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A Comparative Evaluation of Chewable Toothbrush and Audio Tactile Performance Method on Oral Hygiene Maintenance in Visually-Impaired and Hearing-Impaired Children

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KEYWORDS

Dental Plaque, Oral Hygiene Index, Dental Plaque Index, hearing impairment, tooth brushing.

Abstract

Introduction: Visually-impaired and hearing-impaired children daily encounter obstacles in maintaining good oral hygiene as these children lack the normal ability to watch, listen and respond to the audible sounds they are deprived of learning and imitating healthy oral hygiene measures.

Objectives: Clinical efficacy comparison of manual toothbrush, chewable toothbrush and audio-tactile performance method (ATP) on oral hygiene maintenance in visually-impaired and hearing-impaired children.

Materials and Methods: A single-blind crossover study was conducted on 60 visually impaired (group I) and 60 hearing-impaired (group II) children (9-16 years) who matched the inclusion criteria. Each group was then divided into three equal subgroups based on the method utilized. Group A: Manual toothbrush without brushing instructions, Group B: Chewable toothbrush and Group C: ATP using Manual Toothbrush. Oral hygiene index simplified (OHI-S) and Turesky Gilmore Glickman modification of the Quigley Hein plaque index (TQHPI) scores were recorded at baseline, one month, two months and three months. The collected data was subjected to statistical analysis using SPSS 22.0. The intragroup ANOVA and the intergroup t-test were applied. A p -'value<0.05 was considered statistically significant.

Results: In the group I intragroup comparison, group IC showed a statistically significant difference (0.010) after a one-month follow-up for OHI-S and after two-and three-month follow-ups (0.007 & 0.000) for TQHPI. In the group II intragroup comparison, group IIA was significant after the OHI-S follow-up of 1 (0.050), 2 (0.002), and 3 (0.002) months, and it was highly significant after the TQHPI follow-up of 1 (0.000) and 2 (0.002) months. In the intergroup comparison, group IC's OHI-S difference with Group II was significant (0.035) after one-month follow-up and group IIA showed significant differences from group I after two (0.0017) and three (0.002) months of follow-up for OHI-S. Compared to group I, both groups IIA and IIB were highly significant after 1 (0.000 & 0.001), 2 (0.000 & 0.004), and 3 (0.000 & 0.003) months follow-up for TQHPI.

Conclusion: When compared to chewable and manual toothbrushes, the ATP technique proved to be beneficial for visually impaired children. For hearing-impaired children, manual and chewable toothbrushes proved to be more effective than the ATP approach.

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Introduction

Good oral health is important for proper mastication, digestion, appearance, speech and health.[1] Inadequate maintenance of oral health may result in the accumulation of supragingival and subgingival plaque which is the etiologic agent in dental caries, gingival and periodontal diseases.[2] Visually-impaired children daily face challenges for bearing their everyday skills and maintenance of proper oral hygiene is one among them. When compared with their normal sighted peers, visually-impaired children have poorer oral hygiene.[3] Speech and Hearing impairment children lack the normal ability to listen and respond to the audible sounds and are deprived of learning and imitating healthy oral hygiene measures.[4] The frequent removal of plaque or the prevention of its formation may be considered effective methods for the prevention of occurrence of dental caries and periodontal disease.[5] Mechanical plaque removal with a manual toothbrush remains the primary method of maintaining good oral hygiene for the majority of the population.[6] Due to inadequate supervision for proper brushing technique, children with disabilities have difficulty in maintaining their oral hygiene. Often it is noted that certain areas of the oral cavity are brushed more while the others are neglected. Parents and care takers do not consider tooth brushing to be of great importance so these children are left unattended during the same. Chewable toothbrush was developed and commercialized in England as an alternative to a manual toothbrush. Chewable toothbrushes are known to help improve motivation during oral hygiene performance, improve plaque removal, and elevate the level of oral hygiene in areas where mechanical access is difficult.[7] With the vision to improve the knowledge, behavior, and attitude pertaining to oral health an innovative technique known as audio-tactile performance (ATP) technique was introduced to teach Fones technique of tooth brushing in visually-impaired adolescents.[8] ATP includes an interactive session (audio) wherein a good rapport is established first creating a very friendly atmosphere. It is followed by making them feel their teeth on a large sized model (tactile) and is then taught to brush on the model with assistance.[9] Hence, the present study was conducted to evaluate and compare the clinical efficacy of Manual Toothbrush without brushing instructions, Chewable Toothbrush and Audio Tactile Performance method using Manual Toothbrush on oral hygiene maintenance in Visually-impaired and Hearing-impaired Children.

Materials and Methods

A total of 213 children (9-16 years) from two different special children institutes were screened and 120 children meeting inclusion criteria were selected in this single-blind crossover study. Institutional Ethical Committee clearance was obtained before starting the study and Informed consent was obtained from the participating children and their school authorities/parents/guardians. Children who met the inclusion criteria—which include having good general health, having a mixed or permanent dentition, being completely blind, and having hearing impairments—were selected. The study excluded children with orthodontic braces, systemic illness, other disabilities (except visual and hearing impairment), children taking drugs that could affect the state of the gingival tissues, such as convulsion medications, immune-suppressants, corticosteroids, non-steroidal anti-inflammatory drugs, and children using any other supplemental plaque control devices such as mouthwashes or interdental cleansing aids.

Study Size and Design

The selected 120 children were divided into two groups depending on the disability; 60 visually-impaired (Group-I) and 60 hearing-impaired children (Group-II) and based on the approach employed, each group was further divided into three equal subgroups using chit method. Sample size was calculated to be 20 in each subgroup according to previous studies.[10,11]

Group I: Visually-Impaired Children
Group IA: Manual Toothbrush without Brushing Instructions
Group IB: Chewable Toothbrush
Group IC: Audio-Tactile Performance Method Using Manual Toothbrush
Group II: Hearing-Impaired Children
Group IIA: Manual Toothbrush without Brushing Instructions
Group IIB: Chewable Toothbrush
Group IIC: Audio-Tactile Performance Method Using Manual Toothbrush

Methodology

Group A children in both the groups performed tooth brushing with regular manual toothbrush (Ajay– Raghav Lifestyle Products, Haryana, India) without brushing instructions. Chewable toothbrushes (Rolly Brush®, Headquarter - Via Tito ed Ettore Manzini, Parma, Italia) were given to children in group B of both groups, and they were instructed to use them for three minutes once a day instead of manual toothbrushes. In both group C children were trained using the Audio-Tactile Performance method which includes verbal instructions, tactile perception on large size model and at the same time the child was asked to repeat the procedure till the children could perform it independently, correctly, and confidently using a manual toothbrush. Manual and Chewable toothbrushes were changed every month for better efficiency. Throughout the study, an examiner who was blinded of group division recorded debris, calculus, and plaque scores with two-tone disclosing agent alpha plaque (Alpha Plac, Dental products of India, The Bombay Burmah Trading

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Corporation Ltd, Mumbai, India) at baseline, at the end of one month, two months, and three months using the oral hygiene index simplified (OHI-S) index and Turesky Gilmore Glickman modification of the Quigley Hein plaque index (TQHPI). The OHI-S two components of debris and calculus were measured on six teeth (all first molars (4), upper right and lower left central incisors (2)) on different surfaces, including the facial side of three maxillary teeth, the lingual side of two posterior mandibular teeth, and the labial side of one anterior mandibular tooth. The OHI-S interpretation of debris and Calculus index scores was as follows: Good: 0.0-0.6, Fair: 0.7-1.8, Poor: 1.9-3.0. Accordingly each child's oral hygiene was classified as poor (≥2), fair (1.0–1.9), or good (≤0.9).[12] The TQHPI index levels were assessed on the facial and lingual surfaces of all the teeth, except for the third molars, at six sites per tooth. For scoring purpose, each tooth was divided into six areas: mesio-facial, mid-facial, disto-facial, mesio-lingual, mid-lingual and disto-lingual. TQHPI grades plaque on a score of 0-5 (0 – absence of plaque; 5- plaque covering two-thirds or more of the crown of the tooth). The scores from all the sites were summed and divided by the total number of sites. The subject-wise mean plaque score was obtained by adding the indices for the teeth and dividing by the number of teeth examined.

Statistical Analysis

The collected data was subjected to statistical analysis using SPSS 22.0. The intragroup ANOVA and the intergroup t-test were applied. A p-value<0.05 was considered statistically significant.

Results

Table 1: Intragroup and Intergroup comparisons of OHI-S mean scores at different time intervals

OHI-S Time interval	Group I			Group II		t-test	P-value
	Subgroups	Mean	SD	Mean	SD		
Baseline	A	2.8750	.42411	2.3750	.42037	3.745	**0.001***
	B	2.8800	.60053	2.8800	.45259	.000	**1.000**
	C	2.6000	.55630	2.9700	.58499	-2.050	**0.047**
P-value	**0.173**			**0.001***			
1 month	A	2.9600	.35895	2.8250	.45175	1.046	**0.302**
	B	2.9600	.60472	3.2350	.68616	-1.345	**0.187**
	C	2.5050	.57168	2.8800	.51360	-2.182	**0.035***
P value	**0.010***			**0.050***			
2 months	A	3.0200	.35630	2.7050	.44066	2.486	**0.017***
	B	3.0250	.50563	3.3350	.77070	-1.504	**0.141**
	C	3.0100	.30245	2.9350	.35433	.720	**0.476**
P value	**0.993**			**0.002***			
3 months	A	3.1050	.40585	2.7400	.25215	3.416	**0.002***
	B	3.1100	.53793	3.3000	.77256	-.903	**0.372**
	C	2.8600	.30505	2.8200	.35777	.380	**0.706**
P value	**0.116**			**0.002***			
Independent t-test; One-way ANOVA ;*statistically significant; SD=standard deviation							

In group I intragroup comparison, subgroup C was found to be statistically significant after 1 month **(0.010)** follow-up compared to subgroups A and B. In group II intragroup comparison, subgroup A was found to be statistically significant after 1 **(0.050),** 2 **(0.002),** and 3 **(0.002)** months follow-up compared to subgroups B and C. When groups I and II were compared, group I subgroup C was found to be statistically significant after 1 month **(0.035)** compared to group II subgroups A and B. When groups I and II were compared group II subgroup A was found to be statistically significant after 2 **(0.017)** and 3 **(0.002)** months follow-up compared to group I sub groups.

Table 2: Intragroup and Intergroup comparisons of TQHPI mean scores at different time intervals

TQHPI Time interval	Group I			Group II		t-test	P-value
	Subgroups	Mean	SD	Mean	SD		
Baseline	A	2.8350	.27004	2.4900	.19708	4.615	**0.000***
	B	2.8450	.23278	2.4300	.20800	5.945	**0.000***
	C	2.6900	.35079	2.7950	.33162	-.973	**0.337**

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P-value	**0.174**			**0.000***			
1 month	A	2.8100	.19974	2.4750	.21244	5.138	**0.000***
	B	2.8250	.24252	2.5800	.16416	3.741	**0.001***
	C	2.7100	.25319	2.7600	.22804	-.656	**0.516**
P-value	**0.245**			**0.000***			
2 months	A	2.8050	.22821	2.4600	.27796	4.290	**0.000***
	B	2.8350	.23681	2.6450	.13563	3.114	**0.004***
	C	2.6300	.17199	2.6700	.14903	-.786	**0.437**
P-value	**0.007***			**0.002***			
3 months	A	2.8950	.17614	2.6650	.16311	4.285	**0.000***
	B	2.8900	.25319	2.6250	.28074	3.135	**0.003***
	C	2.6475	.12511	2.6550	.17313	-.157	**0.876**
P-value	**0.000***			**0.826**			
Independent t-test; One-way ANOVA; *statistically significant; SD=standard deviation							

In group I intragroup comparison, I C was found to be statistically significant after 2 **(0.007)** and 3 **(0.000)** months follow-up compared to I A and I B. In group II intragroup comparison, II A was found to be statistically significant after 1 **(0.000)** and 2 **(0.002)** months follow-up compared to II B and II C. When groups I and II were compared, both II A and II B of group II were found to be statistically highly significant after 1 **(0.000 & 0.001),** 2 **(0.000 & 0.004),** and 3 **(0.000 & 0.003)** months follow-up compared to group I subgroups.

Table 3: Intragroup comparisons of OHI-S mean scores from baseline to three months

OHI-S		Baseline	1 month	2 months	3 months	P value
Group I	I A	2.87±0.42	2.96±0.35	3.02±0.35	3.10±0.40	**0.591**
	I B	2.88±0.60	2.96±0.60	3.02±0.50	3.11±0.53	**0.557**
	I C	2.60±0.55	2.505±0.57	3.01±0.30	2.86±0.305	**0.582**
Group II	II A	2.37±0.42	2.82±0.45	2.70±0.44	2.74±0.25	**0.732**
	II B	2.88±0.45	3.23±0.68	3.33±0.77	3.30±0.77	**0.735**
	II C	2.97±0.58	2.88±0.51	2.93±0.35	2.82±0.35	**0.611**
ANOVA; *Statistically significant						

The OHI-S mean scores of all subgroups for Group I showed an increase from baseline to three months but was not statistically significant. Similarly, in Group II, II A and II B demonstrated an increase in mean scores from baseline to three months, while II C exhibited a slight decrease in OHI-S mean scores from baseline to three months. However, they were not statistically significant (Table 3).

Table 4: Intragroup comparisons of TQHPI mean scores from baseline to three months

TQHPI		Baseline	1 month	2 months	3 months	P value
Group I	I A	2.83±0.27	2.81±0.199	2.80±0.22	2.89±0.176	**0.105**
	I B	2.84±0.23	2.82±0.24	2.83±0.23	2.89±0.253	**0.627**
	I C	2.69±0.35	2.71±0.25	2.63±0.17	2.64±0.12	**0.593**
Group II	II A	2.49±0.19	2.47±0.21	2.46±0.277	2.66±0.16	**0.026***
	II B	2.43±0.20	2.58±0.16	2.64±0.13	2.62±0.28	**0.454**
	II C	2.79±0.33	2.76±0.22	2.67±0.14	2.655±0.173	**0.671**
ANOVA;*statistically significant						

Group I mean TQHPI scores from baseline to three months were not statistically significant for all subgroups. In Group II, II B and II C mean scores were not statistically significant. However, II A in Group II exhibited statistically significant difference (**0.026**) from baseline to three months. (Table 4)

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Discussion

Children with disabilities often have poor oral hygiene because of their limited physical capabilities, which makes brushing their teeth challenging. The following factors may have an impact on oral health: limited understanding on the importance of oral health management, difficulties in communicating oral health needs, and a dependence on others, such as parents' siblings or caregivers, for oral health management.[13] The American Academy of Pediatric Dentistry defines special health care needs as "any physical, developmental, mental, sensory, behavioural, cognitive, or emotional impairment or limiting condition that requires medical management, health care intervention, and/or use of specialized services or programs**.**[14] The oral health of children who are visually-impaired tends to be compromised as they are at a disadvantage and are often unable to adequately apply the techniques necessary to control plaque**.**[15] When properly focused, visually challenged children can learn effective brushing skills.[16] The removal of plaque from teeth is a skill that can be mastered only when the individual has the dexterity to manipulate a toothbrush and an understanding of the objectives of this activity. Since the hearing impaired children cannot understand and respond to the instructions given to them, they are unable to comprehend and master the technique of oral hygiene practices**.**[17] It is obvious that many disabled individuals will find the maintenance of their own oral hygiene much more difficult than normal individuals.[18] Various plaque control methods include mechanical and chemical. Mechanical methods, including tooth brushing, interdental cleaning, and professional scaling procedures, are required to regularly and effectively disrupt and remove the plaque biofilm**.**[19] Manual tooth brushing is quite effective when performed accurately and at the specified time. Manual tooth brushing remains the most efficient long-term method of removing dental plaque in children; however children's ability to use the toothbrush varies widely depending on their age, individual dexterity, and motivation.[7] In the current study, compared to Groups IIB and C, children in Group IIA displayed a statistically significant difference in OHI-S mean scores after 1 (0.005), 2 (0.002), and 3 (0.002) months of follow-up. These findings were comparable to a study by Sobia Hassan et al.[20] where the manual toothbrush group's mean initial OHI-S value was 1.91 and decreased to a mean of 1.33 following an 8-day trial period ($p<0.05$). These results unequivocally show that children with hearing impairments can effectively remove debris from their teeth using manual toothbrushes. TQHPI index was used in the current study because it can better assess plaque accumulation and interproximal areas for plaque. The TQHPI scores of group IIA children in our study demonstrated a highly statistically significant difference after one (0.000) and two (0.002) months of follow-up. These results were comparable to those of a study by Sobia Hassan et al.[20] in which the Plaque Index, which was calculated at the beginning of the study, showed a mean value of 1.36 and changed to 0.73 after eight days. The chewable toothbrush is a recent innovation in oral hygiene. This disposable, all-in-one brush is comprised of xylitol, flavoring, aqua, and polydextrose. The Chewable toothbrush can be chewed like chewing gum since it is made of compressible elastic material it consists of an elastic part that compresses when squeezed by the upper and lower jaws, a brush used for brushing the upper teeth in combination with the upper surface of the elastic part, and another brush that is used to brush the lower teeth in combination with the lower surface of the elastic part.[11] In the current investigation in both I and II groups, IB and IIB subgroups revealed no statistical significant difference in OHI-S and TQHPI scores after 1, 2, and 3 months of follow-up. This finding was consistent with research by Moon-Jin Jeong (11), which reported that brushing with a manual toothbrush decreased dental plaque at a higher rate than brushing with a chewable toothbrush. Our findings contradicted Kayalvizhi G et al's[7] study, which reported a statistically significant mean plaque reduction ($p<0.0001$) in OHI-S. This could be because, according to the recommendations of the various chewing brush manufacturers, chewing exercise is necessary, and 2-3 uses are required for the best effect, but in our study, chewing exercise was not recommended because the Rolly brush manufacturer did not include it in the instructions, and the study participants used chewable toothbrushes directly without any prior usage. Lavanya Govindaraju et al.[10] assessed the performance of chewable brushes in terms of plaque removal efficiency and found that both manual and chewable brushes resulted in a significant reduction in plaque scores as was a significant reduction in the debris index ($p<0.001$), oral hygiene index ($p<0.000$), and plaque index ($p<0.001$), which contradicted the current study's results where no statistical significance was found. This result could be probably attributed to the compositional difference between the two commercially available chewable brushes. Additionally, it would have been beneficial if children had received constant reminders to use chewable tooth brushes. The audio-tactile performance method employed by Hebbal[21] was proven to be beneficial in improving oral hygiene of visually impaired children. Based on this, the audio-tactile performance technique was applied in the present study to educate visually impaired and hearing-impaired children. In the current study's group of visually impaired children, ATP exhibited a statistically significant difference by decreasing mean OHI-S scores after one month (0.010). Our study's findings were consistent with those of a study by Sushmita Deshpande[8], in which 18 students were classified as good after receiving health education using the ATP technique, and just one student received a fair

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score on the plaque index (P = 0.001). However, mean OHI-S scores increased in the second and third months of follow-ups in our study, which might have been due to a lack of reinforcement. After the current investigation's third month of follow-up, the ATP method was effective in significantly (0.000*) reducing the TQHPI mean scores in visually-impaired children. Our research findings aligned with those of R. Krishna kumar's[22] study, which found a statistically significant difference (P < 0.001) in the pre-health education plaque scores (1.28) and post-health education plaque scores (0.95) among the audio-tactile group. Despite being statistically insignificant, the ATP approach demonstrated decreased mean scores in OHI-S for group II and decreased TQHPI mean scores from baseline to three months in both groups I and II, implying that the ATP approach may have motivated both visually impaired and hearing-impaired children and improved their oral health. When both groups I and II were compared, Group IC OHI-S score was found to be statistically significant after 1 month compared to group II (0.035). OHI-S mean scores in group II A were found to be statistically significant after 2 (0.017), 3 (0.002) months follow-up compared to group I. When both the groups I and II were compared regarding TQHPI scores group IIA and IIB were found to be highly statistically significant after 1,2,3 months. The results of the present study could not be compared with previous studies as our study was the pioneer to explore this comparison**.**

Limitations and Recommendations

The present study possible limitation could be a small sample size. However, long-term research with larger sample sizes and time intervals should be conducted. Chewable toothbrushes don't seem to be available in the commercial market right now, and even if they were, they might not be affordable. The high frequency of dental and periodontal disease among the population of the hearing and mute makes preventive dental care imperative in these types of institutions. The educational component of preventative dental care needs to be focused on the parents and caregivers of these children, as many of them are unable to maintain proper oral hygiene on their own.[23]

Conclusion

When compared to chewable and manual toothbrushes, the ATP technique proved to be beneficial for visually impaired children. For hearing-impaired children, manual and chewable toothbrushes proved to be more effective than the ATP approach.

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