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Assessment of Risk and Protective Factors for Root Caries in Older Adults

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Abstract

Background: Older adults are at increased risk for root caries because of both increased gingival recession that exposes root surfaces and increased use of medications that produce xerostomia. Caries and its associated treatments have become a significant clinical challenge as well as a financial burden for older populations.

Objective: To investigate the prevalence of active and untreated root caries lesions and the association between caries risk and protective factors with root caries in older adults (≥ 65 years).

Methods: This observational and retrospective study used electronic health records from 2,619 patients of the University of Florida College of Dentistry (UFCD) to assess data on a) patients' demographics (age, gender, and race) b) caries risk and protective factors, c) presence of active and untreated root caries lesions, and d) medical history including information on special needs, head/neck cancer radiation, diabetes and use of medications. Bivariate (Chi2) and logistic regression were used for data analysis with root caries as the main outcome variable.

Results: Root caries lesions were diagnosed in 23% (n=603) of the population studied, and the mean age was 73.6 years (±5.9), 54% were male (n=1,479), and 86% (n= 2352) were Caucasian. The final regression model indicated that visible dental plaque (OR:2.19; CI:1.48-3.24) and self-reported dry mouth (OR:1.59; CI:1.31-1.95) were significantly associated with increased risk for root caries lesions while daily fluoride exposure (OR:0.56; CI:0.40-0.78) was identified as a protective factor. Females (OR:0.65; CI:0.53-0.78) were significantly less likely to present root caries.

Conclusion: The presence of visible plaque and self-reported dry mouth were predictive of increased risk for root caries in the population studied.

Keywords: Root caries; Caries diagnosis; Risk assessment; Elderly; Electronic patient health records

Introduction

Over the next 50 years, the number of people aged 65 years and older is expected to double to 92 million, while the number of people aged 85 years and older is anticipated to triple to 18 million worldwide [1]. This demographic shift has significant implications for oral healthcare services as greater life expectancies coupled with enhanced awareness of oral health, better access to dental care, and improved exposure to fluoride, have resulted in patients retaining their teeth for longer into older age. With the increase of tooth, longevity comes common clinical conditions such as the recession of the gingival margins, which is an inevitable result of the loss of periodontal attachment with age. As the gingival margins recede and dental plaque accumulates in the surrounding dental tissues, there is an increased risk for caries development on the root surfaces. In particular, root caries along with periodontal involvement is one of the major causes for tooth loss [2-3]. Tooth loss is the most significant oral health-related variable that can significantly decrease the quality of life for elderly populations [4].

Root caries is a prevalent and debilitating dental disease among older adults [5]. This correlates with data from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) which indicates that root caries are a considerable health problem for adults. For instance, 31.7% of adults ages 65–74 years, and 42.3% of adults ages 75 years and older had decayed or restored root caries [6]. This disease and its associated treatments have become a significant clinical challenge as well as a financial burden for older populations [7-8]. These trends prompted the United States Office of Disease Prevention and Health Promotion (ODPHP) to include reducing the proportion of older adults with untreated coronal and root caries as a Healthy People 2020 objective [9-10]. Clearly, there is an urgent need for an objective method to identify individuals at high risk for developing root caries in order to tailor cost-effective dental interventions and periodicity of these services [11]. Caries Management by Risk Assessment (CAMBRA) is an approach used to identify and manage the factors contributing to the risk of individual patients to develop caries lesions [11]. This approach includes the use of a patient-specific caries risk assessment questionnaires, which categorizes caries risk levels based on the overall assessment of the patient's disease indicators, and caries risk and protective factors [12-13]. The CAMBRA clinical guidelines recommend that adults deemed at high caries risk should be offered intensive and preventive treatment, such as antibacterial therapy, remineralizing agents, and more frequent dental examinations. However, the recommended CAMBRA assessment forms for adult patients do not include specific aspects of root caries, only the presence of exposed root surfaces. Early and accurate identification of individuals at high risk for root caries is critical for developing personalized and appropriate preventive measures that can address the risk factors and manage this largely preventable disease [14]. The objective of this study was to evaluate the prevalence of active and untreated root caries lesions and the association between caries risk and protective factors with root caries in older adults.

Material and Methods

Study design and study population. This was an observational and retrospective cohort study approved by the Institutional Review Board of the University of Florida (IRB#201702093). Data were collected from electronic health records (EHR) of patients aged 65 years and older who received comprehensive care in the predoctoral dental clinics at the University of Florida College of Dentistry (UFCD)from the period of 08/2015 to 07/2017.

Data collection. The instructional technology (IT) personnel served as impartial mediators and retrieved data from the patients 'EHR on a) age, gender, and race, b) Caries Risk Assessment and Management (CRA) electronic forms (caries risk and protective factors), and c) medical history including information on special needs, head/neck cancer radiation, diabetes and use of medications. The data retrieved was de-identified and transferred to the UF Health Integrated Data Repository (IDR)from which the study investigators were able to access the secured data and conduct data mining and analysis.

The UFCD CRA forms are filled out at the Comprehensive Oral Examination (COE) appointment by predoctoral dental students under the supervision and approval of faculty. At this appointment, a complete oral examination of the patient's dental hard tissues is performed including caries detection and diagnosis by visual-tactile and radiographic examinations. The CRA forms were developed based on the original CAMBRA form and adapted for academic and electronic use to a) collect information on disease indicators, risk and protective factors, b) identify the level of caries risk, and c) develop a caries management plan based on individual risk. The CRAM forms include the list of disease indicators (e.g. white spot enamel lesions, cavitated lesion, secondary carious lesions, root carious lesions, etc.) associated with the caries lesion activity (active or non-active), risk factors (e.g. presence of dental plaque, oral hygiene habits, dietary habits, medical risk factors including dry mouth, etc.), and protective factors (e.g. exposure to fluoride, regular visits, saliva flow,

etc.).

Statistical Analysis

Data retrieved were entered into Stata SE (version 15.0, StataCorp, College Station, TX, USA). For descriptive analysis, the distribution of percentages and means were calculated when appropriate. The association between root caries and risk and protective factors was analyzed using the Chi2 test, as all the variables were categorized.

After the bivariate analysis, only the variables with a p-value < 0.20 were included in the multivariate logistic model. The final model was designed using the backward elimination of insignificant independent variables until only the variables with p-value < 0.05 were maintained.

Results

The mean age of the population studied was 73.6 years (±5.9), 54% were male (n=1,479) and 46% were female (n=1269), 86% (n=2352) Caucasian, 7.8% (n=213) African American, 4.4% (n=121) Hispanic, and 1.8%Asian or others(n=62).Root caries lesions were diagnosed in 23% (n=603)of the population. A bivariate analysis investigated the association between the dependent variable "presence of root caries lesions" with several independent variables as shown in Table 1. There were statistically significant associations between root lesions and gender (p<0.001), and between root lesions and the presence of plaque (p<0.001), self-reported dry mouth (p<0.001), daily exposure to fluoride (p<0.001), visible saliva (p<0.01), and diabetes (p<0.01).

Table 1: Bivariate analysis of the associations between the presence of root caries lesions and several demographic, medical, and dental factors.

	Root caries experience	p-value	
Gender	No	Yes	p<0.001*
Male	1040 (39.71%)	372 (14.20%)	
Female	976 (37.27%)	231 (8.82%)	
Race			0.238
Caucasian	1720 (65.67%)	526 (20.08%)	
Other	296 (11.3%)	77 (2.94%)	
Presence of plaque			0.000*
No	226 (8.63%)	31 (1.18%)	
Yes	1790 (68.35%)	572 (21.84%)	
Dry mouth reported			0.000*
No	1490 (56.89%)	393 (15.01%)	
Yes	526 (20.08%)	210 (8.02%)	
Daily fluoride exposure			0.001*
No	118 (4.51%)	59 (2.25%)	
Yes	1898 (72.47%)	544 (20.77%)	
Visible saliva			0.011*
No	212 (8.09%)	83 (3.28%)	
Yes	1804 (68.88%)	517 (19.74%)	
Head/neck radiation			0.420
No	1813 (69.22%)	549 (20.96%)	
Yes	203 (7.75%)	54 (2.06%)	
Diabetes			0.011*
No	1642 (62.7%)	463 (17.68%)	
Yes	374 (14.28%)	140 (5.35%)	
Special Needs			0.096
No	331 (12.64%)	82 (3.13%)	
Yes	1685 (64.34%)	521 (19.89%)	

*statistically significant; p<0.001

Table 2 presents the logistic regression analysis with "the presence of root caries lesions" as the dependent variable. The multivariate logistic regression analyses revealed that the root caries lesions are increased in individuals showing the presence of plaque (OR 2.33; 95%CI 1.47-3.21) and self-reported dry mouth (OR 1.51; 95%CI 1.21-1.87). Females have a reduced prevalence of root caries when compared to males (OR:0.66; 95%CI 0.54-0.79). In addition, daily fluoride exposure was a significant protective factor against root caries (OR: 0.57; 95%CI 0.41-0.79). The final regression model shown in Table 3 revealed that plaque, dry mouth, daily fluoride exposure, and gender were statistically significantly associated with root caries lesions.

Table 2: Logistic regression analysis of the associations between presence of root caries lesions and certaindemographic, medical and dental factors.

Variable	Simple OR	95%CI	p-value	Multivariate OR	95%CI	p-value
Gender	0.66	0.55-0.79	0.000	0.65	0.54-0.79	0.000
Plaque	2.33	1.58-3.43	0.000	2.17	1.47-3.21	0.000
Dry-mouth	1.51	1.25-1.84	0.000	1.50	1.21-1.87	0.000
Daily Fluoride	0.57	0.41-0.79	0.001	0.57	0.41-0.79	0.001
Visible saliva	0.71	0.54-0.92	0.011	0.88	0.65-1.19	0.411
Diabetes	1.33	1.07-1.65	0.012	1.21	0.97-1.52	0.094
Special needs	1.25	0.96-1.62	0.096	1.16	0.89-1.52	0.272

* indicates the variables included in the regression model (p-value <0.2)

Table 3: Final regression model of the associations between presence of root caries lesions and certaindemographic, medical and dental factors.

Variables	Coefficient	Standard error	p-value	OR	95% CI
Gender	-0.43	0.097	0.000	0.65	0.53- 0.78
Plaque	0.79	0.19	0.000	2.19	1.48-3.24
Dry-mouth	0.47	0.10	0.000	1.59	1.31-1.95
Daily Fluoride exposure	-0.57	0.17	0.001	0.56	0.40-0.78

Discussion

The most significant findings of this study were the positive associations between the presence of root caries lesions with visible dental plaque and self-reported dry mouth, and the negative associations between root lesions with female gender and daily exposure to fluoride. These findings align with previous studies and support the use of these risk and protective factors for the assessment of individual risk for the development of root caries [14-16]. The majority (65%) of adults sixty-five years and older are independent, healthy, active, and productive members of society [17].

Aging affects individuals differently and requires a comprehensive assessment of the patient's lifestyle, culture, social, and family history, in addition to physical symptoms [18]. Traditional medical approaches do not generally address the heterogeneity of diseases in older adults. Due to demographic trends, there is an increasing need to better understand risk and protective factors for common diseases such as dental caries and to use these findings to guide future public health policies and targeted prevention measures.

The accumulation of oral biofilms or dental plaque in an oral environment that provides high availability of free sugar-

sis considered the key etiological factor for the development of dental caries. Importantly, poor plaque control has been linked to cardiovascular diseases, stroke, unbalanced glycemic control, and respiratory infections, especially in vulnerable patients [19]. A study conducted by Hayes et al. found that poor plaque control correlates with the prevalence of root caries [16]. However, exposure of root surfaces alone will not represent a risk factor if adequate plaque control is achieved. In addition, clinicians must investigate if poor plaque control is an indicator of a patient's inability to perform adequate oral hygiene due to mechanical, physical, or mental disabilities. Factors impeding the ability to maintain oral hygiene increase with aging as a natural decline in functional and cognitive health status and increased in medical

conditions. For such patients, it will be imperative to ensure that the dedicated care givers have appropriate training and skills to ensure good oral hygiene practices.

Self-reported dry mouth has been previously correlated with dental caries and more specifically root caries incidence [15,20]. Older patients are more vulnerable to comorbidities and chronic conditions associated with a myriad of medications, which often results in hyposalivation or xerostomia. Medications associated with dry mouth syndrome include antidepressants, antihistamines, antihypertensives, and antiasthmatics. Moreover, the presence of multiple medical conditions requiring several prescriptions is likely to increase the incidence and severity of the hyposalivation/xerostomia due to polypharmacy and medication interactions [21]. It is important to emphasize that in the current study, self-reported dry mouth was identified as a potential indicator for root caries. Future studies should correlate the self-report and saliva tests to confirm the xerostomia with the presence of root caries in this population pool.

There are conflicting results in the literature regarding the association between gender and root caries. Some studies identified such association while others did not [15, 22-24]. Data from the Continuous National Health and Nutrition Examination Survey (NHANES) 1999-2004 showed that the prevalence of root caries for adults from 20-40 years old was 15.79% for males and 12.69% for females [6]. Among seniors (65 years old and older), the prevalence increased to 40.36% for males and 32.95% for females, showing not only an increase of root caries prevalence but also an increase in the difference between the genders. Another study also showed better periodontal parameters in women compared to men [25]. Some studies have suggested that reasons for this difference may be attributable to women being more proactive in preventative oral health behaviors, such as tooth brushing and regular dental maintenance visits and other general health behaviors [26-27].

The only protective factor identified in our study was daily exposure to fluoride. Fluoride from different sources (water, toothpaste, gels, varnishes, and rinses) has been shown to reduce the incidence of new lesions and remineralize existing lesions, thus reducing the need for restorative treatments [28-29]. The demographic shift (an increase of the elderly population) associated with changes in the paradigms of caries etiology makes the treatment of this disease a challenge for existing dentists and new practitioners. According to Bradshaw and Lynch, preventing the transmission of Streptococcus mutans without controlling a carbohydrate-rich diet will not result in controlling the disease [30]. Therefore, approaches to optimize fluoride delivery, to target plaque acidogenicity or acidogenic microbes, to increase salivary flow or replace fermentable carbohydrates with non-fermentable alternatives may be more promising, especially for older and dependent patient populations.

The majority of older patients entering retirement lose access to employer-sponsored medical and dental insurance coverage. Medicare Part A (hospital insurance) and Part B (medical insurance) provide coverage to those over age 65 for hospitalizations, surgery, healthcare provider services, and eligible home health services such as; physical therapy and speech-language but, neither insurance product provides coverage for dental treatment. Therefore, it is crucial to identify high-risk patients and introduce them to a preventive care regimen in order to prevent new lesions and aid in the remineralization of existing lesions in an effort to avoid more costly procedures.

This study used patient electronic health records to investigate the risk and protective factors associated with root caries. Data mining can enable health systems to systematically analyze and identify best practices that improve care and reduce costs [31]. Using electronic patient health records, health systems' analytics can improve management, and disease prognosis for large patient populations lead to the discovery of new knowledge about diseases and disease associations [32-33]. Moreover, the modified CRA tool used in the academic environment allowed the identification of important risk indicators and protective factors for root caries targeting the selected study population.

Limitations of our study include the use of a retrospective design, the absence of a standardized measurement for the clinical outcome of root caries. Retrospective studies are subject to bias as some other risk factors information was not collected and there is no mechanism for calibrating the examiners in a school setting other than attendance to didactic lectures and faculty supervision. The data collected in the present study were based on caries risks form used at the UFCD since 2011, which follows the CAMBRA guidelines with some modifications. Although additional information could have been collected, dental students have not required to answer all the questions for faculty approval, which resulted at times incomplete availability of additional variables. One important variable for root caries that was not added in the current model due to limited data is head-and-neck cancer radiotherapy. Studies have shown that structural changes occur in the enamel and dentine after radiotherapy resulting in reduced hardness, more porous structure and more

susceptibletissues to the caries process [34-36]. Regardless of these limitations, the prevalence of 23% of the study population having root caries correlates with other studies and representatives of this age cohort [22].

Conclusion

The findings from this study indicate that visible dental plaque and self-reported dry mouth were significantly associated with increased risk for root caries lesions while daily fluoride exposure was identified as a protective factor. This study can serve as a preliminary framework to foster a design of novel caries risk assessment tools that includes specific factors related to the aging population as well as novel strategies for the management of root caries. Future studies should continue to develop root caries risk models that account for relevant sociodemographic, intraoral, behavioral, and social factors.

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