Clinical Performance of Complete Dentures: A Retrospective Study

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> Purpose: Denture survival, or the time between the date of a denture's insertion and the date of its renewal for any clinical reason, was assessed in this retrospective study on 353 complete dentures. The procedures required to prolong the useful time of the study sample-relines, repair of denture base fractures, or replacement of lost artificial teeth-were also evaluated. Materials and Methods: All dentures were examined by the authors and were constructed according to a standardized protocol by full-time staff members of the Department of Prosthodontics, Regensburg University Medical Center, between 1984 and 2009. Two subgroups were assigned: 94 patients had one complete denture in each arch (group 1), while 165 patients had one complete denture in either the mandible or the maxilla (group 2). *Results:* In group 1, the median (75th, 90th percentile) survival time of dentures was 15.8 years in the mandible (15.7, 7.0; 95% confidence interval [CI]: 15.5 to 16.1) and 19.4 years in the maxilla (15.8, 8.7; 95% CI: 14.0 to 24.7). Reline procedures were required most frequently in the maxilla, while 5year event-free rates were 69.7% for the maxilla and 80.5% for the mandible. Denture base fractures were reported in 5.8% of patients in group 1 and tended to occur more frequently (median: 15.2%) if patients had only one denture (group 2, n = 25 [maxilla: n = 23, mandible: n = 2]). Loss of artificial teeth was a rare complication and found in only 5.8% of patients in group 1 and 10.9% of patients in group 2. During the first 5 years of service, more than 95% of patients in group 1 and 90% of patients in group 2 were "event free" with regard to loss of artificial teeth. Conclusions: Long-term functional service of complete dentures requires a high number of maintenance procedures, and there is a greater need for interventions in patients wearing only one complete denture (group 2). Int J Prosthodont 2010;23:410-417.

S everal countries with a high standard of dental health care still have a significant number of edentulous patients. Recent World Health Organization studies reported that the prevalence of edentulous patients older than 65 years was 58% in Canada (1993),¹ 36% in Finland (1997),² and 46% in the United Kingdom (1998).³ Moreover, many countries now face an aging population.⁴ German estimates predict that the percentage of citizens older than 65 years will be 35% in 2020 and 45% in 2030. In 1997, 24.8% of people in this age group (> 65 years) were found to be edentulous and requiring complete dentures (CDs).⁵ A report on the expected need of prosthodontic treatment up to the year 2020 concluded that, even under the optimistic scenario of improvements in oral health prophylaxis, the percentage of patients without teeth will decrease by only 9%.

These figures suggest that dentists will continue to practice CD prosthodontics in the future, although there is a current lack of unanimity regarding denture fabrication protocols.⁶⁻⁹ Furthermore, there is a lack of reported long-term observations on the performance of CDs, while ample reports exist for fixed and implant-supported prostheses.

This retrospective study collected data on the longterm performance outcomes of CDs in the context of the need to prolong the useful life of dentures via their outright replacement, the need of relining procedures, fracture of the denture base, and repair of artificial acrylic teeth.

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Fig 1 Flow chart showing the number and distribution of cases included or excluded from this study. Group 1 = CDs in both arches; group 2 = CDs in only one arch.



Table 1 Treatment Protocol of C	CDs
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Clinical appointment 1	Preliminary impression of the denture base supporting tissues with Schreinemakers ¹⁰ stock (semi-indi- vidual) impression trays and irreversible hydrocolloid (alginate) (see Fig 2).
Laboratory	Construction of custom resin impression trays.
Clinical appointment 2	Final impression with an individual resin impression tray and silicone or zinc-oxide-eugenol impression material. ¹¹
Laboratory	Construction of record rims on gypsum master casts. ^{11,13}
Clinical appointment 3	Record the approximate hinge axis with a facebow. Adjust the height of the record rims to the required occlusal vertical dimension using the two-dot tech- nique (rest vertical dimension). ^{11,13} Record the relationship between maxilla and mandible in centric relation with a Gerber recording set. ^{7,12,13} This records the mandibular border movements in the horizontal plane (Gothic arch tracings, see Fig 3). Tooth color selection.
Laboratory	Arrangement of acrylic teeth in bilateral balanced articulation. High atrophy of the alveolar bone: cusp- less posterior teeth ¹³ (see Fig 4); low atrophy of the alveolar bone: cusp posterior teeth.
Clinical appointment 4	Try-in of the provisional denture. ¹¹
Laboratory	Denture processing with denture resin packing technique.
Clinical appointment 5	Fitting of the denture and insertion. ¹¹

Materials and Methods

Sample Description

A dental software search tool (HighDent Plus, CompuDENT) generated 1,559 CDs that had been inserted at the Department of Prosthodontics, Regensburg University Medical Center, Regensburg, Germany, between 1984 and 2009. Implant-supported CDs and CDs fabricated in graduate student courses were not considered in this study (n = 1,099); neither were 107 patients with incomplete records (Fig 1). This study concentrated on 353 CDs made by full-time staff members according to a standardized departmental protocol¹⁰⁻¹³ shown in Table 1.

Two subgroups were identified: 94 patients who had CDs in both the maxilla and mandible (group 1, n = 188 dentures) and 165 who had a denture in only one arch (group 2, n = 165 dentures). This differentiation was made for two reasons. First, the occlusal load of single dentures is higher because the antagonists could be

natural teeth with or without fixed or removable prostheses. A higher number of maintenance procedures could therefore be expected for single dentures in contrast to two opposing CDs. Second, most single dentures (83%) were in the maxilla (Table 2).

Based on the clinical records of the patients, the frequency of the events "replacement of CD," "reline," "fracture of the denture base," and "loss of artificial acrylic teeth" during the observation period were analyzed. Furthermore, the time elapsed between insertion of the denture and one of the aforementioned events was recorded.

Statistical analysis

Continuous variables were presented as means and standard deviations, as well as median values and interquartile ranges. Categoric variables were presented as absolute numbers and proportions. Survival times of dentures in the maxilla and mandible were estimated by means of Kaplan-Meier analysis.^{14,15} Survival was

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Figs 2a and 2b Schreinemakers impression trays.¹¹







Fig 4 (left) Provisional denture with cuspless teeth in the posterior area. (right) Cuspless tooth set.¹³

412 The International Journal of Prosthodontics

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	Group 1 (n = 188)	Group 2 (maxilla, n = 137)	Group 2 (mandible, n = 28)	Total (n = 353)	
Sex					
Male	96 (51.1%)	65 (47.4%)	19 (67.8%)	180 (51.0%)	
Female	92 (48.9%)	72 (52.6%)	9 (32.2%)	173 (49.0%)	
Age (y)					
Mean	61.3	59.1	66.48	60.9	
Standard deviation	13.6	11.6	9.9	12.7	

Table 2 Baseline Characteristics Based on Maxillary and Mandibular Subgroups

Table 3 Frequency of Events "Reline," "Denture Base Fracture," "Loss of Artificial Teeth," and "Replacement of the Denture"

	Maxilla					Mandible										
		Gro	up 1			Grou	ıp 2			Grou	ıp 1			Grou	ıp 2	
Frequency	RL	BF	LT	RP	RL	BF	LT	RP	RL	BF	LT	RP	RL	BF	LT	RP
1×	16	2	5	9	30	16	14	9	13	5	1	10	4	1	1	2
2×		1	2	1	18	2	2	1	1		1	1		1		
3×	3				3	2			2							
$4 \times$					1	2	1		2	1	1					
$5 \times$						1										
$6 \times$									1	1						
$7 \times$			1													
8×																
9×																
$10 \times$																
11×		1														

RL = reline; BF = denture base fracture; LT = loss of artificial teeth; RP = replacement of the denture.

defined as the time between the date of denture insertion and the date of renewal from any cause. A case was rated "termination due to failure" (event) when a denture lost its function and a new one had to be made. Dentures not replaced until the last observation were classified as censored. A few patients had multiple events, but only the interval up to the first event was used for analysis.

Differences in survival rates between patients with dentures in only one arch (group 2) and patients with dentures in both arches (group 1) were evaluated by means of the log-rank test.

Because clinicians should be aware of the period of time elapsed until the development of clinical or technical complications, the 75th and 90th percentiles were calculated, as well as the 5-year event-free rate for the events "reline," "fracture of the denture base," and "loss of acrylic teeth" by means of Kaplan-Meier analyses. The 75th (90th) percentile specifies the time at which 25% (10%) of patients had an event. If the number of patients with an event was insufficient to reach

one of the percentiles, these percentiles were omitted. The influence of potential covariates (age, sex, maxilla or mandible, group 1 or group 2) was examined as a single factor in univariate analyses (Kaplan-Meier) and in multivariate analyses (Cox regression model by means of the enter method, ie, all model variables were entered simultaneously). Data entry and all calculations were made with the software package SPSS 15.0 (SPSS). All reported *P* values were two-sided, and a *P* value of .05 was considered the threshold of statistical significance.

Results

The median follow-up times (ie, the time at which 50% of patients were lost to follow-up) calculated using the Kaplan-Meier¹⁶ method were 6.8 years (95% Cl: 6.2 to 7.4) for the event "replacement of dentures," 6.6 years (95% Cl: 5.9 to 7.4) for "reline," 6.7 years (95% Cl: 6.0 to 7.3) for "fracture of denture base," and 6.9 years (95% Cl: 6.3 to 7.5) for "loss of artificial teeth."

Volume 23, Number 5, 2010



Fig 5a One minus cumulative survival rate of all CDs in the mandible. Group 1: n = 94, events: n = 12, censored: n = 82; group 2: n = 28, events: n = 2, censored: n = 25. Hazard ratio: .26 (95% CI: 0.27–5.78), P = .769.

Table 4	Multivariate Analysis by Means of the Cox
Regressio	n Model with the Enter Method* for Survival
Time of D	entures

Variables [†]	Hazard ratio	95% CI	Р
Sex	0.88	0.44-1.76	.878
Group 1 or group 2	0.67	0.31-1.47	.670
Maxilla or mandible	0.63	0.29-1.35	.630
Age	0.99	0.97-1.02	.687

CI = confidence interval.

*All model variables were entered simultaneously.

[†]Male (0) vs female (1), group 1 (0) vs group 2 (1), and mandible (0) vs maxilla (1) were analyzed as continuous variables.

Replacement of Dentures

Mandible. According to the Kaplan-Meier calculation, the median (75th, 90th percentile) survival time of mandibular dentures of patients in group 1 was 15.8 years (15.7, 7.0; 95% Cl: 15.5 to 16.1); the 5-year survival rate was 94.0% and the 10-year survival rate was 85.2%. Patients in group 2 had two events (after 0.3 and 6.2 years; Table 3 and Fig 5a). The 5-year survival rate was 96.3% and the 10-year survival rate was 90.3% (log-rank test, P = .837).

Maxilla. The median (75th, 90th percentile) survival time of maxillary dentures of patients in group 1 was 19.4 years (15.8, 8.7; 95% Cl: 14.0 to 24.7), with a 5-year survival rate of 96.2% and a 10-year survival rate of 89.7%. For patients in group 2, the 90th percentile (median and 75th percentile did not occur) was calculated at 10.7 years (Fig 5b); the 5-year survival rate was 96% and the 10-year survival rate was 94.3% (log-rank test, P = .332).



Fig 5b One minus cumulative survival rate of all CDs in the maxilla. Group 1: n = 95, events: n = 10, censored: n = 85; group 2: n = 137, events: n = 9, censored: n = 128. Hazard ratio: 1.56 (95% CI: 0.63–3.85), P = .336.

Table 5	Multivariate Analysis by Means of the Cox
Regressio	n Model with the Enter Method for Event-Free
Time of th	e First Reline

Variables*	Hazard ratio	95% CI	Р
Sex	1.62	1.07-2.46	.023
Group 1 or group 2	1.61	1.04-2.48	.032
Maxilla or mandible	1.45	0.88-2.38	.144
Age	0.99	0.98-1.01	.214

CI = confidence interval.

*Female (0) vs male (1), group 1 (0) vs group 2 (1), and mandible (0) vs maxilla (1) were analyzed as continuous variables.

Multivariate Cox regression analysis showed that no variable had a significant influence on the event "replacement" (Table 4).

Reline Procedures

Reline was the most frequent maintenance procedure for CDs (n = 94, 26.6%; Table 3). For patients in group 1, the 75th (90th) percentile was 16.2 (0.42) years; for patients in group 2, it was 1.9 (0.36) years (log-rank test, P=.004). The 5-year event-free rates were 80.6% and 65.3%, respectively (Fig 6a).

When divided into subgroups regarding maxilla and mandible, reline procedures were required most frequently for the maxilla. The 75th (90th) percentile was 2.7 (0.4) years for dentures in the maxilla. In the mandible, the 90th percentile was 0.9 (sample size too low for 75th percentile) (log-rank test, P = .025). The 5-year event-free rates were 69.7% and 80.5%, respectively (Fig 6b).

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Fig 6a One minus cumulative event-free rate of reline for CD wearers in one and both arches. Group 1: n = 188, events: n = 38, censored: n = 151; group 2: n = 165, events: n = 56, censored: n = 108. Hazard ratio: 0.56 (95% CI: 0.37–0.84), P = .005.

Sex differentiation showed that men asked for a reline more often and at an earlier stage than women. The 75th (90th) percentile for a reline was 2.0 (0.30) years for men. Women generated a 90th percentile of 0.55 years (sample size too low for 75th percentile) (log-rank test, P=.025). The 5-year event-free rates were 68.9% and 77.8%, respectively (Fig 6c). Table 3 demonstrates that reline procedures were more frequently demanded by individual patients.

Cox multivariate regression analysis identified the variables female (P = .0023) and group 1 (P = .0032) as prognostic factors for prolonging the time to the first reline event (Table 5).

Fracture of the Denture Base

Denture base fracture was observed in 36 (10.2%) of 353 CDs. Group 1 showed 11 (5.8%) denture base fractures (4 in the maxilla, 7 in the mandible). During the first 2 years, 4 base fractures occurred. However, base fractures were noted in only 10% of patients. The difference between the mandible and maxilla was negligible. If a patient wore only one denture (group 2, n = 25), the denture base fractured more frequently (15.2%). Ten percent of patients in group 2 had an event after 2.6 years, which was a significantly higher percentage than in patients in group 1 (log-rank test, P=.003; Fig 7). The low number of fractured mandibular dentures did not allow a separate calculation for both arches. Fracture frequency differed among individual patients (Table 3).



Fig 6b One minus cumulative event-free rate of reline for maxilla and mandible. Maxilla: n = 231, events: n = 71, censored: n = 161; mandible: n = 122, events: n = 23, censored: n = 98. Hazard ratio: 1.70 (95% Cl: 1.06–2.72), P = .027.



Fig 6c One minus cumulative event-free rate of the first reline procedure according to sex. Female: n = 174, events: n = 37, censored: n = 137; male: n = 179, events: n = 57, censored: n = 122. Hazard ratio: 0.63 (95% CI: 0.41–0.95), P = .026.

Loss of Artificial Teeth

Loss of artificial teeth was noted in 8.2% of all patients (n = 29). Less than 10% of patients in group 1 had such an event (n = 11). The 5-year event-free rate was 95.2%. Overall, loss of artificial teeth was reported for eight patients in the maxilla and three patients in the mandible. Patients in group 2 showed loss of acrylic teeth more often in the maxilla (n = 17, compared to n = 1 in the mandible; Fig 8). The 90th percentile was calculated at

Volume 23, Number 5, 2010



Fig 7 One minus cumulative event-free rate of the first denture base fracture according to dentures in one and both arches. Group 1: n = 188, events: n = 11, censored: n = 178; group 2: n = 165, events: n = 25, censored: n = 139. Hazard ratio: 0.36 (95% CI: 0.18–0.72), P = .004.

5.6 years, and the 5-year event-free rate was 90.1% (Fig 6b). No difference was found between patients in either group (log-rank test, P = .078). Frequency and number of events are shown in Table 3.

Discussion

CD prosthodontics has a long tradition in dentistry. Many textbooks describe methods for optimizing impression techniques, occlusal concepts, or polymerization procedures of polymethyl methacrylate denture bases.^{10–13,17,18} However, comprehensive clinical data on CDs that conform to today's standards of evidencebased clinical outcome trials do not exist. Therefore, retrospective studies may provide an insight into the clinical behavior of CDs, as well as offer a scope for designing longitudinal studies in the future, particularly studies of a comparative nature. This retrospective study had a limited perspective because it was based on already existing data. However, the use of a standard treatment protocol for denture construction provides a high degree of reproducibility.

Data Interpretation

Replacement of Dentures. The data showed no significant difference between the survival rates of patients in either group. Kaplan-Meier estimation calculated that less than 90% of patients in group 1 (85.2% in the mandible, 89.7% in the maxilla) and more than 90% of patients in group 2 (90.3% in the mandible,



Fig 8 One minus cumulative event-free rate of the first loss of artificial teeth according to dentures in one and both arches. Group 1: n = 188, events: n = 11, censored: n = 178; group 2: n = 165, events: n = 18, censored: n = 146. Hazard ratio: 0.52 (95% CI: 0.24–1.09), P = .083.

94.3% in the maxilla) were still receiving oral service after 10 years. The survival rate seemed to be higher in the maxilla than in the mandible. Generally, CDs can be expected to last for longer than 15 years before the patient asks for a replacement. None of the investigated variables (ie, sex, age of the patient, location [maxilla or mandible], number of dentures, and the frequency of any maintenance procedure) had a statistically significant influence on the survival rate of a CD.

Reline. The most frequent maintenance procedure was reline of the denture base. However, approximately 70% of dentures were not relined during a 5-year interval. A few patients asked to have their dentures relined more frequently than others. The high incidence of reline may indicate that nearly a third of patients were not confident with their denture fit and stability in service. Hobkirk et al^{19,20} reported that patients with mandibular conventional CDs (not implant-supported) complained about the looseness and misfit of their dentures. Men seemed to suffer more often from denture looseness or misfit than women since they asked for reline procedures more frequently and shortly after denture insertion. The Cox regression model indicated the variables female (P=.0023) and group 1 (P=.0032) as prognostic factors for prolonging the time until the first reline event. Surprisingly, reline was more frequently conducted in the maxilla, although the anatomical situation alleviates denture retention in that arch. However, in this investigation, group 2 consisted of only a few patients. A bias may exist resulting from the overwhelming number of single maxillary dentures.

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Denture Base Fracture. Patients in group 2 may develop greater chewing forces or greater chewing activity because of more stable antagonists,¹⁶ which may explain the greater number of denture base fractures in this group. More than two thirds of the dentures in this investigation were inserted in the maxilla. Maxillary dentures in group 1 had a better chance for satisfying retention because of the more favorable anatomical shape of the denture base saddle.¹¹ The higher occlusal forces may accelerate atrophy of the edentulous alveolar bone. For example, hard plate areas, such as the torus palatinus, work like a fulcrum on the denture base, which may lead to denture base fractures.¹³ This process may occur approximately 2.6 years after insertion. Consequently, 15.2% of patients in group 2 noted fractures, compared to 5.8% of patients in group 1. Fractures seemed to be an individually striking event. One patient had 11 denture base fractures in the maxilla during 8.7 years of oral service.

Loss of Artificial Teeth. Loss of artificial teeth was a rare complication. For 5 years, more than 95% of patients in group 1 and 90% of patients in group 2 were event free. If loss of artificial teeth occurred, it was an event, which was encountered by one patient up to four times. This may be due to unfavorable anatomy or specific oral habits. This investigation could not address possible differences in the quality of manufacturing processes as the cause of losing artificial teeth.

Conclusions

It is readily conceded that the design of this study precluded the inclusion of additional domains of clinical interest, such as patient-mediated concerns or specific supporting tissue evaluations. Nonetheless, this assessment of the clinical performance of CDs demonstrated that in contrast to patients wearing a CD in both arches, patients with a CD in a single arch will be confronted with a higher incidence of complications. Generally, of all maintenance procedures or complications, reline procedures will be necessary in a third of all dentures, whereas fractures of the denture base or loss of artificial teeth may occur in about 10% of dentures.

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417

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