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RESEARCH ARTICLE

SALIVA PARAMETERS AND THEIR DIAGNOSTIC SIGNIFICANCE

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ABSTRACT

The saliva circulating in the mouth at any given time is termed as whole saliva and it comprises of a mixture of secretions from the major and minor salivary glands and traces from the gingival crevicular fluid. Like a mirror of the body's health it contains proteins, hormones, antibodies and other molecules that are frequently measured in standard blood tests to monitor health and disease.

Purpose:- In the present study we evaluated alterations of physical properties like ph, flow rate, buffering cpapcity and biochemical properties like salivary total protein, albumin, sIgA and calcium in periodontal disease in different age groups, analysed their interdependence and thereby assessed the probable role of various salivary parameters as a diagnostic aid in the detection of alterations in oral tissue integrity.

Materials and Methods: - 60 cases and controls were taken for the study and three physical and four biochemical parameters were evaluated in all of them for each age group of 7 to 18 yrs., 18 to 36 yrs. and 40 to 60 yrs. T-test and Pearson test were used to analyze the data.

Results:-Periodontitis patients showed significant change in salivary albumin and some change in buffer capacity with significant intergroup alterations of pH and calcium levels. Certain parametric changes were correlative also.

Conclusion:- Changes in physical and some biochemical properties like calcium and sIgA in periodontitis cases were interrelated and an indirect effect of periodontitis. However, changes in albumin and therefore total proteins were to a greater extent a direct effect of periodontal inflammation.

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INTRODUCTION

Whole saliva is secreted by three pairs of major salivary glands [parotid, submandibular and sublingual] and by many minor salivary glands. It is supplemented with several constituents that originate from blood serum, traces from the gingival crevicular fluid, constituents from immune cells, from intact or destroyed oral microorganisms and their fermentation products, enzymes, RNA, DNA, and structural elements together with fragments from the keratinized mucosal surfaces, cytoplasmic products, and mucosal cells with intact cell organelles from nonkeratinized surfaces . Certain amount of expectorated bronchial and nasal secretum, constituents of foods, administered drugs, smoke (from smoking), toothpastes, mouth rinses, and molecules released from dentures can also be found (Anders Bennick, 2002 and Bardow, 2000). Prior to the seventeenth century and the anatomic demonstrations by Stenson and Wharton of the ducts that bear their name, salivary glands were thought to be accessory excretory organs, that strained off the evil spirits of the brain. Now it is recognized that, saliva, the watery tasteless liquid mixture of salivary and oral mucous gland secretions is a natural resource with many functional capabilities that include – lubricating the chewed food, the predigestion of starches by the enzyme ptyalin, forming acquired pellicle on tooth surfaces, maintaining crystal growth homeostasis, allowing plaque formation & bacterial adhesion and moistening & maintaining mucosal integrity of the oral and upper GIT mucosal surfaces by its lubricating effect. Besides, it also has an important role in physico-chemical defense, antimicrobial defense, and wound healing. These important tasks are achieved by the interactions of its array of constituents like proteins, carbohydrates, lipids and ions under fine regulation (Ericson, 1989 and Mandel, 1987). Saliva is an exocrine secretion consisting of approximately 99% of water and contains a variety of electrolytes and proteins, and therefore, as

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slightly acidic pH, similar to that of plasma. Like other body fluids, saliva is a dilute aqueous fluid,with an osmolality less than or equal to that of plasma, and so, it promotes oral health by constantly bathing the teeth and oral mucosa and thereby serving as a cleaning solution, a lubricant, a buffer and an ion reservoir of calcium and phosphate (Makkonen, 1994). Like the blood , saliva reflects body's health status by changes in levels of its constituent proteins, hormones, antibodies and other molecules that are otherwise, measured in standard blood tests, to monitor health and disease. The people who really appreciate the "miracle" of saliva, however, are those who suffer from xerostomia as they suffer from increased caries and periodontal disease; their oral mucosa is constantly irritated and sore; food is difficult to chew and swallow; and taste acuity is impaired in them (Ferraris Meg, 2006).

Physical Properties

Saliva is the principal defensive factor in the mouth, and a reduction/change even in its physical properties like flow rate, pH , buffering capacity would affect the orodental health if such changes are persistant . Thus, it is important to establish their reference values in various populations (Bardow, 2000 and Ericson *et al*., 1989). In the oral cavity, saliva has a pH normal range of 6.2-7.6 .

The maintainence of normal pH is by-

Flow and therefore its rate ie flow rate

Normal salivary output as quantified by flow rate is an extremely important intrinsic protective host factor. It is measured by measuring the length of time needed to collect the desired amount of saliva and dividing the volume of collected saliva by the time in minutes to get the flow rate.

Acidity neutralized by buffering activity, (sialometrics, 2008)

Buffering capacity is defined as number of equivalents of strong acid required to be added to a liter of the buffer solution so as to change it's pH by 1, in unstimulated whole saliva and involves three major buffer systems (Mandel, 1987). Based on the color change of the indicator paper, buffering capacity is assessed in comparison with a color chart. (the dentobuff method) (Meurman, 2002)

Chemical Properties

Biochemical contents like various proteins, especially albumin, a serum ultrafilltrate to the mouth is of significance because, salivary albumin and therefore salivary proteins have been shown to be increased in medically compromised patients and in local chronic inflammatory conditions like periodontitis where salivary protein and albumin conc. changes ,serve as indicators of plasma protein leakage and also affect oral health status (Makkonen, 1994). Total normal protein concentration of saliva is vital to good oral health and a sustained change in it for any reason adversely affects the oral health of these patients. This is because saliva contains many biological systems involved in soft tissue repair and/or antibacterial functions, and systems for defense against free radical mediated oxidative stress etc. One of them sIgA the largest immunoglobulin component of saliva may be directed at specific bacterial molecules, including cell surface molecules such as adhesins, or against enzymes. By binding to such molecules, adhesion of specific bacteria to oral surfaces may be blocked, so preventing colonisation by the affected species (Avşar, 2009; Brandzeg, 1973 and Zee, 2001). Several studies have confirmed that, sIgA is mainly dimeric rather than monomeric, and it is associated with an epithelial glycoprotein called SC (secretory component) in saliva (Jabak, 2001 and Seidel, 2001).

At least 95% of the IgA normally appearing in saliva is produced by the local glands associated immunocytes rather than being derived from the serum (Jenkins, 1978). As the first line of defense against microbial invasion, sIgA is the dominant immunoglobulin on all mucosal surfaces, because, it has the ability to neutralize viruses, bacteria and toxins and serve as an effective biological barrier by its ability to aggregate bacteria, and inhibit bacterial adherence to oral tissues. Of significance, is the fact that the regulation of immune function is linked to the incidence of infectious diseases, autoimmune diseases, malignancy and the like (Gorriena, 2008 and Proctor, 2001). On the other hand a large serum protein, Albumin, which is the most abundant of serum proteins with functions of distribution of extra cellular fluid, regulation of osmotic pressure, serving as a transport agent for a wide variety of substances like hormones, lipids, vitamins etc. is present as a serum ultrafilltrate in saliva and varies from 100-700 mg/dl. It is selectively adsorbed by different materials in the oral cavity. Increased levels are seen in dehydration. Decreased levels of it are seen in systemic diseases like liver diseases (Hepatitis, Cirrhosis), malnutrition, kidney disorders, increased fluid loss during extensive burns and malabsorption (Jerrapo, 1996 and Doumaasa, 1971). Nephrotic syndrome is the best known example of systemic disorder with characteristic proteinuria and subsequent hypoalbuminaemia which leads to oedema (Laurance, 2007). It is often used as a marker for the degree of mucositis, inflammation in the salivary glands and also root caries. Albumin may also correlate with gingival inflammation and periodontal diseases .According to the latest data, the role of persistent periodontal diseases is significant in, incidence of cardiovascular and cerebrovascular conditions and also in premature birth and so, it implies that "quick screening" of the saliva is of high significance for noting albumin level changes in order to, foresee any forthcoming major health calamity of the likes mentioned.

Thus, local and/or systemic disorders inducing salivary changes may disturb and/or interrupt these complex balanced functions which, in turn can lead to mucosal and tooth damages or no local effects and only salivary changes. However, the molecular changes of saliva most often due to altered expression of secretory proteins, serve as indicators of underlying pathology & reflect cellular signal processing changes causing change of its composition in response to stimuli (Lavin, 1987; Tibor, 2007 and Ben Aryeh, 1993).

The present study was undertaken to analyse the dependendency of physical properties like ph, flow rate, buffering capacity and biochemical properties like salivary total protein, albumin, sIgA and calcium in periodontal disease patients of different age groups to assess the significance of and role of various salivary parameters as a diagnostic aid in the detection of alterations in oral tissue integrity.

The objectives of the present study were:

- Evaluation of the salivary protein concentration in controls and periodontitis patients of different age groups.
- Comparison of the salivary total protein concentration with salivary albumin concentration in children, young adults and older adults of controls and cases.
- Evaluation of the SIgA and calcium concentration in different age groups of cases and controls.
- Comparison of the SIgA and calcium concentration in different age groups of cases and controls
- Evaluation of pH, buffering capacity and flow rate in different age groups of cases and controls.
- Comparison of the salivary pH, buffering capacity, and flow rate in different age groups of cases and controls.

MATERIALS AND METHODS

Source of data: 60 cases were taken for the study and the results of variables were compared. 20 cases and 20 controls were from each group of 7 to 18 yrs., 18 to 36 yrs. and 40 to 60 yrs.

Method of collection of data: The collection of data was done in Darshan Dental College, Udaipur. Detailed case history was taken and the patients were made to spit saliva pool every 2 minutes , 3 times in a sterile container. The amount of saliva collected was noted and the sample was investigated further in the biochemical laboratory for its total protein, albumin, sIgA , Ca++, pH and buffering capacity.
All the patients were subjected to routine examinations and case history was recorded.

Based on the above mentioned criteria patients were subgrouped under 3 groups as:

Group 1	**Adolescent children 7-18 yrs**	**Sub group1** adolescents with no local oral soft- tissue problems **Sub group2** – adolescents with local oral soft tissue problems
Group 2	**Young adults 18-36 yrs.**	**Sub group 1-**without local oral soft tissue problems/ periodontitis **Subgroup2-** with oral soft tissue problems/periodontitis
Group 3	**Older adults 40-60 yrs**	**Sub group 1-** without local or systemic problems or long term drug therapy **Subgroup 2-** with local problems and/or periodontitis

Human whole unstimulated saliva was collected by spitting method without swallowing with the patient seated in an upright position between 11am and 2noon. Approximately 5 ml of saliva was collected.

- Flow rate was calculated as volume collected ,divided by the time required for the collection.
- pH was estimated with the help of pHmeter whose electrodes were washed in a jet of distilled water and were cleaned with a soft tissue paper. Another standard buffer of pH 7 was used to standardize the pH meter and then, the electrodes were placed in salivary sample and read button flipped to read position. pH reading was then taken down.
- Buffer capacity is defined as number of equivalent strong alkali or strong acid required to be added to a litre of the buffer solution so as to change it's pH by one. The sample whose pH is known was first titrated against standard sodium hydroxide till the pH was raised by 1 unit, and then it was titrated against standard hydrochloric acid till the pH was lowered by 1 unit. Buffering capacity was then calculated.
- Salivary samples were then labelled and used for estimation of salivary total protein & albumin concentrations.

Salivary protein estimation: Salivary protein estimation was done based on Biuret method. In this method, protein forms a coloured complex with cupric ions in alkaline medium. Based on this principle salivary protein estimation was done by mixing undiluted saliva with the reagent provided and the coloured product was measured using a photoelectric colorimeter at a wavelength of 536 nm.

sIgA Estimation: The samples were analysed for sIgA using Turbidimetry method. The priniciple of the procedure is that IgA antibodies when mixed with salivary sample form insoluble complexes. These complexes are then analysed with spectrophotometer where they cause an absorbance corresponding to the IgA conc. of the sample. The reading in spectrometer is compared with a calibrator of known IgA concentration.

Salivary albumin estimation: This was done by Bromocresol green method in which a change in colour is produced by the reaction between albumin in saliva and the dye Bromocresol-green & that is proportional to the albumin concentration.

Salivary calcium estimation: It is done using spectrophotometer analysis method by Cobas Integra an automated chemistry analyser which uses the colorimetric method of 'o' cresolpthelamine complex zone.

The values of above mentioned parameters were tabulated and were subjected to Student's T-test, Fisher's test(ANOVA) and Turkey HSD tests to compare the values of parameters among groups and subgroups. Pearsson correlation was used to correlate the parameters among controls and the cases.

RESULTS

When a comparison of the salivary total protein concentration with salivary albumin concentration in children, young adults and older adults was done among controls they did not show any significant changes with age change. However, when a comparison of evaluated parameters was done among cases and controls irrespective of age, as shown in Tables 1 and Table 2, the results were as follows :

The 'p'values of:

- Salivary Albumin, sIgA & Calcium showed a significant difference indicating an inflammation subjected change in its salivary quantity (Graph.1,2,3)
- Buffer capacity & pH also showed a significant alteration from controls to cases.(Graph.4,5)

When a comparison of evaluated parameters was done among the sub-groups of cases as shown in (Table 3 and Table 4).

The mean difference of values and its significance showed -

- Values of significance for pH between young adults and

- Values of significance for salivary calcium between adolescents and older adults (Graph.6,7)

Table 1. (T-Test)

Group Statistics

	Diseas	N	Mean	Std. Deviation	Std. Error Mean
Ph	0	30	6.753	.3963	.0724
	1	30	6.733	.4751	.0867
Buffercap	0	30	6.1000	.34341	.06270
	1	30	5.8833	.48642	.08881
FR	0	30	.6063	.18920	.03454
	1	30	.6307	.18651	.03405
Protein	0	30	2.1673	.56276	.10275
	1	30	2.2817	.41864	.07643
SAlb	0	30	.8293	.26816	.04896
	1	30	1.0787	.36171	.06604
sIgA	0	30	.3053	.05131	.00937
	1	30	.2950	.06892	.01258
Calcium	0	30	4.8963	3.41696	.62385
	1	30	5.5233	2.87769	.52539

Table 2. Indepedent Samples Test Cases

	Mean Difference	Std. Error Difference	t	df	P
Ph	.0200	.1130	.177	58	.860
Buffercap	.21667	.10871	1.993	58	.051
FR	-.02433	.04851	-.502	58	.618
Protein	-.11433	.12806	-.893	58	.376
SAlb	-.24933	.08221	-3.033	58	.004
sIgA	.01033	.01569	.659	58	.513
Calcium	-.62700	.81561	-.769	58	.445

Table 3. ANOVA (Comparitive analysis of subgroups of cases)

		df	Sum of Squares	Mean Square	F	Sig.
Ph	Between Groups	2	.115	.057	.349	.709
	Within Groups	27	4.440	.164		
	Total	29	4.555			
Buffercap	Between Groups	2	.146	.073	.602	.555
	Within Groups	27	3.274	.121		
	Total	29	3.420			
FR	Between Groups	2	.085	.043	1.205	.315
	Within Groups	27	.953	.035		
	Total	29	1.038			
Protein	Between Groups	2	1.093	.547	1.824	.181
	Within Groups	27	8.091	.300		
	Total	29	9.184			
SAlb	Between Groups	2	.265	.132	1.964	.160
	Within Groups	27	1.821	.067		
	Total	29	2.085			
sIgA	Between Groups	2	.002	.001	.290	.750
	Within Groups	27	.075	.003		
	Total	29	.076			
Calcium	Between Groups	2	3.911	1.955	.158	.855
	Within Groups	27	334.682	12.396		
	Total	29	338.593			

On correlation analysis in controls Table 5

Proportional correlation was seen for:

- pH and buffer capacity
- Total salivary protein and salivary albumin
- Flow rate and salivary calcium

On correlation analysis in age groups of periodontitis cases Table. 6

Proportional correlation was seen as follows

a.) Very highly significant correlation between :
**pH and Buffer capacity
**Salivary Protein and Salivary Albumin

b). Significant correlation between:
*pH and sIgA
*Buffer capacity and sIgA
*Flow rate and Buffer capacity

DISCUSSION

In the last few years saliva has gained increasing scientific interest not only for the detection of excretion of various compounds like drugs, pollutants and hormones into saliva but also owing to its well documented relation with bacterial, viral and systemic diseases. In addition, the relationship of saliva and plasma in their various physical and biochemical properties makes saliva an attractive, relatively easy and non-invasive diagnostic tool with which many assays of various parameters can be performed. However, standardization of

collection and storage methods of saliva are essential for obtaining meaningful results. The role of the analysed parameters as markers of periodontal disease occurrence, progression or regression was assessed by evaluating the change in their values subsequent to disease management and follow-up prognosis of one of the most common and chronically damaging disease which although is of a local oral occurrence has a devastating local as well as systemic influence when neglected, which it usually is.

Table 4. Post Hoc Tests Multiple Comparisons of case subgroups by Tukey HSD

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Ph	2	4	.2200	.1904	.489
		6	-.3500	.1904	.176
	4	2	-.2200	.1904	.489
		6	-.5700*	.1904	.016
	6	2	.3500	.1904	.176
		4	.5700*	.1904	.016
Buffercap	2	4	-.05000	.21549	.971
		6	-.32000	.21549	.314
	4	2	.05000	.21549	.971
		6	-.27000	.21549	.433
	6	2	.32000	.21549	.314
		4	.27000	.21549	.433
FR	2	4	-.12100	.08204	.319
		6	-.12400	.08204	.302
	4	2	.12100	.08204	.319
		6	-.00300	.08204	.999
	6	2	.12400	.08204	.302
		4	.00300	.08204	.999
Protein	2	4	-.15000	.18717	.705
		6	.11500	.18717	.814
	4	2	.15000	.18717	.705
		6	.26500	.18717	.347
	6	2	-.11500	.18717	.814
		4	-.26500	.18717	.347
SAlb	2	4	-.11100	.16598	.783
		6	-.01100	.16598	.998
	4	2	.11100	.16598	.783
		6	.10000	.16598	.820
	6	2	.01100	.16598	.998
		4	-.10000	.16598	.820
sIgA	2	4	.01700	.03127	.851
		6	.03400	.03127	.530
	4	2	-.01700	.03127	.851
		6	.01700	.03127	.851
	6	2	-.03400	.03127	.530
		4	-.01700	.03127	.851
Calcium	2	4	2.31300	1.17623	.140
		6	3.15500*	1.17623	.032
	4	2	-2.31300	1.17623	.140
		6	.84200	1.17623	.756
	6	2	-3.15500*	1.17623	.032
		4	-.84200	1.17623	.756

* The mean difference is significant at the 0.05 level.

These parametric changes hence, would indicate the more sensitive parameters in various age groups. The various age based subgroups of controls and periodontitis cases of our study were analysed with whole unstimulated saliva for:

- Three physical parameters of saliva (pH, Buffer capacity, Flow rate)
- Four biochemical parameters of saliva (total protein, salivary albumin, sIgA, calcium)

Thus, it was presumed that, the parameters which would show statistically significant value alterations would prove to be salivary components that are indicators of status of oral mucosal integrity. In our study the parameter that showed the most sensitive as well as, persistent change in its' p' value and correlation analysis was the pH of saliva in the young adults and elderly adults subgroups of cases. The pH, influences other parameters, both biochemical & physical and therefore, leads to alterations of their values, some of them to a statistically significant extent like those of buffer capacity and flow rate. Rising of pH with flow rise is due to increase in bicarbonate ions in saliva thereby, leading to a dramatic increase in buffering power of saliva (Mandel, 1987). pH also influences viscosity of saliva and precipitation of calcium-phosphate salts which form calculus by a simultaneous increase in itself and the buffer capacity of saliva. So, together with ureolysis in dental plaque which facilitates crystal precipitation and also demineralization it leads to - super saturation of saliva with respect to, the calcium-phosphate salts, which is the DRIVING FORCE of calculus formation.It is further facilitated by an increased pH which is therefore aptly called the FACILITATOR of calculus formation and thus periodontal pocket formation. In the study by (Watnobbe *et al*., 1996) and another study by Sewon *et al*, 1998 (Sewon Makela, 1990), no correlation was found between changes in buffering capacity of saliva for controls and periodontitis cases but in the study by Preethi *et al*. 2010 (Preethi, 2010), changes in pH and buffering capacity were simultaneous and showed correlation with caries activity status of children. In various other studies as of J Goriene, 2008 and A. Hegde,2010 (Gorriena, 2008; Hegde Anupama, 2010), pH was altered in mentally handicapped and diabetics and therefore was responsible for dental caries and as monitoring indicator of

Correlations Control: Correlations

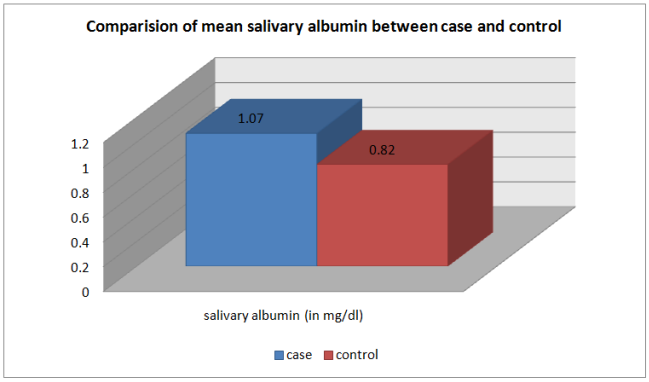
		Ph	Buffercap	FR	Protein	SAlb	sIgA	Calcium
Ph	Pearson Correlation	1	.684**	-.055	-.001	.078	-.216	.260
	Sig. (2-tailed)		.000	.772	.995	.681	.251	.166
Buffercap	Pearson Correlation	.684**	1	.011	-.226	-.069	-.094	.311
	Sig. (2-tailed)	.000		.953	.231	.719	.621	.094
FR	Pearson Correlation	-.055	.011	1	-.243	-.046	.235	-.390*
	Sig. (2-tailed)	.772	.953		.197	.807	.211	.033
Protein	Pearson Correlation	-.001	-.226	-.243	1	.564**	.209	.020
	Sig. (2-tailed)	.995	.231	.197		.001	.268	.916
SAlb	Pearson Correlation	.078	-.069	-.046	.564**	1	-.045	-.170
	Sig. (2-tailed)	.681	.719	.807	.001		.812	.368
sIgA	Pearson Correlation	-.216	-.094	.235	.209	-.045	1	-.307
	Sig. (2-tailed)	.251	.621	.211	.268	.812		.099
Calcium	Pearson Correlation	.260	.311	-.390*	.020	-.170	-.307	1
	Sig. (2-tailed)	.166	.094	.033	.916	.368	.099	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

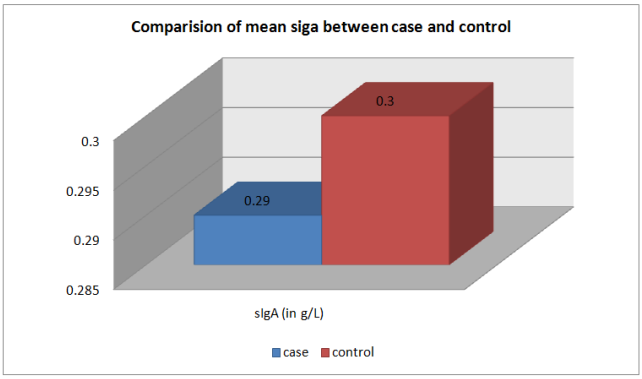
Correlations Diseased: Correlations

		Ph	Buffercap	FR	Protein	SAlb	SIgA	Calcium
Ph	Pearson Correlation	1	.771**	.228	-.089	-.036	-.380*	-.136
	Sig. (2-tailed)		.000	.226	.641	.849	.038	.474
Buffercap	Pearson Correlation	.771**	1	.367*	-.155	-.150	-.454*	-.062
	Sig. (2-tailed)	.000		.046	.414	.429	.012	.745
FR	Pearson Correlation	.228	.367*	1	.076	-.093	-.133	-.093
	Sig. (2-tailed)	.226	.046		.690	.625	.485	.624
Protein	Pearson Correlation	-.089	-.155	.076	1	.695**	.167	.233
	Sig. (2-tailed)	.641	.414	.690		.000	.378	.215
SAlb	Pearson Correlation	-.036	-.150	-.093	.695**	1	.275	.063
	Sig. (2-tailed)	.849	.429	.625	.000		.141	.739
sIgA	Pearson Correlation	-.380*	-.454*	-.133	.167	.275	1	.129
	Sig. (2-tailed)	.038	.012	.485	.378	.141		.496
Calcium	Pearson Correlation	-.136	-.062	-.093	.233	.063	.129	1
	Sig. (2-tailed)	.474	.745	.624	.215	.739	.496	

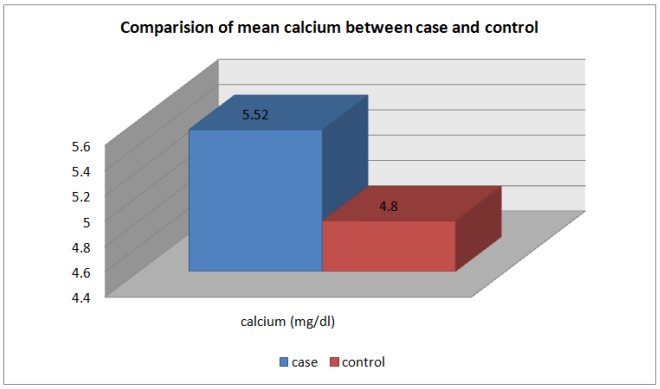
**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed).



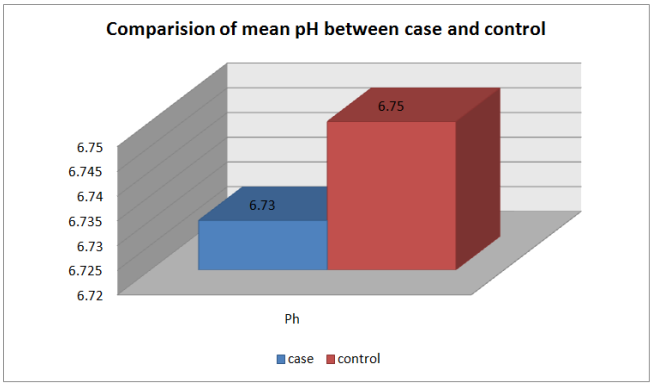
Graph 1.



Graph 2.

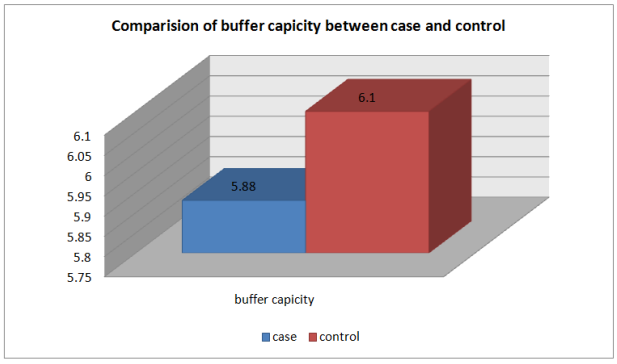


Graph 3.

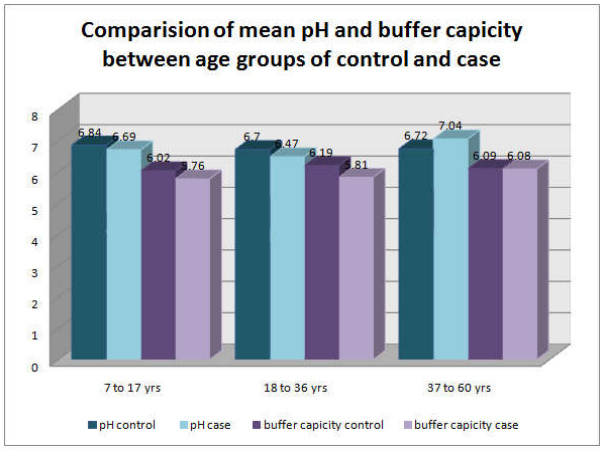


Graph 4.

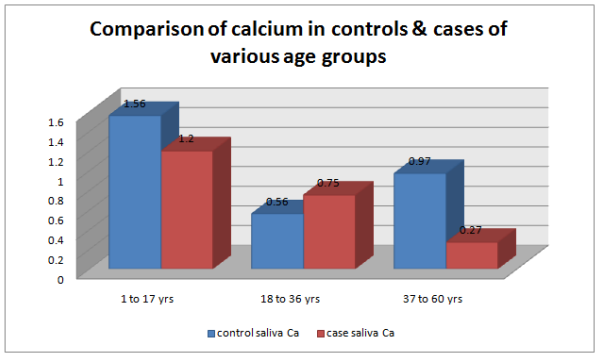
glycemic status respectively. In our study flow rate correlated with buffering capapcity of saliva in the periodontitis cases. In the study by Tibor K Fabion *et al*, 2007, (Tibor, 2007), also, flow rate correlated with buffering capapcity of saliva in the periodontitis cases possibly suggesting that, knowledge of the patient's salivary flow status is of importance to a clinician for judging the susceptibility of oral structures to disease influenced alterations and hence their prevention.



Graph 5.



Graph 6.



Graph 7.

In our study significant correlation was found between sIgA levels, flow rate, pH, buffer capacity. Flow rate increase due to nervous stimulation leads to increased delivery of sIgA to saliva which probably inhibits bacterial adherence and colonization by blocking surface structures involved in the binding (Van Nieu, 2004 and Pienihakkinen, 1987). In the study by Guren *et al*, 1982, also, there was an increase jn sIgA concentration of saliva with increase in severity of gingival inflammation but according to a study by Mandel 1980, no such change was observed (Gorriena, 2008 and Mandel, 1980). In our study also, as in the study by Sewon *et al*., (Sewón, 1995), an increase in calcium content of saliva in Periodontitis patients was noted but it correlated with flow rate changes in our study, whereas in study by Sewon *et al*., (Sewón, 1995) no such correlation was noted.

In our study an intersubgroup comparison of cases showed a highly significant change of calcium values between children and older adults. In saliva, albumin is a component of the Acquired pellicle and it is found in a complexed form with proline rich glycoproteins of pellicle which play an effective role in lubrication of oral tissue surfaces. A very highly significant increase was seen in salivary albumin levels coupled with an increased protein level in periodontitis cases. In studies by Hofman LF *et al*, 2001 and Makkonen TA *et al*, 1994, the findings were similar to our study (Makkonen, 2004 and Hofman, 2001). Thus, we conclude from our study that although sample size was small the results showed that to a significant extent, changes in physical properties in periodontitis cases were interrelated to each other and also to some of the biochemical properties like calcium and sIgA. However, changes in albumin and therefore total proteins was to a greater extent a direct effect of periodontal inflammation. The need of the hour therefore, is of defining a value range of this parameters as normal & abnormal and hence make their estimation indicative of disease occurrence, progression or regression in the oral tissues.

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