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Occupational Stress, Salivary Cortisol, and Periodontal Disease: A Clinical and Laboratory Study

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Abstract:

Background: Periodontitis is a multifactorial disease, commonly associated with most of the lifestyle diseases. In the recent years, the association between periodontitis with occupational stress has evolved in various studies in many developed settings. This study aims at studying the prevalence of periodontal disease and its relationship with job stress among industrial labor workers covered under Employee's State Insurance Corporation Scheme.

Materials and Methods: The study included 180 subjects who were informed about the research goals, and also requested to sign consents. The questionnaire included parts from the generic job stress questionnaire from the National Institute of Job Stress and Health. Dental examinations based on community periodontal index protocol were done using WHO probe. Participants with moderate to severe periodontitis (score 3, 4) were informed about the salivary cortisol test. The saliva samples were collected and transported to the lab. Data were entered in EPI info 3.1.1 and analyzed in SPSS 14. The Chi-square analysis was done to measure association, and logistic regression analysis was done to identify the independent association of job stress to periodontitis.

Results: The study shows that 48% of the participants reported to have job stress, and 55% had periodontitis. The mean salivary cortisol level was 3.42 ng/dl. The results also indicated a higher odds of having low levels of salivary cortisol among those who reported job stress. Bi-variant regression analyses show the relationship of periodontitis with job stress to be much higher on controlling for other risk factors. The odds of having periodontitis in relation to

positive job stress were 6 times higher than those who did not have positive job stress.

Conclusions: This study shows a high prevalence of job stress related periodontitis among industrial workers in India. This research recommends the health and labor ministry to improve access to dental care especially in rural areas and include psychiatric units and oral health care as a part of primary health care. The factories administration should encourage recreation and retreat of the workers so as to reduce the level of stress at work. The factory administrations were recommended to have counselors to help their employees.

Key Words: Alcoholism, community periodontal index and treatment needs, Employee's State Insurance Corporation, oral hygiene, periodontitis, cortisol, psychosocial disorders, smoking

Introduction

The current periodontal paradigm holds that adolescents may be affected by several "clinically distinct periodontal infections." Most of the research into the etiology of these allegedly distinct disease entities focuses on aspects of the complex biological interplay between the infecting plaque microorganisms and the immunological and genetic factors involved in the host response.¹ Strooker *et al.* stated pathogenesis of stress as a risk factor for periodontitis is well-documented by various studies.² Various studies have been done in different parts of the world including, United States, Japan, Norway, United Kingdom, and Italy to identify stress-related periodontitis. Recent cross-sectional studies made in the United States has introduced the use of salivary cortisol test as a parameter to measure the levels of stress in periodontitis cases.³ Earlier, studies in United Kingdom have shown that occupational stress as the most common type of stress in both high and low-income countries.⁴

Studies conducted in India shows that every second, person above the age of 35 years has periodontal pockets and 35% of total teeth extracted after the age of 35 years are due to periodontal disease. The disease process is enhanced under the effect of smoking/tobacco and predisposes to coronary heart disease due to an increased risk of thromboembolic phenomena. Greene, identify the high prevalence of periodontal disease among 94% of the rural population.⁵ Periodontitis in rural population was commonly associated with high accumulation of plaque and other oral factors.⁶

The Indian Council for Research on International Economic Relations is projecting a possible 20-fold increase in lost

productivity due to lifestyle diseases such as heart disease and diabetes over the next decade owing to increasing stress disorders among employees especially in the industrial sector.⁷ Those predominantly affected belong to the labor class as in other developing countries. Work-related stress and mental fatigue are mainly blamed on expectations of better performance, deadlines, and competition over the last few years. The WHO reports 35% of cardiac disease related deaths in India by 2030 will be due to occupational stress. Low level of salivary cortisol is considered as a marker for high levels of stress.⁵ The EIA salivary cortisol test is based on the competition between cortisol and acetylcholine (AChE) esterase conjugate (cortisol tracer) for selected binding sites of specific rabbit antiserum. The amount of cortisol tracer binding with the rabbit antiserum is inversely proportional to the concentration of cortisol in the wells. As the amount of cortisol varies, the amount of cortisol tracer is kept constant. The 96 well EIA plate is filled initially with mouse monoclonal anti-rabbit IgG, which later binds with the added rabbit antiserum cortisol, both free or tracer. The plates are then washed, and Elman's reagent (AChE substrate) is added into the well. The final reaction shows yellow color in the wells on the plate, which is read under a spectrophotometer at 412 nm. The intensity of the color is directly proportional to the level of cortisol tracer and inversely proportional to the free cortisol levels (Salimetrics Cortisol EIA kit Manual).⁸

According to the WHO, 30% of suicidal deaths in India are due to occupational stress. The current study is the first of its kind as it involves studying the association between periodontitis and occupational stress among Employee's State Insurance Corporation (ESIC) insured industrial workers with salivary cortisol test as its key parameter.⁹

Materials and Methods

The study was conducted among the industrial worker of ESIC insured employees in order to explore the relationship between periodontitis and occupational stress (job stress) among industrial workers. The main objective to conduct the study was to:

1. To identify the association between periodontitis and self-reported job stress among industrial workers.
2. To correlate between self-reported job stress and the salivary cortisol levels to identify positive job stress.
3. To explain the association between periodontitis and positive job stress.

Sample size at 95% confidence level and allowable error of 15%, assuming effect in 50% of the study participants, a minimum of 178 subjects were required as sample size. Therefore, final sample size taken for the study was 180 subjects. A written consent was obtained from those interested in participating after providing them with a complete explanation about the purpose of research and procedures to be done. Free dental

examination was done for all participants, and some basic treatment was provided immediately. The subjects were allowed to leave the study in the case of discomfort at any point of time.

The administration of a standardized questionnaire from the National Institute of Job Stress and Health (NIOSH) was done to measure occupational stress among all subjects in the study. This model developed by NIOSH builds upon frameworks proposed by Caplan, Cobb, French, Harrison, and Pinneau (1975); Cooper and Marshall (1976); and House (1974). In this scheme, job stressors refer to working conditions that may lead to acute reactions or strains in the worker. Further, the questionnaire has been used as a key tool in various other studies concerning job stress.¹⁰ Validity and reliability of the generic job stress questionnaire were verified by the NIOSH by doing independent content analysis and recommendations concerning candidate scale inclusion. The researcher and the administration agreed prior that each participant would spend no more than 10 min on the translated questionnaire into the local language (Hindi). The time was considered critical as the absence of participant from work would mean production delay. Considering the time and research goals, questions chosen were all close-ended. Periodontitis was measured by dental examination under sufficient illumination. The second measure was restricted to those subjects diagnosed with periodontitis by the community periodontal index method.⁹ Low cortisol levels indicate chronic fatigue syndrome (CFS) due to excessive stress. Low level of salivary cortisol is considered as a marker for high levels of indicating CFS due to stress. The measure includes a collection of salivary samples from positive cases of periodontitis. The samples are later subjected to assay tests in the laboratory to identify levels of stress marker namely cortisol to assess stress. Samples were collected in a salivette tube containing a cotton plug. The subjects were asked to chew the cotton long enough to soak it with saliva. Without touching, the cotton was spilt into the tube and refrigerated until transportation to the lab. The sample was analyzed, and the test was performed at pathology lab of the hospital. Transportation was done on the same day of the sample collection. Sample collection was done for 3 days based on the subjects' availability and appropriateness of time of collection. The laboratory provides a normal range for salivary cortisol level for a morning to early noon (before lunch) to be from 5 ng/ml to 21.6 ng/ml. Values lower than 5 ng/ml were considered as low levels and those values falling within the normal range were considered as normal. Values above 21 ng/ml were regarded as high values. Morning salivary samples are considered second best after midnight ones samples as it provides accurate results with single samples and is more convenient for the participant and cost effective for the researcher.

The collected data were systematically checked for its clearance, completeness, and coherence. The data entry was done using

SPSS 14 with the outcome variable measured as periodontal disease and the exposure variable as occupational stress. The dependent variable, periodontal disease was defined as a dichotomous variable based on clinical examination. Subjects with mean clinical attachment loss ≥ 3 mm were assigned as periodontitis cases and those with mean clinical attachment loss < 3 mm were assigned as controls. The presence and absence of occupational stress were based on self-reported data obtained from the questionnaire and the salivary cortisol test results. Job stress and periodontitis among various age groups in the presence and absence of other factors was assessed using Chi-square testing. Logistic regression analysis was used to identify the correlation of self-reported job stress to periodontal disease by controlling other possible risk factors. Probability levels at $P < 0.05$ were considered statistically significant. The odds ratios were presented with 95% confidence intervals (CI).

Results

The study included 180 factory workers visiting in a 3 days camp organized by Dental College, Rohini. The completed responses were from 180 full-time employees who had been then in the same job for more than 3 years. About 82% of the subjects were from the age group between 20 years and 44 years in both factories. Three-fourths of them were married ($P = 0.005$). Almost three fourth of them were smokers. It was noted that more than half of the participants consumed alcohol at least once in a week (Table 1).

Of the 180 participants of the study 82% self-reported stressed. On further inquiry, 27% reported that the stressful state was due to financial troubles and their current job conditions. Data also shows that 56% of those reporting to be stressed in order to achieve targets at work. The prevalence of self-reported job stress increases with increase in age ($P = 0.0002$). On referring to the data on smoking, 45% of those who reported to have job stress were smokers. In addition to this, 74% of those who smoke reported to smoke more when they were stressed due to their work.

Of the 60 participants who submitted salivary samples, 63% had self-reported job stress. The odds of having low morning cortisol levels were 5.3 times higher among those who had reported job stress than who had not (Table 2). The mean salivary cortisol levels measured among 60 participants were 3.42 ng/dl.

On studying the association between periodontitis and self-reported job stress, 84% of those who reported to experience job stress were diagnosed to have periodontitis on dental examination. The odds of having periodontitis among those who reported to experience job stress were 7.2 times higher than those without job stress (95% CI 3.7-15.02), and results show statistical significance (Table 3).

Of those 60 participants who submitted saliva samples, nearly three fourth of them had positive job stress. The odds of having

periodontitis among those participants who had positive job stress was 6.13 times higher than those who did not have positive job stress (Table 4). Bivariate logistic analysis was carried out to identify the individual effect of the exposure variable on the outcome variable by controlling the external factors. In this study, the outcome variable periodontitis had a known relationship with having a poor oral hygiene, smoking, alcoholism, and systemic diseases such as diabetes and hypertension. The odds ratio was calculated along with 95% CI.

Those individuals who had poor oral hygiene had 4.6 times higher chance of having periodontitis when compared to those who had good oral hygiene, by controlling other influential factors. Similarly, the odds of having periodontitis among those who smoked were 3.5 times higher when compared to non-smokers, by controlling other associated variables. Furthermore, those who consumed alcohol were at twice higher chance of having periodontitis after controlling other factors. On controlling, other dependent variables in

Table 1: Percentage distribution of variables.

Variables	Percentage distribution
Age (years)	
20-29	48
30-44	40
45-64	12
Married	
Yes	72
No	28
Smoking	
No	26
Yes	72
Alcoholism	
No	38
Yes	62
Self-reported job stress	
No	18
Yes	82

Table 2: Odds ratio indicating the presence of low cortisol levels among those who reported job stress.

Self-reported job stress	Low salivary cortisol levels (%)	Odds ratio
No	22 (36)	1
Yes	38 (63)	5.3 (2.1-22.5)

Table 3: Association describing periodontitis to self-reported job stress.

Characteristics periodontitis	Self-reported job stress (%)	Odds ratio
No periodontitis	11 (18)	1
Periodontitis	49 (81)	7.2 (3.7-15.02)

Table 4: Association between positive job stress and periodontitis.

Characteristics	Positive job stress	Odds ratio (95% CI)
No periodontitis	31	1
Periodontitis	12	6.13 (1.6-30.5)

CI: Confidence interval

associating diabetes to periodontitis, those with diabetes have 2.9 times more chances of having periodontitis. On controlling for all other dependent variables to associate periodontitis with exposure variable self-reported job stress, the chance of having periodontitis among those with job stress was 8.3 times higher than those who did not report of having job stress (Table 5).

Discussion

This study was conducted among the industrial worker insured under ESIC scheme during a screening dental camp. Analysis was done using questionnaires filled by 180 subjects working in the textile factory. Previous studies comparing rural and urban population conducted by Greene in part of India (Mumbai) shows 94% higher prevalence of periodontitis among rural populations than urban.⁶

The two groups under study were widely distributed among various age groups and were also classified based on marital status. The information on marital status indicates the importance of the subject being in job in a setting like India as woman in the lower socioeconomic classes are usually not educated and some are not allowed to work as part of their culture and traditional beliefs. Hence, the importance for a man to work in order to support his family becomes crucial. This study shows that 74% of the subjects are married and have a family to support, and they need a job. Smoking is a common habit in Indian men from the lower socio economic classes.⁹ It is more likely due to the readily available and affordable local smokable tobacco products. The higher prevalence of tobacco consumption was related to the easier availability of newer tobacco products in the vicinity of the factory. The study also reports a high prevalence of alcohol consumption among the study population.¹¹ Results indicated that there was high prevalence of alcohol consumption among subjects as a result of the effect of generalized high prevalence in all parts of India.¹²

This study shows a 61% prevalence of self-reported job stress among the 180 study subjects. The results signify that there could be a correlation between the occurrence of job stress and the work environment. On studying the results from the

age-wise prevalence of self-reported job stress, the prevalence is seen to increase with age. This could be because of increasing financial burden to support families; health disorders neglected due to job conditions; and work conflicts. Of those who reported to have job stress, 74% of current smokers reported that they smoke when stressed and 30% of those who usually consume alcohol reported that they consume alcohol during stress. A high prevalence of poor oral hygiene maintenance was noted among those who reported job stress. The higher prevalence may be due to neglecting oral health during stressful states.¹³

On assessing the hormonal effects of stress, the higher prevalence of low levels of salivary cortisol was found among the selected 60 subjects. The mean level of morning salivary cortisol was 3.42 ng/dl. Correlating the results of salivary cortisol test to self-reported job stress, 69% of those who reported to have job stress had low cortisol levels. The 69% were thus considered to have positive job stress. This result is considered a critical finding unique to this study as previous studies have not compared self-reported stress to salivary cortisol levels.¹⁴ A high prevalence of periodontitis is also seen to increase with increasing age as in self-reported job stress. This could be due to the effects of other health problems or exposure to risk factors related to periodontitis that are common in the setting and problems related to aging.¹¹ This identifies the known correlation between periodontitis and smoking habit that was in par with previous studies that indicate a higher prevalence of periodontitis among smokers than non-smokers. This study also reports that maintenance of oral hygiene plays a significant role in the development of periodontitis.¹³

The prevalence of periodontitis among those who reported job stress was as high as 71% among the study population. The odds of having periodontitis among those who reported job stress was 7.5 times higher than those who did not report job stress. The study included a small group of subjects owing to which the CI (3.7-15.02) though significant ($P < 0.05$) are wide.^{14,15} Regression analysis results show that exposures to self-reported job stress indicated a higher risk of developing periodontitis on controlling other risk factors among the 180 study participants. Furthermore, the results indicate a higher odds ratio for self-reported job stress as an exposure variable than other factors. Thus, the correlation between self-reported job stress and periodontitis is certain. The prevalence of periodontitis among those who had positive job stress was 8.3 times higher than those who did not have positive job stress. This indicates a strong relation between the exposure variable positive job-stress to the dependent variable periodontitis. This is yet another crucial finding unique to this study.

The use of salivary cortisol test as a parameter to study hormonal response to job stress is yet another new approach, even though prior studies of serum cortisol levels in relation

Table 5: Explanatory factors for the presence of periodontitis among factory workers in India.

Variables	N	Odds ratio	CI
Poor oral hygiene			
Fair	4	1	1.71-9.46
Poor	56	2.59	
Smoking			
No	19	1	1.89-4.03
Yes	41	1.90	
Alcoholism			
No	21	1	1.24-5.85
Yes	29	2.70	
Self-reported job stress			
No	48	1	1.76-29.02
Yes	12	12.72	

CI: Confidence interval

to general stress has been done. Furthermore, previous studies done in the United States on stress-related periodontitis using salivary cortisol test have included only 40 cases of periodontitis for the salivary cortisol test.³ This study has had twice the sample size, which included 60 cases and 120 controls making the results comparable. Further, the results from the salivary cortisol test were also correlated with results from self-reported job stress to identify positive job stress, which is also unique to this study.

Conclusion

Health promotion among the industrial workers requires coordinated action by all concerned including the dental profession, local factory authorities, social and economic sectors and voluntary organizations. Mass media could also play a significant role by providing systematic updates regarding native and contiguous working conditions as to how it can be improved.

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