Clinical Performance of Conical and Electroplated Telescopic Double Crown–Retained Partial Dentures: A Randomized Clinical Study

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Purpose: The aim of this study was to quantify and compare the clinical performance of cast conical double crown–retained removable partial dentures (C-RPDs) and electroplated double crown–retained removable partial dentures (EP-RPDs). ***Materials and Methods:*** A total of 60 RPDs were placed in 54 patients. Participants were randomly assigned to two study groups (C-RPD and EP-RPD). Altogether, 217 abutment teeth were provided with double crowns. Patients were reexamined after 6, 12, 24, and 36 months. The main endpoints were the survival times of RPDs and abutment teeth; secondary endpoints included failure of the facing, loss of cementation of primary crowns, and postprosthetic endodontic treatment. Chi-square tests were used to evaluate group differences regarding characteristics of patients and RPDs. Survival differences were investigated using the log-rank test and Cox regression; secondary endpoints were assessed using logistic regression. ***Results:*** After 36 months, survival was 100% for C-RPDs and 93.3% for EP-RPDs. Cumulative survival for abutment teeth was 97.3% (C-RPDs) and 96.2% (EP-RPDs). Survival differences between the two study groups did not reach statistical significance. The survival of abutments depended on tooth vitality and position; for example, the hazard of tooth loss was 676% higher for nonvital teeth. No differences were found between study groups regarding facing failure, decementation of primary crowns, or postprosthetic endodontic treatment. ***Conclusions:*** Vitality and position are important to the survival of teeth supporting partial dentures. Longer follow-up and larger patient collectives are needed to evaluate possible differences between cast conical and electroplated telescopic double crown–retained partial dentures. *Int J Prosthodont 2012;25:209–216.*

Clinicians can choose from a variety of materials and techniques for rehabilitation of partially edentulous patients. An important treatment option is the incorporation of removable partial dentures (RPDs). When considering the design of RPDs, clinicians are often confronted by many different technical possibilities, especially with regard to selection of the mechanism of retention. Anchoring elements used include technically simple and inexpensive retainers (eg, clasps) or more complicated and expensive elements (eg, double crowns); both have been proven clinically to be suitable treatment options in prosthetic dentistry.[1–14]

Double crown–retained RPDs can be designed with either conical or telescopic crowns (6- and 0-degree milling of the primary and secondary crown, respectively). For conical crowns, retention between the primary and secondary crowns is primarily based on static friction between the crowns toward the end of the joining process.[15,16] The mechanism of retention of conventional manually fabricated cast telescopic double crowns is basically the same, but in contrast with conical crowns, the adhesive forces operate during the entire joining process between the primary and secondary crowns (static and dynamic friction).[15,16] The fabrication of cast double crowns demands highly skilled dental technicians. Furthermore, because retention of RPDs with cast conical or telescopic crowns is difficult to determine and could vary in an uncontrolled fashion over long periods of use,[16] new double crown retainers with secondary crowns made of electroplated gold have been developed.[16–18] In contrast with cast secondary crowns, telescopic

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double crown systems with electroplated secondary crowns above all utilize the principle of hydraulic adhesion resulting from the film of saliva between the two crowns.[16] RPDs retained with electroplated telescopic double crowns are believed to be more comfortable for the patient to wear because of the stress-free fit, mostly resulting from the automatic fabrication of the secondary crown using the electroplating process, and the constant effort required for removal without unpredictable increase or decrease in retentive force over a long period of time.[16–18]

Reports on the clinical performance of conventional cast double crown–retained RPDs, eg, survival of RPDs with conical or telescopic double crowns, survival of abutment teeth, and complications, are available.[1–14] However, according to the current dental literature, little is known about the clinical performance of RPDs retained by double crowns with electroplated telescopic secondary crowns.[18] Randomized clinical trials are lacking.

A prospective, randomized clinical trial was conducted to investigate survival and complications of RPDs with different double crowns. The authors previously reported on the oral health–related quality of life of these patients during the first year after treatment and found that it was not significantly different between groups.[19] The objectives of this study were to quantify and compare the clinical performance of cast conical double crown–retained RPDs (C-RPDs) and electroplated double crown–retained RPDs (EP-RPDs). Survival of the RPDs and abutment teeth and common technical and biologic complications in the two groups were also investigated.

Materials and Methods

The study procedure was checked and approved by the local ethics committee (ethical approval: local university review board, no. 074/2003). Fifty-four patients with an indication for RPDs with at least two and a maximum of six abutment teeth were included in the study. Written consent was a precondition for participation. The patients' ages ranged from 38 to 80 years, with a mean age of 64 ± 9 years; 34 (63.3%) patients were men. Participants were randomly assigned to one of the two study groups: C-RPD or EP-RPD. Six participants received RPD treatment in both arches, which resulted in the fabrication of a total of 60 RPDs (n = 30 RPDs in each group). Thirty dentures (n = 15 in both treatment groups) were provided by students and the others by dentists in the Department of Prosthodontics, University Hospital Heidelberg, Heidelberg, Germany. The dentures were made in two dental laboratories (n = 30 dentures in each laboratory) by dental technicians with more than 5 years of experience in both fabrication techniques. Altogether, 217 abutment teeth were provided with double crowns (135 anterior teeth, 58 premolars, 24 molars).

Double Crown Systems

All clinical and technical procedures were performed in strict agreement with a clinical and technical instruction protocol. In the C-RPD group, the double crowns had a conical design with 6-degree milling. The primary and secondary crowns were composed of precious alloy (Bio Portadur, Wieland), and the secondary crown was conventionally cast using the lost wax technique. In the EP-RPD group, the primary crowns (0-degree milling) were also fabricated by casting with precious alloy (Bio Portadur). In contrast, the secondary crowns of the double crown–retained elements were made by electroforming (Goldbath 6607 AGC, Wieland). The secondary crowns were luted to the cobalt-chromium-molybdenum framework (remanium GM 800, Dentaurum) with a composite resin luting agent (AGC Cem, Wieland), which achieved passive fit of the restoration. The buccal and/or occlusal surfaces of the secondary crowns were prepared by use of the Rocatec Universal Bonding System (3M ESPE) and faced with veneering composite resins (Sinfony, 3M ESPE; Signum, Heraeus Kulzer). The primary crowns were luted nonadhesively to the abutment teeth using a glass-ionomer luting cement (Ketac-Cem Aplicap, 3M ESPE).

Measurements

Clinical evaluation was performed by five calibrated dentists using a case record file in written form. Criteria for failures and complications were: failure (renewal) or survival of RPD, failure (extraction) or survival of abutment teeth, loss or fracture of facing with a need for repair, loss of cementation of primary crown, and need for postprosthetic endodontic treatment. The first clinical evaluation (baseline) was 1 week after incorporation of the RPD. After 6, 12, 24, and 36 months, 53, 52, 51, and 49 patients were reevaluated, respectively.

Statistical Analysis

Chi-square tests were used to evaluate group differences regarding characteristics of patients and RPDs. Survival differences were investigated by use of log-rank tests and Cox regression; secondary data were assessed using logistic regression. Calculations were implemented using SAS version 8.2 (SAS).

Table 1 Characteristics of Patients and RPDs

	C-RPD	EP-RPD	Statistical test	*P**
Mean age (y)	65.5 ± 8.9	63.6 ± 9.1	*t*	.37
Sex	50.0% male	76.7% male	Chi-square	**.03**
Restored arch				
Maxilla	56.7%	56.7%		
Mandible	43.3%	43.3%	Chi-square	> .99
No. of abutment teeth	3.7 ± 1.1	3.5 ± 1.3	*U*	.38
Position of abutment teeth				
Anterior	58.0%	66.7%		
Premolar	25.9%	27.6%	Chi-square	**< .001**
Molar	16.1%	5.7%		
Vitality of abutment teeth	75.9% vital	75.2% vital	Chi-square	> .99
Mobility of abutment teeth				
Grade 0	55.4%	67.6%		
Grade 1	38.4%	22.9%	*U*	.13
Grades 2 and 3	6.2%	9.5%		

*Bold values represent statistical significance at the 5% confidence level.

Results

The two study groups were similar regarding age, the restored arch, and the number, vitality, and mobility of abutment teeth. The proportion of male patients was 76.7% in the EP-RPD group and 50.0% in the C-RPD group. The position of abutment teeth, ie, the proportion of anterior teeth, premolars, and molars, differed significantly between the two study groups (Table 1).

Over a period of 36 months, 2 of 30 (6.7%) EP-RPDs failed and had to be replaced. Reasons for failure included technical defects (loss of retention) and loss of abutment teeth. No failure occurred in the C-RPD group. Regarding abutment teeth, the median survival time of extracted teeth was 23 months. Three of 112 teeth (2.7%) had to be extracted in the C-RPD group because of caries (n = 2) or periodontal/endodontic disease (n = 1). In the EP-RPD group, 4 of 105 abutment teeth (3.8%) had to be extracted because of caries (n = 2), tooth fracture (n = 1), or periodontal disease (n = 1). The resulting cumulative survival of abutment teeth after 36 months was 97.3% for C-RPDs and 96.2% for EP-RPDs. The difference in tooth survival between the two study groups was not significant. A higher risk of failure was observed for nonvital abutment teeth than vital teeth (hazard ratio: 7.76, $P = .01$). The failure risk was highest for premolars, followed by molars and anterior teeth ($P = .07$). There were no differences with regard to the age and sex of patients or number, arch, and mobility of abutment teeth (Table 2 [probability values from Cox regression] and Figs 1a to 1c [probability values from log-rank tests]).

Complications

Altogether, 26 losses or fractures of facings occurred. More failures of facings occurred in the EP-RPD group (n = 16, 15.2%) than in the C-RPD group (n = 10, 8.9%), but this difference did not reach statistical significance. The number of abutment teeth in the RPD significantly increased the risk of facing loss (odds ratio: 2.03, $P < .001$) (Table 3). No significant differences between study groups were found for loss of cementation of primary crowns. In the C-RPD group, 7 (6.3%) decementations occurred; 6 (5.7%) occurred in the EP-RPD group. All primary crowns that were lost could be luted again. Other patient or abutment tooth characteristics had no effect on the loss of cementation of primary crowns (Table 4). Only 6 of 164 vital abutment teeth (3.7%) needed postprosthetic endodontic treatment: 3 in the C-RPD group and 3 in the EP-RPD group. No relationship was found between study group and incidence of postprosthetic endodontic treatment (Table 5).

Table 2 Hazard Ratio (HR) of Tooth Loss According to Study Group and Characteristics of Patients and RPDs

	No. of teeth	No. of lost teeth	*P**	HR (95% CI)
Study group				
C-RPD	112	3	.64	Reference
EP-RPD	105	4		1.43 (0.32 to 6.40)
Age (y)				
Median: 65 (range: 38 to 80)	217	7	.42	1.05 (0.94 to 1.16)
Sex				
Male	142	5	.75	Reference
Female	75	2		0.76 (0.15 to 3.93)
Arch				
Maxilla	130	3	.38	Reference
Mandible	87	4		1.95 (0.44 to 8.73)
No. of abutment teeth				
Median: 3 (range: 2 to 6)	217	7	.73	1.12 (0.59 to 2.11)
Position of abutment teeth				
Anterior	135	1	.07	Reference
Premolar	58	5		12.40 (1.45 to 106)†
Molar	24	1		5.76 (0.36 to 92.0)
Vitality of abutment teeth				
Nonvital	53	5	**.01**	7.76 (1.51 to 40.0)
Vital	164	2		Reference
Mobility of abutment teeth				
Median: 0 (range: 0 to 3)	217	7	.34	1.60 (0.60 to 4.25)

CI = confidence interval.
*Bold values represent statistical significance at the 5% confidence level.
†$P = .02$.

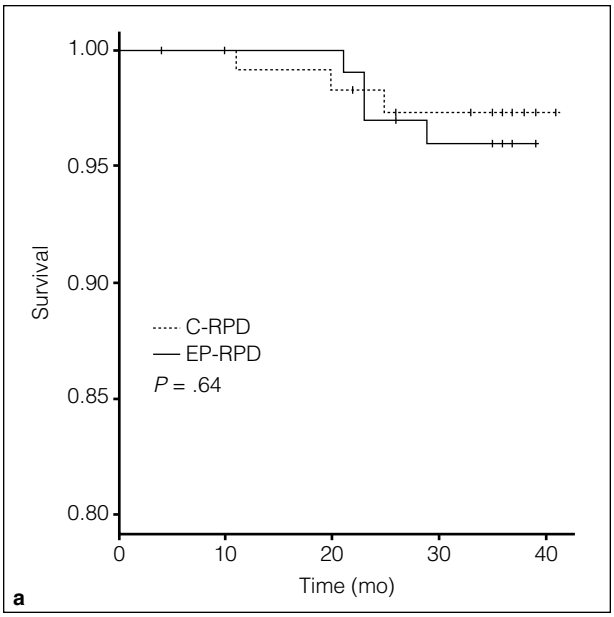
Discussion

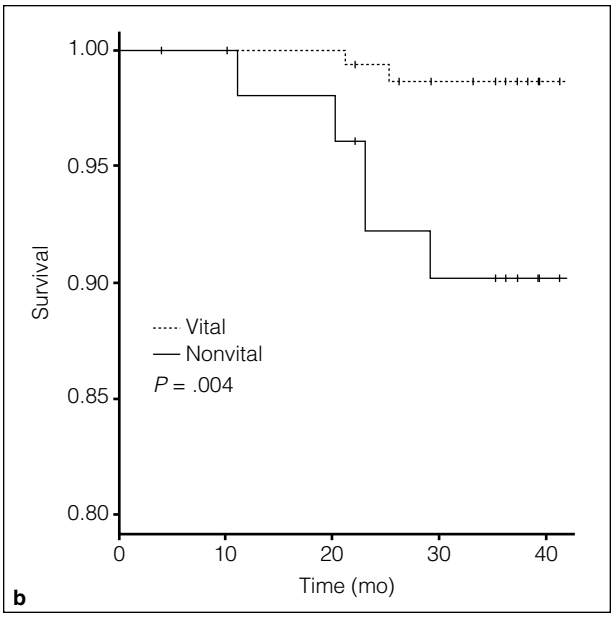
Long-term success of prosthodontic treatment with RPDs strongly depends on useful function of the denture and survival of the abutment teeth. The results of this study after 36 months show few differences between cast conical crowns and electroplated telescopic crown–retained RPDs. This is in agreement with a previous clinical study that concluded that success was comparable for different types of double crown retainers (telescopic crowns, conical crowns, and resilience telescopic crowns).[12]

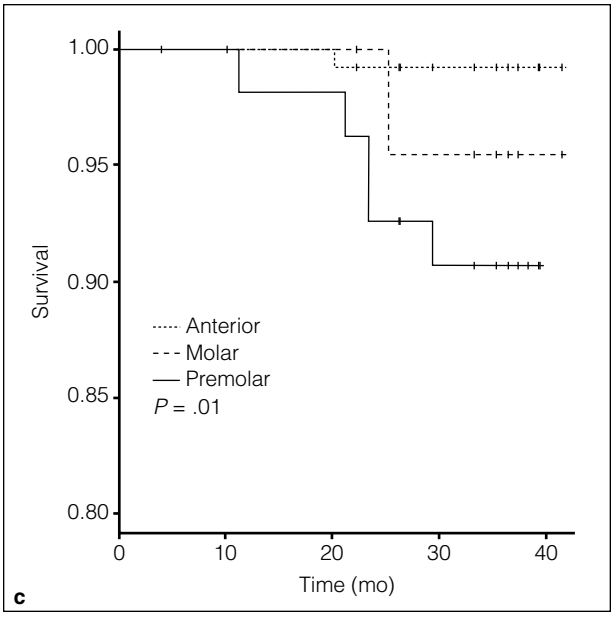
After 36 months, survival was 100% for C-RPDs and 93.3% for EP-RPDs, which is comparable with results from previous studies.[8,11] In the literature, survival of double crown–retained RPDs for longer observation periods varies between 66.7% and 98.8%.[1,5,13]

Survival of the abutment teeth in this study was also similar to that in previous investigations.[8,9,12,14] Other groups found survival of abutment teeth with double crowns to be 93.3% after a mean observation period of 3 years,[14] 93% after 3.8 years,[8] 93.3% after 4.9 years,[9] and 91.2% after 6.3 years.[12] In agreement with a number of previous reports,[10,12,14,20,21] the significant effect of tooth vitality on survival of abutment teeth for double crown–retained RPDs was confirmed with the patients in this study. For example, Dittmann and Rammelsberg[12] reported a survival of 94.3% for vital abutment teeth and 80% for nonvital abutment teeth used for telescopic dentures after a mean observation period of 6.3 years. Furthermore, it was shown that failure was greater for posterior teeth with double crowns than for anterior teeth.[12] In this study, the risk of failure also tended to be higher for premolars and molars than for anterior teeth. Long-term studies as well as the results of this study have shown that the most common reasons for abutment tooth loss were biologic complications, eg, periodontal disease, caries, or fracture of the tooth.[4,8,9,14]

One weakness of double crown–retained RPDs is the facing of the secondary crown. In this study, 8.9% of C-RPDs and 15.2% of EP-RPDs needed repairs of facings; these are within the ranges reported in the literature.[2,3,5,11] Functional overload and elastic deformation of the secondary crown are considered to be responsible for loss or fracture of facings.[2,3,8,11] Although repair of lost facings is not a complex technical procedure, improvements in the facing technique, particularly in the bonding between facing composite resins and secondary crowns, are desirable.







Figs 1a to 1c Survival of **(a)** abutment teeth according to study group, **(b)** tooth vitality, and **(c)** tooth position.

In the current literature, loss of cementation of the primary crown is described as one of the most frequently occurring technical complications of double crown–retained RPDs.[3,8,11,13] Previous clinical investigations have reported loss of cementation between 11% and 26%.[1,3,11,14] According to Behr et al,[13] more than 75% of patients with telescopic double crown–retained RPDs experienced at least one instance of loss of cementation within 10 years. To reduce maintenance needs in the future, the authors suggest use of adhesive resin cements to lute primary crowns.[13] In this study, the occurrence of decementation (13 of 217, 6%) seems somewhat lower than that reported in the literature, which may be a result of the tooth preparation technique and consequent use of glass-ionomer cement for luting the primary crowns. Another factor affecting loss of cementation may be the retentive forces between the primary and secondary crown of the double crown retainers. In clinical function, retentive forces of manually fabricated, cast conical double crowns are unpredictable[16,17]; increased retention may result in greater loss of cementation. On the other hand, with electroplated double crowns, ease of handling without unpredictable

Table 3 Odds Ratio (OR) for Partial and Total Loss of Facings of Abutment Teeth After 36 Months According to Study Group and Patient and Tooth Characteristics

	No. of teeth	No. of lost facings	*P**	OR (95% CI)
Study group				
C-RPD	112	10	.16	Reference
EP-RPD	105	16		0.92 (0.81 to 1.03)
Age (y)				
Median: 65 (range: 38 to 80)	217	26	.72	1.01 (0.96 to 1.06)
Sex				
Male	142	20	.72	Reference
Female	75	6		0.53 (0.20 to 1.38)
Arch				
Maxilla	130	19	.15	Reference
Mandible	87	7		0.51 (0.21 to 1.27)
No. of abutment teeth				
Median: 3 (range: 2 to 6)	217	26	**< .001**	2.03 (1.37 to 3.01)
Position of abutment teeth				
Anterior	135	18	.65	Reference
Premolar	58	5		0.61 (0.22 to 1.74)
Molar	24	3		0.93 (0.25 to 3.43)
Vitality of abutment teeth				
Nonvital	53	6	.86	0.92 (0.35 to 2.42)
Vital	164	20		Reference
Mobility of abutment teeth				
Median: 0 (range: 0 to 3)	217	26	.80	1.08 (0.58 to 2.00)

CI = confidence interval.
*Bold values represent statistical significance at the 5% confidence level.

Table 4 Odds Ratio (OR) for Decementation of Primary Crowns After 36 Months According to Study Group and Patient and Tooth Characteristics

	No. of teeth	Loss of cementation	*P*	OR (95% CI)
Study group				
C-RPD	112	7	.87	Reference
EP-RPD	105	6		0.91 (0.30 to 2.80)
Age (y)				
Median: 65 (range: 38 to 80)	217	13	.95	1.00 (0.94 to 1.07)
Sex				
Male	142	7	.37	Reference
Female	75	6		1.68 (0.54 to 5.18)
Arch				
Maxilla	130	6	.34	Reference
Mandible	87	7		1.81 (0.59 to 5.58)
No. of abutment teeth				
Median: 3 (range: 2 to 6)	217	13	.80	0.94 (0.58 to 1.51)
Position of abutment teeth				
Anterior	135	6	.32	Reference
Premolar	58	4		1.59 (0.43 to 5.87)
Molar	24	3		3.07 (0.71 to 13.2)
Vitality of abutment teeth				
Nonvital	53	4	.58	1.41 (0.42 to 4.77)
Vital	164	9		Reference
Mobility of abutment teeth				
Median: 0 (range: 0 to 3)	217	13	.21	1.62 (0.76 to 3.45)

CI = confidence interval.

Table 5 Odds Ratio (OR) for Endodontic Treatment of Abutment Teeth After 36 Months According to Study Group and Patient and Tooth Characteristics

	No. of teeth	Endodontic treatments	*P*	OR (95% CI)
Study group				
C-RPD	112	3	.94	Reference
EP-RPD	105	3		1.07 (0.21 to 5.42)
Age (y)				
Median: 65 (range: 38 to 80)	217	6	.98	1.00 (0.91 to 1.10)
Sex				
Male	142	5	.37	Reference
Female	75	1		0.37 (0.04 to 3.23)
Arch				
Maxilla	130	5	.26	Reference
Mandible	87	1		0.29 (0.03 to 2.53)
No. of abutment teeth				
Median: 3 (range: 2 to 6)	217	6	.48	0.78 (0.38 to 1.57)
Position of abutment teeth				
Anterior	135	5	.78	Reference
Premolar	58	1		0.46 (0.05 to 3.99)
Molar	24	0		–
Vitality of abutment teeth				
Nonvital	53	0	–	–
Vital	164	6		–
Mobility of abutment teeth				
Median: 0 (range: 0 to 3)	217	6	.60	0.68 (0.16 to 2.89)

CI = confidence interval.

increase or decrease in retentive forces could be expected.[16,17] In this study, there was no significant difference between C-RPDs and EP-RPDs regarding loss of cementation of primary crowns. Loss of cementation in the first 3 years was a rare event, and larger studies and longer observation periods are required to evaluate this complication.

Postprosthetic endodontic treatment of abutment teeth may be necessary if pulp damage caused by tooth preparation or secondary caries lesions occurs. According to Murray et al,[22] a remaining dentin thickness of 0.5 mm or more is necessary to avoid evidence of pulp injury. Thus, removal of enamel and dentin during tooth preparation should be as minimal as possible. In this study, only 3.7% of vital abutment teeth needed postprosthetic endodontic treatment; the type of double crown had no effect. This is not surprising because both retainer systems need comparable space, and therefore, removal of enamel and dentin is nearly equal. Previous studies with double crown–retained RPDs calculated the risk of postprosthetic endodontic treatment to be 6% after 5 years,[6] 5% to 6% after 3.8 years,[8] and 81.6% to 87.2% after 10 years.[13] Considering the risk of pulp damage caused by tooth preparation, the use of clasp-retained RPDs could be a reasonable alternative to double crown–retained RPDs. On the other hand, a natural appearance and similarity to natural teeth is an important reason for choosing or refusing prosthodontic treatment.[23] Considering this, double crowns with facings are advantageous.

A strength of this study was the prospective, randomized study design with two homogenous study groups. Dropouts were very low. Only two dental laboratories with highly skilled dental technicians were involved, and all clinical evaluations were performed by calibrated dentists. The statistical results were almost identical when the dependence of observations within patients and within RPDs was considered. For example, the estimates of loss of facing according to the number of abutment teeth in Table 3 (odds ratio: 2.03, 95% confidence interval: 1.37 to 3.01, $P < .001$) only slightly changed (odds ratio: 2.03, 95% confidence interval: 1.23 to 3.35, $P = .006$) when clustering of the teeth within RPDs was considered in the logistic regression.

A weakness of the study was the relatively small number of participants and events, which limits the statistical power. Therefore, the results should be interpreted with caution, bearing in mind that nonsignificant results do not imply the absence of an effect. Multicenter studies that involve more participants and longer follow-up times are proposed for future investigations. Patients from dental offices should be

included to avoid selection bias. Longer follow-up observations of the patients will show if the clinical performance of C-RPDs and EP-RPDs is equal over time. It must be kept in mind that an increase in self-perceived health and oral health-related quality of life should be the objectives of prosthetic therapy.[24] Therefore, different treatment options must be evaluated to assess not only clinical performance but also oral health–related quality of life.

Conclusions

After 36 months, conical and electroplated telescopic double crown–retained partial dentures showed good clinical performance; both are suitable treatment options in prosthetic dentistry. Survival of teeth supporting partial dentures is influenced by tooth vitality and tooth position. Longer follow-up and larger patient collectives are needed to evaluate possible differences between cast conical and electroplated telescopic double crown–retained partial dentures.

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