Assessment of Salivary Flow Rate in Patients with Chronic Periodontitis

Chitra G. Vallabhan¹, Sujith Sivarajan², Ashwin Devanarayanan Shivkumar³, Vandana Narayanan³, Steffi Vijayakumar¹, RS Indhuja¹

Background: Chronic periodontitis (CP) is an infectious disease, primarily affecting the attachment apparatus of the dentition, and is categorized into mild, moderate, and severe periodontitis on the basis of its severity. It is a well-established and proven fact that an adequate level of saliva is essential for maintaining the integrity of oral tissues including the periodontium. Although various factors, such as stimulation, circadian rhythm, diet, age, and drugs, can affect the salivary flow rate, many recent studies have provided evidence that it can be altered by pathological inflammatory conditions such as periodontal diseases. Therefore, this study has been undertaken to assess the unstimulated and stimulated salivary flow rate in the different clinical stages of chronic periodontitis.

Materials and Methods: This study comprised 60 study participants, who were divided into four groups depending on clinical attachment level (CAL). In all, both unstimulated and stimulated saliva were collected, and the flow rate was expressed in milliliter per minute.

Results: Statistical analysis was accomplished with Statistical Package for the Social Sciences (SPSS) software. One-way analysis of variance (ANOVA) was used to analyze differences in salivary flow rate among the groups. Statistical significance was set at \( P < 0.05 \). The amount of unstimulated saliva in healthy subjects, in mild, moderate, and severe periodontitis was 0.766, 0.400, 0.270, and 0.146 mL/min, respectively. Likewise, the amount of stimulated saliva in healthy subjects, in mild, moderate, and severe periodontitis was 1.017, 0.494, 0.347, and 0.236 mL/min, respectively.

Conclusion: The study identified a significant decrease in both unstimulated and stimulated salivary flow rate with the severity of progression of chronic periodontitis.

Keywords: Chronic periodontitis, inflammation, stimulated saliva, unstimulated saliva

INTRODUCTION

Chronic periodontitis is a chronic inflammatory disease of the oral cavity affecting the supporting structures of the dentition. Microbial challenge in the form of dental plaque and its interaction with host's immune responses are the determining factors of periodontal destruction.[1,2] This destruction based on its severity can be classified as mild periodontitis, when there is no more than 1–2 mm of clinical attachment loss, moderate periodontitis when 3–4 mm of clinical attachment loss has occurred, and severe periodontitis when 5 mm or more of clinical attachment loss has occurred.[3]

It is a well-established and proven fact that an adequate level of saliva is essential for the protection of oral tissues including the periodontium.[4] Saliva, which is more than just water in the mouth, is a primary growth milieu for oral flora and also provides mechanical...
cleansing of the residues such as nonadherent bacteria present in the mouth.\(^9\) Despite the intriguing role played by saliva in the progression of periodontitis by forming conditioning films on all oral surfaces thus contributing to microbial adherence, it also acts as a protective factor. The protective role of saliva is conferred by the vast array of antibacterial factors, antibodies, and buffers present in it, and therefore a reduction in its flow rate can be thought of to affect periodontal health.\(^6\)

Although several studies have focused on the association between salivary flow rate and chronic periodontitis, the results still remain disputable. Some studies showed an increase in salivary flow rate in patients with periodontitis\(^7,8\) However, certain other studies revealed a decrease in salivary flow rate in subjects with periodontitis.\(^9\) On the contrary, studies that revealed no link between salivary flow rate and chronic periodontitis perplexed the situation.\(^10\)

Also, fewer studies have focused on the association of both unstimulated and stimulated salivary flow rate and chronic periodontitis.\(^11\) Although various factors such as stimulation, circadian rhythm, diet, age, and drugs can affect the salivary flow rate, many recent studies have provided evidence that it can be altered by pathological inflammatory conditions such as periodontal diseases.\(^12\) In the light of these observations, this study aimed at assessment of the unstimulated and stimulated salivary flow rate in patients with chronic periodontitis.

**Materials and Methods**

**Study population**

This study was conducted in the outpatient Department of Periodontology, Rajah Muthiah Dental College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India. The study included a total of 60 subjects (28 females and 32 males), aged between 25 and 40 years, and were divided into four groups such as 15 healthy controls, 15 patients with mild periodontitis, 15 patients with moderate periodontitis, and 15 patients with severe periodontitis. Group I was the control group consisting of 15 subjects with clinically healthy gingiva having no clinical attachment loss. Group II consisted of 15 patients with clinical attachment level (CAL) of 1–2 mm were diagnosed with mild chronic periodontitis. Group III included 15 patients with CAL of 3–4 mm were diagnosed with moderate chronic periodontitis, whereas 15 patients with CAL of 5 mm, who were diagnosed with severe chronic periodontitis made up group IV.\(^13\)

The study participants received verbal explanation of the nature of the study, and written consent was obtained. The study was approved by the Medical Ethics Committee of Rajah Muthiah Dental College and Hospital, Tamil Nadu, India.

The exclusion criteria for this study were as follows: (1) patients who have had received any periodontal treatment during their lifetime, (2) patients under any medication at the time of study,\(^14\) (3) smokers—both past and present, (4) pregnant and lactating mothers,\(^15\) (5) females who have attained menopause, and (6) patients with a history of systemic diseases.

**Clinical recordings**

Probing depth (PD) and CAL were measured from the four points of the teeth using a conventional periodontal probe (Hu-Friedy, Chicago, Illinois). The probe was directed parallel to the long axis of the tooth. Probing pocket depth was measured as the distance from the gingival margin to the base of the pocket at six sites in each tooth. The value was measured to the nearest millimeter. All the clinical recordings were carried out by one examiner.

**Collection of saliva**

All the saliva samples were collected between 8.30 to 11.30 am with the study subjects sitting upright in a comfortable position in a calm isolated room. The unstimulated whole saliva was collected by spitting into graduated disposable plastic cups for 5 min, and blood contamination, from inflamed gingival tissue, of the samples was prevented by instructing not to spit forcibly. Subjects spat every 30 s for 5 min. The flow rate was assessed visually from graded plastic cups and expressed in milliliters per minute. To collect stimulated saliva, 2–3 drops of lemon juice were applied to the dorsum of the tongue with a dropper, and samples were spat in graded disposable plastic cups for at least 5 min. The volumes of both unstimulated and stimulated saliva were recorded and expressed in milliliters per minute.

**Statistical analysis**

Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) software. One-way analysis of variance (ANOVA) was used to analyze differences in salivary flow rate among the groups. Statistical significance was set at \(P < 0.05\).

**Results**

The mean (standard deviation) amount of unstimulated saliva in healthy subjects was 0.766 (0.360) mL/min; in mild periodontitis, the amount of unstimulated saliva was 0.400 mL/min with a standard deviation of 0.006. The mean (standard deviation) amount of unstimulated saliva in moderate and severe periodontitis was 0.270
Vallabhan, et al.: Salivary flow rate and chronic periodontitis

The mean (standard deviation) amount of stimulated salivary flow rate in healthy subjects was 1.017 (0.447) mL/min; in mild periodontitis, the amount of stimulated saliva was 0.494 mL/min with a standard deviation of 0.006. The mean (standard deviation) amount of stimulated saliva in moderate and severe periodontitis was 0.347 (0.003) and 0.236 (0.005) mL/min, respectively. Group 1 had maximum mean stimulated salivary flow rate score when compared with Groups 2, 3, and 4, and the difference was statistically significant ($P < 0.05$). Thus, the result of this study showed that the mild, moderate, and severe periodontitis had significantly lesser stimulated salivary flow rate compared to that of healthy subjects. Also, severe periodontitis had significantly lesser stimulated salivary flow rates than mild and moderate periodontitis groups [Table 2 and Graph 2].

**DISCUSSION**

Periodontal disease is an infectious and inflammatory disease of the periodontium associated with biofilms of gram-negative and gram-positive bacteria that manifest clinically as breakdown of the connective tissue (i.e., attachment apparatus surrounding teeth) and destruction of alveolar bone, and is a major cause of tooth mobility and tooth loss worldwide.[2]

Chronic periodontitis leads to a low-grade systemic inflammation and has definite systemic effects such as altered diabetic control, preterm low birth weight, and cardiovascular disease. These systemic effects are mainly due to the systemic spread of oral infection as induced by transient bacteremia and the presence of the elevated levels of pro-inflammatory cytokines released during the inflammatory process.[2,16]

Salivary gland function may be involved due to many systemic diseases and chronic inflammatory conditions with the resultant complication of decreased salivary output.[17] Currently, studies by Bezerra et al.[10] suggested that chronic periodontitis can affect the composition of the saliva (salivary flow rate, total protein, and pH). Also, studies conducted by Sánchez et al.[11] concluded that salivary flow rate is decreased with the severity of periodontal disease.

In this study, both unstimulated and stimulated salivary flow rates were measured. The unstimulated salivary flow rate signifies the amount of saliva that...

**Table 1:** One way analysis of variance test showing mean and standard deviation of unstimulated salivary flow rate (mL/min) in healthy controls, mild, moderate, and severe periodontitis group

| Groups   | N  | Mean   | Standard deviation | P value |
|----------|----|--------|--------------------|---------|
| Healthy  | 15 | 0.766  | 0.360              | 0.001 (Significant) |
| Mild     | 15 | 0.400  | 0.006              |         |
| Moderate | 15 | 0.270  | 0.003              |         |
| Severe   | 15 | 0.146  | 0.003              |         |

**Table 2:** One way analysis of variance test showing mean and standard deviation of stimulated salivary flow rate (mL/min) in healthy controls, mild, moderate, and severe periodontitis group

| Groups   | N  | Mean   | Standard deviation | P value |
|----------|----|--------|--------------------|---------|
| Healthy  | 15 | 1.017  | 0.447              | 0.001 (Significant) |
| Mild     | 15 | 0.494  | 0.006              |         |
| Moderate | 15 | 0.347  | 0.003              |         |
| Severe   | 15 | 0.236  | 0.005              |         |
is constantly secreted into the oral cavity, whereas the stimulated salivary flow rate is a measure of the functional capacity of the salivary gland and a marker of the extent of salivary gland dysfunction.\cite{18,19} Loesche et al.\cite{20} reported that a decreased state of stimulated salivary flow rate resulted in significant increase in anaerobic bacterial level in the oral cavity as that seen during chronic periodontitis.

The association between salivary flow rate and chronic periodontitis has always been debated. Our study showed that the progression of chronic periodontitis was accompanied by a decrease in both unstimulated and stimulated salivary flow rate. This finding is consistent with the studies conducted by Koss et al.,\cite{9} Bezerra et al.,\cite{10} Sánchez et al.\cite{11} On the contrary, the findings of this study is not in accordance with the studies conducted by Sinor and Azirrawani\cite{21} who showed that salivary flow rate is increased in patients with periodontitis.

Periodontitis like other inflammatory conditions might exert a detrimental effect on salivary gland thus causing secretory dysfunction but the mechanisms have not been clearly studied.

The probable mechanisms might be due to increased pro-inflammatory cytokine levels such as interleukin (IL)-2, IL-17, and tumor necrosis factor-β (TNF-β) during periodontitis triggering glandular damage and resultant hyposalivation.\cite{22,23} Furthermore, inflammatory cytokines cause recruitment and activation of hyperresponsive polymorphonuclear neutrophils (PMNs), and thus accelerates the production of reactive oxygen species (ROS).\cite{24} The massive built up of oxidative stress during periodontitis might cause structural changes in salivary gland tissue as that occurs during physiological aging.\cite{25} The significance of our study is that it is one of the few studies that takes into account both unstimulated and stimulated salivary flow rate and its association to the progression of periodontitis. The results of this study implies the fact that periodontitis can exert a detrimental effect on the secretory and functional capacity of salivary gland as evidenced by a decreased unstimulated and stimulated salivary flow rate in patients with chronic periodontitis. Our study also agrees to the fact that a reduced salivary flow rate would be detrimental to the integrity of periodontium.

Limitations of this study were that the periodontal parameters were not correlated with the salivary flow rates. The study also included only a small study population. The study also has not taken into account the cytokines, such as IL-1 and IL-17, or the ROS amount in the saliva and also not correlated it with salivary flow rate. To prove the postulates of this study, rigorous studies on the role of cytokines and ROS in causing salivary gland dysfunction, involving larger study population, and also their correlation with periodontal parameters has to be carried out.

**CONCLUSION**

The results of this study showed that there is a significant decrease in both unstimulated and stimulated salivary flow rate with the progression of chronic periodontitis. This may be attributable to the detrimental effects of inflammatory mediators and free radicals, released in the course of chronic periodontitis, on salivary glandular tissue. However, further studies with better sample size are needed to validate this proposition.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Giannobile WV, Beikler T, Kinney JS, Ramseier CA, Morelli T, Wong DT. Saliva as a diagnostic tool for periodontal disease: current state and future directions. Periodontol 2000 2009;50:52-64.
2. Arigbede AO, Babatope BO, Bamidele MK. Periodontitis and systemic diseases: a literature review. J Indian Soc Periodontol 2012;16:487-91.
3. Wiebe CB, Putnins EE. The periodontal disease classification system of the American Academy of Periodontology—an update. J Can Dent Assoc 2000;66:594-7.
4. Llena-Puy C. The rôle of saliva in maintaining oral health and as an aid to diagnosis. Med Oral Patol Oral Cir Bucal 2006;11:E449-55.
5. Scannapieco FA. Saliva-bacterium interactions in oral microbial ecology. Crit Rev Oral Biol Med 1994;5:203-48.
6. Takeuchi K, Furuta M, Takeshita T, Shibata Y, Shimazaki Y, Akifusa S, et al. Risk factors for reduced salivary flow rate in...
Vallabhan, et al.: Salivary flow rate and chronic periodontitis

7. Fiyaz M, Ramesh A, Ramalingam K, Thomas B, Shetty S, Prakash P. Association of salivary calcium, phosphate, pH and flow rate on oral health: a study on 90 subjects. J Indian Soc Periodontol 2013;17:454-60.

8. Masoumi S, Setoudehmaram S, Golkari A, Tavana Z. Comparison of pH and flow rate of saliva after using black tea, green tea and coffee in periodontal patients and normal group. J Dent School 2016;34:235-43.

9. Koss MA, Castro CE, Salúm KM, López ME. Changes in saliva protein composition in patients with periodontal disease. Acta Odontol Latinoam 2009;22:105-12.

10. Bezerra AA, Pallos D, Cortelli JR, Saraceni CH, Queiroz C. Evaluation of organic and inorganic compounds in saliva of patients with chronic periodontal disease. Rev Odonto Cienc 2010;25:234-8.

11. Sánchez GA, Miozza V, Delgado A, Busch L. Determination of salivary levels of mucin and amylase in chronic periodontitis patients. J Periodontal Res 2011;46:221-7.

12. Humphrey SP, Williamson RT. A review of saliva: normal composition, flow, and function. J Prosthet Dent 2001;85:162-9.

13. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol 1999;4:1-6.

14. Navazesh M, Brightman VJ, Pogoda JM. Relationship of medical status, medications, and salivary flow rates in adults of different ages. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;81:172-6.

15. Karnik AA, Pagare SS, Krishnamurthy V, Vahanwala SP, Waghmare M. Determination of salivary flow rate, pH, and dental caries during pregnancy: a study. J Indian Acad Oral Med Radiol [serial online] 2015:27:372-6.

16. Moutsopoulos NM, Madianos PN. Low-grade inflammation in chronic infectious diseases: paradigm of periodontal infections. Ann N Y Acad Sci 2006;1088:251-64.

17. Mortazavi H, Baharvand M, Movahedian A, Mohammadi M, Khodadoust A. Xerostomia due to systemic disease: a review of 20 conditions and mechanisms. Ann Med Health Sci Res 2014;4:503-10.

18. Dodds MW, Johnson DA, Yeh CK. Health benefits of saliva: a review. J Dent 2005;33:223-33.

19. Valdez IH, Fox PC. Diagnosis and management of salivary dysfunction. Crit Rev Oral Biol Med 1993;4:271-7.

20. Loesche WJ, Bromberg J, Terpenning MS, Bretz WA, Domínguez BL, Grossman NS, et al. Xerostomia, xerogenic medications and food avoidances in selected geriatric groups. J Am Geriatr Soc 1995;43:401-7.

21. Sinor MZ, Ariffin A. Association between salivary parameters and periodontal disease. Int Med J 2013;20:605-9.

22. Chitrapiya MN, Rao SR, Lavu V. Interleukin-17 and -18 levels in different stages of inflammatory periodontal disease. J Indian Soc Periodontol 2015;19:14-7.

23. Bhattarai KR, Junjappa R, Handigund M, Kim HR, Chae HJ. The imprint of salivary secretion in autoimmune disorders and related pathological conditions. Autoimmun Rev 2018;17:376-90.

24. Dahiya P, Kamal R, Gupta R, Bhardwaj R, Chaudhary K, Kaur S. Reactive oxygen species in periodontitis. J Indian Soc Periodontol 2013;17:411-6.

25. Yamauchi Y, Matsuno T, Omata K, Satoh T. Relationship between hyposalivation and oxidative stress in aging mice. J Clin Biochem Nutr 2017;61:40-6.