Long-term Evaluation of IMZ Implants; Success and Survival Rates

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Ⅰ. Introduction

In the past two decades, the replacement of missing teeth with implant restorations has become a treatment modality accepted by the scientific community for fully and partially edentulous patients. Long-term successful outcomes with osseointegrated dental implants, reported in numerous scientific studies, have inspired the dental profession to feel confident about their use. In our clinic, implants are included in a routine treatment modality and several studies about implants have been performed[1~5] But, presently a great number of implant systems are in use, but which system among those many systems is the most successful in long-term, still remains as an important, yet unanswered question.

The "intramobile cylinder implant system" (IMZ) is one of the oldest and mostly used systems in Germany. It was developed by Koch and modified by Kirsch, Kirsch and Ackermann, and Kirsch and Mentag[6~8]. IMZ system is submerged in order to gain the osseointegration between bone and implant surely by excluding external force. The intramobile element(IME) or intramobile connector(IMC) of this system is designed to distribute the occlusal force by acting like the periodontal ligament. The fixture body is made of pure titanium and covered with

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plasma flame spray coating to maximize surface area[9]. Although a number of studies have shown that this implant system has proved itself in everyday practice, there is little assessment of the long-term prognosis.

In a previous study, it was reported that after 5 years from insertion, 96.0% of all implants were in situ and noninflamed and after 10 years the survival rate was 82.4% [10]. The other study reported that the survival rate of IMZ system was 89.9% after 60 months and 83.2% after 100 months[11]. However, failure cases of this system have been recently often reported, and it was suggested that our long-term outcomes would be somewhat different from previous studies.

It is therefore the aim of present retrospective study to evaluate the cumulative success rates and survival rates over long periods and analyze the causatives of failure in the IMZ system.

Ⅱ. Materials and Methods

1. Patients selection and procedure

Between February 1992 and April 1994, a total of 83 implants were inserted in 31 patients. Study center was located at the College of Dentistry, University of Yonsei , Korea; the Department Periodontics and the Department of Prosthodontics. The patients pool consisted of 18 females and 13 males. The age of patients at time of implant placement ranged between 18-68 years.

In this study, 83 implants were inserted in both jaws. The diameters of implants were 3.3mm, 4.0mm and the length of implants were 8,10,11,13,15mm. The implants with the length of 10mm had the diameter of 3.3mm, and those with the length of 11mm had the diameter of 4.0mm.

Table 1. The distribution of patients' age & sex.

Age	Male	Female	Total
18-29	3	1	4
30-39	2	4	6
40-49	6	6	12
50-59	1	5	6
60-69	1	2	3
Total	13	18	31

Table 2. The distribution of implant diameter and length

Implant diameter	Implant length				Total
	8	10(11)	13	15	
3.3	5	23	3	16	47
4.0	10	11	9	6	36
Total	15	34	12	22	83

Table 3. Criteria of success(Albrektsson & Zarb. 1986)

1. That an individual, unattached implant is immobile when tested clinically
2. That a radiograph does not demonstrate any evidence of peri-implant radiolucency
3. That vertical bone loss be less than 1mm in the implant's first year and 0.2mm annually following the first year
4. That individual implant performance be characterized by an abscence of persistent and/or irreversible signs symptoms such as pain, infection, neuropathies, paresthesia, or violation of the mandibular canal

Table 4. Criteria of surviva(Buser et al. 1990)

1. Absence of persistent subjective complaints, such as pain, foreign body sensation, and /or dysesthesia
2. Absence of a recurrent peri-implant infection with suppuration
3. Absence of mobility
4. Absence of a continuous radiolucency around the implant

After an initial healing period of at least 3 months(cases with good bone quality) and no more than 6 months(case with poor bone quality), the patients were recalled to the clinic for a clinical and radiographic examination. Panoramic radiographs and periapical radiographs were used to examine the bone-implant healing process. The implants were defined as successfully integrated into tissue, according to the criteria given in Table 3. And the survival of implants was defined by Table 4.

The annual clinical evaluation included the assessment of several clinical parameters as described previously(Albrektsson & Zarb. 1986[12], Buser et al. 1990[13]). In addition, a radiographic examination was performed consisting either of a panoramic radiograph or a periapical radiograph[14,15]. Based of the clinical and radiographic examination, each implant was classified with "success", "survival", "failed". If a patient could not be followed up at consecutive annual examination, the corresponding implants were classified as "drop-out".

2. Statistical analysis

The data analysis was made at end of October 2005. 83 implants with available charts were included in data analysis and the longest followed-up duration was 13 years and 4 months. The survival analysis for nonparametric observation was not used because the number of entire fixtures involved in this study was relatively small[16].

1) Cumulative survival rate

Implants that were classified to "survival" and "success" were regarded as survival implants.

2) Cumulative success rate

Only implants that were classified to "success" were regarded as success implants.

Periapical radiographs were taken for evaluation. The radiographs were taken perpendicularly with long-cone technique, showing

whole implants at each side of it. The platform of transmucosal implant extension(TIE) and implant body was used as the reference for the bone level evaluation. The marginal bone loss was measured utilizing STARPA-CS™ program digitalizing radiographs. In the present study, marginal bone loss was measured and averaged at mesial and distal sides respectively, only in implants with a survival period for at least 10-years.

Ⅲ. Results

1. Cumulative survival rate

27 implants of 83 implants were "failed" implants. If censored implants are in "survival" or "success", survival rates is 67.5%. Table 4 and Figure 1 shows the cumulative survival rate.

Table 4. Cumulative survival rate

Time Periods	Survival	failed	CsurR(%)
0-12m (1yrs)	83	0	100
13-24m (2yrs)	82	1	98.8
25-36m (3yrs)	82	1	98.8
37-48m (4yrs)	79	4	95.2
49-60m (5yrs)	77	6	92.8
61-72m (6yrs)	75	8	90.4
73-84m (7yrs)	74	9	89.2
85-96m (8yrs)	73	10	88.0
97-108m (9yrs)	72	11	86.7
109-120m (10yrs)	67	16	80.7
121-132m (11yrs)	64	19	77.1
133-144m (12yrs)	59	24	71.1
145-156m (13yrs)	58	25	69.9
157-160m (14yrs)	56	27	67.5

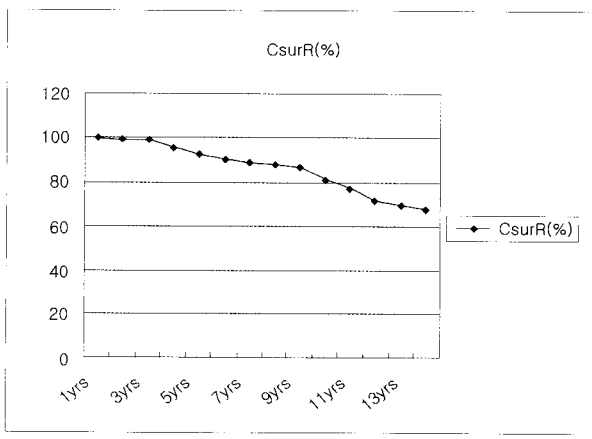

Figure 1. Cumulative survival rate

2. Cumulative success rates

42 implants of 83 implants were classified to "survived" and "failed" implants. If censored implants are in "success", success rates is 49.4%. Table 5 and Figure 2 shows the cumulative success rates.

3. Failure pattern

Failure implants were classified according to failure causes. Most of failure cases were due to progressive bone loss around implants and occasionally combined with fixture fractures. Table 6 shows the distribution of causatives.

Table 5. Cumulative success rates

Time Periods	success	failed	CsucR(%)
0-12m (1yrs)	83	0	100.0
13-24m (2yrs)	82	1	98.8
25-36m (3yrs)	82	1	98.8
37-48m (4yrs)	79	4	95.2
49-60m (5yrs)	72	11	86.7
61-72m (6yrs)	70	13	84.3
73-84m (7yrs)	69	14	83.1
85-96m (8yrs)	67	16	80.8
97-108m (9yrs)	66	17	79.5
109-120m (10yrs)	61	22	73.5
121-132m (11yrs)	55	28	66.3
133-144m (12yrs)	45	38	54.2
145-156m (13yrs)	44	39	53.0
157-160m (14yrs)	41	42	49.4

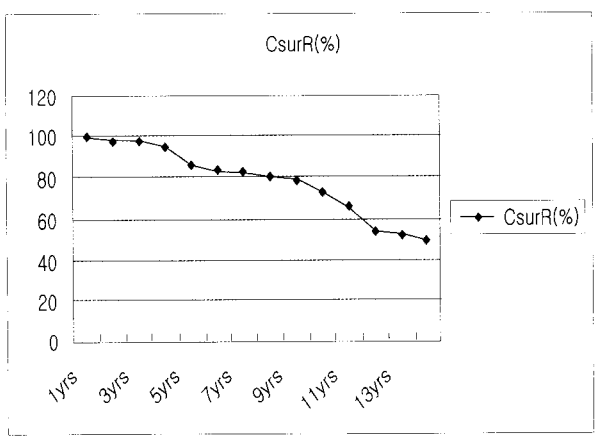

Figure 2. Cumulative success rates

Table 6. Failure pattern analysis

Failure pattern		number
Early failure		1
Late failure	Screw fracture	4
	Fixture fracture	5
	bone loss	17
Total		27

Table 7. marginal bone loss

	Mesial	Distal	Average
Bone loss (mm)	2.91±1.55	2.73±1.36	2.82±1.38

4. Marginal bone loss

The marginal bone loss was measured and averaged at mesial and distal sides respectively, only in implants with a survival period for at least 10-years. Table 7 shows the marginal bone loss.

Ⅳ. Discussion

In this study, the survival rate and success rate were in disagreement with previous others.

In a previous study, Babbush et al(1993). reported that the 5-year survival rate 1,059 IMZ implants was 96%, maxillary survival rate corresponding to 92% and mandibular to 99%[17]. In other study it was reported that after 5 years from insertion, 96.0% of 1,250 implants were in situ and noninflamed, and after 10 years the survival rate was 82.4% Also for both the upper and lower jaws, better results were recorded in the posterior part of the jaw than in the anterior part(Willer et al. 2003)[10]. Haas et al.(1996) reported that the cumulative survival rate of 1,920 IMZ system was 89.9% after 60 months and 83.2% after 100 months. The life table analysis revealed a statistically significantly lower cumulative survival rate for maxillay implants(71.6% at 60 months and 37.9% at 100 months) than for mandibular implants(90.4% at 100 months)[11]. Most studies about IMZ system showed a survival rate of at least 80%[18~26].

But in our present study, though the number of placed implants were relatively small, the survival rate is remarkably lower. If censored implants were successful, the survival rate was 67.4% and the success rate was 49.4%. The survival analysis for nonparametric observation was not used in this study because it was thought that the suvival analysis for nonparametric observation would be underestimated and statistically meaningless in the case that the large portion of patients were censored.

The low survival and success rate is regarded as the essential problems of IMZ system itself and other factors. One of factors

is that success criteria is more strict compared to previous study. The proposed criteria of Albrektsson et al.[12] for long-term success of dental implant are the most commonly used today. These criteria include signs of marginal bone loss determined by the radiographic image as a measurement for success. Most of literature considers implant success rate as implant survival rate and ignore the factor of marginal bone loss[27]. In the present study, marginal bone loss was the criterion used for implant success. Therefore, the success rate cannot be compared to other studies in which implant survival was used to define implant success.

To calculate marginal bone loss, digitalized radiographs was measured with STARPACS™ program, which enabled the accuracy within 0.01mm. As a result, "success" or "survival" implants could be determined according to the proposed criteria of Albrektsson et al[12]. For example, to be regarded as successful, the marginal bone loss must be less than 2.8mm after 10years. The mean marginal bone loss was calculated in 26 implants, which survived more than 10 years. The marginal bone loss calculated in more 10-year survived 26 implants. The marginal bone loss at the mesial side was 2.91±1.55mm and at the distal side 2.73±1.36mm. As a result, the average of marginal bone loss was 2.82±1.38mm.

Even though relatively strict success criteria was appied to this study, remarkedly lower success rate was regard to the IMZ system itself[10,11]. At first, IMZ system has a vent in the cylindrical implant. This design was to induce the in-growth of bone and thereby gain more bone- implant contact. In the present study, all fractured sites were located on the upper border of the vent region. It is suggested that this vented design weakened the strength of the fixture. Figure 1. shows the fractured implants on the upper border of the vent region. This phenomenon occurs more frequently in implants with small diameters(3.3mm). The surface of the IMZ system is coated with titanium plasma spray. Most of failure cases showed degradation of bone around the implant. In this situation, bone-degraded implants were combined with fracture at the upper border of vent region as stated above.

The TPS surface and cylindrical design can be carefully presumed to be a causative factor of this bone loss around IMZ implants [28~31]. In 2004, M. Franchi et al.[32] reported that Ti granules of 3-60㎛ were detectable only in the peri-implant tissue of TPS implants both immediately after surgery, thus suggesting that this phenomenon may be related to the friction of the TPS coating during surgical insertion. It cannot be concluded that detachment of Ti debris endangers the peri-implant tissue, but can be hyposthesized as one of the causatives.

The cylindrical design may also be related to the higher failure rates. Watzak et al. reported that in histologic and histomorphometric analysis of three of dental implants following 18 months of occlusal loading, TPS cylindrical implants showed less absolute BIC(bone-to-implant contact) than commercially pure titanium screws and grit-blasted acid-etched screw[33]. That is, cylin-

drical design and TPS surface was unfavorable to BIC than screw design and other surfaces.

Another point to keep an eye on was that the IMZ system had frequent prosthodontic complications such as screw loosening, fracture of screws, inserts(intramobile element, intramobile connectors) and abutments in this present study. In deed, it was reported that the rate of prosthodintic complications with IMZ components was considerably higher (71%) than that of other systems(13.5%)(Behr M. et al.)[34] This was mainly due to the presence of intramobile elements(IME) and connectors(IMC) in the IMZ system. Already it is proved that precise fitting, non- resilient abutment components leading to rigid connections of suprastructure can be clinically more successful than resilient anchoring components. In this study, 6 implants of failed implants showed screw fracture. Among survived implants, IME fracture occurred frequently. In these cases, IME were replaced.

Therefore many factors were related to the low success and survival rates. Although the patients pool of this study was relatively small and more strict criteria was applied, the results was somewhat different from previous studies. And these causatives of failure in the IMZ system can be a guide in choosing implant systems, and furthermore improving implant dentistry.

V. Conclusion

The "intramobile cylinder implant system" (IMZ) is one of the oldest and mostly used system in Germany. Most studies about IMZ system showed a survival rate of at least 80%. However, failure cases of this system have been recently often reported at the Department of Periodontics and the Department of Prosthodontics, the College of Dentistry, University of Yonsei, Korea and it was suggested that our long-term outcomes would be somewhat different from previous studies.

1. The survival rate of IMZ was 67.5%
2. According to the success criteria of marginal bone loss, the success rate was 49.4%
3. Among 27 implants that failed, 17 had bone loss around implants, 5 implants were fractured on fixture level and 4 implants had screw fracture.
4. The average of marginal bone loss was 2.82mm in patients with a survival period for at least 10-years.

The causatives of failure was regarded to the cylindrical design, titanium plasma spray coating and prosthodontic complication.

VI. Reference

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사진 부도 설명

Figure 3. The structure of IMZ implants. Intramobile element(IME), transmucosal implant extension(TIE), implant body are shown. (a) Diagramed IMZ implant structure. (b) Appearance of IMZ implant.

Figure 4. The surface of IMZ implants. Hydroxyapatite coating(Left) and Titanium plasma flame spray coating(Right)

Figure 5. Titanium plasma flame spray coating. In SEM , the rough surface of 15-20㎛ is shown.

Figure 6. Failed IMZ implants. Implants had bone loss and one of those fractured on vent region. (a) Clinical appearance of implant site. Bone loss around implants is shown. (b) Removed implants. One is fracture on the upper border of vent region and the others have screw fracture.

사진부도(I)

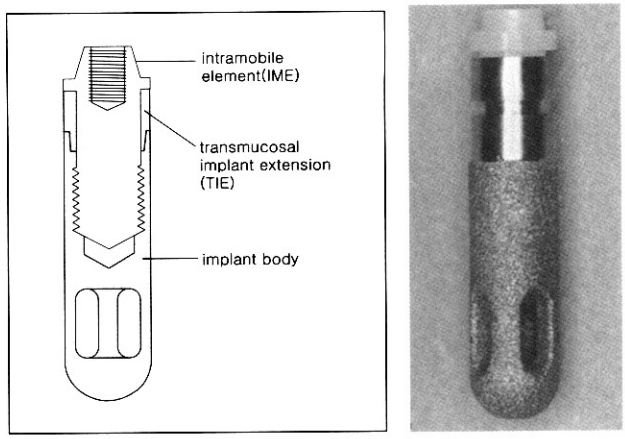


Figure 3. The structure of IMZ implants

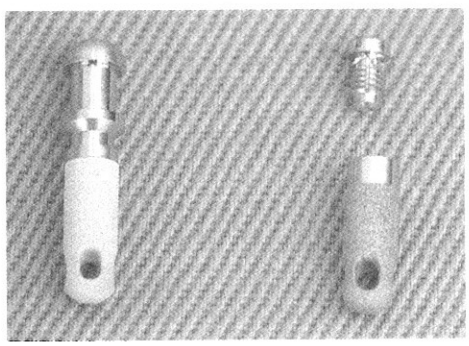


Figure 4. The surface of IMZ implants

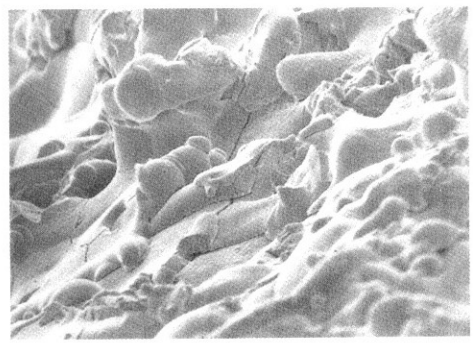
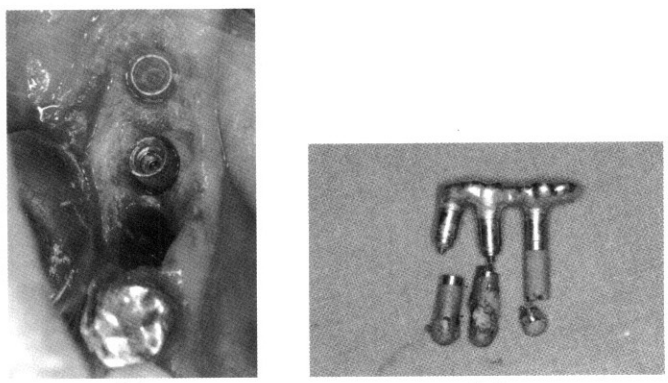


Figure 5. Titanium plasma flame spray coating



(a) (b)

Figure 6. Failed IMZ implants. Implants had bone loss and one of those fractured on vent region.

-국문요약-

IMZ 임플란트의 장기적 성공률과 실패율

박지은[1,2] · 김태균[1,2] · 정의원[1,2] · 김창성[1,2,3] · 최성호[1,2,3]
조규성[1,2,3] · 김종관[1,2,3] · 채중규[1,2]

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IMZ는 "intramobile cylinder implant system"(IMZ)로 독일에서 가장 오래되고 많이 사용되어진 임플란트 중 하나이다. 이 임플란트에 관한 장기적 성공률과 생존률에 대한 연구는 대개 80% 이상을 보고하고 있다. 그러나, 연세대학교 치과병원 치주과에서 식립된 83개의 임플란트에서는 이전의 연구와는 다른 결과를 나타내었다.

1. IMZ 임플란트의 생존률은 67.5% 였다.
2. 변연 치조골 소실에 대한 성공 기준을 적용한 결과 성공률은 49.4%로 나타났다.
3. 발거된 총 27개의 임플란트 중에서 임플란트 주위 골소실을 가지는 경우는 17개, 내부구조 파절은 4개, 식립체 파절은 5개로 보고되었다.
4. 10년 이상 생존된 임플란트에서 변연골 소실의 평균치는 2.82mm였다.

IMZ 임플란트는 장기적으로 높은 실패율을 보고하였다. 이는 cylindrical design, titanium plasma flame spray coating, prosthodontic complication 등의 요소에 기인한 것으로 사료된다. 임플란트는 그 형태, 표면 처리 등 여러 가지 요인들에 의해 실패가 나타날 수 있으며 본 연구를 통해 임플란트의 개발 및 선택에 바탕이 될 수 있을 것으로 생각된다.

주요어 : IMZ 임플란트, 누적 성공률, 누적 생존률, 변연골 소실