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RESULTS OF THE STUDY OF THE MINERALIZING CAPACITY AND HYDROGEN INDICATOR OF THE ORAL FLUID IN CHILDREN TAKING INTO ACCOUNT THE DENTAL STATUS AND AGE

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Caries is one of the most common dental diseases in children, which is characterized by enamel demineralization. The condition of the hard tissues of temporary and permanent teeth is influenced by a significant number of factors, including the oral fluid that is in direct contact with the teeth. The mineralizing ability of the oral fluid affects the state of the hard tissues of the teeth, that is, the acid resistance of the enamel, the decrease of which leads to demineralization with further progression of the carious process. The aim of the study was to study the indicators of the mineralizing potential and the pH of the oral fluid in children aged 7–12 years with caries of temporary and permanent teeth and to compare them with the indicators of children with intact teeth. The dental status of 223 children aged 7–12 years was studied (in each child, the condition of the hard tissues of the teeth was determined and the DMFT (Decayed, Missing and Filled Teeth) in the temporary bite, DMFT/dmft (Decayed, Missing and Filled Teeth) in the variable bite, dft (decayed and filled teeth) in the permanent bite index was calculated), mineralizing potential and pH of the oral fluid were calculated. Indicators were compared in children with and without caries. The course of caries of both temporary and permanent teeth in children occurs against the background of a decrease in pH and microcrystallization of oral fluid. This is especially noticeable in children who have affected permanent teeth. The caries rate of temporary and permanent teeth has inverse correlations with the pH and microcrystallization index of the oral fluid. The obtained data suggest the need for primary and secondary prevention, aimed at improving oral homeostasis indicators, planned remediation, which will make it possible to reduce the prevalence and intensity of caries in children, which will be the subject of our further research.

Keywords: *caries, intact teeth, pH of oral fluid, microcrystallization of oral fluid.*

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Introduction

Caries is one of the most common dental diseases in children, which is characterized by enamel demineralization. Today, it is registered in a significant (up to 90%) part of the child population of the globe [1–3]. In order to maintain enamel resistance at a level that will make it possible to keep teeth healthy, there is a need to create appropriate conditions for this [4; 5].

The state of hard tissues of temporary and permanent teeth is influenced by a significant number of factors [6; 7], including oral fluid that is in direct contact with the teeth. It has certain constants that determine the durability of enamel and the ability to resist the action of cariogenic factors [8; 9].

It is important to study the mineralizing properties of oral fluid, which are closely related to the pH value. The mineralizing ability of the oral fluid affects the condition of the hard tissues of the teeth, that is, the acid resistance of the enamel, the decrease of which leads to demineralization with further progression of the carious process [10; 11].

The aim of the research was to study indicators of mineralizing potential and pH of oral fluid in children 7–12 years old with caries of temporary and permanent teeth and compare with indicators of children with intact teeth.

Materials and Methods

We examined 223 children aged 7–12 with caries of permanent teeth and with intact permanent teeth (134 children aged 7–9, 24 children – 10 years-old, 25 children – 11, and 40 children – 12) from the city of Poltava. In each child, the condition of the hard tissues of the teeth was determined and the DMFT (Decayed, Missing and Filled Teeth) in the temporary bite, DMFT/dmft (Decayed, Missing and Filled Teeth) in the variable bite, dft (decayed and filled teeth) in the permanent bite index was calculated.

The mineralizing potential of oral fluid was assessed by its microcrystallization. Evaluation of microcrystallization was carried out according to Saifulina H.M., Pozdeev O.R. in average scores depending on the types of crystal formation. Assessment of the mineralizing potential of oral fluid: 0.0–1.0 – very low; 1.1–2.0 – low; 2.1–3.0 – satisfactory; 3.1–4.0 – high and 4.0–5.0 – very high. In order to determine the peculiarities of morphological characteristics and the mineralizing potential of oral fluid in children with different levels of enamel resistance, we investigated the mineralizing properties of oral fluid according to indicators of microcrystallization and mineralization potential by the method of Leus P.A. [12].

The hydrogen index of the oral fluid (pH) (before eating) was determined in all examinees using litmus paper with a graduated color scale (5.6-8.0) from the set of the pharmacological drug "Uralit" (Germany). The indicator paper was immersed in oral fluid and compared with a standard color scale.

Student's t-test was used to compare the studied parameters. The correlation coefficient was considered significant at $p<0.05$.

Results and Their Discussion

The study of the hydrogen index in children from 10 to 12 years old showed that its average value in this age period (6.80±0.02) units does not differ from the values of children 7–9 years old (6.83± ±0.01 units) and is in the range of slightly alkaline (*Table 1*).

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Table 1. pH indicator of oral fluid in children 7–12 years old with caries of temporary and permanent teeth and with intact teeth (M±m)

Age of children in years (group) number of patients	pH indicator, unit			p
	Average indicator	In children with intact teeth	In children with caries (DMFT/dmft)	
7–9 (I) n=134	6.83±0.01 n=134	6.97±0.02 n=39	6.77±0.01 n=95	<0.001
10 n=24	6.82±0.03	7.01±0.03 n=5	6.77±0.03 n=19	<0.05
11 n=25	6.80±0.03	6.95±0.08 n=5	6.76±0.02 n=20	<0.05
$p_{10–11}$	>0.05	>0.05	>0.05	
12 n=40	6.79±0.02	6.93±0.06 n=7	6.76±0.02 n=33	<0.05
$p_{10–12}$	>0.05	>0.05	>0.05	
$p_{11–12}$	>0.05	>0.05	>0.05	
10–12 (II) n=89	6.80±0.02	6.96±0.03 n=17	6.76±0.01 n=72	<0.001
p_{I-II}	>0.05	>0.05	>0,05	
Of all examinees n=223	6.82±0.01	6.96±0.02 n=56	6.77±0.01 n=167	<0.001

Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

But there is a significant difference ($p<0.001$) in the average indicator in children with caries and with intact teeth ([6.77±0.01] units, and [6.96±0.02] units, respectively). That is, children without caries had a higher rate than children with affected teeth. In the age aspect, the comparison of the pH indicator did not reveal any significant difference.

The same trend is observed when dividing children who had affected permanent or temporary teeth (*Table 2, Table 3*). During the study, it was found that children with caries always had a lower hydrogen index than children without caries. We did not find significant fluctuations in the activity of hydrogen ions in the oral fluid in age groups.

The next step of our research was to study the mineralizing properties of oral fluid, which are closely related to the pH value. The mineralizing ability of the oral fluid affects the state of the hard tissues of the teeth, that is, the acid resistance of the enamel, the decrease of which leads to demineralization with further progression of the carious process.

This indicator was studied separately in children 7–9 and 10–12 years old with caries of temporary teeth and caries of permanent teeth (*Table 4*).

We found that regardless of whether children have caries of temporary or permanent teeth, the microcrystallization index was better in children without caries, which indicates higher mineralizing pro-

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perties of the oral fluid of children with intact teeth (*Table 5*, *Table 6*). Children with caries of temporary teeth had a microcrystallization index of (1.82±0.04) points against (2.79±0.07) points in children with intact teeth, and with caries of permanent teeth – (1.69±0.06) points and (2.33±0.06) points respectively.

Table 2. pH indicator of oral fluid in children 7–12 years old with caries of permanent teeth and with intact permanent teeth (M±m)

Age of children in years (group) number of patients	pH indicator, unit			p
	Average indicator	In children with intact permanent teeth	In children with caries (DMFT)	
7–9 (I) n=134	6.83±0.01 n=134	6.86±0.02 n=98	6.76±0.02 n=36	<0.001
10 n=24	6.82±0.03	6.92±0.06 n=8	6.77±0.03 n=16	<0.05
11 n=25	6.80±0.03	6.95±0.08 n=5	6.76±0.02 n=20	<0.05
$p_{10\text{-}11}$	>0.05	>0.05	>0.05	
12 n=40	6.79±0.02	6.93±0.06 n=7	6.76±0.02 n=33	<0.05
$p_{10–12}$	>0.05	>0.05	>0.05	
$p_{11–12}$	>0.05	>0.05	>0.05	
10–12 (II) n=89	6.80±0.02	6.93±0.03 n=20	6.76±0.01 n=69	<0.001
$p_{I–II}$	>0.05	>0.05	>0.05	
Of all examinees n=223	6.82±0.01	6.87±0.01 n=118	6.76±0.01 n=105	<0.001

Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

Table 3. pH indicator of oral fluid in children aged 7–11 years with caries of temporary teeth and with intact temporary teeth (M±m)

Age of children in years (group) number of patients	pH indicator, unit			p
	Average indicator	In children with intact temporary teeth	In children with caries temporary teeth (dft)	
7–9 (I) n=134	6.83±0.01 n=134	6.94±0.02 n=47	6.77±0.01 n=87	<0.05
10 n=24	6.82±0.03	6.85±0.03 n=17	6.74±0.07 n=7	>0.05
11 n=25	6,80±0,03	6,81±0,03 n=21	6.77±0.04 n=4	>0.05

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Age of children in years (group) number of patients	pH indicator, unit			p
	Average indicator	In children with intact temporary teeth	In children with caries temporary teeth (dft)	
p_{10-11}	>0,05	>0,05	>0,05	
10–11 (II) n=49	6.81±0.02 n=49	6.83±0.02 n=38	6.75±0.04 n=11	>0.05
p_{I-II}	>0.05	<0.001	>0.05	
Of all examinees n=183	6.82±0.01 n=183	6.89±0.02 n=85	6.77±0.01 n=98	<0.001

Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

Table 4. Indicator of microcrystallization of oral fluid in children 7–2 years old with caries of temporary and permanent teeth (M±m)

Age of children in years (group) number of patients	Microcrystallizationindex (points)			p
	Average indicator	In children with intact teeth	In children with caries (DMFT/dft)	
7–9 (I) n=134	2.16±0.06 n=134	2.97±0.09 n=39	1.83±0.04 n=95	<0.001
10 n=24	2.11±0.11	2.93±0.12 n=5	1.90±0.07 n=19	<0.001
11 n=25	1.97±0.09	2.53±0.17 n=5	1.83±0.07 n=20	<0.001
p_{10-11}	>0.05	>0.05	>0.05	
12 n=40	2.0±0.08	2.81±0.13 n=7	1.84±0.06 n=33	<0.001
$p_{10–12}$	>0.05	>0.05	>0.05	
$p_{11–12}$	>0.05	>0.05	>0.05	
10–12 (II) n=89	2.03±0.05	2.77±0.08 n=17	1.85±0.04 n=72	<0.001
$p_{I–II}$	>0.05	>0.05	>0.05	
Of all examinees n=223	2.11±0.04	2.91±0.07 n=56	1.84±0.03 n=167	<0.001

Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

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Table 5. Indicator of microcrystallization of oral fluid in children 7–12 years old with caries of permanent teeth (M±m)

Age of children in years (group) number of patients	Microcrystallization index (points)			p
	Average indicator	In children with intact permanent teeth	In children with caries (DMFT)	
7–9 (I) n=134	2.16±0.06 n=134	2.33±0.06 n=98	1.69±0.06 n=36	<0.001
10 n=24	2.11±0.11	2.50±0.23 n=8	1.92±0.08 n=16	<0.05
11 n=25	1.97±0.09	2.53±0.17 n=5	1.83±0.07 n=20	<0.05
$p_{10–11}$	>0.05	>0.05	>0.05	
12 n=40	2.0±0.08	2.81±0.12 n=7	1.84±0.06 n=33	<0.001
$p_{10–12}$	>0.05	>0.05	>0.05	
$p_{11–12}$	>0.05	>0.05	>0.05	
10–12 (II) n=89	2.03±0.05	2.62±0.11 n=20	1.86±0.04 n=69	<0.001
$p_{I–II}$	>0.05	>0.05	<0.05	
Of all examinees n=223	2.11±0.04	2.38±0.06 n=118	1.80±0.03 n=105	<0.001

Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

Table 6. Indicator of microcrystallization of oral fluid in children 7–11 years old with caries of temporary teeth (M±m)

Age of children in years (group) number of patients	Microcrystallization index (points)			p
	Average indicator	In children with intact temporary teeth	In children with caries temporary teeth (dft)	
7–9 (I) n=134	2.16±0.06 n=134	2.79±0.07 n=47	1.82±0.04 n=87	<0.001
10 n=24	2.11±0.11	2.26±0.13 n=17	1.76±0.10 n=7	<0.05
11 n=25	1.97±0.09	2.00±0.10 n=21	1.83±0.22 n=4	>0.05
$p_{10–11}$	>0.05	>0.05	>0.05	
10–11 (II) n=49	2.04±0.07 n=49	2.11±0.08 n=38	1.79±0.09 n=11	<0.05
p_{I-II}	>0.05	>0.05	>0.05	
Of all examinees n=183	2.13±0.05 n=183	2.49±0.07 n=85	1.82±0.04 n=98	<0.001

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Notes: $p_{10–11}$ – the probability of the difference in indicators of different age groups;
$p_{I–II}$ – the probability of the difference in indicators of children 7–9 and 10–12 years old;
p – the probability of the difference in the indicators of children with caries and without caries at each age.

Mineralizing properties of oral fluid in children 10–12 years old ([2.03±0.05] points) had no significant difference when compared with children 7–9 years old (2.16± ±0.06) points ($p>0.05$) no depending on whether they had caries or not. But when children were divided into groups with affected and intact teeth, a probable difference in the studied indicator was observed in each age period. That is, children with caries had a lower index of microcrystallization of oral fluid than children without caries. This difference was especially noticeable in children who have affected permanent teeth. The average index of microcrystallization of oral fluid in children with caries of permanent teeth aged 7–9 years was probably lower ($p<0.05$) than in children aged 10-12 years ([1.69±0.06] points and [1.86±0.04] points, respectively).

The mineralizing potential of oral fluid in children 7–9 and 10–12 years old with intact teeth was satisfactory ([2.97± ±0.09] points, and [2.77±0.08] points, respectively), in children with caries it was low ([1.83±0.04] points and [1.85±0.04] points, respectively), which determines the presence of a carious situation in the oral cavity.

We found that the caries index of temporary and permanent teeth (KPV+kp) has inverse correlations with pH ($R=-0.66$; $p<0.001$) and microcrystallization index of oral fluid ($R=-0.85$; $p<0.001$).

Conclusion

Therefore, the course of caries of both temporary and permanent teeth in children 7–12 years old occurs against the background of a decrease in pH and microcrystallization of oral fluid. The caries rate of temporary and permanent teeth has inverse correlations with the pH and microcrystallization index of the oral fluid.

There is no **conflict of interest**.

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РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ МІНЕРАЛІЗУЮЧОЇ ЗДАТНОСТІ І ВОДНЕВОГО ПОКАЗНИКА РОТОВОЇ РІДИНИ У ДІТЕЙ З УРАХУВАННЯМ СТОМАТОЛОГІЧНОГО СТАТУСУ ТА ВІКУ

Карієс – одна з найбільш поширених стоматологічних хвороб у дітей, яка характеризується демінералізацією емалі. На стан твердих тканин тимчасових і постійних зубів впливає значна кількість факторів, серед яких ротова рідина, яка безпосередньо контактує з зубами. Мінералізуюча здатність ротової рідини впливає на стан твердих тканин зубів, тобто на кислотостійкість емалі, зниження якої призводить до демінералізації з подальшим прогресуванням каріозного процесу. Метою дослідження було вивчити показники мінералізуючого потенціалу та pH ротової рідини у дітей 7–12 років з карієсом тимчасових і постійних зубів та порівняти з показниками дітей з інтактними зубами. У 223 дітей 7–12 років вивчали стоматологічний статус (у кожної дитини визначався стан твердих тканин зубів і вираховували показник КПВ, КПВ+кпв, кп), мінералізуючий потенціал та pH ротової рідини. Показники порівнювалися у дітей з карієсом і без нього. Перебіг карієсу як тимчасових, так і постійних зубів у дітей відбувся на фоні зниження показника pH і мікрокристалізації ротової рідини. Особливо це було помітно у дітей, які мали уражені постійні зуби. Показник карієсу тимчасових та постійних зубів мав обернені кореляційні зв'язки з pH та показником мікрокристалізації ротової рідини. В результаті дослідження ми дійшли висновку, необхідно проведення первинної та вторинної

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профілактики, направленої на покращення показників гомеостазу порожнини рота, що дасть можливість знизити поширеність та інтенсивність карієсу у дітей.

Ключові слова: *карієс, інтактні зуби, pH ротової рідини, мікрокристалізація ротової рідини.*

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