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Salivary Profile and Dental Status in Children with Congenital Heart Disease: A Descriptive Study

Profil ślinowy i stan jamy ustnej u dzieci z wrodzonymi wadami serca – badanie opisowe

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article

Abstract

Background. Congenital heart disease is one of the most common developmental anomalies. Saliva plays a crucial role in the oral ecosystem. Due to bicarbonate ion serving as a buffering system, saliva neutralizes acidity of the oral cavity to prevent dental problems.

Objectives. This study aimed to determine salivary parameters and dental status of children with congenital heart disease and in comparison with healthy subjects.

Material and Methods. This descriptive study compared 40 patients aged 7–11 years with verified diagnosis of congenital heart disease with 40 healthy children in terms of salivary calcium, phosphorus, secretory IgA, pH, and the flow rate as well as first permanent molar DMFT. Unstimulated whole saliva samples were collected by means of the spitting method. The salivary flow rate was measured in mL/min. A pH meter and specialized kits were used to measure pH and salivary parameters respectively. Students' t-test was utilized to compare variables between groups.

Results. Eighty children, 37 (46.25%) boys and 43 (53.75%) girls, were studied with the mean age of 8.33 ± 1.14 . There was no significant difference in relation to the age and sex between groups. However, patients had significantly lower body mass index ($p = 0.005$) and frequency of daily tooth brushing ($p = 0.02$) than controls. Patients showed significantly lower salivary flow rate ($p = 0.0001$), pH ($p = 0.02$), phosphorus ($p = 0.01$), and secretory IgA ($p = 0.0001$) than controls. On the other hand, the level of salivary calcium was not significantly different between groups ($p = 0.29$). In regard to the dental status, DMFT of the first permanent molars was significantly higher in patients than controls ($p = 0.05$).

Conclusions. Salivary flow rate, pH, phosphorus, and secretory IgA were significantly diminished in children with congenital heart disease, who had worse dental status as compared to controls (*Dent. Med. Probl.* 2016, 53, 4, 454–458).

Key words: children, saliva, oral, congenital heart defect.

Słowa kluczowe: dzieci, ślina, jama ustna, wrodzona wada serca.

Congenital heart disease (CHD) is considered to be one of the most common developmental anomalies and one of the major causes of death within the first year of age. Approximately one third of all congenital abnormalities consist of congenital heart disease. The prevalence rate varies in different populations with the highest occurrence found in Asia (9.3 per 1000 live births), as opposed to Africa where we have the lowest prevalence (1.9 per 1000 live births). Meanwhile, an ap-

parently increased prevalence has been noticed since 1930 from < 1 per 1000 live births to 9 per 1000 live births [1, 2]. Van der Linde et al. reported 1.35 million live births of CHD annually, which is considered a major challenge for the health sector. Children with congenital heart disease require prolonged medication with diuretics, beta blockers, cardiac glycosides, anticoagulants, etc. Most of these medications have acidic activity. In addition, some fermentable carbohydrates are added

to therapeutic agents in order to ensure long-term children's compliance, which in turn help decrease pH of the oral cavity. In addition, some medications are xerogenic and cause dry mouth via two mechanisms: a direct toxicity effect on salivary gland elements and an anticholinergic effect, which leads to diminished salivary flow rate. These patients are, therefore, likely at risk of increased caries and even oral mucosal damage [3, 4].

Saliva plays a crucial role in the oral ecosystem. Due to bicarbonate ion serving as a buffering system, saliva neutralizes acidity of the oral cavity to prevent dental caries. In the meantime, the salivary anti-bacterial effect helps maintain oral microbial balance. Secretory IgA, the most common salivary immunoglobulin, interferes with bacterial colonization and prevents bacteria, especially *Streptococcus mutans*, from adhering to the tooth surface. On the other hand, sustained remineralization of the enamel can be promoted by salivary supersaturated ions of calcium and phosphorus. Diffusion of salivary fluoride, calcium, and phosphate on the tooth surfaces causes enamel remineralization and increased acid resistance [3, 5].

Due to the severity of the main illness, the oral health status of children with CHD are usually neglected by parents and even by health care providers, which results in several damage to oral structures. Hence, awareness of patients' salivary alterations in quantity and quality aspects would justify preventive measures such as periodic dental examination or prescription of food supplements [4, 6].

In regard to the high prevalence of congenital heart disease and the critical role of orodental health in maintaining general health status, this study aimed to evaluate salivary parameters in terms of flow rate, pH, secretory IgA level, calcium, and phosphorus in children with congenital heart disease in comparison with healthy children.

Material and Methods

In this descriptive study, 40 patients (case group) and 40 age and sex-matched healthy children (control group) were studied in terms of salivary calcium, phosphorus, secretory IgA, pH, and flow rate as well as DMFT of the first permanent molars in the academic year of 2014/2015.

Inclusion criteria were as follows: verified diagnosis of congenital heart disease [2], age range of 7–11 years, not being on supplements or other medications unrelated to cardiac disease within the recent 6 months, and lack of oral lesions.

The control group was selected randomly from healthy 7–11 years old children attending

Pedodontics Department of Shahid Beheshti Dental School, Tehran, Iran with no history of previous heart disease and medication consumption during the recent 6 months. Patients were selected from verified cases of CHD at Modarres Hospital, Tehran, Iran. The study purpose and relevant details were explained to the children's parents and informed consent was obtained from all of them.

A data form was prepared by the researcher to include information regarding age, sex, body mass index (BMI), drug history, type of heart disease, frequency of daily tooth brushing, as well as salivary flow rate, pH, phosphorus, DMFT index of the first permanent molars, and secretory IgA.

Unstimulated whole saliva was collected from all eligible children according to the protocol of saliva sampling [3, 7]. The children were prohibited from eating, drinking, and tooth brushing 90 minutes prior to saliva collection. Saliva sampling was carried out between 10–12 a.m. concordantly to the hospital meal schedule.

Unstimulated whole saliva samples were collected by means of the spitting method into 15 mL sterile falcon tubes (Microteb, Tehran, Iran), and the salivary flow rate was measured in mL/min. Saliva samples were transferred to the laboratory and frozen at -20°C for future analysis.

Secretory IgA was measured by using immune diffusion method and a specialized kit (Bahar Afshan Research & Development Institute, Tehran, Iran). In addition, spectrophotometric assay was used to detect salivary calcium and phosphorus by means of commercially available kits (Darman Kave, Isfahan, Iran, and Pars Azmun, Tehran, Iran, respectively).

Salivary pH was determined by means of an electronic pH-meter (PH600, Milwaukee, Italy).

Since Khan [8] demonstrated that DMFT Index (Decayed, Missing, Filled Teeth) of four first permanent molars was an indicator of dental caries, we used it to evaluate the children's dental status. According to Becker's definition [9], "D" stands for untreated decayed teeth, "M" indicates missing teeth, and "F" shows filled teeth. It is noteworthy that full coverage crowns are considered as "F".

Data analysis was performed by means of SPSS software, version 18 (Chicago, USA). Students' t-test was utilized to compare between studied groups. P-value less than 0.05 considered significant.

Results

In total, 80 children were studied with the mean age of 8.33 ± 1.14 . There was no significant difference ($p = 0.77$) between mean age of case

Table 1. Salivary parameters and dental status in studied groups

Variable	Case (mean $\pm$ SD*)	Control (mean $\pm$ SD)	p
Flow rate (mL/min)	0.33 $\pm$ 0.14	0.72 $\pm$ 0.47	< 0.0001
pH	6.47 $\pm$ 0.4	6.55 $\pm$ 0.28	0.02
Calcium (mmol/L)	0.66 $\pm$ 0.42	0.75 $\pm$ 0.39	0.29
Phosphorus (mmol/L)	4.15 $\pm$ 1.35	4.89 $\pm$ 1.27	0.01
sIgA** (mg/L)	31.45 $\pm$ 7.32	67.82 $\pm$ 17.03	< 0.0001
DMFT*** of the first permanent molars	2.5 $\pm$ 1.3	2.1 $\pm$ 1.1	0.05

*SD – standard deviation; **sIgA – secretory immunoglobulin A; ***DMFT – decayed, missing, filled teeth.

(8.78 $\pm$ 1.39) and control group (8.43 $\pm$ 1.9). Of 40 patients, boys constituted 18 (44%) and girls 22 (56%) ones. In addition, there were 19 (47%) boys and 21 (53%) girls in the control group. No significant difference was found between two groups in terms of sex as well ($p = 0.13$). The body mass index was significantly higher ($p = 0.005$) in the control group than in patients (17.06 $\pm$ 3.76 vs 14.67). Moreover, we found the control group to have a significantly higher ($p = 0.02$) frequency of daily tooth brushing (at least once daily) than the study group (85% vs 62%).

The most commonly used medications among our patients were captopril, digoxin, enalapril and furosemide. The most commonly encountered congenital heart diseases in our patients were atrial septal defect, aortic valve prolapse, transposition of the great arteries, and arterio ventricular septal defect.

Salivary analysis showed a significant difference between groups in terms of flow rate ($p = 0.0001$), pH ($p = 0.02$), phosphorus ($p = 0.01$), and secretory IgA ($p = 0.0001$) (Table 1). On the other hand, the level of salivary calcium was not significantly different between the groups ($p = 0.29$).

In regard to the dental status, DMFT of the first permanent molars was significantly higher in patients than in the controls ($p = 0.05$).

Discussion

In the present study, salivary parameters such as flow rate, pH, calcium, phosphorus, secretory IgA, as well as dental status in CHD children were determined and compared to healthy controls.

Saliva plays a critical role in the ecosystem of the oral cavity, such as neutralization of plaque – induced acidity and buffering effect [4]. In addition, thanks to its several anti-microbial components, saliva serves as a potential protective barrier against micro-organisms. Secretory IgA (sIgA), the predominant salivary immunoglobulin, pre-

vents bacterial adhesion to the tooth surface, and interferes with the colonization of bacteria [10]. Diminished levels of sIgA are associated with an increased risk of dental caries [10]. Diffusion of salivary minerals such as calcium, fluoride, and phosphorus to tooth surface enhances enamel remineralization and acid resistance [3].

There are few studies regarding the comparison of salivary parameters and dental status in children with CHD and healthy ones.

In the present study, we demonstrated a significantly decreased salivary flow rate and pH in patients than in controls. Many pediatric medications contain fermentable sugars to help decrease patients' aversion and increase their compliance, which in turn causes a drop in oral pH due to the effect of acid-producing bacteria on sugars [11, 12]. Lower levels of salivary flow rate in CHD children are presumably due to the side effects of medication. Chew reviewed the anticholinergic activity of 107 medications such as cardiovascular agents, of which digoxin, furosemide, and enalapril were commonly used by our patients [13]. The anticholinergic activity of medications are exerted via several routes: a competition with acetylcholine at effector junction, and an indirect effect through stimulation of sympathetic system [14]. In accordance with our results, Hegde et al. [7] noticed that salivary pH and flow rate were significantly decreased in cardiac patients, which was associated with the level of salivary sialic acid; hence, it was proposed that sialic acid would be a good indicator for the severity of oral disease in these patients. Meanwhile, Rosén et al. [3], in a study on salivary alterations in children with CHD, showed that a low salivary flow rate could be a risk factor for children taking cardiac medications, which was in line with our findings as well.

We found no significant difference between the two groups in terms of salivary calcium level; however, the calcium values in our patients decreased (0.66 mmol/L vs 0.75 mmol/L). Our patients' salivary phosphorus and sIgA were significantly diminished, which might be due to

hyposalivation or malnutrition [14]. Our patients' BMI was significantly lower than that of the controls, reflecting a possible malnutrition state as shown by Vaidyanathan [15], who reported a very high prevalence of malnutrition among patients with CHD.

According to our results regarding DMFT of the first permanent molars, CHD children had worse dental status compared to controls.

In contrast, some reports showed no difference between CHD children and healthy subjects in terms of caries rate. Franco et al. [10] found no difference in sIgA, and caries rate between children with CHD and healthy controls. Hallett et al. [16] in a study found an increased rate of DMFT (peculiar to deciduous teeth) in patients, but the DMFT of permanent teeth did not differ significantly. The same results were obtained by Pollard et al. [17] and Tasioula et al. [18].

However, Ajami et al. [19] pointed out that *Streptococcus mutans* was significantly higher in saliva of children with CHD than those with acquired heart disease and healthy subjects. Pimentel et al. [20] reported a higher rate of dental caries at a young age in CHD patients. The increased risk of dental caries among CHD children might be attributed to several factors such as altered quantity or quality of saliva, and oral health condition. Garg et al. [21] related the higher risk of dental caries in CHD patients to a decrease in salivary nitric

oxide, which has an antimicrobial effect. Saunders and Roberts [22] noticed that the healthier children regularly brushed their teeth twice daily, while almost 80% of CHD patients never or hardly ever brushed on a regular basis, which was in agreement with our findings. Meanwhile, regarding visits to the dentist, 18% of cardiac patients never attended a dental office compared with only 3% for the healthy children [22]. In addition, Hallett et al. [16] found that about 60% of these patients were deprived of even parental help during tooth brushing. They also pointed out that roughly two thirds of CHD patients did not receive adequate dental care, with 21% of patients not having undertaken pulp therapies.

Generally, malnutrition [15], developmental enamel defects, poor oral hygiene habits [16], and the use of sugar-containing medications with acidic or xerogenic effects might lead to an increased risk of caries among CHD patients [23].

Variations in study sample sizes and measurement methods might be the reason for different results.

In conclusion, salivary flow rate, pH, phosphorus, and secretory IgA were significantly diminished in children with congenital heart disease, and they had worse dental status compared to controls. Therefore, continuous monitoring of oral hygiene status is imperative in this group of patients.

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