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CORRELATION BETWEEN THE pH VALUE OF STIMULATED AND UNSTIMULATED SALIVA AND THE CARIES RISK IN CHILDREN

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ABSTRACT

The study aimed to determine the pH value in stimulated and unstimulated saliva in children with a low and high risk of caries, which could correlate with the prevalence of caries. This prospective study included 123 children with permanent dentition, approximately equal sex, aged 13 to 15. Two saliva samples were taken from low and high caries risk patients - unstimulated and stimulated. Saliva samples were collected in sterile tubes, and the pH value was directly determined using a pH meter. The significance of differences in saliva pH values between groups of children at high and low risk was analyzed before and after stimulation of secretion. In the group of children at high risk, the pH values of saliva were statistically significantly lower ($p < 0.001$) compared to the group at low risk, both in basal conditions and after stimulation. The high pH value of the stimulated saliva group with low caries risk plays a significant role in neutralizing the local acidic environment of the oral cavity.

INTRODUCTION

The remineralization process is directly dependent on the presence of ions in saliva. Saliva is a supersaturated solution of calcium and phosphate during secretion, so it is called "liquid enamel." The degree of oversaturation in plaques is even more pronounced. In dynamic equilibrium, saliva oversaturation is a barrier to demineralization and a prerequisite for the remineralization process. This balance is primarily maintained by fluorides, reducing demineralization and enhancing mineralization. Saliva oversaturation decreases only when the pH in the plaques drops low enough to reduce the concentration of hydroxyl and phosphate ions below critical values (by binding PO4 ions to HPO4).[1]

Clinical studies show that stimulated saliva is more saturated than unstimulated, so it is concluded that stimulated saliva is a good remineralizing solution. Numerous salivary proteins (staterin, acidic proteins rich in proline, and many phosphoproteins) support the remineralization of the subsurface enamel lesion. These proteins can bind calcium and prevent the precipitation of calcium salts in a supersaturated solution such as saliva in plaque. As the pH in the plaque decreases and the concentration of calcium and phosphate in the fluid decreases, staterin releases them, and their increase is a prerequisite for remineralization. With increasing of the saliva secretion and increasing of pH values, the secretion of staterins also increases.[2]

One of the basic roles of saliva is to maintain the mineral composition and preserve the surface of hard dental tissues, which are provided by a constant concentration of calcium and phosphate ions. The source of these ions is the dynamic processes of precipitation and dissolution of calcium hydroxyapatite (HAP), the essential inorganic components of hard dental tissues. These processes are directly related to the pH value of the oral environment. When the pH value of the oral environment drops, the thermodynamic conditions become unfavorable, and HAP dissolution (demineralization) occurs. When the pH value in the mouth normalizes, the thermodynamic conditions become favorable, which leads to HAP precipitation (remineralization).[3]

Anderson points out that for de- and remineralization processes, the concentration of calcium ions is also critical in addition to the pH value of saliva. The concentration of calcium from the parotid and submandibular salivary glands increases with the stimulation of salivary secretion in the parotid gland from 0.76 to 1.7 mmol / l and submandibular from 1.5 to 2.2 mmol / l, in the range of secretion from 0, 1 to 3.1 ml/min. It follows from the above that the concentration of calcium ions can increase several times under stimulation conditions, which has a beneficial effect on the remineralization potential of saliva.[3]

MATERIAL AND METHODS

This prospective study included 123 children with permanent dentition, approximately equal sex, aged 13 to

15 years (stratified sample) at the Thumbay Medical and Dental Specialty Center (TMDSC) Sharjah, UAE.

The reason why children of higher grades of primary school were chosen with permanent dentition present is the desire to avoid mixed dentition because DMF (D = decay, E = extracted, F = filling, which represents the total number of teeth with caries, teeth with fillings and extracted teeth) in the conditions of mixed dentition is primarily a consequence of caries of deciduous teeth, which would "mask" the accurate picture of the patient's DMF, which would compromise the results obtained.

Each patient underwent a systematic dental examination and determined the DMF of permanent teeth. The patients were then divided first into two groups based on the DMF of each child.

The first group of respondents includes 52 patients whose average DMF is zero (0) - children with a low risk of caries. The second group consists of 71 patients with an average DMF per child of 7.7 - children at high risk for caries.

Two saliva samples were taken from the patients of both groups - unstimulated and stimulated. Saliva samples were collected in sterile tubes. Samples of unstimulated saliva were taken between meals by collecting saliva currently present in the mouth before noon. Stimulated saliva samples were taken after the patients, also between meals in the morning, chewed medical paraffin for five minutes, which caused extensive secretion of stimulated saliva. Four groups of saliva samples were defined and explained in the following (table 1)

Table 1: Four groups of saliva samples.

Groups	*Type of saliva*	*Risk levelfor caries*	*Number of samples*
I – NNR	Non-stimulated	low	52
II - SNR	Stimulated	low	52
III - NVR	Non-stimulated	high	71
IV - SVR	Stimulated	high	71

Saliva samples were collected in sterile tubes, which were immediately sealed to prevent bicarbonate loss from the sample. The pH value in the models was directly determined using a pH meter.

Data were processed using standard descriptive statistical methods (mean, standard deviation, and correlate on the analysis). The results were analyzed using appropriate tests, depending on the size of the group and the type of trait. Statistical processing was done within and between defined groups.

RESULTS

Determination of the pH value of the salivary group of a low-risk patient was performed under conditions of basal and stimulated secretion. The mean pH of unstimulated saliva was 6.66 ± 0.32. In the same group of children, the average pH value of stimulated saliva was statistically significantly lower (6.8 ± 0.22; p <0.001) compared to the values in unstimulated saliva

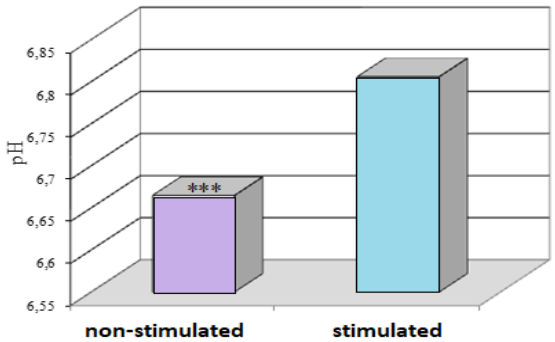

Figure 1: pH values of saliva in children with LOW risk for caries (*p<0.001 vs stimulated).**

In the group of patients at high risk for caries, the mean pH of unstimulated saliva was 6.21 ± 0.34, while in stimulated saliva, there was a statistically significantly (p <0.01) lower value (6.12 ± 0.39).

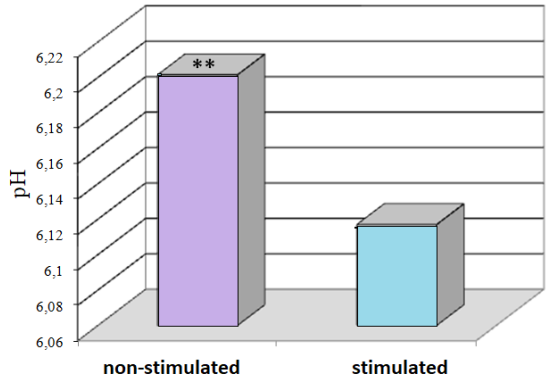

Figure 2: pH values of saliva in children with HIGH risk for caries (p<0.001 vs stimulated).**

The significance of differences in saliva pH values between groups of children at high and low risk was analyzed before and after stimulation of secretion. In the group of children at high risk, the pH values of saliva were statistically significantly lower (p <0.001) compared to the group at low risk, both in basal conditions and after stimulation

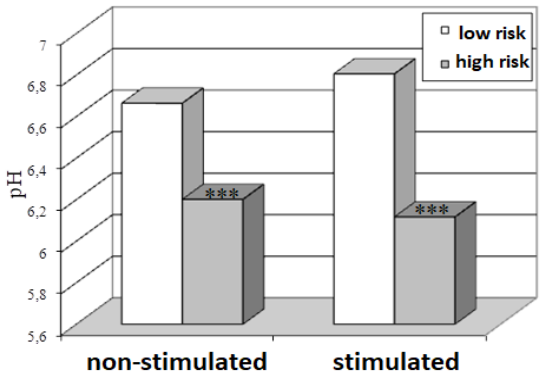

Figure 3: Values of pH of saliva and relationship with caries risk and type of saliva (*p<0.001 vs stimulated).**

DISCUSSION

PH is a measure of the acidity or alkalinity of saliva. pH value 7 is defined as "neutral" at 25 degrees Celsius. At this temperature and the mentioned pH value of 7, the concentration of H3O + is equal to the concentration of OH- ions in pure water. The pH values of saliva in children range from 6.2 to 7.4. With the increase in saliva secretion, its pH value increases. The results of numerous studies point out that the pH value of stimulated saliva (6.3 - 7.8) is higher than that of unstimulated saliva between the values 6.1 - 7, 5.[4],[5]

These data are from the research results, where the mean pH value of stimulated saliva is 6.8 ± 0.22 in children with low caries risk. When these results are compared with the mean pH values of unstimulated saliva of the same test group (6.66 ± 0.32), a statistically significant ($p < 0.001$) decrease in pH before secretion stimulation was observed. The presented data support the fact that the ability of stimulated saliva to reduce local acidity is a significant factor in caries reduction.[6]

Long-term saliva stimulation leads to a decrease in its buffering capacity because the total amount of bicarbonate decreases. During long-term stimulation (e.g., chewing gum), the bicarbonate value drops to about 15 mmol / L, which depletes its buffering power despite further stimulation. As the pH value of saliva depends on the presence of specific buffers, whose synthesis in the salivary glands is genetically determined, it is almost impossible to influence the change of physiological pH values, which are individual and prone to mild variations.[7]

The research results in the examined group of children with high caries risk show the opposite relationship. Mean pH values of unstimulated saliva were 6.21 ± 0.34, and stimulated saliva was 6.12 ± 0.39, with statistically significantly lower values during stimulation ($p < 0.01$). Analysis of the results concludes that stimulation of saliva secretion in this study group causes the opposite effect in terms of lowering the pH of the whole saliva, which undoubtedly leads to a local increase in acidity with the consequent development of many carious lesions. The values obtained in the study agree with the results of other authors, who emphasize the importance of individual variations in the pH value of stimulated saliva in the occurrence and evolution of caries.[8]

The results of the mentioned authors speak in favor of the fact that the higher pH value of stimulated saliva significantly reduces the acidity on the tooth surface, which reduces the release of H + ions from the enamel surface, which ultimately reduces the number of newly formed carious lesions.[9]

When comparing the obtained results of mean pH values of unstimulated and stimulated saliva of both groups of subjects (high and low risk of caries), it is noticed that low- risk is statistically significantly higher pH values. This statistical significance, expressed in both unstimulated and stimulated saliva, indicates that the pH value of the group of subjects with low caries risk is essential in reducing caries in children. By the known literature data, it can be said that pH value is one of the critical parameters in the assessment of caries risk.[2]

As already pointed out, the pH value of saliva is an individual category, hereditarily conditioned and unchangeable, dependent on the secretion of salivary glands.[10]

However, that saliva contains certain substances that are able to increase the pH iodinated l plaque. Such a substance is sialin - a small tetrapeptide that contains arginine and is present in parotid saliva.[11] The essential amino acid arginine also raises the pH value, thanks to its two amino groups that are released by the enzymatic reaction of bacteria to form ammonia. The concentration of ammonia in saliva ranges from 2 to 6 mmol / L, and it originates from deaminated amino acids of bacteria and secreted urea. The urea molecule decomposes under the action of the urease enzyme on ammonia and carbon dioxide, which leads to an increase in the pH value in an acidic environment. Increased urea levels in saliva affect the etiopathogenesis of caries because it reduces its incidence, which has been observed as a low prevalence of caries in children with severe renal dysfunction.[12]

CONCLUSION

Statistically, significantly higher pH values in both examined types of saliva - stimulated and unstimulated, in the group of subjects with low caries risk, indicate the importance of this parameter in the prevalence of caries. A negative correlation was observed between pH and caries incidence. The high pH value of the stimulated saliva group with low caries risk plays a significant role in neutralizing the local acidic environment of the oral cavity.

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