Gustatory Sensitivity And Oral Health In Congenitally Visually Impaired Children: A Randomized Controlled Trial

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Abstract

Objectives
Limited access to visual sensation of visually impaired children causes difficulties in maintaining dental hygiene, resulting in a higher occurrence of caries and gingivitis. Traditional oral hygiene techniques rely on the visual sense, limiting their effectiveness in reducing plaque. The current study aims to assess the efficacy of unique natural flavored dentifrices in improving oral hygiene through sensory stimulation, particularly aroma and taste.

Methods
A single-blind, parallel-group, randomized controlled control trial was carried out on 68 visually impaired children aged 6-15 years at Manik Prabhu Academy for the Blind in Raichur, India, using CONSORT guidelines. Participants were assigned to flavored or unflavored toothpaste groups based on the flavors' tactile, olfactory, and taste experience. Plaque Index was recorded at baseline, 21, and 90 days. Statistical analysis used SPSS version 20, with significance set at $p<0.05$.

Results
When an unpaired t-test is performed both groups showed a decrease in plaque scores over time. However, the flavored toothpaste group showed considerably higher decreases in PI at 21 and 90 days ($p<0.05$). There were no adverse consequences noted.

Conclusion
Flavored toothpaste improves oral hygiene in visually impaired children by encouraging sensory engagement. It increases compliance and brushing efficiency, making it a viable alternative for gingivitis management in this population.

Introduction

Vision is our primary means of perceiving our surroundings, and when it is affected in early life, it can have a significant impact on a child's physical, neurological, cognitive, and emotional development[1]. Over 1.4 million children worldwide are estimated to suffer vision impairments, with India having the largest proportion (15 million)[2]. Visually challenged children commonly face daily difficulties, including dental cleaning, which causes plaque buildup. Plaque control is a crucial component of dental practice that guarantees the long-term success of periodontal and dental care[3]. Disabled patients sometimes prioritize their severe disease over their oral health, resulting in a "halo" effect[4]. Hence the incidence and prevalence of caries and periodontal diseases are higher among these visually impaired children. Mechanical plaque removal is one of the most popular and simple-to-use methods of managing plaque and gingivitis[5]. Toothbrushes, dental floss, mouth rinses, and dentifrices are some of the mechanical aids used globally to remove or control plaque[6]. Plaque-induced Gingivitis and dental caries are more common among people with disabilities who have consistently poor oral hygiene. Because brushing the teeth is the most common approach to maintaining good oral hygiene, dentifrices are the most effective way to administer antibacterial agents regularly. These dentifrices are routinely used in improving dental hygiene. However, these regular unflavoured dentifrices are ineffective in maintaining

oral hygiene practices among visually impaired children. The visually impaired children rely heavily on sound, speech, touch, smell, and taste to navigate their surroundings[7]. Children with visual impairments learn brushing skills more effectively through touch and hearing, as well as the pleasant flavor and aroma of the toothpaste they use[8]. Utilizing natural flavors in dentifrices can enhance dental hygiene, especially in children[9]. By incorporating the true taste of everyday foods like fruits and vegetables, flavored toothpaste can stimulate the senses. This approach is particularly relevant for visually impaired children, who may have heightened senses of smell and taste due to brain plasticity. Yet, little research exists on their olfactory and gustatory experiences, particularly in oral hygiene. Our study investigates the effectiveness of flavored toothpaste in improving oral hygiene in visually impaired children, leveraging their enhanced senses of taste and smell.

Materials and Methods

The current study is a single-blind, parallel-group, randomized controlled clinical experiment. The oral screening was conducted on 70 institutionalized congenitally Visually impaired school children aged 6 to 14 years at Manik Prabhu Academy for the Blind in Raichur, Karnataka, India. All 70 children had plaque-induced gingivitis, which was diagnosed using the American Academy of Periodontology's (AAP) standards. Statistical sample size is estimated using G power software (University of Kiel, Kiel, Germany). A sample size of 68 was needed for an effect size of 0.40 and a power of 0.95 for a two-sided normal distribution with the two groups.

Before the start of the study, ethical clearance was obtained from the Institutional Ethics Committee XXX. The study was conducted according to CONSORT (Flowchart 1) guidelines. Consent was taken from the parents/legal guardians of all the participants and the study was explained to the institution authority. Children who know to write in Braille provided the assent in Braille text and for others verbal assent was taken. Demographic data including name, age, and gender, as well as a questionnaire that evaluated their understanding of oral hygiene procedures and regularity of dental visits, were recorded using a self-designed format. These details are obtained from the parent/guardian or institutional records. The education of oral hygiene practices was collected verbally from all the study participants.

The study included children aged six to fourteen years because of ability to read in braille and also who had mild to moderate gingivitis (According to Modified Gingival index by RR Lobene et al[10]), as determined by a thorough clinical examination. The study included children with congenital visual impairment, including complete visually impaired and low-vision individuals. The study included patients who had not received any periodontal therapy in the prior six months.

Children with advanced periodontal disease were excluded, as were those with any systemic illness, such as diabetes or immunocompromised conditions, that could affect tooth health. Furthermore, children receiving drugs that potentially affect gingival health, such as anticonvulsants and immunosuppressants, were unable to participate. Children’s parents who refused to sign the consent were excluded.

All participants' Plaque Index (Silness and Loe, 1964[11]) were measured and recorded at school while seated in a common chair, under adequate lighting, and using a sterile mouth mirror and explorer while wearing disposable gloves and masks to prevent cross-infection. The professionally qualified Periodontist as well as trained Pedodontist conducted all of the examinations. Both periodontist and Pedodontist underwent special training in the dental hospital for the plaque score record. Inter-examiner reliability and validity were checked before concluding the index scores in twenty normally sighted children. Plaque Index (PI) was determined using the disclosing dye solution (Trace disclosing solution, Young dental manufacturing, USA). The dye solution was transferred to a new cotton swab, well-saturated, and gently applied to the tooth surfaces. The excess solution was removed by allowing the individuals to rinse with tap water once, and the baseline PI was measured.

Patients were randomly assigned to a study group (flavored toothpaste, n=34) and a control group (unflavoured toothpaste, n=34) with a 1:1 allocation ratio using computerised block randomisation. Both groups received full mouth scaling and participants were educated on a home oral

hygiene method based on the Fones Circular brushing method, which has greater neuromuscular control in children and is also easier to use than other brushing techniques by trained Pedodontist[12].

On the same day, four commercially available toothpaste flavors (green apple, bubble gum, melon, and orange) were introduced to all participants in the study group through a multi-sensory approach(Figure 1). Bubble gum flavour is flavour of children chewing gum unlike the natural flavours like green apple, melon and orange. Participants were first educated about each flavor and its relation to natural fruits and daily consumables through Braille pamphlets. They then experienced the flavors through their olfactory sense by smelling natural fruits related to those flavors. Next, participants tasted the natural fruits with their gustatory sense, further familiarizing themselves with the flavors. Finally, after experiencing the flavors through multiple sensory modalities, participants selected their preferred toothpaste flavor. Most of the participants choosed Melon flavor as their preferred toothpaste flavor. Inorder to reduce the flavor-based bias the flavored toothpaste were equally divided in the study groups. Since the study is the institutional based and participants live in the same environment they were educated individually in the separate council room regarding the flavor. Every week it was confirmed by the Pedodontist that whether there was procedural errors or exchange of information between the study participants. The study group was instructed to brush their teeth twice daily with a commercially available flavored toothpaste (Pediflor® Kids, India). Participants allergic history was asked verbally and who had a history of allergic reactions to toothpaste components, particularly flavoring compounds, were excluded in the study.

The control group was provided with Commercially available Unflavoured toothpaste (Enafix®, India) and instructed to brush their teeth twice daily. The investigator was unaware of the group allocation. Every patient was asked to not use any kind of other toothpaste and was told to report any adverse effects. PI was measured after 21 days and 90 days by the same professional investigator.

Statistical Analysis

Statistical Analysis Data was entered in a Microsoft Excel spreadsheet and analyzed using IBM SPSS software version 20. O (Armonk, NY: IBM. Corp., USA). Numerical data were presented as mean and standard deviation values. For the test, a p-value of <0.05 is to be considered statistically significant. Shapiro Wilks test is used to test the normality of the data set and an unpaired t-test is performed for intergroup comparison.

Result

Table 1 indicates the intragroup Comparison of mean PI and SD at 0, 21 and 90 days. The baseline PI values showed no prominent variation between groups 1 and 2. The PI scores in both groups decreased gradually at the 0 and 21-day time intervals. The toothpaste used was the foundation for the discovery, which showed the mean PI at various time points. PI did not significantly alter after using unflavored toothpaste. For group 1, the PI was 1.73+ 0.21 at baseline and 1.48 ± 0.26 after 21 days. Group 2's PI was 1.91 ± 0.34 at baseline and 1.90 ± 0.24 after 21 days. Independent t test was performed to compare baseline scores and post intervention plaque scores between two groups and found that there is statistically significant difference between flavoured and unflavoured toothpaste (p value=0-002). At 90 days, there was a significant difference between Groups 1 and 2. This independent t test shows the effectiveness of flavoured toothpaste among visually impaired children. Throughout the study there was no exchange of procedural information between the study participants which gave the unbiased result. Since Baseline scores were recorded prior to the oral prophylaxis, the comparison of mid intervention and post intervention scores with baseline scores provided the effectiveness of intervention on plaque clearance thus reducing the plaque accumulation.

Discussion

Dental caries, periodontal issues, and tooth loss are oral disorders that can have a serious influence on a person's general health. Because of their high incidence and prevalence worldwide, these illnesses are considered severe health hazards, even in specially abled children. Visually impaired children reported that they have poorer oral hygiene due to plaque. Plaque accumulates faster in the primary and mixed dentitions in children than in adults[13]. In children, the main issues limiting the efficiency of mechanical

toothbrush-aided plaque removal include a lack of motivation to brush, inappropriate toothbrushing technique, and underdeveloped manual dexterity[14,15]. It will be challenging to provide health care services to those with the special medical needs of these impaired people[16]. So multisensory aspects other than vision which include tactile, olfactory, and gustatory sensation can be used as oral health education media due to superior control over it[17]. In our study, tactile learning was made through braille text and olfactory and gustatory education was done using natural flavors of the toothpaste available. Children with visual impairments must use a dentifrice and a high-quality bristle toothbrush inorder to keep their teeth healthy.

In addition to toothbrushes and brushing technique, toothpaste remains the cornerstone of oral hygiene and is recognized as the most effective ingredient for overall plaque reduction. Dentifrices, which exist in several forms and have other benefits, are primarily considered as a means to add flavor to the simple and enjoyable process of toothbrushing. Flavour gives the psychological positive association towards the oral hygiene practices. To improve patient compliance and toothbrushing efficiency, we used a variety of commercially available flavored toothpaste. Natural flavors and daily consumables, such as melon, orange, bubble gum, and green apples, would taste better in dentifrices. This flavored toothpaste was well-accepted by children and enjoyed by all samples in the group, resulting in a significant drop in the gingival index and improved dental hygiene. The flavoured toothpaste will provide motivation for mechanical plaque control by brushing and thus increasing the oral hygiene status. The current study done on inter-group comparison provides that there is decrease in the plaque accumulation thus increasing the oral health status.

The main cause of gingival discomfort is dental plaque. If not treated, chronic gingival inflammation can progress to the more serious stages of periodontitis, causing tissue damage. Controlling plaque helps to preserve a healthy oral cavity. Flavored toothpaste and toothbrushes are effective at mechanically controlling plaque[18]. Mechanical plaque control requires patient cooperation and motivation, hence chemical plaque control is utilized to accomplish the necessary results[19]. However, it should be appropriate for visually impaired children[20]. Our research found that using flavored toothpaste results in a considerable reduction in plaque index.

The current study is the first to assess the efficacy of flavored toothpaste in visually impaired children based on taste and aroma because they rely on it[21]. However, Anju Merin Koshy et al[22] compared the anti-plaque efficacy and consumer satisfaction of herbal toothpaste to commercially available non-herbal toothpaste and discovered that herbal toothpaste had higher consumer satisfaction as well as a lower plaque index. Similarly, any innovative approach that enhances gustatory and olfactory sensations can potentially improve oral hygiene by reducing plaque formation. Consequently, incorporating an additive flavor to toothpaste can increase patient acceptance, ultimately leading to more efficient brushing techniques.

Clinical Relevance:

The current study strengthens knowledge in paediatric dentistry by presenting a novel method to oral hygiene for visually impaired children that uses their sense of taste and smell to improve oral health outcomes. Clinicians can create individualized oral health plans for visually impaired children by taking into consideration their individual gustatory sensitivity profiles. By adding sensory-friendly oral health products and practices, practitioners can enhance patient compliance and adherence to oral hygiene routines. Early intervention and prevention can reduce the need for costly therapies and foster interdisciplinary teamwork among healthcare professionals.

Conclusion

This study provided compelling evidence that flavored toothpaste can significantly improve oral hygiene outcomes in visually impaired children. By harnessing the power of sensory engagement, flavored toothpaste offers a simple but effective strategy for promoting better oral health and reducing the risk of plaque induced gingivitis in the visually impaired children.

Conflict of Interest: NIL

Author Contributions:

Dr Shrutha SP: conceptualization, supervision.

Dr. Raghavendra Havale: writing – original draft preparation.

Dr. Yadlapalli Vineela Chowdary: investigation, methodology, writing – review and editing.

Dr Kashyap Balkattu: methodology, investigation, formal analysis, data curation, writing – review and editing.

Dr Shiny Raj Rajan: writing – original draft preparation.

Dr. Kanchan M Tuppadmath: writing – original draft preparation, writing – review and editing.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request

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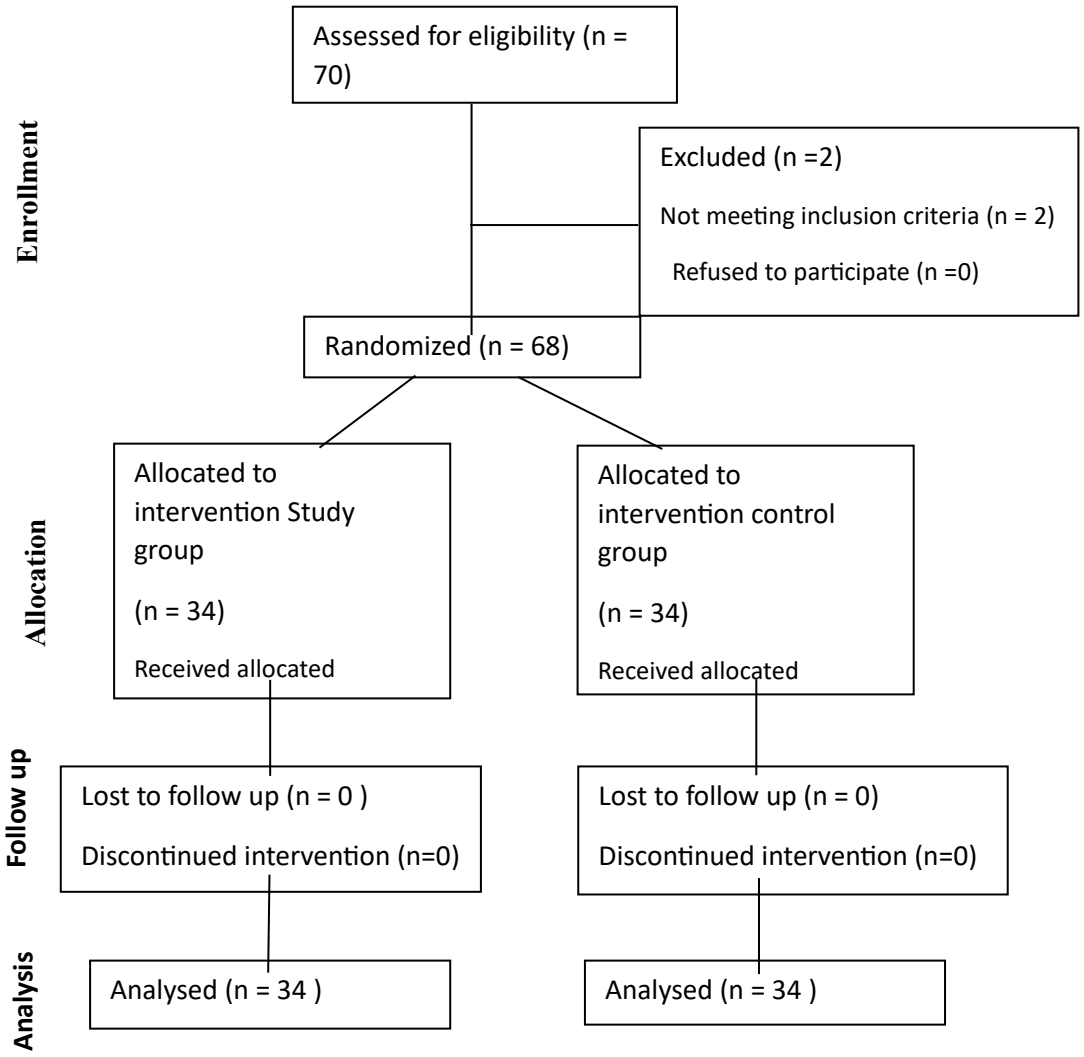

Flowchart 1

	Plaque index during					
	0 days		21 days		90 days	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Mean	1.73	1.91	1.48	1.90	1.24	1.72
SD	0.21	0.34	0.26	0.24	0.41	0.32
P value	**0.89**		**0.29**		**0.00002***	

Table 1 – Comparison of mean PI and SD at 0,21 and 90 days

* P value significant (<0.05)

Figure 1