CIENCIA E INNOVACIÓN EN SALUD

Salivary pH as an improvement parameter in patients with periodontitis: A pilot study

El pH salival como parámetro de mejora en pacientes con periodontitis: Un estudio piloto

Jennifer Orozco Páez[1], **Leonora Contreras de la Rosa**[1] **y Josefyn López Banda**[1]

[1] Corporación Universitaria Rafael Núñez; Cartagena, Colombia

*** Dirigir correspondencia a:** jennifer.orozco@curnvirtual.edu.co

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ABSTRACT

Background: the pH is a chemical parameter of saliva widely studied at present, its normal range is between 6.5 and 7.2. Its alteration has been linked to different oral pathologies, such as periodontal diseases. The purpose of this study was to identify the usefulness of salivary pH measurement as an indicator of improvement in patients with periodontitis and to estimate its possible relationship with the biofilm index and the number of periodontal pockets. **Methods:** A descriptive-comparative pilot study was conducted on forty adult patients; one group was conformed by twenty patients with gingivitis and the second one by twenty patients with chronic periodontitis. In both groups was determined the biofilm index, was performed periodontal probing and a salivary sample was taken for salivary pH measurement, before and after periodontal treatment. **Results:** the results showed that of 20 periodontitis patients evaluated, 6 (30%) had an initial alkaline pH greater than 7,6 and a moderate positive relationship with the biofilm index was observed (r=0.5277). After treatment, 15(75%) periodontitis patients and 14 (70%) gingivitis patients presented a decrease in this parameter. **Conclusions:** there is a variation in the salivary pH after periodontal treatment tending to its restoration, this probably occurs in response to periodontal tissue repair, therefore, pH is a salivary parameter that has potential for monitoring patients with periodontal disease.

Keywords: Periodontal Diseases; Periodontitis; Hydrogen-Ion Concentration; Saliva

RESUMEN

Introducción: el pH es un parámetro químico de la saliva ampliamente estudiado en la actualidad, su rango normal se encuentra entre 6.5 y 7.2. Su alteración se ha relacionado con diferentes patologías bucales, como las enfermedades periodontales. El propósito de este estudio fue identificar la utilidad de la medición del pH salival como indicador de mejoría en pacientes con periodontitis y estimar su posible relación con el índice de biofilm y el número de bolsas periodontales. **Métodos:** se realizó un estudio piloto descriptivo-comparativo en cuarenta pacientes adultos; un grupo estuvo conformado por veinte pacientes con gingivitis y el segundo por veinte pacientes con periodontitis crónica. En ambos grupos se determinó el índice de biofilm, se realizó sondaje periodontal y se tomó una muestra de saliva para la medición del pH salival, antes y después del tratamiento periodontal. **Resultados:** los resultados mostraron que de 20 pacientes con periodontitis evaluados, 6 (30%) tenían un pH alcalino inicial mayor a 7,6 y se observó una relación positiva moderada con el índice de biofilm (r = 0,5277). Después del tratamiento, 15 (75%) pacientes con periodontitis y 14 (70%) pacientes con gingivitis presentaron una disminución de este parámetro. **Conclusiones:** existe una variación en el pH salival posterior al tratamiento periodontal tendiente a su restauración, esto probablemente ocurre en respuesta a la reparación del tejido periodontal, por lo tanto, el pH es un parámetro salival que tiene potencial para el seguimiento de pacientes con enfermedad periodontal.

Palabras clave: Enfermedades periodontales, Periodontitis, Concentración de iones de hidrogeno; Saliva

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I. INTRODUCTION

Periodontal disease (PD) comprises a set of diseases that affect the periodontium; these are diverse, but gingivitis and periodontitis are the ones that most frequently affect the adult population and which the dentist faces in his routine consultation. Specifically, periodontitis presents as an inflammation that affect the supporting tissues of the tooth, causing the destruction of the gingival connective tissue and alveolar bone, resulting in the formation of periodontal pockets. Due to its high prevalence, it has become a topic of public health interest worldwide (1, 2).

Due to this negative impact that PD has generated on the oral health of different populations, this pathology has been studied for many years. This has allowed that at present, the diagnosis and evolution of PD is not only based on clinical and radiographic methods, but also it has become in an open space for the assessment of countless biochemical markers, such as, proteins, enzymes, immunity and inflammatory mediators that reflect the periodontal state of the patient, before and after being subjected to periodontal therapy (4-6). In the case of periodontitis, where the destruction of periodontal tissues is progressive, it has been possible to establish relationships between the patient's periodontal condition and variations of salivary parameters (7-9).

In addition to the markers, a biochemical indicator that is related to the pathophysiology of PD is salivary pH; this parameter is defined as the degree of acidity or alkalinity of an aqueous solution. Since during the periodontal disease the patient experiences changes in the periodontium, such as inflammation, bleeding, bone loss among others, it is feasible to believe this pathology modifies the properties of saliva including its pH (10-12). Thanks to the complex composition and multitude of organic components present in saliva, this is a powerful tool for the diagnosis and monitoring of oral diseases; dental caries, Periodontal diseases, oral cancer, Sjögren's syndrome, are some examples (13). Regarding its buffer function, it is responsible for maintaining a neutral pH (6.5 to 7.2) in oral cavity, however, the salivary pH has been found modified under pathological conditions (14-16).

From these considerations, a hypothesis arises, the salivary pH is altered in patients with periodontitis and returns to its normal ranges after periodontal treatment. In this way, the measurement of salivary pH can helps as a complementary parameter for the diagnosis and periodontal health monitoring in patients with periodontal disease.

The aim of this investigation was to identify the usefulness of salivary pH measurement as an indicator of improvement in patients with periodontitis and to estimate its possible relationship with the biofilm index and the number of periodontal pockets.

II. METHODS

2.1. Design, population and sample: a comparative - descriptive pilot study was designed. The study population corresponded to patients who attended the dental clinic of Corporación Universitaria Rafael Núñez, Cartagena, Colombia. Forty systematically healthy patients were selected by convenience sampling taking into the inclusion criteria and were divided into two groups as follows:

-Group A: Comprised of twenty chronic periodontitis subjects with periodontal pockets ≥4 mm, presence of biofilm, bleeding or not from periodontal probing, with loss of clinical insertion from 1mm periodontitis (Classification of Periodontal Conditions and Diseases 1999) and indication for non-surgical periodontal therapy.

-Group B: comprised of twenty gingivitis subjects with presence of bleeding on probing associated with biofilm, with absence of peridontal pocket and absence of loss of clinical insertion (Classification of Periodontal Conditions and Diseases 1999) (17).

To avoid the entry of sample units that alter the study results, were excluded smoking patients, patients in pharmacological treatments, with dental abscesses or other type of oral pathology and patients with salivary flow disorders or pathology in salivary glands. For data collection, the following methodological steps were developed.

2.2. Clinical history record: Before writing the medical history, the purpose of the study were explained verbally to each patient, the patient confirmed their voluntary participation in the study by signing an informed consent. Subsequently, two previously calibrated examiners performed anamnesis, clinical stomatological examination, evaluation of the biofilm index according to O'Leary, periodontal probing with a North Carolina periodontal probe and the periodontogram in which the presence of periodontal pockets, the level of clinical insertion and the presence of bleeding were recorded. The patients were classified according to their periodontal diagnosis based on the Classification of Periodontal Conditions and Diseases of 1999, as explained above.

2.3. Sampling of saliva: Samples were taken at two different times, as follows:

Sample # 1: first date

Sample # 2: thirty days after periodontal treatment

The sample of unstimulated saliva was collected in a labeled clean tube. The recommendations given to the patient for sampling were:

- do not ingest liquid or solid food at least two hours before the procedure,
- do not brush your teeth at least 3 hours before taking the sample and
- not having consumed medications in the days prior to taking the sample.

Before donating the sample, each patient signed an informed consent for sampling, through which they voluntarily gave in and authorized the study investigators to process and obtain results from their saliva samples.

2.4. Salivary pH measurement: Once the sample was obtained, the salivary pH was immediately measured using a portable digital pH meter (Ref. 315i WTW brand). In this process, the calibration of the equipment was started following the recommendations of the manual, then the electrode was submerged in the depth of the sample, the quantitative pH data was recorded in a data record table.

After the first sampling, each patient was treated by his own operator, receiving supervision from a periodontist during the process. The treatment carried out consisted of non-surgical periodontal therapy, which included teaching in oral health, scaling and root planning (two dates) in patients with periodontitis or prophylaxis in gingivitis patients. Thirty days after the

periodontal treatment, patients were again cited for the second sampling and the second biofilm index measurement and periodontal probing.

Table 1. Comparison of salivary pH before and after periodontal therapy in each study group and intergroup comparison.

		Gingivitis patients (n=20)		Periodontitis patients (n=20)		p-value
		(Mean±SD)	95% CI	(Mean±SD)	95% CI	
Salivary pH	Before treatment	7.01 ± 0.25	6.89 - 7.13	7.42 ± 0.23	7.31 - 7.53	0.000*
	After treatment	6.93 ± 0.12	6.87 - 6.99	7.25 ± 0.23	7.14 - 7.36	0.000*
p-value		0.1027**		0.0012**		

*Independent Samples t-test, (p<0.05 – Statistically Significant)
** Related samples t-test (p<0.05 – Statistically Significant)

2.5. Analysis and interpretation of data: the data were tabulated in an Excel® 2016 table, then the data were exported to statistical software SPSS version 2.0 (IBM Corp. IBM SPSS statistics for Windows version 2.0, Armonk, NY, USA) for statistical analysis. First, a descriptive analysis was performed in which measures of central tendency and dispersion (mean ± standard deviation) were calculated for the quantitative variables. To perform intragroup comparisons (before and after treatment) a Student t-test for related samples was applied. For intergroup comparisons a Student t-test for independent samples was applied, assuming significance when p <0.05. The Pearson correlation coefficient was used to relate the salivary pH to biofilm index and number of periodontal pockets.

2.6. Ethical aspects: The study complied with the ethical aspects and international recommendations of the Declaration of Helsinki of the World Medical Association and of the health research norms of the Ministry of Health of Colombia. According to resolution 008430 of 1993 of Ministry of Health of Colombia, this is an investigation with minimal risk (chapter 1, item 11, subsection b).

III. RESULTADOS

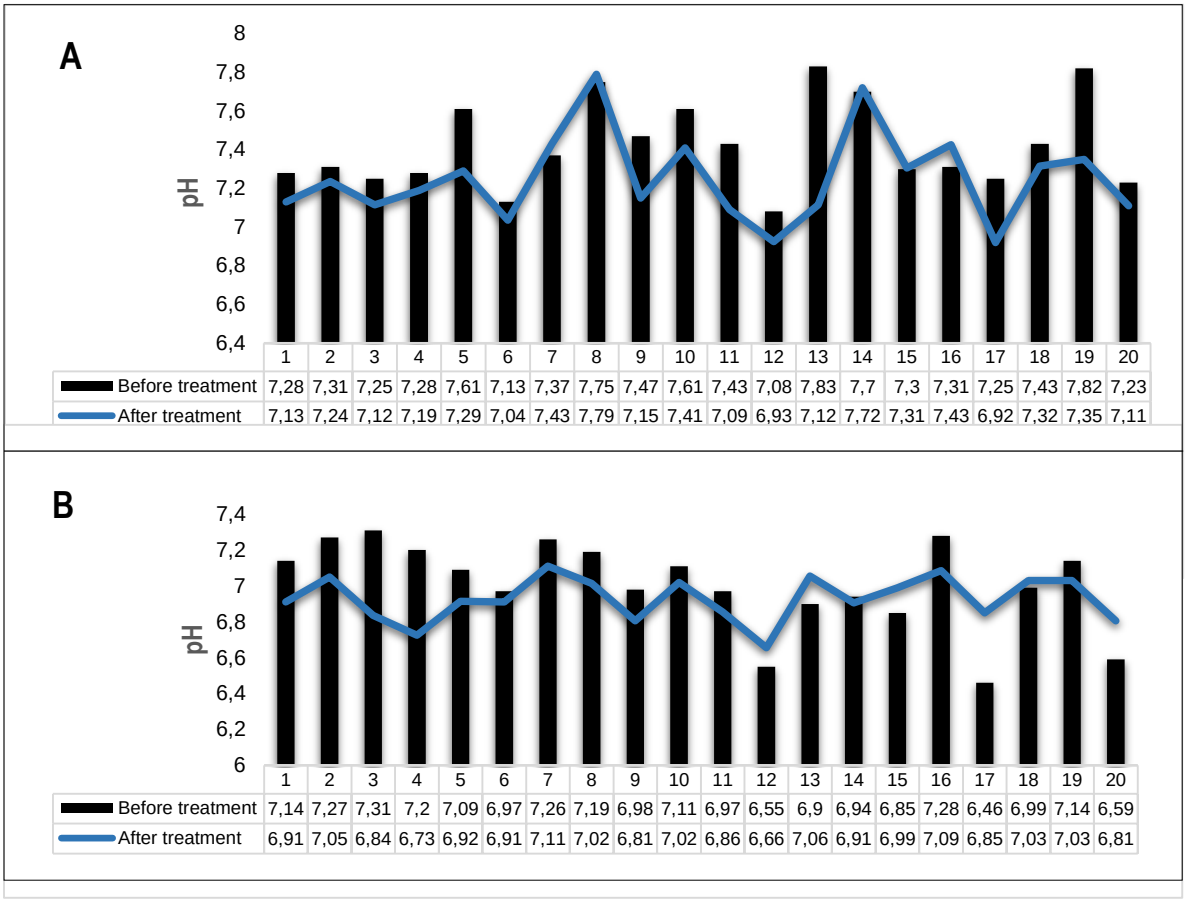
From the forty patients who participated in the study, 30% were male and 70% female. Regarding age, 40% of the population was in an age range greater than 35 years.

3.1. Salivary pH measurement

The group A, presented an initial average pH of 7.42 ± 0.23, which decreased to 7.25 ± 0.23 after periodontal treatment. When comparing the means, a statistically significant difference was found (p = 0.0012) (Table 1). Regarding the individual behavior of salivary pH in each patient, it

was observed that of the 20 patients evaluated in this group, 6 (30%) had an initial pH greater than 7.6 and after treatment 15 (75%) experienced decrease (**Figure 1, A**).

Figure 1. Individual behavior of salivary pH before and after periodontal therapy. Periodontitis patients (A), Gingivitis patients (B).



In the group B, the average initial salivary pH was 7.01 ± 0.25, after the treatment was reduced to 6.93 ± 0.12, no statistically significant difference was found between the two moments (p = 0.1027) (Table 1). Of the 20 patients evaluated in this group, 14 (70%) experienced a decrease in salivary pH, after receiving therapy, while 6 (30%) experienced an increase (Figure 1, B), despite this, the salivary pH of this group always stayed within the normal range. When comparing salivary pH between the two study groups, the values for periodontitis patients were higher compared to the salivary pH of patients with gingivitis at the two times evaluated, this difference was statistically significant (p = 0.000) (**Table 1**).

3.2. Biofilm Index Measurement

Before treatment, group A patients had an average biofilm index of 65.80% ± 14.05 which after treatment was reduced to 50.25% ± 14.55. On the other hand, the group B had an average index of 68.25% ± 17.18 before treatment and was reduced to 39.25% ± 13.80 after being treated (**Table 2**).

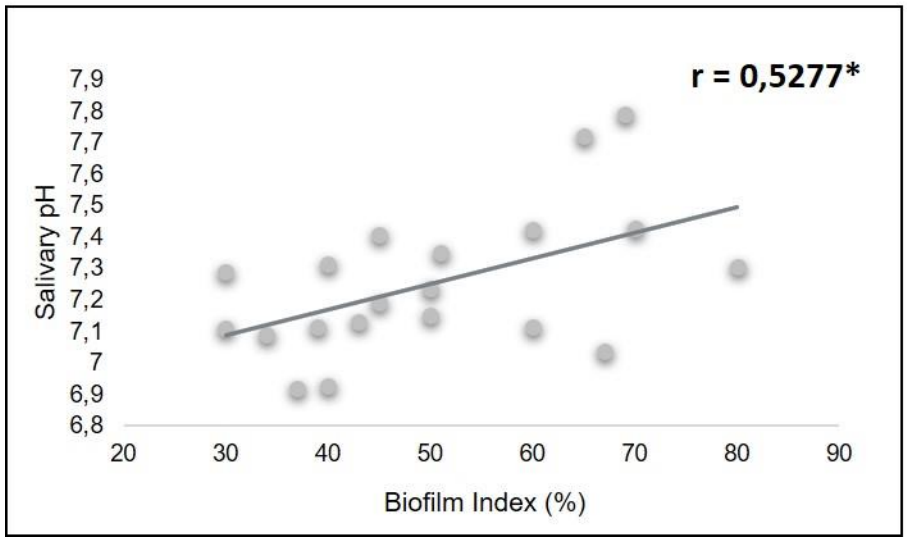
Table 2. Intragroup and intergroup comparison of biofilm index mean and intragroup comparison of number of periodontal pockets mean.

Study group	O'Leary Index (mean ± SD)			N° periodontal Pockets (mean ± SD)		
	Before treatment	After treatment	p-value*	Before treatment	After treatment	p-value*
Gingivitis (n=20)	68.25 ± 17.18	29.25 ± 13.80	0.000	—	—	—
Periodontitis (n=20)	65.8 ± 14.05	50.25 ± 14.54	0.001	5.3 ± 2.28	4.3 ± 2.11	0.000
p-value**	0.695	0,046	—	—	—	—

***** Wilcoxon test ** Mann-Whitney test (p<0.05 – Statistically Significant)

In order to determine if there is a relationship between the biofilm index and salivary pH, the Pearson correlation test was applied. For none of the two groups there was a correlation between these variables before treatment. In contrast, the post-treatment analysis showed a moderate positive correlation (Pearson r=0.5277) between these two variables in patients with periodontitis (**Figure 2**).

Figure 2. Correlation between salivary pH and biofilm index of patients with periodontitis after periodontal treatment. *Pearson correlation coefficient.



3.3. Determination of periodontal pockets

An average of 5.3 pockets per patient was found in the periodontitis group. In 16 (75%) of them, periodontal pockets disappeared after therapy (Table 2). Because this result was an indicator

of improvement, the number of pockets was related to salivary pH at two times, a direct relationship was observed before (r=0.29) and after (r=0.27), the level of relationship was low, however, it lets us know that the variables are not independent, but the number of pockets may be related to the participant's salivary pH.

IV. DISCUSSION

Within its protective role, saliva is responsible for creating the appropriate oral conditions for the maintenance of the environmental balance, one of its mechanisms is maintaining the neutral oral pH through the bicarbonate and phosphate buffer system (18). The salivary pH has been studied due to its possible contribution to monitor or as a complement in the diagnosis of different oral diseases (19).

The results of this research show that salivary pH is maintained within a neutral range in healthy patients/mild gingivitis, while in patients with periodontitis tends to alkalinity maintaining an average pH of 7.42 ± 0.23, of this average, 30% of patients had a salivary pH higher than 7.6 before treatment and 75% experienced a decrease after periodontal therapy. Authors like García S, et al (2008) (20) reported similar results, a salivary pH of 6.9 in healthy patients, while patients with gingivitis and periodontitis had average values of 7.3 and 7.9 respectively. After treatment, from 60 patients treated, 40 responded satisfactorily, observing a considerable reduction in salivary pH. Likewise, these authors reported salivary pH increases as the percentage of affected teeth increases. In this study, a low direct correlation was observed between salivary pH and the number of periodontal pockets before and after treatment, these results suggest that salivary pH is made alkaline as the severity of periodontal disease increases.

Baliga S, et al (2013) (8), report an average salivary pH of 6.85 ± 0.11 in patients with periodontitis, disagreeing with this study that showed a pH with an alkalinity tendency for these patients. These authors expose that a salivary pH above 7.0 generally indicates alkalinity, excessive alkalinity can cause anaerobic conditions, in this case the biofilm take calcium compounds from the oral environment and use minerals to protect themselves from high pH. A high pH above 7.6 promotes the formation of crystals of the biofilm that favors the development of periodontal disease, while a low pH promotes demineralization of the tooth structure and favors the growth and metabolism of acidogenic and acid-tolerating bacteria, whilst at the same time inhibiting many of the beneficial resident species (21).

Although the salivary pH range presented by patients with periodontitis in this study was not at extreme alkalinity values, this could be explained because the participants' periodontal disease was not severe, however, the patients presented high biofilm rates. The fact that salivary pH decreased after periodontal therapy, trying to restore itself, reflects the role of the biofilm in the variation of the pH and especially considering that a moderate direct correlation was found between pH and the biofilm index in patients with periodontitis after treatment.

In a similar study, Patel RM et al (2016) (11) report that patients with chronic generalized periodontitis with periodontal pockets larger than 4 mm and with loss of clinical insertion have oral hygiene rates, gingival index and plaque index significantly higher than those found in periodontally healthy patients with gingivitis. Likewise, they report an average salivary pH of 11.65 ± 2.26, extremely alkaline for this group of patients. Therefore, they suggested that as

the severity of periodontitis increases, the values of oral health indices also gradually increase and salivary parameters are altered, including salivary calcium, phosphorus, alkaline phosphatase and pH.

Regarding to the number of periodontal pockets, a significant improvement was observed after periodontal therapy when a decrease in the number was found. Taking into account that salivary pH was restored in patients with a decrease in the number of pockets, finding a positive direct relationship, although low, it is possible to consider salivary pH as a possible indicator of improvement in patients undergoing treatment. However, it must be confirmed with new studies with a larger sample size and a more extensive follow-up in time.

The main limitation of this study was the small sample size, however, from the results, pertinent conclusions were derived that allowed observing the behavior and relationship of salivary pH with clinical oral health indices that give rise to the formulation of new ideas research.

V. CONCLUSIONS

The salivary pH of patients with periodontitis is slightly alkaline and varies after periodontal therapy tending to restore to normal levels, this probably occurs in response to periodontal tissue repair, likewise, the pH varies keeping a direct relationship with the biofilm index and with the number of periodontal pockets. Taking these results into account, it is possible to consider that pH is a salivary parameter that has potential for monitoring patients with periodontal disease.

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REFERENCES

1. Caton JG, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Periodontol. 2018;89 Suppl 1:S1-S8. DOI:10.1002/JPER.18-0157
2. Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. Int J Health Sci (Qassim). 2017;11(2):72-80. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426403/
3. Ministerio de Salud y Protección Social MINSALUD. IV Estudio Nacional De Salud Bucal - ENSAB IV. "Para Saber Cómo Estamos y Saber que Hacemos." Colombia. 2014. pp 77-84.
4. Zhang L, Li X, Yan H, Huang L. Salivary matrix metalloproteinase (MMP)-8 as a biomarker for periodontitis: A PRISMA-compliant systematic review and meta-analysis. Medicine (Baltimore). 2018;97(3):e9642. DOI: 10.1097/MD.0000000000009642

5. Korte DL, Kinney J. Personalized medicine: an update of salivary biomarkers for periodontal diseases. Periodontol 2000. 2016;70(1):26-37. DOI: 10.1111/prd.12103
6. Podzimek S, Vondrackova L, Duskova J, Janatova T, Broukal Z. Salivary Markers for Periodontal and General Diseases. Dis Markers. 2016. DOI: 10.1155/2016/9179632
7. Prasad M, Toshi, Sehgal R, Mallik M, Tabinda A, Sneha Singh. Periodontal disease and salivary pH: Case control study. IAIM, 2019; 6(2): 1-6. https://iaimjournal.com/wp-content/uploads/2019/02/iaim_2019_0602_01.pdf
8. Baliga S, Muglikar S, Kale R. Salivary pH: A diagnostic biomarker. J Indian Soc Periodontol. 2013;17(4):461-5. DOI: 10.4103/0972-124X.118317
9. Shazam H, Shaikh F, Hussain Z. Bone Turnover Markers in Chronic Periodontitis: A Literature Review. Cureus. 2020; 12(1): e6699. DOI: 10.7759/cureus.6699
10. Cormos G. The contribution of salivary pH in periodontal health assessment. Rev Chim. 2016;67(9):1697-1700. https://pdfs.semanticscholar.org/a19d/019bb1f73ced20a170eecca97d6231d161da.pdf
11. Patel RM, Varma S, Suragimath G, Zope S. Estimation and comparison of salivary calcium, phosphorous, alkaline phosphatase and pH levels in periodontal health and disease: A cross-sectional biochemical study. J Clin Diagnostic Res. 2016;10(7):ZC58–61. DOI: 10.7860/JCDR/2016/20973.8182
12. Seethalakshmi C, Reddy RC, Asifa N, Prabhu S. Correlation of Salivary pH, Incidence of Dental Caries and Periodontal Status in Diabetes Mellitus Patients: A Cross-sectional Study. J Clin Diagn Res. 2016 Mar;10(3):ZC12-4. DOI: 10.7860/JCDR/2016/16310.7351
13. Martina E, Campanati A, Diotallevi F, Offidani A. Saliva and Oral Diseases. J Clin Med. 2020;9(2). pii: E466. DOI: 10.3390/jcm9020466
14. Foglio-Bonda PL, Brilli K, Pattarino F, Foglio-Bonda A. Salivary flow rate and pH in patients with oral pathologies. Eur Rev Med Pharmacol Sci. 2017 Jan;21(2):369-374. http://www.europeanreview.org/wp/wp-content/uploads/369-374-Salivary-flow-rate-and-pH-in-patients-with-oral-pathologies.pdf
15. Pandey P, Reddy NV, Rao VA, Saxena A, Chaudhary CP. Estimation of salivary flow rate, pH, buffer capacity, calcium, total protein content and total antioxidant capacity in relation to dental caries severity, age and gender. Contemp Clin Dent. 2015;6(Suppl 1):S65-71. DOI: 10.4103/0976-237X.152943.
16. 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(4):454-60. DOI: 10.4103/0972-124X.118316
17. Armitage GC. Periodontal diagnoses and classification of periodontal diseases. Periodontol 2000. 2004;34:9-21. DOI:10.1046/j.0906-6713.2002.003421.x
18. Dawes C, et al. The functions of human saliva: A review sponsored by the World Workshop on Oral Medicine VI. Arch Oral Biol. 2015;60(6):863-74. DOI: 10.1016/j.archoralbio.2015.03.004
19. Dawes C, Wong DT. Role of saliva and salivary diagnostics in the advancement of oral health. J Dent Res. 2019;98(2):133-41. DOI: 10.1177/0022034518816961
20. García S, Bravo F, Ayala J, Bardales G. pH en saliva total en pacientes con enfermedad periodontal del Servicio de Periodoncia de la Facultad de Odontología de la UNMSM. Odontol. Sanmarquina 2008; 11(1): 19-21. https://revistasinvestigacion.unmsm.edu.pe/index.php/odont/article/view/3079.
21. Marsh PD, Do T, Beighton D, Devine DA. Influence of saliva on the oral microbiota. Periodontol 2000. 2016;70(1):80-92. DOI: 10.1111/prd.12098