RESEARCH ARTICLE

Comparative Analysis of the Status of Dental Caries and Selected Salivary Electrolytes in Children with Autism

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Abstract

Aim: Autism has been defined as a neurological developmental disability. Children with autism have a higher risk of developing dental caries, due to various factors. The study focuses to compare the dental caries status with respect to the variation in selected salivary constituents [calcium, phosphorus, sodium, potassium, magnesium, and urea] in autistic children and healthy children.

Materials and methods: Hundred children participated in the study. The study group included 50 children who were prediagnosed with autism from various autistic institutions across Bengaluru. The control group comprised of 50 healthy children who visited the Department of Pediatric and Preventive Dentistry for a routine check-up. Assessment of salivary constituents was done using salivary kits and dental caries status was recorded. Descriptive statistics was implemented to evaluate the mean and standard deviation of the study and control groups. Normality of the data was assessed using Shapiro Wilkinson test. The difference in results between the groups was calculated using the independent t-test.

Results: A significant decrease was observed in the concentration levels of calcium, sodium, potassium, phosphorus, urea and a significant increase was observed in the concentration level of magnesium in the study group consisting of autistic children when compared to the control group consisting of healthy children. DMFT/dmft scores were seen to be higher in autistic children when compared to healthy children.

Conclusion: In this study, children with autism were seen to have a higher susceptibility to developing dental caries when compared to healthy children from the same age-group.

Clinical significance: The variations in the electrolytic salivary concentrations of calcium, sodium, potassium, chloride, phosphorus, and urea in autistic children could be stated as one of causative factors for the increased DMFT/dmft scores in them when compared to the control group consisting of healthy children.

Keywords: Autism, Dental caries, Magnesium, Salivary constituents, Urea.

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Introduction

Autism, often referred to as "Autism Spectrum Disorder [ASD]" was first described by Leo Kanner [an American child psychologist] in the year 1943. The World Health Organization [WHO] defines autism as "A complex neurological developmental disability characterized by difficulty in social interaction and communication and a restricted and repetitive repertoire of interests and activities." It comprises a variety of conditions which can be identified by a certain degree of impairment in social behavior, language, and communication. The intellectual functioning capacity in these individuals are highly variable and they usually have a restricted range of interests and activities that are mostly repetitious in nature. They also tend to exhibit concurrent conditions like epilepsy, depression, anxiety, and attention deficit hyperactivity disorder.[1] All of these conditions might complicate dental care. Autism is mostly identified by a triad of impairment in social interaction, impaired communication, and confined interests along with repetitive behavior, all of which further complicate dental care for the autistic child. Hence, a dental visit may be of a great ordeal to an autistic child.[2] An autistic child also presents with severe challenges in cognition and has limited verbal and nonverbal communication abilities. It is also difficult for them to acquire comprehensible speech with ease.[3]

The signs of this highly variable brain disorder appear during infancy or childhood, normally before the child is 3 years old. The conditions are usually evident during the first 5 years of life, leading to the diagnosis. As per the reports released by the Centre for Disease Control and Prevention [CDC], U.S.A, this condition is identified as 1 in 59 children, the frequency being 1 in 37 boys and 1 in 151 girls; thus, reiterating the fact that prevalence of autism is higher in boys than in girls. Children with autism have low frustration levels and lesser attention span; hence they may portray frequent temper tantrums. They are extremely hypersensitive to touch and noise.[4] The level of intellectual functioning in a child with autism can be extremely variable, extending from profound impairment to superior levels. Children with autism are also prone to periodontal diseases and damaging oral habits like lip biting, grinding, tongue thrusting, picking at the gingival margin, etc. After diagnosis of autism, it has come to notice that the parents or guardians of these children concentrate mostly on the medical programs and regimens that are necessary for their betterment. Negligible or considerably less precedence is given to dental and oral well-being of these children, especially during early childhood. Hence, it leads to additional retrogression of systemic health in them.

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An important point to be noted is that diagnosing ASD is difficult as there is no definite medical test like a biopsy test or a blood test available to diagnose this disorder. It can be diagnosed only clinically by screening the developmental or behavioral yardstick of the child. This results in a considerable number of children not receiving a conclusive diagnosis till much later in life. Therefore, it will be of great benefit to develop a biomarker, which will provide a definite diagnosis for this neurological developmental disability. Timely diagnosis of the disability will be of immense help in early support, guidance, and necessary behavioral intervention of the related medical condition.[5,6]

Dental caries is known to be a multifactorial, transmissible disease which includes internal defense components such as saliva, morphology of tooth, nutritional and hormonal status and external components like diet, oral hygiene measures, and fluoride availability. Plaque and saliva contain many different agents that aids in protection of the tooth surfaces against initiation of caries. Saliva is an exocrine solution which consists of 99% water and 1% electrolytes, proteins. The enzymes that are produced by the salivary glands has immense diagnostic and enzymatic functions and plays a major role in the body's defense mechanisms. Besides its importance as a protective agent, saliva also plays a key role in preventing dental caries. Salivary flow reduces the lodgment of plaque on the tooth surface and increases the rate of carbohydrate clearance within the mouth. Any pH below 5.5 in the oral environment promotes demineralization from the tooth surface since the plaque remains unsaturated; but a plaque pH above 5.5 helps in the supersaturation of the saliva with Calcium Phosphate ions which results in remineralization of the tooth surface.[7,8] The other important ions present in saliva are: potassium, sodium, urea, and magnesium. Studies have shown that increased concentrations of these constituents in saliva result in the increase of pH above 5.5 [critical pH] which helps tooth remineralization and hence reduce the caries rate. Very few clinical studies in the past have utilized these salivary constituents to study about the activation of the autonomic nervous system activity in healthy children and compare it to children with neurological disorders.[9,10] Therefore, this study aims to compare and evaluate the selected salivary biochemical constituents namely calcium, potassium, phosphate, sodium, urea, and magnesium in the saliva of both autistic and healthy children in order to compare and assess the dental caries status in them, along with correlating these salivary biomarkers as an additional tool to detect autism.

Materials and Methods

Hundred children participated in the study. The study group included 50 children who were prediagnosed with autism from various autistic institutions across Bengaluru city. The control group comprised of 50 healthy children who visited the department of Pediatric and Preventive dentistry at VS Dental College, Bengaluru, for a routine dental check-up. Ethical clearance was granted for the study by the Institutional ethical committee. Informed consent was obtained from the parents/guardians of the children participating in the study. For the study group, children between age-group of 3–13 years diagnosed with autism were included. Children with other systemic disorders, excluding autism were not included in the study. Disposable sterile glove, sterile mouth mirror, sterile probe, kidney tray, disposable cotton rolls, disinfectant [savlon], optimal artificial lighting, screw capped saliva collection bottles, and salivary electrolyte kits were the armamentarium used for the study. All the children were examined under standardized conditions. Evaluation of dental caries were done using optimal artificial light, mouth mirror, and probe and recorded according to WHO [2013]. Decayed, missing, and filled teeth were assessed using the DMFT/dmft index for primary [dmft] and permanent [DMFT] dentition. Infection control was done as per current recommendations and standards given by Centres for Disease Control [CDC]. Collection of saliva was carried out in the daytime and children were asked not to consume any food or drink 60 minutes before collection. The child was draped and made to sit on the dental chair for examination such that the floor of the mouth was parallel to the ground. Saliva collection was done by asking the patient to spit into a saliva collecting bottle and the sample was sent to the department of biochemistry laboratory for the assessment of salivary constituents [calcium, potassium, phosphorus, sodium, urea, and magnesium]. The data was analyzed using the statistical package SPSS 22.0 [SPSS Inc., Chicago, IL] and the level of significance was set at $p < 0.05$. The mean and standard deviation of the respective groups was evaluated using descriptive statistics. Normality of the data was assessed using Shapiro Wilkinson test. Independent t test was implemented to find out the difference between the groups.

Results

Out of the 100 children who participated in the study, 56% were males and 44% were females. The mean age and SD were 9.38 ± 2.11 years in the control group and 8.94 ± 2.28 years in the autistic group. After assessing the salivary parameters, the mean ± SD value for salivary calcium was 2.49 ± 0.86 for autistic children and 5.30 ± 2.72 for healthy children. Calcium was found to be lesser in the autistic children. The normal value of salivary calcium was 1.2 to 2.8 m mol/L. The difference in salivary calcium between the two groups were statistically significant [$p = 0.0001$] [Table 1].

The salivary magnesium value was much higher in autistic children compared to healthy children with mean ± S.D of 5.95 ± 1.11 for autistic children and 0.66 ± 0.73 for healthy children. The normal salivary magnesium value is 0.08 to 0.5 m mol/L. The difference in salivary magnesium between the two groups were statistically significant [$p = 0.0001$] [Table 1].

The salivary potassium values were seen to be lesser in autistic children when compared to healthy children, with mean ± SD. value of 9.61 ± 3.51 for autistic children and 21.36 ± 4.38 for healthy children. The normal salivary potassium value ranges from 10 to 36 mmol/L. The difference in salivary potassium between the two groups was statistically significant [$p = 0.0001$] [Table 1].

The salivary sodium values were found to be lesser in children with autism as compared to healthy children, with mean ± SD value of 10.12 ± 1.36 for autistic children and 15.8 ± 8.79 for healthy children. The normal salivary sodium value ranges from 2 to 21 m mol/L. The difference in salivary sodium between the two groups was statistically significant [$p = 0.0001$] [Table 1].

The salivary phosphorus values were found to be lower in children with autism as compared to healthy children, with mean ± SD value of 5.66 ± 2.43 for autistic children and 16.06 ± 3.31 for healthy children. The normal salivary phosphorus value ranges from 1.4 to 39 m mol/L. The difference in salivary phosphorus between the two groups were statistically significant [$p = 0.0001$] [Table 1].

There was a significant reduction in salivary urea in autistic children when compared to healthy children, with mean ± SD values of 13.74 ± 5.54 for autistic children and 32.54 ± 15.01 for normal

children. Normal salivary urea ranges from 15 to 4 m mol/L. The difference in salivary urea between the two groups was statistically significant [$p = 0.0001$] [Table 1].

Dental caries was recorded in accordance with the WHO 2013 pro forma. Decayed, missing, and filled teeth were assessed using the DMFT/dmft index for permanent and primary dentition, respectively. The mean dmft in the autistic children was recorded to be 2.28 ± 1.93 and 0.8 ± 1.27 in the healthy children. The results were statistically significant [$p = 0.005$]. The filled component [f] of dmft index was found to be higher in healthy children [mean ± SD = 0.32 ± 0.84] as compared to that of autistic children [mean ± SD = 0.04 ± 0.19], with statistically significant difference [$p = 0.02$] [Table 2].

The mean DMFT in the study group consisting of autistic children was found to be 2.32 ± 1.73 and 0.78 ± 1.29 in healthy children. The result was statistically significant [$p = 0.0001$]. The decayed component [D] of the DMFT was found to be higher in the study group [mean ± SD = 1.96 ± 1.39] as compared to that of healthy group [mean ± SD = 0.74 ± 1.17] and the difference was statistically significant [$p = 0.0001$] [Table 3]. The missing component [M] of the DMFT was higher in the autistic group [mean ± SD = 0.34 ± 0.65] as compared to that of healthy group [mean ± SD = 0] and the difference was statistically significant [$p = 0.0005$] [Table 3].

Discussion

Autism can result in significant challenges in the daily lives of the affected children. The learning process and problem-solving capabilities of people with ASD can range from gifted to severely impaired.[11] Due to this, they are under several medications. Psychotropic drugs needed to manage associated autism are mostly prescribed to these children. Most of them cause systemic and oral complications like xerostomia, swallowing difficulty, sialorrhea, dysphagia, stomatitis, gingivitis, glossitis, discolored tongue, and edema along with orthostatic hypotension. It is of utmost importance for the dentists to know the side effects of these drugs. Most of these children exhibit bruxism, chewing of a non-nutritive type, self-injury [picking at gingiva, biting lips] creating ulcerations, and tongue thrusting. Oral hygiene status is poor due to home care measures that are difficult to follow for many children and their parents. Autistic children have inadequate tongue coordination so soft and sweetened foods are preferred by them. Most of the autistic children have a propensity to pouch food inside the mouth for long durations instead of swallowing it. Due to the presence of food within the mouth for long durations and problems in brushing and flossing, there is an increased propensity to caries. The prevalence and severity of dental caries is affected by several factors, which includes diet, age, gender, and socioeconomic factors, in addition to some medications. Caries index is reported to be high in autism not only because of oral hygiene neglect but also because of low salivary concentration of urea, calcium and high salivary concentration of magnesium.[12] Saliva of the autistic children was used as a mode of examination for this present study, to find out about the biochemical alterations present in autistic children. In this study, calcium concentrations were lesser in autistic children when the results were compared with healthy children and the difference was statistically significant between the groups. This result correlated with the result found by Morales-Chávez et al.

Table 1: Comparison of salivary constituents

Variable	*Normal*	*Autistic*	*p-value [Independent t-test]*
Calcium	5.30 ± 2.72	2.49 ± 0.86	0.0001*
Magnesium	0.66 ± 0.73	5.95 ± 1.11	0.0001*
Sodium	15.8 ± 8.79	10.12 ± 1.36	0.0001*
Potassium	21.36 ± 4.38	9.61 ± 3.51	0.0001*
Phosphorus	16.06 ± 3.31	5.66 ± 2.43	0.0001*
Urea	32.54 ± 15.01	13.74 ± 5.54	0.0001*

$p < 0.05$ is statistically significant*

Table 2: Comparison of d,m,f components and dmft

Variable	*Normal*	*Autistic*	*p-value [Independent t-test]*
d	0.8 ± 1.27	2.04 ± 1.94	0.003*
m	0.16 ± 0.54	0.2 ± 0.40	0.67
f	0.32 ± 0.84	0.04 ± 0.19	0.02*
dmft	1.28 ± 1.60	2.28 ± 1.93	0.005*

$p < 0.05$ is statistically significant*

Table 3: Comparison of D, M, F components and DMFT

Variable	*Normal*	*Autistic*	*p-value [Independent t-test]*
D	0.74 ± 1.17	1.96 ± 1.39	0.0001*
M	0 ± 0	0.34 ± 0.65	0.0005*
F	0.04 ± 0.197	0.16 ± 0.37	0.04*
DMFT	0.78 ± 1.29	2.32 ± 1.73	0.0001*

$p < 0.05$ is statistically significant*

who concluded that patients diagnosed with autism exhibited a lower mean calcium level than the control group consisting of healthy individuals. In the current study, the study group consisting of autistic children exhibited lesser phosphorus content than the control group consisting of healthy children and the results were statistically significant. These results contrasted with the study done by Morales-Chávez et al. who noted that phosphate values were greater in the autistic group than the control group.[13] The result also contrasted with the study done by Sweekruthi et al. in 2016 who found inorganic phosphate to be higher in the autistic group compared to the healthy children.[5] The composition of saliva is greatly varied between individuals and it does not have any constant relationship to the composition of blood. The concentration of inorganic calcium and phosphorus has considerable variation due to several factors. The ionic concentration of calcium and phosphorus in saliva helps in maintaining equilibrium between the dissolution and remineralization of enamel. The carious process is mediated by the rate of diffusion of ions, composition of the salivary solution, and the membrane potential of the tooth surface. Initial stages of caries formation are marked by surface demineralization with a relatively intact surface layer. Hence, the dissolution of calcium and phosphorus, in and out of the carious lesion, is influenced by alkaline phosphatase enzyme which gradually leads to initiation and progression of caries. Magnesium is a highly caries potentiating element. In this study, the magnesium content in autistic children was far higher than the magnesium content in healthy individuals and the *p*-value was found to be statistically significant. Magnesium plays a crucial role in intercepting periodontal diseases and caries since it reduces inflammatory response due to bacterial toxins. Magnesium has strong association with tooth decay as it is highly caries promoting. In the study done by Milaim Sejdini et al. in 2018, it has been found that the concentration of magnesium in autistic children, before stimulation with paraffin wax were lesser than after being stimulated with paraffin wax. This was much lesser than the values that were detected in the present study.[14] Study done by Sweekruthi et al. in 2016 reported that magnesium concentration was 20% greater in patients within the cerebral palsy group compared to normal children. This result was similar to the results of present study.[5] Several trace elements like sodium and potassium are present in our body fluids. Sodium is one of the most important electrolytes present in the oral cavity. It helps in controlling the blood pressure and regulates muscular and neural functions as reported in the study by Natarajan et al. in 2016.[14] In autistic individuals, the salivary sodium is less than that of healthy individuals, thus explaining the alterations in the neurological functions of autistic children which results in behavioral and social changes that these children exhibit clinically. This was in correlation with the present study where the salivary concentration of sodium in autistic kids was found to be much lower than the salivary concentration of sodium in healthy children. Potassium which is one of the most important salivary buffers was found to be significantly less in saliva of autistic children than the saliva of normal children. Due to less buffering capacity of saliva, these children are more prone to caries process. The sodium and potassium concentration variation suggest that there is a certain anomaly in the resorption of electrolytes in the salivary gland duct associated with autism. A significant linear correlation between the salivary flow rate and sodium concentrations was found.[1] Hence, the lower sodium levels in saliva of autistic children can lead to reduced flow rate resulting in increased dental caries. A highly significant reduction in salivary urea in autistic children was noticed in comparison to normal children. This difference was statistically significant. These results contrasted with the study done by Vijayashankar et al. in 2014 who found that the level of uric acid to be elevated in the low functioning autism group as compared to healthy children.[6] Urea secretion occurs continuously in the range of 3 to 10 m Mol in the saliva of healthy individuals. This is rapidly hydrolyzed by the urease enzyme of present in the oral cavity. The ammonia released during ureolysis combines with excess of hydrogen ions present in the oral cavity and assists in tooth remineralization. Ureolysis plays a key role in maintaining homeostasis of plaque and prevents the plaque pH from becoming acidic. It helps to neutralize the plaque acids, and this positively influences the plaque ecology for the outgrowth of aciduric and cariogenic microorganisms. Hence, a decrease in salivary urea will result in the increase in caries rate.

In this study, the mean DMFT/dmft was found to be significantly higher in patients with autism compared to healthy children and the results were statistically significant. The results were concurrent to the results put forth by Vijayashankar et al. in 2014 who found that the autistic individuals were more prone to caries than the normal individuals.[6] A meta-analytical study was conducted by Zhang et al. in 2020, to analyze the dental status of Asian children with ASD revealed that autistic children had a significantly higher DMFT/dmft index than that of the controls in Asia. Hence this study showed that autistic children had a worse dental status than healthy children in Asia.[15] A study done by Jaber et al. in 2011 revealed that autistic children had relatively higher DMFT than the healthy control group. Thus, they required more restorative dental treatment. This was concurrent with our present study which showed that the autistic children had a significantly greater D [decay]-component of the DMFT index when compared to healthy children, thus reiterating the fact that the autistic children are in greater need for restorative treatment.[9]

Conclusion

In this study, the autistic children had reduced concentrations of calcium, sodium, potassium, chloride, phosphorus, urea, and an increased concentration of magnesium in comparison to healthy children. The results were statistically significant. There was a high prevalence of dental caries in autistic children as compared to that of healthy children. There was a positive correlation between the salivary constituents and prevalence of dental caries in both the groups.

Clinical Significance

There is limited research done to compare and evaluate the following salivary constituents: calcium, sodium, potassium, chloride, phosphorus, and urea in autistic children and compare it with healthy children. All these changes in salivary constituents can act like a biomarker which will help in providing a definite diagnosis for this neurological developmental disability. Timely diagnosis of the disability will be of immense help in early support, guidance and necessary behavioral intervention of the related medical condition. Also, the autistic children were seen to have an increased prevalence of dental caries than healthy children which can be due to the altered levels of salivary electrolyte concentrations. So, special measures should be inculcated while instructing the children and their parents to maintain proper oral hygiene. The parents should be guided and motivated to have regular dental check-ups for their children so that appropriate treatment can be provided to prevent disease progression and to have a regular follow-up.

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