Salivary Flow Rate, pH, Viscosity, and Buffering Capacity in Visually Impaired Children

Rizky Fitri Haryuni[1], Margaretha Suharsini[2], Sarworini B. Budiardjo[2], Amrita Widyagarini[3]*

1. Postgrad student, Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia.
2. Prof. Dr. Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia.
3. Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia.

Abstract

The global prevalence of visually impaired children has increased. A limitation or absence of light affects neural stimulation and disturbs circadian rhythms. When the dark phase is longer than the light phase, this limits motor responses, including those of the salivary glands. The aim of this study was to compare salivary flow rate, pH, viscosity, and buffering capacity between visually impaired and visually healthy children.

This study was performed on 35 visually impaired children, 7–11 years old, and 35 visually healthy children, 7–12 years old. All participants provided unstimulated saliva and stimulated saliva for 5 minutes in the morning by a spitting method for measurement of salivary flow rate and pH. Salivary viscosity was rated visually at the base of the mouth. Salivary pH and buffering capacity were measured electrometrically using a handheld pH meter. Salivary buffering capacity was measured by titration of stimulated saliva with 0.005 N HCl, and the flow rate was expressed as mL saliva produced/5 min.

The stimulated salivary flow rate and buffering capacity were significantly lower in the visually impaired children than in the visually healthy children. Unstimulated salivary flow rate and pH showed no statistically significant differences, but were slightly lower in visually impaired children. Salivary viscosity was not significantly different between the two groups.

Visual acuity affects the composition of saliva secretions. Salivary flow rate, pH, and buffering capacity are lower in visually impaired children than in visually healthy children.

Clinical article (J Int Dent Med Res 2018; 11(1): pp. 116-119)

Keywords: Visual impairment, salivary flow rate, salivary pH, salivary buffering capacity, viscosity.

Received date: 25 October 2017 **Accept date:** 04 December 2017

Introduction

Visual impairment is a condition characterized by a decreased ability to see or an absence of light perception. The prevalence of visually impaired individuals has increased globally.[1] In Indonesia, the population of visually impaired children increased from 0.08% in 2010 to 0.17% by 2013.[2]

Limitation of light affects neural stimulation and disturbs circadian rhythms when the dark phase is longer than the light phase.[3,4,5] An absence of light information that enters the hypothalamus (i.e., the suprachiasmatic nuclei [SCN]) causes limitations in the motor responses of the body organs and glands. In the dark phase, minor salivary glands secreted mucus, while in light phase the saliva is serous.[4,5]

Saliva has two main functions and several minor functions, based on its composition. The first function is a digestive function and the second is a protective function. The effectiveness of these functions is associated with the saliva characteristics, such as pH, flow rate, viscosity, and buffering capacity.[5]

Mount categorized the condition of saliva (i.e., flow rate, pH, and viscosity) using a traffic light color system that was associated with the risk of caries, while Ericsson categorized salivary buffering capacity with an electrometric method that involved titration of saliva with 0.005 N HCl.[6,7]

****Corresponding author:***
Margaretha Suharsini
Department of Pediatric Dentistry
Faculty of Dentistry, Universitas Indonesia
Jalan Salemba No. 4, Jakarta Pusat, Indonesia
E-mail: margarethasuharsini@gmail.com; drgnuni@gmail.com

Salivary flow rate, pH, viscosity, and buffering capacity are affected by circadian rhythms, the strength of stimulation, diet, hormone levels, medications, psychological state, and systemic condition.[3,8]

The aim of this study was to compare the salivary flow rate, pH, viscosity, and buffering capacity in visually impaired and visually healthy children.

Materials and methods

This study was approved by the Ethical Committee of the Faculty of Dentistry, Universitas Indonesia. After being informed of the aim of the investigation, the adult responsible for each child provided a written consent to participate in the study. This was a case-control study. The study sample consisted of 70 children, divided into two groups. The first group was composed of 35 visually impaired children, 7–11 years old (15 girls and 20 boys). The second group was composed of 35 visually healthy children, 7–12 years old (19 girls and 16 boys). The inclusion criteria were children who were free from systemic and local diseases that affect salivary gland secretions. The exclusion criteria were children who used dentures, children who were on medication, and children who had multiple disabilities.

Saliva was measured between 8.00 and 10.00 in the morning, 1 hour after the last meal. The viscosity of the unstimulated saliva was measured visually at the base of the mouth and categorized as watery pooling of saliva, no visible pooling, and thick. The unstimulated salivary flow rate was determined by collecting saliva in a tube for 5 minutes using spitting methods. After 5 minutes, the pH and the amount of saliva were recorded. The pH of the saliva was measured with a digital pH meter (Hanna, USA). Stimulated saliva was collected in the tube after the child chewed M-Parafilm for 5 minutes and the stimulated salivary flow rate was recorded. To measure salivary buffering capacity, 1 mL of saliva was titrated with 3 mL 0.005 N H Cl. After mixing the tube contents, the pH electrode was immersed in the tube and the pH value was recorded.

Data were analyzed using the Statistical Package for Social Sciences (ver.17, SPSS). Statistical comparisons data were performed with the Mann-Whitney U test. The values for the unstimulated salivary flow rate, pH, stimulated salivary flow rate, and salivary buffering capacity were expressed as median (minimum–maximum). A *P*-value <0.05 was considered statistically significant.

Results

The results of the studied parameters are presented in Tables 1 and 2. The stimulated salivary flow rate and buffering capacity were significantly lower in the visually impaired children, whereas the salivary viscosity, unstimulated flow rate, and pH were not significantly different between the two groups. Table 1 shows that the most frequent salivary viscosity in both groups was watery pooling: 57.1% in visually impaired children and 67.5% in visually healthy children. No visible pooling was evident in 28.6% of the visually impaired children and 22.9% of the visually healthy children, while 14.3% of the visually impaired children and 11.4% of the visually healthy children had thick salivary viscosity.

Group	Watery pool	No pooling visible	Thick	p-value CI = 95%
Visually Impaired Children	20 (57.1 %)	10 (28.6%)	5 (14.3%)	N.S
Visually Normal Children	23 (65.7%)	8 (22.9%)	4 (11.4%)	

Table 1. Salivary Viscosity in Visually Impaired Children and Visually Healthy Children.

	Visually Impaired Children	Visually Healthy Children	p-value CI=95%
Unstimulated Salivary pH	6.87 (5.95–7.97)	7.06 (6.04–7.86)	N.S
Unstimulated Salivary Flow Rate	1.80 (0.10–6.50)	1.90 (0.3–10.25)	N.S
Stimulated Flow Rate	2.50 (0.30–14.10)	5.00 (0.75–14.25)	*P* = 0.000
Buffering Capacity	5.95 (2.61–6.94)	6.60 (4.73–7.72)	*P* = 0.000

Table 2. Unstimulated Salivary pH, Flow Rate, Stimulated Salivary Flow Rate, Buffering Capacity in Visually Impaired Children and Visually Healthy Children. Data are expressed as median (minimum–maximum)

Table 2 shows the results (median [minimum–maximum]) for stimulated salivary flow rate, pH, unstimulated salivary flow rate, and buffering capacity. The unstimulated salivary flow rate was lower in visually impaired children (1.80 [0.10–6.50]) than in visually healthy children (1.90 [0.3–10.25]), the unstimulated salivary pH was lower in visually impaired children (6.87 [5.95–7.97]) than in visually healthy children (7.06 [6.04–7.86]), the stimulated salivary flow rate was lower in visually impaired children (2.50 [0.30–14.10]) than in visually healthy children (5.00 [0.75–14.25]), and the salivary buffering capacity was lower in visually impaired children (5.95 [2.61–6.94]) than in visually healthy children (6.60 [4.73–7.7]).

Discussion

Analysis of the saliva characteristics of visually impaired children is needed because these characteristics are associated with the oral condition.[9,10,11] Saliva is secreted by salivary glands, which produce difference kinds of mucus. The parotid glands secrete serous saliva, the submandibularis glands secrete seromucous saliva, and the sublingualis and minor salivary glands secrete mucus. In the unstimulated condition, the minor salivary glands produce almost all the saliva,[7,8,11] and this condition is most common at night or in the dark phase.[7,8] A limitation or absence of light entering the hypothalamus also causes a limitation in the motor responses of these glands. The suprachiasmatic nucleus (SCN) in the hypothalamus is associated with the sympathetic preganglionic neurons that organize the minor salivary glands. Low light conditions therefore decrease the salivary flow rate, pH, viscosity, and buffering capacity.[5,8] This is important for visually impaired children, who are reported to have a dark phase that is longer than the light phase.[4]

The children participating in this study were aged 7–12 years old. At 7 years old, children have complex emotions, but they have ability to form friendships, pay attention, and perform systematic tasks. At age 12, they are entering puberty, which can affect hormone levels and saliva secretion.[12] Children who use dentures were not included because dentures can compress the salivary glands. Children taking medications were not included because medications can affect saliva secretion. In addition, when children are sick, they secrete thicker saliva.[13]

Saliva was collected using spitting methods one hour after the previous meal in the morning to minimize circadian rhythm effects. According to the Stephan curve, salivary pH will affect plaque pH, and salivary pH will return to the initial pH after one hour. Spitting methods were selected because less evaporation occurs than with other methods.[6,14]

The buffering capacity of stimulated whole saliva is determined by the levels of bicarbonate and phosphate ions.[15,16] Electrometric methods were used to determine salivary buffering capacity in this study because these methods are easier than the Ericsson and colorimetric methods. Colorimetric methods sometimes give inconclusive results, as the color reaction depends on the time the saliva remains in contact with the strip or solution.[16,17] The results also depend on the visual perception of individual researchers. The Ericsson method is not practical for use as a chair-side test, and the saliva needs special handling for transport to an analytical laboratory.[16]

Conclussions

Visual acuity affects the composition of saliva secretions. The salivary flow rate, pH, and buffering capacity are lower in visually impaired than in visually healthy children.

Acknowledgements

We carried out this research under a grant from the Directorate of Research, Universitas Indonesia (Hibah PITTA 2017).

Declaration of Interest

The authors report no conflict of interest.

References

1. Pascolini D, Mariotti SP. Global Estimates of Visual Impairment: 2010. Br J Opthalmology. 2012;5:614-8.
2. Kemenkes, Badan Penelitian dan Pengembangan Kesehatan Republik Indonesia. Riset Kesehatan Dasar. Jakarta. 2013; 188:231-4.
3. Laidi F, Zaoui F. Salivary Diagnostic and Cancer Monitoring: Overview. J Int Dent Med Res. 2015;8(2):94-7.
4. Lockley SW, Arendt J, Skene DJ. Visual Impairment and Circardian Rhytm Disorders. Dialugues Clin Neurosci. 2007;9:301-14.
5. Barret KE, Barman SM, Boitano S, Brooks HL. Central and Peripheral Neurophysiology. In: Ganong's Review of Medical Physiology. 34th ed. Singapore: McGraw Hill Medical. 2012;278-80,456-7.
6. Mount GJ, Hume WR, Ngo HC, Wolf MS. Preventive Management of Dental Caries. In: Preservation and Restoration of Tooth Structure. 3rd ed. New Delhi: John Wiley & Sons Limited. 2016;33-49.
7. Buchgraber B, Kqku L, Reibnegger G, Stadler P. The Weak Spots of Saliva Buffering Tests. Coll Antropol;2013;3:1001-999.
8. Sherwood L. The Digestive System. In: Human Physiology From Cell to System. 5th ed. Belmont: Brooks/Cole Thomson Learning. 2004;204-7,599-601,677-89.
9. Mahoney EK, Kumar N, Porter SR. Effect of Visual Impairment Upon Oral Health Care : a Review. Br Dent Journal. 2008;204(2):63-7.
10. Doichinova L, Peneva M. Risk Assessment for the Development of Caries in Visually Impaired Children in Sofia City , Bulgaria. Int J Sci Res. 2015;4(2):1108-11.

11. Kusuma H, Saptarini R, Sasmita I, S W, Effendi SH. Correlation Between Flow Rate, Viscosity, Buffering Capacity, pH, and Caries in Full and Mozaic Down Syndrome Children: A Study in Trisomy and Mizaic Type Down Syndrome. J Int Dent Med Res. 2017;10(2):343-9.
12. Cassamassimo PS, Fields HW, McTigue DJ, Nowak AJ. The Transitional Years : Six to Twelve Years. In: Pediatric Dentistry Infancy through Adolescence Fifth Edition. 2013;411-22.
13. Teresa M, Rodrigues B, Luiz W. Flow Rate , pH and Buffer Capacity in Saliva of Adolescents with Cerebral Palsy. J Dissability Oral Heal. 2006;7(3):185-8.
14. Navazesh M, Satish K S Kumar. Measuring Salivary Flow. JADA. 2008;139:35-40.
15. Masruri T, Soebadi B, Hernawan I, Hadi P, Hendarti HT, Ernawati DS. Autofluoresence and p53 Level in Saliva Examination as an Early Detection of Premalignant Lesion in Betel Chewer at Papua, Indonesia. J Int Dent Med Res. 2017;10(2):338-42.
16. Kitasako Y, Burrow MF, Stacey M, Huq L, Reynolds EC, Tagami J. Comparative Analysis of Three Commercial Saliva Testing Kits with a Standard Saliva Buffering Test. Aust Dent J. 2008;53:140-4.
17. Wimardhani YS, Kusuma YW, Sasanti H, et al. Salivary Profile of Recovering Drugs Users In Indonesia. J Int Dent Med Res. 2016;9(1):50-4.