Evaluation of the caries profile and caries risk in adults with endodontically treated teeth

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Objectives. The present study was set up to explore (1) a potential association between a person's caries risk profile and the presence or absence of root-filled teeth, and (2) the caries risk in endodontically treated teeth.
Study design. Two hundred Saudi adults were divided into an Endodontic Group (EG; n = 100), with a minimum of 2 root-filled teeth, and a Non-Endodontic Group (NEG; n = 100), without any root filling. Various caries risk factors were evaluated using a computer-based program (Cariogram). Clinical and radiographic examinations were also carried out.
Results. Cariogram findings showed that "the chance of avoiding caries" was low in both groups (35% in EG and 37% in NEG), and there was no statistically significant difference between the 2 groups. However, DMFS, recurrent caries, and mutans streptococcus count in saliva were significantly higher in the EG compared to the NEG ($P < .05$). When teeth in the EG were evaluated independently, the proportion of recurrent caries to the total fillings associated with endodontically treated teeth was 31.6% versus 19.2% in the non-endodontically treated teeth.
Conclusions. Data were not in favor of an association between caries risk profile and presence of root-filled teeth, but supported the notion that root-filling procedures might make the tooth more susceptible to caries. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:264-269)**

Dental caries is of prime interest for the endodontist, as caries is considered to be a serious threat to the long-term outcome of endodontic therapy as well as to the longevity of root-filled teeth.[1,2] For example, a recent study found nonrestorable caries lesions to be the main reason for extraction of such teeth.[3,4] Despite the obvious importance of the problem, few studies have been aimed to explore factors that influence the etiology and progression of caries in the root-filled tooth.[5,6]

Dental caries is the main cause of irreversible pulpitis and subsequent root canal treatment. Therefore, it might be suspected that endodontically treated teeth most often are found in individuals with high caries risk. Furthermore, there are indications in the literature that the loss of pulp vitality, depriving the dentin of several defense mechanisms, will increase the susceptibility to caries. Also, the loss of an intrapulpal pain-signaling system will make it possible for a caries lesion to be left undetected for a long period of time. The present study was set up to explore the hypotheses that (1) at patient level, individuals with multiple root-filled teeth are at a higher caries risk than individuals without root-filled teeth, and (2) at tooth level, root-filled teeth are at a higher caries risk than non–root-filled teeth.

Dental caries is a multifactorial disease, caused by interplay of several components, including past caries experience, oral hygiene, use of fluoride, dietary habits, cariogenic bacteria, and salivary factors.[7] All of these factors have been studied using different pedagogic models; the most recent is a computer program developed by Bratthall and Hänsel-Pettersson, referred to as the Cariogram.[8] This interactive program analyzes different caries-related factors and presents the results as a pie chart, illustrating the "the chance of avoiding caries" as a percentage value. The program has been validated in both children and the elderly.[9] A significant correlation has been found between the Cariogram results and the caries increment.[7,10,11]

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The aims of the present investigation were (1) to compare the caries risk profile of individuals with a minimum 2 root-filled teeth versus individuals without root fillings using the Cariogram, and (2) to compare the frequency of recurrent caries in root-filled teeth versus non–root-filled teeth.

MATERIALS AND METHODS

Study population and study design

The population was selected from a randomized list using the permuted block strategy of adult patients (≥ 18 years old) attending the screening clinic at the Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia. Of 612 patients who attended, 200 were selected and divided into 2 groups, each comprising 100 patients. Individuals allocated to the endodontic group (EG) had a minimum of 2 endodontically treated teeth, whereas individuals in the control group (NEG; non-endodontic group) had no endodontically treated teeth. There was a similar gender distribution between the 2 groups.

Medically compromised patients, pregnant women and nursing mothers, and individuals with just 1 root-filled tooth were excluded from the study. The population represents middle socioeconomic Saudi adult patients.

The study was approved by the local ethics committee in Jeddah and patients who met the inclusion criteria signed a consent form. Each patient was interviewed, intraoral digital photos and bitewing radiographs were taken, after which patients underwent plaque scoring, saliva sampling, and clinical caries examination.

Plaque index

Plaque index (PI) was scored, according to Silness and Löe.[12] Four surfaces of 6 teeth were examined (16, 12, 24, 36, 32, and 44).

Clinical recording of caries

All registrations, both clinically and radiographically, were carried out by one of the authors (K.M.). After plaque scoring, the teeth were cleaned with a rubber cup, pumice, and dental floss. The teeth were dried with compressed air and then examined using a mirror and standard light. Caries was scored according to the World Health Organization criteria.[13] Number of carious, missing, and filled tooth surfaces (DMFS) was calculated. Caries in a filled surface was scored as recurrent caries. Third molars were not included in the study. Five standardized intraoral photographs were taken. The kappa value for the clinical caries recording, based on 20% of the patients, was 0.85.

Radiographic recording of caries

Four bitewing radiographs were taken to score approximal caries. For primary caries, the Gröndahl index was used.[14] Recurrent caries was diagnosed as present or not. All surfaces from the distal of the first premolar to the mesial surface of the second molars (24 surfaces/patient) were evaluated using a light desk and magnifying viewer. The kappa value for the radiographic recordings, based on 20% of the patients, was 0.90.

Salivary tests

Paraffin-stimulated whole saliva was collected for 5 minutes and the secretion rate expressed as mL/min. The saliva was analyzed regarding buffer capacity and number of mutans streptococci and lactobacilli, using chair-side kits (CRT, Ivoclar-Vivadent, Schaan, Liechtenstein).

Questionnaire

Patients were interviewed using the standardized structured questionnaire as described in the Cariogram manual.[15] Information on medical and dental history, dietary habits, and use of fluoride products was also collected.

Assessment of caries risk profile (Cariogram)

The Cariogram program (Fig. 1), with a built-in algorithm, creates an individual caries risk profile.[8] Data on 9 relevant caries-related factors are scored and entered into the program (Table I). The scores are based on a numeric scale from 0 to 3 (or 0 to 2), with 0 as the most favorable score. The factor "Clinical judgment" was set to 1 in all patients. The individual caries profile was estimated and presented in a pie chart with 5 sectors, expressed in percentages: (1) "diet," based on a combination of sugar intake and number of lactobacilli (dark blue sector); (2) "bacteria," which is a combination of oral hygiene and number of mutans streptococci (red sector); (3) "susceptibility," including fluoride program, salivary secretion rate, and buffer capacity (light blue sector); (4) "circumstances," is the past caries experience and general diseases (yellow sector); and (5) "the chance of avoiding caries" (green sector).

Statistical analyses

To estimate the sample size, a power calculation was carried out before the start of the study, based on earlier experience of caries prevalence in Saudi Arabia. All data were analyzed using the SPSS statistical package (version 11.0, SPSS Inc., Chicago, IL). Descriptive statistics, including mean, standard deviations, and range of all factors, were calculated for all individuals in both groups. Analysis of variance (ANOVA) was used to compare the mean of caries-related factors

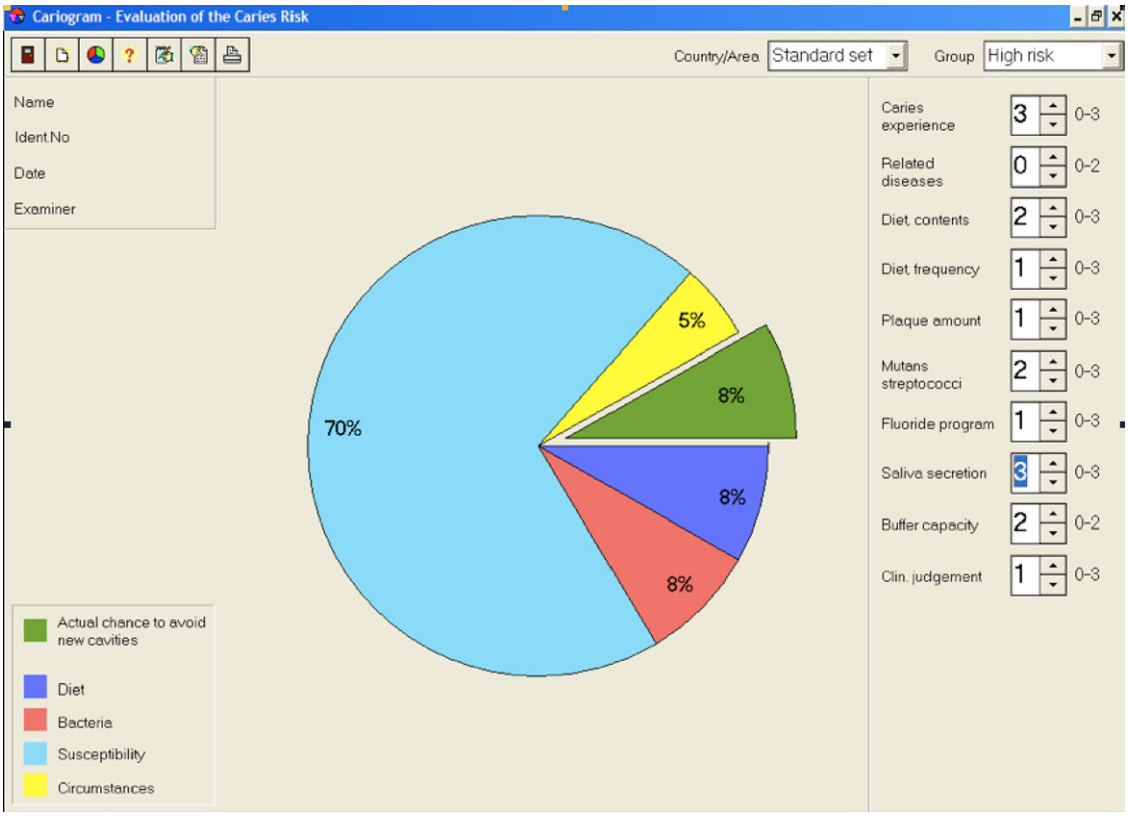

Fig. 1. A Cariogram (as it appears in the computer) showing a high-risk patient with a low percentage (8%) of "actual chance of avoiding new cavities" (green sector). On the lower left, the 5 Cariogram sectors are explained in different colors. On the right, all 9 factors plus clinical judgment are given a score from 0 to 2-3.

Table I. Caries-related factors and the data needed to create a Cariogram

Factor	*Comment*	*Info/data needed*
Caries experience	Past caries experience, including cavities, fillings, and missing teeth because of caries. Several new cavities definitely appearing during the preceding year should give a high score, even if the number of fillings is low	DMFT, DMFS, new caries experience in the past year
Related diseases	General disease or conditions associated with dental caries	Medical history, medication
Diet, contents	Estimation of the cariogenicity of the food, in particular sugar content	Diet history, lactobacillus count
Diet, frequency	Estimation of number of meals and snacks a day, mean for "normal days"	Questionnaire results, 24-h recall or dietary history (3 d)
Plaque amount	Estimation of oral hygiene, according to the Silness-Löe Plaque Index (PI), for example. Crowded teeth leading to difficulty in removing plaque interproximally should be taken into account	Plaque index
Mutans streptococci	Estimation of levels of mutans streptococci (*Streptococcus mutans, Streptococcus sobrinus*) in saliva	Strip mutans test or other laboratory tests giving comparable results
Fluoride program	Estimation of the extent to which fluoride is available in the oral cavity over the coming period of time	Fluoride exposure, interview patient
Saliva secretion	Estimation of amount of saliva, using paraffin-stimulated secretion, for example, and expressing the results as milliliters of saliva per minute	Stimulated saliva test (secretion rate)
Saliva buffer capacity	Estimation of capacity of saliva to buffer acids	Dentobuff test or other laboratory tests giving comparable results

Adapted from Bratthall and Hänsel-Petersson.[8]
For all factors, the examiner gathers information by interviewing and examining the patient, including salivary tests. Each factor is given a score, ranging from 0 to 3 (or 0 to 2), according to predetermined criteria. A score of 0 is the most favorable value and the maximum score 3 (or 2) indicates a high, unfavorable value.

Table II. Mean values, SD, and range of various parameters in the Endodontic Group (EG; n = 100) and the Non-Endodontic Group (NEG; n = 100); the "chance of avoiding caries" (%), according to the Cariogram, is also shown

	EG			*NEG*			
Factor	*Mean*	*SD*	*Range*	*Mean*	*SD*	*Range*	*P value*
Age	34.3	12.3	17-66	32.9	12.8	18-66	
Number of teeth	24.8	3.1	15-28	25.2	3.6	8-28	
DMFS	48.7	21.8	6-97	33.6	22.5	2-118	<.001
Primary caries (DS)	5.0	5.7	0-36	7.5	9.8	0-62	<.01
Recurrent caries (RD)	6.1	6.7	0-38	2.4	3.2	0-14	<.001
Missing surface (MS)	15.7	15.5	0-65	14	18.5	0-94	
Filled surface (FS)	21.9	16.7	0-71	9.7	10	0-62	<.001
Approximal caries	2.7	2.3	0-10	3.6	2.7	0-12	
Saliva secretion (mL/min)	1.7	0.9	0.3-5.4	1.7	1.2	0.3-8	
Plaque index	0.9	0.6	0-2.2	1.0	0.6	0.1-2.7	
Cariogram, %	35	21.7	4-80	37	21.5	6-82	

between EG and NEG and chi-square test to compare the scores. Intragroup comparison of recurrent caries at the tooth level was performed using pairwise *t* tests. *P* values less than .05 were considered statistically significant.

RESULTS

Caries profiles in endodontic versus non-endodontic group

Overall, the mean DMFS was significantly higher in the EG compared to the NEG ($P < .001$; Table II). Moreover, EG showed a higher mean number of surfaces with recurrent caries (RD) (6.1 versus 2.4) and fillings (FS) (21.9 versus 9.7) compared with the NEG ($P < .001$). On the other hand, the mean number of surfaces with primary caries (DS) was lower in the EG compared with the NEG (5.0 versus 7.5) ($P < .01$).

In EG it was found that 32% of the filled surfaces in the root-filled teeth were associated with recurrent caries versus only 19% of the filled surfaces in the non–root-filled teeth (Table III) ($P < .01$).

Table III. Comparison between coronal filled surfaces associated with endodontically and non-endodontically treated teeth in the same group (Endodontic Group; n = 100)

Factors	*Endodontically treated teeth*	*Restored teeth*	*P value*
No. of teeth	362	404	
Mean fillings	11.4 surfaces	10.5 surfaces	
Mean recurrent caries	3.6 surfaces	2.5 surfaces	
Percentage of recurrent caries in total fillings	31.5%	19.2%	<.05

Caries risk profiles in endodontic versus non-endodontic group

Using the Cariogram, analysis showed that the mean percentage of "chance of avoiding caries" was 35% in the EG compared to 37% in the NEG (not significant; Table II).

Frequency distribution of the caries-related factors is presented in Table IV. There was statistically significant difference ($P < .05$) only for a number of individuals with high mutans streptococcus counts (i.e., $>10^5$ colony-forming units [CFU]/mL saliva); 48 in EG (26 + 22 = 48) and 30 in NEG (11 + 19 = 30).

DISCUSSION

Caries prevalence (DMFS or DMFT) gives a general picture of the disease, whereas assessment of the various individual caries-related risk factors gives a broader view. In countries like Saudi Arabia, where the prevalence of caries is high, risk assessment and determining the different risk factors involved are imperative. This has recently been addressed by our research group in Saudi patients with many dental restorations.[7]

In this study, we presented the idea of a relationship between root-filled teeth and the overall caries risk of the patient, and we tested our hypothesis among a group of Saudi adult citizens. As an exploratory step, we compared the DMFS index between EG and NEG. The results showed that, overall, the mean DMFS was high, both in EG (mean 48.7) and NEG (mean 33.6). These data were consistent with a previous study in Saudi Arabia[7,16] in which a mean DMFS value of about 50 was found in patients between 18 and 56 years of age.

The mean number of filled surfaces in the EG was significantly higher compared with the NEG, which was not surprising, as an endodontically treated tooth has to receive a crown filling of some sort ($P < .001$; Table II). By the same token, primary caries was less frequent in the EG compared with the NEG ($P < .01$;

Table IV. Frequency distribution of caries-related factors according to the Cariogram score of the total of 100 individuals in the Endodontic Group (EG) and the 100 in the Non-Endodontic Group (NEG): a chi-square test was used to calculate the difference

Factor	*Cariogram score*	*EG (n = 100)*	*NEG (n = 100)*	*P value*
Lactobacillus score (CFU/mL)				
0-10^3	0	23	36	
10^3-10^4	1	31	23	
10^4-10^5	2	30	28	
>10^5	3	16	13	
Diet (meals/day)				
3	0	73	60	
4-5	1	21	35	<.001
6-7	2	5	0	
>7	3	1	5	
Plaque index				
<0.4	0	16	10	
0.4-1.0	1	51	55	
1.1-2.0	2	30	29	
>2.0	3	3	6	
Streptococcus score (CFU/mL)				
0-10^3	0	27	38	
10^3-10^4	1	25	32	<.05
10^5-10^6	2	26	11	
>10^6	3	22	19	
Secretion rate (mL/min)				
≥1.1	0	71	67	
0.9-1.1	1	13	12	
0.5-0.9	2	10	16	
<0.5	3	6	5	
Buffer capacity (pH)				
>5.5 (Blue)	0	58	50	
5.5-4.5 (Green)	1	19	18	
<4.5 (Yellow)	2	23	32	
Fluoride (F) program				
Constant additional F	0	4	2	
Infrequent additional F	1	26	19	
Toothpaste with F only	2	56	70	
No F	3	14	9	

CFU, colony-forming units.

Table II), which may be attributable to the fewer available surfaces.

On the other hand, recurrent caries was significantly more often found in the EG than in the NEG ($P < .001$; Table II). The figures from the EG group represent both endodontically and non-endodontically treated teeth. Therefore, we made an intragroup comparison at tooth level and found that the proportion of caries in filled surfaces was 31.6% in root-filled teeth versus 19.2% in non–root-filled teeth (Table III).

When assessing the caries risk factors, results showed a statistically significant difference in the mutans streptococci count between the 2 groups ($P < .05$). The higher mutans count in the EG may be considered as a negative factor, as this may influence the pH-drop in dental plaque.[17] Otherwise, there was no overall difference between the 2 groups regarding "chance of avoiding caries"; both groups showed low mean values (<40%), i.e., high caries risk. It should be noted, however, that the range was large in both groups, from 4% up to 82%. It could be argued that the Cariogram evaluates the whole individual as a unit with multiple confounding factors influencing the total score. Further studies are therefore needed in which the tooth, rather than the individual, should be used as a unit.

In the dental literature the significance of pulp vitality to the resistance of caries is controversial. On one hand, Brewer et al.,[6] for example, found that ligation of blood vessels significantly increased the frequency of dental caries in the rat. On the other hand they found that root canal treatment decreased the frequency of dental caries.[18] The latter observation could not be confirmed in the present study, which, in discordance, indicated an increased caries risk in root-filled teeth. However, our study was cross sectional and data were obtained from a sample of individuals with high caries risk and it is not known whether the caries lesions developed before or after the teeth were root filled.

In conclusion, observations did not encourage our first hypothesis, as we found no difference in terms of caries risk between groups of individuals with multiple versus no endodontically treated teeth. However, data were in favor of the notion that root-filled teeth are at higher caries risk than non–root-filled teeth. Thus, the second hypothesis was provisionally accepted and further studies of factors that might influence caries risk in the root-filled tooth were justified.

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