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ORIGINAL ARTICLE

Improvement of oral health-related quality-of-life by use of different kinds of double-crown-retained removable partial dentures

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Abstract

Objective. To verify the hypotheses that treatment with double-crown-retained removable partial dentures (RPDs) improves oral health-related quality-of life (OHRQoL) over a 36-month period and that the performance of RPDs retained by use of electroplated double crowns (EP-RPDs) was different to that of RPDs retained by use of cast double crowns (C-RPDs). ***Materials and methods.*** Fifty-four patients (mean age = 64 years, 63% men) were recruited and randomly assigned to C-RPD or EP-RPD. OHRQoL was assessed pre-treatment, post-treatment and 6, 12, 24 and 36 months after insertion, by use of the oral health impact profile (OHIP). An unweighted total score was calculated (OHIP-SUM). A two-level hierarchical model was used for statistical analysis. First-level units were the measurements on the six occasions; second-level units were the patients. ***Results.*** Improvement of OHRQoL was observed in both groups after treatment ($t = 7.27$, $p < 0.001$). Whereas a treatment–material interaction indicated that treatment with EP-RPDs resulted in greater immediate improvement of OHRQoL, a time–material interaction indicated that long-term improvement was greater for C-RPDs. ***Conclusions.*** Treatment with EP-RPDs and C-RPDs improved OHRQoL initially. Over a period of 36 months the effect was significant. The treatment is, therefore, a promising therapeutic option. The cast conical design seems to have advantages with regard to long-term OHRQoL.

Key Words: *removable partial dentures, telescopic crowns, electroplating, quality-of-life*

Introduction

In prosthetic dentistry, removable partial dentures (RPDs) are regarded as an important treatment option for rehabilitation of partially edentulous patients. Guidelines for this treatment option have been published [1]. The mechanism of retention can be technically simple and inexpensive, for example clasps, or more technically complicated and expensive, for example double-crown systems. In clinical studies both have been proved to be reliable treatment options in prosthetic dentistry [2–8].

The fabrication of double crowns by casting can be challenging and requires highly skilled dental technicians. Fabrication of electroplated double-crown systems with cast primary crowns and electroplated secondary crowns, by use of a largely automated process, was described for the first time in the 1990s [9,10]. Later, use of double-crown-retained RPDs with full ceramic primary crowns in combination with secondary crowns made of electroplated gold was reported [11,12]. Electroplated secondary crowns ensure optimum fit between primary and secondary crowns. They exploit, predominantly, the principle of hydraulic adhesion resulting from the film of saliva between the primary and secondary crowns, and seem to have favourable tribological properties [11,13]. *In-vitro* studies dealing with retentive force measurements and the wear behaviour of electroplated double-crown systems reported slightly lower retentive forces for electroplated double crowns than for cast double crowns [14], whereas another study found the opposite [15]. Electroplated telescopic double-crown systems showed more homogenous retention forces and are, therefore, believed to be more comfortable for the patient to wear, because

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of the stress-free fit which results from automated fabrication of the secondary crown by use of the electroplating process [12,14].

According to the current dental literature, however, little is known about how the patient's self-perceived oral health-related quality-of-life (OHRQoL) varies with different RPD designs or double-crown systems. This is an important concern, because in the provision of healthcare there has been a change in emphasis from a disease-centred biomedical approach to a bio-psychosocial approach [16]. Improvement of self-perceived health and of quality-of-life related to health should, therefore, be the objectives of therapy [17]. Different treatment options should, therefore, be evaluated to assess not only clinical performance but also oral health-related quality-of-life (OHRQoL). Results for the patients in this investigation up to 1 year after treatment have already been reported. It was demonstrated that the OHRQoL of both groups improved over a 1-year period. The difference between the two systems was not significant, however [18].

In this paper we report the development of OHRQoL in the two groups over a longer period—36 months. In addition, because this was not discussed in the previous publication, the effect of the different treatments on OHRQoL, describing the effect on OHRQoL between pre-therapy and baseline, is also evaluated. It was hypothesized that: (i) the treatment and developments over time would result in improvement of OHRQoL and (ii) this would be different for the two groups.

Materials and methods

Patients and RPDs

This investigation was independently reviewed and approved by the ethics board of the University Hospital Heidelberg (code number: 074/2003). Fifty-four patients asking for RPDs and with at least two abutment teeth (up to a maximum of six abutment teeth) were recruited for the study. They received written information about the study and signed an informed consent form. The patients' ages ranged from 38–80 years (mean age = 64.4; SD = 9); 63.3% of the patients were men.

Participants were assigned to the two study groups by simple randomization, by use of computer-generated random numbers; the patients were aware of the treatment group to which they were assigned. A study leader was responsible for randomization, enrolment of the participants and assignment of the participants to intervention.

Six of the 54 participants received treatment with RPDs in both jaws; this resulted in fabrication of a total of 60 RPDs (n = 30 RPDs in each group). Participants receiving two dentures were assigned to one group. The RPDs were made in two dental laboratories (n = 30 dentures and n = 15 for C-RPD and EP-RPD, respectively, per laboratory).

Figure 1. Two examples of partial RPD incorporated in this study. RPD supported by electroplated double crowns (EP-RPD, left); RPD supported by cast double crowns (C-RPD, right).

Different double-crown systems

In the EP-RPD group, the primary crowns (0° milling) were fabricated by casting with noble alloy (Bio Portadur; Wieland, Pforzheim, Germany). The secondary crowns were made by electroplating (Goldbath 6607 AGC; Wieland). The secondary crowns were luted to a CoCrMo framework (Remanium GM 800; Dentaurum, Ispringen, Germany) by use of a composite luting agent (AGC Cem; Wieland), which achieved passive fit. In the C-RPD group the primary and secondary crowns were made by casting (lost wax technique) with noble alloy (Bio Portadur; Wieland) and had a conical design with 6° milling. Two examples of RPD incorporated in this study are shown in Figure 1.

OHRQoL measurements

OHRQoL was measured by use of the Oral Health Impact Profile (OHIP) [19], because the OHIP is the only validated instrument in German for measuring OHRQoL in a not only geriatric collective. The measurements took place before treatment, 1 week after incorporation of the RPDs (post-treatment) and after 6, 12, 24 and 36 months. The German version of the OHIP consists of seven sub-scales containing 49 items plus four extra German-specific items (53 items) [20]. A simple summary score, OHIP-SUM (responses: never = 0, hardly ever = 1, occasionally = 2, often = 3, very often = 4), with a range from 0, indicating good self-perceived oral health, up to a maximum of 212, was calculated and interpreted as an overview of OHRQoL. OHIP was measured by use of a self-administered questionnaire but was checked subsequently by a clinician to ensure no data were missing.

Statistics

OHIP-SUM served as the dependent variable; variables used as predictors were: treatment (pre-treatment vs post-treatment), time (pre-treatment, post-treatment, 6, 12, 24 and 36 months after), double-crown

Table I. Characteristics of patients and RPDs in the two study groups.

Characteristic	C-RPDs	EP-RPDs	Statistical test	*p*
Age	65.5 (SD 8.9)	63.6 (SD 9.1)	*T*	0.37
Gender	50.0% male	76.7% male	Chi-squared	0.03
Restored arch				
Maxilla	56.7%	56.7%	Chi-squared	1.00
Mandible	43.3%	43.3%		
Number of abutment teeth	3.7 (SD 1.1)	3.5 (SD 1.3)	U	0.38
Position of abutment teeth				
Anteriors	58.0%	66.7%	Chi-squared	< 0.001
Premolars	25.9%	27.6%		
Molars	16.1%	5.7%		
Vitality of abutment teeth	75.9% vital	75.2% vital	Chi-squared	1.00
Mobility of abutment teeth				
Grade 0	55.4%	67.6%	U	0.13
Grade 1	38.4%	22.9%		
Grades 2 and 3	6.2%	9.5%		

system (EP-RPDs vs C-RPDs), age, gender, position (maxilla vs mandible) and Kennedy classification for partially edentulous arches (class I, II or III).

To investigate the change in OHIP, a two-level hierarchical model was used, with a total of $n = 318$ measurements on six occasions on the first level and $n = 53$ patients on the second level [21]. On the first level, OHIP-SUM for measurement occasion (i) for person (j) was predicted on the basis of treatment; the interaction between treatment, double-crown material and time was:

$$\text{OHIP-SUM}_{ij} = \beta 0j + \beta_1 \text{ treatment}_{ij} + \beta_2 \text{ treatment}_{ij} * \text{material}_{ij} + \beta 3j \text{ time}_{ij} + \varepsilon_{ij}$$

On the second level, the OHIP-SUM intercept was predicted on the basis of double-crown material, age, gender, position and Kennedy classification:

$$\beta 0j = \gamma_{00} + \gamma_{01} \text{ material}_j + \gamma_{02} \text{ age}_j + \gamma_{03} \text{ gender}_j + \gamma_{04} \text{ position}_j + \gamma_{05} \text{ kennedy}_j + \upsilon 0j$$

The slope of the plot of OHIP-SUM against time was predicted on the basis of the double-crown material:

$$\beta 3j = \gamma_{30} + \gamma_{31} \text{ material}_j + \upsilon 3j$$

All variables were estimated by using the restricted maximum likelihood estimator (REML) implemented in PROC MIXED (SAS 9.2). The level of probability for statistical significance was set at $\alpha = 0.05$.

Results

The two study groups showed no statistically significant differences regarding patients' age, the restored arch or the number, vitality and mobility of abutment teeth. There were more male patients in the EP-RPD group (76.7%) than in the C-RPD group (50%). The position of abutment teeth, i.e. the proportion of anterior teeth, premolars and molars, also differed significantly between the two study groups (Table I).

OHIP data were available for all patients (54) before treatment and 1 week after treatment. After 6, 12, 24 and 36 months, 53, 53, 52 and 50 patients, respectively, could be re-evaluated. Because the OHIP scores from one patient were judged to be outliers ($z > 3.00$), this patient's data were excluded from analysis.

Figure 2 shows the development of the OHIP-SUM for both groups separately for every measurement point. After treatment, a general decrease in OHIP-SUM is apparent; this is indicative of a general improvement of OHRQoL.

The model variables are shown in Table II. A significant effect was observed for treatment, i.e.

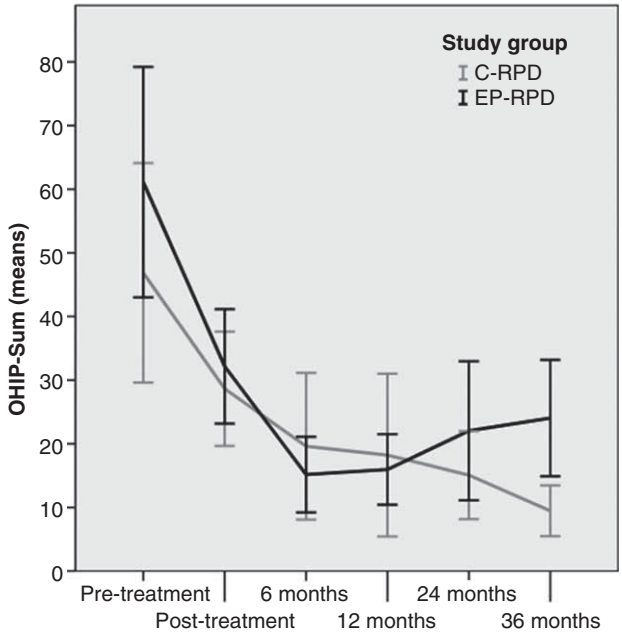

Figure 2. Development of OHIP-SUM scores (means) for both study groups.

Table II. Results from statistical analysis by use of a two-level hierarchical model. The fixed effects at level 1 describe the change of OHIP over time and the fixed effects at level 2 describe OHIP differences among patients. The random effect variances describe the unexplained variance components.

	Variable	Reference category	Estimate	Estimated variance	*t*	*z*	df	*p*
Level 1 fixed effects								
Treatment	β_1	Before treatment	38.26		7.27		51	< 0.001
Treatment–material interaction	β_2	C-RPD	−23.03		−3.13		51	0.003
Level 2 fixed effects								
Intercept	γ_{00}		37.77		1.81		46	0.077
Material	γ_{01}	C-RPD	4.41		0.63		46	0.532
Age	γ_{02}		−0.26		−0.95		46	0.345
Gender	γ_{03}	Male	−1.03		−0.19		46	0.850
Position	γ_{04}	Maxilla	−2.43		−0.45		46	0.562
Kennedy	γ_{05}	Kennedy class I	5.28		0.52		46	0.607
Kennedy	γ_{05}	Kennedy class II	−0.95		−0.09		46	0.929
Time–slope	γ_{10}		−0.02		−0.11		253	0.914
Material on time–slope	γ_{11}	C-RPD	−0.42		−1.91		253	0.058
Random effects								
Intercept	υ_{0j}			338.61		3.45		< 0.001
Time	υ_{1j}			0		0		
Residual	ε_{ij}			465.29		11.03		< 0.001

OHIP-SUM decreased after treatment (t = 7.27, p < 0.001). There was also a treatment–material interaction, indicating that treatment with EP-RPDs resulted in a larger immediate improvement of OHRQoL (t = −3.13, p < 0.003). There was also a marginally significant effect of double crown material on the slope of the plot of OHIP-SUM against time, indicative of further improvement of OHRQoL in the period after treatment with C-RPDs (t = 1.91, p = 0.058).

Discussion

In cross-sectional studies, different OHRQoL has been observed among patients with different prostheses, for example RPDs compared with fixed partial dentures [22,23] or complete dentures compared with RPDs [24]. Comparative studies have revealed differences relating to OHRQoL for implant-supported and conventional complete dentures [25–27]. Furthermore, in a randomized controlled trial and a pilot study comparing RPDs and fixed partial dentures among patients with shortened dental arches it was shown that both treatment options improved satisfaction and QoL, but significant differences between the treatment options could not be observed [28,29]. However, the effect on OHRQoL and on patient satisfaction of minor differences in the design of prosthetic restorations is covered only superficially in the current literature. In this context, partial removable dentures are of special interest, because of the many different technical possibilities in the design of such dentures.

In accordance with other findings [18,30], we showed a positive effect of treatment with RPDs, both C-RPDs and EP-RPDs, on OHRQoL. This was true not only for the effect of treatment, but also, markedly, for a time period of 36 months. Therefore, study hypothesis (i) could be accepted. The analysis also showed that there were differences between the groups with regard to estimated improvement, which led to acceptance of hypothesis (ii). The effect of treatment was lower for C-RPD initially, but the development over time was marginally better (p = 0.058). This could be seen to be consistent with the findings of the 1-year results [18], describing a trend (p = 0.15) toward greater improvement of OHRQoL with time for C-RPD. Therefore, both treatment options could improve OHRQoL, with advantages for C-RPD.

In this regard, the differences between OHIP-SUM scores for EP-RPDs and C-RPDs should be interpreted not only statistically but also clinically. A minimum important difference of six OHIP units using the OHIP questionnaire with 49 items was described by John et al. [31]. Therefore, the differences in our study after 24 months (seven OHIP units) and after 36 months (15 OHIP units) could be regarded as clinically meaningful. One possible explanation of this finding may be the clinical performance of the RPDs used in this study. However, as described elsewhere, survival differences (RPDs and

abutment teeth) between the two study groups did not reach statistical significance after 36 months [32]. Another, more plausible, explanation is that patients with EP-RPDs rated the retention and the aesthetic appearance of their dentures lower after wearing them for 1 year [18].

The strength of this study is the prospective and randomized study design with two quite homogenous study groups. Furthermore, recall periods for all patients were homogenous and the response was acceptable.

Nevertheless, it should be considered that other variables which were not evaluated, such as distribution of abutment teeth and/or the dental status in the opposite jaw with different number of occluding teeth, could be of importance for OHRQoL. Another factor to bear in mind is that various experiences of the participants with RPDs before the actual treatment might have an impact on the results.

A limitation is that, because of the limited number of patients, the general applicability of the findings might be questioned. Furthermore, a longer period than 36 months is needed to furnish substantial evidence of the superiority of one of these systems.

Summary and conclusion

Treatment with double-crown-retained RPDs with cast double crowns (C-RPDs) and electroplated double crowns (EP-RPDs) initially improved OHRQoL. Over a period of 36 months the improvement was significant, so both C-RPDs and EP-RPDs are promising therapeutic options to improve OHRQoL. Within the limitations of this study, cast double crowns with conical design seem to have advantages with regard to OHRQoL.

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References

[1] Wöstmann B, Budtz-Jorgensen E, Jepson N, Mushimoto E, Palmqvist S, Sofou A, et al. Indications for removable partial dentures: a literature review. Int J Prosthodont 2005;18: 139–45.

[2] Wagner B, Kern M. Clinical evaluation of removable partial dentures 10 years after insertion: success rates, hygienic problems, and technical failures. Clin Oral Invest 2000;4: 74–80.

[3] Wenz HJ, Hertrampf K, Lehmann KM. Clinical longevity of removable partial dentures retained by telescopic crowns: outcome of the double crown with clearance fit. Int J Prosthodont 2001;14:207–13.

[4] Saito M, Notani K, Miura Y, Kawasaki T. Complications and failures in removable partial dentures: a clinical evaluation. J Oral Rehabil 2002;29:627–33.

[5] Widbom T, Lofquist L, Widbom C, Soderfeldt B, Kronstrom M. Tooth-supported telescopic crown-retained dentures: an up to 9-year retrospective clinical follow-up study. Int J Prosthodont 2004;17:29–34.

[6] Dittmann B, Rammelsberg P. Survival of abutment teeth used for telescopic abutment retainers in removable partial dentures. Int J Prosthodont 2008;21:319–21.

[7] Koller B, Att W, Strub JR. Survival rates of teeth, implants, and double crown-retained removable dental prostheses: a systematic literature review. Int J Prosthodont 2011;24: 109–17.

[8] Verma R, Joda T, Brägger U, Wittneben JG. A systematic review of the clinical performance of tooth-retained and implant-retained double crown prostheses with a follow-up of ≥3 years. J Prosthodont 2013;22:2–12.

[9] Diedrichs G, Rosenhain P. Galvanoteleskope in der direkten Technik. Quintessenz 1991;42:49–56; in German.

[10] Wirz J, Jäger K. Galvanoteleskope - präzise, einfach und klinisch bewährt. Quintessenz 1998;49:283–92; in German.

[11] Weigl P, Hahn L, Lauer HC. Advanced biomaterials used for a new telescopic retainer for removable dentures: ceramic vs. electroplated gold copings: Part I. In vitro tribology effects. J Biomed Mater Res (Appl Biomater) 2000;53:320–36.

[12] Weigl P, Lauer HC. Advanced biomaterials used for a new telescopic retainer for removable dentures: ceramic vs. electroplated gold copings: Part II. Clinical effects. J Biomed Mater Res (Appl Biomater) 2000;53:337–47.

[13] Beuer F, Edelhoff D, Gernet W, Naumann M. Parameters affecting retentive force of electroformed double-crown systems. Clin Oral Investig 2010;14:129–35.

[14] Engels J, Schubert O, Güth JF, Hoffmann M, Jauernig C, Erdelt K, et al. Wear behavior of different double-crown systems. Clin Oral Investig 2013;17:503–10.

[15] Bayer S, Kraus D, Keilig L, Gölz L, Stark H, Enkling N. Wear of double-crown systems: electroplated vs. casted female part. J Appl Oral Sci 2012;20:384–91.

[16] Locker D. Concepts of oral health, disease and quality of life. In Slade GD, editors. Measuring oral health and quality of life. Chapel Hill, NC: University of North Carolina - Dental Ecology; 1997. p 11–24.

[17] Inglehart M, Bagramian RA. Oral health-related quality of life: an introduction. In Inglehart M, Bagramian RA, editors. Oral health-related quality of life. Chicago, Berlin: Quintessence Publishing Co; 2002. p 1–6.

[18] Grossmann AC, Hassel AJ, Schilling O, Lehmann F, Koob A, Rammelsberg P. Treatment with double crown-retained removable partial dentures and oral health-related quality of life in middle- and high-aged patients. Int J Prosthodont 2007; 20:576–8.

[19] Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health 1994; 11:3–11.

[20] John MT, Patrick DL, Slade GD. The German version of the Oral Health Impact Profile–translation and psychometric properties. Eur J Oral Sci 2002;110:425–33.

[21] Verbeke G, Molenberghs G. Linear mixed models for longitudinal data. Springer, Berlin: Heidelberg New York; 2000.

[22] John MT, LeResche L, Koepsell TD, Hujoel P, Miglioretti DL, Micheelis W. Oral health-related quality of life in Germany. Eur J Oral Sci 2003;111:483–91.
[23] McGrath C, Bedi R. An evaluation of a new measure of oral health related quality of life—OHRQoL-UK(W). Community Dent Health 2001;18:138–43.
[24] Bae KH, Kim C, Paik DI, Kim JB. A comparison of oral health related quality of life between complete and partial removable denture-wearing older adults in Korea. J Oral Rehabil 2006;33:317–22.
[25] Allen PF, McMillan AS, Walshaw D. A patient-based assessment of implant-stabilized and conventional complete dentures. J Prosthet Dent 2001;85:141–7.
[26] Awad MA, Locker D, Korner-Bitensky N, Feine JS. Measuring the effect of intra-oral implant rehabilitation on health-related quality of life in a randomized controlled clinical trial. J Dent Res 2000;79:1659–63.
[27] Heydecke G, Locker D, Awad MA, Lund JP, Feine JS. Oral and general health-related quality of life with conventional and implant dentures. Community Dent Oral Epidemiol 2003;31: 161–8.
[28] Jepson N, Allen F, Moynihan P, Kelly P, Thomason M. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. Int J Prosthodont 2003;16:409–14.
[29] Wolfart S, Heydecke G, Luthardt RG, Marre B, Freesmeyer WB, Stark H. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. J Oral Rehabil 2005;32:815–22.
[30] John MT, Slade GD, Szentpetery A, Setz JM. Oral health-related quality of life in patients treated with fixed, removable, and complete dentures 1 month and 6 to 12 months after treatment. Int J Prosthodont 2004;17:503–11.
[31] John MT, Reissmann DR, Szentpétery A, Steele J. An approach to define clinical significance in prosthodontics. J Prosthodont 2009;15:446–50.
[32] Stober T, Bermejo JL, Beck-Mussoter J, Seche AC, Lehmann F, Koob J, et al. Clinical performance of conical and electroplated telescopic double crown-retained partial dentures: a randomized clinical study. Int J Prosthodont 2012;25:209–16.