Patient-reported outcomes for the immediate loading of mandibular overdentures supported by two implants soon after implant surgery

Yuriko Komagamine a, Manabu Kanazawa a*, Daisuke Sato b,c, Maiko Iwaki d, A. Miyayasu a, Shunsuke Minakuchi a

a Gerodontology and Oral Rehabilitation, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan
b Department of Implant Dentistry, School of Dentistry, Showa University, Tokyo, Japan
c Oral Implantology and Regenerative Dental Medicine, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan
d Oral Diagnosis and General Dentistry, University Hospital of Dentistry, Tokyo Medical and Dental University, Tokyo, Japan

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Abstract Background/purpose: No studies have comprehensively assessed short-term patient-reported outcomes after the provision of overdentures supported by two immediate implants. The purpose of this study was to evaluate short-term patient-reported outcomes for mandibular overdentures retained by ball attachments on two immediately loaded implants. Materials and methods: Nineteen participants with mandibular edentulism were provided with overdentures retained by ball attachments on two immediately loaded, unsplinted implants. The participants’ self-assessment of their dentures and oral health-related quality of life were evaluated with the 22-item Patient’s Denture Assessment (PDA), and the 19-item Japanese version of the Oral Health Impact Profile (OHIP-EDENT), respectively. Patient satisfaction was measured on a 100 mm visual analogue scale. Assessments were conducted at baseline, and at 1 and 6 months after implant surgery.

Results: There were significant increases in the PDA "Lower denture" (P = 0.009) at 1 month, as well as "Function" (P = 0.002) and "Lower denture" (P = 0.009) scores at 6 months. Patient satisfaction was also significantly increased at 1 month (P = 0.007) and 6 months (P ≤ 0.000). Significant decreases were observed in the OHIP-EDENT "Physical pain" (P = 0.046) score at 1 month, as well as the summary score (P = 0.033), "Functional limitation" (P = 0.020) and "Psychological discomfort" (P = 0.019) scores at 6 months.

* Corresponding author. Gerodontology and Oral Rehabilitation, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549, Japan. Fax: +81 3 5803 4645.
E-mail address: m.kanazawa.gerd@tmd.ac.jp (M. Kanazawa).

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Conclusion: The use of two immediately loaded implants for lower mandibular complete overdentures is associated with improvements in patient’s self-assessment of dentures, satisfaction, and oral health-related quality of life, up to 6 months after implant surgery.

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Introduction

Implant-supported overdentures are a well-established treatment modality with a confirmed long-term prognosis. Several studies have demonstrated successful clinical outcomes with the provision of implant overdentures using a one-stage surgical procedure and immediate loading protocol. This protocol requires that the prosthesis is attached on the day of implant placement, whereas in conventional loading the prosthesis is attached after 3–6 months of healing. The success of the one-stage surgical procedure and immediate loading protocol has been despite initial concerns related to detrimental micromotions, which may occur with the immediate loading of unsplinted implants, and impede the process of osseointegration. Indeed, the use of an immediate loading protocol in implant-supported overdenture treatment has some advantages, such as the reduced number of surgical procedures and time to restoration of function, as well as the elimination of the need to use unstable existing dentures during the healing period. While there has been a thorough evaluation of objectively-assessed clinical outcomes, such as implant survival rate, peri-implant bone loss, and masticatory performance, there has been a lack of studies which have assessed patient-reported outcomes for overdentures supported by two immediately loaded, unsplinted implants. Patient-reported outcomes are important metric for treatment success or failure, in addition to laboratory-based outcomes. The immediate loading protocol may have the potential to improve patient-reported outcomes, such as patient satisfaction and quality of life, by reducing the number of surgical procedures and eliminating the requirement for patients to continue wearing their existing unstable dentures during the healing period.

Patient satisfaction, as assessed by a 100-mm visual analogue scale (VAS), is a simple, valid, and widely used tool for evaluating patient-reported outcomes. The McGill Denture Satisfaction Instrument is used to evaluate patient satisfaction with regard to the ease of cleaning, ability to speak, comfort, esthetics, denture stability, chewing difficulty, general satisfaction, and oral condition. In a previous study assessing patient-centered outcomes following the provision of overdentures retained by locator attachments on two immediately loaded implants, all questionnaire items (with the exception of ease of cleaning and the ability to speak) were shown to be significantly improved after 2 weeks of loading. These improvements were maintained at the 1-month and 4-month follow-up assessments.

The other widely used evaluation tool for assessing patient-reported outcomes is the Oral Health Impact Profile (OHIP). This instrument has been translated into many languages, and various versions of the OHIP have been developed. The OHIP assesses the impact of oral conditions on quality of life using an estimation of the frequency of disruptions (e.g., due to dysfunction, discomfort, and disability) in daily activities. Similarly to patient satisfaction, a prior study reported significant improvements in OHIP scores following the provision of implant-supported overdentures retained by locator attachments at 2 weeks, 1 month, and 4 months.

The Patient’s Denture Assessment (PDA) is a questionnaire that was developed to assess the patients’ perception of the impacts of denture treatment. The PDA comprises 22 items which capture both positive and negative denture-related effects, and includes the following six subscales: “function,” “lower denture,” “upper denture,” “expectation,” “esthetics and speech,” and “importance.” Its validity and reliability have been confirmed by prior studies.

By allowing implant placement 3–6 months earlier than the conventional protocol, immediate loading may have a positive effect on patient-reported outcomes, especially short-term outcomes up to 6 months after implant placement. The PDA assesses the impact of denture treatment on patient perception, consciousness, and subjective feelings regarding dentures, whereas OHIP assesses the functional, social, and psychological effects of oral disease conditions associated with prosthetic treatment. A combination of several tools may lead to a more comprehensive evaluation of patient-reported outcomes with implant overdentures.

To date, no studies have comprehensively assessed short-term patient-reported outcomes by evaluating not only changes in patient satisfaction and oral health-related quality of life (OHRQoL) (using OHIP), but also patients’ perception of the impact of denture treatment (using PDA), after the provision of overdentures supported by two immediate implants retained by ball attachments. Therefore, the purpose of this study was to compare these patient-reported outcomes prior to the provision of implant-supported overdentures, and after 1 month and 6 months of loading. The null hypothesis was that there would be no differences in patient-reported outcomes at the follow-up assessments, compared to baseline.
Materials and methods

Study design and study population

This study used a prospective, pretest-posttest design. The study protocol was approved by the Ethical Review Committee of the Faculty of Dentistry, Tokyo Medical and Dental University (Registration No. 441), and released on the University Hospital Medical Information Network (UMIN) Center (UMIN-CTR Clinical Trial, Unique trial number: UMIN000032836). All subjects provided written informed consent prior to participation. All procedures performed in the study were in accordance with the ethical standards of the institutional and/or national research committee. Participants were recruited at the Prosthodontics clinic at Tokyo Medical and Dental University Hospital, Faculty of Dentistry, from 2009 to 2011. Participants had to meet the following inclusion criteria: (1) a completely edentulous mandible, with no restrictions on the status of the opposing maxillary dentition; (2) adequate bone volume in the anterior mandible for the placement of two implants with a minimum dimension of 4.0 × 10.0 mm; (3) no need for bone augmentation; (4) willingness to wait for a healing period of at least 4 months after extraction; (5) good oral hygiene; and (6) an adequate understanding of written and spoken Japanese. Exclusion criteria comprised: (1) an uncontrolled systemic disease, such as hypertension, cardiovascular disease and diabetes (hemoglobin A1c > 7.0%) that might compromise implant surgery; (2) a history of chemotherapy or radiography to the head and neck region; (3) a heavy smoking habit (over 20 cigarettes per day); (4) a history of bisphosphonate administration; (5) the presence of a concurrent infectious disease; (6) any problem of stomatognathic system.

Surgical procedure

The surgical and prosthetic procedures were conducted in accordance with a protocol described in a previous study.28 Panoramic radiographs were utilized for the preoperative clinical assessment of each mandible. All participants either received a new mandibular complete denture, or had their existing mandibular complete denture relined to improve their fit prior to implant placement. Computed tomography scans, preoperative planning, and fabrication of the computer-aided design and manufacturing template (Nobel Guide, Nobel Biocare, Gothenburg, Sweden) were performed prior to implant placement procedures. Two implants (Nobel Speedy Groovy RP 4 × 10–18 mm, Nobel Biocare) were inserted in the inter-foraminal area of each participant according to the manufacturer’s protocol for a flapless surgical procedure. All implants were placed by the same implantologist, who was associated with the Tokyo Medical and Dental University Hospital, Faculty of Dentistry.

Prosthodontic procedure

On the same day as implant insertion, two ball abutments (Nobel Biocare) were positioned and connected to each implant using a torque of at least 35 Ncm. This was followed by the intra-oral incorporation of the gold cap (Nobel Biocare) with autopolymerizing acrylic resin (Unifast Trad, GC, Tokyo, Japan) into the intaglio surface of the denture. The participants were instructed not to remove their denture during the first week, in order to minimize postoperative swelling, and to prevent the denture from being mal-adapted. Dentures were removed for cleaning and oral hygiene by the operator 1 week after surgery. The participants were subsequently instructed to remove their denture and brush the implants three times a day. The new implant-supported overdentures were fabricated 6 months after the operation. The same prosthodontist, who was associated with the Tokyo Medical and Dental University Hospital, Faculty of Dentistry, provided prosthetic treatment for all participants.

Postoperative antibiotics (750 mg amoxicillin per day) and analgesics (60 mg loxoprofen) were prescribed for 7 days. Participants were instructed to rinse with 0.2% benzethonium chloride solution three times per day for 2 weeks, and to start brushing the individual implant attachments 1 week after surgery. No food restrictions were required.

Outcomes

The outcomes described below were assessed in all participants before implant placement (baseline), and at 1 month and 6 months after implant placement. Outcomes were assessed by two dentists who were not involved in treatment provision.

PDA

The PDA comprises 22 questions covering the following six subscales: “function,” “lower denture,” “upper denture,” “expectation,” “esthetics and speech,” and “importance.”25–27 Table 1 shows the 22 questions of the PDA, which were translated from Japanese into English for this article. The reliability and validity of the Japanese version of the PDA have been confirmed.24 These properties are currently being evaluated for the English version. The response to each question was measured using a 100-mm VAS, which consisted of a horizontal 100-mm line anchored by words representing the worst situation at the extreme left of the scale, and words representing the best situation at the extreme right. All participants were instructed to complete the five subscale scores of the PDA, except “upper denture.” The five subscale scores were derived by summing the individual item scores corresponding to each subscale.

Patient satisfaction

Patients rated their general satisfaction with their dentures on a 100-mm VAS, which was anchored at the extreme left and right with the words “completely dissatisfied” and “completely satisfied,” respectively.

OHIP-edentulous (EDENT)

OHRQoL was measured using the Japanese version of OHIP-EDENT, which was derived from the original English language version.29 The Japanese version of OHIP-EDENT is composed of 19 items grouped under seven conceptual
subdomains: “functional limitation,” “physical pain,” “psychological discomfort,” “physical disability,” “psychological disability,” “social disability,” and “handicap.” The validity of this instrument has been previously confirmed (Table 2).

For each OHIP item, the subjects were asked how frequently they had experienced the event in the previous month. Responses were made on a scale of 0–4 (0 = never; 1 = hardly ever; 2 = occasionally; 3 = fairly often; 4 = very often). The OHIP-EDENT summary score (i.e., the sum of the scores for all 19 items) was subsequently calculated. The OHIP-EDENT summary score can range from 0 to 76, with higher scores indicating a greater degree of OHRQoL impairment.

Statistical analysis

Steel’s test was conducted to compare patient satisfaction, the summary and subdomain scores of the OHIP-EDENT, as well as the PDA subscale scores, between baseline and the follow-up assessments at 1 month and 6 months. All statistical analyses were performed using the statistical software JMP ver. 13 (SAS Institute). The level of statistical significance was set at $P < 0.05$.

Results

Of the 23 participants who provided informed consent, 19 (9 males and 10 females, mean age 69.8 years) were provided with two immediately loaded implants and an overdenture retained by ball attachments. In terms of the prosthetic status of the opposing maxillary arch, 12 participants had complete dentures and 6 had removable partial dentures. Among the removable partial denture wearers, the number of missing teeth was more than seven. One patient had a completely dentate maxillary arch.

A total of 19 participants were evaluated at the 1-month assessment, and 17 participants were evaluated at the 6-month assessment. Two participants were excluded at the 6-month assessment. One participant had removed the denture for a 48-h period; this was contrary to instructions not to remove their denture during the first week. As a result, the gingiva around the implants had swollen, and the denture could not be re-inserted into the correct position; gingival plastic surgery was subsequently performed. The second excluded participant was a smoker with diabetes in the past, and had lost a single implant. As both excluded participants did not request another implant operation, they were not subsequently provided with implant overdentures.

There was a significant increase in the “lower denture” subscale score ($P = 0.009$) of the PDA at 1 month compared to baseline. Both the “lower denture” ($P = 0.009$) and “function” subscale scores ($P = 0.002$) were significantly higher at 6 months compared to baseline (Table 3). Patient satisfaction was found to be significantly greater at both the 1-month ($P = 0.007$) and 6-month ($P < 0.001$) assessment points compared to baseline (Table 4).

In terms of OHRQoL, the “physical pain” subdomain score ($P = 0.046$) of the OHIP-EDENT was significantly lower at the 1-month evaluation compared to baseline. The OHIP-EDENT total score ($P = 0.033$), “functional limitation” subdomain score ($P = 0.020$), and “psychological discomfort” subdomain score ($P = 0.019$) were significantly lower at the 6-month evaluation compared to baseline (Table 5).

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Table 1 Questions included in the Patient’s Denture Assessment.

| Subscale        | Questionnaire items                                                                 |
|-----------------|-------------------------------------------------------------------------------------|
| Function        | Q1. How much pain do you feel? Q2. How easy is it to swallow foods and liquids? Q3. How pleasant is it to eat food? Q4. How tired does your jaw feel? |
| Esthetics and Speech | Q5. How concerned are you about being stared at by others? Q6. How difficult is it to engage in a conversation with others? Q7. How concerned are you about the appearance of your mouth? Q8. How often do your dentures click when chewing? |
| Lower denture   | Q9. How often are food particles stuck in your lower denture? Q10. How stable is your lower denture? Q11. How well does your lower denture fit your gums? Q12. How uncomfortable is your lower denture? |
| Expectation     | Q13. Do you think your new dentures will meet your expectations? Q14. Do you think that there will be any problems with your new dentures? Q15. Do you think your new dentures will suit you? |
| Upper denture   | Q16. How often are food particles stuck in your upper denture? Q17. How well does your upper denture fit your gums? Q18. How often does your upper denture fall off? |
| Importance      | Q19. Do you think your dentures are a part of your body? Q20. How important are your dentures to you? Q21. How easy is it to take care of your dentures? Q22. Do you feel at ease when wearing your dentures? |

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Discussion

This study assessed patient-reported outcomes 1 month and 6 months following the provision of overdentures supported by two immediately loaded implants. The null hypothesis was rejected, as there were significant improvements in patient satisfaction, and specific PDA subscale and OHIP-EDENT subdomain scores. Thus, the results suggested that the immediate loading of two unsplinted implants could provide sufficient stability and retention for a lower denture at 1 month after surgery, and that there was an improvement of patients’ general satisfaction after 1 month and 6 months. Functional limitation and psychological disability also showed subsequent improvement for at least 6 months after initial loading. These results emphasize the importance of evaluating short-term patient-reported outcomes during the early period after initial surgery and immediate loading.

Significant improvements in the “physical pain” subdomain of the OHIP-EDENT (which refers to painful aching, discomfort during eating, sore spots, and uncomfortable dentures) were observed 1 month after loading. This suggests that insertion of overdentures supported by two immediately loaded implants can alleviate pain caused by the instability of conventional mandibular complete dentures worn prior to implant surgery. However, “physical pain” scores at 6 months were not significantly different from baseline.

Table 2 Question items in the Oral Health Impact Profile.

| Subdomain                | Questionnaire items                                                                 |
|--------------------------|-------------------------------------------------------------------------------------|
| Functional limitation    | Q1. Have you had difficulty chewing any foods because of problems with your teeth, mouth or dentures?  
Q2. Have you had food catching in your teeth or dentures?  
Q3. Have you felt that your dentures have not been fitting properly? |
| Physical pain            | Q4. Have you had painful aching in your mouth?  
Q5. Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth or dentures?  
Q6. Have you had sore spots in your mouth?  
Q7. Have you felt dry in your mouth? |
| Psychological discomfort | Q8. Have you been worried by dental problems?  
Q9. Have you been self conscious because of problems with your teeth, mouth or dentures? |
| Physical disability      | Q10. Have you had to avoid eating some foods because of problems with your teeth, mouth or dentures?  
Q11. Have you been unable to eat well with your dentures because of problems with them?  
Q12. Have you had to interrupt meals because of problems with your teeth, mouth or dentures?  
Q13. Have you been upset because of problems with your teeth, mouth or dentures?  
Q14. Have you been a bit embarrassed because of problems with your teeth, mouth or dentures?  
Q15. Have you avoided going out because of problems with your teeth, mouth or dentures?  
Q16. Have you been less tolerant of your spouse or family because of problems with your teeth, mouth or dentures?  
Q17. Have you been a bit irritable with other people because of problems with your teeth, mouth or dentures?  
Q18. Have you been unable to enjoy other people’s company as much because of problems with your teeth, mouth or dentures?  
Q19. Have you felt that life in general was less satisfying because of problems with your teeth, mouth or dentures? |
| Social disability        | Q20. Have you avoided going out because of problems with your teeth, mouth or dentures?  
Q21. Have you been a bit irritable with other people because of problems with your teeth, mouth or dentures?  
Q22. Have you been upset because of problems with your teeth, mouth or dentures?  
Q23. Have you avoided going out because of problems with your teeth, mouth or dentures?  
Q24. Have you been less tolerant of your spouse or family because of problems with your teeth, mouth or dentures?  
Q25. Have you been a bit irritable with other people because of problems with your teeth, mouth or dentures?  
Q26. Have you been upset because of problems with your teeth, mouth or dentures? |

Table 3 Difference in PDA scores between baseline and the 1-month and 6-month evaluations.

| Subdomain       | Median [first quartile, third quartile] | 1 month (T1) | P-value Δ(T0–T1) | 6 months (T2) | P-value Δ(T0–T2) |
|-----------------|----------------------------------------|--------------|------------------|----------------|------------------|
| Function        | 297 [252, 352.5]                       | 360 [322.5, 370] | 0.083            | 380 [363, 384] | 0.002*           |
| Lower denture   | 225 [156.5, 280]                       | 305 [251.5, 351.5] | 0.009*           | 296 [260, 370] | 0.009*           |
| Expectation     | 273 [249, 283]                        | 281 [265, 294] | 0.398            | 285 [266, 294] | 0.462            |
| Esthetics and speech | 240 [183.5, 354.5] | 368 [257.5, 382] | 0.164            | 354 [305, 384] | 0.111            |
| Importance      | 340 [306.5, 371.5]                    | 360 [345.5, 375] | 0.229            | 373 [334, 386] | 0.159            |

*P-value < 0.05.
PDA, Patients’ Denture Assessment.
significantly different from those observed at baseline. This may reflect the need for denture adjustments after insertion of immediately loaded implant-supported overdentures, as for conventional removable prostheses. Notably, a previous study reported that post-operative pain, experienced within 72 h of implant surgery, masked any functional improvements gained by increased denture stability. Therefore, while the immediate loading protocol may be of benefit for the avoidance of pain caused by denture instability in the short-term, this may not be apparent in the first few days after implant loading. Improvements in OHQoL within the first month of immediately loaded implant-supported overdenture delivery may be most evident after the initial healing period, and any subsequent improvements will require continual long-term maintenance and denture adjustment.

At 6 months after initial loading, significant improvements were observed in the total OHIP-EDENT score, as well as the "function limitation" subdomain score (which referred to chewing difficulties, food entrapment, and ill-fitting dentures), and the "psychological discomfort" subdomain score (which referred to being worried, upset, embarrassed, and self-conscious of denture problems). However, a previous study evaluating implant-supported overdentures retained by locators, 2 weeks after implant surgery, reported significant improvements in both OHIP-20 total scores and all subdomain scores. OHIP detects psychological and behavioral impacts, which are severe and relatively less common. The observation of comparatively fewer improvements in the present study may have been attributed to the provision of new conventional dentures before implant surgery. This may have resulted in less severe denture-related functional and psychological problems documented at baseline. In contrast, the baseline scores in the previous study reflected more severe functional and psychological issues related to the patients’ old dentures. Thus, the results of the present study demonstrated the additional improvements in OHQoL (i.e., "physical pain" at 1 month, and both "functional limitation" and "psychological discomfort" at 6 months after initial loading) obtained with immediate loading of an overdenture supported by two implants, above and beyond that of providing a new conventional complete denture.

In the PDA, the "lower denture" subscale score showed significant improvement at both the 1- and 6-month assessments, this likely being due to the improved retention and stability of the implant-supported denture compared to the conventional denture. Loss of retention and stability with mandibular complete dentures also causes discomfort and functional limitation, thus negatively impacting OHQoL. Indeed, a prior study identified the "lower denture" subscale score as the most significant independent predictor among the six subscales of the PDA, for positive change in total OHIP-EDENT scores 2 months after the insertion of new conventional complete dentures. It was thus suggested that increasing retention and stability of mandibular dentures is the most important concern for edentulous individuals. On the other hand, the "function" subscale scores of the PDA (which assess perceptions regarding functional problems related to dentures such as eating, swallowing, pain, and fatigue) only showed significant improvements at the 6-month evaluation. This improvement may correspond with that of the "functional limitation" subdomain of the OHIP-EDENT at 6 months after initial loading.

Patient satisfaction significantly improved at the 1- and 6-month follow-up assessments, which was in agreement with the results of a prior study assessing patients’ general satisfaction with immediately loaded implant-supported overdentures retained by locator attachments using the

| Table 4 | Difference in patient satisfaction between baseline and the 1-month and 6-month evaluations. |
|---------|--------------------------------------------------------------------------------------------------|
|         | Median [first quartile, third quartile] | 1 month (T1) | P-value Δ(T0–T1) | 6 month (T2) | P-value Δ(T0–T2) |
| Patient satisfaction | 60 [50, 90] | 90 [80, 94] | 0.007* | 93 [90, 99] | 0.000* |
| *P-value < 0.05. |

| Table 5 | Difference in OHIP-EDENT-J scores between baseline and the 1-month and 6-month evaluations. |
|---------|--------------------------------------------------------------------------------------------------|
|         | Median [first quartile, third quartile] | 1 month (T1) | P-value Δ(T0–T1) | 6 months (T2) | P-value Δ(T0–T2) |
| Total score | 25 [16.5, 30] | 15 [11, 20] | 0.054 | 16 [15, 22] | 0.033* |
| Functional limitation | 6 [5, 7] | 4 [3.5, 6] | 0.117 | 4 [3, 5] | 0.020* |
| Physical pain | 5 [3, 6.5] | 3 [2, 4] | 0.046* | 4 [3, 5] | 0.334 |
| Psychologic discomfort | 3 [2.5, 4] | 2 [1, 3] | 0.056 | 2 [1, 2] | 0.019* |
| Physical disability | 4 [3, 6] | 3 [2.5, 4] | 0.263 | 3 [3, 4] | 0.191 |
| Psychologic disability | 2 [0.5, 2] | 1 [0, 2] | 0.150 | 1 [0, 2] | 0.207 |
| Social disability | 2 [0, 3] | 0 [0, 3] | 0.477 | 1 [0, 3] | 0.679 |
| Handicap | 2 [0, 2] | 0 [0, 2] | 0.276 | 0 [0, 2] | 0.566 |
| *P-value < 0.05. |

OHIP-EDENT-J, Japanese version of the Oral Health Impact Profile.
McGill denture satisfaction questionnaire. In that study, Menassa et al.\textsuperscript{13} reported significant improvements in satisfaction 2 weeks after immediate loading, which remained stable for 4 months.\textsuperscript{13}

Some limitations are acknowledged in the present study. Since participants were provided newly fabricated complete dentures, or had their existing mandibular complete dentures relined prior to implant surgery, the majority of them may not have perceived any remaining denture-related problems that they had as severe. In addition, the sample size was small, and no comparisons were made with a control group due to the use of a pre-post intervention study design. Furthermore, the inclusion criteria in this study did not place restrictions on the prosthesis status of the maxillary arch; while 9 of the participants wore maxillary complete dentures, 8 participants had maxillary bilateral removable partial dentures with more than 7 artificial teeth. Nevertheless, a previous study has reported the lack of differences in OHIP-49 total and subdomain scores, between complete denture wearers and removable partial denture wearers.\textsuperscript{32} One of the excluded participants during the follow-up period had a smoking habit and diabetes in the past. In the exclusion criteria of the present study, the criteria for the heavy smoking habit was over 20 cigarettes per day and the criteria for the uncontrolled diabetes was hemoglobin A1c > 7.0%. Although the participant did meet the criteria for neither the heavy smoking habit nor the uncontrolled diabetes at the screening, he had a smoking habit and previous diabetes. Therefore, those who had a smoking habit and diabetes in the past should have excluded at the screening.

Future studies should consider a randomized controlled study design with a larger sample size. Furthermore, as all participants in the present study were recruited at a single university hospital setting, the results may not be generalizable to other settings and patient groups, and need to be interpreted with caution.

The use of two immediately loaded implants for the support and retention of lower mandibular complete overdentures was associated with improvements in satisfaction and patient-perceived denture stability, as well as alleviated denture-related pain, 1 month after initial loading. Subsequent improvements in functional limitation and psychological disability were also observed at 6 months.

Declaration of competing interest

The authors do not have any financial interest in the companies whose materials are included in this article.

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