ABSTRACT

Aim: The aim of the present study is to compare the subgingival temperature in smokers and non-smokers, having adult periodontitis.

Materials and methods: Thirty-three patients (16 smokers and 17 non-smokers) having adult periodontitis were selected for the purpose of this study. A modified digital thermometer was used for recording the subgingival temperature. Other clinical parameters like probing pocket depth, gingival bleeding index and plaque index were also recorded. Only the upper anterior teeth were included in the study.

Results: The subgingival temperature in smokers was found to be considerably less than that of non-smokers. The subgingival temperature increased with increase in probing pocket depth. The gingival bleeding index in smokers was lower than that of non-smokers.

Discussion: The decreased subgingival temperature in smokers is due to the decrease in cellular activity in smokers, thereby generating less heat. As the cellular and molecular activity increases with increase in probing pocket depth in both the smokers and non-smokers, the subgingival temperature was found to increase with increase in probing pocket depth. The vasoconstrictive action of nicotine in the peripheral circulation in smokers causes a decrease in gingival bleeding in smokers when compared to non-smokers.

Conclusion: This study shows that the subgingival temperature in smokers is lower than that of non-smokers. Also it can be said that subgingival temperature measurements, can be successfully used as a chair side diagnostic technique to measure the presence of disease, as it reflects the clinical status of the periodontium.

Key words: Subgingival temperature modified digital thermometer, probing pocket depth, chair-side diagnosis.

INTRODUCTION

Acquired habits of a human being are known to play a major role in causing periodontal diseases. One of the most common habits affecting the periodontium is smoking. The chronic smokers are more prone to periodontitis. Lots of long-term studies had been carried out in this regard and the fact that smokers are more prone to periodontitis than others in the absence of other etiological factors had been a good proven one19. As periodontitis literally refers to inflammation of the periodontium, the
periodontal apparatus must be associated with the cardinal signs of inflammation. The color change of the gingiva can be clearly seen with the naked eye. It ranges from dull red to fiery red depending upon the severity of the disease. There will be an increase in temperature at the affected site. This is due to the release of inflammatory mediators at the site. The mediators—histamine, prostaglandins and interleukin-1 are known to increase micro vascular permeability and cause vasodilatation. This increased fluid transport increases the temperature at the site of inflammation. Localized rise or fall in temperature also occurs in an affected area of the body due to localized inflammation, circulatory disturbances and increased metabolic activity. The rise or fall in body temperature can be easily measured with the help of thermometer. Either oral or rectal temperature can be measured to calculate the body temperature.

To measure the temperature in the periodontal pocket, temperature sensitive probe known as periotemp is used. It gives accurate values of subgingival temperature and is used as a diagnostic tool for measuring changing temperature values at the sites of inflammation. The aim of the present study is to compare the subgingival temperature in smokers and nonsmokers, with adult periodontitis.

REVIEW OF LITERATURE

It had been identified earlier that cigarette smoking is one of the major risk factor for periodontitis. Smokers, in particular, have more loss of connective tissue attachment and more severe bone loss when compared to nonsmokers. As periodontitis, literally refers to inflammation of the periodontium, one could expect the presence of the four cardinal signs of inflammation in the periodontium. Temperature changes, being one of the cardinal signs of inflammation, could be expected to accompany inflammatory process and therefore, diagnostic and prognostic information of the affected area can be obtained by recording the temperature changes.

The subgingival temperature is indicative of the inflammatory status of the periodontium. So measurement of subgingival temperature would indicate the presence or absence of disease at a particular site. As smoking is one of the risk factor for periodontitis, the subgingival temperature in smokers, pose some variations in smokers than that of nonsmokers.

In 1990, Kung RT, Ochs B et al, used a temperature probe to measure the subgingival temperatures. They also said that diseased tooth have higher temperatures than anatomically equivalent healthy teeth. They found that the periodontium of healthy tooth had a lower temperature. They concluded that elevated temperature observed in the diseased sites, is a natural response of inflammatory activity. Meyerov et al, in 1991, used a thermocouple to measure temperature gradients in the periodontal pockets. They said that the pocket site temperature were cooler than the sublingual temperature. This may be due to the fact that the bottom of those pockets lies below the level of the floor of the mouth, or the buccal reflection respectively. Haffajee AD, Socransky SS, et al, [1992], said that elevated subgingival temperature was associated with increased risk of new attachment loss. They also added that subgingival temperature was lower than sublingual temperature. They proved that...
elevated subgingival temperature was related to subsequent attachment loss\(^7\). A digital thermometer equipped with a measuring probe was used by Pedok, et al, [1992], to measure the subgingival temperature. They concluded that sulcus temperatures could be used as an early indicator for the occurrence of gingival inflammation\(^15\). They noticed temperature variations in the presence and absence of oral hygiene. Niderman R, Naleway, et al, [1995], said that subgingival temperature measurements provided an immediate report on the inflammatory status of the periodontium. They concluded that it is a useful tool in determining the inflammatory status of the pocket\(^13\).

In 1999, Trikilis N, Rawlinson A, Walsh TF et al, noticed a lower subgingival temperature in smokers when compared to nonsmokers. Also they noticed a significant relationship between pocket depth and subgingival temperature\(^17\).

MATERIALS AND METHODS

The following are the inclusion and exclusion criteria:

**Inclusion criteria:**
1. Patients in the age group between 35-50 years with adult periodontitis.
2. Patients with the upper six anterior teeth.
3. Patients with a probing depth not more than five millimetres.

**Exclusion criteria:**
1. A history of cardiovascular, circulatory or autoimmune disorders and diabetes.
2. Patients taking medications, which could modify the inflammatory response.
3. Systemic antibiotic therapy.
4. Any periodontal therapy including scaling or root planning within the preceding three months.

**Instruments used**
1. Modified digital thermometer.
2. Digital thermometer.
3. Mouth mirror.
5. Explorer.

**Thermometer (Modified Digital thermometer)**
The instrument used for recording the subgingival temperature was a modification of the commercially available digital thermometer manufactured by Microcare systems.

A thermistor connected to a battery was used to measure the temperature. The bulbous sensor was modified, so that the thickness was 0.88 mm and length was 0.74 mm, which facilitated its insertion into the sulcus. The design of the original thermometer remained the same except for the modification of the sensor and the temperature measurement was recorded in centigrade.

The sensor was passed through a commercially available 3 cm long stainless steel needle, which was angulated for easy access and insertion into the sulcus. The design of the thermometer was such that a beep sound would be heard when the temperature recording was stabilized in the digital display window.

**The following were the criteria recorded:**

**a. Temperature measurements**: Each patient had remained at rest in the dental chair, before the recordings were made. The recordings were made without a chair light, while they were instructed to breathe through the nose to eliminate the effect of expired air on temperature recording.

The subgingival temperature is measured first followed by the sublingual temperature. The subgingival temperature is measured with the modified digital thermometer and the sublingual
temperature is measured with the digital thermometer. The other clinical parameters were measured after the temperature readings are taken.

**b. Probing pocket depth:** Probing pocket depth was measured by a Williams periodontal probe with markings at 1, 2, 3, 5, 7, 8, 9 & 10 millimetres. Probing pocket depth was measured as the distance from the gingival margin to the base of the pocket. The value is measured to the nearest millimetres.

**c. Gingival bleeding index:** Gingival bleeding index of Ainamo and Bay was developed as an easy and suitable way for the practitioner to assess a patient’s progress in plaque control. The presence or absence of gingival bleeding is determined by gentle probing of the gingival crevice with a periodontal probe. The appearance of bleeding within 10 seconds indicates a positive score. When there is no bleeding a score of zero is given, and a score of one is given when there is bleeding.

**d. Plaque index:** The scoring is done on the selected teeth. The surfaces examined are the four gingival areas of the tooth that is, the distofacial, mesiofacial, facial and lingual areas. Only plaque of the cervical third of the tooth is evaluated with no attention to plaque extended to the middle of the incisal thirds.

**Procedure**
The tooth is dried and examined visually. When no plaque is visible, an explorer is used to test the surface. The explorer is passed across the tooth surface in the cervical third and near the entrance of the sulcus. When no plaque adheres to the point of the explorer, the area is considered to have a score of zero.

The scoring is done as follows:

**Score 1:** No plaque can be observed in situ with the naked eye. A film of plaque adhering to the free gingival margin and adjacent areas of the tooth, which can be recognised only running the explorer or pointed probe across the tooth surface or by using a disclosing agent.

**Score 2:** A thin to moderate accumulation of soft deposits within the gingival pocket or on the tooth and gingival margin, which can be seen with the naked eye.

**Score 3:** Abundance of soft matter within the gingival pocket or on the tooth surface and gingival margin. The interdental area is stuffed with soft deposits.

**Calculation of Plaque Index.**
The scores from the four areas of the tooth are added and then divided by four. This gives the plaque index for the tooth.

**e. Statistical Analysis:** The statistical software SPSS PC+(Statistical Package for Social Science.version 4.0.1.) was used for statistical analysis. Mean and standard deviation were examined from the sample for each study group. The mean values were compared by student’s independent t test and Mann-Whitney u test appropriately. Mean differences were tested by students paired t test. Pearson’s correlation coefficient was estimated for linear relationship between two variables. In the present study, p < 0.05 was considered as the level of significance.
RESULTS

Table 1 Comparison of Subgingival temperature in smokers and nonsmokers with adult periodontitis.

|-------------------------|--------------------------|-----------------------------|---------|
| 13                      | 33.44±.30                | 34.82±.28                   | <0.0001[
sig] |
| 12                      | 33.23±.34                | 34.82±.25                   | <0.0001[
sig] |
| 11                      | 33.41±.56                | 34.79±.21                   | <0.0001[
sig] |
| 21                      | 33.38±.33                | 34.88±.20                   | <0.0001[
sig] |
| 22                      | 33.28±.30                | 34.82±.21                   | <0.0001[
sig] |
| 23                      | 33.39±.33                | 34.86±.34                   | <0.0001[
sig] |
| Average                 | 33.36±.15                | 34.83±.08                   | <0.0001[
sig] |

Table 1 shows the mean and standard deviation of subgingival temperature in smokers and nonsmokers with adult periodontitis.

The mean value of subgingival temperature in smokers is 33.36 C [p-value <0.0001] and in nonsmokers is 34.83 C [p-value <0.0001].

For tooth 13 mean subgingival temperature for smoker [33.44±.30] is significantly lower than non-smoker [34.82± .28].

For tooth 12 mean subgingival temperature for smoker [33.23± .34] is significantly lower than non-smoker [34.82± .25].

For tooth 11 mean subgingival temperature for smoker [33.41± .56] is significantly lower than non-smoker [34.71± .21].

For tooth 21 mean subgingival temperature for smoker [33.38± .33] is significantly lower than non-smoker [34.88± .20].

For tooth 22 mean subgingival temperature for smoker [33.28± .30] is significantly lower than non-smoker [34.82± .21].
For tooth 23 mean subgingival temperature for smoker [33.39± .33] is significantly lower than non-smoker [34.86± .34].

The average subgingival temperature in smokers [33.36± .15] is significantly lower than nonsmokers [34.83± .08].

**Table 2 Comparison of subgingival temperature and probing pocket depth in smokers and nonsmokers.**

<table>
<thead>
<tr>
<th>VARIABLE [tooth number]</th>
<th>Correlation coefficient (r)</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smokers</td>
<td>Nonsmokers</td>
</tr>
<tr>
<td>13</td>
<td>0.88</td>
<td>0.91</td>
</tr>
<tr>
<td>12</td>
<td>0.91</td>
<td>0.97</td>
</tr>
<tr>
<td>11</td>
<td>0.46</td>
<td>0.84</td>
</tr>
<tr>
<td>21</td>
<td>0.93</td>
<td>0.88</td>
</tr>
<tr>
<td>22</td>
<td>0.93</td>
<td>0.88</td>
</tr>
<tr>
<td>23</td>
<td>0.94</td>
<td>0.64</td>
</tr>
<tr>
<td>Average</td>
<td>0.78</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Table 2 shows the results of correlation analysis for subgingival temperature and probing pocket depth in smokers and nonsmokers with adult periodontitis.

The above results indicate that subgingival temperature is directly proportional to pocket depth, that is, it increases with increase in pocket depth, in both smokers and nonsmokers.

**Table 3 Comparison of gingival bleeding index between smokers and nonsmokers with adult periodontitis.**

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>MEAN</th>
<th>Standard Deviation</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMOKER</td>
<td>0.325</td>
<td>0.101</td>
<td>&lt;0.0001 [Sig]</td>
</tr>
<tr>
<td>NONSMOKER</td>
<td>0.816</td>
<td>0.170</td>
<td>&lt;0.0001 [Sig]</td>
</tr>
</tbody>
</table>

The mean, standard deviation and test of significance of mean values between smokers and nonsmokers are tabulated above in table 3.

The above results indicate that the gingival bleeding index in smokers is significantly lower than that of nonsmokers.
Table 4 Comparison of plaque index between smokers and nonsmokers with adult periodontitis.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>MEAN</th>
<th>Standard Deviation</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMOKER</td>
<td>1.37</td>
<td>0.20</td>
<td>0.21[Non sig]</td>
</tr>
<tr>
<td>NONSMOKER</td>
<td>1.48</td>
<td>0.22</td>
<td>0.21[Non sig]</td>
</tr>
</tbody>
</table>

The mean, standard deviation and test of significance of mean values between smokers and nonsmokers are tabulated above in table 4. The above results indicate that the plaque in smokers and nonsmokers are statistically nonsignificant.

**DISCUSSION**

Periodontitis occurs due to inflammation of the periodontium, caused by a variety of etiological agents, including smoking. Evaluating the inflammatory status of the periodontium may be of diagnostic value in predicting the periodontal status\(^9\). In this clinical study, subgingival temperatures was measured to evaluate the inflammatory status of the periodontium, both in smokers and nonsmokers with adult periodontitis, and statistical comparisons were made between the two groups. As it had been proved beyond doubt that cigarette smoking is one of the chief etiological agents for adult periodontitis and the upper anteriors are the ones that are initially affected by smoking, only the upper anteriors were taken into account in the present study\(^9\).

The results of the present clinical study suggest that subgingival temperature in smokers is significantly lower than that of nonsmokers. This may be reasoned out by the fact that, nicotine has a vasoconstrictive action on the peripheral circulation in smokers. Also the cellular activity in the periodontal pocket of smokers is decreased, thereby generating less heat and therefore a lower subgingival temperature in smokers than nonsmokers. This is in accordance with the study done by Trikilis N, Rawlinson A, Walsh TF et al\(^17\) in 1999 and Dinsdale Cr, Rawlinson et al\(^3\) in 1997. Based on the results of the present study, the subgingival temperature is found to significantly rise with increase in probing pocket depth and probing attachment level, both in smokers and nonsmokers. This is
caused by an increase in cellular and molecular activity, due to periodontal inflammation, with increasing probing pocket depth. Higher temperatures had also been associated with the presence of periodontal pathogens in the depths of the periodontal pocket. Whether the pathogens are responsible for the higher temperature or the increased temperature provides an environment susceptible for the pathogens, remains unclear. The above mentioned results of the present study, is in accordance with the studies done by Haffajee AD, Socransky SS et al7 in 1992, Dinsdale CR, Rawlinson et al3 in 1997 and Trikilis N, Rawlinson A, Walsh TF et al17 in 1999.

Periodontal bleeding is considered as an objective sign of inflammation associated with gingivitis and periodontitis, and is widely used for diagnosis, in clinical periodontology. Smoking, not only suppress gingival bleeding and heat, but also redness and edema. When the gingival bleeding index between the two groups was compared statistically, smokers were found to have a significantly lower value of gingival bleeding index than nonsmokers. This may be attributed to the vasoconstrictive action of nicotine in the peripheral circulation of smokers. Varied opinions exist as far as scores of gingival bleeding indices in smokers is concerned. Tonetti Ms, Pin-Prato et al16 1995, said that smokers have high scores of gingival bleeding index than nonsmokers. The results of this study is in accordance with the results published by Gun Solley JC, Quinn SM, et al1 in 1998, Bostrom L, Bergstrom J, et al2 in 2001 and van Wonkelhoff AJ, et al18 in 2001.

When the scores of plaque indices for smokers and nonsmokers were compared statistically they were found to be more or less the same, that is, statistically nonsignificant14. Gunnar et al6 in 1994 and Tonetti MS, Pin-Prato et al16 in 1995 noticed a higher plaque scores for smokers than nonsmokers. This may be attributed to the difference in the oral hygiene measures taken by smokers and nonsmokers. The result of the present study is in accordance with the results published by Liaden et al11 in 1994.

SUMMARY AND CONCLUSION
The present clinical study was done to compare the subgingival temperature in smokers and nonsmokers having adult periodontitis. A total of 33 patients, out of which 16 were smokers and 17 were nonsmokers, with a probing pocket depth not more than 5 millimetres were subjected to the study. In addition to sublingual temperature and subgingival temperature, other significant clinical parameters were also recorded and statistical comparisons were made. The following conclusions were drawn based on the statistical analysis:

1. The mean values of subgingival temperature were lower in subjects, who were smokers, than in nonsmokers.
2. The mean values of subgingival temperature increased proportionally with probing pocket depth, in both the group of subjects.
3. The mean values of gingival bleeding index scores was found to be statistically more in subjects, who were non-smokers, than in smokers.
4. The mean values of plaque index scores were found to be nonsignificant in both the group of subjects.

From this study, it can be said that, subgingival temperature is lower in smokers than in nonsmokers, having adult periodontitis. As subgingival temperature reflects the present clinical status of the periodontium, it can be successfully used
as a chair-side diagnostic technique to measure the presence of disease.
In future, further explorations can be made in this study, expanding it to a longitudinal form, to measure temperature variations in a variety of patients with periodontal disease.

REFERENCES