

The Influence of the Chemical Composition of the Saliva, Buffer Capacity and the Salivary pH on Children with Diabetes Compared to Non-diabetics

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The aim of this study was to evaluate some salivary parameters (flow and pH) and also the buffer capacity of the saliva in children with diabetes versus non-diabetic children, as a low buffering capacity of the saliva increases the carious process and premature aparition of the decays. It is known that patients with diabetes have the secretion and chimical composition of the saliva different compared to non-diabetic subjects but no research was stimated for young patients. Our study took place between 2013 - 2015 and included 148 patients (62 diabetics and 86 non-diabetic children), with the age between 7-18 years. It was used Saliva-Check Buffer Kit. The children with diabetes had an unstimulated salivary flow average of 0.15 ml/min versus 0.36 ml/min for children without diabetes. The average flow of stimulated saliva was similar in both groups: 2.2 ml/min in children with diabetes and 2.5 ml/min in non-diabetic children. A high buffering capacity of saliva may be seen in patients without diabetes, average of buffering capacity of the saliva is 9.6, and the buffering capacity of diabetic patients saliva has an average of 5.09. Diabetic patients have significantly lower salivary pH compared with non-diabetic patients. pH average was 6.0 for children with diabetes and 7.0 for non-diabetic patients. The increasing number of children with diabetes recommends an adequate assessment of salivary clinical parameters, such as spontaneous salivary flow and buffering capacity of saliva, both obvious and significant modified in our study in diabetic patients.

Keywords: children, diabetus mellitus, pH, salivary flow, buffer capacity

Studies show that the number of cases of type I and II diabetes is increasing in children in many countries [1]. In the literature are datas that prove the existence of evidence that salivar secretion and chemical composition are different in patients with diabetes compared to non-diabetic subjects [2, 3]. Diabetes mellitus is a group of metabolic diseases characterized by high blood glucose levels due to problems in secretion of insulin or insulin action or both.

The number of cases of diabetes in children has increased almost three times in the last two decades. In 1988 there were three new cases of diabetes annually to one hundred thousand children, and in 2008 there are nine new cases per hundred thousand children. Almost 2.500 children are insulin-dependent, 500 have type 2 diabetes and obesity. Almost 42% of diabetics have between zero and five years and 58% were between 6 and 18 years. The Czech Republic has a slight increasing incidence of diabetes with a average increase of 300 new children diagnosed diabetes per year [4].

Periodontal disease is considered by some authors as the sixth complication of diabetes, the association of these two diseases is well known and extensively studied. There are numerous scientific studies that have shown an increased prevalence of inflammatory disease of periodontal tissue in patients with diabetes. In a study on children with diabetes in Brazil with an average age of 13 years, authors noted gingivitis in 21% cases and periodontitis 6% [5]. Diabetes is thought to be a contributing factor of periodontitis [6]. In Kuwait, India and Puerto Rico was also observed and increased risk of dental caries in

diabetic patients [7]. Zalewska et al. [8] believe that the salivary glands suffer functional changes that decreases salivary secretion and when diabetes is installed sooner the changes are greater. Other studies show that children with diabetes accumulates more plaque and periodontal problems are higher compared with healthy children [9].

We would like to propose a well defined methodology examination that motivates the exact reason for choosing a specific objective examination techniques, so that errors are minimized. The aim was to estimate the prevalence of periodontal damages in our country, given the lack of national prevention programs in this regard or in health education.

Experimental part

In our research we succeeded to measure the salivary pH and to establish stimulated saliva buffer capacity in diabetic subjects compared with nondiabetic subjects, in order to evidientiate the differences between the two categories of patients. We focused on the children patients because it becomes a frecvent desese at this age and the buffering capacity of saliva offers a natural resistance to carious process.

There were 143 children in the study, 68 children with diabetes and 75 nondiabetic children. The study group ranged in age between 5-18 years. Both groups were homogeneous in terms of age and sex.

For the salivary pH we instructed the patient to expectorate the collected saliva into the collection cup. Then, with a pH test strip placed into the sample of collected saliva after 10 s we checked the color. The color obtained

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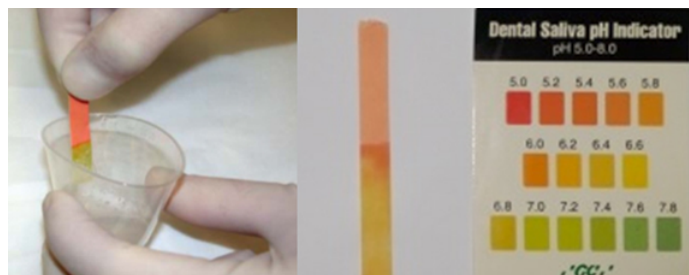


Fig.1. Salivary pH testing. a) saliva collection cup with and salivary strip immersed for 10 s; b) salivary strip; c) salivary chart indicating a pH of 6.4 for the strip presented

is compared with the diagram of the kit (fig. 1). As the color comparison with the diagram of the kit indicates, the saliva can be :

- between 5 and 5.8 highly acidic
- between 6 to 6.6 moderately acidic
- between 6.8 and 7.8 healthy saliva

For the buffer capacity of saliva the patient is instructed to chew a piece of wax to stimulate salivary flow, after which, for a period of five minutes, the patient spit the accumulated saliva in the collection cup. Tear the foil packaging protection of the buffer capacity test strip and place the strip onto an absorbent tissue. Test strip is used immediately after the package was opened. Using a pipette, draw sufficient saliva from the collection cup and dispense one drop of saliva onto each of the three areas on the test strip. Immediately turn the strip 90° to soak up excess saliva on the absorbent tissue. This will prevent the excess saliva from swelling on the test pad and possibly affecting the accuracy of the test result. Test strip will begin to change color immediately and after 2 min. The final result is calculated by giving each corresponding color points according to the table converter as is shown in figure 2. Where the combination of colors is unclear it is used intermediate score.

The clinical issues for the test strip after 2 min were granted 4 points for green; 3 points for green/blue; 2 points for blue; 1 point for red/blue and 0 points for red. We gathered the total of the three pads obtained and the final results are interpreted as follows:

- 0-5 points for a very low buffering capacity
- 6-9 points for a low buffering capacity
- 10-12 points for a normal to high buffering capacity

We divided the glycemic status of diabetic patients in:

- convenient glucose (126 mg% <fasting plasma glucose < 150 mg%)
- slightly unbalanced diabetes (151 mg% <fasting plasma glucose < 200 mg%)
- moderate unbalanced diabetes (201 mg% <fasting plasma glucose < 250 mg%)
- severely unbalanced diabetes (251 mg% <fasting plasma glucose < 350 mg%)

Results and discussions

The 143 patients were registered as is indicated in table 1. The data processing was obtained by the statistic T test.

The largest number of diabetic patients in our study had slightly unbalanced diabetes (39 cases) . Moderately unbalanced diabetes and conveniently glucose had an equal number of cases (12 cases). It is noteworthy, however, that there are 5 cases of glucose above 251 mg% (severely unbalanced diabetes) as it is revealed in table 2.

It is noted statistically significant ($p < 0.0001$) correlations, revealing a difference between the average pH in diabetics and average pH in nondiabetics, meaning that those with diabetes had a lower average of pH, a moderately acidic saliva to a acidic saliva (6.3529), while

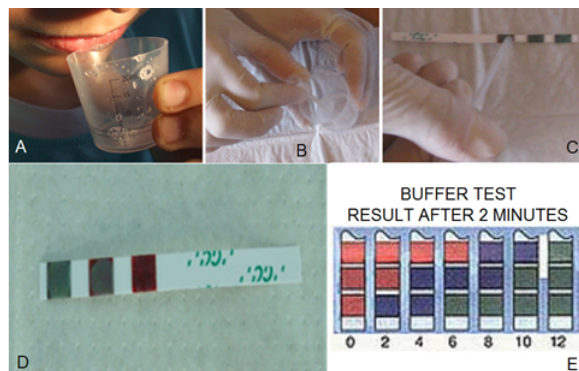


Fig.2. Salivary buffering capacity. pH. a) collecting the saliva into the collection cup; b) droplet collection into a pipette of saliva; c) droplet distribution of the saliva on the test strip; d) after 2 min the test strip changes colours; e) table converter indicating a 6 points for the test strip shown

Table 1

DISTRIBUTION EXAMPLES OF SALIVARY pH AND BUFFERING CAPACITY OF SALIVA ACCORDING TO DIABETIC STATUS

Patients nr.	Confirmed diabetic status	Salivary PH	Buffering capacity of saliva
1	YES	5.6	3
2	YES	6.2	4
3	YES	6.2	4
4	YES	6.8	5
5	YES	6.0	4
.....			
64	YES	7.0	6
65	YES	6.0	5
66	YES	7.2	7
67	YES	6.4	7
68	YES	5.8	3
69	NO	7.4	11
70	NO	7.2	10
71	NO	7.2	9
72	NO	7.0	9
73	NO	6.6	7
.....			
139	NO	7.0	9
140	NO	7.4	10
141	NO	6.8	9
142	NO	6.8	8
143	NO	7.2	10

Table 2

DISTRIBUTION OF DIABETIC PATIENTS ACCORDING TO THEIR GLYCEMIC STATUS

Glicemic status	number of patients	%
1.00	12	17.6
2.00	39	57.4
3.00	12	17.6
4.00	5	7.4
TOTAL	68	100.0

the average is higher in nondiabetic, healthy saliva (7.4133) as shown in table 3. Decreased salivary pH in patients with T1D is clear evidence of saliva buffer capacity reduction and an increased risk of dental caries.

There are reports indicating that patients with diabetes have more acidic saliva while others have not reported this difference. It is not clear yet whether caries risk may be higher in children with diabetes due to damage on

pH for type	Number of patients	Mean	Standard Deviation
diabetics	68	6.3529	0.3458
non diabetics	75	7.4133	0.4428

Table 3
SALIVARY pH IN DIABETIC VERSUS
NON-DIABETIC PATIENTS

Buffering capacity for type	Number of patients	Mean	Standard deviation
diabetics	68	5.09	1.39
non diabetics	75	9.61	2.46

Table 4
BUFFER CAPACITY OF SALIVA IN
DIABETIC VERSUS NONDIABETIC

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
Constant	18.490	1.591		11.619	0.000
pH	3.756	0.229	0.810	16.383	0.000

Table 5
THE CONNECTION BETWEEN
THE BUFFER CAPACITY
TOWARDS pH

salivary factors compared to non-diabetic children. In addition to conflicting reports, salivary parameters should be measured in children with diabetes, as we already said that until now the clinical studies have been performed in adults.

A high buffer capacity of saliva can be observed in nondiabetic, the average of buffer capacity of saliva is 9.61. This amount is classified in the third category of normal to high buffer capacity. In diabetics, buffer capacity of saliva, with an average of 5.09 is classified as very low buffer capacity of the saliva. We have indicated a significant difference $p < 0.0001$ between the average of buffer capacity of saliva in diabetics and the average of buffer capacity of saliva in nondiabetics (table 4). Subjects with a low pH has also a lower buffer capacity with a significant difference of $p < 0.001$. It is known that an acid pH increases the risk of tooth decay.

A synthese of the research is shown in table 5, regarding the connection between the buffer capacity and pH. As a result knowing the pH we can found out the buffer capacity of the saliva using the equation (1).

$$\text{Buffer capacity} = 3.756 \text{ pH} - 18.49 \quad (1)$$

Periodontal disease is a major problem facing the dentist with a high frequency in the population, which includes many clinical entities, depending on the age of onset of the disease, extent of lesions, speed of disease progression, etc. Diagnostic modalities of these diseases are in many cases laborious, and treatment options are often limited. Successful treatment depends on early detection of disease, when destructive lesions are minimal.

Lopez et al. [10] observed in pH small differences between the sexes in both groups also because of the age differences between the sexes. Some authors have found significant differences between diabetics and those nondiabetic regarding stimulated buffer capacity of saliva, just like in this study, but there were also authors that found no differences Thorstensson et al. [11, 12] came to the conclusion in the study on diabetics versus non-diabetic children that there are no significant differences between groups in terms of buffering capacity. In the study done by Moreira et al. [13] saliva of people with diabetes is both quantitatively and qualitatively changed. The only difference found by El-Tekeya et al. [14] in children with diabetes and healthy ones was the value of mutans streptococci. Differences between the results may be due to different methods of determination.

This theme was chosen for the reason that in our country there were not, to our knowledge, recent communications on the subject and most clinical studies up to now have only been performed in adults [15]. Saliva has a major role in preserving the oral cavity homeostasis [16].

This study inform the public and healthcare professionals about the need to prevent diabetes complications in her mouth by reducing buffering capacity. An additional care to prevent plaque and tartar accumulation could be recommended particularly at patients with poorly controlled diabetes. We propose also to further investigate the impact that diabetes has on the health of the oral cavity. Establish measures aimed on early intervention and prevention of periodontal disease complications in diabetic patients, also to monitoring salivary secretion and measuring pH together with buffer capacity in these patients to maintain these values at glycemic status placed in convenient glucose. It is imperative to implement a plan to educate diabetics children and those non-diabetic on oral cavity care to reduce the risk of periodontal disease. Health education must fulfill depending on purpose multiple roles. The first role would be the preventive one in which children will be educated on the need for a proper brushing properties. Other role would be curative, to follow the recommendations made by the dentist and making the necessary treatments. Education for learning the techniques of brushing is recommended to be done in small groups, on level of classes, groups. Dentist with educator or teacher, as appropriate, will develop courses using methods such as visual slides, posters, drawings and models imitating toothbrushes and dental arches to impact and capture children's attention. A stage of assuming the results of the course is recommended so that it can be tested the instruction levels of groups of children who received prior education program.

Conclusions

Buffer capacity of saliva is significantly lower in diabetics and fits into the category of very low buffering capacity of saliva versus nondiabetic children that fits from normal to high buffering capacity. The efficiency of the saliva to neutralize the acids in the oral environment is very low in diabetic patients. Patients with diabetes showed a salivary pH significantly lower compared to non-diabetic patients. Salivary pH average was 6.35 for children with diabetes and represents an acid saliva when the non-diabetics have a base saliva with an average of 7.4.

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