Relation of Salivary Risk Factors to Dental Caries in Children with Cerebral Palsy

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One of the primary handicapping conditions of childhood is cerebral palsy (CP). Controversy exists about the incidence of dental caries and its associated salivary risk factors in cerebral palsied children. Thus the present study evaluated the correlation between dental caries and certain salivary risk factors in these children. One hundred non-institutionalized children in the age group of 5-12 years having cerebral palsy were selected. The W.H.O. criteria was used for diagnosis and recording of dental caries. Determination of the unstimulated salivary pH, buffering capacity and flow rate of stimulated saliva was carried out. The mean deft and DMFT values were 2.51 and 0.73, respectively. Salivary pH was 6.83, buffering capacity 10.84 and salivary flow rate 1.08ml/per min. A significant correlation was observed only between salivary pH and dental caries in the primary dentition of CP children.

Keywords: *cerebral palsy, salivary pH, buffering capacity, flow rate,*
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INTRODUCTION

One of the primary handicapping conditions of childhood is cerebral palsy (CP). This non-progressive infantile encephalopathy, is the definition for a group of non-progressive motion disorders, subject to variations, as a result of cerebral lesions during the first stages of development.[1] It is a static encephalopathy and excludes all progressive neurological disorders. Cerebral palsy was first described by Little in 1862.[2] "Cerebral" refers to the brain and "palsy" to muscle weakness or poor control. The causes of cerebral palsy may be due to perinatal anoxia, prematurity, prenatal (rubella, toxoplasmosis, cytomegalovirus) or postnatal (meningoencephalitis) infections. According to the type of motion alteration presented, various types of cerebral palsy can be observed such as spastic, athetoid, ataxic and mixed. The prevalence of CP worldwide is around 1.5-2.5 *per* 1000 live births.[3]

The dental problems of handicapped children are not different from those of the non- handicapped. Controversy exists not only about the incidence of dental caries among cerebral palsied children but also regarding the comparison of dental caries incidence between the handicapped and non handicapped population.[4] The management of CP individuals includes not only the prevention and treatment of diseases such as dental caries, but also the identification and assessment of associated risk factors.

It is well recognized that saliva plays an important role in the equilibrium between demineralization and remineralization of enamel in a potentially cariogenic oral environment. A distinction can be made between static protective effects, which act continuously, and dynamic effects, which act during the time-course of the Stephan curve.[5] Evidence implicates salivary buffering and sugar clearance as important dynamic effects of saliva to prevent demineralization.[5]

The aim of this study was to evaluate and compare the dental caries status between CP and normal children. It also aimed at providing data on associated salivary risk factors such as salivary pH, buffering capacity and salivary flow rate in these children.

MATERIALS AND METHODS

Prior to the study, consent was obtained from the authorities of two schools for disabled children in Bangalore, India; namely Shradhanjali Integrated School and Mobility India. Ethical clearance to conduct the study was obtained from the institutional review board. One hundred non-institutionalized children in the age group of 5-12 years having cerebral

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palsy formed the study group. The selected CP children were not further categorized based on the type of neuromuscular dysfunction and their motor disabilities were limited to staggering gait, monoplegia, and paraplegia. The control group consisted of one hundred normal, healthy children visiting the Department of Pedodontics, The Oxford Dental College, Hospital and Research Centre, Bangalore. These children were matched for age and gender with children of the study group.

Exclusion Criteria

Children with associated medical conditions, mental retardation and those on regular long term medication were not included. Children who did not get parental consent and who were unable to cooperate sufficiently for collection of saliva were excluded from the study.

Only those children who obtained written consent from their parents/caretakers were subjected to dental examination and assessment of salivary parameters. Relevant personal and medical information of each child was recorded. A single investigator conducted the oral examination and assessed salivary parameters with the help of an assistant to record the data. The W.H.O. criteria was used for diagnosis and recording of dental caries.[6] The CPI probe was used to confirm visual evidence of caries on the occlusal, buccal and lingual surfaces. Training and calibration for examination of dental caries was carried out in the Department of Pedodontics and Preventive Dentistry, The Oxford Dental College and Research Centre, Bangalore. Caries was recorded by a dental surgeon sitting besides the examiner, so that the codes given by the examiner could be easily heard. Ten percent of children were examined twice for intra-examiner reliability. The kappa value for intra-examiner agreement of the tooth status was 0.88.

Saliva was collected from each child for determination of the pH, buffering capacity and flow rate using the 'Saliva Check' kit (GC Asia Dental Pte Ltd). Both unstimulated and stimulated salivary samples were collected from children between 9am to 12 noon. The saliva was collected at the same time of the day with an adequate time interval after breakfast so that the observations of different children could be compared.[7]

The unstimulated saliva was collected first by requesting the subject to sit in a quiet environment in the "coachman" position and expectorate into a graduated cup. For the stimulated saliva, the children were given a unflavored paraffin wax to chew for 1 minute.[8,9] The children were given a trial session before collecting saliva for the study. This had to be done because children are not accustomed to sampling procedures and could be uncomfortable with the paraffin chewing resulting in possibly low flow rate values at the initial time of saliva collection.[7] Similarly, all saliva that accumulated within the oral cavity for a total of 5 minutes was collected into the graduated cup, at intervals of 30 seconds.

pH of unstimulated saliva: A pH test strip was taken and placed into the sample of saliva for 10 seconds. The color obtained on the strip was matched to the color coded pH indicator chart, provided by the manufacturer. This chart gave a definite pH value for each color. The pH value recorded were considered to be low (5.0-5.8)-red, moderate (6.0-6.6)-yellow and high (6.8-7.8) - green.

Quantity and flow rate of stimulated saliva: The quantity of stimulated whole saliva collected at the end of 5 minutes in the graduated cup was measured to a precision of 0.5 ml. The amount was measured and the stimulated flow rate was calculated by total volume to saliva collected / time period for collection of saliva.[8] If the quantity of saliva after 5 minutes was less than 3.5 ml, it was considered to be very low, if found to be between 3.5-5.0 ml, it was considered low and any quantity more than 5 ml was considered normal. The flow rate of saliva was expressed in ml/min and was grouped accordingly as very low (below 0.7ml/min), low (0.7-1.0ml/min) and normal (above 1 ml/min).

Buffering capacity of stimulated saliva: Using a pipette, a sufficient quantity of stimulated saliva was drawn from the collection cup and one drop was dispensed onto each of the three test pads on the buffer test strip. The test strip was immediately turned 90° to soak up excess saliva on the absorbent tissue. This was done to prevent the excess saliva from swelling on the test pad and possibly affecting the accuracy of the readings. The test pads showed a change in color immediately and after 2 minutes the final result was interpreted by comparing the color change observed on the test strips with the color-coded reference chart. The corresponding colors observed were given points: Green - 4, green/blue - 3, blue - 2, blue/red -1 and red – 0. Points from each of the three pads were then added to obtain the total score. The combined score for the 3 pads gave the buffering capacity of the stimulated saliva as follows: A score of 0-5 was considered to be very low, between 6-9 low/medium and between 10 –12 was considered to be high/normal.

The collected data was subjected to statistical analysis using Student t test (two tailed, independent) to find the significance of study parameters and Mann Whitney U test to find the significance of deft and DMFT between study and control group. Multivariate Regression analysis was done to assess the correlation between salivary parameters and dental caries scores.

RESULTS

Dental caries status: A higher percentage of both CP children (64%) and normal children (68%) were affected with caries in their primary dentition (Table 1). In the study group, the mean deft score recorded was 2.51, with males showing a mean deft of 2.71 and females showing a mean deft of 2.75. The DMFT score obtained was 0.73 with mean values of 0.69 for males and 0.66 for females. In the control

Table 1. Percentage of caries affected children with regard to the type of dentition

Group	Percentage of Caries Affected (%)	
	Primary teeth	Permanent teeth
Study	64.22	36.96
Control	68.05	25.60

Table 2. Comparison of dental caries status.

Dental caries	STUDY GROUP		CONTROL GROUP		p value
deft	2.51±2.40 (0-9)		2.12±1.96 (0-9)		0.280
	Males (n=58) 2.71±2.40(0-9)	Females(n=42) 2.75±2.40(0-9)	Males (n=58) 2.04±1.97(0-9)	Females (n=42) 2.43±1.97(0-9)	
	p=0.653		p=0.776		
DMFT	0.73±1.10 (0-4)		0.68±0.88(0-4)		0.679
	Males (n=58) 0.69±1.10(0-4)	Females (n=42) 0.66±1.10 (0-4)	Males (n=58) 0.62±0.88(0-4)	Females (n=42) 0.57±0.88(0-4)	
	p=0.487		p=0.554		

group the mean deft was 2.12, with males and females showing a mean deft of 2.04 and 2.43, respectively. The mean DMFT was 0.68, with mean values of 0.62 for males and 0.57 for females. There was no significant difference in the dental caries status between the two groups and also between males and females in both groups (Table 2).

Evaluation of salivary parameters: The study group showed a mean pH of 6.83 as compared to a slightly higher mean pH of 6.98 observed in the control group. This difference was highly significant (p≤0.01).However, no significant difference was observed in buffering capacity and flow rate of saliva between the two groups. The mean salivary pH and buffering capacity did not show significant difference between males and females in both the groups. In both groups, flow rate of saliva was observed to be higher in males but it was not significant (Tables 3).

Correlation between dental caries status and salivary parameters: The salivary pH showed a negative correlation with both deft and DMFT scores of the control group. A similar relationship was seen between salivary pH and only the DMFT scores of the study group. The buffering capacity and quantity of saliva were also observed to have a negative

Table 3. Comparison of salivary pH, buffering capacity and flow rate.

Salivary parameters	STUDY GROUP		CONTROL GROUP		p value
pH (unstimulated)	6.83±0.50 (5.20-7.60)		6.98±0.27 (5.8-7.40)		0.007**
	Males (n=58) 6.9±0.50) (5.20-7.60)	Females(n=42) 6.82±0.27 (5.20-7.60)	Males (n=58) 6.82±0.27 (5.8-7.40)	Females (n=42) 7.1±0.27 (5.8-7.40)	
	p=0.356		p=0. 0.212		
Buffer Capacity (stimulated)	10.84±1.11 (8-12)		10.90±0.99 (8-12)		0.687
	Males (n=58) 10.5±0.50 (8-12)	Females (n=42) 11.8±0.50 (8-12)	Males (n=58) 10.8±0.27 (8-12)	Females (n=42) 10.66±0.2 (8-12)	
	p=0.443		p=0.322		
Salivary Flow rate (ml/min)	1.08±0.13 (0.70-1.30)		1.09±0.10 (0.90-1.30)		0.424
	Males (n=58) 1.12±0.13 (0.70-1.30)	Females (n=42) 1.067±0.13 (0.70-1.30)	Males (n=58) 1.172±0.10 (0.90-1.30)	Females (n=42) 1.144±0.10 (0.90-1.30)	
	p=0.512		p=0.423		

[p≤0.01** is highly significant]

Table 4. Multivariate Regression Analysis for correlation between dental caries status and salivary parameters

Dental Caries →	deft				DMFT			
Salivary parameters ↓	Control group		Study group		Control group		Study group	
	β coefficent	P value	β coefficient	P value	β coefficent	P value	β coefficent	P value
pH	-1.272	0.161	0.152	0.734	-0.075	0.843	-0.017	0.938
Buffering capacity	0.272	0.408	-0.563	0.007	0.005	0.964	-0.203	0.004
Quantity	2.646	0.350	-3.078	<0.001**	-0.185	0.875	-1.003	<0.001**
Flow Rate	-10.086	0.471	4.082	<0.001**	2.073	0.722	1.426	<0.001**

P<0.01** is highly significant

correlation with the dental caries scores of the study group, which was highly significant. The salivary flow rate showed a highly significant correlation with dental caries scores of the study group (Table 4).

DISCUSSION

There is contradictory information in literature regarding the incidence of oral diseases in patients with cerebral palsy. According to Brown, these controversies are due to failure of non standardized criteria used for diagnosis, absence of control groups and lack of statistical analysis of the results.[4]

The dental status of cerebral palsied children studied in the UK showed similar decay levels, fewer carious teeth restored, and more extractions when compared with controls.[10] Studies in the US have also described similar inferior dental heath status and poorer levels of care in CP children.[11] The findings of the present study were in accordance with other studies which described higher (but not significant) dmf values for CP children.[2,12] Sixty four percentage of the cerebral palsied children in our study were found to be affected with caries in their primary dentition, compared to 68% of the normal children. A previous study conducted on children below 6 years of age showed 59% of CP children and 34% of normal children to be affected.[1] In the 6-11 year age group; carious permanent teeth were seen in 9% of CP children as compared to 34% of normal children.[1] In our study, 37% of children with CP had caries in their permanent dentition as compared to 26% of normal children. Children in this study had more caries in their primary dentition, probably because at a younger age the erupted permanent teeth would have been exposed to the oral environment for a shorter duration.[1]

Many factors such as the presence of fluoride in water, diet, oral hygiene and socio-economic factors are important for the prevalence of dental caries in both normal and handicapped children. It has been observed that developmental enamel defects in primary teeth are more frequent in cerebral palsied children thus, making their teeth possibly more prone to dental caries.[13] The severity of the handicap as influenced by motor and mental ability of an individual should also be considered.[14] Although the CP children in our study were not institutionalized and were not subjected to any dietary regime, they did not show significantly higher levels of caries compared to normal children. This could be due to both groups of children living in an urban city with similar oral hygiene practices, exposure to cariogenic diet and access to dental health care. Also, the CP children included in this study did not have any mental retardation nor were they on any prolonged medication. This was in contrast to another Indian study, in which 56% of CP children with mental retardation showed dental caries.[15] Although the CP children in our study presented with varying degrees of motor deficits such as staggering gait, monoplegia and paraplegia, they found no major difficulty in grasping a tooth brush, oral rinsing and following simple routine oral hygiene measures. Both children and their parents did not express any difficulty in brushing or cleaning their teeth. Wheel chair bound children were assisted by their parents/caretakers. Moreover, these CP children did not differ from normal children in their level of understanding the importance of oral hygiene.

Caries is a multifactorial disease, of which salivary parameters represent only a fraction of all contributing factors. Furthermore, salivary compositions show considerable inter-subject variations and, unlike the compositions of other body fluids, are dependent on flow rate.[16] Flow rate of saliva changes as a function of stimulation.

Salivary flow rate is a clinical measure of the total secreted output of the salivary glands, either individually or in combination.[16] The mean salivary flow rate recorded in this study for both normal and CP children is within the normal physiological range. This is in accordance with a Brazilian study[17] but is lower than that found in a study, which reported 1.6 ml/min in 60 adults.[18] Such variations could be related to the age differences of subjects studied and also supports the concept that the flow rate and contents of saliva

change with age.[9,16] During the teens salivary glands record maximum development and the size of the glands have been shown to be the best predictor of secretory capacity.[9] A range of salivary flow rates has been reported in different age groups.[18]

It is estimated that 37% of children with CP have drooling problems significant enough to interfere with their daily social and practical functions.[19] Earlier studies had shown that drooling in CP children is not due to excess saliva production but due to a neuromuscular defect that leads to ineffective swallowing.[20] In the present study, none of the children with CP presented with hypersalivation (salivary flow rate higher than 1.6ml/min),[18] thus suggesting that those who drool do not produce excess saliva.

Certain studies have clearly shown a correlation between low salivary flow rate and dental caries experience.[9,21] These studies examined whole saliva, while a few of them also examined parotid gland secretion.[18] In the present study, a significant correlation was seen between salivary flow rate and dental caries in CP children. This could be due to other contributory factors such as drooling and reduced oral clearance rates, rather than flow rate per se.

Studies that distinguished stimulation status reported a relationship between caries and unstimulated whole saliva flow rate, but not necessarily with stimulated flow rate.[9] Although flow rate per se appears to be inversely related to caries experience, there is no clear consensus that the stimulation status of either whole saliva or pure glandular secretion is important in caries risk.[22]

The hydrogen ion concentration of oral fluids may be considered the 'master variable', since it influences most chemical reactions taking place in the oral cavity, most notably the equilibrium between the calcium phosphates of the dental hard tissue and its surrounding liquid phase.[23]

The salivary pH was measured by an easy, quick chair side method in which unstimulated saliva was evaluated according to the color change observed on pH test strips. The mean pH value of unstimulated saliva was 6.83 for CP children and 6.98 for normal children. This difference was highly significant. The salivary pH of normal children thus showed a negative correlation with their dental caries scores. Whereas in CP children, this negative correlation was limited to caries in the permanent dentition only. Caries susceptibility of primary teeth was reported higher than that of permanent teeth due to low salivary flow.[18] It should be noted that there is a large increase in pH in response to a small change in salivary flow in the low flow rate range, but is comparatively small in the high flow rate range.[18]

Buffering capacity is distinguished from pH per se in various studies in that, it is a more useful measure of an individual's innate ability to maintain a neutral or slightly alkaline pH in saliva.[24] Whereas, the pH of saliva is a

labile parameter highly influenced by the types and timing of food intake and also an individual's oral hygiene habits. The parameter of buffering capacity is measured using a salivary pH endpoint in acid-base titrations. Individuals with a lower, more acidic final pH value are deemed to have diminished buffering capacity.

The bicarbonate system of saliva is the main mechanism of buffering action of saliva. The bicarbonate concentration is very low in unstimulated saliva and such saliva is poorly buffered.[23] Stimulated saliva was thus evaluated in the present study for its buffering capacity. The colorimetric method was used because it is a simple, non invasive, feasible chairside test which could be easily carried out in a community setting. It was also possible to discriminate between high, medium and low buffering capacity.

In the present study, the salivary buffering capacity in both the groups showed no significant differences between males and females. An earlier study which found a difference with regard to gender was justified by the drop in buffering capacity during early adolescence and the effect of female sex steroid on salivary bicarbonate.[9]

Buffering capacity of saliva is a very significant property that affects the dental caries process. It has also been reported that there is an increased risk of caries in primary but not permanent teeth due to low buffer capacity.[18] None of the children examined in our study showed a low buffering capacity. This could explain the negative correlation observed between caries and buffering capacity of saliva.

CONCLUSIONS

The following conclusions were drawn from the study:

1. The deft and DMFT scores for CP children were not significantly higher than those for normal children.
2. Among the salivary parameters examined, only the unstimulated salivary pH was significantly lower in children with CP than in normal children.
3. There was no significant difference in the flow rate and buffering capacity of stimulated saliva of CP and normal children.
4. Quantity of saliva was observed to have a highly significant negative correlation with deft and DMFT scores of CP children.

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