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Original Article

Correlations between implant success rate and personality types in the older people: A preliminary case control study

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Abstract *Background/ purpose:* Older patients inevitably have a higher need for implant treatment, it is unknown how mental changes or psychological aspects affect the outcome of implant treatment. This study evaluated the success rate of implants and the influence of personality traits in the older people. The goal was to provide evidence for predictable implant treatment while taking into account the unique psychological changes of elders.
Materials and methods: Participants were patients who were able to independently visit our hospital between March 2004 and May 2021. Inclusion criteria were patients aged 65 years or older at the time of implant placement with regular follow-up for at least 1 year. The implant success rate was calculated by counting peri-implantitis and implant loss as failures. Multivariate analysis was used to examine the effect of patient personality characteristics on the success rate.
Results: Fifty-six implants were included in 23 patients (12 men, 11 women), with a mean age of 68.5 years (65–76) and mean maintenance duration of 9 years and 2 months. The cumulative survival rate was 87% at the patient level (94.6% at the implant level). Statistically significant differences were found for adaptive traits (odds ratio [OR] = 0.04) and non-adaptive traits (OR = 6.38); however, no significant differences were found for the other independent variables.
Conclusion: The overall implant success rate was 69.6% at the patient level (82.1% at the implant level). The personality traits in older people had a significant effect on the implant failure rate.

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Introduction

Implant therapy is the most promising and effective rehabilitation method for the treatment of partially or completely edentulous patients.[1] The cumulative survival rate of implants exceeds 98%, and implants are recognized as a restorative treatment with high predictability and a favorable long-term prognosis when osseointegration is achieved.[2] In a recent survey, approximately 5% of the population in their 40s and older were treated with implants, with the largest percentage of 4.6% reported in the 60–65 year age group.[3] Previous studies and systematic reviews have shown that implant treatment in the older people can be successful if the patient's situation is carefully considered,[4–6] while others have shown that old age itself is a factor that increases the risk of failure.[7] Therefore, the evidence for implant success rate in relation to age is currently unclear. Furthermore, even though there are positive reports on implant treatment for the older people, these study designs vary in terms of age and observation period. Thus, it is difficult to obtain consistent evidence, and caution is still needed in applying these results to implant clinical practice in a super-aged society.

Evidence has been obtained for risk factors affecting implant treatment, such as history of periodontitis, lack of prophylaxis, and smoking habits.[8,9] However, systemic diseases in elders, which increase with aging, are expected to have some effect on the local immune response around implants;[10] therefore, clinical research targeted at older age groups is needed. Furthermore, in addition to physical changes, elders often experience a decline or alteration in mental functioning,[11] indicating that there is a close relationship between oral health and psychological status.[12–14] Although older patients inevitably have a higher need for prosthetic treatment, especially implant treatment,[15] it is unknown how mental changes or psychological aspects affect the outcome of implant treatment. Therefore, the aim of this descriptive statistical observational study was to examine the personality traits that underlie emotional and behavioral tendencies. This case series aimed not only to evaluate the cumulative implant success rate in the older people, but also to fill the evidence gap for performing predictable implant treatment while taking into account the psychological changes unique to elders.

Materials and methods

This study was approved by the Ethics Committee of Nihon University School of Dentistry (permission number EP16D013) and was conducted in accordance with the 1975 Declaration of Helsinki, revised in 2013. Moreover, this case control study was conducted in accordance with the guidelines for observational/descriptive studies enhanced reporting of observational studies in epidemiology.[16] The subjects of this study consisted of patients who were able to independently visit the Department of Dental Implantology, Nihon University Dental Hospital between March 2004 and May 2021. Patient information records were collected for treatments that were consistently administered. Written informed consent was obtained from all participants.

Inclusion criteria

All patients were diagnosed and had their treatment planned by a periodontist (K.S.). They received periodontal treatment, implant surgery, prosthetic procedures and maintenance. Inclusion criteria were as follows: (1) adults with implants placed in the department after 2004, (2) age 65 years or older at the time of implant placement, (3) able to visit the clinic independently, and (4) regular follow-up for at least 1 year after the delivery of prosthetic rehabilitation. The exclusion criteria were as follows: (1) contraindication for implant surgery, (2) prior radiation therapy in the head and neck region, (3) previous or current bisphosphonate therapy, and (4) implants that did not achieve osseointegration before function. This was because the purpose of this study was to observe the prognosis of functional implants in older people. Even if an implant was lost, in the case of the other implants were functioning in same patient, the analysis of remain implants was performed.

Surgical protocol for implant placement

A diagnostic template based on setup models was used at preoperative cone-beam CT (3D Accuitomo F17D, Morita, Kyoto, Japan) examination. All implant surgeries were performed in a two-stage procedure according to the manufacturer's recommendations, using either local anesthesia alone or a combined intravenous sedation approach. An incision was made on the alveolar crest and full-thickness flap was prepared. The following implants were placed within the bone crest: Replace Select™ (Nobel Biocare, Zürich, Switzerland), OsseoSpeed™ (Dentsply Sirona, Charlotte, NC, USA), Brånemark System® Mk III (Nobel Biocare, Zürich, Switzerland), OSSEOTITE® XP (Biomet, Inc., Warsaw, IN, USA), and Straumann® Bone Level (Straumann, Basel, Switzerland). Primary stability was achieved for all implants. The sites were closed with 5-0 sutures (MONOCRYL®5.0, Ethicon, Inc., Somerville, NJ, USA). For patients with insufficient supporting bone mass, simultaneous bone grafting (Bio-Oss®, Geistlich Pharma AG, Wolhusen, Switzerland) was performed at the time of implant placement. Secondary surgery was performed after an adequate healing period, with confirmed osseointegration during surgery. Drug therapy was selected carefully based on the personal general status, medical history, medication history and allergies for the older people. For each postoperative medication, oral antibiotics (cefuroxime axetil, amoxicillin hydrate) were used three times a day for 3 days after primary or secondary surgery to prevent infection. Diclofenac sodium and loxoprofen sodium hydrate were prescribed for analgesia. Sutures were removed 1 week after surgery, and oral hygiene instructions were provided.

Diagnosis of peri-implantitis and implant failure

After delivery of the prosthetic rehabilitation, maintenance treatment was performed mainly by professional mechanical tooth cleaning at intervals of 3–6 months according to the oral hygiene of each patient. During the follow-up

period, peri-implant diseases were monitored by probing of the peri-implant tissues and radiographic examination. The diagnostic criteria of periimplantitis were as follows: deepened implant probing depth and radiographic bone resorption compared with baseline, as well as (1) probing depth $\geq$ 6 mm, (2) suppuration and bleeding at the time of probing, and (3) bone resorption observed radiographically for $\geq$ 25% of the implant length.[17] Peri-implantitis was diagnosed when all of these conditions were met. Implants that were removed for any reason after placement surgery were recorded. In addition, only peri-implantitis was also recorded. Implant failure was defined to include these situations (periimplantitis, removal and dislocation) in this study. Medical records were referred to and dates were recorded for all failure cases. The success rate was estimated based on this failure rate while the survival rate was calculated based on removal only.

Data collection

Information on age at implant placement, site of implantation, observational duration (from the time of superstructure installation to the time of final follow-up, date of diagnosis of any implant failures), and number and date of visits after placement of the prosthesis was extracted from the medical records. In addition, information about sex, history of moderate or severe periodontitis prior to implant surgery,[18] smoking habits, bone grafts, peri-implantitis, and systemic diseases (malignant tumor, diabetes mellitus, hypertension, and osteoporosis) was extracted and expressed as binary variables. The systemic diseases considered are those found in many of the implant patients in the authors' previous cohort study (unpublished data). Information on the prosthetic method and the fixation method was also extracted and recorded.

Determining patient personality

The personalities of older patients were classified into five types based on the Reichard classification, which is commonly used in the field of nursing care and welfare.[19] Table 1 shows the types of personality. Mature type, rocking chair type, and defensive type are classified as adaptive traits, and extrapunitive type and intropunitive type are classified as non-adaptive traits. In this study, a written format such as a questionnaire or psychological testing were not used and this assessment was positioned as empirical research equivalent to observational research or interview research based on clinical or personal interviews. The evaluation was made subjectively by the same surgeon on the basis of communication with the patient during the implant treatment and follow-up, and the content of medical records written in a problem-oriented system (POS) format.[20] The present personality analysis of the patients was conducted according to the information collected at the initial visit and during follow-up. In cases in which the two evaluations differed, the information from the time of follow-up, when the patient was older, was given priority in the final decision.

Statistical analysis

All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R 2.13.0 (R Foundation for Statistical Computing, Vienna, Austria).[21] The rate of implant failure including peri-implantitis was calculated descriptively and the Kaplan–Meier analysis method and log-rank test were applied for analysis of the cumulative success rate. The implant level analysis was applied in order to examine the personality types for individual implant failure. A logistic regression model was used to measure the association between the predictor and outcome variables while controlling for confounders. A statistical analysis was performed with implant failure as the objective variable and adaptive traits, non-adaptive traits, sex (man: 1, woman: 0), average number of visits ($<$3.9: 1, $>$ 4.0: 0), smoking habit (yes: 1, no: 0), history of periodontitis (moderate or severe periodontitis: 1, mild periodontitis or gingivitis: 0), and bone graft (yes: 1, no: 0) as the explanatory variables. A level of 95% ($P < 0.05$) was considered statistically significant.

Table 1 Types of personalities for older people.

Adaptive traits	Mature type (Type 1)	No regrets about the past and has hope for the future. Actively participates in society even after retirement and takes an interest in various hobbies. Generous and highly satisfied with relationships.
	Rocking chair type (Type 2)	Accepts reality and has a passive attitude. Tends to rely on others to provide material and emotional support. Has no ambition for work, and is trying to live comfortably in their current situation of being retired.
	Defensive type (Type 3)	Tries to maintain the same level of activity as when they were younger. Does not acknowledge aging and takes a strong defensive stance. Believes that they can adapt by staying active forever after retirement.
Non-adaptive traits	Extrapunitive type (Type 4)	Expresses frustration with aging as an attack on others. Blames others for life's failures. Has no hobbies and is particularly anxious and fearful of death.
	Intropunitive type (Type 5)	Thinks that their life was a failure and has a self-doubting attitude. Is less motivated and more passive. Is isolated, with little interest in others. Death is interpreted as liberation from an unbearable existence and is not feared. Sometimes commits suicide.

Results

Description of patients and implants

The demographics of this case series study are summarized in Table 2. A total of 56 implants were included in 23 patients (12 men, 11 women). The mean age of the patients was 68.5 years (65–76 years), and the mean maintenance duration was 9 years and 2 months. During the study period, two patients died or became unable to visit the hospital due to dementia. The implants used were 8–13 mm in length and all had a rough surface structure: Replace Select™ (Nobel Biocare, Zürich, Switzerland; n = 20), OsseoSpeed™ (Dentsply Sirona, PA, USA; n = 6), Brånemark system® Mk III (Nobel Biocare; n = 10), Nobel Replace® Groovy (Nobel Biocare; n = 11), OSSEOTITE® XP (Biomet, Inc., IN, USA, n = 3) and Straumann® Bone Level (Straumann, Basel, Switzerland, n = 6). The TiUnite surface accounted for approximately 73.2% of the total. All the bone grafts at the implant sites were only minor grafts with a simultaneous approach; none used a staged approach. The most common implant superstructure was a single crown with side screw fixation. Only one patient was fitted with a bone anchored bridge. A total of 14 patients had systemic diseases (malignant tumor, diabetes mellitus, hypertension, and osteoporosis: single or complications). The average number of visits to the clinic after prosthetic treatment per year ranged widely from 2.4 to 11.3 times. This result reflected not only implant maintenance but also the need for treatment of other sites (Table 3).

Distribution of patient personalities

Although Type 1 was the most common personality among men patients, there was an almost even distribution from Type 1 to Type 5 among women (Fig. 1). By overall categories, 17 patients had adaptive traits and 6 patients had non-adaptive traits. Type 2 had the largest number of implants (23 implants) and Type 3 had the smallest number of implants (5 implants) (Table 4).

Table 2 Characteristics of participants.

	Total number (implants)
Patients	23 (56)
Women	11 (28)
Age at implant placement (year, mean ± SD, median)	68.5 ± 3.2, 67
Systemic disease	15 (38)
History of periodontitis	7 (24)
Smoking	4 (12)
Maxilla[a]/mandible[a]	16 (29)/14 (27)
Augmentation prior to implantation	10 (11)
Prosthesis[a]	
Single crown	15 (20)
Connecting crown	9 (18)
Fixed partial denture	3 (9)
Bone anchored bridge abutment	1 (9)
Abutment connection[a]	
Occlusal screw	3 (10)
Side screw	12 (33)
Cement retention	8 (13)
Mean maintenance duration (median)	9 y 2 m, 9 y

[a] Total patient number.

Implant success rate

When the failure rate of peri-implantitis and loss was combined, they overlapped in only one patient. In the final analysis, 30.4% (7 out of 23) failed at the patient level and 17.9% (10 out of 56) failed at the implant level (Table 4). Therefore, the cumulative success rate was 69.6% at the patient level and 82.1% at the implant level, and the survival rate was 87% at the patient level and 94.6% at the implant level. Excluding one implant that dropped out before functioning, the cumulative implant survival rate for the 55 functioning implants by personality category was examined, and no significant difference was found between the two personality groups (Fig. 2).

Risk factors for implant failure

Risk factors for implant failure were examined at the implant level by logistic regression analysis. The explanatory variables were adaptive traits (Types 1–3), non-adaptive traits (Types 4 and 5), sex, smoking habit, history of moderate or severe periodontitis, bone grafts, and average number of visits per year after superstructure placement. Statistically significant differences were found for adaptive traits (odds ratio [OR] = 0.04) and non-adaptive traits (OR = 6.38); however, no significant differences were found for the other independent variables (Table 5).

Discussion

Few reports in the field of dentistry have attempted to incorporate psychoimmunological factors into an etiological theory of dentistry based on psychological research.[22] There is limited research on the effects of mental changes in elders on dental treatment, especially implant treatment. One of the objectives of this study was to evaluate the implant survival rate in the older people. A previous study in the elders reported an implant survival rate of 99–100% in 47 patients over 79 years of age, but with a short observation period of 6 months.[6] Of the total Japanese population, 28.4% is over the age of 65, and this number is increasing every year.[23] Life expectancy is 80.50 years for men and 86.83 years for women, while the average healthy life expectancy is 71.28 years for men and 74.06 years for women. The healthy life expectancy is the average age at which a person can live a completely independent life, and in an aging society, it is important to extend the period of healthy life expectancy and shorten the period of illness.[24] The difference between life expectancy and healthy life expectancy is 9.22 years for men and 12.77 years for women, which can be regarded as the period during which nursing care will be required. During this period, home dental treatment is increasingly likely,

Table 3 Details of participants.

Patient	Age at implant placement (sex)	Characteristic type	Site	Implant	Failure	Systemic diseases	Number of visits per year after superstructure placement
1	67 (M)	1	16	OsseoSpeed ™	None	Malignant tumor	7.4
2	73 (M)	1	46	Branemark system® Mk III	Peri-implantitis	Diabetes mellitus	6.9
3	66 (M)	1	24	Replace Select ™	None	Hypertension	11.3
4	68 (M)	1	47	Straumann® Bone Level	None	Diabetes mellitus	5
5	70—71 (W)	3	25,44	Replace Select ™	None	Osteoporosis	7
6	65—66 (M)	2	13, 15, 17, 21, 23, 25, 35, 37, 44	Brånemark system® Mk III	Peri-implantitis (13)	Hypertension	3
7	66 (W)	1	25, 26	OsseoSpeed™	None	None	2.4
8	72 (M)	2	46, 47	Replace Select ™	None	None	3.5
9	70 (M)	3	45	OsseoSpeed™	None	Diabetes mellitus Hypertension	5.8
10	67 (W)	2	45, 46	Replace Select ™	None	Malignant tumor	5.9
11	73 (W)	2	15	Straumann® Bone Level	None	None	6.1
12	65—66 (M)	1	24, 35, 36	Replace Select ™	None	Diabetes mellitus	3
13	70—76 (M)	2	15, 16, 36, 46	Replace Select ™, OsseoSpeed ™	Peri-implantitis (15) Lost (16)	Malignant tumor Hypertension	7.5
14	71 (W)	1	36	Straumann® Bone Level	None	Hypertension	7
15	66—67 (W)	4	11, 12, 13	Replace Select ™	Lost (11)	Hypertension	3.2
16	71 (M)	3	35, 36	Replace Select ™, Straumann® Bone Level	Lost (36)	None	7.1
17	69 (W)	2	23, 25	Replace Select ™	Peri-implantitis (23)	None	4.8
18	66—68 (W)	3	27, 35	OsseoSpeed ™, Straumann® Bone Level	Peri-implantitis (35)	None	9.2
19	66 (W)	2	16, 35, 37, 44, 46	Replace Select ™	None	None	11.2
20	67 (M)	5	26	Replace Select ™	Peri-implantitis	None	5.1
21	74 (W)	2	16, 25, 26, 35, 36	Replace Select ™	None	None	4.6
22	66 (W)	4	16, 17	OSSEOTITE® XP	None	Hypertension	5.8
23	65 (M)	5	24	OSSEOTITE® XP	None	Hypertension	3

M, man; W, woman.

Figure 1 Clinical findings (Case 15, 76 years old, woman). a. After #11 failed, fixed partial denture (#12, #13) was refabricated. The peri-implant tissue shows findings of inflammation. Type of personality was extrapunitive type (Type 4). b. Superstructure with side screw type.

Table 4 Distribution of personality types and implant survival rate.

	Sex (M/W)	Implants
Adaptive traits		
Type 1	6/2	11
Type 2	3/3	23
Type 3	1/2	5
	10/7	39
Non-adaptive traits		
Type 4	1/2	8
Type 5	1/2	9
	2/4	17
Implant survival	Patient level	Implant level
Failure	7 (30.4%)	10 (17.9%)
Success rate	69.6%	82.1%
Survival rate	87.0%	94.6%

M, man; W, woman.

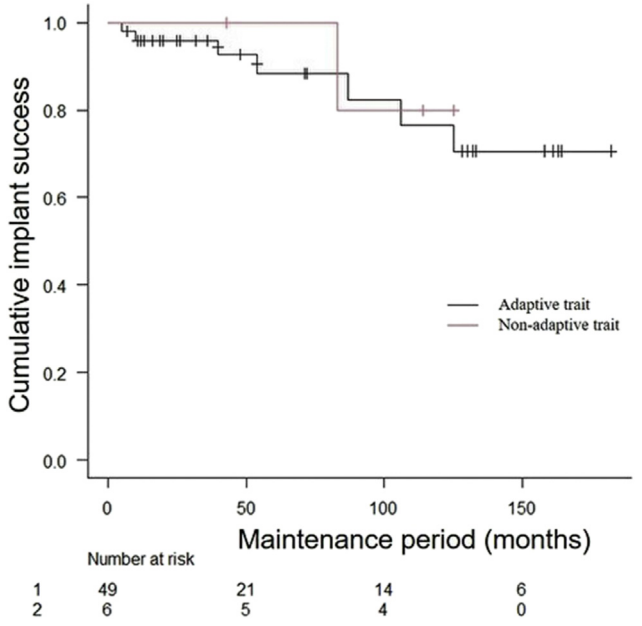

Figure 2 Kaplan–Meier survival curves for cumulative implant success according to patient personality type.

and treatment of older patients with implants may be more difficult.[25]

Peri-implantitis, a biological complication that significantly worsens the success rate of implant treatment, has a significant negative impact on the patient's oral health, financial burden, and quality of life.[26] In this study, smoking habit (OR: 0.32) and a history of moderate or severe periodontitis (OR: 1.13), which were considered as possible factors for the development of peri-implantitis,[9,27,28] were examined by logistic regression analysis, and no significant difference was found for either. Although this is in contrast with previous reports, this may reflect the results of more rigorous periodontal treatment. The prevalence of cerebrovascular disease, malignant neoplasms, hypertension, cardiovascular disease, and spondylolisthesis is high in people aged 65 years and older,[29] and there is a possibility of multiple comorbidities. Approximately half of the patients in this study also had some systemic diseases. Although the role of systemic diseases in the development and progression of peri-implantitis is still unclear,[30] it needs to be discussed from various perspectives and verified in the future. Simultaneous bone augmentation with implant placement was performed in 19.6% of all the sites (11 out of 56), and there was no statistically significant difference between cases with and without bone augmentation, although a high risk (OR: 3.46) was expected. Previous studies have shown that the failure rate of bone grafts increases in the older people, which is consistent with the results of this study.[10]

Individuals experience a variety of losses as they age, including the following: shifting from a life centered on social roles to a life of freedom, declining physical abilities, retirement from professional life, declining social status, declining economic power, and awareness of life expectancy. These changes are speculated to form personality traits unique to the older people.[31] In this study, we referred to the number of visits to the hospital as one of the indicators of social participation and treatment compliance. There was no statistically significant difference between high and low frequency of visits (OR = 1.11). It was unclear the difference between adaptive traits (OR = 0.04) and non-adaptive traits (OR = 6.38) may be failure risk, further research is required. Although pathological factors are the main causes of implant failure, patient personality traits such as neglect of adverse symptoms and lack of regular checkups may also delay the detection of symptoms. Personality in old age may be regarded as a result of previous lifestyle habits. Based on this hypothesis, a tendency might expect earlier detection of problems such as peri-implantitis in the adaptive trait and later detection in the non-adaptive trait. In the future, access to dental care is expected to change in the new normal social structure after the COVID-19 pandemic, and opportunities for treatment, especially for elders, may decrease. To achieve successful long-lasting implant treatment for the older people, it is necessary for dental professionals to understand the psychological aspects of older patients with personality traits, in addition to recognizing the importance of a mutual understanding approach from the family and society.

The strength of this rare study is that it highlights psychological aspects of the medical information about

Table 5 Risk indicators for implant failure according to logistic regression analysis.

Explanatory variable	Odds ratio	[95% CI]	P value	Significant difference
Adaptive traits (Types 1—3)	0.04	[0.004—0.463]	0.007	**
Non-adaptive traits (Types 4 and 5)	6.38	[1.000—40.500]	0.049	*
Sex (woman; 0, man; 1)	3.50	[0.501—24.400]	0.206	ns
Smoking habit (no; 0, yes; 1)	0.32	[0.0241—4.320]	0.393	ns
History of periodontitis (mild periodontitis or gingivitis; 0, moderate or severe periodontitis; 1)	1.13	[0.216—5.900]	0.886	ns
Bone graft (no; 0, yes; 1)	3.46	[0.684—17.500]	0.133	ns
Average number of visits per year (>4.0; 0, < 3.9; 1)	1.11	[0.183—6.770]	0.906	ns

CI, confidence interval; ns, not significant; *P < 0.05, **P < 0.01.

implant treatment for the older people. However, one limitation of this study is that the sample size was too small for a statistical comparison of the two groups, and it was limited to a case control study. The application of various psychoanalytic assessment methods is necessary to obtain more objective results and will be the subject of future research.

In conclusion, despite the limitations of a study design, we examined the risk factors for implant failure in the older people and evaluated their personality characteristics. The overall implant success rate was 69.6% at the patient level and 82.1% at the implant level. Among the older people, personality traits had a significant effect on the implant failure rate.

Declaration of competing interest

The authors declare no conflicts of interest relevant to this article.

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