www.jmscr.igmpublication.org Impact Factor 3.79
ISSN (e)-2347-176x

Journal Of Medical Science And Clinical Research
IGM Publication An Official Publication Of IGM Publication

An Insight into Saliva as a Biomarker for Periodontal Disease

Authors

Dr. Arvind Garg[1], Dr. Suruchi Hans[2], Dr. Shweta Bansal[3], Dr. Arun Garg[4]
Dr. Asmita Sethi[5]

[1]Professor, JCD Dental College, Barnala Road, Sirsa 125055
Email:- *docarvindgarg@gmail.com*
[2]Reader, Maharaja Gangasingh Dental College, Ganganagar, Rajasthan
Email: *suruchihans9@gmail.com*
[3]Reader, JCD Dental College Barnala Road, Sirsa 125055
Email: *dr_shwetaagarwal@hotmail.com*
[4]Reader, JCD Dental College Barnala Road, Sirsa 125055
Email: *doc7602@gmail.com*
[5]Senior Lecturer, JCD Dental College, Barnala Road, Sirsa 125055
Email: *asmita.sethi@gmail.com*
Corresponding Author
Dr. Arvind Garg
Professor, JCD Dental College, Barnala Road, Sirsa 125055
Email:- *docarvindgarg@gmail.com*

ABSTRACT

periodontal disease is a immune-inflammatory disease with varying degree of disease severity. It has been a challenge to determine biomarkers for screening and predicting the early onset of periodontal disease, evaluating the disease activity and the efficacy of therapy. Traditional clinical criteria are often insufficient for determining sites of active disease, for monitoring the response to therapy, or for measuring the degree of susceptibility to future disease progression. . In the recent past, research on saliva have been directed towards better understanding of the potential of saliva as an aid in the diagnosis of several diseases where presence/absence or a change of one or more of its constituents can act as a marker. Saliva is a fluid that can be easily collected non-invasively, contain locally derived and systemically derived markers of periodontal disease hence may offer the basis for patient specific diagnosis for periodontal disease. This review highlights the various potentials of saliva as a diagnostic biomarker for periodontal diseases.

Keywords: *Biomarker, diagnostic fluid, periodontal disease, saliva*

INTRODUCTION

Early detection of disease plays a crucial role in successful therapy. In most cases, the earlier the disease is diagnosed, the more likely it is to be successfully cured or well controlled.

Currently, three major limitations have prevented people from recognizing the full potential of disease detection, and have seriously hampered the development of clinical diagnostics, namely:

1. Lack of definitive molecular biomarkers for specific diseases;
2. Lack of an easy and inexpensive sampling method with minimal discomfort; and
3. Lack of an accurate, easy-to-use, and portable platform to facilitate early disease detection.

Saliva, an oral fluid that contains an abundance of proteins and genetic molecules and is readily accessible *via* a totally noninvasive approach, has long been recognized as the potential solution to these limitations[1]. According to the AAP glossary of terms 1987, ***Saliva is defined as the tasteless clear fluid secreted by the major and minor salivary glands***. Three major salivary glands produce about 95% of the total salivary volume and numerous minor salivary glands produce minute amounts of saliva. Saliva consists of 99% water, and varying amounts of proteins, enzymes, mucoproteins, blood group substances, hormones, carbohydrates, lipids, nitrogen containing compounds, lactoferrin and inorganic substances. Saliva is not only a pleasant lubricant which makes oral functions such as speech, mastication and swallowing easier, but also a fluid with many important functions in the maintenance of oral and general health. Rather than just providing lubrication, saliva is important for the metabolic health of the mouth as a whole. Some systemic diseases and hormonal changes can alter the flow and composition of saliva, so that in many cases saliva analyses have diagnostic value. In recent years saliva has attracted much attention, it has been suggested that saliva might be substituted for plasma in the areas of pharmacokinetic studies and drug monitoring. The diagnosis of active phases of periodontal disease, and the identification of patients at risk for active disease, represents a challenge for both clinical investigators and clinicians. In general, clinical parameters including probing depth, attachment level, bleeding on probing (BOP) plaque index (PI) and radiographic loss of alveolar bone are used to assess disease severity[2]. It has long been realized that a rapid and simple diagnostic test that can provide a reliable evaluation of periodontal active disease would be of value to both clinicians and patients.

Periodontal Diagnosis by Clinical Monitoring-

The diagnosis of active phase of periodontal disease and identification of patients at risk of active disease represents a challenge for both investigators and clinicians. In general these are the clinical parameters that are used to assess the disease severity[2]

- Probing depth
- Bleeding on probing

- Attachment level loss
- Plaque index
- Radiographic loss

Recently, genetic analysis has also been suggested as a means to identify individuals who are at increased risk for more severe periodontitis [3]. However, as of yet, no clinical or laboratory test is routinely employed in the monitoring of patients with periodontal disease. Clinical and radiographic assessment of periodontal disease remains the basis for patient evaluation.

Disadvantages of clinical monitoring –

1) It is time consuming subject to considerable measurement errors and is often poorly tolerated by the patients.
2) These measurements provide information about disease severity and do not provide measurements of disease activity.
3) Information is about the past pathology but not the present condition or the probability of alterations occurring in the future.

MARKERS IN SALIVA WITH POTENTIAL IMPORTANCE FOR PERIODONTAL DISEASE:

ENZYMES-

Enzymes present in saliva can be produced by cells in the salivary glands, oral microorganisms, polymorphonuclear leucocytes (PMNs), epithelial cells and GCF entering oral cavity[4]. Studies have examined enzyme activity in saliva in relation to periodontal status and in response to periodontal treatment.

Nakamura & Slots (1983) studied the enzymatic activity of mixed whole saliva and parotid saliva in 10 healthy, 10 Adult periodontitis and 4 Localized juvenile periodontitis patients. Mixed whole saliva from Adult Periodontitis patients demonstrated the highest enzyme activity as compared to healthy controls. **Zambon et al. (1985)** evaluated changes in the levels of enzymes in whole mixed saliva of Adult Periodontitis patients before and after treatment which included scaling, root planing and tetracycline therapy. This treatment resulted in reduced salivary levels of caprylate esteraselipase, leucine, valine and cysteine aminopeptidases, trypsin, β galactosidase, β glucuronidase and β -glucosidase.

Comparable results were reported by **Uitto et al. (1990)**, who collected saliva from subjects with a healthy or diseased periodontium to assay collagenase activity which was higher in the periodontitis patients than the controls. Children with **Down's syndrome** have an increased prevalence and severity of activity of salivary collagenase in 9 affected children, 9–17 years of age, was higher than controls suggesting its role in early periodontal tissue and alveolar bone destruction [5].

a) Collagenase & related Matrix Metalloproteins-

Collagenase is a family of matrix metalloproteins (MMPs) which degrade collagen.MMP 8 is found in the inflammatory cells such as PMNs, macrophages and can be detected in the saliva. MMP 9 is also found in Polymorphonuclear

leukocytes. These can be immuno detected using monoclonal/polyclonal antibodies with the ELISA technique (**Ingman 1996**), Western blot (**Killi 2002**).

b) Salivary Gelatinase-

Makela et al. (1994) determined that the concentration of MMP-9 (92 kDa gelatinase) was significantly higher in whole saliva of periodontitis patients compared with healthy subjects.

c) Lysozymes-

Antibacterial enzyme found in the body secretions notably tears and saliva. The concentration of lysozyme in Patients with periodontitis demonstrated decreased lysozyme concentration compared to controls (**Markkanen et al. 1986**).

d) Lactoferrin-

Antibacterial agent found produced by inflammatory cells. **Soumalainen et al. (1996)** evaluated myeloperoxidase (MPO), lysozyme and lactoferrin activity in relationship to periodontal disease. Following periodontal therapy, these values declined and approached those observed in healthy controls.

e) PEROXIDASE-

Salivary peroxidase activity significantly increases with inflammation and reduces after oral hygiene measures[6].

f) Kallikrein-

Kallikrein hydrolyzes kininogen to release vasoactive kinin peptide such as bradykinin[7].These peptides are important mediators of inflammation.

IMMUNOGLOBULINS

The predominant immunoglobulin in saliva is secretory IgA (sIgA) which is derived from plasma cells in the salivary glands. sIgA maintains homeostasis in the oral cavity. sIgA controls the oral microbiota by reducing the adherence of bacterial cells to the oral mucosa and teeth[8.]

Immunoglobulin Isotypes in Saliva

sIgA is actively secreted by the salivary glands, therefore studies have attempted to determine if a relationship exists between salivary levels of sIgA and periodontal status.

Guven et al. (1982) reported that higher levels of IgA were present in whole saliva collected from patients with gingivitis and periodontitis. **Sandholm et al. (1984)** evaluated that Salivary IgA, IgG, and IgM levels were higher in the JP patients as compared with the healthy siblings and controls. **Bokor et al. (1997)** reported that the concentration of IgA in mixed unstimulated saliva was lower in subjects with more gingival inflammation. **Reiff et al. (1984)** examined changes in the concentration of immunoglobulins in saliva following the treatment. A decrease in salivary levels of both IgA and IgG was observed after periodontal therapy.

Myint et al. (1997) assessed levels of IgA to bacteria in dental plaque in parotid saliva from

HIV+ and HIV- subjects with healthy gingiva, chronic gingivitis, chronic marginal periodontitis and necrotizing ulcerative periodontitis. When the HIV+ group was compared with the HIV- group, regardless of periodontal status, total salivary IgA concentration was higher in the HIV+ patients. It was thus concluded that salivary IgA response to bacteria in dental plaque may have been influenced by acute periodontal infection.

Specific Immunoglbulins in Saliva

Specific immunoglobulins in saliva directed towards periodontal pathogens have also been examined for their diagnostic potential.

Eggert et al. (1987) reported that saliva from treated periodontitis patients had higher IgA and IgG levels than did saliva from control subjects. **Tynelius-Barthall & Ellen (1985)** found similar trends measured changes in salivary antibodies to *Actinomyces viscosus* and *Actinomyces naeslundii* in 6 patients with gingivitis prior to and after treatment. **Anil et al (1995)** reported higher IgA and IgG levels in Non Insulin Depebdent Diabetes Mellitus patients as compared to non diabetic patients. This can be attributed to an altered immune response found in diabetic due to greater antigenic challenge present.

Neiminen et al (1993) reported that concentration of specific IgA and IgG to *A.actinomycetemcomitans* in saliva of patients with advanced periodontitis correlated significantly with corresponding antibody titres in serum of these patients.

OTHER PROTEINS

1) **Fibronectin**

It is a glycoprotein which mediates adhesion between cells and is also involved in chemotaxis , migration , inflammation and wound healing and tissue repair. Fibronectin levels in saliva do not differentiate between periodontal health and disease[9].

2) **Cyseine proteinases**

These are proteolytic enzymes originating pathogenic bacteria, inflammatory cells, osteoclasts and fibroblasts. These enzymes have collagenolytic activity which may cause tissue destruction[10].

Henskens et al. (1996) evaluated the change in concentration and activity of salivary cystatins in whole and parotid saliva from 20 periodontitis patients undergoing treatment. After periodontal treatment, total cystatin and cystatin C concentration decreased to control levels.

ACTIVATING FACTOR (PAF)

It is potent phospholipid mediator of inflammation which stimulates the activity of production of platelets.

Garito et al. (1995) studied PAF in whole saliva collected from 69 subjects found a significant positive correlation between the level of PAF in saliva and measures of periodontal inflammation. **Rasch et al. (1995)** conducted a longitudinal evaluation of the effect of periodontal therapy (oral hygiene instruction, prophylaxis and scaling/root planing) on salivary PAF levels in 15

chronic Adult periodontitis patients. These levels declined further following Scaling and root planning. It was therefore concluded that PAF might participate in inflammatory events during periodontal tissue injury and disease.

EPIDERMAL GROWTH FACTORS (EGF)

Involved in wound healing and functions with hormone like properties to stimulate epithelial cells. In humans, the parotid gland is a major source of EGF[10]. **Oxford et al. (1998)** found a transient increase in salivary EGF levels in response to periodontal surgery. **Hormia et al. (1993)** observed higher EGF secretion rates in unstimulated and stimulated saliva in 17 Juvenile periodontitis patients as compared with healthy age and gender matched controls.

VASCULAR ENDOTHELIAL GROWTH FACTOR (VEGF)

It is also known as permeability factor or vasculoprotein. It is a multifunctional angiogenic cytokine important in inflammation and wound healing. This cytokine was found to be a component of whole saliva[11].

INFLAMMATORY CELLS

The number of leukocytes in saliva varies from person to person, and cell counts vary for an individual during the course of the day. The majority of salivary leukocytes enter the oral cavity via the gingival crevice[13].

Klinkhammer et al. (1968) standardized collection and counting of leukocytes in saliva and developed the Orogranulocytic Migratory Rate (OMR). In an experimental gingivitis model, the number of granulocytes in saliva increased before the appearance of clinical gingivitis[14,15]. **Raeste et al. (1978)** studied that OMR was determined with sequentional mouthrinse sampling in periodontitis patients and controls. The results indicated that the OMR reflects the presence of oral inflammation.

SALIVARY IONS

Calcium ion is most intensely studied as a periodontal marker for periodontal disease in saliva. A high concentration of Calcium was correlated with good dental health in young adults, but no relationship was detected with periodontal bone loss as measured from dental radiographs[16]. **Sewon et al. (1990 & 1995)** demonstrated that salivary Calcium and the saliva Calcium to phosphate ratio were higher in periodontitis-affected subjects in comparison to healthy controls. He also examined a higher concentration of Calcium in whole stimulated saliva from the periodontitis patients.

SERUM MARKERS-

CORTISOL

Emotional stress has been established as a risk factor for periodontitis[17,18,19,20]. One mechanism proposed to account for the relationship is that elevated serum cortisol levels associated with emotional stress exert a strong inhibitory effect on the inflammatory process and immune response[21, 22, 23]. Recently, salivary cortisol levels were used

to evaluate the role of emotional stress in periodontal disease. Higher salivary cortisol levels were detected in individuals exhibiting severe periodontitis, a high level of financial strain, and high emotion-focused coping, as compared to individuals with little or no periodontal disease, low financial strain, and low levels of emotion-focused coping[24].

BACTERIA

Microorganisms in dental plaque can survive in saliva, and can utilize salivary components as a substrate. It was shown that saliva could serve as a growth medium for oral *Streptococus* species and *A. viscous*[25].

Asikainen et al. (1991) recovered *actinomycetemcomitans* from subgingival sites, it was also found in 69.9% and 35.9% of the samples of stimulated and unstimulated saliva, respectively.

Umeda et al. (1998) examined the presence of *P. gingivalis, Prevotella intermedia, Prevotella nigrescens* and *T. denticola* in whole saliva and in periodontal pocket samples.

Schaeken et al. (1987) examined the effect of plaque accumulation on the salivary counts of some dental plaque microorganisms in 20 subjects who refrained from oral hygiene for 7 days. The large increase in the number of bacteria on the teeth was reflected by an increase in salivary counts of Actinomyces species. A highly significant correlation was found between S. mutans level in dental plaque and the salivary level of these microorganisms. **Rosenberg et al. (1989)** described a microbial rinse test (Oratest).In this study Oratest was found to be a simple method for estimating oral microbial levels. In a companion study[26], Oratest results were correlated with plaque index and gingival index scores, and the authors stated that this test provides a reliable estimate of gingival inflammation.

VOLATILES

Volatile sulphur compounds, primarily hydrogen sulfide and methylmercaptan, are associated with oral malodor[27, 28]. Salivary volatiles have been suggested as possible diagnostic markers and contributory factors in periodontal disease. Pyridine and picolines were found only in subjects with moderate to severe peroidontitis[29, 30.] Furthermore, saliva seems to be a useful medium to evaluate oral malodor. A significant association between the BANA scores from saliva and oral malodor was found[31].

CONCLUSION

Saliva is a complex fluid which serves many important functions in the oral cavity that also contributes to the quality of life of an individual. Research on saliva has seen a paradigm shift over the years. In the earlier part of the century, attention was focused on studying the quantitative properties of saliva. As newer methods of analysis developed, the focus duly shifted to the analysis of the composition of saliva. In the recent past, efforts have been directed towards better understanding of the potential of saliva as an aid in the diagnosis of several diseases where

presence/absence or a change of one or more of its constituents can act as a marker. Until just recently, dentistry seemed to have had a monopoly on saliva, with some overlap from health professionals dealing with procedures that resulted in decreased or total lack of salivary flow.

Whole saliva samples contains desquamated epithelial cells from oral mucosa can be extracted and used for gene characterization may be utilized for gene mapping for identification of systemic disease polymorphism that will give a further insight into pathophysiology of disease. The combination of identification of disease gene polymorphism and understanding the expression of genes will be an important tool for new therapies not only for salivary glands disease but systemic disease as it is said- *Mouth is a mirror of the systemic diseases.*

REFRENCES

1) Lee Y, Wong DT. Saliva: An emerging biofluid for early detection of disease. Am J Dent. 2009;22:241–8.
2) Polson A. M., Goodson J. M. Periodontal diagnosis-current status and future need. J Periodontol 1985; 56:25–34.
3) Kornman K. S., Crane A., Wang H. Y., Di Giovine., F. S., Newman M. G., Pirk F.W., Wilson T. G. Jr., Higginbottom F.L., Duff, G. W. The interleukin-1 genotype as a severity factor in adult periodontal disease. J Clin Periodontol 1997; 24: 72–77.
4) Chauncey, H. H. Salivary enzymes. J Am Dent Assoc 1961; 63: 361–369.
5) Ingman T., Sorsa T., Konttinen Y. T., Liede K., Saari H., Lindy O., Suomalainen K. Salivary collagenase, elastase and trypsin like proteases as biochemical markers of periodontal tissue destruction in adult and localized juvenile periodontitis. Oral Microbiol Immunol 1993; 8:298–305.
6) Smith A. J., Smith G., Basu M. K., Walsh T. F. Changes in salivary peroxidase activity observed during experimentally-induced gingivitis. J Clin Periodontol 1984; 11, 373–378.
7) Fujimoto Y., Moriya H., Moriwaki, C. Studies on human salivary kallikrein. J Biochem1973;74: 239–246.
8) Marcotte H., Lavoie M.C. Oral microbial ecology and the role of salivary immunoglobulin A. Microbiology and Molecular Biology Reviews 1998;62:71–109.
9) Lamberts B. L., Pederson, E. D., Bial, J. J. & Tombasco, P. K. (1989) Fibronectin levels of unstimulated saliva from naval recruits with and without chronic inflammatory periodontal disease. J Clin Periodontol 16, 342–346.
10) Cutler C. W., Kalmar J. R., Genco C. A. Pathogenic strategies of the oral anaerobe, p.gingivalis. Trends in Microbiology 1995;3: 45–51.
11) Thesleff I., Viinikka L., Saxen L., Lehtonen E., Perheentupa J. The Parotid gland is the main source of human

epidermal growth factor. Life Sciences 1988; 43: 13–18.

12) Taichman N. S., Cruchley A. T., Fletcher L.M., Hagi-Pavli E. P., Paleolog E. M., Abrams W. R., Booth V., Edwards R. M., Malamud D. Vascular endothelial growth factor in normal human salivary glands and saliva: a possible role in the maintenance of mucosal homeostasis. Laboratory Investigation 1998; 78: 869–875.

13) Schiott R C., Loe H. The origin and variation in number of leukocytes in the human saliva. J Periodontal Res 1970;5: 36–41.

14) Friedman L. A., Klinkhammer J. M. Experimental human gingivitis. J Periodontol1971; 42: 702–705.

15) Skougaard M. R., Bay I., Klinkhammer J. M. Correlation between gingivitis and orogranulocyte migratory rate. J Dent Res 1969; 48: 716–718.

16) Sewon L., Makela M. A study of the possible correlation of high salivary calcium levels with periodontal and dental Saliva and periodontal diagnosis 465 conditions in young adults. Arch Oral Bio 1990;35: 211–212.

17) Breivik T., Thrane P. S., Murison R., Gjermo P. Emotional stress effects Non immunity,gingivitis and periodontitis. Eur J Oral Sci 1996; 104: 327–334.

18) Genco R. J.,Current view of risk factors for periodontal diseases. J Periodontol. 1996; 67: 1041–1049.

19) Linden G. J., Mullally B. H., Freeman R. Stress and the progression of periodontal disease. J Clin Periodontol 1996; 23: 675–680.

20) Axtelius B., Soderfeldt B., Nilsson A., Edwardsson S., Attstrom R. Therapy-resistant periodontitis. Psychosocial characteristics. J Clin Periodontol 1998; 62: 482–491.

21) Chrousos G. P.,Gold, P. W. The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. J Amer Med Assc 1992; 267: 1244–1252.

22) Johnson E. O., Kamilaris T. C., Chrousos G. P., Gold P. W. Mechanisms of stress: A dynamic overview of hormonal and behavioral homeostasis. Neuroscience and Biobehavioral Review 1992; 16: 115–130.

23) Fantuzzi G., Ghezzi, P. Glucocorticoids as cytokine inhibitors: role in neuroendocrine control and therapy of inflammatory diseases. Mediators of inflammation 1993; 2: 263–270.

24) Genco R. J., Ho A. W., Kopman J., Grossi S. G., Dunford R. G., Tedesco L. A. Models to evaluate the role of stress in periodontal disease.
Ann Periodontol 1998; 3, 288–302.

25) De Jong M. H., Van der Hoeven J. S., Van Os J. H., Olijve J. H. Growth of oral streptococcus species and actinomyces viscosus in human saliva. Applied and Environmental Microbiology 1984; 47, 901–904.

26) Tal H., Rosenberg M. Estimation of dental plaque levels and gingival inflammation using a simple oral rinse technique. J Periodontol 1990; 61: 339–342.

27) Rosenberg M., McCulloch C. A. G. Measurement of oral malodor: current methods and future prospects. J Periodontol 1992; 63, 776–782.

28) Tonzetich J. Production and origin of oral malodor: A review of mechanisms and methods of analysis. J Periodontol 48:13–20.

29) Kostelc J. G., Preti G., Zelson P. R., Stoller N. H., Tonzetich J. Salivary volatiles as indicators of periodontitis. J Periodontal Res1980; 15: 185–192.

30) Kostelc J. G., Zelson P. R., Preti G., Tonzetich J. Quantitative differences in volatiles from healthy mouths and mouths with periodontitis. Clin Chem 1981; 27: 842–845.

31) Kozlovsky A., Gordon D., Gelernter, I., Loesche W. J., Rosenberg, M. Correlation between the BANA test and oral malodor parameters. J Dent Res 1994; 73: 1036–1042.