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Research Article

Evaluating Salivary Alkaline Phosphatase Levels as a Biochemical Marker of Periodontal Disease in Periodontal Patients in a Tertiary Hospital in Nigeria

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Abstract

Background and aims. Traditional methods of diagnosing periodontal diseases have their limitations, which include inability to provide information about the recent activity of the disease and difficulty in diagnosing the disease at an early stage when clinical changes have not started. This has necessitated the use of biomarkers designed to overcome these short-comings.

Materials and methods. A cross-sectional investigation was conducted among three groups of 27 participants each to assess the level of salivary alkaline phosphatase (SALP). The groups consisted of a control group (healthy) and two test groups (gingivitis and periodontitis). Saliva samples were collected and spectrophotometric analyses were carried out.

Results. The highest mean SALP level (87.78 U/L) was found in group III, followed by group II (73.56 U/L), with group I exhibiting the least (38.89 U/L). The differences in the mean SALP between groups I and II, II and III, and I and III were statistically significant. Correlation between periodontal pockets depth and mean SALP was significant in group III.

Conclusion. Variations in mean SALP levels among subjects with different periodontal conditions showed that mean SALP can differentiate various degrees of periodontal conditions and therefore has the potential to be used as a biochemical marker for periodontal disease.

Key words: **Alkaline phosphatase, chronic periodontitis, gingivitis, periodontal health, saliva.**

Introduction

Periodontal disease has been reported to be highly prevalent throughout the world, with the prevalence of gingivitis approaching 100% in some studies.1-5 Eke et al reported that over 47% of adult Americans aged 30 years and older, which translates to about 64.7 million Americans, had mild, moderate

or severe forms of periodontitis. The disease has been described as one of the most prevalent non-communicable diseases similar to cardiovascular disease and diabetes mellitus, and it is more prevalent among ethnic minorities.2,5 People of African origin tend to have higher prevalence of periodontal diseases than the Caucasians, irrespective of their socio-economic status.4,6

A bidirectional relationship has been reported between periodontal disease and systemic conditions such as uncontrolled diabetes mellitus, pregnancy and pregnancy outcome.7-11 Due to this relationship, periodontal disease has been considered to be the sixth complication of diabetes mellitus, which underscores the importance of the disease to systemic health.12 Apart from the possible effects on the systemic health, periodontal disease, whether the chronic or the aggressive form, also has negative psychosocial consequences on the lives of many individuals. Such effects include depression, mood changes and avoidance due to the unacceptable state of the affected teeth and loss of many teeth as a result of the disease.13,14 This disease poses both health and psychosocial risks to human beings. Therefore, it is necessary to accurately diagnose the disease early enough for prompt management, which will prevent many of the possible consequences.

Traditional methods of diagnosing periodontal disease are based on the identification of clinical signs of inflammation, which are usually a result of tissue destruction. This may lead to a delay in the diagnosis of the disease, which has led to searching for better alternatives. One of the evolved methods is the use of molecular biomarkers that will reveal a hidden lethal threat to the periodontium before the disease becomes complicated.15,16 Alkaline phosphatase (ALP), a phosphor-hydrolytic enzyme, which plays a role in bone metabolism and expressed during inflammation, is an example of such biologic molecules studied as a potential marker for periodontal disease.17-19 Therefore, this study was carried out to assess the level of ALP in health in comparison with that in gingivitis and chronic periodontitis to ascertain the possibility of its usefulness as a biomarker in the diagnosis of periodontal diseases.

Materials and Methods

This study was conducted on 81 patients attending the Periodontology Clinic of the University College Hospital, Ibadan, Nigeria. The subjects were allocated to three equal groups, consisting of a control group (group I) and two test groups (groups II and III). Group I consisted of subjects with clinically healthy periodontium (no mucosal ulceration, absence of any probing pocket depth that exceeded 3 mm, no bleeding on gentle probing and no clinical attachment loss). Group II consisted of subjects with gingivitis (presence of gingival bleeding on probing, no probing pocket depth that exceeded 3 mm, and no clinical attachment loss). Group III consisted of subjects with chronic periodontitis having at least a pocket that was deeper than 4 mm, or clinical attachment loss of $\geq$ 1 mm, and/or radiographic evidence of bone loss.

Sample Collection

Sterile sample bottles were coded according to the grouping of the participants. Three milliliter (3 mL) of un-stimulated whole saliva pooled in the floor of the mouth was collected using a micropipette into the sterile bottles, which were immediately placed in an ice bag and transported to the laboratory for determination of its ALP level. In the laboratory, the samples were stored in a refrigerator at a temperature of -20°C and spectrophotometric analyses were carried out within five days of collection.20,21

Exclusion criteria

Pregnant, lactating, menstruating and post-menopausal women were excluded from the study. Furthermore, active smokers, those with systemic diseases necessitating the use of prophylactic antibiotic before periodontal examination, those that had used an antimicrobial agent or anti-inflammatory drugs within the last three months and those with history of xerostomia were excluded. The study was approved by the joint UI/UCH Ethics Review Committee before commencement.

Statistical Analyses

Data was entered into a personal computer and analyzed using a commercial statistical software program. Mean ± SD were calculated for each variable. One-way ANOVA was used to evaluate the differences between the groups. The correlation between salivary ALP and clinical parameters were calculated using Pearson's test. Statistical significance was considered at $P < 0.05$.

Results

Eighty-one subjects were recruited for the study and were grouped into three equal groups of 27 subjects per group. Each group consisted of 13 (48.1%) males and 14 (51.9%) females. Subjects with a healthy periodontium constituted the youngest among the participants with a mean age of 31.2 ± 4.6 years and

Table 1. Age distribution of the subjects

Age group (Years)	Group I (%)	Group II (%)	Group III (%)	Total (%)
< 30	14 (51.9)	10 (37.0)	7 (25.9)	31 (38.3)
31–40	12 (44.4)	14 (51.9)	8 (29.7)	34 (42.0)
> 41	1 (3.7)	3 (11.1)	12 (44.4)	16 (19.7)
Total (%)	27 (100)	27 (100)	27 (100)	81 (100)
Mean Age ± SD	31.2 (4.6)	32.6 (4.8)	37.9 (8.3)	

those in group III, with chronic periodontitis, were the oldest with a mean age of 37.9 ± 8.3 years (Table 1). The subjects in group I had the least mean gingival index of 0.44 ± 0.76 mm, while in group III they had the highest with a mean of 1.78 ± 0.41 mm. Probing pocket depth was the deepest among those in the chronic periodontitis group (III), with a mean of 3.46 ± 0.79 mm, while the subjects with healthy periodontium had the least pockets (Table 2).

Salivary alkaline phosphatase levels of subjects in group I ranged from 30 to 52 U/L with a mean of 38.89 ± 4.99 U/L, while those of subjects in groups II and III ranged from 39 to 101 U/L with a mean of 73.56 ± 14.04 U/L and 46 to 137 U/L with a mean of 87.78 ± 22.52 U/L, respectively (Table 3). The mean salivary alkaline phosphatase levels of the subjects in group III was the highest (87.78 U/L), followed by those in group II (73.56 U/L) while those in group I had the least (38.89 U/L).

When the levels of salivary alkaline phosphatase of subjects in the three groups were compared using one-way ANOVA, there were statistically significant differences between groups I and II, II and III, I and III (Table 4). There was also a positive correlation between the probing pocket depths and salivary alkaline phosphatase levels in group III, albeit mild (Figure 1).

Discussion

Periodontal disease is an inflammatory condition which may involve gingival inflammation, periodontal ligament destruction and alveolar bone resorption. In periodontal disease changes in biochemical constituents in tissues occur as a result of metabolic changes. These metabolic changes are brought about by the interaction between the bacteria and the host cells. These lead to production of tissue breakdown products, release of enzymes from host cells and secretion of pro-inflammatory products.15 These products have been evaluated for the diagnosis of diseases, including periodontal disease. ALP is one of the enzymes evaluated for the early diagnosis of periodontal disease.15 It has been reported to have the potential to differentiate among varying periodontal conditions.22 ALP also plays a role in gingival inflammation and bone metabolism.18 Subjects with periodontal disease, either gingivitis or chronic periodontitis, were averagely older than those with healthy periodontium, which presents a picture of periodontal disease being associated with older age groups (Table 1). However, many studies have reported that rather than being associated with aging, it seems that the effects of past untreated and/or incomplete treatment of past periodontal disease is responsible for the disease being commoner in the older age groups.23-26 There is therefore the need to make efforts at early diagnosis of periodontal disease and adequately treat it in order to reduce the burden of the disease at old age.

This study showed that the mean salivary alkaline phosphatase levels vary with the severity of periodontal disease as subjects with chronic periodontitis had the highest level (87.78 U/L), followed by those with gingivitis (73.56 U/L) while those with healthy periodontium had the least (38.89 U/L). The results suggest that salivary alkaline phosphatase levels increase in periodontal disease (gingivitis and periodontitis) than in health, which is consistent with previous studies.15,17 Todorovic et al15 examined the activities of some salivary enzymes in subjects with periodontal disease and compared them with those having healthy periodontium and reported a significant increase in the activity of ALP in periodontal disease compared to that in healthy periodontium. Desai et al17 also reported that the level of salivary alkaline phosphatase was significantly different among subjects with healthy periodontium, gingivitis

Table 2. Means of gingival index and probing pocket depths in different study groups

		Group		
		I (mm)	II (mm)	III (mm)
Gingival Index	Range	0–1.0	1.0–2.0	1.0–2.5
	Mean	0.44	1.57	1.78
	SD	0.76	0.21	0.41
Probing Pocket Depth	Range	1.0–2.5	1.5–3.8	2.33–5.67
	Mean	1.86	2.62	3.46
	SD	0.29	0.61	0.79

Table 3. Mean salivary alkaline phosphatase levels (S-ALP) in the three groups

	Groups	S-ALP (U/L)
I	Range	30–52
	Mean	38.89
	SD	± 4.99
II	Range	39–101
	Mean	73.56
	SD	± 14.04
II	Range	46–137
	Mean	87.78
	SD	± 22.52

SD*: represents standard deviation*

Table 4. Comparison of the mean values of the measured clinical parameters and S-ALP levels assessed by one-way ANOVA

parameters	Groups	P-values	Inference
G.I	I&II	0.001	s
	II&III	0.021	s
	III&I	0.001	s
Pocket depth	I&II	0.001	s
	II&III	0.001	s
	III&I	0.001	s
ALP	I&II	0.001	s
	II&III	0.006	s
	III&I	0.001	s

I: Healthy periodontium; II: Gingivitis; III: Chronic periodontitis.

and periodontitis. However, some other studies have reported differences that were not statistically significant when the ALP in periodontal health was compared with that in gingivitis and periodontitis.22,27 This is in contrast to the present study in which the difference between the healthy and periodontal diseases was statistically significant. This possibly could have been due to the effect of sociocultural differences between the studied groups.

The mean ALP was significantly higher in periodontitis as compared to gingivitis (Table 3), suggesting that ALP levels increase with increased severity in periodontal tissue destruction. This is consistent with the results of other studies, which also reported a highly significant difference in the mean ALP levels between these two groups.18,28 The increase in salivary alkaline phosphatase levels could be traced to increased activities of polymorphonuclear neutrophils (PMNs), osteoblasts and fibroblasts within the periodontal pocket as a result of persistent inflammation. The increased salivary ALP in periodontitis could also be associated with alveolar bone loss, with a small contribution from the serum.29 Comparison of salivary alkaline phosphatase levels in the three groups by one-way ANOVA showed a significant difference between the diseased and the healthy periodontium groups just the way the comparison of periodontal clinical parameters (GI and PD) did (Table 3). This showed that salivary alkaline phosphatase levels may distinguish, in a similar way as the periodontal clinical parameters, varying periodontal conditions. This is similar to the findings by some other studies.18,22,27 This study also showed that ALP levels correlate significantly with pocket depth, suggesting that ALP will be able to adequately predict progression of periodontal disease. This is consistent with previous studies.15,17,18,30

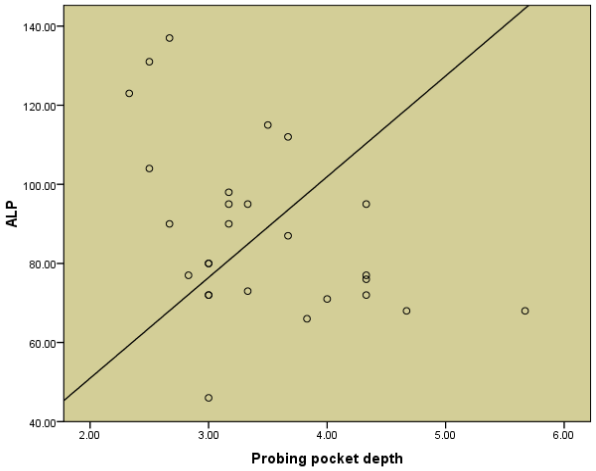

Figure 1. Correlation between salivary alkaline phosphatase levels (ALP) and probing pocket depths in group III.

Conclusion

The difference in the levels of salivary alkaline phosphatase among the three groups implies that salivary alkaline phosphatase can actually differentiate the various periodontal conditions, with the possibility of earlier diagnosis of the disease than with the use of clinical parameters. The use of biomarkers should therefore be encouraged to enhance clinical practice.

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Conflict of interest

We declare that there was no conflict of interests in this study.

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