Prevalence of root caries in relation to various risk factors in a sample of subjects aged (25-64) years in Erbil city: A cross sectional study

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Backgrounds: Root surface caries is a significant oral public health problem among humans' due to improvements in health care, long life expectancy, and increasing demand to maintain oral health. The objective of this study was to determine the prevalence of root caries in subjects in Erbil city and its relation to various risk factors.

Subjects and methods: The study was conducted in twelve primary health care centers in different directions of the city. A total of 2600 subjects (1352 males and 1248 females) attending these centers aged 25-64 years old were examined. The following clinical parameters were evaluated: root caries index, plaque index, gingival index, unstimulated salivary flow rate, other related factors as behavioral habits, oral practices, and educational level were assessed by means of multiple choice questionnaires by direct interview.

Results: The results of this study showed that the prevalence of root caries was (22.3%) and the mean value of root caries was (33.650±16.504) in the whole sample with statistically significant age differences of both. Males were more prevalent in root surface caries than females with significant differences. Results showed that the mandibular teeth were more affected than the maxillary teeth, and that mandibular first molars were the mostly affected teeth by root caries. Prevalence of root caries was significantly associated with these risk factors: gingival index, plaque index, unstimulated salivary flow rate, educational level, wearing removable partial dentures, frequency of snacks, tooth brushing and frequency of tooth brushing, systemic disease and use of medication, while the results showed no association between prevalence of root caries and smoking.

Conclusions: The results indicate that adults and older aged individuals in Erbil city have a high prevalence of root caries and high experience of root caries as expressed by root caries index and the prevalence of root caries was associates with these risk factors: Gingival index, Plaque index, unstimulated salivary flow rate, educational level, wearing removable partial dentures, frequency of snacks, tooth brushing and frequency of tooth brushing, systemic disease and use of medication while there was no association with smoking.

Keywords: Root caries, risk factors, root caries index, unstimulated salivary flow rate, behavioral habits.

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Introduction

Dental caries is defined as a progressive, irreversible, microbial disease affecting the hard parts of the tooth exposed to the oral environment, resulting in demineralization of the inorganic constituents and dissolution of the organic constituents, thereby leading to a cavity formation.[1]

Root caries is a soft, progressive lesion that is found anywhere on the root surface that has lost its connective tissue attachment and is exposed to the environment. RC occurs at or apical to the cementoeanamel junction (CEJ). Generally RC lesions have been described as having a distinct outline and presenting with a discolored appearance in relation to the surrounding non carious root.[2]

The prevalence of RC in the general population is increasing as the population ages, since RC increases with age the increased prevalence is associated with people retaining their teeth longer and with root surfaces becoming physiologically (aging) or pathologically (periodontal disease) exposed, and therefore at risk.[3]

The periodontal disease which is always followed by the loss of the epithelium and connective tissue junction, is definitely a risk factor for the appearance of RC. There are many risk factors associated with RC such as are: xerostomia, partial prosthesis, general diseases, and drugs in mature patients,[4] Tobacco,[5] dietary habit, microbial plaque and a decreased salivary flow.[6]

Caries originating on root is alarming because: it has a comparatively rapid progression, it is often asymptomatic, it is closer to the pulp, and it is more difficult to restore[7].

RC are often very difficult to restore due to their location, problems with moisture control and proximity to the pulp and are therefore prone to high recurrence rates[6].

There are few studies made on the prevalence of root caries in Iraq, but there is no such data available on Erbil City. So the purpose of this study is to assess the prevalence of RC and its association with various risk factors in a population as a guide for RC prevention in Erbil City for the upcoming years.

Patients and methods

This study was carried out on patients attending primary health care centers in Erbil city started from 1st December 2014 to 1st July 2015. After obtaining the ethical approval from the ethical committee of the college of dentistry/ Hawler Medical University, a random sample of (2600) patients were examined who were permanent residents in Erbil city aging (25-64) year. The following patients were excluded from the study: individuals with physical disability because they have limited manual dexterity that makes the removal of plaque during tooth brushing difficult, also diabetes, autoimmune disorders, radiation therapy, pregnant women and people who refuse to participate in the survey were excluded.

Personal and medical information such as age, gender, any systemic disease, use of medication, information about times of drinks or diet eaten between meals, tobacco use, denture wearing, level of education was obtained by direct interview with the patients using a specially designed case sheet.

Intraoral examination was carried out using disposable dental mouth mirrors, exploratory probes and periodontal probe. All patients were examined in a room using an artificial light for illumination, where patients seated in an ordinary chair supporting their head to the wall with the examiner standing in front of the chair for diagnosis[8].

The examination was started with measurement of plaque index (PI) following the criteria of Silness and Löe 1964[9]. Gingival index described by Löe and Silness 1963[10] was used for assessment of the gingival health condition. Then followed by the examination of RC and measurement of unstimulated salivary flow rate.

To obtain RC index (RCI), each of the four surfaces (mesial, buccal, distal, and lingual) of the root is examined for a single tooth. All teeth are examined in both lower and upper arch (third molars were excluded). RCI expresses the proportion of carious and filled root surfaces among exposed root surfaces to the buccal environment, i.e. with gingival recession, and can be calculated by the following formula Katz 1980[11]:

$$RCI = \frac{(R-D)+(R-F)}{(R-D)+(R-F)+(R-N)} * 100$$

The study of salivary secretion was performed without any stimulus at the morning (9 to 11 a.m.), under standard temperature and humidity conditions. All subjects examined after at least 90 minutes of eating and drinking. The subject was seated in a chair in a room with his or her head bent down. The subject was instructed to avoid swallowing and to avoid moving the head or

body during the test. The technique of collecting saliva is done by using draining method where saliva allowed to passively drain from the mouth into a graduated test tube, through a glass funnel for ten minutes[12]. The unstimulated whole saliva flow rate ≤0.1 ml/min is recorded as hyposalivation.[13]

Statistical analysis. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 19). Chi square test of association was used to compare between proportions. When the expected count of more than 20% of the cells of the table was less than 5, Fisher's exact test was used. Student's t test was used to compare between means of two groups. One-way Analysis of Variance (ANOVA) was used to compare between three or more means. A p value of ≤ 0.05 was considered statistically significant.

Table 1: Distribution of patients according to age groups and gender.

Age groups	Females	Males	Total
	No. (%)	No. (%)	No. (%)
25-34	435(34.9)	544(40.2)	979(37.7)
35-44	409(32.8)	328(24.3)	737(28.3)
45-54	246(19.7)	263(19.5)	509(19.6)
55-64	158(12.7)	217(16.1)	375(14.4)
Total	1248(100)	1352(100)	2600(100)

Table 2: Prevalence of RC according to age.

Age group	N	Prevalence of RC	P value
		No. (%)	
25-34	979	93(9.5)	<0.001
35-44	737	129(17.5)	
45-54	509	146(28.7)	
55-64	375	211(56.3)	
Total	2600	579(22.3)	

Results

Table 1 presents distribution of patients according to age groups and gender. The prevalence of RC among the whole patients examined was 22.3%. The percentage of patients with RC and the mean RCI value increased significantly with increasing age, data showed RCI was 23.995±10.329, 29.732±15.955, 33.740±15.882, 40.237±16.712 for 25-34, 35-44, 45-54, 55-64 years of age group respectively (Table 2, 3).

The prevalence of RC in males (25.8%) was significantly higher than in females (18.4%) (Table 4). The males mean RCI was 32.801±16.172 for all age groups, while in females it was 34.937±16.950, the differences in mean RCI was not significant by gender (*P*=0.128) as seen in Table 5.

Regarding the type of tooth mostly affected by RC, the results showed that the mandibular teeth were more affected than the maxil-

Table 3: Caries experience of root surfaces (RCI: mean and standard deviation) among patients according to the age.

Age groups	Mean RCI (±SD)	P value (ANOVA)	Significant by LSD
25-34	23.995 (10.329)	<0.001	all age groups
35-44	29.732 (15.955)		
45-54	33.740 (15.882)		
55-64	40.237 (16.712)		
Total	33.650 (16.504)		

Table 4: Prevalence of RC according to gender.

Gender	N	Prevalence of RC	P(value)
		No (%)	
Males	1352	349(25.8)	<0.001
Females	1248	230(18.4)	
Total	2600	579(22.3)	

Table 5: Caries experience of root surfaces (RCI: mean and standard deviation) among patients according to the gender.

Gender	Mean RCI(±SD)	P value
Male	32.801(16.172)	0.128
Female	34.937(16.950)	

lary teeth and that first molars were the mostly affected teeth by RC in both arches.
The results showed that (59%) of the whole sample patients were with gingival recession, the prevalence of gingival recession increased with increased age (Table 6). The results showed that (37.7%) of the patients with gingival recession had RC, while (62.3%) of them had no RC.
As shown in Table 7 the prevalence of RC seen increased significantly with the increase in the GI and PI scores, the increase of frequency of snacks and decreased significantly with the use of brush and increased frequency of tooth brushing and

Table 6: Distribution of patients according to gingival recession by age group.

Age groups	Gingival recession		Total
	No	Yes	
	No. (%)	No. (%)	No. (%)
25-34	635(64.9)	344(35.1)	979(100)
35-44	365(49.5)	372(50.5)	737(100)
45-54	65(12.8)	444(87.2)	509(100)
55-64	1(0.3)	374(99.7)	375(100)
Total	1066(41.0)	1534(59.0)	2600(100)

Table 7: distribution patients with RC according to many variables.

Variable		N	Prevalence of RC (%) .No	P value
GI	**1 .0>**	38	(7.9)3	0.001 >
	0.1-1	898	(12.7)114	
	2-1.1	1422	(26.9)382	
	2.1-3	242	80(33.1)	
PI	**0.1-1**	740	68(9.2)	<0.001
	1.1-2	1432	316(22.1)	
	2.1-3	428	195(45.6)	
Tooth brushing	**No**	349	122(35.0)	<0.001
	Yes	2251	457(20.3)	
Frequency of tooth brushing	**Seldom**	1193	283(23.7)	<0.001
	Once a day	693	133(19.2)	
	Twice and more	365	42(11.5)	
Saliva flow	**Normal**	2320	424(18.3)	<0.001
	hypo	280	155(55.4)	
Frequency of snacks	**≤ 2 times / day**	1158	191(16.5)	<0.001
	≥3 times/day	1442	388(26.9)	
Smoking	**No**	2111	474(22.5)	0.638
	Yes	489	105(21.5)	
RPD	**No**	2473	539(21.8)	0.010
	Yes	127	40(31.5)	
Educational level	**illiterate**	383	149(38.9)	<0.001
	primary	872	177(20.3)	
	secondary	1076	217(20.2)	
	College +	269	36(13.4)	
Disease	**No**	1584	286(18.1)	<0.001
	Yes	1016	293(28.8)	
Drug	**No**	2404	478(19.9)	<0.001
	Yes	196	101(51.5)	
	Total	2600	579(22.3)	

increased educational level. Data showed that the prevalence of RC in patients with hyposalivation, who wear removable partial denture, with systemic diseases and on medication was significantly higher than in patients with normal salivation, without removable partial denture, with no systemic disease and medications.

The prevalence of RC in nonsmoker patients (22.5%) was higher than smoker patients (21.5%), a statistical analysis showed that there were no significant differences in prevalence of RC with the smoking habit of patients (P=0.638).

Discussion

RC is a significant oral public health problem among human due to improvements in healthcare, longer life expectancy, and increasing demand to maintain oral health.[14]

Adults have increased risk of RC since the prevalence of exposed root surfaces is increasing with age due to the long-term effects of trauma from inappropriate tooth brushing and gingival recession associated with periodontal disease.[15] Restorative management of RC is a challenge in view of the difficulties of visibility, moisture control, access to carious lesions, proximity of the pulp, proximity to the gingival margin, and the organic content of the dentin.[16] Therefore, to prevent or reduce RC in a community, it is necessary to have data on the distribution of RC among population and to determine the risk factors associated to it. This can only have achieved through an epidemiological study. Comparisons of the RC findings with those of other studies should be done with caution, since there is a great variation of results in the literature.[15]

In general, the prevalence of RC obtained in this study was nearly similar to a survey in US[17] with (22.5%). Lower percentage reported in Iraq (Ramadi city)[18] with (18.5%). While other researchers[19,4] reported much higher percentages.

The study revealed that the prevalence of RC tends to be increased with age. This confirmed the findings of other studies. This may be attributed to the fact that the prevalence of exposed root surfaces was increasing with age due to long term effects of trauma from inappropriate tooth brushing and gingival recession associated with periodontal disease[15].

In terms of root caries index (RCI), which expresses the risk of developing caries due to the root surfaces that are at risk for the development of RC surface being exposed to the buccal environment,[22] the mean value of RCI among the subjects of this study was with highly significant differences between age groups. This mean value is higher than that reported in other studies.[18,23] A study in Brazil[20] found no significant difference in RCI by age. The differences in the results of the present study and others are due to several reasons:

1. In the original formulation of the RC Index (RCI) according to Katz[11], only lesions and restorations of root surfaces infected with recession can be taken into account. While many researchers follow this protocol, others have modified it.

2. For instance, some authors exclude the caries close to restorations or crowns even it is present on root surfaces, while other authors take into consideration both caries and restorations, irrespective of recession[23,24].

Regarding gender difference, the prevalence of RC in males were higher than in females with significant difference. This finding was in consistent to other studies[14,19,21,25,26]. Other studies[15,20] have reported the opposite. In the present study, the mean value of RCI in females were higher than in males with no significant differences, this finding also found in a study[20] that mean value of RCI is higher in females than males but with significant differences, while in another study[15] the opposite found with non significant differences regarding RCI and gender. Males are more susceptible to RC, the reason is, men may be less likely to practice preventive oral health behaviors such as tooth brushing and visiting the dentist[27], but females were with in-

creased risk (activity) of RC (higher RCI), this due to:

1. Physiological changes associated with fluctuating hormone levels during individual life histories, and the impact these changes have on the oral health of women.

2. The biochemical composition of saliva and overall saliva flow rate are modified in several important ways by hormonal fluctuations during events such as puberty, menstruation, and pregnancy, making the oral environment significantly more cariogenic for women than for men.

The finding of this study confirmed that mandibular teeth were more affected and that first molars were the most susceptible. This finding was also reported in Turkey[28]. While other studies reported that maxillary teeth were more affected with RC[23,29]. A study[30] reported that RC are evenly distributed within the dentition. However, these patterns might be related to the high recession frequency in these types of teeth[14].

Table 6 showed the prevalence of gingival recession was significantly increased with increasing age and that from (59%) subjects with gingival recession, (37.7%) had RC. There was different prevalence of gingival recession with RC reported in other studies[4,19,20] with (41.9%, 87.1%, 68.5%) respectively. Gingival recession commonly occurs with aging. Causes of gingival recession include deposition of plaque and calculus, occlusal trauma, tooth brush trauma, and other oral hygiene practices. Once the protection of the gingival tissue is lost, the tooth becomes vulnerable to colonization with plaque biofilm and is exposed to the inciting factors for caries[31].

Regarding gingival health, this study found that prevalence of RC increased significantly with increased scores of GI. Several studies showed an association between RC and gingival health[4,32]. This positive association between RC and gingival inflammation may be due to RC occur in a location adjacent to the crest of the gingiva where dental plaque accumulates46 gingivitis is usually caused by the buildup of the plaque. The toxic effects of the bacteria cause gums to become irritated, red and swollen and the gums may bleed easily[33]. Also, it was found that prevalence of RC was significantly associated with PI scores. There are few researches studied the relation of RC to PI. Reiker et al.[34] found that the individual number of root lesions correlate with individual dental plaque scores. While Chi et al.[26] who study the presence of visible heavy plaque found no relation between the prevalence of RC and plaque. Association between RC experience and plaque is due to:

1. Plaque bacteria are capable of anaerobically metabolizing dietary carbohydrates into acids. These acids produce a drop in pH that initiates demineralization of the tooth structure. The drop in pH necessary for demineralization in cementum and dentine (pH 6.2 to 6.7) is less than that required for enamel (pH=5.4 to 5.5)[35]. This means that given the particular environment, both the initiation and progression of root surface caries lesions will occur more readily in dentine than in enamel surfaces[36].

2. With aging and gingival recession, the root surfaces are exposed to the oral environment and growth of microbiota proceeds more rapidly on root surfaces because of the irregular surface topography[37].

In the present study, it was found that the prevalence of RC was significantly associated with tooth brushing. This may be related to the high level of plaque and gingival mean index in those who did not brush their teeth than those who brushed their teeth. The main reason for the emergence of root surface caries is progressive gingival recession due to poor oral hygiene leading to periodontal diseases and gradual loss of periodontal attachment with age, this result in the subsequent exposure of the susceptible root surfaces to the microorganisms in the oral environment[38]. In regard to the frequency of tooth brushing, this study found that the prevalence of RC was significantly decreased with increased frequency of brushing even subjects who brushed their teeth. A

study in China[14] reported the presence of decayed/ filled root surface were significantly associated with frequency of brushing. Christensen et al.[5] reported brushing teeth more than once a day was associated with less active caries, while Sugihara et al.[39] found no association between root surface caries and frequency of brushing.

In this study the results showed that significantly higher prevalence of RC in subjects with hypo salivation. Other study in Iraq also reported similar association[40], Chi et al.[26] reported that self-reported dry mouth was significantly associated with RC experience in middle-aged adults but not in older adults, in India[19] found significant association of RC and dryness of the mouth. Saliva is essential in neutralizing the acidic environment, thus inhibiting the growth of bacteria. Any decreased levels of saliva can put one at increased risk for developing caries[41].

The prevalence of RC increased significantly with increased frequency of snacks. This result is the same as reported in US[37]. Many studies[21,42,43] found that the RC was clearly related to a high frequency of sugar intake. While Du et al.[14] reported different results in a study in China found frequency of sugary drinks or foods not statistically significant with the presence of RC but tea consumption was significantly associated with RC. The difference between studies is that habitual diet intake can only be assessed by, asking subjects to report intake and this depends on memory[5]. The higher the number of consumption episodes during which the pH falls below the resting level for dentin and/or enamel, the greater the total time for demineralization to occur[44].

The prevalence of RC in non-smokers was higher than smokers in this study with non-significant differences. This finding consisted with a study in Sudan[21]. Qasim[40] found non-significant differences in RC with smoking in urban area but significant differences in rural area. A study in India[19] found a significant association between prevalence of RC and smoking and tobacco chewing and tobacco chewing only. Although the actual role of tobacco smoking in relation to crown and RC seems to be unclear[45], the less caries prevalence in smokers in the present study may be due to:

1. Number of teeth retained, many studies reported higher number of missing teeth in smokers.[43,44]

2. Concentration of thiocynate found to be higher in smoker's saliva may have possible caries inhibiting effect.[45]

Wearing denture has been considered as a risk indicator for RC[43]. The present study found that there was a significant association between the prevalence of RC and wearing dentures (P=0.01). Other studies[5,23,39,46,47] also showed the same finding. This finding may be due to that the removable partial denture (RPD) in the mouth has the potential for increase plaque formation on tooth, especially to abutment teeth, to which clasps or attachments are attached[48]. RPD's with clasp increased level of gingival inflammation in regions covered by the dentures and below the clasp arms in abutment teeth[49]. Beside the inflammatory changes, during the chronic periodontal disease, the gingiva also suffers from degenerative and dystrophic changes. This brings about the decay of the juncture tissue elements, appearance of recession of the gingiva and stripping of dental roots[4,50].

The prevalence of RC was significantly decreased with increased level of education. Other researchers also found that decayed/ filled root surfaces were significantly associated with educational level[14,15,51] while there was no significant relation between the prevalence of RC and educational level as a study in Sudan[21]. However, decreased RC with increased educational level is due to that persons with higher education are more likely to have health-promoting behaviors and lifestyles, and they have also better access to and use of health care services[51].

The present study found that the prevalence of RC in diseased subjects was higher than

non-diseased subjects with significant differences. This may be due to:

Individuals with systemic disease tend to neglect their oral health and so showed a higher incidence of oral disease[41]. Qasim[40] showed significant higher RCI in subjects with systemic disease. Investigators[41,52,53] have found associations between cardiac

Conclusion

The results indicate that adults and older aged individuals in Erbil city have a high prevalence of root caries and high experience of root caries as expressed by root caries index and the prevalence of root caries was associates with these risk factors: Gingival index, Plaque index, unstimulated salivary flow rate, educational level, wearing removable partial dentures, frequency of snacks, tooth brushing and frequency of tooth brushing, systemic disease and use of medication while there was no association with smoking.

Conflict of interest

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