A Novel Music based Tooth Brushing System for Blind Children

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Objectives: *To assess the Oral Health Status (OHS) of visually impaired children in South India, to devise and implement a specially designed Oral Health Education (OHE) program for them and to assess its efficacy in improving their OHS.* ***Study design:*** *OHS of 98 institutionalized visually impaired children aged 6 to 14 years were evaluated at the start of the study (Pre-OHE level) using the Modified Gingival Index (MGI), the Turesky-Gilmore-Glickman modification of the Quigley Hein Plaque Index (MQHPI) and Streptococcus mutans colony count. Oral Health Education was imparted with the help of specially designed models and tooth-brushing taught with specially formulated music aided instructions in a song format. These parameters were re-evaluated after a period of reinforced (two weeks and one month) and non-reinforced (two months) tooth-brushing.* ***Results:*** *Mean values of MGI and MQHPI showed a statistically very highly significant drop from the Pre-OHE level to the end of both the periods of reinforcement and non-reinforcement. There was a significant decrease in the S.mutans counts from the Pre-OHE levels to the period of non-reinforcement ($p < 0.0005$).* ***Conclusion:*** *The OHE program specially formulated for the visually impaired children was effective in improving their OHS significantly.*

Keywords: *Visually impaired, Oral Health Status, Oral Health Education*

INTRODUCTION

"My darkness has been filled with light of intelligence, and behold, the outer day-lit world was stumbling and groping in social blindness" Hellen Keller

Oral health is a vital component of overall health, which contributes to an individual's quality of life by positively affecting physical and mental well being, appearance and interpersonal relations.[1] Literature review has revealed poorer oral hygiene and increased severity of gingivitis and periodontitis in handicapped people.[2-4] A number of studies[5,6] have shown that challenges to oral health are more complex for disabled children, who are often unable to adequately apply the techniques necessary to control plaque.

Primary prevention, before the development of disease, should be the single most important dental objective for children with developmental disabilities. This is the principle of Oral Health Education (OHE). These children should learn about their teeth, what they are made of, why and how they decay, the benefits of proper oral hygiene procedures and the importance of a proper diet.[7]

Blind children are challenged daily in learning everyday skills, maintaining proper oral hygiene being one. Conventional methods of teaching oral hygiene involves primarily the use of visual perception, using disclosing agents to visualize the plaque and tooth brushing to remove it and re-disclosing periodically to monitor improvement.[8] However, the blind children depend much more on sound, speech and touch to orient themselves to a situation.[9] Thus, modification of Oral Health Education would be required while teaching these children. Hence in the present study, the efficacy of a specially formulated Oral Health Education (OHE) program for blind children was evaluated.

MATERIALS AND METHOD

98 blind children aged 6-14 years were selected and examined from various schools for the visually impaired in Kerala. Out of the 98 children examined, 53 were males and 45 were females. Children with partial visual impairment, with underlying systemic disease and/or other handicapping conditions, individuals on medications, uncooperative children and children with rampant caries were excluded from the study. Prior consent was obtained from the respective schools/center authorities and from the parents/guardians before the start of the study. Ethical clearance was obtained from the institution.

Baseline data regarding gingival health and oral hygiene of the children were recorded at the beginning of the study (Pre-OHE) by the same examiner. The visually impaired children were examined at their respective schools/centers, seated on an ordinary chair, under good illumination, either natural light or hand torch, using a sterile mouth mirror and CPI probe while taking protective cross infection control measures using disposable gloves and masks. Gingival

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Table 1. Mean scores of Modified Gingival Index and the Modified Quigley Hein Plaque Index in Group 1 (two weeks of reinforcement).

Evaluation Period	Modified Gingival Index		Modified Quigley Hein Plaque Index	
	Mean	S.D (±)	Mean	S.D (±)
Pre-OHE	2.1535	.26766	2.1225	.28560
Reinforcement Period	1.9631	.26931	2.0057	.28019
Non-reinforcement Period	1.8480	.27246	1.9037	.21007

Table 2. Mean scores of Modified Gingival Index and the Modified Quigley Hein Plaque Index in Group 2 (one month of reinforcement).

Evaluation Period	Modified Gingival Index		Modified Quigley Hein Plaque Index	
	Mean	S.D (±)	Mean	S.D (±)
Pre-OHE	2.2168	.25279	2.0426	.25076
Reinforcement Period	1.8915	.22993	1.7864	.23160
Non-reinforcement Period	1.7651	.20525	1.6157	.21007

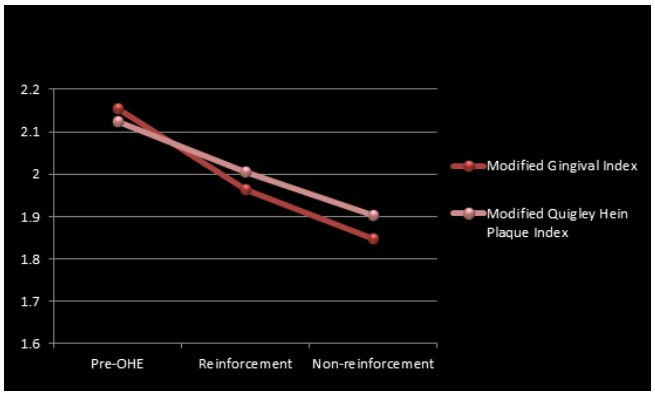

Figure 1. Mean scores of Modified Gingival Index and Modified Quigley Hein Plaque Index at Pre-OHE, Reinforcement and Non-reinforcement periods in Group 1.

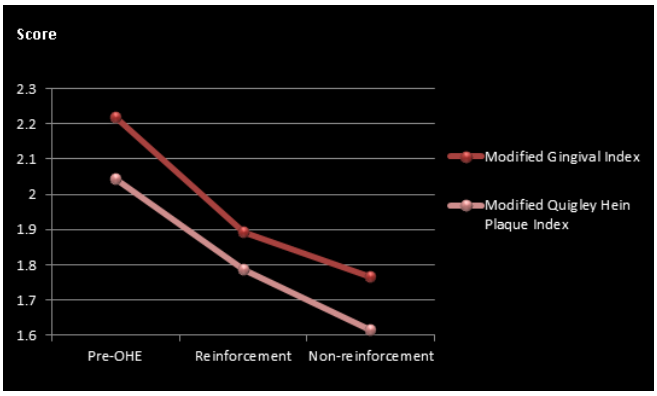

Figure 2. Mean scores of Modified Gingival Index and Modified Quigley Hein Plaque Index at Pre-OHE, Reinforcement and Non-reinforcement periods in Group 2.

Health Status was recorded using the Modified Gingival Index given by Lobene, Weatherford et.al (1986).[10] Oral hygiene of the children was assessed using the Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index (1970).[11] *Streptococcus mutans* colony count[12,13] was done using unstimulated salivary samples.

An Oral Health Education talk was delivered stressing on the importance of teeth, what they are made of, why and how they decay, the benefits of proper oral hygiene procedures and the importance of a proper diet. Normal and common pathological conditions of the teeth and gingiva were simulated on specially designed models. Modeling clay was used to simulate boggy gums and zinc phosphate cement placed and contoured to resemble calculus. These models were given to the children and they were asked to move their fingers over it to help them identify the disease manifestation.

Tooth brushing instructions in the form of a tailored pre-recorded music/audio play were taught to the children as well as their care providers. The song was worded and formulated in such a way so as to enable the children to remember the brushing sequence. The audio play stressed on the direction of tooth brushing for each surface, quadrant and jaw and timed so as to give equal importance to all surfaces. First, the lyrics of the song were explained to the children in their local language. The song was played section by section while physically and verbally guiding the children to brush, through each section. Finally, the entire song was played from the beginning and children allowed to perform the tooth brushing by themselves listening to the song, under supervision, until the children were able to satisfactorily brush unassisted. Children who were unable to grasp the instructions adequately or perform brushing satisfactorily were given more time and attention until they coped.

Table 3. Comparison of the mean differences of the Modified Gingival Index between the Pre-OHE and periods of reinforcement and non-reinforcement in Group 1 and 2.

Evaluation Period	Modified Gingival Index				p value
	Group 1		Group 2		
	Mean Difference	Standard Deviation (±)	Mean Difference	Standard Deviation (±)	
Pre-OHE – Reinforcement period	.1904	.12215	.3253	.13403	p<0.001 vhs
Pre-OHE – Non-reinforcement period	.3055	.17210	.4517	.10453	p<0.001 vhs
Reinforcement period - Non-reinforcement period	.1151	.11041	.1264	.08149	p<0.001 vhs

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Table 4. Comparison of the mean differences of the Modified Quigley Hein Plaque Index between the Pre-OHE and periods of reinforcement and non-reinforcement in Group 1 and 2.

Evaluation Period	Modified Quigley Hein Plaque Index				p value
	Group 1		Group 2		
	Mean Difference	Standard Deviation (±)	Mean Difference	Standard Deviation (±)	
Pre-OHE – Reinforcement period	.1168	.08150	.2562	.13693	p<0.001 vhs
Pre-OHE – Non-reinforcement period	.2188	.19290	.4268	.15509	p<0.001 vhs
Reinforcement period - Non-reinforcement period	.1020	.14811	.1706	.10973	p=0.011 sig

The teachers and care takers were also trained to supervise tooth brushing so as to equip them to guide the children subsequently.

The children were now subdivided into two groups:

- Group 1 – 51 children who were given a period of two weeks of reinforced tooth brushing.
- Group 2 – 47 children who were given a one month period of reinforced tooth brushing.

During the period of reinforced tooth brushing, copies of the song were distributed to the care takers and schools authorities to be played every day while the children brushed their teeth while at the same time guided and monitored by the care takers. At the end of the periods of reinforced tooth brushing of two weeks and one month respectively, all the children were subjected to a re-evaluation of their Oral Health Status by assessing their Gingival Health Status and Oral Hygiene Status. *Streptococcus mutans* colony count of the children was also assessed.

Thereafter, all children in both the groups were subjected to a period of two months of non-reinforced tooth brushing. During this period, the children continued the tooth brushing but without the music play or assistance. Oral Health Status of the children were re-assessed at the end of this period.

Statistical Analysis

The results were statistically analysed using Unpaired t test, Students paired T test, Wilcoxon Signed Rank Test and Chi-Square Test.

RESULTS

In both the groups, we observed statistically very highly significant decreases in the mean differences of both the Modified Gingival Index and Modified Quigley Hein Plaque Index from the Pre-OHE levels to the levels obtained at the end of the respective periods of reinforcement and non reinforcement. (Tables 1 and 2).

When the intergroup comparisons in our study were done, we found very highly significant decreases in Group 2 from the Pre-OHE levels to the levels at the end of the periods of reinforcement and further to the end of the period of non-reinforcement of both Modified Gingival Index and Modified Quigley Hein Plaque Index suggesting a longer period of reinforcement (1 month) significantly further improved the Gingival Health Status and Oral hygiene status of the children (Tables 3 and 4)

When the *S.mutans* count of the children of Group 1 were evaluated at the end of the reinforcement period, not much change was observed in the percentages of children in the distribution of the various levels of *S.mutans*, when compared to the pre OHE levels. However, at the end of the period of non-reinforcement, there was a considerable change in the percentages of children with various levels of *S.mutans* which was analyzed to be statistically very highly significant (Table 5).

Meanwhile, in Group 2, we observed a dramatic increase in the number of children with low *S.mutans* count at the end of the reinforcement period which further increased considerably at the end of the non-reinforcement period (Table 6). At the end of the non-reinforcement period, none of the children exhibited high counts of *S.mutans*.

DISCUSSION

The sensory modalities are often taken for granted as long as they function normally. It is through the senses that we learn about our world; therefore the development of a child may be severely compromised by loss of one or more of the sensory modalities. Of the utmost importance when working with special or medically compromised is emphasizing the need for excellent preventive dental care. Teaching good oral hygiene practices to the visually impaired children requires a special approach with time and patience.[14]

Table 5. Changes in salivary *S.mutans* count at Pre-OHE, and at the end of the periods of reinforcement and non reinforcement in Group 1.

Examination Interval	n	LOW		MODERATE		HIGH	
		Number of children	Percentage	Number of children	Percentage	Number of children	Percentage
Pre-OHE	51	2	3.9%	36	70.6%	13	25.5%
Reinforcement	51	3	5.9%	37	72.5%	11	21.6%
Non-reinforcement	51	14	27.5%	35	68.6%	2	3.9%

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Table 6. Changes in salivary *S.mutans* count at Pre-OHE, and at the end of the periods of reinforcement and non reinforcement in Group 2.

Examination Interval	n	LOW		MODERATE		HIGH	
		Number of children	Percentage	Number of children	Percentage	Number of children	Percentage
Pre-OHE	47	5	10.6%	35	74.5%	7	14.9%
Reinforcement	47	24	51.1%	22	46.8%	1	2.1%
Non-reinforcement	47	33	70.2%	14	29.8%	0	0%

Gingivitis and dental caries are multi-factorial diseases where dental plaque plays a major role in the initiation and progression of the disease. Therefore, an effective preventive program should include methods to control and eliminate plaque. Literature review reveals very few innovative methods to improve the oral hygiene of visually impaired children which could be incorporated as a routine part of their daily lives. In our study, we have devised a simple but effective method of tooth brushing specially designed for the visually impaired children.

We have used two indices, the Modified Gingival Index (MGI) and the Modified Quigley Hein Plaque Index (MQPI) to measure the changes in gingival health and oral hygiene in these children. In our study, the mean values of MGI and MQPI in both Group 1 and 2 showed a dramatic decline from the baseline (Pre-OHE) values upto the end of the corresponding periods of reinforcement and further decline till the end of the corresponding Non-reinforcement periods (Tables 1 and 2, $p < 0.001$). These results attest to the effectiveness of the Oral Health Program in reducing plaque and improving the gingival health of the children.

Our findings are in accordance with the results of a study conducted by Chan Sek Lun *et al* who provided a tailored OHE program for visually impaired children in Hong Kong which stressed on the use of tactile sense and music and excluded the use of visual aids. Oral hygiene status of the children was assessed using the Visible Plaque Index (VPI) and Gingival Bleeding Index (GBI). They found a significant drop in the mean VPI from the Pre-OHE to the Post-OHE levels. Mean percentage of GBI were also found to decrease in all sites except the upper lingual sites, however, they observed these changes were not statistically significant.[15]

Intergroup comparisons in our study revealed very highly significant decreases of both MGI and MQHPI in Group 2 from the Pre-OHE levels to the levels at the end of the period of reinforcement and further significant decrease till the end of the period of non-reinforcement. From this we infer that, a longer period of reinforcement (1 month) significantly further improved the Gingival Health and Oral hygiene of these children.

The beginning and progression of dental caries are influenced by several risk factors, including bacterial, dietary, environmental and socioeconomic factors. The most significant indicators of caries risk are past caries experience, concentration of *S.mutans* and *Lactobacilli*, and the presence of protective factors like buffering capacity of saliva.[16] Subjects with more than 10^6 *S.mutans* per ml saliva were considered to be at higher risk for dental caries than were subjects with lower counts.[17] Assessment of the salivary *S.mutans* counts are therefore important to evaluate the success of preventive programs.

In our study, when the *S.mutans* counts of the children in both groups were analyzed, very highly significant increases in the number of children with low counts were observed from the pre OHE periods to the end of the non reinforcement periods. Meanwhile a steady decline in the number of children with high *S.mutans* counts were also observed. In Group 2, at the end of the non reinforcement period none of the children exhibited high *S.mutans* counts. The above findings showed the strong positive impact of our OHE program in reducing the high counts of *S.mutans* in these children and thereby decreasing the caries activity in them.

Analyzing the *S.mutans* counts in both groups at the various periods of evaluation, the results of our study indicated very highly significant reduction in Group 2 as compared to Group 1 which further reinforces the strong positive impact of time factor in the OHE program imparted to these children.

The results from our study showed the effectiveness of the OHE talk and tooth brushing program on significantly improving the oral hygiene status of the blind children. This program can be of great value to level the barrier of visual impairment towards better communication of oral hygiene instructions in the blind children, in order to achieve optimum levels of oral health. Modifications and improvements of the OHE program can also be done for these children and also for children with other special health care needs. Further long term studies focusing on longer periods of reinforcement followed by appropriate periods of non-reinforcements should be planned to elicit and investigate better results. The findings of our study support the need for an individualized and specific OHE program for the visually impaired children which address their unique problems and are effective at the same time.

CONCLUSIONS

- A very highly significant decrease was found in the Modified Gingival Index scores of all the children from the Pre-OHE levels to the end of the reinforcement period and a further similarly significant decrease at the end of the non-reinforcement period.
- An appreciable decrease in the scores of the Modified Quigley Hein Plaque Index was found in all the children from the Pre-OHE levels to the end of the reinforcement period and a further similarly significant decrease at the end of the non-reinforcement period.
- There was a significant reduction in the levels of *S.mutans* from the Pre-OHE levels up to the end of the Non-reinforcement period in all the children.
- A longer period of reinforcement of one month significantly improved the Oral Health Status of the children.
- The Oral Health Education program specially formulated for the visually impaired children was effective in improving their Oral Health Status significantly.

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