants* 2004;19:247-59.
14. Wennström JL, Ekestubbe A, Gröndahl K, Karlsson S, Lindhe J. Implant-supported single-tooth restorations: a 5-year prospective study. *J Clin Periodontol* 2005;32:567-574.
 15. Hwang HS, Jung JH, Kim YL. Retrospective study on marginal bone loss around maxillary anterior implants with or without bone graft.
 16. Astrand P, Engquist B, Dahlgren S, Gröndahl K, Engquist E, Feldmann H. Astra Tech and Branemark system implants: a 5-year prospective study of marginal bone reactions. *Clin Oral Implants Res* 2004;15:413-420.
 17. Paolantonio, Michele, et al. "Immediate implantation in fresh extraction sockets. A controlled clinical and histological study in man." *Journal of periodontology* 72.11 (2001): 1560-1571.