# Efficacy of Removable Partial Denture Treatment: A Retrospective Oral Health-Related Quality of Life Evaluation


## Keywords

*Removable Partial Denture*
*Oral Health Related Quality Of Life*
*Partially Edentulous*
*Person-Centered Outcomes*



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## ABSTRACT

*Successful removable partial dentures (RPDs) use may be influenced by patient and denture variables including age, denture experience and number or position of teeth being replaced. Influence of patient and denture variables on OHRQoL with RPDs was investigated using ordinal logistic regression analysis. Methods: Participants provided with RPDs were invited to complete OHIP-20 at least 4 weeks after dentures were fitted. Clinical records were retrieved to identify a number of independent variables. Variables meeting a standard of statistical significance were included into regression analysis to quantify influence on OHIP-20 scores. Results: 84 patients agreed to participate. No. of missing teeth, age, gender, replacement of anterior teeth and framework material were entered into the model, which was statistically significant, $p<0.001$, with pseudo $R^2$ of 0.39. Significant variables were age ($p<0.05$), no. of missing teeth ($p<0.01$), gender ($p<0.05$) and replacement of anterior teeth ($p<0.001$). Replacing anterior teeth showed 9.68 point reduction in OHIP-20 score in patients with replaced anterior teeth. Discussion: Replacing anterior teeth was associated better post-operative OHRQoL outcomes, suggesting RPDs address impacts on OHRQoL of missing anterior teeth. Success of RPDs in overcoming impacts of tooth loss on OHRQoL was worse as more teeth were lost.*


## INTRODUCTION

The success of removable partial dentures (RPDs), both at an individual and societal level, is variable and difficult to measure.[1] Patient satisfaction with removable partial dentures can be rather variable, though studies indicate a majority of patients expressing satisfaction, significant numbers do report dissatisfaction and avoidance of wearing an RPD.[2,3] Both patient and denture variables may be strong determinants of success. Examination of the relationship of denture quality to patient satisfaction has demonstrated some patients find RPDs that are fit for purpose clinically difficult to tolerate, whilst others may find dentures satisfactory on a personal level, whilst clinically they may be considered sub-optimal, and no particular 'standards' of removable partial denture construction are related to patient satisfaction.[4] The interplay between patient variables and denture variables may have a role to play on changes to oral health-related quality of life (OHRQoL); with some variables being more influential on success than others. It is not known which variables are most important, across



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the population of partially dentate patients requiring RPDs, though it has been reported that patients are more likely to wear an RPD if it replaces missing anterior teeth.[2] The number of variables to consider is significant with patient variables including psychological acceptance, adaptation capacity, oral and dental status.[4,5] Denture variables include the number, position and size of edentate saddles and variables associated with the design and manufacturing of the prostheses, including the type of materials, derivation of support, numbers of teeth used for support etc.[6] The relative impact of these denture and patient variables on success with RPDs has been measured using measures of success such as continued denture use and measures of satisfaction, but not using objective, validated measures of OHRQoL as the outcome measure.[2,4,6,7]

A number of specific objective markers of success for the assessment of RPDs have been developed, that include measures of masticatory efficiency, patient satisfaction, continued use of prostheses and subjective assessment against various success criteria judged by specialists in the field.[2,4,6,7] Studies using these have considered the relative effects of patient and denture variables on success measured against these surrogate markers. In this respect, denture success, as a measure of patient and denture variables, have been studied retrospectively in several studies, which have looked at continued use of the denture and clinical acceptability.[6-8] None, however, have fully explored the effect of these variables on OHRQoL in RPD wearers. OHRQoL seeks to evaluate the physical, psychological, and social impact of oral conditions on an individual.[9] This has been described by Locker in 1988 as a construct used to quantify the positive and negative effects of oral symptoms on patient's quality of life.[10] The effects on this construct can be measured through Patient Reported Outcome Measures (PROMs) that have been specifically developed and validated. Validated PROMs offer a reliable means of quantifying OHRQoL such that differences between patient and denture variables may be quantified and their influence on outcome compared. Ultimately, as the purpose of providing a RPD is to restore function and aesthetics to overcome the impact of tooth loss.[11] Rehabilitation with a removable partial denture has been shown to improve an individual's quality of life and it is by overcoming the impairment of tooth loss, restoring functional ability and thereby reducing the consequent disability, that improvements in OHRQol are made and it is therefore logical to focus on outcome measures such as OHRQoL.[12] The choice of measure is an important one and should be considered in the context of the purpose of analysis, the population being studied and the audience being asked to interpret the results.[13] In this case, a tool designed and validated for use in partially dentate patients, used in the context of measuring OHRQoL over periods of follow-up anticipated in this cohort of patients, with items that would be expected to have impacts in denture wearers would be considered to be an appropriate tool and a representative measure of success from a patient perspective.[13]

Disease specific measure of OHRQoL such as the Oral Health Impact Profile, have been validated to evaluate the range of domains that describe OHRQoL. The OHIP-20, a 20-item subscale of the original OHIP-49 has been validated for the measurement of OHRQoL in patients with fixed and removable prostheses.[14] Studies that have measured success with RPDs have identified that factors such as the type of support derived for the denture, the framework material, whether or not the denture replaced anterior teeth etc., play a role in the patient's experience with and continued use of RPDs.[2] Mandibular Kennedy Class 1 dentures, i.e. those replacing posterior teeth in bilateral free-end saddles, were often not worn and patients with a shortened dental arch are reported to only perceive benefits of an RPD when anterior teeth are being replaced.[6,15] Neither of these studies however has investigated the relative impact of these important patient and denture variables on a validated measure of OHRQoL such as the OHIP.

The concept of minimum clinically important differences (MCID) in OHRQoL is another important feature of PROMs; defined as the smallest change in an outcome that a patient would identify as important.[16] The calculation of the MCID has been reported by Allen *et al*. that investigated the MCID for the OHIP-20 using the anchor-based method and determined that a MCID for the OHIP-20 was 7 to 8 points.[12,16]

Patient and denture variables are not the only factors likely to modify OHRQoL. Scores from PROMs may be modified by a person's characteristics, their social status, family and cultural circumstances, and of course by their experience of disease whether due to environmental (e.g. caries) or genetic causes (e.g. congenital absence of teeth); both in terms of extent and severity.[8] It would not be feasible for clinicians to take account of all these variables in an attempt to predict a successful outcome with RPDs. However, there are a number of variables which can be considered and, if their relative effects could be quantified, could help clinicians predict which cases are more or less likely than others to be perceived by patients as successful.

Given that both patient and denture variables play a role in the success outcomes, it is appropriate to undertake a study that seeks to control some of these parameters and in this way obtain data that is more representative of the wearing of a denture that is 'fit for purpose'. In particular, it is the process of denture fabrication that can be a significant confounder in this type of study given the high levels of quality variability associated with both the clinical and technological aspects (design and manufacturing) of denture fabrication.[17,18] The levels of scrutiny to each aspect of treatment planning and denture design and fabrication at a Dental Teaching Hospital provides a setting with a carefully controlled production process with strong quality assurance protocols used for all clinical and technological stages of denture production.



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The aim of this retrospective evaluation was to explore the impact of various independent patient and denture variables associated with the provision of RPD treatment on OHRQoL outcomes and to test the construct validity of our chosen person centered outcome measure, the OHIP-20, in the context of RPD provision in a dental teaching hospital.

# METHODS

Patients provided with an RPD from the 1st April 2014 until the 1st December 2014, were identified from an electronic database kept at the Removable Prosthodontic Laboratory at a large UK Dental Hospital. These patients were contacted by mailshot, which included a participant information leaflet, a questionnaire including the OHIP-20 as well as questions concerning continued use of the RPD and a free-text box for additional comments. The OHIP-20 is a 20-item questionnaire measured on a 5-point Likert scale, scoring from never (0, least impact) to very often (4, greatest impact), giving a range of total score from 0 to 80 points. Questionnaires were individually coded and a stamped addressed envelope was enclosed for return of the questionnaires. Three questionnaires were sent to participants and returns were accepted within a 4-month period between 5th January and 1st May 2015.

The following patient and denture variables were recoded from clinical and laboratory records for those patients who returned completed questionnaires: age, gender, number of missing teeth (excluding third molars), denture configuration (complete denture against partial denture, partial denture against partial denture, partial denture against dentate arch), type of framework support material (tooth-and-mucosa supported Cobalt-Chromium RPDs only, mucosa supported acrylic dentures only, combined, i.e. each arch restored with a different style), replacement of anterior teeth, presence of a free-end saddle, patient experience of denture wearing.

## STATISTICAL ANALYSIS

The Kolmogrov-Smirnov test was used to investigate normality of the outcome data and due to the skewed nature of the OHIP-20 total score, non-parametric tests were used in the analysis. Independent variables were investigated to determine if they could be entered into a multi-variate regression analysis. Correlations between OHIP-20 and skewed variables, namely, number of missing teeth and age, were measured using Kendal's tau correlation coefficient. Binary categorical variables: gender, previous denture usage, replacement of anterior teeth and presence of a free-end saddle were analysed using a Mann Whitney U test. Nominal variables for denture configuration and framework materials used were tested using a Kruskal Wallis ANOVA. The threshold for inclusion in the model was be set at $p<0.219$. For each variable a minimum of 10 responses were be required as a sufficient sample to undertake multi-variate regression analysis, therefore on the assumption that all variables are included into the multivariate linear regression model a minimum of 100 responses would be required.[19] Due to the skewed nature of the OHIP-20 total score this was transformed on a $\log^{10}$ scale before regression analysis. A pseudo $R^2$ was calculated by entering variables that met the threshold for inclusion into an ordinal logistic regression analysis.

Internal consistency of the OHIP-20 scale was investigated using a Cronbach's alpha statistic. External validity was investigated by investigating the relationship between the OHIP-20 score and the continued use of the RPD provided, a commonly reported positive predictor of a successful outcome with RPDs.

# RESULTS

One hundred and twenty patients were identified from the dental laboratory database and were sent questionnaires. All patients had worn their dentures for a minimum of 4 weeks in line with previous studies measuring effects of RPD treatment on OHRQoL. Eighty-four completed questionnaires were collected representing a response rate of 70%. Questionnaires of those patients who responded were complete and there was therefore no missing outcome data.

Descriptive data for patient and denture variables of those patients who returned completed questionnaires are presented in Table 1. Ages ranged from 26 to 93 years, though the mean was skewed towards older patients at 65.8 years (SD = 13.4 years). There were 12% more male responses than females. Three quarters of participants had already had experience of denture wear. Most RPDs, 64%, were made using a tooth-and-mucosa supported cobalt chromium framework, with only 27% being acrylic mucosa borne RPDs. 8% of participants received a chrome denture in one arch and an acrylic denture in the opposing arch.

Internal consistency of OHIP-20 was measured using a Cronbach's alpha statistic. Including all items of the OHIP-20 gave an alpha statistic of 0.97. The Cronbach's alpha was also measured for the scale if each item was removed and did not show a significant reduction upon removal of any one of the scale items, which indicates excellent internal consistency of the scale used. Patients who were still using their dentures had median OHIP-20 scores of 18 compared to 27 for those wearing only one of the dentures provided and 46 for patients not wearing any dentures provided. This difference was not statistically significant $p=0.098$. Only three patients were not wearing either dentures provided representing a failure rate of 3.6%. 70 patients were wearing all of the dentures provided representing total success in 83.33%, the remaining 11 patients, 13.1%, were provided with two dentures but only wore one of them.

Kilmogorov-Smirnov test for normality of the OHIP-20 score confirmed a non-normal distribution ($p<0.001$), which is not unusual when using quality of life measures.

Kendal's tau correlation coefficient for OHIP-20 against missing teeth and age are shown in Table 2. Gender, previous denture usage, replacement of anterior teeth and presence of a free-end saddle were analysed using a Mann Whitney U test. Denture configuration and framework materials used were tested using a Kruskal Wallis ANOVA. Table 2 also shows the median OHIP-20 scores for each of these groups with the respective p-values for differences between groups.



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**Table 1.** Descriptive data for patient and denture variables

| | | n = | Range | Mean | S.D. |
|---|---|---|---|---|---|
| **Age (years)** | | | 26 – 93 | 66 | 13 |
| **Gender** | Female | 37 (44%) | | | |
| | Male | 47 (56%) | | | |
| **No. missing teeth (excluding 3rd molars)** | | | 3 – 23 | 13 | 6 |
| **No. missing teeth in mandible** | | | 2 - 16 | 8 | 3 |
| **No. missing teeth in maxilla** | | | 2 - 16 | 9 | 4 |
| **Previously wore a denture?** | No | 21 (25%) | | | |
| | Yes | 63 (75%) | | | |
| **Denture configuration** | RPD vs RPD | 39 (46%) | | | |
| | Complete denture vs RPD | 16 (19%) | | | |
| | RPD vs Dentate/Fixed | 29 (35%) | | | |
| **Framework material** | Acrylic | 23 (27%) | | | |
| | Chrome | 54 (64%) | | | |
| | Both | 7 (8%) | | | |
| **Replacement of anterior teeth by removable denture** | No | 28 (33%) | | | |
| | Yes | 56 (67%) | | | |
| **Free end saddle** | No | 23 (27%) | | | |
| | Yes | 61 (73%) | | | |

The variables which were significant to include in the regression were number of missing teeth, age, gender, replacement of anterior teeth and framework material. Ordinal logistic regression analysis (OHIP-20 score as the outcome) was performed to test the model and was found to be statistically significant, $p<0.001$, with a pseudo R2 of 0.39. Independent variables within the model were age ($p<0.05$), number of missing teeth ($p<0.01$), gender ($p<0.05$) and whether anterior teeth were replaced ($p<0.001$). Ordered log odds regression coefficients were transformed using the exponential to arrive at regression coefficients for statistically significant variables. For age the co-efficient was 0.97 (this relationship was negative), for gender it was 2.45, for missing teeth the co-efficient was 1.10 and for replacement of anterior teeth the co-efficient was 9.68. Figure 1 shows a box and whisker plot of OHIP-20 total score against whether anterior teeth were replaced or not.

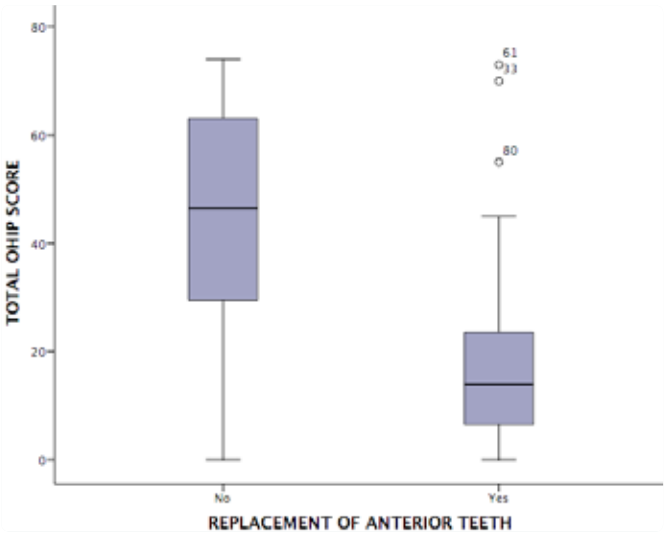


**Figure 1:** Box and whisker plot representing median, interquartile range and range for OHIP-20 total score, according to whether anterior teeth were replaced or not.



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**Table 2.** Denture and patient-related variables and OHRQoL

| Variable | Group | Median OHIP-20 score | p-value |
|---|---|---|---|
| Gender | Male | 16 | 0.18* |
| | Female | 24 | |
| Previous Denture Usage | Yes | 19 | 0.43 |
| | No | 26 | |
| Replacement of Anterior Teeth | Yes | 14 | <0.001* |
| | No | 47 | |
| Presence of a Free-end Saddle | Yes | 20 | 0.64 |
| | No | 18 | |
| Framework material | Chrome Only | 19 | 0.15* |
| | Acrylic Only | 34 | |
| | Both | 12 | |
| Denture configuration | RPD vs RPD | 21 | 0.91 |
| | RPD vs CD | 20 | |
| | RPD vs Dentate | 20 | |
| **Variable** | | Correlation coefficient | p-value |
| Age | | - 0.11 | 0.15* |
| Total number of missing teeth (excluding third molars) | | 0.18 | <0.05* |

* Indicates p values deemed appropriate for inclusion in multivariate linear regression analysis

# DISCUSSION

This was the first evaluation of the influence of patient and denture variables on success of RPDs in the rehabilitation of tooth loss as measured by OHRQoL. Previous studies have measured the influence of patient and denture variables on the success in terms of continued denture usage and patient satisfaction.[2,20] The data provides additional evidence that the use of OHIP-20 is a valid measure for the construct of OHRQoL in partially dentate patients. Internal consistency of the OHIP-20 was found to be excellent. The Cronbach's alpha remained strong even when items were removed. External validity was good with higher OHIP-20 total score in patients who continued to wear their dentures. Response rate was excellent considering the use of postal questionnaires.

The most significant variable having an effect on OHRQoL was that of whether anterior teeth were being replaced by the prostheses. This was negatively correlated with OHIP-20 score, which suggests that where anterior teeth are replaced, the OHIP-20 score is reduced, i.e. there is better OHRQoL. Where anterior teeth were replaced patients had a 33-point improved median OHIP-20 score. There are several possible reasons for this. Firstly, where anterior teeth are being replaced in a partial denture, it is quite likely that on each side of the missing teeth space, there will be natural teeth to support the prosthesis and give greater stability and retention of the denture by means of clasping arms and supporting rests. Secondly, where patients have missing anterior teeth, it is likely that these spaces are visible to other people, which the patient in question may be particularly conscious of in their interactions socially and intimately. It is understandable that these impacts would be improved by the provision of prostheses.

The second important variable was found to be the number of missing teeth, which was positively correlated such that, as number of missing teeth increases so does the OHIP-20 score. It is understandable that as the number of teeth increases the number and degree of impacts on OHRQoL will increase. It is worth noting that whilst one additional missing tooth only changes OHIP-20 scores by 1.1 points, a loss of six or seven teeth would have a magnitude of impact of the order associated with a clinically meaningful difference to patients, the MCID (minimum clinically important difference).

Age and gender were also significantly related to the OHIP-20 score with females demonstrating a reduced OHRQoL measured by 2.45 points on the OHIP-20 scale. Whilst this is statistically significant it would not meet the threshold for clinical meaningfulness to a patient measured by the MCID. Age on the other hand was found to be related to OHRQoL, with an increase in OHRQoL, measured as a reduction by 0.97 OHIP-20 points for each additional year. As such we may argue that every seven to eight additional years of life improves OHRQoL by the MCID, a phenomenon, which is difficult to explain from this study. Social handicap is an important domain measured by the OHIP, which may in some part describe this interesting finding. Social handicap is be shaped by the individual's expectations, which, as with all components of quality of life, is informed by the "individual's perceptions of their position in life in the context of culture and value systems... in relation to their goals, expectations, standards and concerns".[13,21] Could it be the case that as patients age their expectations and standards change in respect of social-life, and perhaps even in respect to other domains such as functional status?

Previous literature, however, does shed some light on this with Steele *et al.* comparing samples from the UK Adult Dental Health Survey 1998 with the Australian National Dental Telephone Interview Survey of 1999, using the OHIP-14 as a measure of OHRQoL, found the 'impact of oral health problems reduces with age', p<0.00122. This phenomenon has been demonstrated in other studies.[22-25] It is suggested that the lower impacts on older persons may not be entirely age-related *per se*, but rather that effects are 'cohort dependent'.



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That is to say that patients in older age groups age socially different to persons in younger age groups and their levels of health-expectations set at a different threshold, and that these relationships may change as people in older age brackets approach expectations to healthcare with different expectations in the future.[22,23]

Patients who were still using their dentures had median OHIP-20 scores of 18 points compared to 27 points for those wearing only one of the dentures provided and 46 for patients not wearing any dentures provided, giving a correlation coefficient of $\rho = 0.182$. This co-efficient was not statistically significant, $p = 0.098$, however, with only three patients not wearing any of the dentures provided there were too few to make a reliable comparison.

Participants in this study have been selected from a database of patients treated in a teaching dental hospital with strong clinical and technological quality assured protocols and processes. This reduces the potential impact of the variability in quality of denture fabrication and enables the study to focus on the patients' true denture wearing experience with the knowledge that all dentures were fit for purpose. The participating patients ranged from varying degrees of clinical complexity, as they included those managed and treated on undergraduate, postgraduate and specialist clinics, in accordance with their needs and expectations. Participants included in this study may therefore be considered to be representative of the population in general as they are likely to include patients at all levels of complexity. In this sense, we can consider that this retrospective evaluation is testing the efficacy of RPDs as we have carefully controlled a significant variable and potential confounder; the quality of the RPD. The use of postal questionnaires, however, may have introduced selection bias, excluding some participants who had barriers to completion and returning these forms.

Clearly the retrospective nature of this study has limitations. It was not possible to measure the magnitude of change is OHRQoL in the absence of a pre-treatment score. Indeed change scores would be just as useful in evaluation of OHRQoL impacts of RPD treatment, it could be argued more useful as indeed it is the change score which is of greatest value in determining the extent of impact therapy had had on OHRQoL. Of interest further still would be the impact of follow-up in terms of response shift representing either greater adaptation to the removable prosthesis or perhaps gradual return of the negative impacts of tooth loss as the RPDs age. The current evaluation allows for the assessment of OHRQoL at a particular time-point after treatment and whilst this does not provide information about the change score it does enable an assessment to be made of the impact, which various patient and denture variables have on OHRQoL in patients recently provided with RPDs.

Prospective evaluation would also allow standardisation of follow-up appointments. With the range of follow-up found in this study of anywhere between one and seven months, a further limitation of this retrospective evaluation was in the control over follow-up, potentially an important confounding variable. A similarly designed prospective study, controlling for the follow-up period as well as measuring the change score, would provide greater information about the impact of patient and denture variables on change in OHRQoL as well as giving greater control of potential bias introduced by phenomena such as response shift.

The types of dentures provided may have been different within a dental teaching hospital compared to the provision more generally. In this study 64.3% were provided with only chrome dentures and 8.3% were provided with a mixture of chrome and acrylic dentures in each arch. The provision of laboratory work in primary care incurs a cost directly to the prescribing practitioner and the prescription of more costly chrome framework dentures in the general population is unlikely to be represented by the percentages demonstrated here. Furthermore the dentures provided in Dental Teaching Hospitals are subject to several levels of scrutiny, which helps to ensure a high level of care and attention. In this respect this evaluation is one made on dentures provided within a controlled environment to enhance the efficacy of RPD provision. Whether this can be translated to the effectiveness of RPD provision in a more general sense is uncertain. To further improve the generalizability of the study and consider the degree of beneficial effect of RPD provision under 'real world' conditions, and hence test the effectiveness of the intervention, it would be appropriate to conduct the study in multiple settings, including primary, secondary care and dental teaching hospitals or other care settings.

With regards to the functional limitations caused by missing anterior teeth, it is likely to be more difficult, where anterior teeth are missing, to function with either no dentures or an ill-fitting and unstable prosthesis and so items concerned with food catching or difficulty chewing would be affected in such patients, as well as avoidance of some foods or unsatisfactory diets.[26] Where anterior teeth are all present it is less likely that a patient will have difficulty incising into foods and may even have learnt to undertake other masticatory functions using anterior teeth, furthermore the masticatory efficiency may be influenced by aesthetics.[3,27,28] The work of Kayser *et al* demonstrates that where anterior teeth are present, though there are missing occlusal units, social functions related to aesthetics and phonetics were given greater importance by patients.[5,28]

In conclusion, this retrospective cohort study investigating the factors impacting on one to seven month post-treatment OHRQoL outcomes in patients provided with RPDs for the replacement of missing teeth, has shown that:

Replacement of anterior teeth is associated with improved OHRQoL outcomes. The clinical significance of this effect is over the level of minimal clinically important difference.



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OHRQoL is lower as more teeth are lost and as such clinicians should be mindful of the cumulative effect of tooth loss on OHRQoL impacts for patients. The loss of six to seven additional teeth demonstrates a clinically meaningful reduction in OHRQoL.

Increased age is associated with a reduced impact of oral diseases on OHRQoL and this had a clinically meaningful difference for every seven to eight additional years of age.

Validity of measuring OHRQoL using the OHIP-20 scale in removable prosthodontics outcome research has been further supported as it has demonstrated excellent internal consistency and correlation with other variables denoting patient-perceived success.

RPDs provided in an environment with strong clinical and technological quality assured protocols and processes demonstrate high levels of success with 96.4% continued use of RPDs during the follow-up period.

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