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Root-filled teeth and recurrent caries—A study of three repeated cross-sectional samples from the city of Jönköping, Sweden

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Abstract

Objective. The aim of the study was to test the hypothesis that root-filled teeth are at a higher caries risk than non-root-filled teeth. ***Materials and methods.*** Two sub-samples from epidemiologically obtained data collected in 1983, 1993 and 2003 in the city of Jönköping, Sweden, were analysed. All the participants were examined clinically and radiographically and the type of filling and the presence or absence of caries were recorded. Sub-sample 1 comprised 832 individuals (9202 teeth) aged 20–70 years with at least eight premolars/molars. In sub-sample 2, 163 subjects (577 teeth) with only one or two decayed tooth surfaces and at least one tooth with full crown coverage were analysed. ***Results.*** Logistic regression analysis found that root-filled teeth were predictive of recurrent caries when controlling for the type of restoration in sub-sample 1 (OR = 1.68; 1.41–2.0; CI 95%) and sub-sample 2 (OR = 2.20; 1.07–4.52; CI 95%). ***Conclusion.*** In support of the suggested hypothesis, the data revealed a significant association between root-filled teeth and recurrent caries.

Key Words: *caries susceptibility, endodontic treatment, Jönköping, Sweden, recurrent caries*

Introduction

Dental caries might jeopardize the long-term successful outcome of endodontic therapy. On the one hand, studies have shown that micro-organisms from the carious lesion might penetrate the root canal seal and cause or sustain apical inflammation [1–3]. On the other hand, the lack of pulpal nerve function will allow caries to progress without overt clinical symptoms and cause a major loss of tooth substance. Accordingly, several studies have reported that non-restorable carious lesions are the main reason for the extraction of root-filled teeth (RFT) [4,5]. Despite the obvious importance, few authors have explored the factors that influence the progress of caries in RFT.

Dental caries is the result of an interaction between elements in the close external environment and various factors in the tooth structure [6]. For example, the loss of pulp vitality deprives the tooth of several defence mechanisms, such as the production of antibodies against caries-related micro-organisms and the ability to deposit tertiary dentine, a situation that might make the tooth more receptive to caries. In support of this idea, Brewe et al. [7] found that the ligation of pulpal blood vessels significantly increased the susceptibility to caries in the rat. This observation was confirmed by Mascres et al. [8], who, in an animal study, concluded that reduced blood supply increased the incidence of dental caries. Furthermore, current endodontic treatment methodology was reported to alter the quality of dentine [9,10], which might in turn make the tooth more sensitive to caries. In consequence, Merdad et al. [11] proposed the hypothesis that RFT are exposed to a higher risk of caries than

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non-root-filled teeth (NRFT). In a study of 200 Saudi adults, they found that 31.6% of restored RFT were associated with recurrent caries vs 19.2% of restored NRFT. The aim of the present study was to further explore the hypothesis by comparing the frequency of recurrent caries in RFT vs NRFT in three large Swedish epidemiological samples obtained in 1983, 1993 and 2003, respectively.

Materials and method

In 1983, subjects aged 20, 30, 40, 50, 60 and 70 years in the city of Jönköping, Sweden, were examined. In each age group, 130 randomly selected individuals were invited for a clinical and radiographic examination. It was repeated in the same manner and in the same geographical area in 1993 and 2003. For details relating to the reasons for non-attendance, see Hugoson et al. [12–15]. In the present study, only individuals with ≥ 8 premolars/molars were included. The participants were organized in two sub-samples, sub-samples 1 and 2. For a description of the sub-samples, see Figure 1.

Clinical examination and diagnostic criteria

All the examinations were carried out by calibrated examiners [12–15] (seven examiners in 1983 and 1993, eight examiners in 2003). Primary caries was recorded when the lesions could be verified as cavities by probing on a surface not previously restored. Recurrent caries was recorded according to the same criteria on a restored surface. The type of restoration and material (amalgam, silicate, composite, gold inlays and full crowns and porcelain crowns) was recorded for each surface. In this report, restorations were categorized as fillings (1–5 surfaces) or full crown coverage.

Radiographic examination and diagnostic criteria

All subjects had a full mouth radiographic examination (FMR) and/or an orthopantomogram (OPG) supplemented with 4–6 bite-wing radiographs, depending on age and examination year.

Carious lesions were recorded when a clearly defined reduction in the mineral content of the

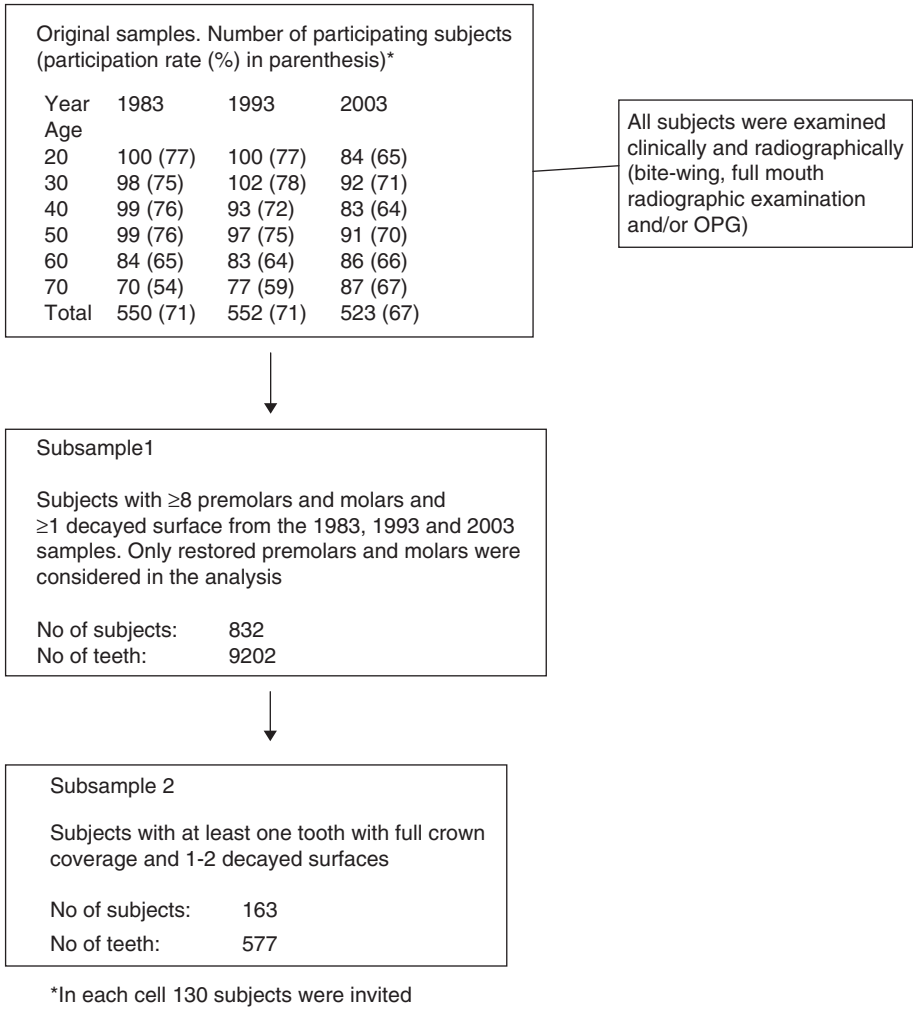

Figure 1. Description of original samples and sub-samples 1 and 2.

proximal surfaces could be seen and the lesion extended into the dentine. A tooth was considered to be endodontically treated when it was root filled or pulpotomized. All registrations from the radiographs were made by the same examiners that performed the clinical examination.

Analysis of observer variation

In 1983, seven calibrated examiners performed all the examinations. Reliability was tested for three clinical and 10 radiographic variables. Reliability was expressed as the intra-class correlation coefficient (ICC), where an ICC close to 1 indicates good agreement. In the present study, reliability was tested for filled surfaces (ICC = 0.996) (clinical variable), sound surfaces (ICC = 0.983), decayed surfaces (ICC = 0.711) and surfaces with recurrent caries (ICC = 0.810) (radiographic variables) by three examiners in 20 randomly selected subjects.

After the examination in 2003, reliability was tested for interpretation of the status of approximal surfaces. Radiographs from 140 individuals in the examinations in 1983, 1993 and 2003 yielded 7840 approximal surfaces, which were all re-evaluated by two observers. Agreement between the original examination and the re-evaluation were calculated according to Cohen's kappa. The agreement was 0.57 for 2003 and 0.79 for the 1983 and 1993 examinations, respectively [12].

Statistical method

The null hypothesis was that there was no difference in the frequency of recurrent caries between RFT and NRFT. The association between RFT and recurrent caries was studied by means of logistic regression, with recurrent caries as the dependent variable. The statistical computer program used in the analyses was SPSS version 17 (version 11.0, SPSS Inc., Chicago, IL).

Results

At tooth level in sub-sample 1, the logistic regression analysis revealed that RFT was predictive of recurrent caries, OR = 1.68 (1.41–2.0; CI 95%), when controlling for the number of restored surfaces (Table IA). The results in Table IA also indicate that the type of restoration is a stronger predictor of recurrent caries than whether or not a tooth is root filled. The association between the number of restored surfaces and recurrent caries in RFT was significant for 5-surface fillings when compared with 1-surface fillings (Table IB). For NRFT, there were significant associations between the number of restored surfaces and recurrent caries for teeth with 2–5 restored surfaces and full crowns when compared with teeth with 1-surface fillings (Table IC).

To test the association between RFT and recurrent caries further, only individuals with 1–2 decayed surfaces were included in a sub-analysis, yielding a sample of 163 individuals with 577 teeth with full crown coverage (sub-sample 2, see Figure 1). The association between RFT and recurrent caries still held (OR = 2.20 (1.07–4.52; CI 95%)).

Discussion

This study found a statistically significant association between RFT and recurrent caries. Our hypothesis that RFT are at higher risk for recurrent caries than NRFT was not refuted.

To test the hypothesis, we used data from three repeated cross-sectional samples of individuals of 20–70 years of age living in the city of Jönköping. Conclusions drawn from epidemiogical surveys are often based on radiographic examination alone. However, the presence of dense filling materials might hide recurrent carious lesions on the radiograph [16,17] and reduce the diagnostic accuracy. One strength of the present study was that all the participants were examined clinically and radiographically.

From the original pool of 1625 examined individuals (Figure 1), a sub-sample was constructed. All included individuals had to have at least eight premolars and molars (sub-sample 1 (n = 832)) and only premolars and molars were considered in the analysis. The rationale for this was to explore a homogenous set of teeth with regard to tooth position and approximal contacts, important from the viewpoint that caries risk is site-specific. Sub-sample 1 showed a significant association between RFT and recurrent caries. However, bias in terms of confounding factors such as the type of restoration and individual caries activity weakened the validity of the conclusion and another sub-sample was therefore constructed. In sub-sample 2, individuals with only one or two decayed surfaces were included and only teeth with full crown coverage were analysed. In spite of this, a significant association was found between RFT and recurrent caries.

As in most epidemiological studies, we have not been able to fully control for current and past individual caries risk or site-specific caries risk factors as for example treatment quality. Thus, the finding that root filled teeth were predictive of having recurrent caries may be confounded by other factors than the endodontic treatment per se. It must be remembered that caries risk is site-specific. Recurrent caries in RFT may have developed as a result of the environmental factors that caused the caries lesion necessitating endodontic treatment. However, past caries activity that results in endodontic treatment in most cases warrants a new restoration of the tooth, e.g. a full crown, and thus may alter the site-specific caries risk. The authors think that the construct of sub-sample 2 controls for potential confounders as far as possible.

Table I. Logistic regression model analysing the association between (A) endodontic status and recurrent caries, controlled for number of restored surfaces, (B) number of restored surfaces in root-filled teeth and recurrent caries and (C) number of restored surfaces in non-root filled teeth and recurrent caries.

	A	B	C
	All restored teeth	Root filled teeth	Non-root filled teeth
	(N = 9202)	(N = 1196)	(N = 8006)
	OR (CI)	OR (CI)	OR (CI)
Endodontic status			
Non-root filled	Reference	N/A	N/A
Root filled	1.68 (1.41–2.0)	N/A	N/A
Number of restored surfaces			
1 surface	Reference	Reference	Reference
2 surfaces	2.80 (2.14–3.67)	5.35 (0.66–43.23)	2.72 (2.07–3.57)
3 surfaces	4.55 (3.51–5.89)	4.84 (0.62–37.70)	4.59 (3.53–5.96)
4 surfaces	5.66 (4.29–7.46)	3.49 (0.45–27.21)	6.50 (4.90–8.61)
5 surfaces	5.34 (3.98–7.16)	7.75 (1.02–59.17)	4.55 (3.27–6.31)
Full crown	2.69 (1.99–3.64)	3.47 (0.46–26.47)	2.42 (1.70–3.43)

OR = Odds ratio. CI 95%. N/A = not applicable.

Although controlled for, possible confounding of the result cannot be ruled out.

In a previous study conducted on a Saudi population [11], we evaluated the caries risk profile using the Cariogram. We found that the overall 'chance of avoiding caries' did not differ significantly between groups of patients with at least two RFT and no RFT, respectively. However, in agreement with the present study, the frequency of recurrent caries was higher in RFT than in NRFT. The data thus support the idea that the root-filled tooth *per se* is more susceptible to caries than the non-root filled.

Merdad et al. [18] speculated that an increased caries susceptibility in RFT could be due to a change in the biological environment of the tooth. In intra-individual comparisons, they found that the *S. mutans* count and *de novo* plaque formation were significantly higher in RFT than in NRFT. However, in that study, the marginal fit of large restorations to the RFT was often found to be inadequate, a situation that might have influenced the microbiological comparisons. In sub-sample 2 in the present study, we therefore attempted to eliminate the role of the restoration as a confounding factor and compared only teeth with full crown coverage and again found a significant association between root-filled teeth and recurrent caries.

It has been recommended that, in order to prevent tooth fractures, RFT in the posterior region should be covered by full crowns [19]. Data from the present study indicate a decreased risk of recurrent caries in teeth with full crown coverage as compared to teeth with multi-surface fillings, thus offering additional justification for a recommendation of this kind.

To conclude, the present study supports the notion that RFT are predictive of recurrent caries. However, the underlying reasons are not well understood and require further exploration.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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