Composite Resin Core-Crown Reconstructions: An Up to 17-Year Follow-up of a Controlled Clinical Trial

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Purpose: The aim of this long-term follow-up study was to collect up to 17 years of survival data of endodontically treated single teeth with or without a prefabricated metal post. ***Materials and Methods:*** Single teeth were provided with direct composite resin core-crown reconstructions with or without posts by 15 operators. Restorations consisted of either a prefabricated metal post and a composite core-crown reconstruction or a post-free direct composite reconstruction. Allocation of either restoration was performed by balanced drawing. These restorations were not covered by an artificial crown. The study sample consisted of 87 patients who received 98 core-crown reconstructions. The performance of the restorations was evaluated based on data collected from the files of the clinicians currently monitoring the oral health of the patients. The survival probability was analyzed at different levels: on the restoration level and on the level of the tooth carrying the restoration. Kaplan-Meier analysis was used to compare survival probabilities. ***Results:*** Post placement showed no influence on the survival probability at either level ($P > .05$). The estimated overall survival rate at 17 years was 53% ± 14% at the restoration level and 79% ± 11% at the tooth level. ***Conclusion:*** The results of this long-term follow-up study showed no difference in survival probabilities between different direct composite resin core-crown reconstructions of endodontically treated single teeth (with or without a post). *Int J Prosthodont 2008;21:109–115.*

The coronal restoration of an endodontically treated tooth is a challenge for any dental practitioner. The traditional way to restore severely damaged endodontically treated teeth is to place a cast post-and-core restoration and a subsequent crown. An alternative method using prefabricated metal posts and composite resin as a core material was introduced around the 1970s and has been used ever since on a large scale.[1–3]

Along with the less time-consuming procedure, the main advantage of a prefabricated post compared to the cast post and core is that undercuts of the pulp chamber can be maintained, thus preserving tooth material.[4] Today, the use of a post is questioned even with the use of adhesive buildup materials in the reconstruction of endodontically treated teeth. Omitting a post is the optimal way to preserve tooth material. For crowned teeth, it was demonstrated that post placement did not increase the longevity of the teeth.[5,6]

Another factor related to longevity of an endodontically treated tooth is the type of coronal reconstruction. Retrospective clinical reports suggest an increased longevity if endodontically treated teeth are provided with an artificial covering crown.[7,8] A prospective clinical study, however, showed no difference in the 3-year survival rates of endodontically treated teeth with either full cast coverage or with adhesive direct composite reconstructions.[9] In the latter study, all teeth were provided with fiber posts. The absence of a difference in survival rates between endodontically treated teeth with artificial crowns or adhesive coronal

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Table 1 Restorations Investigated in the Study

Restoration	Specifications	No. per tooth
Prefabricated metal post and direct composite resin core-crown reconstruction	Post: Radix or RS prefabricated post (Maillefer) Cement: Panavia (Kuraray) Bonding: Clearfil New Bond (Kuraray) Core: Clearfil Core composite resin (Kuraray) and Clearfil Ray Posterior (Kuraray)	I/C: 11 P: 27 M: 16 Total: 54
Post-free direct composite resin core-crown reconstruction	Post: none Bonding: Clearfil New Bond (Kuraray) Core: Clearfil Core composite resin (Kuraray) and Clearfil Ray Posterior (Kuraray)	I/C: 8 P: 27 M: 9 Total: 44

I/C = incisor/canine; P = premolar; M = molar.

reconstructions was also suggested by a 5-year prospective clinical study.[5,6] Thus, the results of studies regarding the necessity of a covering crown on endodontically treated teeth are contradictory.

The purpose of the present report was to describe up to 17-year survival data of core buildup coronal reconstructions with composite resin material. The hypothesis tested was that there is no difference in long-term survival probability between direct composite resin core-crown reconstructions with or without posts on endodontically treated single teeth.

Materials and Methods

Trial Design

The present study was a follow-up of a clinical trial on 2 types of direct composite core-crown reconstructions that were made between January 1988 and June 1991 on endodontically treated single teeth. The design of the trial, the patients involved, and the materials used have been described in detail in previous reports.[5,6,10] The main conditions will be mentioned briefly here.

The study was composed of 3 trials. Two trials focused on the reconstruction of endodontically treated teeth with different post systems and covering crowns.[5] A third trial included either teeth for which a covering crown was not indicated or patients who could not afford a cast crown to cover the core buildup restoration.[6] These endodontically treated teeth had substantial dentin height, which was defined as follows: $>$ 75% of the circumferential dentin wall has minimum thickness of 1 mm and a minimum height of 1 mm above the gingival level, and $<$ 25% of the circumference has less than 1 mm above the gingival level. Restorations were provided either with or without posts. In all cases, the core buildup and crown reconstruction was an extensive composite resin restoration using all-etch and adhesive resin. Thus, restorations under investigation consisted of either a prefabricated metal post and a direct composite reconstruction or a direct post-free composite reconstruction. Allocation of either restoration type was performed by balanced randomization. Table 1 describes the materials and the distributions of the restorations.

The clinical study was organized in a multi-practice clinical setting. Fifteen operators were involved in the present trial: 14 dental clinicians practicing in private clinics in the Nijmegen area and 1 dental clinician at the university clinic of the College of Dental Science of the Radboud University Nijmegen Medical Centre. The study protocol was screened and approved for ethical acceptability by the Committee on Experimental Research on Man of the Radboud University Nijmegen. Further, the Ethical Committee approved an addendum for the present follow-up study.

Study Sample

The study sample consisted of 87 adult patients (44 women, 43 men, ages 18 to 65 years at baseline; mean age: 36 years) who received 98 composite core-crown reconstructions: 63 in the maxilla and 35 in the mandible (Table 1). Seventy-eight patients received 1 composite core-crown reconstruction and 9 patients received more than 1, with a maximum of 3 reconstructions per patient.

Evaluation

Survival data were collected for up to 17 years. As a result of a 3-year intake period at baseline and the data collection period (starting 15 years after the first clinical treatments and also lasting approximately 3 years), the available follow-up data varied from 15 to 17 years. The performance of the restorations was evaluated based on data collected from the files of the dental clinicians currently monitoring the oral health of the patients. To assess whether patient records from these dental practices provided valid data, a convenience sample of 28 reconstructed teeth (29% of the total) was clinically examined and cross-checked with the patient records. The data appeared to be reliable and therefore no further checks were done.

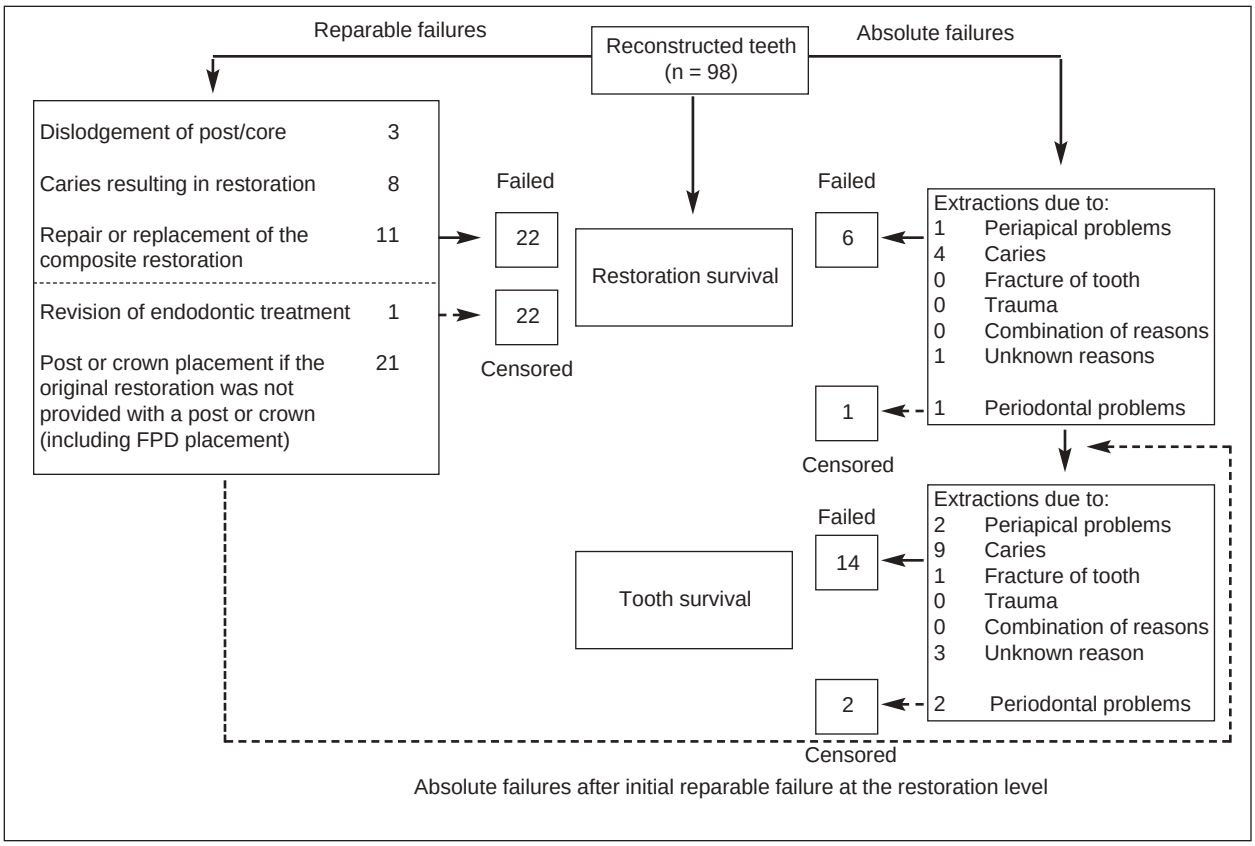

Fig 1 Schematic representation of the status of the direct composite core-crown reconstructions.

A restoration was recorded as having survived if the restoration was still present in its original form at the time of evaluation. The survival probability was analyzed at both the level of the restoration and the level of the tooth carrying the restoration.

Endpoints for survival at the level of the restoration were restorative intervention because of caries at the margins of the restoration, dislodgement of the post and composite restoration, repair of the composite restoration, and loss or extraction of the tooth (as a result of periapical problems, caries, fracture of the root/tooth, trauma, a combination of problems, or unknown reasons). Inclusion of the tooth as an abutment for a crown or fixed prosthesis, endodontic revisions, and extractions because of periodontal problems were considered as censored data for this survival level, because the restoration was not present in its original form. Maintenance treatments (eg, finishing and polishing after chipping of small fragments of composite) and apical surgeries were not considered to affect survival of the restoration. For survival at the level of the abutment tooth, the endpoints were loss or extraction of the tooth, except for extraction caused by periodontal problems, in which case the reconstruction was censored at the date of extraction.

Missing data were censored at the last date that information was available. If the exact date of the last evaluation could not be retrieved, then July 1 of the year in which the last checkup was recorded was recorded as the evaluation date. If only the month and year were known, the 15th day of that particular month was recorded as the evaluation date.

Statistical Analysis

Kaplan-Meier analyses with log-rank tests were used to assess the influence of the type of post-and-core restoration on survival probability, with a cutoff value of $P = .05$. The analyses were performed with SPSS version 14.0 (SPSS).

Results

At year 5, data from 87% of the teeth were available for evaluation; this decreased to 82% at year 10, 67% at year 15, and 39% at year 17. Figure 1 shows the interventions of the reconstructed teeth during the follow-up. Characteristics of all interventions are shown in Tables 2 and 3. Numbers may differ between the survival data for teeth and restorations, because a

Table 2 Characteristics of Interventions at the Level of the Restoration

	Lifetime (y)	Tooth no. (FDI)	Restoration	Failed/censored	Intervention
1	0.18	22	M/C	Failed	Composite restoration
2	0.62	35	C	Censored	Crown placement
3	1.09	26	M/C	Censored	Crown placement
4	1.47	15	M/C	Censored	Crown placement
5	1.79	13	M/C	Censored	Revision of endodontic treatment
6	2.24	38	M/C	Failed	Caries: composite
7	2.42	11	C	Failed	Caries: composite
8	2.72	14	C	Censored	Post placement
9	3.08	25	C	Censored	Crown placement
10	3.22	14	C	Failed	Composite restoration
11	3.34	25	C	Failed	Extraction (caries)
12	4.28	24	M/C	Censored	Extraction (periodontal problems)
13	4.40	21	M/C	Failed	Composite restoration
14	4.50	46	M/C	Failed	Extraction (caries)
15	5.03	24	M/C	Failed	Dislodgement of post and core
16	5.22	24	C	Censored	Crown placement
17	5.34	25	M/C	Censored	Crown placement
18	5.35	33	M/C	Censored	Crown placement / FPD
19	5.35	12	M/C	Censored	Crown placement
20	5.42	25	C	Failed	Dislodgement of post and core
21	5.72	27	M/C	Failed	Dislodgement of post and core
22	6.10	12	C	Failed	Caries: composite
23	6.32	16	C	Failed	Extraction (unknown reason)
24	6.43	38	C	Failed	Composite restoration
25	6.78	41	M/C	Failed	Composite restoration
26	6.81	24	M/C	Censored	Crown placement
27	7.49	25	M/C	Censored	Crown placement
28	7.57	36	M/C	Censored	Crown placement
29	7.68	15	M/C	Censored	Crown placement
30	7.87	16	M/C	Censored	Crown placement
31	8.74	25	M/C	Censored	Crown placement
32	9.39	35	C	Failed	Composite restoration
33	9.64	12	M/C	Censored	Crown placement
34	9.66	14	M/C	Failed	Extraction (caries)
35	9.72	16	M/C	Failed	Extraction (periapical problems)
36	10.42	35	C	Censored	Crown placement
37	10.74	15	M/C	Failed	Caries: composite
38	10.74	14	C	Failed	Caries: composite
39	10.78	27	M/C	Failed	Caries: composite
40	11.14	45	M/C	Censored	Crown placement
41	11.58	12	M/C	Failed	Composite restoration
42	12.24	25	M/C	Failed	Caries: composite
43	12.36	12	M/C	Censored	Crown placement
44	12.44	16	C	Failed	Composite restoration
45	12.99	15	C	Failed	Composite restoration
46	14.06	14	M/C	Failed	Composite restoration
47	14.22	16	C	Failed	Caries: composite
48	14.23	22	C	Censored	Crown (and post) placement
49	14.47	25	C	Censored	Crown placement
50	15.75	24	C	Failed	Extraction (caries)
51	15.93	45	C	Failed	Composite restoration

M/C = prefabricated metal post and direct composite resin core-crown reconstruction; C = direct post-free composite resin core-crown reconstruction; FPD = fixed partial denture.

restoration may have been registered as a failure while carrying a tooth that was registered as a nonfailure. Further, the same tooth may be registered as a failure after a longer follow-up than the failure of the restoration.

The Kaplan-Meier survival curves are presented in Figs 2 and 3. Post placement showed no influence on the survival probability ($P > .05$) (Table 4). The overall estimated restoration survival rate at year 17 was 53% ± 14%, and the overall estimated tooth survival rate at year 17 was 79% ± 11%.

Four teeth received apical surgery (between years 1 and 3 in 3 cases and after 16.9 years in 1 case). Two of these teeth had no other treatments, while 1 apically treated tooth (at 2.2 years) received a crown at year 12. The fourth apically treated tooth (at 1.3 years) received a composite restoration after 6.7 years.

Maintenance treatment was performed in 3 cases. After several repairs of the composite restoration, 1 tooth was eventually extracted after 12 years because of periapical problems. One tooth was censored at year

Table 3 Characteristics of Interventions at the Level of the Tooth

	Lifetime (y)	Tooth no. (FDI)	Restoration	Failed/Censored	Intervention
1	3.34	25	C	Failed	Extraction (caries)
2	4.28	24	M/C	Censored	Extraction (periodontal)
3	4.50	46	M/C	Failed	Extraction (caries)
4	6.32	16	C	Failed	Extraction (unknown reason)
5	8.25	25	C	Failed	Extraction (unknown reason)
6	9.66	14	M/C	Failed	Extraction (caries)
7	9.72	16	M/C	Failed	Extraction (periapical)
8	10.93	14	C	Failed	Extraction (caries)
9	12.08	38	M/C	Failed	Extraction (periapical)
10	13.41	38	C	Failed	Extraction (caries)
11	14.64	25	M/C	Failed	Extraction (caries)
12	15.08	12	M/C	Failed	Extraction (fracture)
13	15.20	16	M/C	Censored	Extraction (periodontal)
14	15.52	45	M/C	Failed	Extraction (caries)
15	15.75	24	C	Failed	Extraction (caries)
16	16.73	12	M/C	Failed	Extraction (unknown reason)

M/C = prefabricated metal post and direct composite resin core-crown reconstruction; C = direct post-free composite resin core-crown reconstruction.

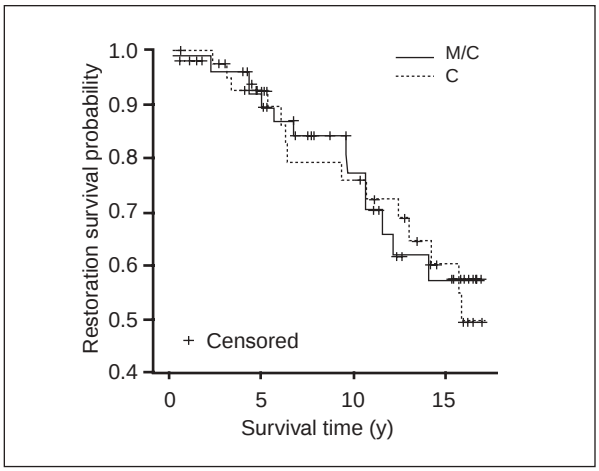

Fig 2 Restoration survival probability as a function of time of the composite reconstructions with and without posts. Vertical lines in survival curves indicate points of censoring (Kaplan-Meier analysis, $P > .05$). M/C = prefabricated metal post and direct composite resin core-crown reconstruction; C = direct post-free composite resin core-crown reconstruction.

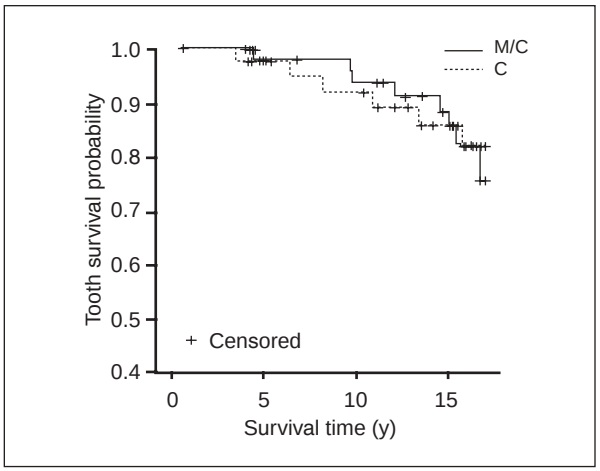

Fig 3 Tooth survival probability as a function of time of the composite reconstructions with and without posts. Vertical lines in survival curves indicate points of censoring (Kaplan-Meier analysis, $P > .05$). M/C = prefabricated metal post and direct composite resin core-crown reconstruction; C = direct post-free composite resin core-crown reconstruction.

12 without any additional intervention, and the third tooth survived 17 years without any other intervention.

Discussion and Conclusions

The present study compared long-term survival probabilities of direct composite resin core-crown reconstructions in endodontically treated teeth with and without a post. The conditions of the teeth included in this study represent a common daily dilemma in clinical dentistry. Generally, it is preferred to avoid immediate prosthodontic reconstruction of endodontically treated teeth to create an evaluation period. During this

Table 4 Survival Probabilities Up to 17 Years (Kaplan-Meier Log-Rank Test)

Survival level	Variable	Survival probability	95% confidence interval	*P*
Restoration	M/C	0.57	0.49–0.75	.88
	C	0.49	0.29–0.69	
Tooth	M/C	0.75	0.67–0.83	.92
	C	0.82	0.78–0.96	

M/C = prefabricated metal post and direct composite resin core-crown reconstruction; C = direct post-free composite resin core-crown reconstruction.

period, an adequate transitional restoration must be offered to the patient. Adhesively bonded (extended) composite resin restorations may be used for this purpose. However, the decision remains whether to immediately place a post or postpone post placement until the prosthodontic treatment. The treatment options studied in this trial address these clinical questions. The interventions are based on maintaining tooth material for the benefit of future reconstructions. At initiation of this study, the adhesive approach was not generally accepted. Thus, the objective of this study was quite innovative, and the long-term results are unique.

To support external validity, it was decided to involve general dental practices in the study design; however, this is a disadvantage in terms of reliability. A relatively high number of operators was required to include a reasonable number of teeth. It is difficult to calibrate all operators, and therefore numbers in subsequent reports may differ as a result of inconsistencies among operators; for example, N = 98 is given in this study, as opposed to N = 99 as described in the 5-year report.[6] For survival analyses, it was intended to use multivariate analyses (Cox regression) to check for possible influence of covariables (patient age, gender, and tooth type). However, proportional hazard models (log-time versus log-hazard) revealed that the proportional hazard assumption was not met in a few plots; therefore, the Cox regression model could not be used. As a consequence, this report presents only the results from the univariate Kaplan-Meier analyses. Since some patients received more than one restoration, the condition stating that all measurements are independent was violated. Therefore, results of the Cox model (with covariables that did not violate the proportional hazard assumption) were checked with an extended Cox model containing a gamma frailty term.[11] This last model was implemented using the R statistical software. For both survival levels, the extended Cox model confirmed that correction for clustering made no difference. Therefore, the survival analyses are not sensitive to the violation of the assumption of all observations being independent.

The restorations involved in this study should not be regarded as full-crown replacements, but rather as extensive Class 2 restorations with cusp replacement(s). All teeth had substantial remaining tooth material, and some of the teeth still had natural cusps. Nevertheless, if these teeth were provided with a cast covering crown, remaining tooth material had to be removed for retentive purposes of the indirect restoration. To what extent differences in restoration size in this study affected survival probability remains unclear.

Long-term survival of large direct composite resin restorations may be moderate compared to cast covering crowns. General experience suggests that the longevity of direct restorations in stress-bearing posterior cavities is lower than that of indirect restorations.[12] After 5 years, no difference in survival was found between indirect crowns and direct composite resin restorations on endodontically treated teeth.[5,6] Another study reported a 5-year survival rate of 36% for endodontically treated molars without crown coverage.[13] A retrospective study reported survival rates of 89% for crowned teeth and 62% for adhesively restored teeth after 10 years.[8] Moreover, the present study showed an estimated difference of 26% between the survival of restorations and teeth. If failures of the restoration occurred, they were reparable, and the tooth survival was clinically satisfactory. Thus, in case of failure of a direct composite restoration, it is anticipated that a new restoration can be made easily. This makes the adhesive core-crown reconstruction suitable as a transitional restoration during an evaluation period. During this evaluation period, basic function and acceptable esthetics must be provided, and direct reconstruction with composite must appear both promising and feasible.[14,15]

No difference regarding survival probability was found between reconstructions that were provided with a post and those that were post-free. The substantial amount of remaining dentin of the teeth involved in the study may have negated the positive effect of a post. On this basis, it may be suggested that posts are not primarily required, particularly if significant amounts of dentin remain. The fact that only 1 post-treated tooth was extracted because of fracture of the root may emphasize the importance of the remaining dentin.

The results of this study showed no difference in survival probability between endodontically treated single teeth reconstructed with direct composite restorations either with or without a metal post. It is possible that the absence of a statistically significant difference is the result of a lack of power. A post hoc power analysis ($P = .05$; conventional power = 0.8) based on the results of this study revealed that with the present sample size a difference of factor 2.3 between groups was detectable. Given the failure rates in this study (which the authors consider realistic and representative for clinical practice), a far larger sample would be needed to prove statistically (non) significant differences between survival probabilities. However, differences between groups in this study are so small that the authors consider the survival of direct composite core-crown reconstructions in teeth with substantial initial tooth tissue as independent from the use of a metal post.

Acknowledgments

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Literature Abstract

Safety and effectiveness of topical dry mouth products containing olive oil, betaine, and xylitol in reducing xerostomia for polypharmacy-induced dry mouth

This investigation evaluated the safety and efficacy of a group of a topical dry mouth products (Xerostom). These products—containing olive oil, betaine, and xylitol—were developed to reduce xerostomia. In the form of toothpaste, mouth rinse, mouth spray, and gel, the products were tested in a population of adults experiencing polypharmacy-induced salivary hypofunction and xerostomia. Forty adults were selected into a single-blinded, open-label, crossover clinical study, in which 39 subjects completed all the visits. These subjects were randomly assigned at baseline to either *(1)* use the novel topical dry mouth products daily for a week or *(2)* to maintain their normal dry mouth routine care. One week later, the subjects were crossed over to the other dry mouth regimen. Measurements before and after the study included collection of unstimulated whole saliva and administering an 8-item 100-mm dry mouth visual analog scale (VAS) questionnaire and a xerostomia-related quality-of-life questionnaire. Comparisons of baseline measurements were conducted using Student *t* tests. Analyses were carried out using SAS 9.0 software. A *P* value of .05 was accepted for statistical significance. Results indicated that the use of Xerostom products for 1 week led to a significantly greater increase in unstimulated whole salivary flow rates (0.05 ± 0.05 $mLmin^{-1}$ to 0.140 ± 0.26 $mLmin^{-1)}$ than subjects' normal dry mouth routine (0.047 ± 0.05 $mLmin^{-1}$ to 0.05 $mLmin^{-1}$) (*P* = .033). Dry mouth symptoms assessed using the 8–item VAS questionnaire indicated that the use of Xerostom products produced greater overall improvement compared with subjects' normal dry mouth routine for the same period (*P* = .011). The effect of xerostomia on a subject's quality of life was assessed with a 15-item survey, and the overall results also demonstrated a greater improvement in the group that used topical dry mouth products. The results demonstrated that the use of novel topical dry mouth products significantly increased unstimulated whole salivary flow rates, reduced complaints of xerostomia, and improved xerostomia-associated quality of life. There were no clinically significant adverse events noted. The author concludes that the use of topical dry products containing olive oil, betaine, and xylitol is safe and effective in relieving symptoms of dry mouth in a population with polypharmacy-induced xerostomia.

Ship JA, McCutcheon JA, Spivakovsky S, Kerr AR. *J Oral Rehabil* 2007;34:724–732. **References:** 74. **Reprints:** Dr Jonathan A. Ship, New York University, 421 First Avenue, 2nd Floor, New York, NY 10010-4086. E-mail: jonathan.ship@nyu.edu—*Beatrice Leung, Toronto, ON*