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A retrospective study on survival rates of dental implants in elderly patients

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ABSTRACT

노인 환자에서 임플란트의 생존율에 대한 후향적 연구

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목적: 노인 환자에서 식립된 임플란트의 생존율을 조사하고 다양한 요인에 따라 생존율에 미치는 영향을 후향적으로 평가하고자 하였다.

재료 및 방법: 2001년 1월부터 2007년 12월까지 조선대학교 치과병원 치주과에 내원한 65세 이상 노인 환자 56명에게 식립된 138개의 임플란트를 대상으로 하였다.(남자 38명, 여자 18명, 평균 연령69.38 ± 3.91세) 임플란트 생존율은 환자 성별 및 연령, 전신질환 유무, 치아 상실 원인, 식립 위치, 임플란트 직경 및 길이, 골질, 골이식 여부, 상부 보철물 유형에 따라 조사되었다.

Kaplan-Meier survival analysis을 통해 각 요인에 따른 누적 생존율을 조사하였고, chi-square test를 통해 누적 생존율과 각각의 요인 간의 통계학적 유의성을 평가하였다.

결과: 보철물 시적 후 5 ~ 140개월 간 추적 관찰을 시행하였다. 65세 이상 노인 환자 56명에게 식립된 총 138개의 임플란트 중 추적 관찰 기간 동안 5개의 임플란트가 실패하였다. 그 중 63개의 임플란트는 환자가 정기적인 내원 약속에 응하지 않아 도중에 조사대상에서 제외되었으며, 결과적으로5년간 누적 생존율은 94.9%였다. 임플란트 생존율에 영향을 미치는 다양한 요인 중 골질 (P=0.037) 및 상부 보철물 유형 (P=0.015) 간에 누적 생존율이 통계적으로 유의한 차이가 있었다. 그외 연령, 성별, 전신질환 유무, 치아상실 원인, 식립 위치, 임플란트 직경 및 길이, 골이식 유무 관련 요인과 누적 생존율 사이에는 통계적으로 유의한 차이가 없었다.

결론: 여러 한계가 있었지만 노인 환자의 무치악 부위에 있어 임플란트는 장기간에 걸쳐 예지성 있고 받아들여질 만한 치료이면서 적은 합병증과 실패율을 가진다.

Key words : Aged, Dental implants, Cumulative survival rate

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Ⅰ. Introduction

The percentage of elderly population is increasing globally along with growth in average life expectancy and a decline in birth rate. People aged 65 years and above are considered as the 'elderly population' by the United Nations, and the same in Korea. According to the data by Statistics Korea[1], the ratio of elderly population reached 7% (ageing society) of all Korean population in 2000, and is expected to reach 14.3% (aged society) by 2018 and 20.8% (post-aged society) by 2026. As Korea is about to enter into the aged society, measures and solutions on social problems caused by a rapid increase of elderly patients are crucial. Although controversial, health insurance plan has recently added coverage for dental implants as a measure for resolution. Moreover, the dental implant treatment in the elderly has drawn much attention as the association between oral health and quality of life has been reported.

Potential related factors and risk factors need to be identified to reduce the occurrence of implant failure. According to El Askary et al.[2, 3], factors that increase the risk of implant failure are as follows: First, influential factors are host related factors including patient's age, gender, systemic disease, smoking, oral hygiene and others. Second, implant placement site related factors are position in arch, bone quality, bone quantity and others. Third, surgery related factors are initial stability, angulation and direction, skillfulness of an operator and others. Fourth, implant fixture related factors are fixture diameter and length, surface roughness and others. Finally, implant prosthesis related factors are prosthesis type, occlusal scheme and others. For implant treatment predicta bility, how these factors affect implant failure needs to be taken into account. Furthermore, clinical considera tions need to be incorpo rated into the treatment of elderly patients.

According to de Baat[4], problems that could occur during implant placement in elderly patients are as follows: First, osseointegr ation associated with bone healing response is one of the problems. In particular, elderly individuals are more prone to the risk of osteoporosis due to a decrease in overall bone density and this could hamper the healing process. Second, another problem is soft tissue response. Since elderly individuals fall short of the ability to manage oral hygiene compare to young patients, they have a higher risk of inflammation in soft tissue around the implant site and inflammation may result in peri-implant marginal bone loss. Peri-implant soft tissue, in particular, is more vulnerable to inflammation unlike natural teeth. Likewise, physiological limits in elderly patients could influence implant failure to some extent. Therefore, this study aimed to retrospec tively analyze the survival rates of dental implants and factors affecting the survival rate in elderly patients.

Ⅱ. Materials and Methods

1. Study population and Materials

This study involved a total of 56 elderly patients who underwent implant placement at Department of Periodontology, Chosun University Dental Hospital from January 2001 to December 2007. Those patients received implant placement performed by a single surgeon, and they were 38 men and 18 women. The mean age was 69.38 ± 3.91 years (Table 1).

Among a total of 138 implants, 65 were placed in the maxilla and 73 were inserted in the mandible. Following implant placement, a 4- to 6-month healing period was given for osseointegration, and then the prosthesis was placed on the abutment. After beginning of implant loading, the patients were kept on periodic recall every 6 months. Patient were enrolled in a postoperative supportive care program every recall check. And periapical radiographs of implant site were taken once a year. The mean follow up period was 53.0 ± 33.0 months (range, 5-140 months).

2. Methods

This study was conducted after obtaining the approval from the ethics committee of Chosun University Hospital (IRB number: CDMDIRB-1323-121). Subjects were examined for the presence of dental implant complications based on their medical records and oral radiographs. Based on the reasons for dental implant failure suggested by El Askary et al.[2, 3], the 5-year cumulative survival rate of implants was investigated according to host related factors such as gender, age, systemic disease and cause of tooth loss, and implant related factors including implant location, fixture diameter and length, bone quality, use of bone graft and prosthesis type. Implants with 2 or more systemic diseases or multiple additional surgical procedures were all included overlapping in the criteria. In addition, smoking, implant type and surface such as SLA, HA coating, Anodizing initially included were excluded from analysis because of inadequate medical records.

Table 1. Age and gender distribution of the subjects, number of implants

Age (yrs)	Male	Female	Total
65-74	33 (83)	18 (46)	51 (129)
75-84	4 (7)	-	4 (7)
85-	1 (2)	-	1 (2)
Total	38 (92)	18 (46)	56 (138)
Mean age	69.75 ± 4.45	68.63 ± 2.35	69.38 ± 3.91

1) Criteria for implant survival

Implant survival was determined based on the criteria proposed by Buser et al.[5] and Cochran et al.[6].The clinical criteria included: (1) absence of clinically detectable implant mobility, (2) absence of pain and subjective discomfort, (3) absence of peri-implant infection, and (4) absence of continuous radiolucency around the implant. Implant removal due to clinical symptoms against the above mentioned criteria was regarded as a failure, and otherwise considered survival.

2) Statistical analysis

The above stated factors were identified and stored as Excel file based on the data gathered from medical records. Statistical analyses of data were performed using IBM SPSS statistics version 19.0 (IBM, New York, NY, USA).

Implant cumulative survival rates between 1 to 5 years were calculated using life-table analysis. Kaplan-Meier survival analysis was performed to compute implant cumulative survival rate according to criteria, and chi-square test (Fisher's exact test when the expected value of one or more cells was less than[10] was used to analyze significance difference between each related factor and survival rate. Differences were considered statistically significant at $P < 0.05$.

Ⅲ. Results

This research consisted of 56 elderly patients who were aged 65 years and who underwent implant placement during study period. A total of 138 implants were placed to subjects. After a 5-year follow-up, there were 5 cases with dental implant failure and 63 cases with missed periodic recall check-up. Thus, the 5-year cumulative survival rate of all implants was 94.9% (Table 2). The 5-year cumulative survival rates according to different factors were

Table 2. Analysis of implants placed and lost during 5 years.

Period after placement	Followed (n)	Failed (n)	Withdrawn (n)	ǂCumulative survival rate (%)
Placement	138	-	-	-
1st year	125	2	11	98.5
2nd year	103	-	22	98.5
3rd year	84	2	17	96.3
4th year	75	-	9	96.3
5th year	70	1	4	94.9
Total	70	5	63	94.9

ǂ Kaplan-Meier survival analysis

examined as below.

1. Survival rate according host related factors

1) Gender (Table 3)

Among 56 elderly patients, 92 implants were inserted in 38 male patients. Of these, 4 implants failed and the cumulative survival rate was 94.1%. 46 implants were placed in 18 female patients. Of these, an implant failed and the cumulative survival rate was 97.6%. Survival rate showed no statistically significant difference between gender (P=0.676) (Fig. 1).

2) Age (Table 4)

Of all implant failures, 5 were shown in the 65-69 age group exhibiting the lowest cumulative survival rate at 94.1%. Other age groups displayed a cumulative survival rate of 100%.Survival rate showed no statistically significant difference by age (P=0.521) (Fig. 2).

3) Systemic disease (Table 5)

A total of 66 implants were placed in patients under the management of systemic disease. Multiple systemic diseases of each patient were all included to each

Table 3. Survival rate according to gender

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
Male	92	66.7	4	94.1	0.676	1.00	1.00, 1.00
Female	46	33.3	1	97.6		0.49	0.50, 4.50
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

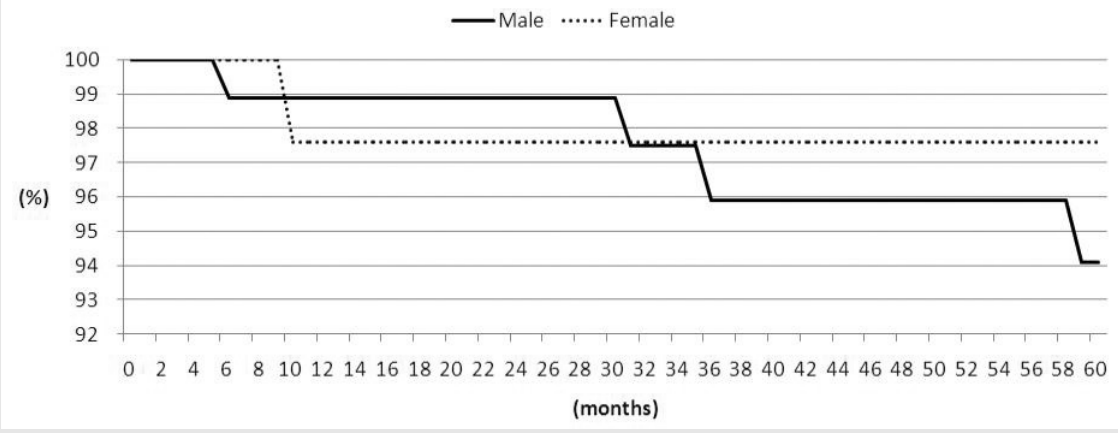

Figure 1. Survival curve according to gender

Table 4. Survival rate according to age (years)

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
65~69	85	61.6	5	94.1	0.521	1.00	1.00, 1.00
70~74	44	31.9	-	100.0		0.00	
75~79	4	2.9	-	100.0		0.00	
80~84	3	2.2	-	100.0		0.00	
85~	2	1.4	-	100.0		0.00	
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

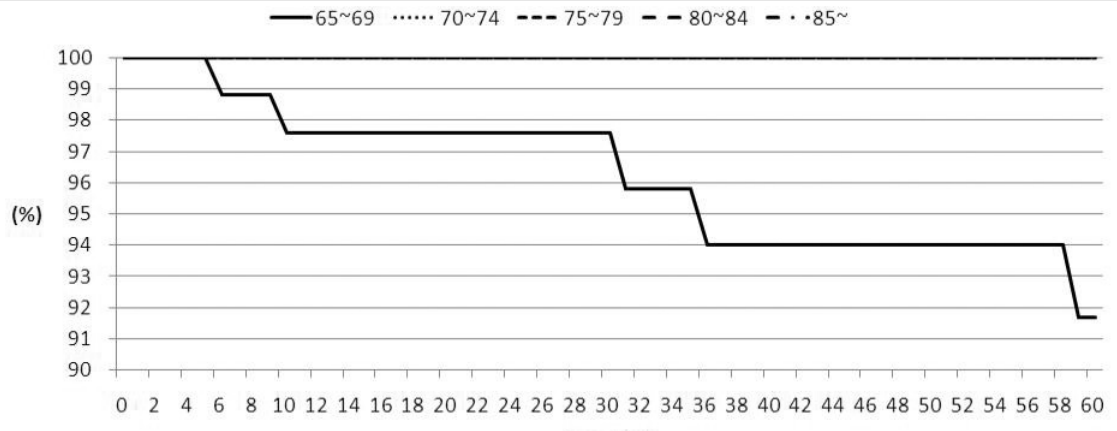

Figure 2. Survival curve according to age (years).

assessment criteria. As results, 36 implants were inserted in patients with a single systemic disease, 29 implants were placed in patients with 2 systemic diseases, and an implant was inserted in patients with 3 systemic diseases. Of all 5 failed implants, 3 occurred in patients without any systemic disease, 1 occurred in a patient with hypertension, and 1 occurred in a patient with hypertension and other systemic diseases. No statistically significant differences were observed in survival rate according to systemic disease (P=0.406) (Fig. 3).

4) Cause of tooth loss (Table 6)

The most common cause of tooth loss before implant placement was periodontitis in 60 implanted cases, followed by dental caries, trauma, and pulpitis. The survival rate was lowest in implants of patients who had lost a tooth or teeth due to periodontal

Table 5. Survival rate according to systemic disease

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
Normal	72	42.6	3	94.0	0.406	1.00	1.00, 1.00
DM	29	17.2	-	100.0		0.00	
HTN	56	33.1	2	95.7		0.85	0.14, 5.28
Osteo	-	-	-	-		-	
Hepa	4	2.4	-	100.0		0.00	
Others	8	4.7	1	80.0		3.29	0.30, 35.97
Total	169	100	6	94.8			

DM, diabetes mellitus; HTN, hypertension; Osteo, osteoporosis; Hepa, hepatitis; CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

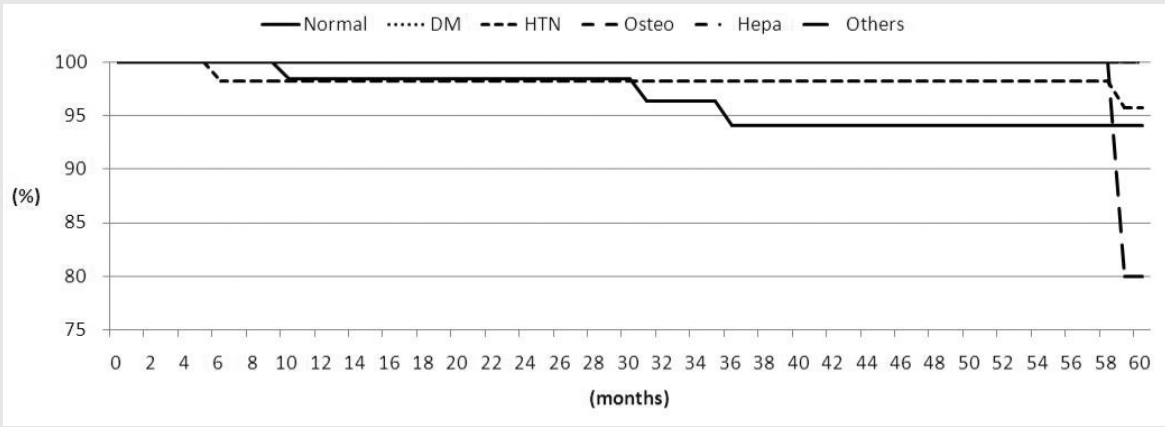

Figure 3. Survival curve according to systemic disease.
DM, diabetes mellitus; HTN, hypertension; Osteo, osteoporosis; Hepa, hepatitis

Table 6. Survival rate according to cause of tooth loss

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
Perio	60	43.5	4	90.1	0.549	1.00	1.00, 1.00
Caries	20	14.5	1	95.0		0.74	0.08, 7.01
Endo	3	2.2	-	100.0		0.00	
Trauma	6	4.3	-	100.0		0.00	
Unknown	49	35.5	-	100.0		0.00	
Total	138	100	5	94.9			

ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

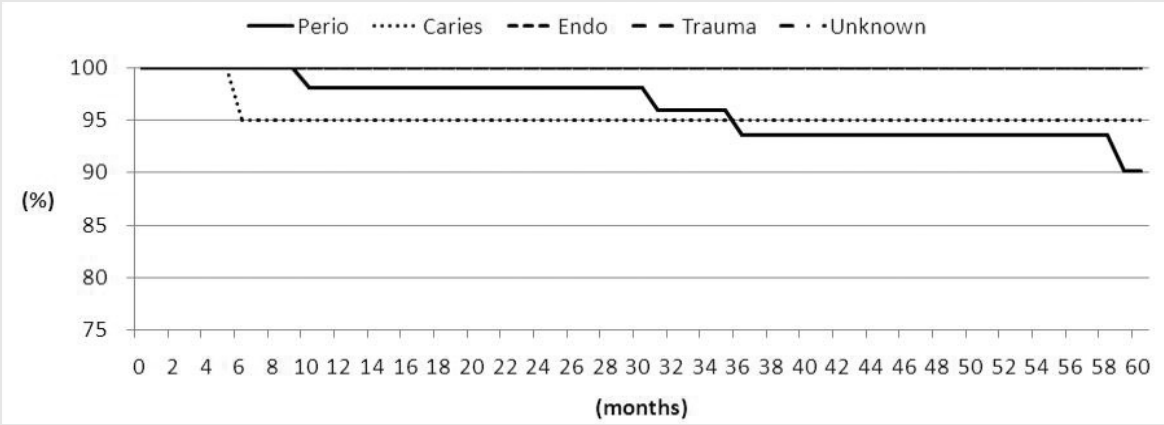

Figure 4. Survival curve according to cause of tooth loss.

disease at 90.1%. On the other hand, the survival rate was the highest in implants of who had lost a tooth or teeth due to trauma or pulpitis at 100.0%. However, no statistically significant differences were seen in survival rate according to cause of tooth loss (P=0.549) (Fig. 4).

2. Survival rate according implant related factors

1) Implant placement site (Table 7)

According to implant site, survival rates were 50.0% and 93.9% in the maxillary anterior and posterior areas, respectively, and 100.0% and 97.3% in the mandible anterior and posterior areas. The survival rate was higher in the maxilla than in the mandible, and was lowest in the maxillary anterior area. However, no statistically significant difference was found in survival rate according to implant site (P=0.141) (Fig. 5).

2) Implant diameter (Table 8)

The implant diameters of 4.6-5.0mm were most frequently used in 59 cases, followed by 3.6-4.0mm in 51 cases and 4.1-4.5mm in 19 cases. The lowest survival rate was demonstrated in implants with diameters of 3.6 to 4.0mm at 90.4%. Survival rates were 96.9% in implants with diameters of 4.6-5.0mm and 100.0% in the rest of implants. Implant diameters showed no statistically significant difference in survival rate (P=0.502) (Fig. 6).

3) Implant length (Table 9)

The implant lengths of10-11.9mm were most frequently used in 68 cases, followed by 12 mm or longer in 54 cases. Implant failure was observed in short-length implants rather than lengths longer than 10mm. Survival rates were 94.4% in lengths between 10-11.9mm and longer than 12 mm, 100.0% in the other two groups.

Table 7. Survival rate according to implant location

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
Mx. ant.	5	3.6	1	50.0	0.141	1.00	1.00, 1.00
Mx. post.	60	43.5	3	93.9		0.21	0.02, 2.51
Mn. ant.	10	7.2	-	100.0		0.00	
Mn. post.	63	45.7	1	97.3		0.06	0.00, 1.23
Total	138	100	5	94.9			

Mx, maxillary; Mn, mandible; ant, anterior; post, posterior; CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

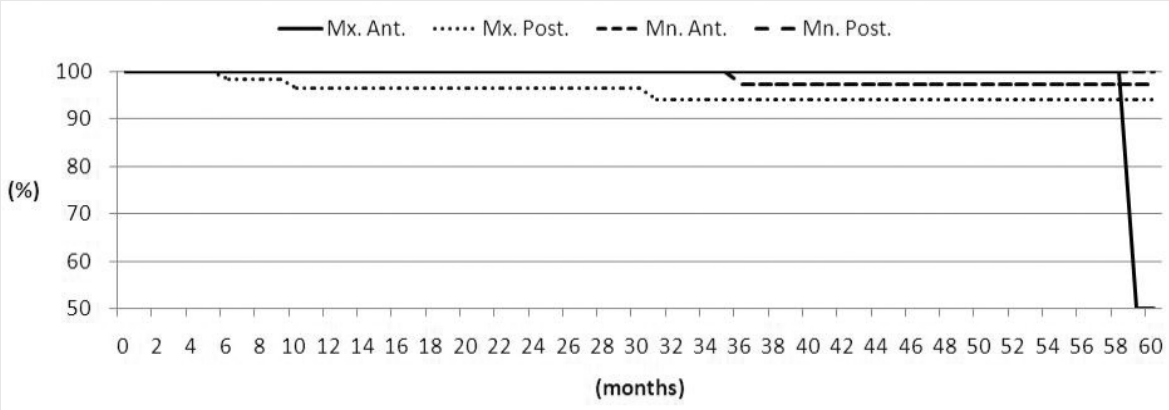

Figure 5. Survival curve according to implant location.
Mx, maxilla; Mn, mandible; ant, anterior; post, posterior

Table 8. Survival rate according to fixture diameter (mm)

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
3.0 ~ 3.5	4	2.9	-	100.0	0.502	0.00	
3.6 ~ 4.0	51	37.0	4	90.4		1.00	1.00, 1.00
4.1 ~ 4.5	19	13.8	-	100.0		0.00	
4.6 ~ 5.0	59	42.8	1	96.9		0.20	0.02, 1.87
≥ 5.1	5	3.6	-	100.0		0.00	
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

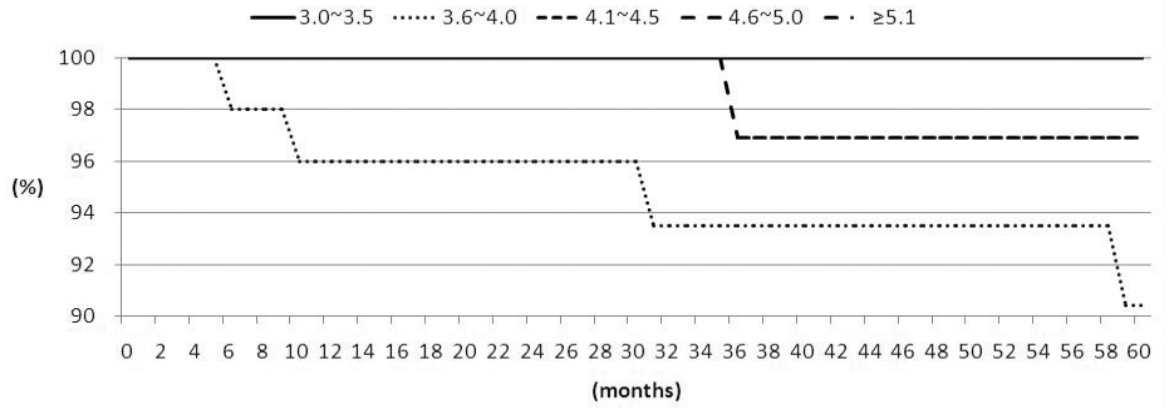

Figure 6. Survival curve according to fixture diameter (mm).

Table 9. Survival rate according to fixture length (mm)

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
〈 8	8	5.8	-	100.0	0.873	0.00	
8~9.9	8	5.8	-	100.0		0.00	
10~11.9	68	49.3	3	94.4		1.20	0.19, 7.45
≥ 12	54	39.1	2	94.4		1.00	1.00, 1.00
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

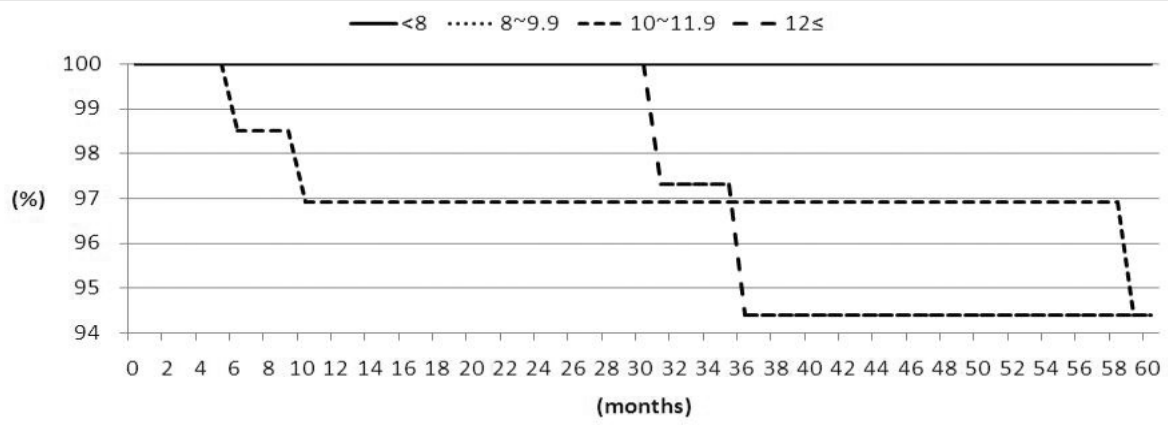

Figure 7. Survival curve according to fixture length (mm).

Implant lengths showed no statistically significant difference in survival rate (P=0.873) (Fig. 7).

4) Bone quality (Table 10)

Bone quality was classified by Lekholm and Zarb[7] classification. And it was measured by tactile evaluation during drilling and radiographic assessment. Excluding 52 cases unable to be measured with bone quality, failure occurred in type III bone of 86 implants. Survival rates were 100.0% in the other types I, II and IV bone, but was particularly low in type III bone at 75.0%. Bone quality showed statistically significant difference in survival rate (P=0.037) (Fig. 8).

5) Bone graft (Table 11)

There were 103 implants that underwent

Table 10. Survival rate according to bone quality

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮ P value	Odds ratio	95% CI
N/A	52	37.7	2	95.9	0.037*	1.00	1.00, 1.00
1†	10	7.2	-	100.0		0.00	
2†	24	17.4	-	100.0		0.00	
3†	28	20.3	3	75.0		3.00	0.47, 19.13
4†	24	17.4	-	100.0		0.00	
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval; N/A, not available
* Statistically significant difference (P<0.05)
† Lekholm and Zarb12) presented a classification of bone quality
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

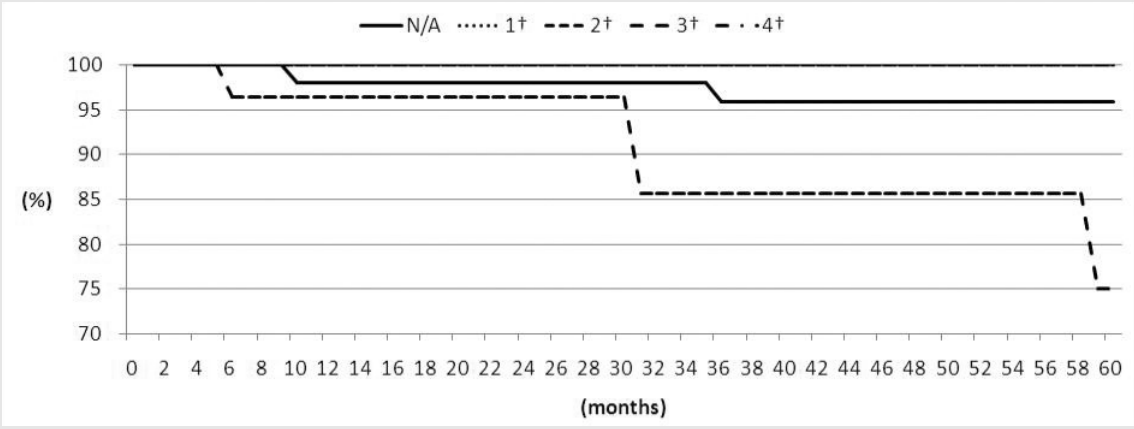

Figure 8. Survival curve according to bone quality.
N/A, not available
† Lekholm and Zarb[12] presented a classification of bone quality

additional surgical procedures such as bone graft. Guided bone graft with membrane was most commonly performed in 66 cases, followed by lateral approach sinus floor elevation in 14 cases. Multiple surgical procedures of an implant were all included overlapping in the total number of implants. Survival rates were 100.0% in implants with bone graft only and the concurrent use of lateral approach sinus floor elevation, 95.1% in implants with the concurrent use of osteotome sinus floor elevation with crestal approach, and 96.3% in simple implant placement. The lowest survival rate was

Table 11. Survival rate according to use of bone graft

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∫P value	Odds ratio	95% CI
No	35	23.5	1	96.3	0.406	1.00	1.00, 1.00
GBR	without membrane	9	6.0	-	100.0	0.00	
	with membrane	66	44.3	2	95.1	1.06	0.09, 12.14
Sinus	lateral approach	14	9.4	-	100.0	0.00	
	crestal approach - OSFE	4	2.7	1	75.0	11.33	0.56, 230.56
	crestal approach - BAOSFE	11	7.4	1	90.9	3.40	0.19, 59.38
Ridge split	10	6.7	1	90.0		3.78	0.21, 66.47
Total	149	100	6	94.7			

GBR, guided bone regeneration; OSFE, osteotome sinus floor elevation; BAOSFE, bone-added osteotome sinus floor elevation; CSR, cumulative survival rate; CI, confidence interval
ǂ Kaplan-Meier survival analysis
∫ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

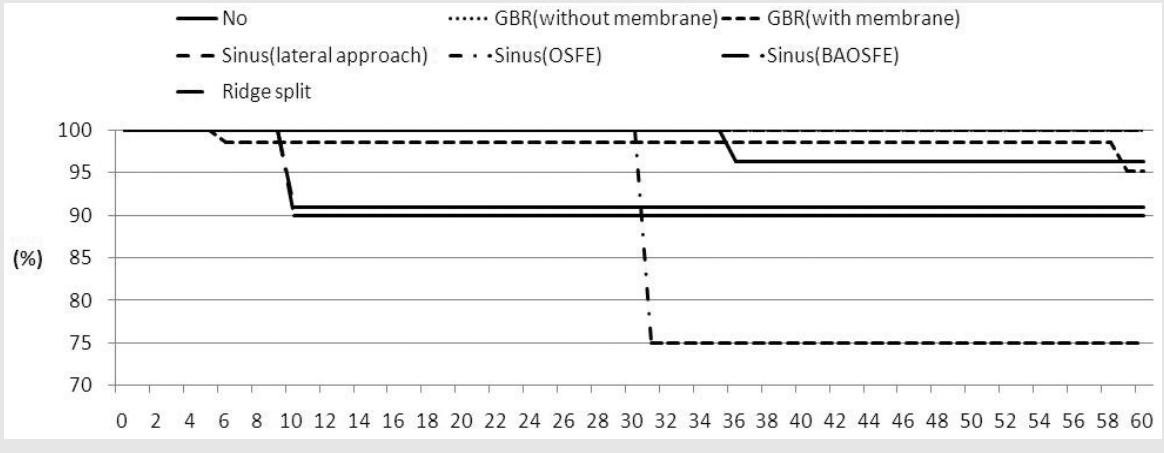

Figure 9. Survival curve according to presence of bone graft.
GBR, guided bone graft; OSFE, osteotome sinus floor elevation; BAOSFE, bone-added osteotome sinus floor elevation

found in osteotome sinus floor elevation with crestal approach at 75.0%. There was more number of failures in implants with additional surgical procedures such as bone graft compare to simple implant placement. However, bone graft had no statistically significant difference in survival rate (P=0.406) (Fig. 9).

6) Prosthesis type (Table 12)

Most commonly used implant prosthesis type was implant-supported fixed dental prosthesis in 82 cases, followed by implant-supported single crown in 36 cases. Of these, failure was detected in implants restored with implant-supported single crown and overdenture. No failure was observed in cases connected to the adjacent implant. Survival rates were 100.0% in implant-supported fixed dental prosthesis, 90.2% in implant-supported single crown, and 80.0 in overdenture

Table 12. Survival rate according to prosthesis type

	Placed implant (n)	Distribution (%)	Failed implant (n)	ǂCSR (%)	∮P value	Odds ratio	95% CI
N/A	11	8.0	1	90.0	0.015*	1.00	1.00, 1.00
Single	36	26.1	3	90.2		0.91	0.08, 9.74
Splint	82	59.4	-	100.0		0.00	
Overdenture	9	6.5	1	80.0		1.25	0.07, 23.26
Total	138	100	5	94.9			

CSR, cumulative survival rate; CI, confidence interval; N/A, not available; Single, implant-supported single crown; Splint, implant-supported fixed dental prosthesis
* Statistically significant difference (P<0.05)
ǂ Kaplan-Meier survival analysis
∮ chi-square test (Fisher's exact test when the expected value of one or more cells was less than 10)

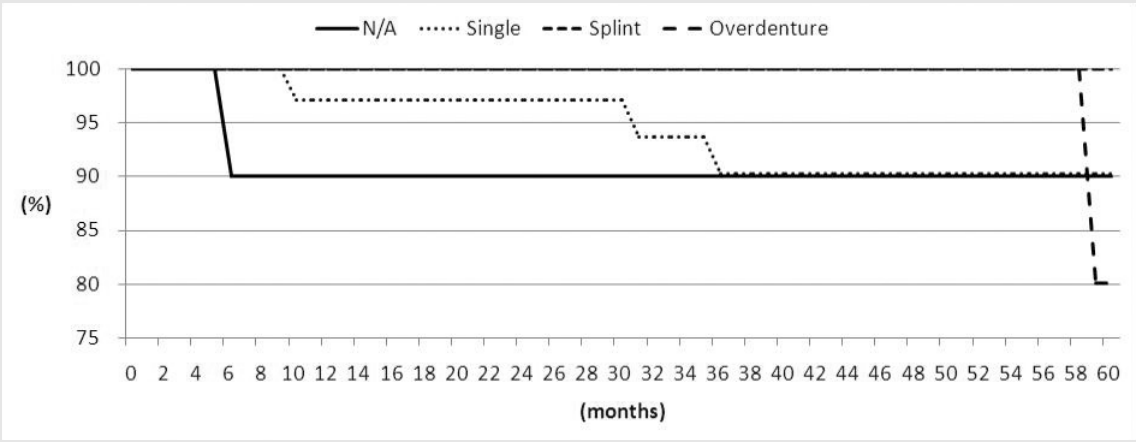

Figure 10. Survival curve according to prosthesis type.
N/A, not available; Single, implant-supported single crown; Splint, implant-supported fixed dental prosthesis

restoration. Prosthesis type exhibited statistically significant difference in survival rate (P=0.015) (Fig. 10).

3. Time and type of failures (Table 13)

Of all 138 cases, 5 implants failed within a 5-year follow-up, exhibiting the cumulative survival rate of 94.9%. According to failure period, there was a case with early failure before loading and 4 cases with late failure after loading. Of these, an implant failed within the first 6 months, two implants failed between 6 months to 3 years, and an implant failed three years after loading. The leading cause for implant failure before loading was osseointegration failure. Among implants failed after loading, there were a case with loss of osseointegration, 2 cases with marginal bone loss of implant due to unilateral chewing, and a case complaining of discomfort due to persisting peri-implantitis (Fig. 11).

4. Complication

Except for 5 cases of implant failure, various complications were detected in 19 implants including detached prosthesis, paresthesia, peri-implantitis, continuous bone loss, screw loosening and others. Cases with complications accounted for 13.8% of all implants. The most common complication was peri-implantitis in 8 implants, followed by prosthetic complic ations such as detached prosthesis and screw loosening in 7 implants, continuous bone loss in 3 implants, and paresthesia in an implant (Fig. 12).

Ⅳ. Discussion

A wide range of clinical standards have been suggested to evaluate the success and failure of implant treatment. Albrektsson et al.[8] presented the clinical and radiographic criteria utilized to define implant success at Toronto Conference in 1986. The success criteria are absence of implant mobility, continuous radiolucency around the implant, gradual bone loss (a vertical bone loss less than 0.2mm annually after the first year), and persistent subjective complaints such as pain or purulent effusion. In addition, Albrektsson et al.8) stated that the required implant success rate is a minimum of 85% for 5 years and 80% for 10 years. In 1998, Zarb and Albrektsson[9] proposed that the success criteria are satisfactory functional and esthetic prosthesis to both patient and dentist, absence of pain, discomfort, paresthesia and infection, and no mobility.

Although it is difficult to clearly define criteria for the success and survival of implant, the success rate implies the ratio of implants satisfying the success criteria after a certain period of time. The survival rate refers to the percentage of implants remaining in the mouth before removal of

Table 13. Implant failure analysis

Gender	Age (years)	Systemic disease	Cause of loss	Site	Bone quality	Implant diameter (mm)	Implant length (mm)	Bone graft	Prosthesis type	Time of failure	Cause of failure	Failure type
M	68	HTN	Caries	#25	†3	4	11	GBR with membrane	N/A	6 months	Osseointegration failure	Early failure
F	69	Normal	Perio	#16	N/A	4	11	Sinus (BAOSFE) Ridge split	Single	10 months	Osseointegration failure	Late failure
M	68	Normal	Perio	#24	†3	4	13	Sinus (OSFE)	Single	31 months	Progressive bone loss	Late failure
M	65	Normal	Perio	#47	N/A	5	13	No	Single	36 months after surgery	Progressive bone loss	Late failure
M	68	HTN Others (stroke)	Perio	#23	†3	4	11.5	GBR with membrane	Overdenture	59 months after surgery	Peri-implantitis	Late failure

M, male; F, female; HTN, hypertension; N/A, not available; GBR, guided bone graft; OSFE, osteotome sinus floor elevation; BAOSFE, bone-added osteotome sinus floor elevation; Single, implant-supported single crown; Early failure, implant failure before loading; Late failure, implant failure after loading
† Lekholm and Zarb[12] presented a classification of bone quality

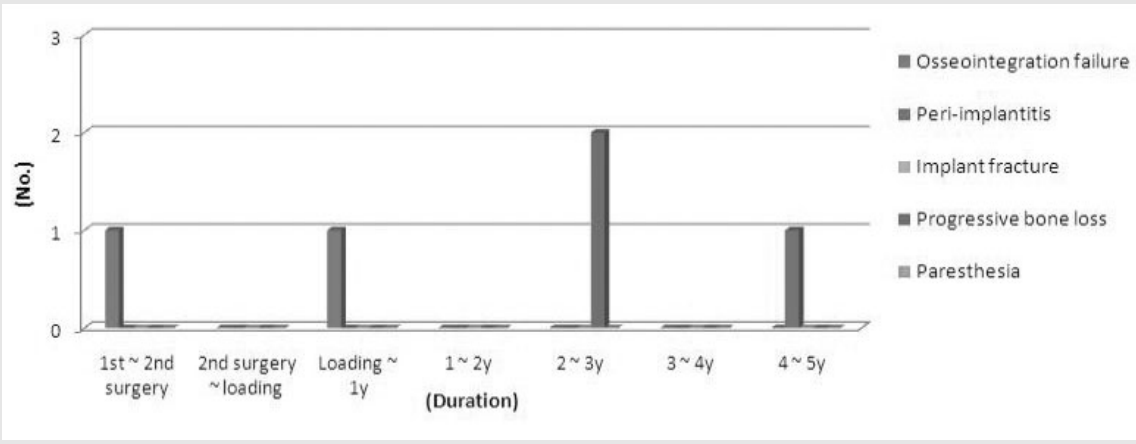

Figure 11. Implant failure analysis.

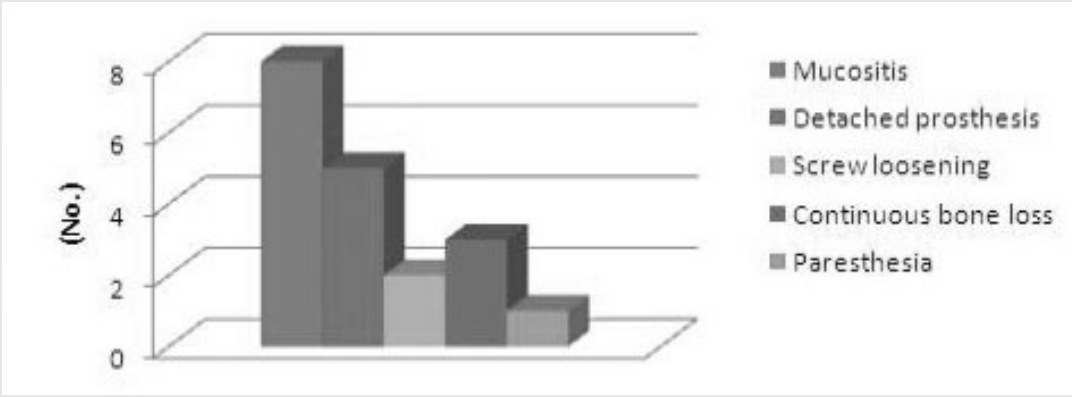

Figure 12. Complications after loading of implant prosthesis.

the implant[10]. Therefore, failed implant remaining in the mouth is considered survived.

Since the criteria for survival rate is less strict than those of success rate, they are more convenient for clinicians to use. Survival rate is usually higher than success rate. Survival rate having less strict criteria is more commonly used in recent years, because it is clinically complicated to meet the criteria for success rate.

Based on the criteria for implant survival proposed by Buser et al.[5] and Cochran et al.[6], survival rate was assessed in this study. Based on the related factors for implant survival, suggested by El Askary et al.[2, 3], implant cumulative survival rate was examined according to host related factors including gender, age, systemic disease, cause of tooth loss and others, and implant related factors including implant site, fixture diameter and length, bone quality, bone graft, prosthesis type.

In regards to implant survival rate according to gender, Higuchi et al.[11] suggested that stronger mastication and higher smoking frequency in men than in women are anticipated to influence implant survival rate to some extent. Schwartz et al.[12] reported that implant failure rate is higher in men than in women. In this study, the survival rate was 94.1% in men and 97.6% in women, indicating a higher failure rate in men.

Implant survival rate was examined according to systemic disease. Moy et al.[13] suggested that osteoporosis patients are less capable of bone formation and osseointegration by 20-30%, but the condition is not contraindication when a longer healing time is given for osseointegration. Moreover, Holahan et al.[14] reported that no significant correl ation was found between osteoporosis and implant failure.

When implant treatment was first

introduced in the 1970s, implant placement was not taken into consideration in patients with diabetes due to dental-related complications including vulnerab ility to infection and delayed wound healing. Unlike before, diabetes is regarded as relative contraindication depending on blood glucose levels. In this study, the survival rate was 100.0% in patients with well-controlled diabetics. Even though no statistically significant difference was observed, higher survival rate was exhibited compared to survival rates of 86-96%[15, 16] in previous studies.

Implant survival rate was reviewed according to the cause of tooth loss. Ellegaard et al.[17], suggested that the survival rate of implants was higher in periodontally healthy individuals compare to patients with periodontal disease, but no significance was detected in the results. In contrast, Karoussis et al.[18] stated significant difference. In this study, the leading cause of tooth loss before dental implant was periodontitis. The implant survival rate was lowest in this implant site at 90.1%.

Survival rate was examined by implant site. Through literature review, Schwartz et al.[12] reported that the lowest failure rate was shown in the mandible anterior area. Implant placement in the maxillary posterior area is anatomically limited by maxillary sinus or inferior alveolar nerve, more affected by chewing ability than the anterior area, and physically inferior due to a higher risk of poor crown-root ratio. In particular, the implant success rate in the maxillary posterior area is reported to be lower by 5-10% compare to other areas[19]. In the maxillary posterior area, vertical bone defects are commonly detected due to maxillary sinus pneumatization associated with alveolar, and most implants are place in bone quality type III or IV with a thin cortical bone layer and a low mineral content. Poor bone quality hampers the adequate distribution of stress by inducing initial stability and decreased bone to implant contact while the progression of osseointegration and occlusal loading. In this study, the lowest survival rate was shown in the maxillary anterior area at 50.0%. The outcome is thought to be attributable to the small number of population size.

In relation to fixture diameter, Langer et al.[20] proposed the use of a 5-mm diameter implant as an alternative measure when the primary stability of implant is not secured due to insufficient bone quantity and quality, osseointegration is failed, or standard implant is fractured. Larger-diameter implants have structural and mechanical advantages by enabling esthetic prosthesis and stress distribution[21]. Despite these advantages, Ivanoff et al.[22] reported a higher failure rate of larger-diameter implant, since large diameter implant could inhibit early osseointegration

due to lack of blood supply and delayed healing process. In this study, survival rate was low in implant diameter smaller than 4 mm, but no statistically significant difference was seen in survival rate by fixture diameter (P=0.502). Therefore, the appropriate diameter of implant needs to be chosen according to bone quality and quantity.

The effect of fixture length on implant survival rate still remains controversial. Friberg et al.[23] and Deporter et al.[24] reported that short fixture length had insignificant effect on implant failure, whereas Brocard et al.[25] and Lazzara et al.[26] found out a higher failure rate in short-length implants. Although failure was observed in implants longer than 10 mm in this research, survival rate displaced no statistically significant difference according to fixture length (P=0.873).

With respect to bone quality, Holahan et al.[14, 27] stated that reduction in general bone density and osteoporosis frequently detected in elderly patients were found to have no influence in implant survival, while bone quality determined by an operator had significant influence on implant survival rate. Thus, senescence is not a cause, but a risk factor of bone quantity reduction in osteoporosis, therefore bone quality needs to be discriminated from physiological aging. Bone quality on implant sites is crucial regardless of age. In this review, a low survival rate was seen in type III bone, in particular, at 75.0%. Implant failure in type III bone was the case of detached prosthesis due to rapid marginal bone loss and persistent inflammation after delivery of the prosthesis and this case was not well managed despite good bone quality at early implant placement. Statistically significant difference was found in survival rate according to bone quality (P=0.037).

Becktor et al.[28] and Fugazzotto[29] proposed that survival rate was insignificantly affected by bone graft or guided bone regeneration except for implants with early failure before loading. In this study, there were more cases of failures in implants with additional surgical procedures such as bone graft compare to simple implant placement. However, bone graft had no statistically significant difference in survival rate (P=0.406).

According to prosthesis type, Pjetursson et al.[30] reported that relative failure rate was high in the order of tooth-supported fixed dental prosthesis, implant-supported fixed dental prosthesis, and implant-supported single crowns. In this study, the cumulative survival rate of splinted implants was relatively higher than that of implant-supported single crowns and overdenture prosthesis. Survival rate showed statistically significant difference by prosthesis type (P=0.015).

Implant treatment in elderly patients has long been controversial. A large number of studies have investigated age as an

importance factor for predicting implant success rate. Salonen et al.[31] and Brocard et al.[25] proposed that implant success is determined by age in elderly patients because there are various soft tissue response, bone?resorption, and potential contraindication. Pikner et al.[32] reported that the amount of marginal peri-implant bone loss was greater in elderly patients. On the other hand, Bryant and Zarb[33] the amount of marginal bone loss was similar between young and elderly patients. Engfors et al.[34] also found insignificant difference in implant treatment between young and elderly patients, but suggested that the incidence of complications including peri-implant mucositis was statistically significantly higher in elderly patients due to poor oral hygiene. Furthermore, de Baat[4] proposed that age is no longer an important factor in implant treatment through literature review of studies on implant success. In addition, Al Jabbari et al.[35] analyzed various factors affecting implant success in elderly patients, and suggested that reduced oral hygiene with age is not a contraindication in implant treatment in elderly patients.

In this study, the 5-year implant cumulative survival rate was 94.9% in elderly patients, comparable to standard implant survival[36], and had statistically significant difference according to bone quality and prosthesis type.

Therefore, implant placement is a desirable treatment option for elderly patients to overcome disturbance caused by tooth loss and promote oral hygiene. The findings imply that bone quality and prosthesis type need to be carefully considered in elderly patients. However, this study was limited by a relatively small sample size and a small number of failures.

Ⅴ. Conclusion

This study involved 56 elderly patients who were aged 65 years or older and who underwent implant placement during study period. A total of 138 implants were inserted in those patients. Implant cumulative survival rate was analyzed according to host related factors including gender, age, systemic disease, cause of tooth loss and others and implant related factors including implant location, fixture diameter and length, bone quality, use of bone graft, prosthesis type and others. The results are as follow:

1) After a 5-year follow up, 5 cases were failed in implant placement and 63 cases were excluded due to missed periodic recall check-ups. The 5-year implant cumulative survival rate was 94.9%.

2) In relation to bone quality, survival rate was particularly lower in type III bone at 75.0%. Implant failure in type III bone was the case of detached prosthesis due to rapid marginal bone loss and persistent inflammation after delivery of the

prosthesis and this case was not well managed despite good bone quality at early implant placement. Statistically significant difference was found in survival rate according to bone quality (P=0.037).

3) With respect to prosthesis type, the cumulative survival rate of splinted implants was relatively higher. Statistically significant difference was observed in survival rate according to prosthesis type (P=0.015).

To sum up the above findings, the 5-year implant cumulative survival rate was 94.9% in elderly patients, demonstrating a similar survival rate for standard implants. The effects of potential risk, medical complication and psycho-social factor on implant prognosis need to be always taken into account by clinicians. Although some limitations remain, it appears that implant placement in edentulous area of elderly patients is predictable in long term and acceptable treatment. Additional studies need to be performed for further investigation.

Ⅵ. Acknowledgements

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