Clinical Longevity of Removable Partial Dentures Retained by Telescopic Crowns: Outcome of the Double Crown with Clearance Fit

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Purpose: It was the aim of this study to investigate the long-term success of a telescopic crown system that can be used for both rigid and resilient support and to evaluate by means of a literature review whether the use of resilient support may be advantageous compared to other double crown systems when the restoration is placed on only a few remaining teeth. **Materials and Methods:** Patient records were used to evaluate 125 dentures (with 460 abutment teeth) based on the Marburg double crown system. The loss of abutment teeth, endodontic treatment, and fracture of the metallic framework were investigated with regard to the different types of denture support. **Results:** The probability that a patient would have kept all abutment teeth was 84% after 5 years and 66% after 10 years. No significant differences were found for the two groups "resilient support" (≤ three abutment teeth) and "rigid support" (≥ four abutment teeth). For abutment teeth with a double crown with clearance fit, the risk of loss was 4% after 5 years and 15% after 10 years for rigid support, and 10% and 24%, respectively, for resilient support. The risk of endodontic treatment was 7% after 5 years and 9% after 10 years for rigid support, and 3% and 7%, respectively, for resilient support. None of the denture frameworks showed a fracture during the observation period. **Conclusion:** Removable partial dentures retained by double crowns with clearance fit and constructed without major or minor connectors provide good clinical longevity. The survival rates of abutment teeth were comparable to those reported in the literature for other double crown systems. There was no significant increase of the risk of abutment loss when the restoration was placed on three or fewer remaining teeth and the concept of resilient support was applied. *Int J Prosthodont 2001;14:207–213.*

Clinical longevity of removable partial dentures (RPD) is essentially influenced by the applied restorative concept of connecting the removable denture with the remaining teeth. With regard to number, alignment, and periodontal status of the remaining teeth, the clinician has to select the appropriate retainer for a long-term successful restoration, also considering the esthetic demands and financial limitations of the patient.

Telescopic or double crowns have proven an effective means of retaining RPDs. They transfer forces along the long axis of the abutment teeth and provide guidance, support, and protection from movements that might dislodge the denture. Three different types of double crown systems are used to retain RPDs. They are distinguished from each other by their differing retention mechanisms. Telescopic crowns achieve retention using friction of parallel-milled surfaces, and conical crowns exhibit friction only when completely seated using a "wedging effect," whereas the double crown with clearance fit exhibits no friction or wedging during insertion or removal. Retention is achieved by using additional attachments.

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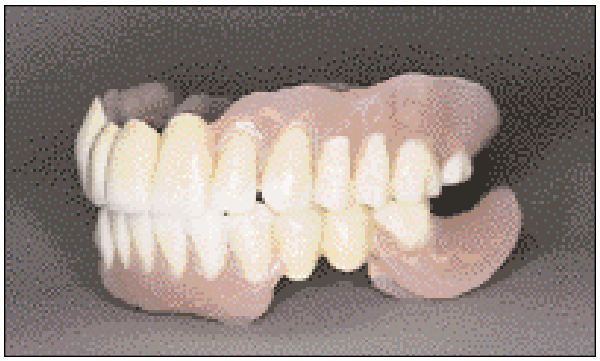

Fig 1a Restoration of maxilla and mandible (male patient, age 75). The MDC system is a complete-arch reconstruction; double crowns with clearance fit are usually fabricated for all remaining teeth of the respective arch.

Fig 1b Restoration of maxilla and mandible.

Fig 1c Because of the high rigidity of the framework, major connectors can be avoided, and outer crowns serve as minor connectors. Adjacent to the abutment teeth, the denture base is perioprotective—similar in design to fixed partial dentures to facilitate cleaning and other hygiene procedures.

Fig 1d The marginal periodontium of the abutment teeth is not covered by the denture base.

Contrary to other telescopic crown systems, double crowns with clearance fit can be used to retain both tooth-supported (rigid support) and mucosa-supported (resilient support) RPDs. A previous study[1] described a concept using a perioprotective denture design and double crowns with clearance fit as retainers for the restoration of the partially edentulous arch.

It was the aim of this study to investigate the long-term clinical success of this double crown system and to evaluate by means of a literature review whether the use of resilient support may be advantageous compared to other double crown systems when the restoration is placed on only a few remaining teeth.

Materials and Methods

Treatment Concept

All restorations were based on the Marburg double crown system (MDC system),[1] which was first described by Lehmann and Gente[2] in 1988. The MDC system is a complete-arch reconstruction. With very few exceptions, double crowns are fabricated for all remaining teeth of the respective arch. All occluding surfaces of the complete-arch removable device are usually fabricated in composite resin to facilitate occlusal adjustments. The marginal periodontium of the abutment teeth is not covered by the denture base. Adjacent to the abutment teeth, the denture base is perioprotective—similar in design to fixed partial dentures to facilitate cleaning and other hygiene procedures. Distal extension saddles are functionally extended to provide maximum support (Fig 1).

The inner crowns and framework of the denture are precisely cast in a cobalt-chromium-molybdenum alloy. The inner crown, which is luted onto the abutment tooth, is a thin, cast coping. The framework, including the outer crowns, is cast in one piece without any soldering or welding. Because of the high elastic modulus of the Co-Cr-Mo alloy and the resulting rigidity of the framework, major connectors can be avoided, and outer crowns serve as minor connectors (Fig 1c).

Table 1 Patient Characteristics by Denture Support Type

	Rigid support (n = 55)	Resilient support (n = 70)
Age (y)		
Mean	54.5 ± 11.0	58.5 ± 13.3
Range	25–78	18–81
Gender		
Female	19 (35%)	22 (31%)
Male	36 (65%)	48 (69%)
Jaw		
Maxilla	39 (71%)	38 (54%)
Mandible	16 (29%)	32 (46%)

Table 2 Observation Period (y) and Service Time (y) by Denture Support Type

	Rigid support (n = 316)	Resilient support (n = 144)
Abutments per denture		
Mean	5.8 ± 1.5	2.1 ± 0.7
Range	4–9	1–3
Observation period		
Mean	4.0 ± 3.7	4.2 ± 3.6
Max	14.4	14.1
Length of service		
> 5	97 (31%)	45 (31%)
> 10	44 (14%)	19 (13%)

The outer crown fits onto the inner crown without any friction or wedging. This clearance fit is precise, allowing a minimal, invisible lateral movement and a smooth, effortless gliding along the axis of the path of insertion. To achieve retention, the authors use the TC-SNAP system (Si-tec). To enable resilient support, the RPD is fabricated with an occlusal space of 0.3 to 0.5 mm between the inner and outer crowns.[1] If occlusal load is applied, the denture moves in an occlusoapical direction, depending on the resilience of the denture-supporting mucosa, and returns to its former position after the load is removed.

Study Population

The records of patients who obtained an RPD retained by double crowns with clearance fit between 1984 and 1998 in the Department of Preclinical and Maxillofacial Prosthodontics, Marburg School of Dental Medicine were checked as to whether endodontic treatment and extraction of abutment teeth had taken place. The restorations were subdivided into two groups: *(1)* RPDs that were supported by four or more abutment teeth were fabricated to be tooth supported, with a definite terminal stop between inner and outer crown, and constituted the "rigid support" group; and *(2)* RPDs that were supported by three or fewer abutment teeth were fabricated to be mucosa supported and constituted the "resilient support" group. RPDs with observation periods of less than 6 months were not included in the study.

Seventy (56%) of the restorations were classified into the resilient support group, and 55 (44%) were classified into the rigid support group. The mean age of the patients at the time of insertion was 56.7 years (standard deviation 12.4 years, range 18 to 81 years). Seventy-seven (62%) of the dentures were fabricated for the restoration of the maxilla, and 48 (38%) were for the mandible. About two thirds (67%) were fabricated for male patients. The distribution of the parameters in the rigid and resilient groups is illustrated in Table 1. Of the 125 dentures investigated, 33 (26%) were fabricated to restore partially edentulous jaws that included intraoral defects. They were placed at least 2 years after tumor surgery, and their distribution into the rigid support (41%) and the resilient support groups (59%) was very similar.

The mean observation period of the dentures was 4.1 ± 3.6 years, with a minimum observation time of 0.5 years and a maximum observation period of 14.4 years. Thirty-four (27%) of the dentures had been in service for more than 5 years and 15 (12%) for more than 10 years. Observation period and service time were practically identical for both groups of dentures. The 125 RPDs were retained by a total of 460 abutment teeth (with a range of one to nine per denture). Their distribution into the rigid and resilient groups is illustrated in Table 2.

Statistical Evaluation

The survival estimation of Kaplan and Meier[3] was used to evaluate the survival probability of the dentures and the risk of abutment loss or endodontic treatment. This nonparametric method calculates the survival probability for each time between incorporation of the denture and the maximum observation time. The statistical unit was either the denture or the abutment tooth (the vital abutment tooth for the risk of endodontic treatment). The period of observation started with the date of insertion determined by the record's notes. It ended with the last documented recall examination (positive censored event) or with the date of extraction or pulp extirpation of the abutment tooth (negative uncensored event). The program STATA[4] was used to calculate the survival curves including the 95% confidence interval; the significance of differences between survival curves was determined with the log rank test.[5]

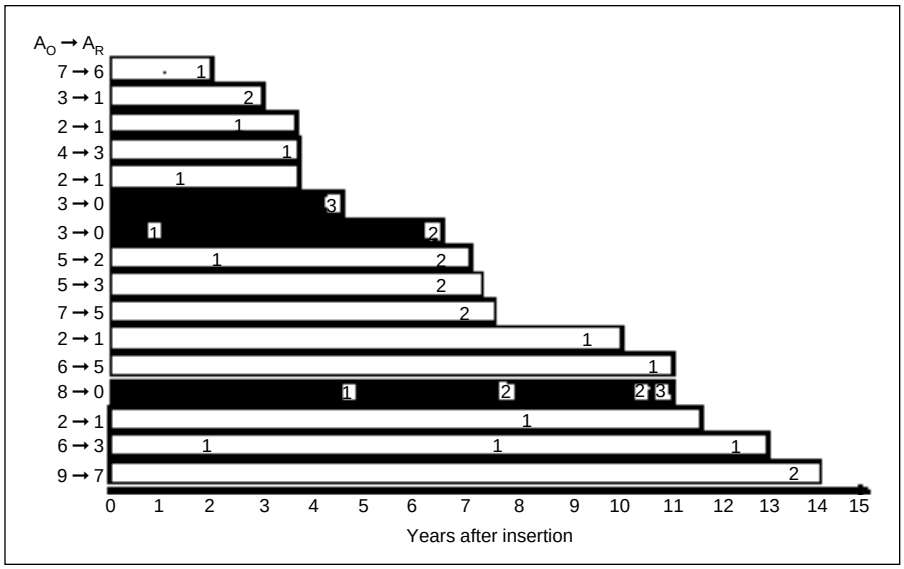

Fig 2 Length of observation period and individual distribution of time and number of lost abutments for the 16 dentures that lost abutment teeth. A_O = No. of abutment teeth at the time of insertion; A_R = No. of abutment teeth at the end of observation period.

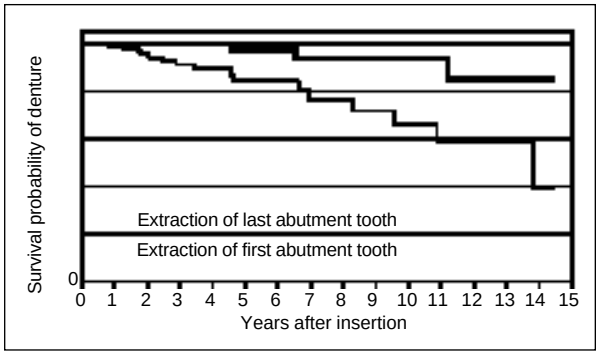

Fig 3 Survival probability (Kaplan-Meier) of losing all abutment teeth of the denture retained with double crowns with clearance fit (extraction of last abutment tooth) and of keeping all abutment teeth (extraction of first abutment).

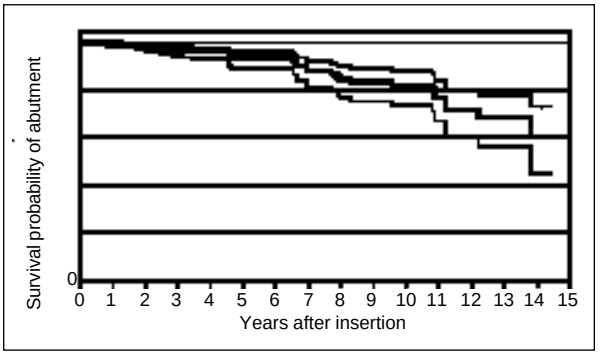

Fig 4 Survival probability (Kaplan-Meier) of the abutment tooth (double crown with clearance fit), calculated for all abutments (n = 460) with 95% confidence interval.

Results

Sixteen (13%) of 125 dentures lost a total of 35 abutment teeth. Three dentures lost all of their abutment teeth and were transformed into complete dentures. The individual distribution of time and number of lost abutments is illustrated in Fig 2.

The estimated probability that a patient would have kept all abutment teeth was 84% after 5 years and 66% after 10 years. The estimated probability that a patient would have lost all abutment teeth was 3% after 5 years and 6% after 10 years (Fig 3 and Table 3). No significant differences were found between the resilient support and rigid support groups.

The estimated risk of abutment loss was 6% after 5 years and 18% after 10 years for all abutments (Fig 4). It was nonsignificantly higher in the resilient group than in the rigid group (Table 4).

Of the 460 abutment teeth, 53 had endodontic treatment in combination with posts and cores prior to the insertion of the new restoration. Of the 407 vital abutment teeth, 17 (4%) needed endodontic treatment after the insertion of the denture. The estimated risk of endodontic treatment was 6% after 5 years and 8% after 10 years for all abutments, with similar values for the two groups (Table 5). None of the metal frameworks showed a fracture during the observation period.

Discussion

When double crowns are chosen to retain an RPD, two different treatment concepts are typically applied. Either double crowns are fabricated for only two or three selected teeth of the remaining dentition, or they are fabricated for all remaining teeth of the respective arch. When evaluating clinical longevity of double crown systems, it has to be considered that abutment selection differs essentially for both treatment concepts. Similar to combined fixed-removable restorations with precision attachments, abutment selection is crucial for the long-term success of the whole restoration when the removable denture is retained by only two or three selected abutment teeth of the remaining dentition. Because abutment loss will usually result in costly repair or redoing of the complete restoration, only teeth with an excellent prognosis should be selected to retain the RPD.

On the other hand, when double crowns are fabricated for all remaining teeth, it is easy to compensate for abutment loss because this concept enables easy modification with maintained function of the restoration. Thus, indications for its use include dentitions with few remaining teeth, often with unfavorable locations and doubtful or heterogeneous prognosis.[6,7] Complications such as loss of one or several abutments may therefore occur more frequently.[8] Despite the described differences, survival probabilities for the abutment teeth reported in the literature[9–13] are surprisingly similar for the two concepts (Table 6). Nevertheless, a similar risk of abutment loss will not necessarily result in a similar denture survival. In this study, an estimated risk of abutment loss of 18% after 10 years resulted in the conversion of only three dentures (2%) into complete dentures, and no costly remakes were required. On the contrary, a risk of abutment loss of 19% after 8 years resulted in the complete remake of 15% of the investigated dentures because the success of the whole restoration depended on the survival of selected abutment teeth.[11]

One major advantage of the double crown with clearance fit is that insertion and removal of the denture are easy to perform for the patients because retention is achieved by an exchangeable attachment. Retentive forces of friction-fit and conical double crowns are clinically difficult to control. For conical crown-retained RPDs, different authors report a marked or extremely marked retention, which in some cases necessitated a percussion-type crown remover, even after 2 and more years of service, to remove the superstructure.[6,7,13] On the other hand, a marked decrease in retention because of wear after long-term use is described.[14,15]

Table 3 Survival Probability of RPDs

Estimated probability of	% survival	95% CI
Having kept all abutment teeth		
After 5 y	84	67-94
After 10 y	66	38-84
Having lost all abutment teeth		
After 5 y	3	1-10
After 10 y	6	3-21

Table 4 Survival Probability of Abutment Teeth

Estimated risk of abutment loss	After 5 y		After 10 y	
	%	95% CI	%	95% CI
All abutments (n = 460)	6	4-11	18	12-27
Rigid support (n = 316)	4	2-9	15	9-26
Resilient support (n = 144)	10	5-20	24	13-41

Table 5 Risk of Endodontic Treatment

Estimated risk of endodontic treatment	After 5 y		After 10 y	
	%	95% CI	%	95% CI
All abutments (n = 407)	6	4-10	8	5-13
Rigid support (n = 282)	7	4-13	9	5-15
Resilient support (n = 125)	3	1-11	7	2-18

Milling of inner crowns in the dental laboratory according to the path of insertion, which is necessary for conical crowns and friction-fit telescopic crowns, typically leads to cervical overcontouring; this may increase plaque retention and make hygiene procedures more difficult, thereby increasing the risk of caries at the margins of the inner crowns.[8] Because retention of the double crown with clearance fit does not depend solely on the geometric form of the inner crown, cervical overcontouring of the inner crown can be reduced or avoided.

Whereas the clinical longevity of the different double crown systems as described in the literature is generally excellent, with survival probabilities for the abutment teeth of more than 90% after 5 years and 80% after 10 years, less favorable results are reported when the restoration is placed on only a few remaining teeth (Table 6). A significant reduction of the survival probability is described when the restoration is placed on three or fewer conical crown abutments,[12] a result that was confirmed by the same authors in 1999.[16] In another study, 36% of abutments were reported lost

Table 6 Survival Probability of Abutment Teeth for Different Types of Double Crowns (Rigid Support)

Study	No. of abutments (mean per denture)			Denture design	Mean age at time of insertion	Observation period (y)	Kaplan-Meier survival probability of abutment	
Present (≥ 4 abutment teeth)	316	(5.8)	CF	PPD	54.5 ± 11.0	4.0 ± 3.7 (max 14.4)	97% (5 y)	85% (10 y)
Stark and Schrenker[9]	258	(3.8)	FF	MCD*	60	6	96% (6 y)	—
Möser[10]	1739	(2.2)	FF	MCD	44.5 ± 12.3	1970–88†	96% (5 y)	84% (10 y)
Nickenig and Kerschbaum[11]	402	(4)	FF	MCD/PPD	43.4 ± 6.3	5 ± 2.8	95% (5 y)	81% (8 y)
Igarashi and Goto[14]	674	No info	CC	No info	62‡	12 (min 10)	—	86%§ (12 y)
Bergman et al[13]	78	(4)	CC	PPD	68.6‡	6.1–7.7	91%§	—
Hultén et al[8]	188	(3.0)	CC	No info	67 ± 10.3‡	3.3 ± 1.5	82%§	—
Heners and Walther[12]	655	(2.8)	CC	MCD	No info	2–7	94% (5 y)	—
Heners and Walther[12] (≥ 4 abutment teeth)	894	(4.8)	CC	PPD	No info	2–7	91% (5 y)	—
With few remaining teeth								
Present (≤ 3 abutment teeth)	144	(2.1)	CF	PPD/res	58.5 ± 13.3	4.2 ± 3.6 (max 14.1)	89% (5 y)	76% (10 y)
Pöggeler[22]	236	(2.4)	CF	ODD/res	66.3 ± 8.9‡	2–11	90% (5 y)	71% (7 y)
Igarashi and Goto[14]	62	No info	CC	No info/rig	62‡	12 (min 10)	—	65%§ (12 y)
Heners and Walther[12] (≤ 3 abutment teeth)	545	(2.2)	CC	PPD/rig	No info	2–7	78% (5 y)	—

*Study included 19 resilient-supported overdentures.
†Period in which the investigated restorations had been placed.
‡Age at time of examination.
§Mean survival rate (not calculated by the Kaplan-Meier method).
CF = double crown with clearance fit; PPD = perioprotective design (no major connectors, double crowns for all remaining teeth, marginal periodontium of abutment teeth not covered); FF = double crown with friction fit; MCD = design with major connectors (double crowns only for selected remaining teeth); CC = conical crown; ODD = overdenture design (double crowns for all remaining teeth, marginal periodontium of abutment teeth covered); res = resilient support; rig = rigid support.

after a mean service period of 12 years when the restoration was placed on few remaining teeth.[14] In the study of Hultén et al,[8] the 12 dentures that failed (out of 62 conical crown-retained RPDs) all had few abutments (one to three) and a large extension of the removable denture. These characteristics are less favorable with regard to the distribution of loading forces, and in combination with the rigid connection between conical crown and RPD will act as predicting factors for early failure.[8] Nevertheless, survival rates of double crown–retained RPDs are still favorable compared with those reported for alternative treatment concepts in distal extension–base prostheses. For extensive cantilevered fixed prostheses, a survival rate of 56% after 7 years was described,[17] and Studer et al[18] observed a high number of failed combined fixed-removable reconstructions with a rigid type of precision attachment, especially in cases with free-end situations and a dentate opposing jaw (survival rate 30% after 8 years).

To reduce extraaxial loading of the abutment under function, double crowns with clearance fit can be constructed to allow a distinct vertical movement of the denture under load and therefore to retain a mucosa-supported denture in cases with few remaining teeth. This concept of resilient support using double crowns with clearance fit was first described in 1966 in two separate studies.[19,20] It was applied in the present study in combination with a rigid metal framework and perioprotective design when the restoration was supported by three or fewer abutments. For this group, the risk of abutment loss was slightly higher, but a significant increase with decreasing number of abutments, as reported for conical crowns,[12] was not observed. It is remarkable that, although the dentures were designed without major and minor connectors, none of the metal frameworks fractured during the observation period.

Perioprotective designs play a key role in ensuring the long-term periodontal health of the abutment teeth.[1,2,21] A marked decrease in survival probability, from 90% after 5 years to 71% after 7 years, for double crowns with clearance fit and resilient support was reported when the denture design is similar to that of complete dentures, completely covering the remaining abutment teeth and the marginal periodontium.[22]

There is little information available on the risk of endodontic treatment after placement of double crowns, with only one study reporting an estimated risk of 3% after 5 years and 7% after 8 years.[11] In the present study, the risk of endodontic treatment was 6% after 5 years and 8% after 10 years, with no significant differences between the rigid and the resilient support groups; the risk lay well within the range of other types of cemented restorations.[23] It is of interest that in this study, only 12% of the abutments had endodontic treatment prior to the prosthodontic treatment, whereas in another study 51% (127) of the abutments had been endodontically treated prior to the placement of the conical crowns.[17] Many practioners still believe that double crown restorations require "preprosthetic"

endodontic treatment to avoid pulpal complications caused by extensive tooth preparation. The results of this study demonstrate that preprosthetic endodontic treatment is not a prerequisite for the long-term success of a double crown–retained restoration.

In case studies including censored observations, mean survival times should not be used to evaluate the clinical longevity; the calculation of survival curves is required.[24] The method of Kaplan and Meier provides an estimation of the survival probability for each point of time during the observation period, including the censored observations, and enables principally a comparison of the results of several studies with different follow-up times.[24] When using methods of survival estimation it must also be considered that a given survival rate is a "point estimate" without any information about the "spread around." In the context of estimation, the confidence interval provides a range of values within which the "true parameter" is believed to be found with a given level of confidence. Therefore, confidence intervals are extremely useful in assessing the clinical significance of the given survival rates.[25] Additionally, assessment is facilitated by the use of apparent and unmistakable criteria like "extraction of abutment tooth." But even when comparing Kaplan-Meier abutment survival rates of different studies, varying treatment modalities and different criteria for abutment selection will essentially influence the outcome. This limitation should be kept in mind when evaluating the results of the different studies.

Conclusions

Within the limitations of the study design, the following conclusions may be made:

1. RPDs retained by double crowns with clearance fit and constructed without major or minor connectors provide good clinical longevity. The survival rates of abutment teeth were comparable to those reported in the literature for other double crown systems.
2. No significant increase of the risk of abutment loss was observed when the restoration was placed on three or fewer remaining teeth and the concept of resilient support was applied.

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