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Assessment and comparison of periodontal status among young smokers and nonsmokers of Bangalore, India - a cross sectional study.

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Objectives: To compare the periodontal status among young smokers and nonsmokers and to assess the influence of frequency and duration of smoking on the periodontal status. ***Basic Research Design:*** A cross sectional study. ***Participants:*** The study was conducted among 1,081 male employees (aged between 20-35 years) working in Bharat Electronics Limited (BEL), a factory located in Bangalore, India. ***Setting:*** Two medical centers (FMC-North and FMC-South) situated within the factory premises. ***Method:*** A specially designed form was used for collecting the information on socio-demographic factors, oral hygiene practices, smoking habits including the frequency and duration of smoking in addition to recording community periodontal index (CPI index) together with its loss of attachment (LA) component. Independent t-test, one-way analysis of variance (ANOVA), post hoc test (Bonferroni), chi square test and logistic regression analysis were carried out. ***Main Outcome Measures:*** CPI scores and LA codes. ***Results:*** Mean number of sextants per person with both periodontal pockets and loss of attachment measuring 4 mm or more was significantly higher ($p<0.001$) in smokers when compared to nonsmokers. Increase in the extent and severity of periodontitis was evident with an increase in the frequency and duration of cigarette smoking. Smokers were eight times more at risk of periodontal pockets (C.I: 5.79-10.68) and five times more at risk for loss of attachment (C.I: 3.79 -6.52) when compared to nonsmokers ($p<0.001$). ***Conclusions:*** Smoking is a risk factor strongly associated with periodontal disease among this young population of male employees working in BEL factory located in Bangalore. The extent and severity of the periodontitis was related to the amount of cigarettes smoked and the duration of the habit.

Key words: Periodontitis, smoking, young adults

Introduction

Oral health is an important aspect in the promotion of general health and the impact of oral illness has a bearing on general health and quality of life. Periodontal disease has contributed significantly to the global burden of oral disease. Though the primary cause of periodontitis is bacterial infection of long standing, tobacco usage is one of the major environmental risk factors among others which may be associated with periodontal disease.

Developing countries account for about half of the world's disease burden related to tobacco as measured by Disability-Adjusted Life Years (World Health Organization, 2002). Smoking is the most widely used form of tobacco consumption. The prevalence of smoking has been increasing in many low and middle-income countries even though it is decreasing in high income countries (Petersen, 2003).

Increasing evidence points to smoking as a primary behavioural risk factor for periodontitis (Johnson and Hill, 2004). Unfortunately, smoking has become more popular among the youth. Despite the decline observed in smoking in the developed countries its prevalence is still high among the younger individuals. Although more limited, there is some evidence that smoking is also an increasing problem among the young in developing countries (Warren *et al*., 2000).

Even though a number of studies have assessed the effect of smoking on the periodontal status, very few studies have been reported in the literature on the association of smoking and the extent and severity of periodontal disease in young adults especially in developing countries like India. The aim of the current study was to compare the periodontal status among young smokers and nonsmokers and to assess the influence of frequency and duration of smoking on the periodontal status in a sample of young smokers.

Method

This cross sectional study was conducted among employees who were aged between 20-35 years, working in Bharat Electronics Limited (BEL) a factory located in Bangalore. Informed consent was obtained from the study participants and permission to conduct the study was also obtained from the authorities of BEL before the start of the study. Ethical clearance was obtained from the ethical committee of M.S. Ramaiah Dental College and Hospital.

Based on the following inclusion and exclusion criteria, 1,081 subjects were included in the study.

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Inclusion Criteria

All male employees of BEL who were aged between 20-35 years.

Nonsmokers were those subjects who had never smoked in their lifetime.

Smokers were those subjects who had previously smoked or those who were smoking currently.

Exclusion Criteria

Subjects with systemic diseases and those on long term medication [3 subjects].

Subjects who have undergone periodontal therapy within the past six months [11 subjects].

Subjects who used tobacco in any other form other than smoking [15 subjects].

The study was conducted in two medical centers (FMC-North and FMC-South) situated within the factory premises, for about a period of 50 working days between 1st October to 30th November 2007. Examination was carried out on a daily basis at the fixed hours during the scheduled days given to the employee's respective divisions. A form was designed exclusively for obtaining the information on socio-demographic factors, oral hygiene practices, smoking habits including the frequency and duration of smoking. Socio economic status was assessed using a scale based on the revised version of Kuppuswamy's classification (Kumar *et al*., 2007). Revision is done by updating the original 1976 family income. It was obtained by multiplying 1976 income by a factor of 9.764 in order to comply with the increasing prices. Periodontal status was assessed using CPI index (World Health Organization, 1997) with its two components namely community periodontal index (CPI scores) and loss of attachment (LA codes). CPI probe with ball end was used for recording the periodontal status of the index teeth in each of the six sextants where in the two molars in posterior sextants were paired for recording.

SCORING CRITERIA FOR CPI INDEX

CPI SCORES:

0 - Healthy
1 - Bleeding observed directly or by using a mouth mirror, after probing
2 - Calculus detected during probing, but all of the black band on the probe visible.
3 - Pocket 4 - 5 mm (gingival margin within the black band on the probe)
4 - Pocket 6mm or more (black band on the probe not visible)
X - Excluded sextant(less than two teeth present)
9 - Not recorded.

LA CODES:

0 - Loss of attachment 0-3 mm (CEJ not visible and CPI score 0-3).

If the CEJ is not visible and the CPI score is 4, or if the CEJ is visible:

1 - Loss of attachment 4-5 mm (CEJ within the black band)
2 - Loss of attachment 6-8 mm (CEJ between the upper limit of the black band and the 8.5 mm ring)
3 - Loss of attachment 9-11 mm (CEJ between the 8.5 mm and 11.5 mm rings)
4 - Loss of attachment 12 mm or more (CEJ beyond the 11.5 mm ring)
X- Excluded sextant (less than two teeth present)
9 - Not recorded (CEJ neither visible nor detectable)

The specially designed form was used for the data collection which was pilot tested before the commencement of the study. Before the start of the study calibration of the investigator was carried out on 25 subjects on two separate occasions with a week interval between the two measurements. An experienced examiner who had participated in the state and national epidemiological surveys of periodontal disease guided the entire calibration exercise which took place 10 days prior to the actual study. The intra examiner reliability was assessed using Cohen's kappa coefficient (k coefficient .86 for CPI scores and .82 for LA codes) which was computed by comparing the observed agreement against that which might be expected by chance.

The clinical examination was performed by one investigator. Eight assistants were trained in recording the findings using the study forms. The subjects were interviewed individually by the principal investigator. To avoid possible bias the clinical examination was conducted before the subjects were interviewed so that as far as possible the examiner did not know if the subject was a smoker or non-smoker.

The outcome measures CPI scores and LA codes were analyzed using the SPSS version 10.

As the data was found to be normally distributed, independent t-tests were used to determine the significance of difference between the mean sextants affected per person with CPI scores and LA codes among smokers and non smokers. One way ANOVA was performed to check the mean sextants affected by frequency and duration of smoking which if found significant was accompanied by post hoc test (Bonferroni) to determine the significance of difference between each pair of groups. Chi square test was employed in comparing the prevalence of worst scores among smokers and nonsmokers. Logistic regression analysis was carried out to determine the risk of periodontitis in smokers and to assess the influence of confounding variables such as age, oral hygiene aids used, frequency of brushing, and socioeconomic status on the periodontal status for which the highest score for both CPI scores and LA scores were used. Outcome variables, per person CPI scores and LA codes were only transformed into binary variables (presence [1] or absence [0] for both periodontal pockets and loss of attachment) for logistic regression analysis. Cut off points for the division of CPI scores included recoding of scores 0, 1 and 2 to '0' representing absence of periodontal pockets and scores 3 and 4 were recoded to '1' to represent the presence of periodontal pockets. For LA codes the code '0' was retained to represent the absence of attachment loss and all other higher codes were combined into '1' to represent the presence of attachment loss. The level of statistical significance was fixed at 0.05.

Results

The majority of the subjects were aged between 20-25 years and a large proportion of the subjects were in a lower socio-economic class (Table 1). Almost all the subjects used a tooth brush and tooth paste and the vast majority of the subjects brushed their teeth once daily. Smokers outnumbered the nonsmokers. Of the 630 smokers, 84 % smoked less than five cigarettes per day and 78% of the smokers smoked for less than five years.

The mean number of healthy sextants per person was found to be higher among nonsmokers in contrast to smokers and the difference was found to be highly significant ($p<0.001$) (Table 2). The mean number of sextants per person with pockets measuring 4 mm or more was higher among smokers when compared to nonsmokers, which was also highly significant ($p<0.001$). However, it should be noted that CPI scores 3 and 4 were combined into score 3 as the great majority were 3 and there were very few subjects with the CPI scores 4. Hence CPI scores 3 in the tables also include pockets measuring 4mm or more. Similar findings were observed for various LA codes also where in LA codes 2, 3 and 4 were combined into code 2**.** Hence LA codes 2 in the tables include some pockets measuring 6mm or more. The number of sextants with missing teeth and not recorded was very rare.

Table 3 shows, the mean number of sextants per person with pockets measuring 4 mm or more was higher for those smoking less than five cigarettes /day and also for those smoking more than five cigarettes / day in contrast to nonsmokers and the differences were highly significant among all the three groups ($p<0.001$). Similar findings were also observed for loss of attachment though the loss of attachment of 6 mm or more failed to show any statistically significant difference ($p>0.05$) between nonsmokers and those smoking less than five cigarettes /day**.** As shown in Table 4, similar results were

Table 1. Distribution of socio-demographic and other factors among the study subjects.

	CATEGORIES	*NUMBER (n)*	*PERCENTAGE (%)*
Age	20-25 yrs	645	59.7
	26-30yrs	279	25.8
	31-35 yrs	157	14.5
Socioeconomic Class	Upper	55	5.1
	Upper lower	191	17.7
	Lower	600	55.5
	Upper middle	229	21.2
	Lower middle	6	.6
Oral hygiene aids used	Tooth brush and tooth paste	1068	98.8
	Tooth brush and tooth powder	6	.6
	Finger and tooth paste	2	.2
	Finger and tooth powder	5	.5
Frequency of brushing	Once daily	940	87.0
	Twice daily	138	12.8
	More than twice daily	3	.3
Smoking status			
Non smokers	–	451	41.7
Smokers	Less than 5 / day ; More than 5 / day	529 ; 101	48.9 ; 9.3
	Less than 5yrs ; More than 5yrs	488 ; 142	45.1 ; 13.1

Table 2. Mean number of sextants affected with various CPI scores and LA-codes among smokers and nonsmokers.

	Smokers Mean ± S.D		*Non smokers Mean ±S.D*	
	CPI scores	*LA codes*	*CPI scores*	*LA codes*
0	1.77 ± 1.39	4.27 ± 1.64	2.95 ± 1.61	5.47 ± 0.98
1	1.81 ± 1.23	1.21 ± 1.23	2.05 ± 1.27	0.37 ± 0.85
2	1.30 ± 1.05	0.25 ± 0.63	0.78 ± 1.07	0.02 ± 0.16
3&4	1.11 ± 1.29	-	0.21 ± 0.61	-

All are significant at $p < .001$ (Independent t test)
Note: LA code 2 is recoded to include codes 3 and 4 also.

Table 3. Mean number of sextants affected with various CPI scores and LA codes among smokers and nonsmokers by frequency of smoking.

	Non smokers Mean ±S.D#		*Smokers (≤ 5/day) Mean ± S.D#*		*Smokers (>5/day) Mean ± S.D#*		*Significance (ANOVA)*
	CPI scores	*LA codes*	*CPI scores*	*LA codes*	*CPI scores*	*LA codes*	
0	2.95 ± 1.61	5.47 ± 0.98	1.96 ± 1.40	4.66 ± 1.42	0.78 ± 0.84	2.22 ± 1.05	p <.001
1	2.05 ± 1.27†	0.37 ± 0.85	1.90 ± 1.25†	1.00 ± 1.20	1.34 ± 1.01	2.28 ± 0.76	p <.001
2	0.78 ± 1.07	0.02 ± 0.16†	1.26 ± 1.07*	0.07 ± 0.29 †	1.53 ± 0.93*	1.18 ± 0.98	p <.001
3&4	0.21 ± 0.61	-	0.87 ± 1.08	-	2.34 ± 1.55	-	p <.001

post hoc test; †p >0.05; * p<0.05; p< 0.001 between all other pairs of groups
Note: LA code 2 is recoded to include codes 3 and 4 also.

Table 4. Mean number of sextants affected with various CPI scores and LA codes among smokers and nonsmokers by duration of smoking.

	Non smokers Mean ±S.D#		*Smokers (≤ 5 yrs) Mean ± S.D#*		*Smokers (> 5 yrs) Mean ± S.D#*		*Significance (ANOVA)*
	CPI scores	*LA codes*	*CPI scores*	*LA codes*	*CPI scores*	*LA codes*	
0	2.95 ± 1.61	5.47 ± 0.98	2.09 ± 1.39	4.79 ± 1.33	0.96 ± 1.05	2.49 ± 1.31	p <.001
1	2.05 ± 1.27†	0.37 ± 0.85	2.01 ± 1.26†	0.84 ± 1.01	1.13 ± 0.83	2.47 ± 1.08	p <.001
2	0.78 ± 1.07	0.02 ± 0.16*	1.22 ± 1.06*	0.11 ± 0.40 *	1.56 ± 0.97*	0.73 ± 0.95	p <.001
3&4	0.21 ± 0.61	-	0.76 ± 0.99	-	2.34 ± 1.43	-	p <.001

post hoc test; † p >0.05; * p < 0.01; p< 0.001 between all other pairs of groups.
Note: LA code 2 is recoded to include codes 3 and 4 also.

Table 5. Mean number of sextants affected with various CPI scores and LA codes among smokers and nonsmokers by frequency and duration of smoking.

	Non smokers Mean ±S.D#	*Smokers (≤ 5/day & ≤ 5 yrs) Mean ± S.D#*	*Smokers (≤ 5/day & > 5 yrs) Mean ± S.D#*	*Smokers (>5/day & ≤ 5 yrs) Mean ± S.D#*	*Smokers (>5/day & > 5 yrs) Mean ± S.D#*	*Significance (ANOVA)*
CPI score 0	2.95 ± 1.61	2.10 ± 1.40*	1.25 ± 1.14	1.06 ± .76*	0.65 ± 0.75	p <.001
LA code 0	5.47 ± 0.98	4.95 ± 1.19	2.88 ± 1.46	2.53 ± 1.11	2.07 ± 0.99	p <.001
CPI score 1	2.05 ±1.27†	2.00 ±1.28†	1.30 ± 0.84*	2.16 ± 0.99*	0.96 ± 0.78	p <.001
LA code 1	0.37 ± 0.85	0.77 ± 0.99	2.46 ± 1.34†º	1.88 ± 0.71º	2.48 ±0.72†º	p <.001
CPI score 2	0.78 ± 1.07	1.18 ± 1.07*	1.71 ± 0.92	1.81 ± 0.69*	1.41 ± 1.00	p <.001
LA codes 2, 3 & 4	0.02 ± 0.16†	0.04 ± 0.21†	0.26 ± 0.53	0.94 ± 0.67	1.04 ± 0.93	p <.001
CPI scores 3 & 4	0.21 ± 0.61	0.72 ± 1.00	1.74 ± 1.19	0.97 ± 0.78	2.78 ± 1.37	p <.001

post hoc test; †p >0.05 ; ºp < 0.05 *p < 0.01; p< 0.001 between all other pairs of groups.

also observed for the association of CPI scores and LA codes with the duration of smoking, except that the loss of attachment of 6 mm or more showed a statistically significant difference (p<0.01) between nonsmokers and those smoking for less than five years**.**

Table 5 shows, the mean number of sextants per person affected with pockets measuring 4mm or more increased significantly(p<0.001) with increased frequency and duration of smoking being highest in those smoking more than five cigarettes /day for more than five years. The findings for loss of attachment showed similar trend. However, loss of attachment of 4-5mm failed to show any significant difference (p>0.05) between those smoking less than and more than five cigarettes /day for more than five years. Likewise there was no statistically significant difference between nonsmokers and those smoking less than five cigarettes /day for less than five years.

Table 6 shows, cross tabulation of smoking status with the CPI scores and LA codes based on the worst score or highest of all the six scores in a subject. The original scoring criterions of CPI Index were retained for the analysis of the worst scores without any recoding. Significant differences (p<0.001) were observed in the periodontal status of smokers and non smokers depending upon the frequency and duration of smoking supporting the findings obtained by taking the mean number of sextants affected with each score or code. However, calculus detected on probing showed a reverse trend.

Table 6. Cross tabulation of smoking status with worst CPI scores and LA codes

Smoking status	*scores/codes*	*0*	*1*	*2*	*3*	*4*	*Total*
Non smokers	CPI Scores*†	22 (4.9%)	197(43.7%)	167(37%)	65(14.4%)	0	451(100%)
	LA codes#º	347 (76.9%)	99(22%)	5(1.1%)	0	0	451(100%)
< 5 per day	CPI Scores*	3(0.6%)	81(15.3%)	178(33.6%)	261(49.3%)	6(1.1%)	529(100%)
	LA codes#	253(47.8%)	245(46.3%)	27(5.1%)	1(0.2%)	3(0.6%)	529(100%)
> 5 per day	CPI Scores*	0	0	9(8.9%)	82(81.2%)	10(9.9%)	101(100%)
	LA codes#	0	31(30.7%)	56(55.4%)	8(7.9%)	6(5.9%)	101(100%)
< 5 years	CPI Scores†	3(0.6%)	81(16.6%)	175(35.9%)	224(45.9%)	5(1%)	488(100%)
	LA codesº	244(50%)	206(42.2%)	31(6.4%)	4(0.8%)	3(0.6%)	488(100%)
> 5 years	CPI Scores†	0	0	12(8.5%)	119(83.8%)	11(7.7%)	142(100%)
	LA codesº	9(6.3%)	70(49.3%)	52(36.6%)	5(3.5%)	6(4.2%)	142(100%)

* $\chi 2 = 337$; d.f =8; p< 0.001 † $\chi 2 = 359.2$; d.f =8; p< 0.001
# $\chi 2 = 555.4$; d.f =8; p< 0.001 º $\chi 2 = 350.2$; d.f =8; p< 0.001
Note: The original scoring criteria of CPI Index were retained for this analysis without any recoding.

Results of the logistic regression analysis showed smokers to be at eight times more risk for periodontal pockets (C.I: 5.79-10.68) and five times more at risk for loss of attachment (C.I: 3.79 -6.52) when compared to nonsmokers which was highly significant (p<0.001). Age and socioeconomic status were found to have a significant influence on the loss of attachment (p< 0.05) but not on the pocket depth (p>0.05).

Discussion

A higher prevalence of cigarette smoking (58%) was observed in our study compared to most of the previous studies. This is possibly because of the one segment of the population studied, which may not be representative of the prevalence in the general population.

Smokers and nonsmokers in our study had comparable oral hygiene standards. Reduced number of sites with bleeding on probing was observed in smokers which is consistent with the previous studies (Machuca *et al*., 2000; Tanner *et al*., 2005) and was contrary to the studies Al-Wahadni and Linden, 2003 and Hashim *et al*., 2001. But this reduction in bleeding among smokers was statistically significant only after smoking more than five cigarettes /day and for more than five years of smoking history, suggesting that suppression of bleeding on probing among smokers may be a late phenomenon.

More sites with calculus detected on probing were observed in smokers compared to nonsmokers, which increased significantly with increased frequency and duration of smoking. This is in line with the study conducted by Susin and Albandar (2005). This might be due to the effect of tobacco smoke upon properties of saliva resulting in increased flow rate of saliva, a reflex phenomenon produced by an irritant particulate matter in the smoke. However, no attempt was made to differentiate between supra and subgingival calculus as this is not catered for in the CPI index..

The number of sites with pockets measuring 4 mm or more and loss of attachment of 4-5 mm were found to be significantly higher in smokers especially with increasing frequency and duration of smoking in comparison to nonsmokers in whom it was considerably low. This is in agreement with most of the previous studies (Al-Wahadni and Linden, 2003; Levin *et al*, 2006; Wickholm *et al*, 2004). However, Ramao and Wennstrom (2007) found no statistically significant difference in probing depths and loss of attachment among young smokers and nonsmokers.

Extensive loss of attachment of 6 mm or more was evident in smokers but it achieved statistical significance only in those smoking more than five cigarettes /day suggesting a higher dose may be associated with the manifestation of extensive loss of attachment in smokers as shown in the study conducted by Calsina *et al* (2002).

More sites with probing depth and attachment loss among smokers could be explained on the basis that smoking diminishes both cell mediated and humoral immune responses. Oxygen uptake by polymorphonuclear cells and production of oxygen radicals are severely compromised by nicotine (Pebst *et al*., 1995), leading to dual impairments in chemotaxis and phagocytosis ability of leucocytes in smokers.

The present study showed a greater influence of smoking on loss of attachment than on pocket depth supporting the study by Haffajee and Socransky (2001). This indirectly points to the increased number of sites with gingival recession in smokers compared to nonsmokers in accord with the studies (Muller *et al*., 2002; Thomson and Williams, 2002).

The findings of the present study reveal a marked association between cigarette smoking and the extent and severity of periodontitis suggesting that cigarette smoking may be a risk factor for periodontal disease from an early age especially with smoking of more than five cigarettes per day and for more than five years. This association could be interpreted to reflect the effects of smoking on the susceptibility to periodontitis at an age when young adults are at their healthiest and when the progression of the disease is low in most of the subjects.

This will aid in planning preventive measures such as strongly discouraging smoking from an early age for the betterment of periodontal health in this young population of smokers.

However, it should be remembered that the present study was a cross sectional study and therefore there are limitations in its ability to ensure that exposure (smoking) preceded the onset of disease (periodontitis). Hence the results of the study should be further confirmed or validated by means of longitudinal studies with extended follow up of larger groups of young individuals. Additional data are needed before definitive conclusions are drawn regarding the association between smoking and periodontitis.

Conclusion

The current study points to smoking as a risk factor strongly associated with periodontal disease among this young population of male employees working in BEL factory located in Bangalore. The extent and severity of the periodontitis depends upon the amount of cigarettes smoked and the duration of the habit with a tendency to increase with increased frequency and duration.

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