Effect of Gingival Crevicular Fluid Volume in Smokers

Aishwarya A.S., Jaiganesh
Saveetha Dental College, Department of periodontics, Chennai, TN, India.

ABSTRACT

The association between smoking and periodontal disease has been proven by many epidemiological evidences. This article reviews the recent studies and compiles the effect of smoking on Gingival crevicular fluid volume. Many studies support the fact that tobacco smoking affects the periodontium through different pathways like microcirculatory, host immune systems, connective tissue and bone mechanisms.

Key Words: Smoking, Periodontal disease, Gingival crevicular fluid

INTRODUCTION

Periodontal disease is defined as inflammatory destruction of periodontal tissue and alveolar bone supporting the teeth. Smoking is accepted as a risk factor for periodontal disease and detrimental to periodontal tissues. Many investigations suggest negative periodontal effects among smokers in comparison with non smokers. Smokers tend to have greater numbers of deeper periodontal pockets and probing depth. Studies show that cigarette smokers are 2 to 6 times more likely to develop severe periodontitis than in non-smokers. Several epidemiological studies indicate that smoking has harmful effects on the response to non surgical and surgical procedures.

Paradoxically, smoking tends to mask the gingival inflammation by causing constriction of blood vessels of gingiva. Smoking is known to alter the host response including changes in vascular function, neutrophil activities, adhesion molecule expression, antibody production, release of cytokine inflammatory mediators.

Biological mechanism of periodontal disease is occurring due to the imbalance between bacterial virulence and host defence activity. The most possible mechanism that explains the relationship between smoking and periodontal disease is that smoking, an environmental factor, interacts with the host cells and affects the inflammatory changes. These underlying mechanisms can be understood by linking findings of the previous epidemiological studies with in vitro studies.

Biological markers called as biomarkers which are indicative of the status of the disease and have been measured for several studies to reveal the mechanism of disease. For example host immune inflammatory response systems have biomarkers like immune cells, immunoglobulins and metalloproteinase, cytokines, and adhesion molecules. These biomarkers are obtained limitedly particularly from non-diseased smokers. Thus commonly used specimens are saliva, blood serum, gingival crevicular fluid.

Gingival crevicular fluid is a fluid present in the sulcus or periodontal pocket between the surface of the tooth and the gingival epithelium. Gingival crevicular fluid is a transudate as well as inflammatory exudates, produced by osmotic gradient containing low protein content. The amount of gingival fluid is greater when inflammation is present. Physiologically the fluid volume increases while masticating, brushing, ovulation etc. Gingival crevicular fluid is a well known marker of gingival health status. This study reviews articles relating the gingival fluid flow in smokers.

SEARCH ENTITY

This article reviews based on the strategy, keywords like smoking and periodontitis, gingival fluid flow, Gingival

Corresponding Author:
Aishwarya A.S., Saveetha Dental College, Department of periodontics, Chennai, TN, India.

ISSN: 2231-2196 (Print) 0975-5241 (Online) DOI: 10.7324/IJCRR.2017.9175
Received: 08.03.2017 Revised: 02.06.2017 Accepted: 28.07.2017
crevicular fluid volume in smokers. Many articles reviewed were published in the last 5-7 years. This article constructs the relation between smoking and the gingival crevicular fluid flow rate by reviewing the previously conducted studies.

**METHODS OF COLLECTING GINGIVAL CREVICULAR FLUID** [7, 9]:

There are several methods to collect Gingival crevicular fluid

- By using absorbent papers
- Brill technique (intra sulcular method) – filter paper strip is placed inside the gingival sulcus until the resistance is felt.
- Loe and Holm-Pedersen technique (extra sulcular technique) – filter paper strip is placed at the entrance of the gingival sulcus.

a. Collection of Gingival crevicular fluid using micropipettes
   - Micropipettes with standardized length and diameter and uses the capillary action to collect the fluid.

b. By using twisted threads
   - Pre weighed twisted threads are placed in the crevice and after placing, the threads are measured and measured.

c. Collecting Gingival crevicular fluid by using paper points

**ESTIMATION OF AMOUNT OF GINGIVAL CREVICULAR FLUID:** [7]

a. The amount of Gingival crevicular fluid collected in periopaper can be measured by several means
   - By weighing the absorbent medium:
     - The weight of the twisted threads are measured before and after placing in the gingival crevice and compared.
   - By measuring capillary fill of micropipettes
     - As the capillary tubes are marked with standardized length and diameter.
   - By staining with ninhydrin
     - The wetted area with Gingival crevicular fluid becomes more visible by staining with ninhydrin which can be then measured planimetrically on an enlarged photograph or with a microscope.
   - Electronic method
     - Amount of Gingival crevicular fluid can be estimated by using an electronic device called as periotron.

**COMPOSITION OF GINGIVAL CREVICULAR FLUID**

The contents of Gingival crevicular fluid are usually as a result of interaction between the bacterial biofilm and the periodontal tissues. It contains the products of tissue breakdown, inflammatory mediator and antibody produced against them[7]. From the hypothesis postulated by Pashley which suggested that the initial fluid produced represents interstitial fluid which appears in the crevice as the result of osmotic gradient. This initial, pre-inflammatory fluid is a transudate and on stimulation it becomes as an inflammatory exudates[8].

Composition of Gingival crevicular fluid

- Enzymatic components
  - Host derived and other products
  - Bacteria derived
- Non enzymatic components
  - Cellular components
  - Electrolytes
  - Organic components

<table>
<thead>
<tr>
<th>Cellular components</th>
<th>Neutrophil, lymphocytes, monocytes, desquamated cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enzymes</td>
<td>Alkaline phosphatase, Cathepsin B, D, Collagenase, Elastase, Lactoferrin, Lysosomes, Gelatinases</td>
</tr>
<tr>
<td>Organic ions</td>
<td>Proteins. Albumins, Immunoglobulins, Gamma globulin, Glucose hexosamine, Hexuronic acid.</td>
</tr>
<tr>
<td>Inorganic ions</td>
<td>Sodium, potassium, calcium, magnesium, phosphate</td>
</tr>
<tr>
<td>Bacterial products</td>
<td>Acid phosphatase, Alkaline phosphates, Trypsin like enzymes, Prostaglandins, Endotoxins, hyaluronidase, Hemolysin, β-lactamase, DNase, Fibrinolysin, Chondroitin sulphatase</td>
</tr>
</tbody>
</table>

Organic compounds: Glucose hexosamine and hexuronic acid are two main components of Gingival crevicular fluid, where the glucose level of blood do not coincide with the level of glucose in Gingival crevicular fluid, its concentration is three or four times greater than in serum level [6].

**COMPOSITION OF CIGARETTES**

Tobacco smoke contains millions of noxious chemicals which comprises of gaseous phase and particulate phase. The gas phase contains carbon monoxide, ammonia, formaldehyde, hydrogen cyanide and 60 known carcinogen such as benzo(a)pyrine, dimethylnitrosamine. The particulate phase includes nicotine, benzene, and tar. Tar is in condensate form, sticky substance that stains the fingers and teeth yellow/brown. Nicotine an alkaloid found in tobacco leaves evaporates when the cigarette is lighted. It’s quickly absorbed in the lungs and reaches the brain within 10-19 seconds. Nicoc-
Aishwarya et al.: Effect of gingival crevicular fluid volume in smokers

tine is highly addictive and causes rise in blood pressure, increased heart rate and respiratory rate with peripheral vasoconstriction. Plasma and saliva cotinine concentration in smokers is approximately 300ng/ml and the urine concentration s approximately 1500 ng/ml. Non-smokers has plasma and saliva concentration

**Table 2: Composition of Cigarette**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Effect on Human Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAR</td>
<td>Stains finger nails and teeth yellow/brown</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>This odourless gas is fatal in large doses because it takes the place of oxygen in the blood. Each red blood cell contains haemoglobin that transports oxygen molecules around the body. Carbon monoxide binds to haemoglobin better than oxygen. More red blood cells are produced leading to thickening of blood</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>Hydrogen cyanide restricts lung clearance leading to accumulation of toxic chemicals in tobacco smoke. Other chemicals that damage the lungs include hydrocarbons, nitrous oxides, organic acids, phenols and oxidising agents.</td>
</tr>
<tr>
<td>Oxidizing chemicals</td>
<td>Free radicals can damage the heart muscles and blood vessels. This increases the risk of atherosclerosis leading to heart disease and stroke</td>
</tr>
<tr>
<td>Metals</td>
<td>Tobacco smoke contains carcinogenic metals including arsenic, cadmium and lead.</td>
</tr>
<tr>
<td>Radioactive compounds</td>
<td>Carcinogenic</td>
</tr>
<tr>
<td>Nicotine</td>
<td>It binds to root surface and can be stored and released from fibroblasts. It may inhibit fibroblast attachment and integrin expression, fibronectin and type I collagen production and increase fibroblast collagenase activity.</td>
</tr>
</tbody>
</table>

**Changes in Gingival Crevicular Fluid Composition Associated with Smoking:**

**Effect on microvasculature**

Smaller number of vessels was observed in inflamed gingival tissues of smokers compared to non smokers. Smoking causes decrease in gingival blood flow and vascular conductance, leading to delay in healing and increases the risk of periodontal health. Smoking causes inflammatory activation by inducing endothelial dysfunction which increases the cytokine adhesion molecules.

**Host immune response**

Smoking can affect the neutrophil count in blood in a dose-dependent manner. Smoking reduces the proliferation of T lymphocytic cells and affects B cell function and antibody generation.

**Connective tissue and bone metabolism:**

Crevicular fluid in smokers has increased levels of Interleukins (IL 6, IL 8, IL 4), MMP, and free radicals. Gingival crevicular fluid has decreased levels interleukins (IL 1a), osteoprotegrin, prostaglandins, and gingival fibroblasts.

**Table 3: Effect of Smoking on Body Tissues**

<table>
<thead>
<tr>
<th>Effect Site</th>
<th>Change in Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connective tissue metabolism</td>
<td>↑ IL 6, IL 8, IL 4, ↑ MMP , ↓ IL 1a</td>
</tr>
<tr>
<td>Host immune system</td>
<td>↓ Neutrophil, ↓ T lymphocyte, ↑ Calprotectin</td>
</tr>
</tbody>
</table>

[↑- Increase, ↓ - Decrease]

Viability of PMNs was significantly lower in light, moderate and heavy smokers compared to non-smokers. The ability of PMNs to phagocytose was significantly impaired in light, moderate and heavy smokers compared to non-smokers. In periodontally diseased subjects the total amounts of IL-1β, IL-6 and IL-8 were significantly elevated as compared to healthy subjects, whereas IL-4 showed an inverse relationship to periodontal status and higher amounts were found in the healthy group. The levels of calprotectin, a leukocyte protein, in body fluids of patients with some inflamma-
tory diseases are raised. Recently, we detected calprotectin in Gingival crevicular fluid and its concentrations in periodontal pockets were higher than those in healthy gingival crevices [16,17]. Investigations done by Jun-ichi Kido found the correlations between Gingival crevicular fluid calprotectin levels and clinical indicators (probing depth and bleeding on probing, BOP), and the IL-1β and PGF_2α levels [14].

**DISCUSSION**

Smoking is highly prevalent and can be considered an epidemic both developed and developing nations, smoking was higher in younger groups than older groups. Studies estimate that 1.3 billion people smoke per year worldwide on an average [6]. Smoking is detrimental to body tissues such as lungs, heart muscles, blood vessels, periodontium etc.

The periodontal probing depth and attachment loss were higher in smokers compared to non smokers [3]. Smoking tends to mask gingival inflammation by causing constriction of blood vessels of the gingiva [20,21,22]. Smoking decreases oxygen tension in the gingival tissues. Smoking decreases tissue oxygen from 65±7 to 44±3 mmHg. Oxygen tension of 40-50 mmHg has increased risk of infection [9]. Vasocstriction of blood vessels leads to reduced clinical signs and suppressed clinical expression of disease [11]. A study done by Kemal et al showed that smoking significantly increased Gingival crevicular fluid flow/volume when compared to non-smokers. Purnima et al conducted a study with Gingival crevicular fluid, marginal and sub gingival plaque that revealed early acquisition and colonization of oral biofilm in smokers [12].

Cigarette smokers with periodontitis have increased periodontal destruction especially in palatal region of maxilla [35]. Study done by Xia Chen et al showed that 16% of smokers had higher chance of becoming edentulous within 10 years while only 0.3% of non-smokers become edentulous in the same period of time [19].

The research by Kaushal Luthra et al shows a clinically significant decrease in Gingival crevicular fluid volume in smokers when compared to non smokers and an increase in the volume of Gingival crevicular fluid 10 minutes post smoking [1]. Nicotine plays a major role in altering the gingival blood flow which subsequently correlates with the volume of Gingival crevicular fluid in smokers [3]. A similar result was reported by Morozumi et al [11]. There is an immediate increase in Gingival crevicular fluid volume five days after smoking cessation.

**CONCLUSION**

The Gingival crevicular fluid volume is known to increase with the degree of inflammation. The increased Gingival crevicular fluid volume shows the presence of masked inflammation in smokers. Smoking alters the gingival blood flow which concomitantly relates to the Gingival crevicular fluid volume. This review concludes that the result may vary according to the pattern of smoking, methods of collection of Gingival crevicular fluid and sample size.

**ACKNOWLEDGEMENT**

The Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

**REFERENCES**

10. Andrew J. Delina, origin and function of the cellular components in Gingival crevicular fluid, periodontal 2000:2003; volume 31,55-76.
14. Giannopoulou C, Kamma JJ, Mombelli A: Effect of inflamma-
Aishwarya et al.: Effect of gingival crevicular fluid volume in smokers