A clinicomicrobiological study to evaluate the efficacy of manual and powered toothbrushes among autistic patients

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Abstract

Aim: To compare the efficacy of powered toothbrushes in improving gingival health and reducing salivary red complex counts as compared to manual toothbrushes, among autistic individuals. **Materials and Methods:** Forty autistics was selected. Test group received powered toothbrushes, and control group received manual toothbrushes. Plaque index and gingival index were recorded. Unstimulated saliva was collected for analysis of red complex organisms using polymerase chain reaction. **Results:** A statistically significant reduction in the plaque scores was seen over a period of 12 weeks in both the groups ($P < 0.001$ for tests and $P = 0.002$ for controls). This reduction was statistically more significant in the test group ($P = 0.024$). A statistically significant reduction in the gingival scores was seen over a period of 12 weeks in both the groups ($P < 0.001$ for tests and $P = 0.001$ for controls). This reduction was statistically more significant in the test group ($P = 0.042$). No statistically significant reduction in the detection rate of red complex organisms were seen at 4 weeks in both the groups. **Conclusion:** Powered toothbrushes result in a significant overall improvement in gingival health when constant reinforcement of oral hygiene instructions is given.

Keywords: Autism, *Porphyromonas gingivalis*, *Tannerella forsythia*, *Treponema denticola*, tooth brushing

Introduction

Autism is a disorder of neural development characterized by impaired social interaction and communication, which includes restricted and repetitive behavior.[1] Pervasive developmental disorders (PDDs), commonly referred to as autism spectrum disorders, is an umbrella term for 5 disorders, including: (1) Autistic disorder (AD), (2) Rett's disorder, (3) childhood disintegrative disorder, (4) Asperger's disorder, and (5) PDD not otherwise specified.[2] Reviews quote a prevalence of 6 per 1000 for autism spectrum disorders as a whole and 1–2 per 1000 for autistics.[3] It has been estimated that there are more than 2 million autistic persons in India. However in India, the majority of people have not been diagnosed for this disorder and do not receive the services they need, as there is a tremendous lack of awareness about autism.[4]

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The risk of gingivitis is expected to be higher in children with autism due to improper brushing and flossing, lack of necessary manual dexterity, and the difficulties the caregivers have when brushing their teeth.[5] In addition, generalized gingivitis can be one of the side-effects of medications that are typically prescribed to individuals with autism.[6]

Tooth brushing is the most commonly performed oral hygiene practice in the world. Both powered and manual toothbrushes achieve a high level of oral hygiene, but powered toothbrushes are more efficient, easier to use,[7] and surprisingly appealing to the patients.[8] For these reasons, it has a definite use in some patients lacking fine motor skills, such as handicapped[8] and autistic patients.

The major purpose of tooth brushing is to lower the organisms in dental plaque that are responsible for oral diseases and halitosis. Microorganisms of the red complex (*Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*) are the major causative agents in the initiation and progression of periodontal disease. Supragingival plaque removal affects the composition of subgingival microbiota and reduces the counts of these red complex microorganisms.[9] Periodontal pocket bacteria are continuously washed into saliva by gingival crevicular fluid (GCF). Saliva is an easily obtainable

and noninvasively collected sample containing microbes which detach from various oral surfaces.[10] Whole saliva is superior to pooled periodontal pocket samples to detect *P. gingivalis* and *T. denticola* in the oral cavity.[11] Due to the uncooperative behavior of autistic patients, collection of subgingival plaque samples was anticipated to be difficult. Hence, it was decided to collect saliva samples to detect red complex organisms in these patients.

Autistic patients lack manual dexterity and have poor oral hygiene.[12] Hence, the objective of this study is to compare the efficacy of powered and manual toothbrushes in improving plaque control and gingival health and reducing the salivary red complex microorganism counts in patients with ADs.

Materials and Methods

Study population
This is a single-blind, randomized, controlled, clinical study, conducted between February and May 2012. Ethical approval was obtained from the Ethical Committee of our institution. Individuals with a diagnosis of typical AD were screened for the study from an Autistic Institution.

Selection criteria
Patients diagnosed to have autism in the age group of ≥15 years with a minimum of 20 teeth, with no prior experience of using a powered toothbrush, and willing to participate were selected. Patients were excluded if they had any other systemic disease, were undergoing orthodontic therapy or wearing a dental prosthesis.

Informed consent was obtained from the parents of the selected patients, before commencement of the study. Patients were randomly allotted into two groups by using the lottery method, comprising 20 patients each. The test group received powered toothbrushes, and the control group received manual toothbrushes.

Patients from both groups were instructed to brush their teeth. Demonstration of the brushing technique was given to each patient and his/her caregiver using a model and a toothbrush. The circular Fone's technique was selected as it an easy to learn technique.[13] Patients were sensitized to the powered toothbrushes. They were asked to brush their teeth twice daily for 3 min each time. Caregivers were asked to supervise the patients during tooth brushing for the entire period of the study. Every subject was asked to demonstrate the technique that he/she learned. Individual tailor-made oral hygiene instructions (OHIs) were given to the patient and caretaker at baseline and reinforced at 1 week. The powered toothbrush (Colgate 360° sonic power toothbrush, Colgate-Palmolive Company, 300 Park Avenue, New York City, New York, United States) generated high energy sonic oscillations of 20,000 oscillations per min and in manual toothbrushes (Colgate 360° toothbrush, Colgate-Palmolive Company, 300 Park Avenue, New York City, New york, United States), the number of strokes per min was patient-dependent.

One examiner recorded the clinical parameters using the plaque index (Silness 1964) and gingival index (Loe 1963) at baseline, 1, 4, and 12 weeks. The examiner was blinded from knowing which group the patient was from 2 to 5 ml of unstimulated saliva was collected by the spit method in a sterile container and then transferred to an eppendorf tube. The Saliva was then stored at −80°C. Microbiological analyses of red complex organisms were performed using polymerase chain reaction (PCR) at baseline and at 4 weeks.

Plaque was measured using plaque index; oral hygiene was recorded as excellent when plaque score was 0, good when it was 0.1–0.9, fair when 1.0–1.9, and poor when it was 2.0–3.0. Gingival status was evaluated using gingival index. Gingival score 0.1–1.0 indicates mild gingivitis, 1.1–2.0 indicates moderate gingivitis, and 2.1–3.0 indicates severe gingivitis. A short drug history was taken from the patient. The patients were either on antiepileptics, Indian medicine systems, or without any medication.

Intraexaminer calibration
Intraexaminer calibration was achieved by examination of 10 patients twice, 24 h apart before beginning the study. The Kappa coefficient value for intraexaminer reliability with respect to plaque index scores was 0.79, and gingival index scores was 0.84. These values reflect a high degree of conformity in observations.

Microbiological technique
Nested PCR procedure:[14] DNA Extraction was done from saliva using Qiagen DNA extraction kit. Bacteria-specific primers were used to amplify the 16s rRNA gene using both forward and reverse primers. Table 1 shows the various base pair fragments (bp fragments) and primers used for the particular bacteria. Amplification of each sample was done using a total volume of 20 µl amplification reaction mixture consisting of 0.2 mM deoxynucleoside triphosphate mix, 1.5 mM MgCl$_2$, ×10 Taq buffer, 1 µM each primer, 1.5 U of Taq polymerase, and 5 µl of template. PCR amplification was performed in a thermal cycler (Eppendorf Pro). PCR cycle for all primer pairs consisted an initial denaturation of 40 cycles at 95°C for 1 min followed by denaturation at 95°C for 30 s, annealing at 65°C for 1 min, and extension at 72°C for 1 min, and then final extension at 72°C for 2 min. Gel photography system (G-BOX) was used as documentation system.[11]

Statistical analysis
Statistical analysis was done using Statistical Package for the Social Sciences (SPSS): (SPSS Statistics is a software package used for statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009) 20 software. Descriptive statistics,

Table 1: bp-fragments and primers used for the particular bacteria

Bacteria	bp-fragment	Forward primer	Reverse primer
P. gingivalis	404-bp	5`AGGCAGCTTGCCATACTGCG 3`	5`ACTGTTAGCAACTACCGATGT 3`
B. forsythus	426-bp	5`AAAACAGGGGTTCCGCATGG 3`	5`TTCACCGCGGACTTAACAGC 3`
T. denticola	316-bp	5`TAATACCGAATGTGCTCATTTACAT 3`	5`TCAAAGAAGCTTCCCTCTTCTTCTTA 3`

P. gingivalis: *Porphyromonas gingivalis*; *T. denticola*: *Treponema denticola*; *B. forsythus*: *Bacteroides forsythus*

Table 2: Intra- and inter-group comparison of plaque and gingival scores at baseline, 1, 4 and 12 weeks

	Test	Control	P* (intergroup)
Plaque scores			
Baseline	1.03±0.37	1.03±0.26	0.024
1 week	0.89±0.32	0.95±0.27	
4 weeks	0.80±0.29	0.89±0.27	
12 weeks	0.71±0.3	0.93±0.29	
P* (intragroup)	0.000	0.002	
Gingival scores			
Baseline	0.75±0.29	0.81±0.23	0.042
1 week	0.65±0.26	0.73±0.22	
4 weeks	0.60±0.25	0.67±0.21	
12 weeks	0.49±0.25	0.65±0.20	
P* (intragroup)	0.000	0.001	

P set at 0.05 and CI of 95%.*Degrees of freedom: 1. CI: Confidence interval

contingency coefficient test, ANOVA test, Chi-square test, and McNemar test were performed. Statistical significance was accepted at a significance level of 0.05. ANOVA was used to compare the mean plaque and gingival scores between the test and control groups. Chi-square test and McNemar test were used to assess the difference between the detection rates of *P. gingivalis, T. forsythia,* and *T. denticola* at baseline and 4 weeks.

Results

The mean age in the test group was 18.6 years and in the control group was 17.7 years.

Plaque scores
The baseline, 1-, 4-, and 12-week plaque scores are shown in Table 2. Intragroup analysis in both test ($P < 0.001$) and control ($P = 0.002$) groups showed statistically significant reduction in plaque scores over a period of 12 weeks. Intergroup analysis showed a statistically significant reduction in plaque scores in the test group as compared to the control group ($P = 0.024$). Table 2 shows the mean plaque scores in both groups at various time intervals.

Gingival scores
The baseline, 1-, 4-, and 12-week gingival scores are shown in Table 2. Intragroup analysis in both test ($P < 0.001$) and control ($P = 0.001$) groups showed a statistically significant reduction in gingival score over a period of 12 weeks. Intergroup analysis showed a statistically significant reduction in gingival scores ($P = 0.042$). Table 2 shows the mean gingival scores in both groups at various time intervals.

Bacterial load
There was no statistically significant reduction of any of the red complex bacteria in both the intragroup and intergroup analyses. Table 3 shows the detection rate of various microorganisms at different time intervals.

Discussion

The purpose of the present study was to assess and compare the effects of manual and powered tooth brushing in young adults with autism spectrum disorders both clinically and microbiologically after reinforcement of adequate OHI. Forty individuals with autism spectrum disorder were selected from an autistic institution and randomly allocated into 2 groups; test group received powered toothbrushes, and the control group received manual toothbrushes.

Powered toothbrushes, which were introduced in the 1960s, as an alternative to manual toothbrushes are known to be beneficial in patients with special needs.[15] In a study of autistic population in India, it was found that autistic patients frequently needed assistance in brushing had a higher rate of periodontal disease and lower caries compared to controls.[16] Thus, the primary outcome of this study was to achieve lower plaque and gingival scores in autistic patients. The secondary outcome was to reduce the bacterial count of salivary red complex microorganisms.

Good compliance was seen in both groups. The baseline plaque and gingival scores could not be made zero, as performing supra-gingival scaling in the autistic institution was not possible. However, at baseline, there was no significant difference in the mean plaque and gingival scores between the tests and controls as shown in Table 2.

Autistic patients are frequently prescribed with medications, which may have an influence on the periodontal status.[6] A short drug history was taken from the patient. In the present study, there was no significant difference in the medication history between the test and control groups.

The reduction in plaque and gingival scores in both and between groups can be attributed to the constant

Table 3: The detection rate of *P. gingivalis, T. forsythia* and *T. denticola* at baseline and 4 weeks using Chi-square and McNemar test

| | *P. gingivalis* | | | | McNemar test |
| | Baseline | | 4 weeks | | |
	Absent	Present	Absent	Present	P*
Test					
Count	10	10	13	7	0.375
Percentage within groups	50.0	50.0	65.0	35.0	
Control					
Count	10	10	12	8	0.500
Percentage within groups	50.0	50.0	60.0	40.0	

| | *T. forsythia* | | | |
| | Baseline | | 4 weeks | |
	Absent	Present	Absent	Present	
Test					
Count	15	5	18	2	0.250
Percentage within groups	75	25	90	10	
Control					
Count	15	5	17	3	0.625
Percentage within groups	75	25	85	15.0	

| | *T. denticola* | | | |
| | Baseline | | 4 weeks | |
	Absent	Present	Absent	Present	
Test					
Count	16	4	19	1	0.250
Percentage within groups	80	20	95	5	
Control					
Count	17	3	17	3	1.000
Percentage within groups	85	15	85	15.0	

P set at 0.05 and CI of 95%. *Degrees of freedom: 1. *P. gingivalis*: *Porphyromonas gingivalis*; *T. denticola*: *Treponema denticola*; *T. denticola*: *Tannerella forsythia*; CI: Confidence interval

reinforcement of OHI given to the subjects and supervision by the caregivers. The significant improvement in the test group can be attributed to the ease of using powered toothbrushes with lesser effort. In addition, the numbers of oscillations in the powered toothbrushes are predetermined, whereas, in the manual toothbrushes, the number of strokes is dependent on patient's dexterity. The powered toothbrush has proven to play a major role in enhancing patient compliance and motivation.[17,18]

This is in accordance with previous studies which have found a statistically significant reduction in the clinical parameters in powered toothbrushes as compared to manual toothbrushes. Few studies have contradicted this stating that powered toothbrushes were not superior to manual toothbrushes in improving gingival health.[17,19-21] However; many of these studies[17,19,20] have been conducted on a normal population whereas the present study was conducted on a special need population.

PCR methods have been proven valuable for the detection of periodontopathic bacteria in periodontal pocket samples.[22,23] However, as the microbiota may vary significantly from periodontal pocket to periodontal pocket within a subject, a large number of pockets may have to be examined to confirm or exclude the oral presence of specific periodontopathic species. Given that periodontal pocket bacteria are continuously washed into saliva by GCF, a whole saliva sample may offer a rapid and easy alternative to individual pocket samples for determining subgingival bacterial presence. Saliva represents an easily and noninvasively obtainable sample containing bacteria from all oral sites, Umeda *et al*.[11] showed that whole saliva is superior to pooled periodontal pocket samples to detect *P. gingivalis, T. forsythia,* and *T. denticola*. Saliva is easily obtainable from the oral cavities of young autistic children than subgingival plaque. Thus, saliva was used in the present study to detect the periodontal pathogens.

There was no statistically significant reduction in the red complex organisms in both groups. Haffajee *et al*. 2001[9] have found that supragingival plaque removal decreases counts and prevalence of periodontal pathogens in both the manual and powered toothbrush groups. In the present study, as scaling was not done prior to the initiation of the study, a significant reduction in the bacterial load might not be expected. In addition, the nested PCR technique is highly sensitive as compared to the other culture techniques and it does not provide a quantitative assessment of the bacterial counts such as the real-time PCR technique. Hence, these could explain the reasons for the insignificant results obtained.

The study examines the efficacy of manual and powered toothbrushes among a large population of autistic patients. The study has been complemented by the detection of red complex organisms using PCR. The limitation of this study is that the subgingival plaque for microbial analysis could not be obtained due to apprehensive behavior of the autistic patients. Furthermore, a quantitative PCR could not be carried due to lack of resources.

Oral health is integral to general health and quality of life. Basic oral health services are an essential component of primary healthcare. To the best of our knowledge, this is the first interventional study done on this population. This study adds to literature the importance of special preventive measures to improve their oral health. Attempts should be

made by parents and dentists to teach oral hygiene methods to these patients by constant repetition and patience, as autistic individuals can develop skills over a period of time.

Conclusion

In patients with autism spectrum disorder, powered toothbrushes result in a significant overall improvement in plaque control and gingival health, when constant reinforcement of OHI is given. However, there was no difference in the detection rate of red complex organisms between the groups.

Conflicts of interest
There are no conflicts of interest.

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