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Correlation of Clinical Attachment Level (CAL) and C - Reactive Protein (CRP) Levels in Smoker and Nonsmoker Patients with Chronic Generalized Periodontitis

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Abstract: Periodontal disease, caused mainly by bacteria, is characterized by inflammation and destruction of the attachment apparatus of the teeth. Periodontitis is a multi-factorial disease with microbial dental plaque as the initiator of periodontal disease. Studies indicate that the periodontal lesion is not strictly a localized process but may lead to systemic alterations in the immune function. The present study intends to evaluate the correlation of clinical attachment level and C-reactive protein levels in smoker and non-smoker patients with chronic generalized periodontitis. A total of fifty patients were included in the study, and they were divided into two group. Group A consisting of 25 patients who are smokers and they are having chronic generalized periodontitis, while Group B consist of 25 patients who are nonsmokers and having chronic generalized periodontitis. In the study clinical parameters we checked were Oral hygiene index – Simplified (OHI-S), Gingival Index (GI), Probing pocket depth (PPD) and Clinical Attachment level (CAL). Furthermore, CRP was evaluated as well between Group-A (Smokers with chronic generalized periodontitis) and Group-B (Nonsmokers with chronic generalized periodontitis). The results showed higher OHI – S, PPD, CAL and CRP levels in Group - A (Smokers having chronic generalized periodontitis) than Group - B (Nonsmokers having chronic generalized periodontitis). GI score was higher in Group - B as compared to Group - A. Increased levels of clinical attachment level (CAL) were seen in smokers suffering from chronic periodontitis. Significantly an increased level of C - reactive protein (CRP) was seen in smokers suffering from chronic periodontitis. Correlation between Clinical attachment level (CAL) and C-reactive protein levels (CRP) was very strongly positive and significant. Suggesting, as value of CAL increases, CRP also increases.

Keywords: C – Reactive Protein (CRP), Clinical Attachment Level (CAL), Smoker, Nonsmoker, Chronic Generalized Periodontitis.

INTRODUCTION

Periodontal disease, caused mainly by bacteria, is characterized by inflammation and destruction of the attachment apparatus of the teeth [1] Periodontitis is a multi-factorial disease with microbial dental plaque as the initiator of periodontal disease. Studies indicate that the periodontal lesion is not strictly a localized process but may lead to systemic alterations in the immune function.

Several mechanisms have been proposed to explain or support such theories. One of these is based around the potential for the inflammatory phenomenon of periodontitis to have effects by the systemic dissemination of locally produced mediators such as C-reactive protein (CRP), interleukins–1beta (IL-1β) and –6 (IL-6) and tumor necrosis factor-alpha (TNF-α)[2]. C-reactive protein is an acute phase reactant released by the body in response to acute injury or other inflammatory stimuli and is a fundamental response of the body to injury [3]. An elevated serum concentration of CRP is an evidence of active tissue–damaging process [4] and CRP is an indicator of current disease activity. The finding of a smoking related acute-phase response provides additional evidence of significant tissue inflammation associated with smoking. The rise in CRP concentration may prove to be a more accurate index of inflammation [4].

The present study intends to evaluate the correlation of clinical attachment level and C-reactive protein levels in smoker and non-smoker patients with chronic generalized periodontitis.

MATERIALS AND METHODS

Patients for this study were selected from the Out-Patient Department of Periodontology, People's College of Dental Sciences and Research Centre, Bhopal, Madhya Pradesh.

Grouping of Subjects

A Total of 50 patients were included in the study and they were divided into 2 groups:-

- Group A- Smokers with chronic generalized periodontitis (25)
- Group B- Nonsmokers with chronic generalized periodontitis (25)

Selection Criteria

Inclusion criteria for Group A

- Systemically healthy patients of more than 18 yrs of age.
- Chronic generalized periodontitis.
- Patients with probing pocket depth greater than or equal to 5mm in more than 30% sites.
- Smokers.

(Assessment of smoking status was done according to the criteria established by US Centre for Disease Control and Prevention [CDC, Atlanta]. Current smokers were defined as those who had smoked over 100 cigarettes over their lifetime and who were smokers at the time of evaluation).

Inclusion criteria for Group B

- Systemically healthy patients of more than 18 yrs of age.
- Chronic generalized periodontitis.
- Patients with probing pocket depth greater than or equal to 5mm in more than 30% sites.
- Non-Smokers.

Exclusion Criteria

- Patients receiving any kind of periodontal treatment 3 months prior to examination.
- Pregnant and lactating females.
- Patients suffering from systemic diseases (like diabetes mellitus, immunosuppressed conditions or systemic infections etc) that could aggravate periodontal manifestation.

A Performa was used to record the details of all the patients included for the study. A proper medical, dental history and an informed consent were obtained from the patients. The intra-oral examination was done using a mouth mirror, dental explorer and UNC 15 periodontal probe.

Intra Oral Examination

The materials and instruments used for Intra-oral examination are shown in Figure 1, 2 and 3. Clinical parameters assessed for the study were oral hygiene index simplified (OHI-S), gingival index, probing pocket depth and clinical attachment level. The intraoral examination was done with the help of mouth mirror, explorer and UNC -15 graduated periodontal probe along with radiographic evidence of bone loss either by OPG (Orthopantomographic radiograph) or IOPA (Intra oral periapical radiograph).

STATISTICAL ANALYSIS

Frequency, percentages, mean, standard deviation (SD), median, minimum and maximum values of variables in smoker and non-smoker groups were calculated. Shapiro-Wilks test showed that age, Simplified Oral Hygiene Index, Gingival Index, Probing pocket depth (PPD in mm), Clinical attachment loss (CAL in mm), C-reactive protein levels (CRP in mg/dl) did not follow normal distribution. Hence for comparison between smoker and non-smoker for these variables non-parametric test namely Mann-Whitney U test (M-W test) was applied.

Categorical variables (percentages and frequencies) were analysed using Pearson's Chi square test. Correlations between Clinical attachment loss (CAL in mm) and C-reactive protein levels (CRP in mg/dl) among study subjects were evaluated by Spearman's Rank Correlation test. P values <0.05 were considered statistically significant. Data analysis was done using IBM Statistical Package for Social Sciences (SPSS) v.21.

RESULTS AND OBSERVATION

The mean value of OHI-S score was 2.82 with a standard deviation of 0.75 in Group-A and 2.0 with a standard deviation of 0.52 in Group-B. This difference was found to be statistically significant ($p > 0.05$) showing that Group-B had a better OHI-S status as compared to Group-B. The result also showed that Group-A had a higher tendency towards poor oral hygiene as shown in table 1.

The mean value of GI score was 1.98 (moderate) with a standard deviation of 0.16 in Group-A and 2.37 (severe) with a standard deviation of 0.28 in Group-B. This difference was found to be statistically significant ($p > 0.05$) as shown in table 2.

The mean value of PPD was 4.24 mm with a standard deviation of 0.33 in Group-A and 3.92 mm with a standard deviation of 0.58 in Group-B. This difference was found to be statistically significant as well ($p < 0.05$) as shown in table 3.

The mean value of CAL was 4.51 mm with a standard deviation of 0.50 in Group-A and 4.06 mm with a standard deviation of 0.70 in Group-B. This difference was found to be statistically significant ($p < 0.05$) as shown in table 4.

The mean value of CRP was 1.15 mg/dl with a standard deviation of 0.75 in Group-A and 0.74 mg/dl

with a standard deviation of 0.61 in Group-B. This difference was found to be statistically significant ($p < 0.05$) as shown in table 5.

Correlating the clinical attachment level and C- reactive protein within the groups and overall study subjects, it was observed that the correlation was very strongly positive and significant as shown in table 6, depicting that as the CAL increases CRP levels also increases.

Table-1: Comparison of mean values of simplified oral hygiene index (ohi-s) score between group-a and group-b subjects

Groups	Mean ± SD	N	Median	Min-Max	Mann Whitney U test value	P value	Result
Group – A: (Smokers with Chronic Generalized Periodontitis)	2.82 ± 0.75	25	3.165	1.17-5.16	167.500	0.0083	S
Group – B: (Nonsmokers with Chronic Generalized Periodontitis)	2.00 ± 0.52	25	2.58	1.00-4.16			

Table-2: Comparison of mean values of gingival index (gi) score between group-a and group-b subjects

Groups	Mean ± SD	N	Median	Min-Max	Mann Whitney U test value	P value	Result
Group – A: (Smokers with Chronic Generalized Periodontitis)	1.98 ± 0.16	25	1.99	1.63-2.36	51.500	0.000	S
Group – B: (Nonsmokers with Chronic Generalized Periodontitis)	2.37 ± 0.28	25	2.41	2.01-3.00			

Table-3: Comparison of mean values of probing pocket depth (ppd in mm) between group-a and group-b subjects

Groups	Mean ± SD	N	Median	Min-Max	Mann Whitney U test value	P value	Result
Group – A: (Smokers with Chronic Generalized Periodontitis)	4.24 ± 0.33	25	4.28	3.23-5.01	133.000	0.000	S
Group – B: (Nonsmokers with Chronic Generalized Periodontitis)	3.92 ± 0.58	25	3.80	3.22-6.05			

Table-4: Comparison of mean values of clinical attachment level (cal in mm) between group-a and group-b subjects

Groups	Mean ± SD	N	Median	Min-Max	Mann Whitney U test value	P value	Result
Group – A: (Smokers with Chronic Generalized Periodontitis)	4.51 ± 0.50	25	4.63	3.46-5.55	149.000	0.002	S
Group – B: (Nonsmokers with Chronic Generalized Periodontitis)	4.06 ± 0.70	25	4.09	2.24-6.25			

Table-5: Comparison of c-reactive protein (crp in mg/dl) between group-a and group-b subjects

Groups	Mean ± SD	N	Median	Min-Max	Mann Whitney U test value	P value	Result
Group – A:(Smokers with Chronic Generalized Periodontitis)	1.15 ± 0.75	25	1.20	0.00-2.40	199.000	0.020	S
Group – B: (Nonsmokers with Chronic Generalized Periodontitis)	0.74 ± 0.61	25	0.60	0.00-2.40			

Table-6: Correlation between clinical attachment level (cal in mm) and C-reactive protein (crp in mg/dl) among study subjects

Correlation between CAL and CRP	Correlation Coefficient (Spearman's rho)	P value
Group – A: (Smokers with Chronic Generalized Periodontitis) (n=25)	0.885 (Very strong positive relationship)	0.0001 (<0.05), Significant Correlation
Group – B: (Nonsmokers with Chronic Generalized Periodontitis) (n=25)	0.882 (Very strong positive relationship)	0.0001 (<0.05), Significant Correlation
Overall (n=50)	0.930 (Very strong positive relationship)	0.0001 (<0.05), Significant Correlation

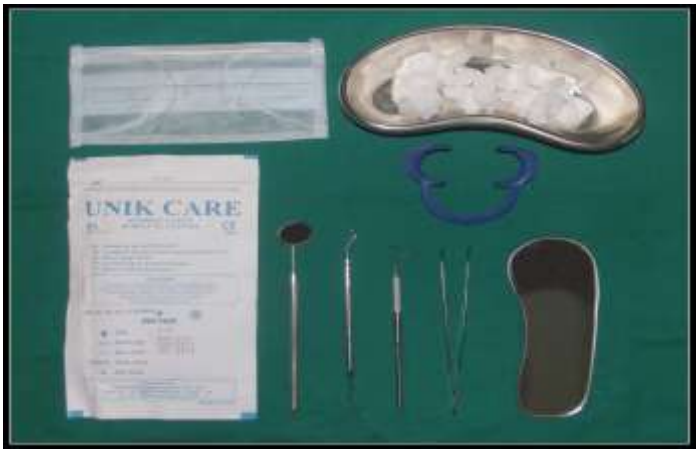

Fig-1: Armamentarium for clinical periodontal examination

Fig-2: Kit used for estimation for serum crp level

Fig-3: Centrifuge used for preparation of serum

DISCUSSION

Results in the present study showed that there was significant difference for OHI-S in Group A and Group B. The mean value of OHI-S score was 2.82 with a standard deviation of 0.75 in Group-A and 2.00 with a standard deviation of 0.52 in Group-B as shown in table 1. This difference was found to be statistically significant ($p > 0.05$). The results observed in this study are in accordance with the results of a study done by Aubrey Sheiham [5] who found poor oral hygiene status on the basis of OHI-S scores in a group of smokers. He concluded that the persons who smoked tobacco had more debris and calculus than nonsmokers. Similar results were obtained in a study done by Modupe O. Arowojolu *et al*. [6] who found that the values of OHI-S were significantly lower in nonsmokers than smokers. This finding can be explained by the fact that cigarette smoking causes staining of teeth, which roughness the surface of the teeth and encourages more rapid plaque accumulation. However, there are some contrary studies that reported that smokers do not necessarily have poorer oral hygiene in comparison with their non-

smoking counterparts. Alexander [7] reported that accumulation of bacterial plaque was not associated with tobacco smoking among a group of students, a report that was corroborated by the report of Bastiaan and Waite [8] among young adults. The contrary findings of this study could have been due to the fact that majority of the respondents were in the lowest socio- economic classes and had little education in comparision with the students studied by Alexander. Poorer health generally had been associated with those in the lower socio- economic classes compared with those in higher class.

In the present study, the mean value of GI score was 1.98 (moderate g) with a standard deviation of 0.16 in Group-A and 2.37 (severe g) with a standard deviation of 0.28 in Group-B. This difference was found to be statistically significant ($p > 0.05$) as shown in table 2. The development of gingival redness was lower in smokers, suggesting a suppression of the normal inflammatory response to plaque. The reduced gingival bleeding as a result of smoking must be considered detrimental because it may lead to an inaccurate assessment of periodontal status and fail to alert the patient the presence of the disease. It may also indicate a diminution of the defense capabilities of the gingival tissues. This effect is due to the potential vasoconstrictive effect of nicotine. Nicotine from cigarette smoke stimulates the sympathetic ganglia to produce neurotransmitters including catecholamines. These affect the alpha receptors on blood vessels which in turn causes vasoconstriction. The vasoconstriction of peripheral blood vessels caused by smoking can also affect the periodontal tissue and can lead to less overt signs of gingival inflammation such as redness, bleeding and exudation [9].

The results observed in this study are in accordance with the results of a study done by Erdemir EO *et al*. [10] who found a statistically significant difference in the Gingival Index (GI) score between smokers and non-smokers with a higher GI score in non-smokers. In a study conducted by Bulent K *et al*. [11] statistically significant difference was found in the Gingival Index (GI) scores between smokers and non-smokers with a higher GI score in non-smokers. Similar results were found in the studies conducted by Buduneli N *et al*. [12], Sumona B [13], Deepti W *et al*. [13] found higher GI scores in non-smokers as compared to smokers.

In the present study the mean value of PPD was 4.24 mm with a standard deviation of 0.33 in group-A and 3.92 mm with a standard deviation of 0.58 in group-B. This difference was found to be statistically significant ($p < 0.05$) as shown in table 3. Similar results were observed in the studies done by Bergstrom J *et al*. [14], Bergstrom J *et al.* [15], Hamdan S *et al*. [16], Sukumaran A [17], Sumona B *et al*. [18]. While Tomasi C *et al*. [19] reported that clinical characteristics in terms of PD and frequency of diseased sites and supragingival plaque did not differ in smokers and non-smokers. Apatzidou *et al*. [20] found no significance difference for the initial PD recordings between smokers and non-smokers (mean PD=5.9±0.6 for smokers; 6.2±0.8 for non-smokers). In harmony with these two contrary studies, there were no significant differences between smoker and non-smoker groups for the baseline clinical values in the study done by Bulent K *et al*. [21].

In the present study the mean value of CAL was 4.51 mm with a standard deviation of 0.50 in group-A and 4.06 mm with a standard deviation of 0.70 in group-B. This difference was found to be statistically significant ($p < 0.05$) as shown in table 4. Similar results were observed in the studies conducted by Erdemir EO *et al*. [22], Hamdan S *et al*. [23], Wang Q-T *et al*. [24], Sukumaran A [25], Buduneli N *et al*. [12], Sumona B *et al*. [18], Abdul SA *et al*. [26], Deepti W *et al*. [13].

This significant difference of PPD and CAL between Group-A (Smokers with chronic periodontitis) and Group-B (Non-smokers with chronic periodontitis) could be associated with host response. It has been seen that Smoking impairs various aspects of the innate and adaptive host responses as summarized in thorough reviews of mechanisms of tobacco-related periodontal destruction [27, 28]. These include alterations in neutrophil function, antibody production, fibroblast activities, vascular factors, and inflammatory mediator production. Smokers exhibit elevated total white blood cell and granulocyte counts in their systemic circulation; however, the influence of cigarette smoking on polymorphonuclear leukocyte cell numbers in the gingival crevice is not clear. Polymorphonuclear leukocyte viability [29] and functions, such as phagocytosis [29, 30] superoxide and hydrogen peroxide generation [31, 32], integrin expression [33], and protease inhibitor production [34] can be altered by cigarette smoking or various tobacco components. Neutrophils play a key role in both host protection and tissue destruction. Smoking appears to elicit the more destructive activities of polymorphonuclear leukocytes.

In the present study, the mean value of CRP was 1.15 mg/dl with a standard deviation of 0.75 in group-A and 0.74 mg/dl with a standard deviation of 0.61 in group-B. This difference was found to be statistically significant ($p < 0.05$) as shown in table 5. This finding is in the present study was in agreement with the studies conducted by Indrajit Das [35], Lowe *et al*. [36], Bermudez EA *et al*. [37], Frohlich M *et al*. [38], Ohsawa M *et al*. [39], Wannamathee *et al*. [40], Xian QL *et al*. [41], Behbudi L *et al*. [42]. C-reactive protein is an acute phase plasma protein, synthesised in response to general inflammatory episodes within the body [3].

Indeed, CRP has been detected by immunofluorescence in atherosclerotic plaques from human coronary arteries. The acute inflammatory response is induced by numerous challenges to the body, including infections and trauma, and leads to gross changes in the levels of CRP and other acute phase proteins. The primary regulators of CRP and the acute phase proteins are the cytokines interleukin (IL)-6 and IL-1β and tumour necrosis factor (TNF-α), which are secreted by neutrophil granulocytes and macrophages at sites of injury. These cytokines bind to cell surface receptors and initiate an intracellular signalling cascade, which leads to the activation of several transcription factors. C⁄EBPb, a member of the CCAAT-enhancer binding protein transcription factor family, is directly responsible for inducing the transcription of CRP [43].

Smoking men possess higher levels of CRP than non-smoking men. It is known that nitrogen oxides and other oxidants from cigarette or tobacco smoking increase inflammation in the respiratory pathways leading to increased mucus secretion and increased sensitivity of them to allergens which is eventually associated with the eosinophil count and the secretion of inflammatory mediators from the respiratory tract and other tissues of the body. Inflammatory markers, such as CRP and TNF-α, play a central role in the regulation of inflammatory responses and although the structure of CRP is independent of immunoglobulins it shares many biological activities with immunoglobulins. It is known that male smokers who are constantly using tobacco or cigarette have higher baseline CRP levels than non-smokers and this is indicative of augmented inflammatory processes in these individuals [44]. However, some previous studies have also reported insignificant increases of CRP Plasma in smokers compared with non-smokers [45, 46]. It is not clear whether these conflicting results are due to differences in genetic, environmental factors or changes associated with CRP half-life or it has roots in other interfering factors.

So in the present study (Group A, Group B and overall study subjects); Correlation between Clinical attachment level (CAL in mm) and C-reactive protein (CRP in mg/dl) were very strongly positive and significant as shown in table 6. From the results it can be concluded that as the value of CAL increases, CRP also increases in Group A as compared to Group B.

CONCLUSIONS

The conclusions which can be drawn from this study are:

- Increased levels of clinical attachment level (CAL) were seen in smokers suffering from chronic periodontitis.
- Significantly an increased level of C-reactive protein (CRP) was seen in smokers suffering from chronic periodontitis.
- Correlation between Clinical attachment level (CAL) and C-reactive protein levels (CRP) was very strongly positive and significant. Suggesting, as value of CAL increases, CRP also increases.

However, further studies involving larger sample size will throw more light on the correlation between clinical attachment level and C- reactive protein levels in smoker and nonsmoker patients with chronic generalized periodontitis.

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