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Tooth loss in institutionalized coronary heart disease patients of Punjab Institute of Cardiology, Lahore, Pakistan

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Abstract Objective: To observe frequency and possible association of tooth loss with prevalent coronary heart disease in Pakistani population.

Methodology: Angiographically determined coronary heart disease (CHD) patients of Punjab Institute of Cardiology, Lahore, Pakistan, and healthy individuals were enrolled for status of tooth loss.

Results: Nine hundred and thirty six CHD patients and 595 healthy subjects with mean age of 51.9 ± 8.4 years were examined. Mean (\pm SD) tooth loss was significantly ($P \leq 0.001$) higher in cardiac patients (9.8 ± 9.2) than healthy subjects (6.8 ± 6.9) with odds ratio (OR) = 1.543 (95%CI = 1.985–2.851). Tooth loss was significantly ($P \leq 0.001$) associated with CHD males and females and cardiac patients with diabetes and smoking. After adjustment of age, gender, diabetes and smoking, subjects with CHD were more likely to have higher tooth loss.

Conclusion: Tooth loss was significantly associated with prevalent CHD independent of classic risk factors of age, gender, smoking and diabetes in this study sample.

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1. Introduction

Potentially preventable noncommunicable chronic diseases (NCDs) are causing 20% of deaths in high-income countries, while 80% of deaths in low-income and middle-income countries are

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attributed to NCDs [1]. Correlation of poor oral health, periodontal disease and tooth loss with increased risk of cardiovascular diseases (CVD), pulmonary diseases, diabetes, pregnancy outcomes, and all-cause mortality has been observed [2]. Chronic diseases and oral diseases share many risk factors such as age, gender, education, smoking, diet, and obesity which are important risk factors both for tooth loss and cardiac diseases [3–5].

A healthy mouth is a premise for overall health. When oral health is compromised, overall health can be affected [6]. Tooth loss is common among human beings, and having less than 20 natural teeth is marked as poor oral health [7]. Higher incidence of tooth loss has been reported to be significantly associated with cardiovascular disorders in case–control and cross-sectional studies [8–10]. Tooth loss is found to be associated with CVD on the basis of chronic oral infections, such as caries/periodontal diseases and the process of tooth extraction may be accompanied by pre/post infection [11]. Tooth loss may lead to changes in diet and other behaviors which in turn lead to increased risk for CVD [12]. CVDs are expected to rise as an epidemic in developing countries and projected to be a major cause of death by 2020 [13].

Despite an expected rise in NCDs in Asia and a high prevalence of oral disease, few studies on their association have been conducted in this region. The purpose of this study was to observe prevalence of tooth loss in cardiac patients of the Pakistani population and to explore its possible association with coronary heart disease.

2. Methodology

2.1. Study design

A convenient, time-based sampling technique was used. All indoor cardiac patients aged 40 and above clinically and angiographically diagnosed with CHD at Punjab Institute of Cardiology, Lahore, were included in the study. Demographic and clinical data (age, gender, smoking, and diabetes) were noted from patients' personal files. Missing teeth were examined at bedside with the help of a mouth mirror and tweezers by two dentists. The number of teeth missing was estimated from the number of teeth remaining in the mouth upon clinical examination. Healthy individuals without a history of cardiac disease having the same social origin, i.e., attendants of the cardiac patients who agreed to be included in the study, were examined for comparison of tooth loss. Study subjects with other chronic systemic diseases, such as chronic obstructive pulmonary disease (COPD), chronic arthritis, chronic liver disease, and kidney diseases were excluded from the study.

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2.2. Data analysis

Data was analyzed using SPSS version 14. Summary statistics were calculated through descriptive analysis; independent *t*-test was applied for comparison of tooth loss between cardiac and healthy subjects. For comparisons of categorical variables, chi-square test was applied. Subjects were grouped into smoker–diabetic and nonsmoker–nondiabetic for a comparison of tooth loss. Multivariate regression models were fit to observe the association of tooth loss and CHD and confounding factors.

3. Results

3.1. Summary statistics of study population

During a one-month study period, 1531 subjects were examined. Subjects' age ranged from 40 to 70 years and the mean age was 52.0 ± 8.4 years; 936 were CHD patients with a mean age of 53.7 ± 8.4 years, and 595 were healthy individuals with a mean age of 49.1 ± 7.7 years. Seventy four percentage of cardiac patients and 58% healthy subjects were males. Thirty seven percentage of cardiac patients and 20.5% healthy individuals were smokers. Thirty six percentage were diabetic among cardiac patients as compared with 16.5% among healthy individuals. There was a statistically significant ($p < 0.001$) difference among cardiac and healthy genders, smokers and diabetic subjects with OR of 2.82 (CI = 2.287–3.512), 2.036 (CI = 1.612–2.572) and 2.840 (CI = 2.202–3.663), respectively (Table 1).

3.2. Tooth loss

The main variable of this study – tooth loss – was found in 1242 (81%) subjects of the study sample. Subjects with at least one missing tooth showed a mean (\pm SD) tooth loss 8.8 ± 8.5 . CHD patients showed a mean tooth loss of 9.8 ± 9.2 and healthy subjects had a mean tooth loss of 7.0 ± 6.9 ; the difference was statistically significant ($p \leq 0.001$). Seventeen percentage of CHD patients had all natural teeth as compared with 33% healthy individuals. CHD patients were at OR of 1.54 (CI = 1.192–1.197) for having more tooth loss as compared with healthy individuals. Seventy eight percentage of subjects showed tooth loss in the range of 1–15 teeth and 88% of subjects showed

Table 1 Summary statistics of cardiac and healthy subjects.

Variable	Cardiac n (%)	Healthy n (%)	Total n (%)	p-Value/OR (CI 95%)
Study sample	936 (61)	595 (39)	1531 (100)	
<i>Age (years)</i>				
Mean \pm SD	53.7 \pm 8.4	49.1 \pm 7.7	52.0 \pm 8.4	<0.001 ^a
Range	40–70			
<i>Genders</i>				
Males	692 (74)	298 (50)	990 (65)	<0.001/2.827 (2.287–3.512) ^b
Females	244 (26)	297 (50)	541 (35)	
<i>Smoker</i>				
Smokers	348 (37)	134 (22.5)	482 (31.5)	<0.001/2.036 (1.612–2.572) ^b
Nonsmokers	588 (63)	461 (77.5)	1049 (68.5)	
<i>Diabetic</i>				
Diabetic	336 (36)	98 (16.5)	434 (28)	<0.001/2.840 (2.202–3.663) ^b
Nondiabetic	600 (64)	497 (83.5)	1097 (72)	

^a Stands for Independent t-test.

^b Stands for Chi sq. test.

tooth loss up to 20 teeth. Thirteen percentage CHD patients as compared with 4% of healthy individuals were presented with 21–32 teeth lost (Table 2).

Tooth loss analysis among genders showed that a mean tooth loss in CHD (56%) and healthy (21%) males was 7.1 ± 8.4 and 4.4 ± 6.5 , respectively, with a significant difference ($p \leq 0.001$). Mean tooth loss among CHD (42%) and healthy (46%) females was 11.5 ± 10.2 and 6.4 ± 6.8 respectively, with a statistically significant difference ($p \leq 0.001$). CHD males with tooth loss had an OR of 1.78 (CI = 1.307–2.427) and CHD females had an OR of 2.79 (CI = 1.521–5.148) (Table 3).

Among smoker–diabetic subjects, 67% of cardiac patients were presented with a mean tooth loss of 8.8 ± 9.3 as compared with 13% of healthy individuals with a mean tooth loss of 4.7 ± 6.00 ($p = 0.014$). Nonsmoker–nondiabetic CHD (40%) and healthy (40%) subjects were found with a mean tooth loss of 8.0 ± 8.6 and 7.3 ± 8.5 , respectively.

Smoker–diabetic patients with tooth loss (OR = 2.246; CI = 1.789–6.394) had higher risk for CHD (Table 3).

Table 4 presents an age-related pattern of tooth loss prevalence in cardiac and healthy subjects. Forty to fifty five year old subjects showed a significantly higher tooth loss ($p = 0.015$) in cardiac patients with an OR of 1.396 (CI = 1.046–1.863). Mean tooth loss showed a steady increase in age groups 40–49 years (3.9 ± 5.2), 50–59 years (7.7 ± 8.2), and ≥ 60 years ($12.9–10.8$), however, statistical differences were insignificant in all age cohorts.

In multivariate regression analysis, coefficient was positive and a higher code for smoking was 1, the OR was 1.33; higher code for diabetes was 1 and the OR was 3.50; higher code for genders was 1 and the OR was 3.24; higher code for tooth loss was again 1 and the OR was 1.45. It can be significantly concluded that cardiac patients with smok-

Table 2 Cardiac and healthy subjects compared for tooth loss.

Variable	Cardiac n = 936	Healthy n = 595	Total n = 1531	p-Value/OR (CI 95%)
<i>Tooth loss</i>				
Mean \pm SD	9.8 \pm 9.2	7.0 \pm 6.9	8.7 \pm 8.5	<0.001 ^a
<i>n (%) subjects with tooth loss</i>				
≥ 1 teeth	784 (84)	458 (77)	1242 (81)	$\leq 0.01/1.543$ (1.192–1.997) ^b
1–15 teeth	606 (65)	373 (63)	979 (79)	
16–32 teeth	178 (19)	85 (14)	263 (21)	NS ^b
1–20 teeth	659 (70)	437 (73)	1093 (88)	
21–32 teeth	125 (13)	24 (4)	149 (12)	$\leq 0.01/3.04$ (1.997–4.637) ^b

NS; nonsignificant.

^a Stands for Independent t-test.

^b Stands for Chi square test.

Table 3 Cardiac and healthy subjects with tooth loss compared among genders, diabetics and smokers.

Variable	Cardiac	Healthy	Total	p-Value/OR (CI 95%)
<i>Males (n = 990)</i>				
n (%)	555 (56.0)	207 (23)	762 (76.9)	0.015/1.781 (1.307–2.427) ^b
Mean ± SD	7.1 ± 8.4	4.4 ± 6.5	6.2 ± 7.9	<0.001 ^a
<i>Females (n = 541)</i>				
n (%)	229 (42)	251 (46)	480 (88.7)	0.030/2.798 (1.521–5.148) ^b
Mean ± SD	11.5 ± 10.2	6.4 ± 6.8	8.8 ± 8.9	<0.001 ^a
<i>Smokers and diabetics (n = 115)</i>				
n (%)	77 (67)	15 (13.0)	92 (80.0)	0.025/2.246 (1.789–6.394) ^b
Mean ± SD	8.8 ± 9.3	4.7 ± 6.0	8.0 ± 8.8	0.014 ^a
<i>Nonsmokers and nondiabetics (n = 730)</i>				
n (%)	290 (40)	291 (40)	581 (79.6)	NS ^b
Mean ± SD	8.0 ± 8.6	7.3 ± 8.2	7.8 ± 8.5	NS ^a

NS; nonsignificant.

^a Stands for Independent t-test.^b Stands for Chi square test.**Table 4** Cardiac and healthy subjects compared for tooth loss in different age groups.

Variable	Cardiac	Healthy	Total	p-Value/OR (CI 95%)
<i>40–55 years (n = 1046)</i>				
n (%)	451 (43)	354(34)	805(77)	<0.050/1.396 (1.046–1.863) ^b
Mean ± SD	5.7 ± 7.0	4.1 ± 5.2	5.0 ± 6.3	<0.001 ^a
<i>56+ years (n = 485)</i>				
n (%)	333 (69)	104 (21)	437 (90)	NS ^b
Mean ± SD	12±10.6	10.42 ± 9.6	11.6 ± 10.3	NS ^a
<i>40–49 years (n = 615)</i>				
n (%)	207 (34)	241 (39)	448 (73)	NS ^b
Mean ± SD	3.9 ± 5.2	3.3 ± 4.0	3.6 ± 4.6	NS ^a
<i>50–59 years (n = 538)</i>				
n (%)	307 (57)	141 (26)	448 (83)	<0.050/1.665 (1.049–2.643) ^b
Mean ± SD	7.7 ± 8.2	6.3 ± 7.0	7.2 ± 7.8	NS ^a
<i>60+ years (n = 378)</i>				
n (%)	270 (71)	76 (20)	346 (91.5)	NS ^b
Mean ± SD	12.9 ± 10.8	11.6 ± 9.9	12.7 ± 10.6	NS ^a

NS; nonsignificant.

^a Stands for Independent t-test.^b Stands for Chi square test.

ing, diabetes, male gender and tooth loss were at higher risk as compared with healthy individuals. Logistic regression model adjusted for all risk factors of CHD noted in this study showed that tooth loss ≥ 1 teeth ($p = 0.010$), ≤ 20 teeth ($p = 0.024$) and >20 teeth ($p < 0.001$) are statistically significant predictors of CHD. Adjusted OR for tooth loss ≤ 20 teeth and >20 teeth were 1.39 (95%CI = 1.04–1.78) and 3.52 (95%CI = 2.01–6.18) (Table 5).

4. Discussion

This first cross-sectional study on the topic from Pakistan has found a statistically significant differ-

ence in tooth loss between cardiac and healthy subjects. An association of tooth loss with prevalent coronary heart disease is observed in this study that supports previous studies [8,10,11,14,15] on the relationship of tooth loss and cardiac conditions. Demographic data of the study sample shows that males, diabetics and smokers were more than twice (OR ≥ 2.036 ; CI = 1.612–2.572) at risk of CHD as compared with the healthy individuals. Males were significantly higher than females in the CHD group; whereas there was no difference in male–female ratio in the healthy group. Age is the constant and most commonly reported factor associated with missing teeth [16,17]. Tooth loss difference is found in genders; in particular, males

Table 5 Multivariate logistic regression models for CHD/nonCHD subjects.

Variable	OR (95%CI)	p-Value
<i>Tooth loss</i>		
No	1	
≥1 teeth	1.45 (1.08–1.95)	0.010
≤20 teeth	1.39 (1.03–1.86)	0.029
>20 teeth	3.52 (2.01–6.18)	<0.01
<i>Smoking</i>		
No	1	
Yes	1.33(1.00–1.77)	0.018
<i>Diabetes</i>		
No	1	
Yes	3.50 (2.64–4.63)	<0.01
<i>Gender</i>		
Female	1	
Male	3.24 (2.46–4.27)	<0.01

have less retained teeth [18]. This study has noted a monotonous relationship between increasing tooth loss and advancing age in CHD/nonCHD individuals who were closely related with respect to their socioeconomic status (SES) background, and this finding corresponds with another contemporary study [19]. The current study showed that CHD males with tooth loss were twice the number of CHD females; however a mean tooth loss was much higher in females. These findings also correspond with other studies [20,21].

In the current study, incidence of tooth loss was noted significantly higher in subjects with diabetes and smoking, which are the most important confounding factors associated with cardiac diseases; and the OR associated with cardiac patients was more than two times than the noncardiac subjects. CHD subjects with diabetes and smoking having missing teeth were five times higher in number and two times higher with a mean tooth loss than the healthy subjects. These results support the previous studies [22,23] showing that smoking and diabetes significantly contribute to tooth loss. However, cardiac patients of this study remained 1.232 times at higher risk for tooth loss, and this association was observed independent of confounding factors.

Tooth loss (partial/total) is the dental equivalent of death, and tooth loss diminishes quality of life, often substantially [11]. The findings of studies on tooth loss and systemic diseases provide a clue that tooth loss may be considered as one of the important components of oral diseases that affects the general health of the people. Desvarieux et al. [24] reported that the greater the number of teeth lost, the greater the extent of severe periodontal

disease; in turn the severity of periodontal disease is associated with the increased risk of CHD [25]. Correspondingly, other previous studies [8,10,11] have reported on the risk of myocardial infarction, stroke and prevalent coronary heart disease in relation to tooth loss. The findings emerging from this study analysis explained a relationship between tooth loss and cardiac diseases and partially/fully confirm other studies on the same topic [26–29]. The association of tooth loss, as observed in this study, with CHD and previous periodontal disease may be a significant public health problem because of the prevalence of the periodontal disease in the general public [30].

Tooth loss distribution and risk association in individuals with and without cardiac diseases in this study provides a good reason for conducting such studies in developing countries like Pakistan where oral health is not a priority for the country stakeholders and the public at large where non-communicable diseases are also showing a steep rise [31]. This study illustrates that total tooth loss is a risk indicator for established CHD and confirms that some classical risk factors associated with an increase in CHD risk are also associated with the increased likelihood of tooth loss. Other risk factors for tooth loss, such as education and income, could not be included in this study; these may be considered as limitations.

Conflict of interest

No conflict of interest by the authors.

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