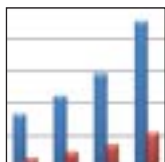# Reduction of Tooth Loss Associated with Periodontal Treatment

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Comparing tooth loss for populations comprising subjects with periodontal disease has been limited by broad and different definitions of disease severity. Numeric scores for periodontal disease severity and risk were used to enhance the precision of comparing tooth loss for two populations. Both populations received routine dental care, but only one received comprehensive periodontal treatment. The analysis provides evidence that adding periodontal treatment to routine dental care is associated with less tooth loss and more patients who do not lose any teeth. Furthermore, it may be possible to nearly eliminate tooth loss associated with periodontal disease. (Int J Periodontics Restorative Dent 2011;31:471–479.)

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Tooth loss parallels periodontitis severity[1] and increases over time at a rate defined by risk when periodontal treatment is not applied.[2–4] Tooth loss is predicted by periodontitis severity and risk regardless of the proportion of the population that has been treated for periodontitis.[4,5] An objective of periodontal treatment is to prevent tooth loss.[6] A purpose of the current study was to validate the hypothesis that less tooth loss occurs when periodontal therapy is added to routine dental care.

Since the duration of the study period affects the number of teeth lost, controlling for time is a way to compare tooth loss for two or more populations. This can be accomplished by means of the tooth loss rate (TLR), defined as the number of teeth lost per subject per year. As shown in Table 1, populations comprising subjects with moderate to severe periodontitis who did not receive periodontal treatment had a TLR that ranged from 0.541 to 0.250.[7–10] The TLR was generally lower for populations comprising similarly diseased subjects who

Table 1	Tooth loss and periodontitis				
Study	**Periodontal treatment**	**Subjects**	**Study length (y)**	**No. of teeth lost**	**TLR***
Becker et al[7]	None	29	3.7[†]	58	0.541
Papapanou et al[8]	None	201	10.0	760	0.378
Harris[9]	None	30	2.1[†]	21	0.333
Buckley and Crowley[10]	None	82	10.0	205	0.250
Checchi et al[11]	Comprehensive	92	6.7[†]	170	0.276
Becker et al[12]	Comprehensive	95	6.6[†]	150	0.239
McLeod et al[13]	Comprehensive	114	12.5[†]	308	0.216
Goldman et al[14]	Comprehensive	211	22.2[†]	771	0.165
McGuire and Nunn[15]	Comprehensive	100	10.0[†]	131	0.131
Martin et al[5]	Comprehensive	776	13.2[†]	980	0.096
Axelsson et al[16]	Comprehensive	317	15.0	71	0.015

*TLR = the number of teeth lost divided by the number of subjects divided by the number of study years.
[†]Mean study length reported.

received comprehensive periodontal treatment (TLR 0.276 to 0.015).[5,11–16] Pooling the data for populations that did and did not receive periodontal treatment yields TLRs of 0.111 and 0.348, respectively. However, the categorization of subjects by periodontitis severity is broad, and many definitions have been used.[17] Furthermore, periodontal disease risk was not reported. Page and Martin[18] described a method to objectively define 100 categories of periodontal disease severity and 5 categories of risk. This method was used by Martin et al[4,5] to report tooth loss for two populations. One population was composed of subjects who received routine dental care, but only a small proportion indicated that they had received periodontal treatment.[4] The second population was composed of subjects who received comprehensive periodontal treatment.[5] A further purpose of the current study was to compare tooth loss for subjects of these two populations who had the same level of severity and risk, as defined by Page and Martin.[18]

Method and materials

The tooth loss experience of a population composed of subjects of the Veterans Affairs Dental Longitudinal Study (VA DLS) was compared to a population of subjects treated by periodontists. The VA DLS data were collected at triennial exams over a time period that ran from the late 1960s to late 1980s. VA DLS subjects were not patients of the Veterans Affairs health care system but received their dental and medical care from private health care providers. The vast majority regularly saw their private dentists, received routine preventive and diagnostic services, and received various restorative/prosthetic services. Also, as part of the VA DLS, patients received triennial comprehensive oral exams, full mouth radiographs, and prophylaxis. VA DLS subjects received written information and recommendations regarding needed care. A copy of the recommendations and radiographs was mailed to the subject's general dentist. On the basis of self-reports, only 8% of VA DLS subjects reported receiving some form of periodontal treatment. Tooth loss for the VA DLS population was reported previously.[2–4] Additional information about the VA DLS population has been described.[2,19]

Data were collected from periodontists from 2003 to 2004 for subjects who received comprehensive periodontal treatment that was initiated between 1971 and 2003. Ninety-five percent of periodontist-treated subjects received scaling and root planing, surgery to reduce or eliminate pockets, or both types of periodontal treatment. Tooth loss for the periodontist-treated population was reported previously.[5] Additional information about the periodontist-treated population has been described.[2,3]

The current analysis will refer to the VA DLS population as the historic comparison population (HCP) and the periodontist-treated population as the periodontally treated population (PTP).

Disease and risk scores, described by Page and Martin,[18] were determined for all subjects of both populations. Subjects were grouped into a two-factor matrix based on their severity category, defined in Tables 2 and 3, and risk score. The severity category ranged from 1 (no sextant has periodontitis) to 9 (more than 50% of sextants have severe periodontitis); the risk score ranged from 1 (very low risk) to 5 (very high risk). The 9 severity categories and 5 risk scores produced 45 severity-risk combinations available to segment the populations for analysis. Periodontist-treated subjects were excluded from analysis if the subject's study period was less than 3 years. Subjects also were excluded from analysis if the number of subjects of a severity-risk combination was less than 5 for both populations. These criteria reduced the number of subjects in the HCP and PTP from 523 to 443 and from 900 to 653, respectively. Populations representing 10 severity-risk combinations, illustrated in Table 4, were compared.

Table 2	Severity categories

Severity category	Description
1	No sextant has periodontitis
2	At least 1 and less than 40% of sextants has mild periodontitis; no sextant has moderate or severe periodontitis
3	40% or more sextants have mild periodontitis; no sextant has moderate or severe periodontitis
4	At least 1 and less than 40% of sextants has moderate periodontitis; no sextant has severe periodontitis
5	40% or more sextants have moderate periodontitis; no sextant has severe periodontitis
6	Only 1 sextant has severe periodontitis
7	More than 1 and less than 40% of sextants have severe periodontitis
8	40% or more sextants and 50% or less sextants have severe periodontitis
9	More than 50% of sextants have severe periodontitis

Table 3	Definition of periodontitis severity

Severity	Greatest clinical probing pocket depth in the sextant	Greatest radiographic distance of bone crest to CEJ in the sextant	Bleeding on probing in the sextant
Healthy	< 5 mm	< 2 mm	No
Gingivitis	< 5 mm	< 2 mm	Yes
Mild periodontitis	< 5 mm	2–4 mm	Not applicable
	5–7 mm	< 2 mm	Not applicable
Moderate periodontitis	< 5 mm	> 4 mm	Not applicable
	5–7 mm	2–4 mm	Not applicable
	> 7 mm	< 2 mm	Not applicable
Severe periodontitis	5–7 mm	> 4 mm	Not applicable
	> 7 mm	> 2 mm	Not applicable

CEJ = cementoenamel junction.

Statistical analysis

The correlation between age and tooth loss, study period and tooth loss, and age and TLR was evaluated using the Pearson correlation coefficient for the HCP and PTP. The statistical significance of the difference for each severity-risk combination between the HCP and PTP for age and TLR was evaluated using a two-sample t test. The difference between the HCP and PTP for the proportion of each population that lost a specific number

Table 4 — Severity-risk combinations analyzed in the study

		Severity category								
		Healthy or gingivitis	Periodontitis							
			Mild		Moderate		Severe			
Risk Score		1	2	3	4	5	6	7	8	9
Very low	1									
Low	2			X						
Moderate	3			X	X	X				
High	4				X	X				
Very high	5						X	X	X	X

Table 5 — Study characteristics of each severity-risk combination

Severity category	Risk score	No. of subjects		Subject age (y)		Study period (y)	
		HCP	PTP	HCP*	PTP*	HCP	PTP*
3	2	44	5	45.4 ± 8.3	45.2 ± 16.1	15	12.9 ± 7.2
3	3	55	7	46.2 ± 7.1	45.7 ± 11.1	15	13.1 ± 8.5
4	3	77	24	49.0 ± 8.6	53.3 ± 11.7	15	11.2 ± 4.8
4	4	69	45	44.1 ± 7.7	41.4 ± 9.7	15	15.1 ± 7.5
5	3	50	30	48.9 ± 7.5	53.9 ± 15.1	15	10.6 ± 7.6
5	4	44	117	48.4 ± 5.7	44.6 ± 8.8	15	11.6 ± 6.7
6	5	46	97	49.3 ± 8.4	40.8 ± 6.7	15	13.4 ± 6.4
7	5	31	74	49.9 ± 7.4	41.2 ± 8.9	15	14.7 ± 6.9
8	5	13	81	49.6 ± 4.2	43.1 ± 9.1	15	14.5 ± 6.6
9	5	14	173	45.5 ± 6.2	44.8 ± 8.5	15	14.0 ± 7.2

*Mean ± standard deviation.

of teeth was evaluated using the Pearson chi-square test. Binary logistic regression was used to compare the likelihood of tooth loss between the HCP and PTP. The Hosmer-Lemeshow and Brown tests were used to determine the fit of the model for tooth loss likelihood. Analyses were performed using statistical programs (Minitab Statistical Software, Minitab).

Results

Table 5 describes the number of subjects, subject age, and study period for each severity-risk combination of the HCP and PTP. Based on

Table 6	TLR (mean ± standard deviation) for each combination of disease score category and risk score		
		TLR	
Severity category	**Risk score**	**HCP**	**PTP**
3	2	0.036 ± 0.053	0.000 ± 0.000
3	3	0.064 ± 0.076	0.013 ± 0.023
4	3	0.132 ± 0.221	0.024 ± 0.052
4	4	0.157 ± 0.198	0.027 ± 0.071
5	3	0.169 ± 0.202	0.031 ± 0.086
5	4	0.182 ± 0.190	0.031 ± 0.084
6	5	0.246 ± 0.237	0.056 ± 0.118
7	5	0.325 ± 0.329	0.079 ± 0.148
8	5	0.508 ± 0.363	0.122 ± 0.177
9	5	0.610 ± 0.517	0.218 ± 0.369

TLR = tooth loss rate.

the definition of periodontal disease severity described by Page and Martin,[18] every subject of the HCP and PTP was categorized as having mild, moderate, or severe periodontitis. Table 6 and Fig 1 describe TLR and subjects with a specific number of teeth lost for each severity-risk combination of the HCP and PTP.

Age and tooth loss are mildly correlated for the HCP (Pearson correlation coefficient, 0.182; $P = .000$), but for the PTP, the correlation was not significant (0.045, $P = .246$), indicating that the different tooth loss values observed in subjects cannot be explained simply as a function of age. The correlation between study period and tooth loss for the PTP (0.242, $P = .000$) shows that while significant, it can only be con-

sidered mild at most. Age and TLR were mildly correlated for both populations (HCP: 0.182, $P = .000$; PTP: 0.137, $P = .000$). The difference in age between the HCP and PTP for each severity-risk combination was statistically significant for only 4 of the 10 categories (two-sample t test, $P < .05$). The difference in TLR between the HCP and PTP was statistically significant for each severity-risk combination ($P < .05$). There was a tendency to have subjects with more teeth lost in the HCP and subjects with fewer teeth lost in the PTP (Pearson chi-square, $P = .000$). Based on binary logistic regression, the probability of tooth loss is larger with the HCP compared to the PTP ($P < .0005$). The Hosmer-Lemeshow and Brown tests indicated that the

Fig 1 *Tooth loss for the severity-risk combinations of* (a) *the HCP and* (b) *the PTP. Each bar corresponds to the severity-risk combination listed on the x-axis, where the number following "S" is the severity category and the number following "R" is the risk score.*
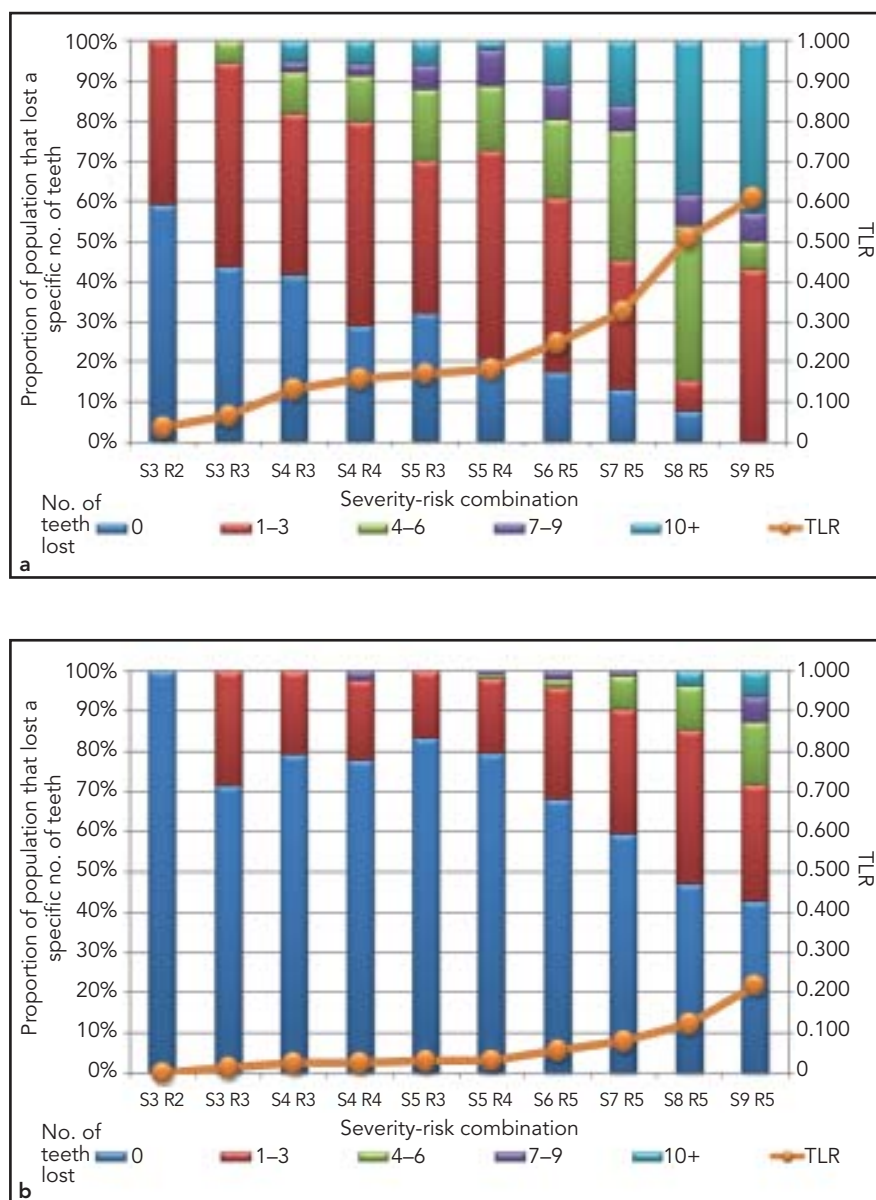

model for the probability of tooth loss fits the data properly and accurately, since all three corresponding *P* values indicate no lack of fit (ie, *P* > .05).

Table 6 shows that the TLR was consistently lower for the PTP compared to the HCP for each severity-risk combination. Furthermore, TLR

for the PTP was generally about 20% of the TLR for the HCP. It is noteworthy that the TLR for an average PTP subject with a severity category less than 6 (ie, mild or moderate periodontitis) was less than 0.031, which was lower than the lowest TLR for HCP (ie, 0.036). Figure 1 clearly shows that for each

severity-risk combination, a higher proportion of PTP subjects lost no teeth (blue segment) compared to subjects of the HCP and a higher proportion of subjects of the HCP lost four or more teeth compared to subjects of the PTP (olive green, purple, and aqua segments).
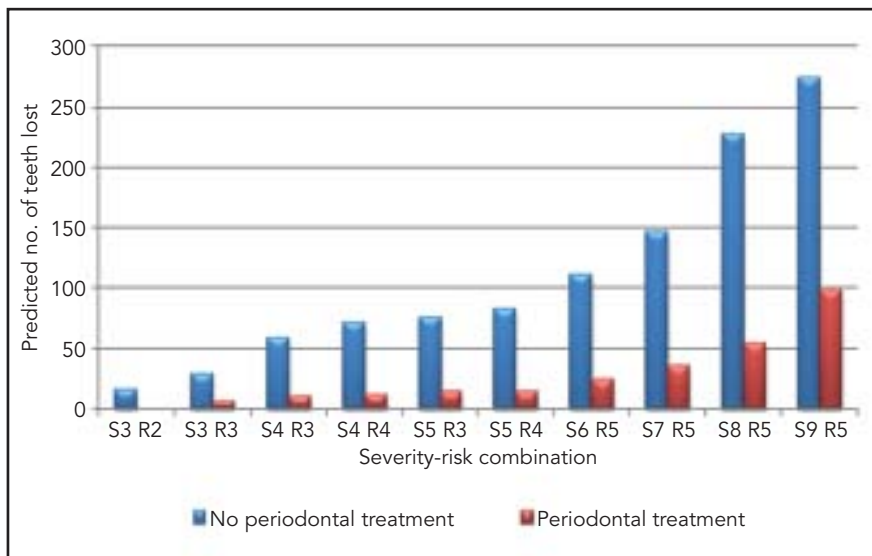
Fig 2 *The predicted number of teeth lost for 30 individuals during a 15-year period when periodontal treatment was and was not provided. The x-axis is the severity-risk combination, where the number following "S" is the severity category and the number following "R" is the risk score.*

Discussion

This study provides evidence that a patient with periodontitis can retain more teeth when comprehensive periodontal treatment is added to routine dental care. The study is consistent with those studies listed in Table 1, but the current study has greater precision regarding the relationship of tooth loss, periodontal disease severity, and risk. This was a result of capitalizing on a numeric definition of periodontal severity to establish severity categories that were much less broad. The inclusion of risk allowed further narrowing of the comparative categories. Figures 1a and 1b illustrate that for every severity-risk category, the addition of periodontal treatment to regular dental care was associated with a lower TLR and more subjects who lost no teeth.

The effect of different study time periods was managed by using TLR. Since the time period was equivalent for subjects of the HCP, the correlation between study period and tooth loss was irrelevant. However, Page and colleagues[3] reported that the TLR was linear and in rank order of risk (ie, TLR for risk 5 > 4 > 3 > 2) when measured at 3, 9, and 15 years for subjects who received routine dental care. No reports exist that describe the TLR during comprehensive periodontal treatment using a similar approach. Even though the correlation between study period and tooth loss for the PTP was mild, it is possible that the TLR could be higher during the first 3 years of treatment, with a reduction in the rate as the treatment period is extended. This effect would occur when the majority of teeth lost by a patient with periodontal disease are extracted during the initial phase of treatment. Hence, the validity of inferring the results of the current study to time periods longer or shorter than 15 years is unknown at this time. While age could be expected to strongly influence TLR, age was not useful in the current analysis of routine dental care,[4] comprehensive periodontal treatment,[5] and comparison of the HCP and PTP. This analysis lacks data comparing the two groups across various important baseline characteristics, such as sex, education, income, number of teeth at baseline, and alcohol use, which may have biased the results and, hence, the conclusions. Additional studies that evaluate multiple potentially important confounding or contributing factors are needed to elucidate their effect. Also, while both populations were fairly large, they were much too small to fill all 45 cells of the matrix, thereby limiting the disease-risk categories that could be compared. Additional studies using more subjects are needed to expand these observations and validate the conclusions drawn.

It is possible to use the TLR for each severity-risk category listed in Table 6 and a time period of 15 years to predict the number of teeth lost when periodontal treatment was or was not applied for 30 individuals. The predicted number of teeth lost is shown in Fig 2. Tooth loss was less for treated subjects at every severity-risk category, and the magnitude of the reduction was greatest for the most severely affected individuals. The example shows that periodontal treatment can result in nearly no lost teeth when severity is low, and this benefit is progressively reduced as severity increases. Since Cobb et al[20] reported that patients referred to a periodontist typically have severe periodontitis, less tooth loss for dental patients in the United States may be possible. Furthermore, the current study indicates that nearly no tooth loss could be expected when periodontal treatment was initiated as soon as severity is mild. The reduction of tooth loss achieved by periodontists may be indicative that achieving an objective of no tooth loss may be more highly related to earlier diagnosis and vigilant management of the periodontal patient, which have been described,[6,18,21–23] than advances in technology.

Acknowledgments

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