An 8- to 10-Year Follow-up of Denture Satisfaction and Oral Health–Related Quality of Life with Implant-Retained Mandibular Overdentures

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Purpose: To report changes in denture satisfaction and oral health–related quality of life (OHRQoL) in edentulous patients treated with two-implant mandibular overdentures (IODs) over a follow-up of 8 to 10 years. Materials and Methods: This is a follow-up of a previous study carried out between 1997 and 2005. The patients were originally randomly divided into one group receiving IODs and another group who had their conventional mandibular dentures relined (RCD group). The RCD group was offered and received IODs at the 2-year follow-up. The participants completed a self-administered questionnaire containing demographics, 15 variables related to denture satisfaction, and 20 questions from the Oral Health Impact Profile (OHIP-20). Changes over time were analyzed using multilevel linear models for denture satisfaction and multilevel ordinal regression analyses for OHIP-20 variables. Comparisons between groups were analyzed using Mann-Whitney U test for ordinal data and t test for metric data. Results: Disregarding patients who passed away during follow-up, the 29 responders represented a response rate of 76%. The degree of denture satisfaction and the OHIP-20 scores remained high and stable in the IOD group over the 10-year observation period for all but one variable. The same factors showed only a modest improvement in the RCD group for the first 2 years; however, during the subsequent 8 years of the observation period (after receiving IODs), denture satisfaction and OHIP-20 scores improved to the same level as the original IOD group. Conclusion: The positive effect on denture satisfaction and OHRQoL of edentulous patients treated with two-implant mandibular overdentures remained unchanged 8 to 10 years after treatment. Int J Prosthodont 2021;34:317–323. doi: 10.11607/ijp.7521

Patients who are affected by the loss of all teeth face disabilities that must be adequately addressed. Edentulism limits some vital functions, such as speaking and eating,1 and may reduce subjective oral health and quality of life.2 These aspects are commonly assessed with the patients’ degree of satisfaction with their dentures and their oral health–related quality of life (OHRQoL). The former is often composed of global and specific questions related to satisfaction with dentures; the latter is a multidimensional concept that focuses on how the well-being of individuals is affected by oral problems.3

Mandibular overdentures retained by two osseointegrated implants (ie, implant-supported overdentures [IODs]) overcome several of the limitations associated with conventional complete dentures and are shown to improve OHRQoL of edentulous patients.4–7 Conventional complete mandibular dentures and IODs have been compared in a number of studies, and the findings indicate the superiority of IODs in terms of OHRQoL.1,8–10 Based on such results, the McGill Consensus Statement and later the York Consensus Statement concluded that the standard treatment for the edentulous mandible should be an IOD.11,12 However, it should be noted that the insertion of new conventional dentures also tends to improve both OHRQoL and patient satisfaction,13

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albeit to a lesser extent than IODs. The insertion of dental implants to support a mandibular overdenture is regarded as a safe and predictable treatment. Mostly short-term studies (between 2 and 5 years) on IODs have been published. A few longer-term studies have also been published (between 9 and 20 years). To the best of the present authors’ knowledge, only two such long-term studies report OHRQoL and/or denture satisfaction with IODs, which are the focus of the present study. Both studies found that the participants were satisfied with such aspects at all times of recording; however, different methods of measuring OHRQoL and denture satisfaction were used, making comparison of the results challenging. Some uncertainty therefore remains regarding long-term results. As the number of elderly individuals with IODs is rapidly increasing, this question becomes ever more important, and the evidence needs to be corroborated.

In a previous study, patient-reported outcome measures (PROMs) of OHRQoL and denture satisfaction at baseline, 3 months, and 2 years were published. This paper presents the 10-year PROMs of the same measures and patients, thus expanding the knowledge on the subjective long-term clinical outcome of IODs. The working hypothesis was that these measures remain unchanged over the study period.

**MATERIALS AND METHODS**

**Study Design and Sample**

The present study is a follow-up of a previous study carried out in the time period of 1997 to 2005 by Gjengedal et al. Its participants originally consisted of 54 edentulous patients with complete dentures of satisfactory technical quality who were nevertheless dissatisfied with their mandibular denture. The patient sample was randomly allocated into two groups. One group (n = 28) had their existing mandibular denture converted into IODs, and the other group (n = 26) had their conventional mandibular denture relined (RCD). After 2 years, the RCD group was offered the IOD treatment modality, which all participants in the RCD group accepted.

The surviving original participants received a letter in 2017 inviting them to take part in the present follow-up study. The letter contained information about the study, a form with informed consent to be signed if they wished to participate, and a questionnaire. Participants who did not respond to the letter were telephoned, and information was obtained verbally.

The previous study reported findings of OHRQoL and denture satisfaction at baseline, 3 months, and 2 years. This study reports the 10-year trends and status of the same outcome variables.

**Questionnaire**

The questionnaire contained demographic items and 15 aspects of patient opinion of dentures. These included global assessments of patient satisfaction with maxillary and mandibular dentures considered together and with the maxillary and mandibular dentures separately. The questionnaire also included specific aspects associated with wearing dentures: comfort, retention, fit, occurrence of soreness or pain, esthetics (of both maxillary and mandibular dentures), and chewing, which were all registered on a 4-point Likert scale. The categories ranged from very satisfied to dissatisfied. In the case of occurrence of soreness or pain, they included no soreness or pain, little soreness or pain, some soreness or pain, and much soreness or pain. A 3-point Likert scale was used for the variable of speech (no problems, some problems, major problems). The above items are the same as those used in the previous study by Gjengedal et al.

In addition, the questionnaire included 20 items on the Oral Health Impact Profile (OHIP-20), which is designed to assess edentulous patients’ OHRQoL. The OHIP-20 questions are grouped into seven domains.

**Ethics Approval and Consent to Participate**

This study was approved by the Norwegian Committee for Medical Research Ethics in Norway, Health Region West (2017/618), on May 16, 2017.

**Statistical Analyses**

Statistical analyses were performed with SPSS version 25 (IBM) and Stata version 15. Standard descriptive statistics were calculated for all variables. Changes over time (at 3 months, 2 years, and 10 years) for the IOD and the RCD groups regarding denture satisfaction were separately analyzed using multilevel ordinal regression analyses, taking the repeated measures for an individual over time into account. Changes in the OHIP-20 scores over the same time periods and groups were correspondingly analyzed using multilevel linear models. Comparisons were made between the RCD and IOD groups at 10 years, as well as between dropouts and remaining patients at baseline, with regard to denture satisfaction and the OHIP-variables using independent samples Mann-Whitney U test and independent samples t test, respectively. When multiple comparisons were made, Scheffe’s method was used for post hoc analyses based on the corresponding multilevel regression analysis.
RESULTS

Sample
At the 10-year follow-up, 16 of the 54 patients who participated in the original project had passed. Of the 38 remaining patients, 29 responded, for a response rate of 76%. The 9 dropouts consisted of 4 patients with severe health problems and 5 who were nonreachable. Of the 29 responders, 17 belonged to the original IOD and 12 to the RCD group.

Demographics
The responding patients consisted of 17 women (mean age: 75 years; range: 57 to 90; SD: 8.30) and 12 men (mean age: 77 years; range: 67 to 84; SD: 4.85).

Changes Over Time
Changes over 10 years for patient satisfaction with the mandibular denture are shown in Fig 1, and for the OHIP-20 sum score in Fig 2.

Overall analyses over the time periods from 3 months to 10 years of denture satisfaction are shown in Table 1. In the IOD group, only satisfaction with the mandibular denture showed a borderline significant reduction between 2 years and 10 years (post hoc analysis, $P = .015$).

In the RCD group, significant differences between the time periods from 3 months to 10 years were found in chewing with both dentures considered together and in all variables pertaining to the mandibular denture except esthetics. Post hoc analyses of these variables show that there were significant improvements in denture satisfaction between recordings made before the intervention with IODs and after intervention (between all time periods from 3 months and 8 years), with $P$ values ranging between $< .001$ and $.007$.

Overall analyses of the time periods from 3 months to 10 years of the OHIP-20 domains and sum scores for the IOD and RCD groups are shown in Table 2. None of the variables of the IOD group showed significant differences over the observation period (all $P > .05$). Regarding the RCD group, all the variables except the domain handicap

Table 1 Changes in Satisfaction with Denture Variables Over Time (3 mo to 10 y)

| Variable                        | IOD  | RCD  |
|---------------------------------|------|------|
| Both dentures considered together | .288 | .100 |
| Satisfaction, maxillary denture | .495 | .664 |
| Satisfaction, mandibular denture | .049 | .001 |
| Comfort, maxillary denture      | .122 | .423 |
| Comfort, mandibular denture     | .052 | <.001 |
| Retention, maxillary denture    | .346 | .368 |
| Retention, mandibular denture   | .062 | .002 |
| Fit, maxillary denture          | .955 | .280 |
| Fit, mandibular denture         | .149 | .008 |
| Soreness or pain, maxillary denture | .712 | .060 |
| Soreness or pain, mandibular denture | .231 | .003 |
| Esthetics, maxillary denture    | .849 | .056 |
| Esthetics, mandibular denture   | .717 | .062 |
| Chewing                         | .165 | .003 |
| Speech                          | .398 | .206 |

ANOVA was used for analyses. Significant values are shown in bold.
showed significant changes after the intervention with an IOD. Apart from handicap, the post hoc analyses showed significant improvements between 2 years and 10 years for all OHIP-20 domains and sum scores, with \(P\) values ranging between < .001 and .034. Between 3 months and 10 years, post hoc analyses showed significant improvements for functional limitation, physical pain, psychologic disability, and social disability, with \(P\) values ranging between < .001 and .034.

### Comparison Between the RCD and IOD Groups at 10 Years

The RCD and IOD groups were not significantly different at 10 years, either in terms of any of the denture variables (\(P\) values ranging from 0.11 to 0.93) or the OHIP-20 domain or sum scores (\(P\) values ranging from 0.41 to 0.82).

### Level of Satisfaction with Dentures and OHIP-20 at 10 years, with IODs and RCDs Pooled

The patients’ level of denture satisfaction at 10 years is shown in Table 3. Dissatisfaction with the dentures ranged between 0 and 3 patients (0% to 11%), with the total of 3 dissatisfied patients referring to the retention of the mandibular denture. Also, the maxillary denture did not cause any soreness or pain for 11 out of 29 patients (38%), little soreness or pain for 15 out of 29 (52%), some soreness or pain for 3 out of 29 (10%), and much soreness or pain for 0 patients. In regard to speech, 16 out of 28 (57%) of the patients had no problems, 11 out of 28 (39%) had some problems, and 1 out of 28 (4%) had major problems.

#### Table 2 Changes in OHIP-20 Domain and Sum Scores Over Time (3 mo to 10 y)

| Variable                  | IOD 3 mo | IOD 2 y | IOD 10 y | RCD 3 mo | RCD 2 y | RCD 10 y | \(P\) 3 mo | \(P\) 2 y | \(P\) 10 y |
|---------------------------|----------|---------|----------|----------|---------|----------|------------|----------|-----------|
| Functional limitation     | 7.52 (13.51) | 6.23 (0.56) | 7.43 (0.65) | .268 | 11.23 (0.74) | 11.42 (0.75) | 8.09 (1.02) | .005 |
| Physical pain             | 7.61 (0.65) | 7.37 (0.70) | 8.16 (0.82) | .725 | 12.65 (0.93) | 13.41 (0.94) | 7.25 (1.19) | < .001 |
| Psychologic discomfort    | 3.85 (0.38) | 3.96 (0.41) | 3.94 (0.48) | .981 | 5.19 (0.60) | 6.20 (0.60) | 3.83 (0.77) | .006 |
| Physical disability       | 6.57 (0.58) | 6.77 (0.62) | 6.76 (0.72) | .954 | 10.50 (1.02) | 11.48 (1.03) | 8.11 (1.33) | .035 |
| Psychologic disability    | 3.57 (0.34) | 3.45 (0.36) | 3.60 (0.42) | .944 | 5.35 (0.62) | 6.03 (0.63) | 3.46 (0.78) | .002 |
| Social disability         | 4.21 (0.36) | 3.84 (0.38) | 4.53 (0.45) | .430 | 4.85 (0.61) | 5.15 (0.61) | 3.86 (0.66) | .037 |
| Handicap                  | 3.28 (10.56) | 2.89 (0.30) | 3.19 (0.36) | .764 | 4.35 (0.53) | 4.40 (0.54) | 3.37 (0.68) | .226 |
| Sum score                 | 35.82 (2.49) | 34.55 (2.68) | 37.68 (3.14) | .707 | 54.04 (4.32) | 58.06 (4.36) | 37.31 (5.18) | < .001 |

Data are reported as mean score (SE). ANOVA was used for analyses. Significant values are shown in bold.

#### Table 3 Denture Satisfaction at 10 Years

| Variable                  | Very satisfied | Satisfied | Not quite satisfied | Dissatisfied |
|---------------------------|----------------|-----------|---------------------|--------------|
| Both dentures considered together | 8 (28) | 11 (38) | 9 (31) | 1 (3) |
| Satisfaction              |                |           |                     |              |
| Maxillary dentures        | 7 (24)         | 15 (52)   | 5 (17)              | 2 (7)        |
| Mandibular denture        | 6 (21)         | 12 (43)   | 9 (32)              | 1 (4)        |
| Comfort                   |                |           |                     |              |
| Maxillary denture         | 8 (28)         | 16 (55)   | 4 (14)              | 1 (3)        |
| Mandibular denture        | 7 (25)         | 12 (43)   | 7 (25)              | 2 (7)        |
| Retention                 |                |           |                     |              |
| Maxillary denture         | 5 (17)         | 15 (52)   | 7 (24)              | 2 (7)        |
| Mandibular denture        | 7 (25)         | 11 (39)   | 7 (25)              | 3 (11)       |
| Fit                       |                |           |                     |              |
| Maxillary denture         | 9 (32)         | 16 (57)   | 3 (11)              | 0 (0)        |
| Mandibular denture        | 9 (33)         | 14 (52)   | 2 (7)               | 2 (7)        |
| Esthetics                 |                |           |                     |              |
| Maxillary denture         | 5 (18)         | 18 (64)   | 5 (18)              | 0 (0)        |
| Mandibular denture        | 8 (29)         | 13 (46)   | 6 (21)              | 1 (4)        |
| Chewing                   | 5 (19)         | 15 (56)   | 6 (22)              | 1 (4)        |

Data are reported as n (%).
The scores of the OHIP-20 domains and sum score at 10 years are shown in Table 4. The least oral health problems were found for the domains handicap and psychologic disability, with scores of 3.31 and 3.78, respectively.

Dropout Analysis: Comparison at Baseline Between Dropouts and Responders at 10 years
There were no statistically significant differences at baseline between dropouts and responders for any of the denture variables (P values ranging from .14 to .97) or for any of the domains and sum scores of the OHIP-20 (P values ranging from .27 to .95).

DISCUSSION

The main findings of this study indicate an immediate improvement in denture satisfaction and OHRQoL after treatment with mandibular IODs. This was maintained throughout the follow-up period of up to 10 years, thus confirming the working hypothesis. The striking effect of such treatment on OHRQoL and denture satisfaction is further demonstrated by the fact that the RCD group showed only a modest improvement after baseline, but a radical one at the 2-year stage, after it had received IODs.

One of the most important objectives of any kind of treatment is that the patients are satisfied with the outcome. Seeing that the data upon which these results are based are subjective assessments by the patients and that the positive effect is maintained over such a long period of time, this objective is undoubtedly achieved for the present patient sample. At least in terms of denture satisfaction and OHRQoL, these findings thus tend to corroborate the McGill Consensus Statement on Overdentures and the York Consensus Statement that IODs should be regarded as the first-choice standard of care for edentulous patients.

An important consideration is to what extent the findings can be regarded as representative of the general edentulous population. On the one hand, there is no doubt that the present patient sample was highly selected. One of the original intake criteria was that they should all be dissatisfied with their existing mandibular denture. Also, some of them had dentures made by dental students under the supervision of qualified university teachers and might for that reason be atypical. Furthermore, both the surgical and prosthetodonic two-implant mandibular overdenture treatments were performed by specialists in their fields, and the number of participants was fairly small. The fact that many participants were lost, mainly due to mortality during the follow-up period, may theoretically also bias the results.

On the other hand, it seems likely that patients who were dissatisfied with their mandibular denture would also be the most challenging to satisfy. Less than one-third of the patient sample was recruited from dental school patients. The rest were recruited either by advertisements in seven newspapers in the city of Bergen and the surrounding regions or by referrals from several general dental practitioners. Thus, patients from both urban and rural areas participated, and the majority had been treated by general practitioners.

The patient sample of this study was small; however, treatment with two-implant mandibular overdentures is presently shown to have a striking and long-lasting favorable effect on patient satisfaction with both the dentures and OHRQoL. This makes bias due to a small patient sample less likely. The same is indicated by the fact that, excluding deceased patients, 76% of the patients responded at 10 years. Also, in Norway, such treatment is normally performed by specialists in their field, as this is a condition for public funding.

Moreover, the theoretical possibility of bias due to differences between remaining patients and dropouts seems less likely, as no statistically significant differences were found at baseline between the two groups for any of the variables of denture satisfaction or OHRQoL. Even though, for the above reasons, it seems likely that the present findings might also be representative for other edentulous patients, this supposition must be tested with other patient samples and other settings.

To the present authors’ knowledge, there are only a few long-term studies of IODs comparable to the present one that report denture satisfaction and OHRQoL. Different methods of recording these factors were used in each of these. Thus, in a 20-year report, den-}
outcomes can therefore be directly compared to the present findings. Nevertheless, the concurrent main findings of these two long-term studies unequivocally indicate that the level of satisfaction and OHQoL remain high, even after such long periods of observation.

Other studies with shorter follow-up periods of 3-15,27 and 5 years14 appear to show similar significant improvement of OHQoL after being treated with IODs. By contrast, no such difference was found in a retrospective study28 conducted after 4 years between patients treated with IODs and conventional dentures. Unlike the follow-up studies, these patients were not seeking treatment, which might explain the difference. Also, the considerable human capacity to adapt to difficult situations may have played a part. The shorter-term reports all used the OHIP-14, the results of which are not directly comparable with the presently used OHIP-20.

Two of these studies also report denture satisfaction27,28 but with instruments different from each other and from the ones used in the present study. Even if not directly comparable, apparent high levels of denture satisfaction were recorded. As indicated above, not only changes over time, but also the level of OHQoL and denture satisfaction are of clinical interest. In the present study, the OHIP-20 sum score was 38.61 at the end of the observation period. This level is 18.61 points from the theoretically most favorable score of 20 on this scale (range 20 to 120), which appears to be similar to shorter-term postoperative results reported by others.9 However, a major problem when comparing present OHIP sum scores to those of others is that different numbers of items and categories are sometimes used when measuring basically the same phenomenon. A case in point is the OHIP-EDENT,24 which, compared to the OHIP-20, contains 19 items vs 20, categories ranging from 0 to 4 vs 1 to 6, and a theoretical range of 0 to 95 vs 20 to 120. A pre-intervention sum score norm of 28.6 has been reported based on a meta-analysis of OHIP-EDENT.29 However, if the ranges of the two OHIP scales are regarded as a continuum ranging from 0% to 100%, then the OHIP-EDENT sum score is 30.1% (28.6/95) from the theoretical minimum. Correspondingly, keeping in mind that the range for OHIP-20 is between 20 and 120, the present postintervention OHIP-20 sum score of 38.61 is 18.61% (38.61 – 20) from the minimum value, which may appear lower and perhaps more favorable. This supposition is strengthened by the fact that the wording of all but one of the two items of the two OHIP versions are identical.

Denture dissatisfaction ranged between 0 and 3 patients (0% to 11%) for all variables in the present study. Although these levels cannot be directly compared to others, the steep decline of the OHIP-20 score depicted in Fig 1, indicating radical improvement of OHQoL, and the low number of denture dissatisfaction testify to a subjectively successful treatment.

Of the present OHIP-20 domains, handicap, psychologic disability, and psychologic discomfort show low scores, indicating that these areas are the least challenging for the patients. Similar short-term results have been reported by others.10

CONCLUSIONS
Within the defined limitations, the present PROMs indicate that a high degree of satisfaction with dentures and OHQoL can be achieved and remain stable over a period of 10 years after intervention with a two-implant mandibular overdenture even among patients dissatisfied with their conventional dentures at baseline.

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Factors Related to the Outcomes of Cracked Teeth After Endodontic Treatment

Cracked teeth are a common clinical finding; however, their presence renders diagnosis and prognosis unreliable. The purpose of this research was to assess the correlations of multiple factors on the prognosis of cracked teeth that had undergone endodontic treatment. A total of 3,680 patients who received endodontic treatment from an advanced postdoctoral education program in endodontics with follow-up records of at least 1 year were assessed. From this sample, 62 patients met the inclusion criteria and were included in the final analysis. The factors evaluated included demographics, clinical symptoms and signs, radiographic findings, and restoration type. Statistical analysis was then completed using chi-square and Fisher exact tests. The mean follow-up period was 23.3 months, with an overall tooth success rate of 75.8%. The success rates differed significantly when the patient had an existing preoperative periapical lesion, lacked a proper permanent restoration on the treated tooth, or had a post placed after root canal treatment. Data analysis showed that restoring the tooth after endodontic treatment was the single most important factor for prognosis. In fact, the endodontically treated teeth with definitive full-coverages restorations had a 2-year success rate of 93.6%. Full-coverages restorations should be considered an important part of the treatment plan for cracked teeth treated endodontically.

Chen YT, Hsu TY, Liu H, Chogle S. J Endod 2021;47:215–220. References: 30. Reprints: S. Chogle, chogle@bu.edu — Ray Scott, USA

Literature Abstract

Longevity and Risk Factors of Post Restorations After up to 15 Years: A Practice-Based Study

The aims of this multicenter, practice-based cohort study were to evaluate the success and survival of endodontically treated teeth with post restorations (ETT+Ps) and to analyze factors associated with the longevity of ETT+Ps. Eight general dental practitioners each placed up to 27 ETT+Ps without any restriction on post materials or dimensions. Only incisors, canines, and premolars were included. At the final follow-up visit, ETT+Ps were considered as successful if the post and the initially placed definitive restoration were sufficient, whereas ETT+Ps were considered as survived if the post was still in function. Multilevel Cox proportional hazards models were used to evaluate the association between a range of predictors and time until no success and no survival. Overall, 195 endodontic posts in 195 patients were followed up for a mean (95% CI) of 91 (81–101) months; the longest follow-up was 15 years. Of these, 122 ETT+Ps were considered successful (estimated success time = 110 [101–120] months), and 152 ETT+Ps survived (estimated survival time = 133 [124–141] months). Regarding the categories of success and survival, the annual failure rates were 6.0% and 3.3%, respectively. Recementation of old (telescopic) crowns after placing new posts was the only significant predictor for decreased time until failure for both success and survival analyses. By excluding recemented restorations, annual failure rates decreased to 3.5% and 2.1%, respectively. For ETT+Ps placed in a private practice setting, high success and survival rates were observed. If old (telescopic) crowns are recemented after new posts were placed, the high risk of subsequent failure should be considered and communicated with patients.

Linnemann T, Kramer EJ, Schwendicke F, Wolf TG, Meyer-Lueckel H, Wierichs RJ. J Endod 2021;47:577–584. References: 34. Reprints: Theresa Linnemann, theresa.linnemann@gmx.de — Ray Scott, USA

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