

Satisfaction of patients with mandibular implant-supported overdentures using a generalized estimating equation model: A prospective study

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ABSTRACT

Aims: To assess the effect of history of conventional denture use, number of implants, age, gender, and time passed since delivery (1 and 3 months) on satisfaction of patients with mandibular implant-supported overdentures.

Materials and Methods: This prospective study was conducted on 54 eligible edentulous patients (48-74 years, 30 males and 24 females). After obtaining written informed consent and ethical approval, the patients filled out a questionnaire regarding their satisfaction with the overdenture. Data were analyzed by the generalized estimating equation (GEE) model at 5% level of significance.

Results: History of denture use ($P=0.232$) and number of implants ($P=0.609$) had no significant effect on the overall satisfaction of patients. The overall satisfaction was not significantly different between males and females ($P=0.415$). The effect of time passed since delivery and age on satisfaction level was significant, such that the overall percentage of satisfaction was higher at 3 months after delivery ($P<0.001$) and in older individuals ($P=0.040$).

Conclusion: The satisfaction level of patients with mandibular implant-supported overdentures depended on the time passed since delivery and age of patients; number of implants (2 or 3) and history of denture use had no significant effect on patient satisfaction with the overdenture.

KEYWORDS Implant-Supported Denture; Edentulous Jaw; Patient Satisfaction.

INTRODUCTION

Complete dentures have been the standard of care for patients with long-term edentulism (1). However, edentulous patients often experience problems with their mandibular complete dentures (2). Lack of stability and retention of mandibular denture, together with decreased chewing ability, are the main complaints of such patients (3). Therefore, the most widely used treatment plan is to place endosseous implants in the mandible to support an overdenture (3).

Implant-retained or implant-supported dentures have been shown to be more efficient than a complete denture in terms of quality of life, satisfaction rate of patients, mastication efficiency, speech, and nutritional status of patients (2, 4-6). They have higher retention and are more stable for use in edentulous patients (7). Implant-supported mandibular overdentures may be retained by a range of precision attachments on individual implants such as ball, locator or magnetic attachments, telescopic crowns, or a bar between implants (3).

The patient-reported outcome measures, such as oral health-related quality of life, have often been used as tools to assess the functional, social and psychological effects of oral conditions; whereas, evaluation of patient satisfaction allows for direct quantification of patients' opinion about different aspects of a given treatment (8). Several factors such as the anatomy, stability, and retention of dentures, chewing ability, speech, esthetics, psychological characteristics, and patient adaptation to denture may affect the clinical prediction of patient satisfaction with denture. Therefore, it is known as a complex concern (9). Pera et al. (10) showed that degree of satisfaction was not solely correlated with the masticatory and oral function. They concluded that satisfaction was a highly complex parameter influenced by a number of factors, not strictly related to the stomatognathic system. Hence, one of the most important elements in treatment planning for

edentulous patients is to take a detailed history by asking questions regarding the level of masticatory function and the impact of the existing dentures on the quality of life (11).

Siadat et al. (12) showed that by an increase in the number of dentures used before receiving an implant-supported overdenture, the patients became more dissatisfied with the function and comfort. They stated that it could be a hypothesis that having numerous dentures before the implant treatment might imply maladaptability of the patient or emotional problems, and additional research might be needed on this topic. Therefore, one of the factors that may affect the prediction of patient satisfaction with implant-retained overdenture may be the history of denture use; and one question may be that whether patients with a history of complete denture would better accept an overdenture treatment or not.

The number of implants used in mandibular implant-retained overdentures is another controversial topic. The majority of available studies were conducted on two or four implants (13-21). Studies on three-implant-supported-overdentures especially with stud attachments are limited (22-25). Also, studies comparing the patient satisfaction with two- and three-implant-supported overdentures are scarce (22, 25). Evidence shows that addition of the third implant with stud attachment at the midline to an implant-supported overdenture can decrease the rotational movement of overdenture without increasing the strain in the implant, abutment or mucosa (26).

Moreover, studies have reported controversial results regarding patient satisfaction based on age and gender (13, 27-29). Therefore, the purpose of this prospective study was to assess the effect of history of denture use, implant number (2 and 3), gender, age, and time passed since delivery on patient satisfaction with mandibular implant-retained overdentures.

MATERIALS AND METHODS

This prospective study evaluated 54 patients presenting to the Implant Department of School of Dentistry in 2019. Standard treatment planning according to the standard protocol was performed for all patients (30, 31). The patients were divided into two groups with and without a previous history of denture use. The inclusion criteria were requiring a complete conventional maxillary denture and a two- or three-implant-supported mandibular overdenture, absence of systemic diseases affecting the oral conditions, meeting the criteria of class I Prosthodontics Diagnostic Index (mandibular bone height > 21 mm, maxillary ridge morphology capable of withstanding vertical and horizontal loads, adequate attached gingiva, and class I maxillomandibular relationship), and absence of

medical conditions contraindicating implant surgery. Patients with a history of temporomandibular disorders, those with psychological disorders, and patients with a history of head and neck radiotherapy were excluded. To find the patients who met the eligibility criteria, clinical and radiographic examinations were performed by a prosthodontist and an oral and maxillofacial surgeon. The patients were informed about the study protocol and objectives, and signed informed consent forms. The age and gender of participants were also recorded. The study was approved by the medical ethics committee.

For the purpose of standardization of the treatment course as much as possible, necessary coordination was made with the specialists at the department to supervise the procedures. Accordingly, implants (Dentium Co, Seoul, Korea) were placed in the anterior mandible at the sites of lateral incisor-canine bilaterally for patients who required two-implant-supported mandibular overdentures. The third implant was placed at the midline. All patients underwent two-stage surgery, and after a 3-month healing period, the implants were exposed and the healing abutments were placed. In patients who had an old denture, soft liner was used during this period. Next, prosthetic treatment was performed according to the standard protocol (30, 31). The same prosthetic design, in terms of the metal suprastructure and use of ball attachments, was considered for all patients. Patients who could not receive dental implants at the abovementioned sites for any reason, and cases for whom the ball attachments could not be used were excluded.

In this study, a questionnaire with 13 items/questions was used to collect information regarding patient satisfaction (Table 1). The questionnaire was developed by 10 experts (periodontists, general dentists, radiologists, and maxillofacial surgeons) in Persian language and used after confirming its appropriate content validity ratio (CVR) and content validity index (CVI).

The CVR was calculated to assess the necessity of each question and was found to be 100% for all questions one by one. Thus, according to the Lawshe's table, all questions were suitable for assessment of patient satisfaction with the overdenture. In assessment of CVI, of 13 questions, 12 had a CVI > 90%, and only one question had a CVI of 80%. Thus, this question was slightly revised. The reliability of the questionnaire was assessed by the parallel-form reliability test. For this purpose, 13 questions of the questionnaire were arranged in two different forms in terms of order and sequence of questions, and were given to 6 patients. Accordingly, based on the test-retest reliability, the satisfaction scores obtained from the two forms were found to be almost the same with no significant difference. Thus, the test-retest reliability of the questionnaire was found to be >98%. The Cronbach's alpha was also calculated to be 0.898, which confirmed optimal internal consistency of the questionnaire for measurement of satisfaction.

Do you have problem pronouncing the words due to the use of denture?
Is your denture mobile when speaking?
Do you have difficulty opening your mouth when using denture?
Do you feel interference between your teeth when eating or speaking?
Have you experienced a change in sense of taste due to denture use?
Do you feel pain or discomfort in a certain point when using your denture?
Do you feel pain or discomfort in a certain point when eating by using your denture?
Do you feel food impaction under your denture?
Do you feel mouth fullness?
Does your denture easily become loose when eating?
Do you have problem in swallowing liquids?
Do you feel a change in your appearance when using your denture?
Do you feel that the fabricated denture is not what you expected?

TABLE 1. Questions of the questionnaire used for assessing patient satisfaction with mandibular implant-supported overdenture.

The patients responded to the questions of the questionnaire 1 and 3 months after prosthetic delivery via an interview. As mentioned earlier, there were 13 items/questions in the questionnaire. Each question had multiple answer choices and was scored as follows: never (4), sometimes (3), often (2) and always (1). Therefore, the total satisfaction score ranged from 0 to 52. A higher score indicated lower level of problems. The percentage of satisfaction was determined using the equation below:

$$\text{Satisfaction rate} = \frac{\text{Obtained score}}{52} \times 100$$

A generalized estimating equation (GEE) model was applied to analyze the data. This test was used to assess the differences between the two groups with and without a history of denture use by taking into account the time passed since delivery. Since the number of implants was different between the two groups, it was considered as a predictive variable to adjust its effect. Age, gender, and time passed since delivery were also considered as predictive variables. Score 1 indicated always and score 4 indicated never. To select the working correlation matrix structure, an autoregressive model was applied. The quasi likelihood under independence model criterion was used to select this correlation matrix structure. All statistical analyses were carried out by SPSS version 24 (SPSS, Inc, IBM Company, IBM Corporation, Chicago, Illinois) at 5% level of significance.

RESULTS

A total of 54 patients between 48 to 74 years (with a

mean age of 63.4 years) were evaluated in this study. Table 2 shows the demographic characteristics of the study population regarding age, gender, and number of implants in the two groups with and without a previous history of denture use.

For each question of the questionnaire, the effect of variables namely the study group (with/without a history of denture use), number of implants, gender, age, and time passed since delivery on the score was evaluated. Regarding the history of denture use, the difference in the scores of the second ($P=0.03$, $B=-0.176$), fifth ($P=0.013$, $B=-0.342$), tenth ($P<0.001$, $B=-0.410$) and thirteenth ($P<0.001$, $B=0.591$) questions was significant between the two groups. In other words, patients with no history of denture use had higher problems in the abovementioned items. The only exception was the unmet expectations from treatment, which was lower in patients with no previous history of denture use.

Comparison of the acquired satisfaction scores over time (1 and 3 months after delivery) revealed that the change in all question scores, except for question 11 ($P=0.075$), was significant. In all these items, patients reported an improved status over time, except for the unmet expectations from treatment, which increased with time.

The effect of implant number (2 or 3 implants) on the scores of questions 2 ($P=0.025$, $B=-0.181$), 8 ($P=0.004$, $B=-0.423$), 9 ($P=0.047$, $B=0.225$) and 10 ($P<0.001$, $B=-0.570$) was significant. In all these items, patients with three implants reported fewer complications, except for the question 9 (sense of mouth fullness), which was higher in patients with three implants.

Regarding the effect of age (>60 years and < 60 years), the scores of questions 7 ($P=0.035$, $B=0.007$) and 8 ($P=0.013$, $B=0.009$) were significantly higher in



Variable	Levels	No history of denture use n (%)	Positive history of denture use n (%)	Value*	p
Gender	Male	19 (63.3)	11 (36.7)	0.34	0.561
	Female	17 (70.8)	7 (29.2)		
Age (years)	Age <60	12 (70.6)	5 (29.4)	0.17	0.679
	Age >60	24 (64.9)	13 (35.1)		
Implants	Two implants	18 (50)	18 (50)	13.5	<0.001
	Three implants	18 (100)	0 (0)		

TABLE 2 Demographic information of patients.

* Pearson Chi-Square

Parameter	B	Std. Error	Hypothesis Test		
			Wald Chi-Square	df	Sig.
(Intercept)	48.626	2.3475	429.050	1	.000
Negative history of denture use	-1.634	1.3681	1.427	1	.232
Positive history of denture use	0 ^a	.	.	.	.
Two implants	-.728	1.4241	.261	1	.609
Three implants	0 ^a	.	.	.	.
Gender (male)	.905	1.1104	.664	1	.415
Gender (female)	0 ^a	.	.	.	.
Age	.062	.0303	4.222	1	.040
Time passed since delivery	3.508	.4413	63.174	1	.000

TABLE 3 GEE model of satisfaction percentage by taking into account the effect of independent variables such as group, number of implants, gender, age, and time passed since delivery.

patients > 60 years, which indicated fewer problems. No significant difference was noted in other items. With regard to the effect of gender, only the score of question 13 (P=0.041, B=-0.268) was significantly different between males and females, and male patients complained of food impaction more than females. The overall mean percentage of satisfaction in the groups without and with a history of denture use was 53.95±6.85 and 56.62±5.98 at 1 month and 62.23±3.56 and 61.11±3.06 at 3 months, respectively. Simultaneous assessment of the effect of independent variables using the GEE model revealed that only the effect of age and time passed since delivery was significant on patient satisfaction (P=0.040 and P<0.001, respectively), such that the overall percentage of satisfaction was higher at 3 months after delivery and in older patients. The effect of other variables was not significant (Table 3).

DISCUSSION

To meet patient satisfaction, dental clinicians need to focus on each patient's expectations and opinion regarding the use of denture, including the comfort level, esthetic appearance, function, and speech (32). Using a patient-based outcome not only shows what patients think about the treatment but also provides indications for clinical choices for treatment of different cases.33 Furthermore, a patient-oriented evaluation can predict the outcome of treatment, as it reveals the patients' opinion about the treatment (33). The final goal is to

achieve a standard protocol to fully satisfy edentulous patients and help them acquire a better understanding of the impact of edentulism on their quality of life (27). Several studies have assessed the patient satisfaction and complaints regarding mandibular overdentures, and most of them have assessed these parameters in long-term follow-ups from 6 months to a couple of years, reporting positive results (2, 13, 17). However, less attention has been paid to patient status in the first months following prosthesis delivery. Evidence shows that adaptation to a new denture occurs within 3 months (17). Thus, it is normal to witness improvement of results in this period. It seems that the first 3 months is more critical for acceptance of denture by patients, and dissatisfaction of patients with the denture during this time period may result in its rejection. Thus, knowledge about the problems encountered by patients during the early period after delivery and their prediction can greatly help in their management. Therefore, in this study, we assessed patient satisfaction at 1 and 3 months after prosthesis delivery. According to the results of this study, the patients had higher satisfaction at 3 months after delivery compared with 1 month. Of all the items evaluated, only the "unmet expectations" increased over time, which may be explained by the fact that as the patients tolerate the problems and hardship of treatment over time, their expectations from the treatment outcome increase. Knowledge of dental clinicians in this regard and effective communication with patients before starting the treatment can help prevent such problems and create realistic expectations

of treatment in patients (22).

Since complete edentulism is often observed in the elderly, use of implant-supported overdentures is common in old patients. Evidence shows that old patients are often incapable of optimal adaptation to changes, and adaptability can affect the quality of life (29, 34, 35). Nonetheless, according to the current results, the elderly (>60 years), comprising 68.52% of our study population, reported significantly higher overall satisfaction, which was in line with previous findings (13, 28, 35). The reason may be that older patients are satisfied with less-than-ideal oral health and have less unrealistic expectations than younger patients; whereas, younger patients are still involved with their occupational life and social encounters and have higher expectations from treatment (35).

The current results revealed no significant difference between males and females in the overall percentage of satisfaction, which was in agreement with previous studies (7, 12, 17, 22, 36, 37). In a study by Pan et al, (36) on patients with mandibular overdenture, no significant difference was noted between males and females in terms of comfort, speech, and esthetics. In a study by Siadat et al, (12) males had higher expectations with regard to comfort and were more satisfied with their appearance. However, the overall difference was not significant between males and females. These results were in contrast to the observations of Fernandez-Estevan et al, (28) who reported that males were more satisfied with their mandibular implant-supported overdenture.

In the present study, no significant difference was noted in the overall satisfaction of patients with and without a previous history of denture use. However, patients with a previous history of denture use reported superior results in questions regarding denture stability when eating, sense of taste, and food impaction. The reason may be the improved capabilities of these patients in coping with efficient use of denture in function. The only item that acquired a higher score (less problems) in patients with no history of denture use was the "unmet expectations". It may be explained by the fact that partially edentulous patients who require implant overdenture often have a poor dental status and severely impaired function. Thus, a suitable prosthesis would significantly improve their masticatory function, leading to their satisfaction and meeting their expectations; whereas, patients with a previous history of denture use already have a functional conventional denture and often expect an unrealistically great improvement by switching to an implant-supported overdenture. Two previous studies assessed the effect of number of dentures used prior to implant rehabilitation on patient satisfaction and reported controversial results. Jacobs et al. (38) showed that number of conventional dentures used by patients had no significant effect on their speech problems; whereas, Siadat et al. (12) discussed

that by an increase in the number of previous dentures used before implant rehabilitation, the dissatisfaction of patients with the function and comfort increased. The aforementioned two studies did not mention whether they included patients with no history of denture use or not. Several studies have assessed the required number of implants for a mandibular overdenture to achieve maximum patient satisfaction, reporting controversial results. The majority of such studies compared overdentures supported by two and four implants. Some studies recommended placing four implants in the mandible to increase retention and subsequently the patient satisfaction (13-15, 39-41). Some others, however, discussed that insertion of only two implants would suffice for mandibular overdentures (16-18, 42, 43). Nonetheless, limited information is available regarding overdentures supported by three implants; while, in many cases, placement of four implants may not be feasible due to financial restraints or surgical limitations. In such cases, placement of three implants may yield satisfactory results. This study revealed that number of implants (2 or 3 implants) had no significant effect on the overall satisfaction of patients, which was in contrast to the results of previous studies that reported a significant increase in patient satisfaction in case of placing three implants (22, 25). This difference may be due to the assessment of patient satisfaction at a sooner time after delivery in this study. The three-implant-supported overdenture group acquired significantly higher scores in only a few items; the most important of which, was less complains regarding mobility in function, that was in agreement with the results of Emami et al, (22) who reported that retention and stability of implant overdentures were significantly affected by the placement of the third implant. Moreover, it has been reported that the third implant placed in the anterior region prevents tissue intrusion in the anterior part of denture, and serves as an indirect retainer for a distal-extension removable partial denture (24, 26). One limitation of the present study was the lack of a control group which might decrease the generalizability of the results. Moreover, possibility of selection and response shift bias and confounding factors should be considered. Another limitation was relatively small sample size. However, it is comparable with other studies (19).

CONCLUSION

Considering the limitations of this study, it may be concluded that no significant difference exists in the satisfaction rate of patients with their mandibular implant-supported overdenture regarding the number of implants (2 or 3 implants), presence/absence of a history of conventional denture use, and gender. Nonetheless, the overall satisfaction rate significantly increased with time and also in older patients.

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Conflict of interest

None.

Ethics statement

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