REGULAR ARTICLE

Changes in mental health and quality of life with dental implants as evaluated by General Health Questionnaire (GHQ) and Health Utilities Index (HUI)

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Abstract

Objectives The purpose of this study was to assess and compare the improvement in oral and systemic conditions and health-related quality of life in patients with missing teeth receiving dental implants and conventional treatment.

Methods A total of 97 patients with missing teeth, of whom 59 received dental implants and 38 received conventional treatment, were included in this study. The patients were divided into two age groups for a more detailed analysis: a 30- to 59-year age group (young) and a >60-year age group (old). The changes in oral condition, mental health, and health utility level before and after (pre- and post-, respectively) the procedures were assessed using an original questionnaire, the General Health Questionnaire 12 (GHQ12), and Health Utilities Index Mark 3.

Results Responses to the GHQ12 indicated that treatment with implants significantly improved the oral health of patients in all treatment groups, except for the young group receiving partial dentures (PD). The mental state improved with a lower GHQ score; in terms of pre- versus post-procedure, mental state improved after the procedure in the young group receiving full dentures (FD) (1.75 ± 2.12 vs. 0.88 ± 2.10, $p < 0.05$), in the old group receiving PD (2.61 ± 3.91 vs. 0.72 ± 1.71, $p < 0.05$), and in the old group receiving FD (2.63 ± 3.12 vs. 0.44 ± 0.27, $p < 0.05$). The sleep score also improved by implant in FD of the old group (2.00 vs. 1.00, $p < 0.05$); it also is better with a lower score.

Conclusions Recovery of oral function and oral stability in middle-aged people who did not receive implants was possible with PD. However, the results suggest that implant treatment in edentulous denture cases and particularly in elderly people with dentures has a certain efficacy on the physical condition mediated through an improvement in aspects of the mental state.

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Introduction

In order to properly evaluate the outcome of a medical intervention, it is very important to measure the quality of life (QOL). More attention tends to be paid to the evaluation of medical interventions which are more often associated with life-threatening illnesses than with those that have primarily aesthetic and nutritional function. The use of a systemic evaluation index to assess the effects of dental treatment impacting on the improvement of life function, from a conventional viewpoint, of the elderly has been an uncommon practice. Missing teeth have traditionally been replaced with dentures or bridges. The first dental implant first successfully placed and reported by Brånemark in 1965 [1]. Since then, implant treatment has become increasingly applied for tooth replacement

worldwide. Titanium implants have the advantage of binding with bone (osseointegration) and are inserted directly into the bone at the site of tooth loss to serve as an artificial tooth root. The general condition of the patient and both the quantity and quality of bone at the implant site must be assessed before the procedure is undertaken. The ability or inability to ingest food orally has a large impact on the general health condition of an individual, both physically and mentally, especially in the elderly, who frequently have missing teeth. However, the systemic effects of dental treatment have not been adequately evaluated, and these effects are now considered to be significant as ways are being sought to improve the QOL of the elderly. Although improvements in QOL as a result of dental care or implant therapy have been reported [2–5], few scientific studies have used health utility to investigate the effect of oral health on the state of general health of dental patients.

Health-related QOL (HRQOL) measures can be used to assess the effectiveness and quality of medical care, and either disease-specific or generic instruments are used to measure HRQOL, depending on the specific aim of the study. Disease-specific instruments have been developed to evaluate the changes in each specific aspect of a disease, such as specific symptoms, treatment, and medical outcomes. Conversely, generic instruments are used for the quantitative evaluation of a wide range of health statuses, not only those related to disease but also those that give a sense of general health, such as physical functioning in daily life, mental health, social engagement, and social life functions of a patient. This enables generic instruments to be applied in local health surveys, and the results obtained can be compared across various realms of related treatments and conditions, or applied to a variety of diseases. Among the generic instruments used are the Health Utilities Index (HUI) [6], EuroQol (EQ 5D) [7], and MOS 6-Item Short-Form Health Survey (SF-6D) [8], and these are known to be useful in the calculation of quality-adjusted life years (QALYS) [9]. QALYs are outcomes that are necessary to perform cost utility analyses (CUA) [10]. HUI is an instrument for health utility measurement that was developed by G. Torrance and colleagues at McMaster University, Ontario, Canada. The Japanese version has been validated in several studies [11]. HUI assesses eight attributable aspects of QOL, producing one simple value of a multi-attribute utility score for use as an indicator of health status. It is based on the utility theory of von Neumann–Morgenstern [12, 13], with states of being that are worse than death indicated by negative utility values [14]. Scoring functions are based on a direct method of utility measurement, such as time-trade-off or standard gambling method. It contains a questionnaire that is simple to answer and is useful in studies with multiple subjects. This standardized simple questionnaire method has become popular in recent utility measurement studies [15].

Investigations of the validity and utility of these generic instruments have indicated that health utility and other studies of medical economics studies should be conducted in each country [16]. Uemura et al. [17] reported on the construct validity of the Japanese HUI3, while O'Brien [18], Luo et al. [19], and Naglie et al. [20] reported on the reliability of the HUI.

The General Health Questionnaire (GHQ) is one of the most common mental health tools in use. The GHQ is a measure of current mental health and has been extensively used in different settings and cultures since its development by D.P. Goldberg in the 1970s [21–25]. The questionnaire was originally developed as a 60-item instrument, but shortened versions, including the GHQ30, GHQ28, GHQ20, and GHQ12, are now available. Each item is rated on a four-point scale that indicates whether the respondent has recently experienced a particular symptom or behavior: less than usual, no more than usual, slightly more than usual, and much more than usual. For example, the GHQ12 gives a total score of 36 or 12 based on the scoring method selected. The most common scoring methods are bimodal (0-0-1-1) and Likert scoring style (0-1-2-3).

The aim of this study was to assess the improvement of oral and systemic conditions and HRQOL in patients with missing teeth who were treated by receiving dental implants or by more conventional treatments.

Materials and methods

Subjects

Sets of survey questionnaires were distributed to 140 patients who attended 11 dental clinics from April 2007 to March 2009. A total of 119 completed questionnaires were subsequently returned (response rate 85.0 %); 97 subjects were used as a comparative database for the 119 patients. The age of the subjects ranged from 20 to 80 years, and all individuals provided informed consent to participate in this study. Those patients under 30 years of age and maxillary cases were excluded because of an imbalance in the number of implant cases and conventional restorations. Analysis was performed on two age groups, with one group comprising patients aged between 30 and 59 years, and the other comprising patients aged >60 years. Due their older age, the latter group requested implants more often than patients in the younger age group ($p = 0.014$). A self-administered questionnaire was completed by the respondents before and after the dental procedure. The

post-procedure survey was conducted 3–6 months after the prosthodontic treatment and between 1 and 4 weeks after the superstructure of the implants or denture had been placed.

The dentists were certified implantologists, approved by the Deutschen Gesellschaft für Zahnärztliche Implantologie e.V. (DGZI; German Association of Dental Implantology, International Section). Cases requiring simple operations were selected; cases requiring complicated procedures, such as guided bone regeneration were excluded. Therefore, all implantologists were considered to have comparable skill levels in implant placement and the surgical procedure was standardized. All of the dentists performing the conventional procedures had more than 15 years of clinical experience and were therefore also considered to have comparable skill levels in terms of undertaking conventional treatments. The patients were classified into either an implant group (i.e., implant as an abutment for a bridge or as an abutment for dentures; $n = 59$) and a conventional treatment group [complete denture or removable partial denture (PD); $n = 38$], as per age group (Table 1).

The pre-procedure cases with a PD (the consecutive loss of one side of isolation edges in which more than two of the second molars from the second premolars are involved) and a full denture (FD; non-metal) were treated with implants or conventional dentures.

The treatment for conventional dentures was conducted with the aim of replacing an old denture with a new denture. The number of missing teeth did not change between the old and new dentures. Subjects were divided into four groups; PD for the 30- to 59-year age group (Young PD), FD for the 30- to 59-year age group (Young FD), partial denture for the >60-year age group (Old PD), and FD for the >60-year age group (Old FD).

In terms of the implants, the cases of PD were performed with a single standing implant or a bridge using implants. The cases of FD treated with implants were over denture (attachments). The subject's upper jaws were treated and prepared as normal occlusion.

Contents of the questionnaire

Original questionnaire on lifestyle and oral amenity

We asked the patients to complete the original questionnaires on daily living habits (lifestyle) and state of associated dental disease (Fig. 1). The questions were related to basic living habits, such as sleep, ability to concentrate, fatigue, and frequency of going out. They were rated on a scale of 1–4, with higher total scores indicating a tendency towards poor living habits. Lifestyle was evaluated from the total scores of living habits. Questions on oral comfort included pronunciation, esthetics, sense (foreign body sensation), and chewing ability (satisfaction of chewing and eating) and were rated on a scale of 1–4. A higher total score indicated a tendency for higher dissatisfaction.

The General Health Questionnaire 12

We used the 12-item version of the General Health Questionnaire (GHQ12) to measure the mental health condition of the patients (Table 2). The level of mental health in the previous month was determined from 12 questions. Positive items were collected from 0 (always) to 3 (never), and the negative items were collected from 3 (always) to 0 (never). The rating method on GHQ12 was 0–0–1–1, and the ratings were summed to a global score (range 0–12), with a higher score representing more psychiatric morbidity. According to the evaluation standards for level of mental health in the Japanese version of the GHQ written by Fukunishi, a score ≥3 represents a condition of mental illness [26, 27]. In this study, the total scores were directly analyzed.

The Health Utilities Index Mark 3

The HUI Mark 3 (HUI3) is the later version of the HUI Mark 2 and is based on quality of well-being (QWB). The utility scores are designed to be an interval scale, with death scored as 0 and complete good health scored as 1.0.

Table 1 Characteristics of subjects

Demographic/clinical characteristics	Implant	Conventional	Chi-square test
Male ($n = 33$)	19 (57.6)	14 (42.4)	$p = 0.67$
Female ($n = 64$)	40 (62.5)	24 (37.5)	
30–59 years old ($n = 51$)	25 (49.0)	26 (51.0)	$p = 0.014*$
Over 60 years old ($n = 46$)	34 (73.9)	12 (26.1)	
Full denture ($n = 36$)	24 (66.7)	12 (33.3)	$p = 0.40$
Partial denture ($n = 61$)	35 (57.4)	26 (42.6)	

Data are presented as the number (n) of patients, with the percentage given in parenthesis

* $p < 0.05$

Fig. 1 Questionnaire on lifestyle and oral amenity

These questions below are regarding your lifestyle in the past one month.
Please choose one of the four choices which most.applies to your condition.

1. **Can you sleep well?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

2. **Can you concentrate on things?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

3. **How is your fatigue?**
   1．none　　 2．small problem　　 3．some problem　 4．Very much

4. **How frequent are you going out?　（Include the work）**
   1．Approximately every day　　 2．3~4 time/a week　 3．1~2 time/a week　4．less time one /a week

5. **How about your easiness of pronunciation?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

6. **How about the satisfaction of the appearance of the tooth?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

7. **How about the sense (foreign body sensation) in the mouth?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

8. **How easy do you feel with your daily chewing ability?**
   1．very well　　 2．well　　 3．unsatisfactory　　 4．worst

Table 2 Items of the General Health Questionnaire (GHQ12)

1. Able to concentrate
2. Lost much sleep
3. Playing useful part
4. Capable of making decisions
5. Under stress
6. Could not overcome difficulties
7. Enjoy normal activities
8. Face up to problems
9. Feeling unhappy and depressed
10. Losing confidence
11. Thinking of oneself as worthless
12. Feeling reasonably happy

The HUI was used to measure health utility and determined eight attributable aspects using a profile approach to determine subordinate concepts that constituted QOL. The index is obtained by combining five or six levels prepared for each of the eight aspects (vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain), which are calculated from the 17-item questionnaire. The global score is obtained by combining five or six levels. A single score of each aspect is also obtained. Th HUI3 can be used to evaluate 972,000 health states [28] (Table 3).

Informed consent

Written and oral explanations of this study were distributed to patients in 11 clinics by hospital staff who performed implant and denture procedures and consent obtained. This study was approved by the Kyorin University Medical Ethics Committee (No. 231, April 16, 2007).

Statistical analysis

Statistical analysis was conducted using SPSS ver. 15.0 for Windows. The characteristics of subjects were analyzed by the chi-square test. Total scores in lifestyle, oral amenity, GHQ12 score, and HUI3 were analyzed by a paired t test. Scores of each item in lifestyle and oral amenity were analyzed by the Wilcoxon signed-rank test (Tables 4, 5, 6, 7).

Results

The characteristics of subjects in both groups at baseline were examined using the chi-square test to clarify statistical differences.

No significant differences were observed between males and females in the implant group and conventional group

Table 3 The Health Utilities Index Mark 3 (HUI3) health status classification system

Attribute	Level	Level description
Vision	1	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street without glasses or contact lenses
	2	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street, but with glasses
	3	Able to read ordinary newsprint with or without glasses but unable to recognize a friend on the other side of the street, even with glasses
	4	Able to recognize a friend on the other side of the street with or without glasses but unable to read ordinary newsprint, even with glasses
	5	Unable to read ordinary newsprint and unable to recognize a friend on the other side of the street, even with glasses
	6	Unable to see at all
Hearing	1	Able to hear what is said in a group conversation with at least three other people without a hearing aid
	2	Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but requires a hearing aid to hear what is said in a group conversation with at least three other people
	3	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid, and able to hear what is said in a group conversation with at least three other people with a hearing aid
	4	Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid
	5	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid
	6	Unable to hear at all
Speech	1	Able to be understood completely when speaking with strangers or friends
	2	Able to be understood partially when speaking with strangers but able to be understood completely when speaking with people who know the respondent well
	3	Able to be understood partially when speaking with strangers or people who know the respondent well
	4	Unable to be understood when speaking with strangers but able to be understood partially by people who know the respondent well
	5	Unable to be understood when speaking to other people (or unable to speak at all)
Ambulation	1	Able to walk around the neighborhood without difficulty, and without walking equipment
	2	Able to walk around the neighborhood with difficulty, but does not require walking equipment or the help of another person
	3	Able to walk around the neighborhood with walking equipment, but without the help of another person
	4	Able to walk only short distances with walking equipment, and requires a wheelchair to get around the neighborhood
	5	Unable to walk alone, even with walking equipment; able to walk short distances with the help of another person, and requires a wheelchair to get around the neighborhood
	6	Cannot walk at all
Dexterity	1	Full use of two hands and ten fingers
	2	Limitations in the use of hands or fingers, but does not require special tools or help of another person
	3	Limitations in the use of hands or fingers, is independent with use of special tools (does not require the help of another person)
	4	Limitations in the use of hands or fingers, requires the help of another person for some tasks (not independent even with use of special tools)
	5	Limitations in use of hands or fingers, requires the help of another person for most tasks (not independent even with use of special tools)
	6	Limitations in use of hands or fingers, requires the help of another person for all tasks (not independent even with use of special tools)
Emotion	1	Happy and interested in life
	2	Somewhat happy
	3	Somewhat unhappy
	4	Very unhappy
	5	So unhappy that life is not worthwhile

Table 3 continued

Attribute	Level	Level description
Cognition	1	Able to remember most things, think clearly, and solve day-to-day problems
	2	Able to remember most things, but has a little difficulty when trying to think and solve day-to-day problems
	3	Somewhat forgetful, but able to think clearly and solve day-to-day problems
	4	Somewhat forgetful, and have a little difficulty when trying to think or solve day-to-day problems
	5	Very forgetful, and have great difficulty when trying to think or solve day-to-day problems
	6	Unable to remember anything at all, and unable to think or solve day-to-day problems
Pain	1	Free of pain and discomfort
	2	Mild to moderate pain that prevents no activities
	3	Moderate pain that prevents a few activities
	4	Moderate to severe pain that prevents some activities
	5	Severe pain that prevents most activities

Table 4 Scores obtained for lifestyle, oral amenity, GHQ12, and utility scores in HUI3 in the partial denture group of the 30- to 59-year age group (Young PD)

Variables	Implant[a]			Conventional[b]		
	Before	After	Significance	Before	After	Significance
Lifestyle	6.29 ± 1.69	5.88 ± 1.76	ns	7.30 ± 2.08	7.25 ± 1.52	ns
Sleep	2.00	1.00	ns[c]	2.00	2.00	ns[c]
Concentration	2.00	2.00	ns[c]	2.00	2.00	ns[c]
Fatigue	2.00	2.00	ns[c]	2.00	2.00	ns[c]
Going out	1.00	1.00	ns[c]	1.00	1.00	ns[c]
Oral amenity	9.35 ± 3.97	7.12 ± 1.80	$p = 0.029$*	9.40 ± 3.84	7.40 ± 2.33	$p = 0.020$*
Pronunciation	1.00	1.00	ns[c]	1.50	1.00	ns[c]
Esthetic	2.00	1.00	$p = 0.020$*[c]	2.00	1.50	$p = 0.007$**[c]
Sense	1.00	1.00	ns[c]	2.00	1.00	$p = 0.047$*[c]
Chewing ability	1.00	1.00	ns[c]	2.00	1.00	$p = 0.036$*[c]
GHQ12	1.65 ± 1.58	0.65 ± 0.93	ns	2.55 ± 3.07	1.75 ± 3.28	ns
HUI global	0.77 ± 0.18	0.83 ± 0.15	ns	0.79 ± 0.13	0.80 ± 0.18	ns
Vision	0.98 ± 0.04	0.98 ± 0.04	ns	0.98 ± 0.02	0.98 ± 0.05	ns
Hearing	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Speech	0.99 ± 0.03	1.00 ± 0.00	ns	0.98 ± 0.05	0.99 ± 0.03	ns
Ambulation	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Dexterity	1.00 ± 0.01	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.11	ns
Emotion	0.97 ± 0.03	0.98 ± 0.03	ns	0.97 ± 0.37	0.97 ± 0.05	ns
Cognition	0.92 ± 0.13	0.94 ± 0.10	ns	0.93 ± 0.06	0.93 ± 0.93	ns
Pain	0.97 ± 0.04	0.97 ± 0.03	ns	0.98 ± 0.27	0.98 ± 0.03	ns

Data are presented as the median or as the arithmetic mean ± standard deviation (SD), as indicated

ns not significant

* $p < 0.05$, ** $p < 0.01$ for total scores of lifestyle, total of scores of amenity of tooth, GHQ12, and utility scores in HUI3 by paired *t* test

[a] Composition of group: 8 males, 9 females; median age ± SD: 50.09 ± 9.06 years

[b] Composition of group: 5 males, 5 females; median age ± SD: 45.78 ± 9.23 years

[c] * $p < 0.05$, ** $p < 0.01$ for scores of each item of lifestyle and each item of amenity of tooth by Wilcoxon signed-rank test

($p = 0.67$). However, significant differences were found between the two treatments when patients aged 30–59 years were compared with those aged >60 years ($p = 0.014$). No significant differences were observed in FD and PD among the two treatments ($p = 0.40$) (Table 1).

Table 5 Scores obtained for lifestyle, oral amenity, GHQ12, and utility scores in HUI3 in the full denture group of the 30- to 59-year age group (Young FD)

Variables	Implant[a]			Conventional[b]		
	Before	After	Significance	Before	After	Significance
Lifestyle	6.50 ± 1.85	5.75 ± 1.75	ns	6.17 ± 1.17	6.67 ± 2.88	ns
Sleep	1.50	1.00	ns[c]	1.00	1.50	ns[c]
Concentration	2.00	1.50	ns[c]	1.00	1.50	ns[c]
Fatigue	2.00	1.50	ns[c]	2.00	2.00	ns[c]
Going out	1.00	1.00	ns[c]	1.00	1.00	ns[c]
Oral amenity	8.38 ± 3.73	6.63 ± 1.77	ns	9.50 ± 4.23	8.00 ± 1.55	ns
Pronunciation	1.00	1.00	ns[c]	1.00	1.50	ns[c]
Esthetic	2.00	1.00	ns[c]	2.00	1.00	ns[c]
Sense	1.50	1.00	ns[c]	2.00	2.00	ns[c]
Chewing ability	1.50	1.00	ns[c]	2.50	2.00	ns[c]
GHQ12	1.75 ± 2.12	0.88 ± 2.10	$p = 0.041$*	1.17 ± 1.17	1.83 ± 2.79	ns
HUI global	0.80 ± 0.08	0.84 ± 0.10	ns	0.87 ± 0.07	0.78 ± 0.32	ns
Vision	0.98 ± 0.00	0.98 ± 0.00	ns	0.99 ± 0.01	0.99 ± 0.01	ns
Hearing	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Speech	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	0.98 ± 0.04	ns
Ambulation	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Dexterity	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Emotion	0.97 ± 0.03	0.96 ± 0.02	ns	0.96 ± 0.03	0.97 ± 0.03	ns
Cognition	0.95 ± 0.06	0.96 ± 0.06	ns	0.98 ± 0.03	0.91 ± 0.16	ns
Pain	0.95 ± 0.03	0.98 ± 0.02	ns	0.96 ± 0.04	0.96 ± 0.09	ns

Data are presented as the median or as the arithmetic mean ± SD, as indicated

* $p < 0.05$, ** $p < 0.01$ for total scores of lifestyle, total of scores of amenity of tooth, GHQ12, and utility scores in HUI3 by paired t test

[a] Composition of group: 2 males, 6 females; median age ± SD: 48.50 ± 6.61 years

[b] Composition of group: 3 males, 13 females; median age ± SD: 52.00 ± 7.04 years

[c] * $p < 0.05$, ** $p < 0.01$ for scores of each item of lifestyle and each item of amenity of tooth by Wilcoxon signed-rank test

Young PD group

In both the implant and conventional groups we observed significant improvements in the total score of oral amenity (pre- vs. post-procedure: implant 9.35 ± 3.97 vs. 7.12 ± 1.80, $p < 0.05$; conventional 9.40 ± 3.84 vs. 7.40 ± 2.33, $p < 0.05$). For each item of oral amenity, significant improvements were observed in esthetics (pre- vs. post-procedure: 2.00 vs. 1.00, $p < 0.05$) in the implant group and in esthetics (pre- vs. post-procedure: 2.00 vs. 1.50, $p < 0.01$) and sense (pre- vs. post-procedure: 2.00 vs. 1.00, $p < 0.05$) chewing ability (pre- vs. post-procedure: 2.00 vs. 1.00, $p < 0.05$) in the conventional group. No significant improvement in GHQ and HUI3 was observed (Table 4).

Young FD group

No significant changes were observed in HUI3 in the total score and score of each item of lifestyle and oral amenity. Significant improvements were observed in GHQ12 in the implant group (pre- vs. post-procedure: implant 1.75 ± 2.12 vs. 0.88 ± 2.10, $p < 0.05$) (Table 5).

Old PD group

Significant improvements were observed in GHQ12 in the implant group (pre- vs. post-procedure: implant 2.61 ± 3.91 vs. 0.72 ± 1.71, $p < 0.05$). In HUI, significant improvements were observed in the single score of pain in the implant group (pre- vs. post-procedure: 0.96 ± 0.03 vs. 0.98 ± 0.03, $p < 0.01$) and observed in the global score in conventional (pre- vs. post-procedure: 0.57 ± 0.26 vs. 0.80 ± 0.13, $p < 0.05$) (Table 6).

Old FD group

No significant changes were observed in the total score of lifestyle. However, significant improvements were observed in the score for sleep (pre- vs. post-procedure 2.00 vs. 1.00, $p < 0.05$) and total score for oral amenity (pre- vs. post-procedure: 9.13 ± 1.75 vs. 7.06 ± 1.84, $p < 0.01$), score

Table 6 Scores obtained for lifestyle, oral amenity, GHQ12, and utility scores in HUI3 in the partial denture group of the >60-year-old age group (Old PD)

Variables	Implant[a]			Conventional[b]		
	Before	After	Significance	Before	After	Significance
Lifestyle	6.56 ± 1.82	5.72 ± 1.45	ns	8.33 ± 0.36	7.00 ± 2.00	ns
Sleep	2.00	1.00	ns[c]	1.50	2.00	ns[c]
Concentration	1.00	1.00	ns[c]	2.00	1.50	ns[c]
Fatigue	2.00	2.00	ns[c]	2.50	2.00	ns[c]
Going out	1.50	1.00	ns[c]	2.00	1.50	ns[c]
Oral amenity	7.78 ± 3.25	6.56 ± 1.54	ns	12.50 ± 3.67	8.67 ± 2.07	ns
Pronunciation	1.00	1.00	ns[c]	3.00	1.50	ns[c]
Esthetic	1.50	1.00	ns[c]	2.50	1.50	ns[c]
Sense	1.00	1.00	ns[c]	3.00	1.50	ns[c]
Chewing ability	1.00	1.00	ns[c]	4.00	2.00	ns[c]
GHQ12	2.61 ± 3.91	0.72 ± 1.71	$p = 0.030^*$	4.83 ± 3.19	2.00 ± 2.28	ns
HUI global	0.82 ± 0.15	0.88 ± 0.62	ns	0.57 ± 0.26	0.80 ± 0.13	$p = 0.039^*$
Vision	0.98 ± 0.03	0.98 ± 0.03	ns	0.98 ± 0.00	0.98 ± 0.00	ns
Hearing	0.99 ± 0.03	0.99 ± 0.03	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Speech	0.99 ± 0.03	0.99 ± 0.04	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Ambulation	1.00 ± 0.02	0.99 ± 0.02	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Dexterity	1.00 ± 0.00	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 0.00	ns
Emotion	0.98 ± 0.03	0.97 ± 0.04	ns	0.94 ± 0.05	0.97 ± 0.03	ns
Cognition	0.94 ± 0.10	0.97 ± 0.04	ns	0.79 ± 0.16	0.91 ± 0.07	ns
Pain	0.96 ± 0.03	0.98 ± 0.03	$p = 0.002^{**}$	0.93 ± 0.09	0.99 ± 0.02	ns

Data are presented as the median or as the arithmetic mean ± SD, as indicated

* $p < 0.05$, ** $p < 0.01$ for total scores of lifestyle, total of scores of amenity of tooth, GHQ12, and utility scores in HUI3 by paired t test

[a] Composition of group: 8 males, 20 females; median age ± SD: 66.96 ± 5.81 years

[b] Composition of group: 4 males, 2 females; median age ± SD: 68.89 ± 6.74 years

[c] * $p < 0.05$, ** $p < 0.01$ for scores of each item of lifestyle and each item of amenity of tooth by Wilcoxon signed-rank test

for sense (pre- vs. post-procedure: 2.00 vs. 1.00, $p < 0.05$) and chewing ability (pre- vs. post-procedure: 2.00 vs. 1.00, $p < 0.05$) in the implant group. Significant improvements were observed in GHQ12 in the implant group (pre- vs. post-procedure: 2.63 ± 3.12 vs. 0.44 ± 0.27, $p < 0.05$) (Table 7).

Discussion

The subjects in the older age group requested implants more often than those in the younger age group. Although the cost of dental treatment is covered by health insurance in Japan, implant treatments are not covered. Thus, our observation that older patients more often requested implant treatment is likely based purely on economic reasons.

Our results suggest that aesthetics-related issues were improved both by implants and conventional treatment in the Young PD group and that this group expressed concern about the improvement in the appearance of their teeth.

Sense and chewing ability are significantly improved by conventional treatment. It follows, therefore, that the oral function and the stability of the missing mandible molar teeth of middle-aged patients can be recovered satisfactorily with PD. In addition, conventional treatments for elderly persons can contribute to an improvement in QOL, based on the improvement of HUI global score. These improvements were not seen with an implant treatment. One possible explanation has been proposed by Takenaka et al. [29], who reported that implants resulted in significantly more physical discomfort than the requested conventional dentures. Pain was significantly improved by implants in the Old PD group, possibly because the area of mucous membranes was freed from considerable stress by the loss of the denture base. Shimada et al. [3] reported that the function, presence/absence of pain, and level of satisfaction with oral health are related to general health and mental health and that these factors greatly affect QOL. We also believe that the improvement of pain after treatment by implants in Old PD is related to an improvement in the GHQ12 score at this time. Using the Oral Health Impact

Table 7 Scores obtained for lifestyle, oral amenity, GHQ12, and utility scores in HUI3 in the full denture group of the >60-year age group (Old FD)

Variables	Implant[a]			Conventional[b]		
	Before	After	Significance	Before	After	Significance
Lifestyle	7.94 ± 2.67	6.81 ± 1.28	ns	8.83 ± 2.56	7.17 ± 2.48	ns
Sleep	2.00	1.00	$p = 0.031$*[c]	2.00	1.50	ns[c]
Concentration	1.50	2.00	ns[c]	2.00	2.00	ns[c]
Fatigue	2.00	2.00	ns[c]	2.50	2.00	ns[c]
Going out	2.00	2.00	ns[c]	2.00	2.00	ns[c]
Oral amenity	9.13 ± 1.75	7.06 ± 1.84	$p = 0.002$**	11.83 ± 3.76	9.83 ± 1.17	ns
Pronunciation	2.00	1.00	ns[c]	3.00	2.00	ns[c]
Esthetic	2.00	1.50	ns[c]	3.50	2.00	ns[c]
Sense	2.00	1.00	$p = 0.033$*[c]	3.50	2.00	ns[c]
Chewing ability	2.00	1.00	$p = 0.010$*[c]	3.50	2.00	ns[c]
GHQ12	2.63 ± 3.12	0.44 ± 0.27	$p = 0.011$*	1.83 ± 1.94	0.50 ± 1.23	ns
HUI global	0.73 ± 0.26	0.84 ± 0.20	ns	0.64 ± 0.37	0.78 ± 0.21	ns
Vision	0.97 ± 0.04	0.98 ± 0.01	ns	0.97 ± 0.04	0.97 ± 0.04	ns
Hearing	0.97 ± 0.10	0.97 ± 0.10	ns	1.00 ± 0.00	1.00 ± 1.00	ns
Speech	0.99 ± 0.03	0.99 ± 0.03	ns	0.98 ± 0.05	0.99 ± 0.02	ns
Ambulation	0.99 ± 0.04	1.00 ± 0.02	ns	0.98 ± 0.06	0.98 ± 0.06	ns
Dexterity	1.00 ± 0.01	1.00 ± 0.00	ns	1.00 ± 0.00	1.00 ± 1.00	ns
Emotion	0.97 ± 0.05	0.98 ± 0.02	ns	0.95 ± 0.05	0.97 ± 0.03	ns
Cognition	0.91 ± 0.11	0.95 ± 0.06	ns	0.85 ± 0.19	0.93 ± 0.83	ns
Pain	0.96 ± 0.04	0.97 ± 0.33	ns	0.94 ± 0.09	0.99 ± 0.02	ns

Data are presented as the median or as the arithmetic mean ± SD, as indicated

* $p < 0.05$, ** $p < 0.01$ for total scores of lifestyle, total of scores of amenity of tooth, GHQ12, and utility scores in HUI3 by paired t test

[a] Composition of group: 1 males, 5 females; median age ± SD: 71.50 ± 5.95 years

[b] Composition of group: 2 males, 4 females; median age ± SD: 74.67 ± 7.10 years

[c] * $p < 0.05$, ** $p < 0.01$ for scores of each item of lifestyle and each item of amenity of tooth by Wilcoxon signed-rank test

Profile (OHIP-14) and GHQ12, Smith et al. estimated the mental health and QOL of patients treated with implants and observed decreased stress and improved QOL [4].

The improvement in aspects of mental health was seen more with implants than with dentures in both age groups. It is thought that this improvement was due to a decrease in the feeling of looseness in the dentures with the change from FD without anchors to FD with implant anchors. Suzuki et al. [5] surveyed QOL in oral impairment and oral satisfaction in full denture and in implant denture patients and reported that there was no difference in the QOL after the procedure and that treatment satisfaction was similar. However, satisfaction with the oral cavity and daily living was higher in the implant patients. Moreover, Heydecke et al. [30] reported that oral health QOL was improved with implants over dentures, along with a simultaneous improvement in HRQOL. In addition, as a result of the stability of the dentures provided by implant anchors, there was an improvement in the lifestyle of the elderly people in terms of sleep and oral global assessment.

The results of our study suggest that implants have a positive influence on a change in the mentality of people who still have some teeth and in elderly persons, with the exception of middle-aged persons still with some teeth. In this regard, Matsuoka et al. [31] reported that subjective happiness was high and a tendency towards dejection was low; therefore, the high intra-oral satisfaction and the number of surviving teeth is related to the physical balance and function in elderly persons. Naito et al. [32] reported that the maintenance of the oral cavity function contributes to physical QOL, as observed from their findings that the greater the number of residual teeth, the higher the physical QOL; as bite and tooth alignment worsen, physical QOL decreases and the degree of intraoral health will show a decline together with a decline in mental health. According to these reports it is thought that the number of remaining teeth is related to aging of the oral mucosa and the aging of the whole body in elderly persons and that mental health aspects were improved significantly in GHQ12 for elderly persons with residual teeth still in place.

One of the key issues of this survey is whether dental implants contribute to the improvement of QOL. Patient satisfaction is an important factor in dental treatment, as it is expected to contribute to an improved standard of living and a prolonged life-expectancy. The acceptability of the risk of medical intervention differs depending on individual patients, as choice of the preferred medical treatment also varies from patient to patient. Health service providers must properly consider the patient's preference during treatment planning in various clinical situations. In our study, significant differences in HUI3 were observed for the HUI global score and pain in the Old PD group. One explanation for this result is that dental treatment does not have a direct effect on vision and hearing. However, a few reports do state that oral condition may affect the eyes [33] or hearing [34], among other conditions. In our study we also used the HUI as an indicator of health status, but this index was originally used to calculate QALYs and CUA. These medical economic analyses are more useful for diseases with a poor prognosis, such as cerebrovascular disease, cancer and rheumatic disease. We considered measuring the health utility score as an important outcome assessment of implant treatment. Heydecke et al. [30] reported that patient satisfaction and cost effectiveness were acceptable in implant treatment rather than conventional treatment, although initial costs are more expensive in the former. These findings are meaningful to studies performed in Japan where although most dental treatments are covered by insurance, implants are excluded. Therefore, measurement of QOL using HUI3 will show the effects of treatment, and we believe this preliminary result suggests the effectiveness of dental therapy.

One of the limitations of this study is that due to the limited number of cases available, it was difficult to randomly assign two different treatments, while comparing every prosthesis of the implant, including differences between genders. Another limitation is the simplicity of the mental health condition test. The 12-item GHQ is a rather crude tool to measure the subtleties of mental health.

In conclusion, the recovery of oral function and the stability in middle-aged people treated without implants were possible with PD. However, the results suggest that implant treatment in middle-aged people in edentulous denture cases and in elderly people in partial and edentulous denture cases improves mental health and may exert a positive impact on QOL.

This is the first study to use both GHQ and HUI to evaluate changes in the oral condition before and after dental implant therapy from a systemic viewpoint. The sample size in this study was small, and it will be necessary to conduct further studies with a larger number of subjects involving more dentists to ascertain the validity of our findings and the efficacy of this new intervention. A greater number of health professionals are expected to focus increasing attention to dental implant therapy, which will improve not only oral function but also produce systemic effects.

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