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Original Research Article

Correlation of the Salivary Alkaline Phosphatase Activity in Individuals Experiencing Dental Erosion

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Abstract: ***Background and Aims*:** An important enzyme for dental health, alkaline phosphatase (ALP) serves a variety of purposes in preserving the structure and functionality of oral tissues. In order to better understand salivary ALP's potential as a biomarker for dental erosion and its diagnostic and prognostic utility in both young and adult populations, this study set out to clarify its possible role. ***Materials and Methods*:** In the study, there were twenty-seven patients with dental erosion and an equal number of age and gender-matched healthy controls. Before a meal and without stimulation, samples were taken from the control and study groups by passively drooling into a sterile glass tube until 5 ml was collected. ***Results*:** Salivary ALP levels showed a significant difference between patients with and without dental erosion (63.68 ± 4.36 (IU/L) versus 21.47 ± 1.16 (IU/L)), with a p-value of 0.0001 indicating a very high significance. Alkaline phosphatase enzyme levels and teeth erosion were found to have sturdy positive relation (r= 0.989) high significantly P< 0.001. ***Conclusion*:** Salivary alkaline phosphatase is a vital enzyme, which is essential for the mineralization of teeth and it considers biomarker for the severity and progression of dental erosion.

Keywords: Correlation, Dental erosion, Oral health, Remineralization, Salivary alkaline phosphatase.

INTRODUCTION

Salivary alkaline phosphatase is considering an important enzyme for the health of teeth, serves a diversity of aims in preserving the texture and functionality of dental tissues. Salivary alkaline phosphatase firstly participates in the dephosphorylation of organic phosphates which considers an essential physiological process that involve mineralization of bone and regulation of phosphate level [1]. Salivary alkaline phosphatase helps in the preservation and repair of hard tissues in the oral cavity, including alveolar bone and teeth. Salivary glands produce salivary alkaline phosphatase, which has a diversity of utilize in the mouth, remineralization of enamel is one of its major functions [2]. The enzyme serves the enamel absorb minerals such as phosphate and calcium, strengthening it and preventing demineralization grab by acidic dietary or bacterial activity, this process is necessary for avoiding dental erosion and caries, which are cases produce by acid exposure collapse the tooth structure [3]. Also, salivary alkaline phosphatase plays an important role in preservation of periodontal health, its more popular in periodontal tissues, where it plays a role in the development and repair of alveolar bone and periodontal ligament [4]. Salivary alkaline phosphatase may play a part in the inflammatory processes and remolding of tissue connected to periodontal disease, as manifested by increased levels of alkaline phosphatase in saliva found in those patients, therefore salivary alkaline phosphatase can function as a biomarker for periodontal health, supporting the monitoring and diagnosis of periodontal disturbances [5]. Teeth erosion, or progressive loss of dental hard tissues result of dissolution of acids in the mouth, is becoming universal interest for both children and adult populations [6]. Teeth wear is the consequence of direct chemical action rather than bacterial intervention, in contrast to the caries of teeth, which is firstly caused by bacterial action [7]. According to the current information, dental erosion is becoming more popular, particularly as result of dietary habit and lifestyle changes [8]. Ingestion of dietary acid is one of the major risk factors for teeth wear,

there is sturdy relation between raised erosion and consumption of acidic diets and beverages, such as fruit juices, citrus fruits, soft drink and sports drinks. The severity of erosion is extremely affected by the frequency and long duration exposure to the acid [9]. Function of saliva as an organic buffer, neutralizing acids and enhancement remineralization of enamel. Saliva protective characteristics can be reduced and erosion capability elevated by decreased salivary flow or alters in saliva composition [10]. The danger may be increased by status such as xerostomia, which can be brought on by systemic diseases or drugs [11]. The correlation between salivary enzymes and teeth erosion has been researched in the past, with a confirms on how these salivary enzymes may be utilized as biomarker for the condition [12]. Salivary alkaline phosphatase is considered important enzyme to reservation of oral health that is contributed in the dephosphorylation process of organic phosphates, is one of the main enzymes under search. Increased severity of dental erosion has been correlated with raised levels of salivary alkaline phosphatase, according to research by Jazaeri *et al.*, 2015, persons had more noteworthy teeth erosion in those with higher salivary alkaline phosphatase levels, referring that alkaline phosphatase may be beneficial marker for evaluating the condition risk and path [13]. Previously research have explained that the relation between different salivary enzymes and teeth erosion, highlighting the possibility that these enzymes could help as biomarkers for the disease. Matrix metalloproteinases, salivary peroxidase and carbonic anhydrase have all been identified as important participants in the biochemical processes that effect teeth erosion. So as to reduce the negative effect of teeth erosion on oral health, it is necessary to understand this relation in order to get develop preventive measures and diagnostic tools [14]. In order to better understand salivary alkaline phosphatase potential as a biomarker for dental erosion and its diagnostic and prognostic utility in both young and adult population, this study set out to clarify its possible.

MATERIAL AND METHOD

A case _control study, we looked into the relationship between the degree of dental erosion in patients, at age 25-55 years and salivary alkaline phosphatase (ALP) levels. The sample size for this study is 54 patients. twenty-seven Patients with dental erosion were chosen from the patient population that attends the dental clinic at Anbar University's College of Dentistry. Conversely, the same number of people who are the same age and gender were chosen, but they do not experience dental erosion. The criteria for inclusion involved at least twenty natural teeth and no history of systemic diseases that could have affected the composition of saliva in the participants. Recent use of antibiotics, continued orthodontic treatment, and use of drugs known to impair salivary flow were among the exclusion criteria. gaining the relevant authority's ethical approval. Informed consent was obtained from the participants after they were informed of the purpose of the study. Five milliliters of un stimulated saliva was taken out of each subject using the spitting method. Before gathering the saliva, the participants were instructed to refrain from eating for two hours. They were told to sit up straight, tilt their head forward slightly, gather saliva on the floor of their mouths, and then spit into a sample container after rinsing their mouths with water for ten minutes. As soon as possible, the collected saliva samples were put on ice and brought to the lab for examination. The amount of ALP in saliva was determined using a colorimetric enzyme assay kit. To remove debris, the samples were centrifuged at 3000 rpm for 15 minutes. in order to extract the saliva supernatant. To estimate the S-ALP levels, 20 µl of the supernatant and 1000 µl of Alkaline Phosphatase (ALP) reagent were mixed together. The supernatant was then used for the assay. Using a spectrophotometer, the assay measured the absorbance of the resultant product at 405 nm after adding a particular substrate to the saliva samples. Units per liter (U/L) were used to express the ALP activity. The Basic Erosive Wear Examination by using Basic Erosive Wear Examination (BEWE) [15], as show in Table I. This index was chosen due to easily comparable and widely use all surfaces of teeth were examined. Restored or carious teeth were excluded from analysis. Score 0-3 were given according to the severity of wear. Statistical software was used to analyze the data. The participant's demographics, salivary ALP levels, and tooth wear scores were compiled using descriptive statistics. The relationship between salivary ALP levels and the degree of dental erosion was investigated using t. test, ANOVA test, Pearson correlation and logistic regression analysis. Statistical significance was attained when the p-value was less than 0.05.

Table I: Basic Erosive Wear Examination

Scores	Criteria
0	No dental erosion
1	Superficial loss of enamel
2	Hard tissue loss involving < 50% of the tooth surface
3	Hard tissue loss involving > 50% of the tooth surface

RESULTS

Fifty-four participants were divided equally into those with and without dental erosion, and their demographics, salivary alkaline phosphatase (ALP) enzyme levels, and their correlation with dental erosion were examined. There was no discernible difference in age or gender between the groups according to the demographic data as show Table Ⅱ. Salivary ALP levels showed a significant difference between patients with and without dental erosion (63.68 ± 4.36 IU/L versus 21.47 ± 1.16 IU/L), with a p-value of 0.0001 indicating a very high significance as show Table Ⅲ. ALP levels and dental

erosion were found to have a strong positive correlation (R=0.989, p=0.0001) by correlation analysis as show Table Ⅳ. Furthermore, there was a positive correlation between the degree of dental erosion and rising ALP levels; mild cases had lower levels (60 ± 2.9 IU/L) than moderate cases (65.12 ± 1.24 IU/L) and severe cases (68.6 ± 0.7 IU/L), with a p-value of 0.0001 Table Ⅴ. The substantial correlation between high ALP levels and dental erosion was further supported by logistic regression (Odds Ratio=3.6516, p=0.0001) as show Table Ⅵ. These results highlight salivary ALP's potential as a biomarker for dental erosion.

Table Ⅱ: Study Participants' Demographics

Variable	Patients with dental erosion (n=27) Mean ± SD	Patients without dental erosion (n=27) Mean ± SD	P- value
Age (years) (25-55)	40.41± 9.01	40.41± 9.01	1.00
Gender (male/female)	16/11	16/11	

Table Ⅲ: Salivary alkaline phosphatase enzyme level for all patients

Groups	(n)	Mean± SD(IU/L)	95% confidence interval	t. value	P. value
With dental erosion	27	63.68 ± 4.36	40.47 - 43.96	48.58	0.0001*
Without dental erosion	27	21.47 ± 1.16			

df= 52 P<0.05 Very high significant

Table Ⅳ: Correlation Analysis between Salivary alkaline phosphatase enzyme levels and dental erosion

Variables	Correlation	P Value
ALP Level and dental erosion.	R= 0.989	0.0001*

* Very high significant at P < 0.05 ** Strong negative relation

Table Ⅴ: ALP Level Comparisons Among Groups with Varying Dental Erosion Severities by ANOVA Test

Severity of dental erosion	Number of patients	alkaline phosphatase enzyme level Mean ± SD (IU/L)	P- Value
Mild	13	60 ± 2.9	0.00001*
Moderate	6	65.12 ± 1.24	
Sever	8	68.6 ± 0.7	

***** Very high significant

Table Ⅵ: Logistic Regression analysis, for the association between Salivary alkaline phosphatase enzyme levels and dental erosion

Independent Variables	Coefficient	Odds Ratio	95% Confidence Interval	Chi-square P -Value
ALP Level	1.295	3.65	(0.0000, 1.0000)	0.0001*
dental erosion	-51.8093			

Df= 1 * very high significant

DISCUSSION

Alkaline phosphatase (ALP) is a hydrolase intracellular enzyme participating in the metabolic processes of cells. Rise in salivary ALP (S-ALP) levels reflects inflammation and destruction of healthy tissues suggesting it as a clinical biomarker [16]. The demographic analysis of patients with and without dental erosion show were well matched in term age and gender, no significant differences between them. Age mean of study and control groups were same 40.41± 9.01, with equal gender distribution. Matching in this study reduce confusing variables and enhancement the validity of the comparison between the study groups in term of (S-ALP) and dental erosion. This study investigates the relationship between patients' levels of salivary alkaline phosphatase (ALP) and the degree of dental erosion. Our results show a strong relationship between higher ALP levels and more severe dental erosion (63.68 ± 4.36 IU/L) compare with control group was (21.47 ± 1.16 IU/L), with very high significantly differences between them, this refers that the difference is away to be due to chance. Because S-ALP is involved in the metabolism of minerals and bone, there is a correlation between the amount of salivary ALP and the degree of dental erosion. The dephosphorylation process, which is essential for the mineralization of teeth, is mediated by ALP. Increased turnover of dental hard tissues in response to erosion is one pathological process that could be the cause of elevated ALP levels in saliva [17]. Our research is comparable to that done by Jazaeri *et al*. (2015), who found that higher salivary ALP levels are linked to more severe dental erosion. High levels of salivary alkaline phosphatase were related with more sever dental wear in participant patients, this is indicating that salivary alkaline phosphatase could be beneficial biomarker for evaluate the dangerous and progression of dental erosion [13]. Research have been conducted on levels of salivary alkaline phosphatase as a possible biomarker for the severity and progression of dental erosion [18]. Our research displays sturdy correlation between ALP enzyme levels in saliva and teeth

wear (R= 0.989). These results correspond with hypothesis that salivary alkaline phosphatase may be engaged in the pathological process of dental erosion or may useful as a biomarker for it. In accordance with this relation, hunting salivary alkaline phosphatase levels may be noninvasive diagnostic procedure to evaluate how teeth erosion is progressing and help direct management and prevention plans [19]. Furthermore, our results show increase in ALP enzyme in saliva with increase severity of dental erosion patients with severe dental erosion had highest alkaline phosphatase levels (68.6 ± 0.7 IU/L) then follow by moderate dental erosion ALP levels (65.12 ± 1.24 IU/L and mild (60 ± 2.9 IU/L), significantly high differences between them, these results confirm the potential of salivary alkaline phosphatase as a biomarkers that not only refer to the presence of dental erosion but also reflects its progression. Our results were similar to study conducted by Melo Belila *et al* (2021) where found strong relationship between severity of dental erosion and levels of salivary alkaline phosphatase and this supporting the potential diagnostic advantage of salivary alkaline phosphatase enzyme in hunting dental erosion. The raise in the activity of ALP enzyme in saliva has also been considered result dissolution process of dental hard tissues in advanced stage [20]. Teeth erosion and salivary ALP enzyme levels are related, according to the logistic regression analysis, there is sturdy relation between severity of teeth erosion and levels of salivary alkaline phosphatase enzyme. Raising patient's salivary alkaline phosphatase levels is related with a higher risk of sever teeth wear. Increased body turnover of dental hard tissues as means of rectifying the harm inflicted by erosive factors may be associated with the enzyme activity [21]. To understand the role of salivary ALP enzyme completely in the pathophysiology of teeth wear and to establish standardized alkaline phosphatase enzyme thresholds, further studies is necessary. Alkaline phosphatase is present in dental hard tissue, including saliva ad connected to metabolism of bone. Sever teeth wear has been connected to higher salivary alkaline phosphatase levels, suggesting that increased alkaline phosphatase activity may be reflex of the tissue's response to enamel and dentine demineralization [18]. Thus, raising salivary alkaline phosphatase enzyme is considers part of the reparative process and this is significant to refer that it elevates is considered as a preventive measure to remineralization surfaces of enamel.

CONCLUSION

Salivary alkaline phosphatase is vital enzyme, which is essential for the mineralization of teeth and it considers biomarker for the severity and progression of dental erosion.

Clinical Implication

In the treatment of dental health, clinical implication of salivary alkaline phosphatase levels in relation to severity of teeth erosion are noticeable. Elevated bone turnover, which can be response to teeth erosion, is frequently referred by increased salivary alkaline phosphatase levels. Patients with teeth erosion may benefit from early detection and intervention during the surveillance of salivary alkaline phosphatase levels, which may stop further dental dissolution and related issues.

Limitations of Study

Although our research displays insightful information, but there were some of limitations. Case control study makes it more difficult to demonstrate causation. To verify the causal correlation between salivary alkaline phosphatase levels and the progression of teeth erosion, longitudinal studies are needed. As well as its important to look to the effect of further possible confounders such as oral hygiene habits, dietary habit and genetic predisposition.

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Conflict of Interest: The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

Regulatory Statement: This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of university of Anbar (Ethical reference No.160).

REFERENCES

1. Sekaran S, Vimalraj S, Thangavelu L. The Physiological and Pathological Role of Tissue Nonspecific Alkaline Phosphatase beyond Mineralization. Biomolecules. 2021 Oct 21;11(11):1564. doi: 10.3390/biom11111564. PMID: 34827562; PMCID: PMC8615537.
2. Razi MA, Qamar S, Singhal A, Mahajan A, Siddiqui S, Mohina Minz RS. Role of natural salivary defenses in the maintenance of healthy oral microbiota in children and adolescents. J Family Med Prim Care. 2020 Mar 26;9(3):1603-1607. doi: 10.4103/jfmpc.jfmpc_1134_19. PMID: 32509658; PMCID: PMC7266239.

3. Aldafaai RR, Jafar Z, Al-Rubbaey Y. Impact of dental anxiety on dental caries and salivary alkaline phosphatase in children across different nutritional statuses. J Med Life. 2023 Oct;16(10):1540-1545. doi: 10.25122/jml-2023-0085. PMID: 38313167; PMCID: PMC10835552.
4. Shurooq A and AKRAM H. Assessment of salivary Alkaline Phosphatase in patients with healthy gingiva on reduced periodontium versus periodontitis. Basrah Journal of Surgery. 2023, vol 29(1):49-54. DOI: 10.33762/bsurg.2023.138019.1041
5. Zhang C, Liu M, Wang X, Chen S, Fu X, Li G, Dong N, Shang X. ALP Inhibitors Inhibit Inflammatory Responses and Osteoblast Differentiation in hVIC via AKT-ERK Pathways. Altern Ther Health Med. 2023 Jan;29(1):58-65. PMID: 35951069.
6. Nolasco SC, Rocha LC, Silva PS, Auad SM, Ferreira FM, Assunção CM. Effects of different toothpaste formulations on erosive tooth wear prevention: systematic review. Braz Dent Sci. 2023;26(1):e3688. https://doi.org/10.4322/bds.2023.e3688
7. Oliveira BP, Buzalaf MAR, Santos NM, Silva NC, Ventura TMO, Rodrigues JA. Knowledge and attitudes related to erosive tooth wear of professional wine tasters: a cross-sectional study. Braz. Dent. Sci. 2023; 26(1): e3517. https://doi.org/10.4322/bds.2023.e3517
8. Campus G, Niu JY, Sezer B, Yu OY. Prevention and management of dental erosion and decay. BMC Oral Health. 2024 Apr 17;24(1):468. doi: 10.1186/s12903-024-04257-y. PMID: 38632545; PMCID: PMC11025157.
9. RAMOS NC, AUGUSTO MG, ALVES LMM, KLEVERLAAN CJ, DAL PIVA AMO. Wear of dental ceramics. Braz. Dent. Sci. 2023;26(1):e3638. https://doi.org/10.4322/bds.2023.e3638
10. Batista GR, Zanatta RF, Augusto MG, Arantes GS, Borges AB, Torres CRG. The ability of different formulations of artificial saliva to protect dentin from erosive wear. Braz Dent Sci. 2023;26(2):e3767. https://doi.org/10.4322/bds.2023.e3767
11. Madariaga VI, Pereira-Cenci T, Walboomers XF, Loomans BAC. Association between salivary characteristics and tooth wear: A systematic review and meta-analysis. J Dent. 2023 Nov;138: 104692. doi: 10.1016/j.jdent.2023.104692. Epub 2023 Sep 9. PMID: 37678744.
12. Cleaver LM, Carda-Diéguez M, Moazzez R, Carpenter GH. Novel bacterial proteolytic and metabolic activity associated with dental erosion-induced oral dysbiosis. Microbiome. 2023 Mar 31;11(1):69. doi: 10.1186/s40168-023-01514-0. PMID: 37004076; PMCID: PMC10064782.
13. Jazaeri M, Malekzadeh H, Abdolsamadi H, Rezaei-Soufi L, Samami M. Relationship between Salivary Alkaline Phosphatase Enzyme Activity and The Concentrations of Salivary Calcium and Phosphate Ions. Cell J. 2015 Spring;17(1):159-62. doi: 10.22074/cellj.2015.523. Epub 2015 Apr 8. PMID: 25870846; PMCID: PMC4393665.
14. Donovan T, Nguyen-Ngoc C, Abd Alraheam I, Irusa K. Contemporary diagnosis and management of dental erosion. J Esthet Restor Dent. 2021 Jan;33(1):78-87. doi: 10.1111/jerd.12706. Epub 2021 Jan 6. PMID: 33410255.
15. Bartlett D, Ganss C, Lussi A. Basic Erosive Wear Examination (BEWE): a new scoring system for scientific and clinical needs. Clin Oral Investig. 2008 Mar;12 Suppl 1(Suppl 1): S65-8. doi: 10.1007/s00784-007-0181-5. Epub 2008 Jan 29. PMID: 18228057; PMCID: PMC2238785.
16. Chaudhary, Roopam, and Manish Kumar. "Evaluation of Salivary Alkaline Phosphatase Levels in Tobacco Users to Determine Its Role as A Biomarker in Oral Potentially Malignant Disorders." International Journal of Health Sciences, no. II, 27 Mar. 2022, pp. 796-802, doi:10.53730/ijhs. v6nS2.5070.
17. Vimalraj S. Alkaline phosphatase: Structure, expression and its function in bone mineralization. Gene. 2020 Sep 5;754: 144855. doi: 10.1016/j.gene.2020.144855. Epub 2020 Jun 6. PMID: 32522695.
18. Hara AT, Zero DT. The potential of saliva in protecting against dental erosion. Monogr Oral Sci. 2014; 25:197-205. doi: 10.1159/000360372. Epub 2014 Jun 26. PMID: 24993267.
19. Nunes LA, Mussavira S, Bindhu OS. Clinical and diagnostic utility of saliva as a non-invasive diagnostic fluid: a systematic review. Biochem Med (Zagreb). 2015 Jun 5;25(2):177-92. doi: 10.11613/BM.2015.018. PMID: 26110030; PMCID: PMC4470107
20. de Melo Belila, N., Martins, R. J., Garbin, A. J. Í., Moimaz, S. A. S., Neto, A. H. C., & Garbin, C. A. S. (2021). Analysis of oral health and salivary biochemical parameters of women with anorexia and bulimia nervosa. Research, Society and Development, 10(3), e8710312971-e8710312971.
21. Baranova J, Büchner D, Götz W, Schulze M, Tobiasch E. Tooth Formation: Are the Hardest Tissues of Human Body Hard to Regenerate? Int J Mol Sci. 2020 Jun 4;21(11):4031. doi: 10.3390/ijms21114031. PMID: 32512908; PMCID: PMC7312198.