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Saliva pH testing in predicting dental caries in children aged 7–10 years

Badanie pH śliny w predykcji ryzyka choroby próchnicowej u dzieci w wieku 7–10 lat

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STRESZCZENIE

Wstęp: Próchnica zębów jest najbardziej rozpowszechnioną chorobą narządu żucia. Według raportów WHO oraz FDI nie udało się zmniejszyć epidemii próchnicy. W Polsce zachorowalność dzieci na próchnicę zębów utrzymuje się na wysokim poziomie i jest jedną z najwyższych w Europie. **Cel:** 1. Ocena wartości badania pH śliny jako testu screeningowego w modelowaniu ryzyka wystąpienia choroby próchnicowej zębów u dzieci. 2. Ocena korelacji wartości pH śliny ze stanem jamy ustnej wyrażonym za pomocą wskaźnika PUW. **Materiał, metody:** Badaną grupę stanowiło 128 dzieci w wieku 7–10 lat. Badanie polegało na: 1. Dokonaniu przeglądu uzębienia, przy pomocy podstawowych narzędzi stomatologicznych, 2. Ocenie pH śliny pacjenta za pomocą papierka lakmusowego. Na podstawie przeprowadzonych przeglądów jamy ustnej, wyznaczono dla każdego pacjenta wskaźnik PUW. **Wyniki:** 1. Występowanie próchnicy – 75,8%. 2. Odsetek dzieci z usuniętymi zębami – 18%. 3. Odsetek dzieci leczonych – 79,7%. 4. Wartość korelacji współczynnika PUW oraz pH śliny: 0,693; -0,730 ($p = 0,000$). **Wnioski:** 1. Stan zdrowia jamy ustnej dzieci w wieku 7–10 lat jest zły. U 76% stwierdza się próchnicę, 18%

ABSTRACT

Introduction: Dental caries remains the most widespread disease of the masticatory system. According to WHO and FDI reports, the epidemic of dental caries has not been reduced. In Poland, dental caries prevalence among children remains high and is among the highest in Europe. **Aims:** 1. to assess the values of saliva pH testing used as a screening test for assessing the risk of dental caries in children. 2. to assess the correlation of saliva pH testing with the condition of the oral cavity, expressed by means of the DMF index. **Material, methods:** The research group consisted of 128 children aged 7–10 years. The research involved: 1. a check-up performed by means of basic dental instruments. 2. assessment of patient's saliva pH by means of a litmus paper. On the basis of the check-ups performed, the DMF index was established for each patient. **Results:** 1. Presence of dental caries – 75.8%. 2. Percentage of children with missing teeth – 18%. 3. Percentage of children undergoing treatment – 79.7%. 4. Correlation value of the DMF index and saliva pH: 0.693; - 0.730 ($p=0.000$). **Conclusions:** 1. The condition of health of the oral cavity in children aged 7–10 years is bad. 76% have been diagnosed with dental caries, 18%

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dzieci ma już usunięty przynajmniej jeden ząb. 2. Badanie pH śliny w wysokim stopniu koreluje z aktywną próchnicą zębów, przez co może być użytecznym testem samokontroli stanu zdrowia jamy ustnej u dzieci.

Słowa kluczowe: próchnica, ślina, zdrowie publiczne

Introduction

Dental caries remains the most prevalent disease of the masticatory system [1]. It is closely related to modern living conditions, its severity particularly concerns populations of those countries where refined sugar is consumed in large quantities. World organizations dealing with public health such as WHO or FDI are sounding alarm because, despite the formulated goals to be achieved by the year 2000, the epidemic of dental caries has not been halted, or even, in light of recent research, has not been reduced [2].

According to data by WHO, in Poland dental caries prevalence in children remains high and is among the highest in Europe and in the world [2]. Therefore, prophylaxis is indispensable, accompanied by extensive education of society as a whole, in particular children and youth.

The decay-inducing factor is dental bacterial plaque adhering to teeth, and the specific microorganisms it contains. Saliva is one of the factors influencing the susceptibility of tooth tissues to the intensity of the decay process [3]. According to Shrestha [3], for the processes of decalcification and proteolytic decay of the hard tooth tissues to begin, it is necessary for four factors to occur at the same time:

- susceptibility of tooth tissues,
- existence of dental plaque (bacterial film)
- base, substrate (simple sugars)
- time

The activity of decay-inducing bacteria, in particular *Streptococcus mutans* and *Lactobacillus*, results in generating acids which acidify the environment of dental plaque, which initiates the process of demineralization of hard tooth tissues. Teeth environment is also acidified by the salivary flow rate, viscosity and saliva's buffering capacity, the presence of fluorides in dental plaque and enamel, dietary habits and the frequency of consuming sugars [4].

Saliva plays a key role in the caries disease process as the environment of bacterial activity [5]. The role of saliva begins with the mechanical cleansing of the teeth surface, and dissolving the food mass [6]. Also numerous salivary proteins contribute to its protective activity, like glycoproteins (mucins), histatins, statherins, cystatins, lactoferrin, several immunoglobulins (IgA, IgG, IgM), lysozyme, enzymes and hormones [7]. Numerous cations and anions create buffering components, among which the carbohydrate buffer plays a key role. Daily an adult produces 1-1.5 liters of saliva, consisting in 99% of water. The pH value of fresh saliva is around 6.6.[8]. On the basis

of children have at least one missing tooth. 2. Saliva pH testing is highly correlated with active dental caries, thus it can be a useful self-control test for assessing the condition of health of the oral cavity in children.

Key words: dental caries, saliva, public health

of the experience of Scandinavian countries, one can assume that saliva pH testing is a good and simple way to establish salivary buffering capacity. Saliva's physiological buffering capacity ranges between 5.75 and 6.5 [8]. Lower values indicate acidity of the oral environment, which in healthy patients can result from improper hygiene of the oral cavity, numerous carious lesions, accumulation of dental calculus or improper diet. According to Ahmadi-Motamayel et al. [8], a low pH value of saliva requires a treatment process including, among other things, restoration of homeostasis in the enamel-saliva system. The generation of acids resulting from consuming products containing sugars can be reduced by fluoride components or by using bacteriostatic agents. Saliva pH testing allows to predict the activity of decay-inducing bacteria, and assess the body's defensive capacity [9]. Saliva is a source of information on the condition of health of the oral cavity, and it is also an easy to obtain research material. Saliva pH testing is noninvasive and it does not require large financial outlays or specialist medical equipment. It is an imaging examination, understandable to the patient and motivating to undertake prophylactic activity.

Aims:

The work is aimed:

1. to assess the value of saliva pH testing as a potential screening test in the modeling of the risk of prevalence of decay disease in children,
2. to assess the correlation of the value of saliva pH with the condition of the oral cavity expressed by means of the Decayed, Missing and Filled Index (DMF).

Material

The research group constituted 128 children aged 7-10 years attending schools in the District of Przemyśl.

Inclusion criteria:

1. the presence of mixed teeth (permanent and milk),
2. parental consent to perform the test.

Method

In order to assess the condition of health of the oral cavity the DMF index was used, defined as a sum of teeth with cavities, teeth missing due to decay, and teeth with fillings but without secondary decay [10].

The test involved:

1. a check-up performed by means of basic dental instruments (explorer, mirror, air spray).
2. assessment of patient's saliva pH by means of a litmus paper.

Tab. 5. Correlation of children's saliva pH with the DMF index

Correlation:		Tooth with caries	Extracted tooth	Filled tooth	DMF Index	pH saliva
Decay	Correlation Pearson	1	-,155	-,455**	,693**	-,730**
	Essentiality (two-sided)		,082	,000	,000	,000
	N	128	128	128	128	128
Missed	Correlation Pearson	-,155	1	,051	,055	,083
	Essentiality (two-sided)	,082		,565	,535	,354
	N	128	128	128	128	128
Filled	Correlation Pearson	-,455**	,051	1	,210*	,251**
	Essentiality (two-sided)	,000	,565		,017	,004
	N	128	128	128	128	128
DMF	Correlation Pearson	,693**	,055	,210*	1	-,599**
	Essentiality (two-sided)	,000	,535	,017		,000
	N	128	128	128	128	128
PH	Correlation Pearson	-,730**	,083	,251**	-,599**	1
	Essentiality (two-sided))	,000	,354	,004	,000	
	N	128	128	128	128	128

** . Correlation is significant at 0.01 (mutually).

* . Correlation is significant at 0.05 (mutually).

Discussion

There exists a need to find tools which can help to define the degree of decay danger for a given patient, as well as factors motivating the patient to undertake actions improving the condition of hygiene in the oral cavity. Data concerning hygiene of the oral cavity are an important indicator for the patient and a big motivation to improve prohealth activities. They allow the doctor to draw patient's attention to performing training on hygiene of the oral cavity, as well as identifying a wider group of patients, persons at higher risk for decay. The imaging of the condition of oral cavity hygiene is an important element of health education in dentistry. Its main aim is making the research population aware of the significance of prophylaxis of the diseases of the oral cavity. The goal of prophylactic programmes conducted by dentists is patient education in the area of prevention of the diseases of the oral cavity, which to a great degree depends on oral cavity hygiene, diet, dental hygiene visits and treatment in dental practice.

Analysis of WHO data [2] shows that in the year 2000 Poland did not meet the goals formulated in the 1980's, namely:

- 50% of 5-6 year-olds to be free of dental decay in both permanent and milk teeth,
- The average for dental caries to be no more than 3 DMF at 12 years of age,
- 85% of 18 year-olds with a full set of teeth,
- A 50% reduction in edentulousness among the 35-44 year-olds,
- A 25% reduction in edentulousness at the age of 65 years and over.

Research presented in this work indicates that the goal of reducing the average DMF number in children to the value below 3 pts. has not been achieved even 14

years later, that is in 2014. In the research group, children with the DMF index below 3 points constituted nearly 7%. This proves there is a need for searching for new tools in the fight with decay, including screening tests. The worsening socio-economic conditions in several European countries, including Poland, the times of crisis require cheaper, simpler and repetitive screening methods of the condition of hygiene of the oral cavity. In addition, the long-term previous programmes run by pro-health organizations like WHO or FDI have indicated how important education and patient motivation is to engage in activities improving the quality of hygiene of the oral cavity. Tests which allow to identify and predict the risk for decay involving saliva testing can motivate patients to improve their hygiene of the oral cavity, and if repeated at regular intervals, together with other simple indicators of oral cavity hygiene, allow to control the applied methods. Saliva pH testing should be routinely performed by dental practitioners during check-ups, due to its numerous benefits and great significance in enhancing patient awareness. Thanks to screening, identification of patients at high risk for dental caries from among the overall group of examined patients, will make it possible to involve the target group in educational and prophylactic measures, such as antibacterial and fluoride prophylaxis, or more frequent check-ups. Research [11-13] has proved that saliva takes part in the process of mineralization and demineralization of the hard tooth tissues. At pH levels between 6.8 and 7.2 saliva is a supersaturated solution of calcium phosphates, thus after a slight demineralization the lost mineral components can return to the hard tissues of the tooth from saliva. Saliva and enamel remain in balance. The composition of the buffering components rises. Acidity of the environment (e.g., due to fermentation of sugar by bacterial enzymes) increases the solubility, thus

decreases the degree of saturation of saliva with calcium phosphates and turns into an unsaturated solution. The process of initiation of enamel demineralization and proteolytic dissolution of tissues begins. A lower level of saliva pH is often present at high bacterial activity, which is a signal of inadequate hygiene of the oral cavity. There is a need for working out and popularization of screening tests, which could aid in the assessment of the decay advancement process, and in turn, show the patients their individual susceptibility to decay.

Conclusions

1. The state of health of the oral cavity in children aged 7–10 years is bad. Decay has been identified in 76%, and 18% have missing teeth due to extraction.
2. Saliva pH testing correlates to a high degree with active dental decay, which is why it cannot be a useful self-control test of the condition of health of the oral cavity in children

Bibliografia / Bibliography

1. Krawczyk D, Sikorska-Jaroszyńska MH, Mielnik- Błaszczak M, et al. Dental caries and total antioxidant status of unstimulated mixed whole saliva in patients aged 16-23 years. *Adv Med Sci* 2012; 57: 163-8. doi:10.2478/v10039-012-0015-9
2. Janczuk Z. Caries prevention in children and adolescents in Poland and the realization of the WHO health goals. The possibility of realization till the year 2000. *Czas Stomatol* 1988; 41:193-7.
3. Shrestha A, Mohamed-Tahir M, Hegde J, et al. Caries-risk assessment with a chairside optical spectroscopic sensor by monitoring bacterial-mediated acidogenic-profile of saliva in children. *J Conserv Dent* 2012;14: 395-400.
4. Culp DJ, Robinson B, Parkkila S, et al. Oral colonization by *Streptococcus mutans* and caries development is reduced upon deletion of carbonic anhydrase VI expression in saliva. *Biochim Biophys Acta* 2011; 1567-76. doi:10.1016/j.bbdis.2011.09.006
5. Yang F, Zeng X, Ning K, et al. Saliva microbiomes distinguish caries-active from healthy human populations. *ISME J* 2012; 6:1-10. doi:10.1038/ismej.2011.71
6. Preethi BP, Reshma D, Anand P. Evaluation of Flow Rate, pH, Buffering Capacity, Calcium, Total Proteins and Total Antioxidant Capacity Levels of Saliva in Caries Free and Caries Active Children: An In Vivo Study. *Indian J Clin Biochem* 2011; 25: 425-8. doi: 10.1007/s12291-010-0062-6
7. Denny PC. A saliva-based prognostic test for dental caries susceptibility. *J Dent Hyg* 2009; 83: 175-6.
8. Ahmadi-Motamayel F, Goodarzi M, Hendi S, et al. Total antioxidant capacity of saliva and dental caries. *Med Oral Patol Oral Cir Bucal* 2013; 18: 553-6. doi:10.4317/medoral.18762
9. Zimmer S, Bizhang M, Barthel C, et al. Caries risk assessment - are saliva tests as well as microbiological and clinical test procedures worthwhile? *Gesundheitswesen* 2008; 70: 702-6.
10. Stec M, Pypec J. Ocena intensywności próchnicy oraz częstości występowania zaburzeń rozwojowych uzębienia u dzieci i młodzieży z jedno- lub obustronnym rozszczepem wargi, wyrostka zębodołowego i/lub podniebienia. *Czas. Stomat* 2005; 58: 12
11. Nurelhuda NM, Al-Haroni M, Trovik TA, et al. Caries experience and quantification of *Streptococcus mutans* and *Streptococcus sobrinus* in saliva of Sudanese schoolchildren. *Caries Res* 2010; 44: 402-7. doi: 10.1159/000316664
12. Sanchez-Garcia S, Gutierrez-Venegas G, Juarez-Cedillo T, et al. A simplified caries risk test in stimulated saliva from elderly patients. *Gerodontology* 2008; 25: 26-33. doi: 10.1111/j.1741-2358.2007.00184.x
13. Tayab T, Rai K, Kumari AV. Evaluating the physicochemical properties and inorganic elements of saliva in caries-free and caries-active children. An in vivo study. *Eur J Paediatr Dent* 2012;13:107-12.