A comparative evaluation of manual and powered brushing on oral health and microbial status of mentally challenged individuals

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INTRODUCTION

The recent National Sample Survey Organization (NSSO: 2003) report number 485 (58/26/1)[1] suggests that the number of disabled persons in the country is estimated to be 18.49 million, accounting for about 1.8% of the total population, while the mentally challenged population amounted to 0.44 million individuals.[1] Tooth brushing is a very simple and effective method for removing daily dental deposits and for preventing dental and periodontal diseases. However, it can cause considerable manipulative difficulties among some populations, for example, young children, physically handicapped, and mentally retarded patients.[2] Physical inability to adequately clean their teeth and decreased neuromuscular co-ordination in such individuals makes use of manual toothbrushes less effective, so powered toothbrushes have been suggested as an alternative to manual brush for such individuals.

Dental plaque is the primary etiological factor in periodontal diseases. The elimination and control of plaque formation helps in the prevention of gingivitis as well as in minimizing the severity of periodontal disease. The adequacy of plaque control depends on patient’s compliance. In physically or mentally challenged person, often there arises difficulty in oral hygiene maintenance so that oral hygiene methods may need to be simplified or modified to suit the individual situation. Hence, the management of these mentally challenged children is a task which needs special effort on the part of dental surgeon.[2] There are numerous studies done in the past which have assessed the plaque removal efficacy of these new creations are licensed under the identical terms. Distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

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of manual and powered toothbrush in mentally challenged groups, but no studies exist utilizing the same configuration brush in active (Powered) and inactive (Manual) state wherein the Colgate 360° is one such brush which fulfills the above criteria. The quantitative assessment of clinical parameters is a regular protocol to assess the efficacy of toothbrushes. However, the qualitative assessment of brush effect on plaque by means of microbiologic evaluation has not been done so far, as confirmed by Medline search. In the current study, microbial profile of mentally challenged individuals has been attempted for the first time.

Hence, this particular study was aimed to assess and compare the effectiveness of manual and powered toothbrush on the oral health and microbial status of mentally challenged individuals.

**METHODOLOGY**

A randomized split mouth double blind clinical trial which consisted of two clinical phases (Phase I and Phase II) of 3 weeks duration each with a wash out period of 3 days in between the 2 phases. The study duration was 0–45 days. A total of 30 individuals (20 males, 10 females age group: 15–30 years) with mild to moderate mental retardation with moderate amount of plaque and gingivitis were selected. Ethical clearance was obtained from Institutional Ethics Committee (Ref.No.CODS/2249/2010-2011) before commencement of the study. Before the study, informed consent of parents and the principal of the school were obtained. The patients were selected based on the inclusion criteria: patients with at least 20 teeth, prebrushing score of 1.5 or more (modification of Quigley–Hein plaque index [QPI]), mild to moderate gingivitis (according to modified gingival index [MGI], scoring criteria: 2, 3) and mild to moderate degree of mental retardation (according to Stanford–Binet scale: mild retardation: 55–69, moderate retardation: 40–54). The exclusion criteria included individuals with known systemic diseases, who have received any antibiotic therapy in the last 6 months, with true periodontal pockets. The schematic representation of the study design is shown in Figure 1.

The study period was for 45 days; in the 1st Phase (0–21 days), brushing was done by the individual’s care taker (Aided) throughout study period; in the 2nd Phase (25–45 days) brushing was carried out by the selected individuals under supervision of care taker (Unaided). The clinical parameters of this study are expressed for 0–21 days (aided), 25–45 days (unaided), and 0–45 days (overall presentation).

Before start of the study, all the individuals underwent professional oral prophylaxis to achieve a standardized plaque score. In Clinical Phase-I (aided), the caretaker randomly did the manual brushing (MB) and powered brushing (PB) in the selected half of the mouth of all the individuals using Colgate 360° Sonicpower toothbrush, (Colgate-Palmolive Company, New York, USA) [Figure 2] with Colgate toothpaste using Fones method of toothbrushing for 2–3 min per subject once daily in the morning for 3 weeks, respectively. The Colgate 360° Sonicpower toothbrush has a unique feature of dual action that is Powered brushing (PB) was carried out in its active state (Power button: On) which operates at 20,000 strokes per minute and the same toothbrush can be used for Manual brushing (MB) in its inactive state (Power button: Off). The recording of all the clinical parameters and microbial sampling was done on the 0th day (baseline) and 21st day of each clinical phase [Figure 3]. After recording the clinical parameters, at least 10–12 sites were selected for pooled plaque sample collection from cervical area of tooth separately for each quadrant of the mouth. The pooled plaque samples were collected on baseline and 21st day. The main investigator who recorded the clinical indices was blinded. The microbiologist was also blinded about the samples and treatment groups.

After the clinical Phase-I (Aided), a wash out period of 3 days included education, motivation and training of mentally challenged individuals before the initiation of clinical Phase-II. In the clinical Phase-II (Unaided), the follow up of tooth brushing that is manual brush (MB) and powered brush (PB) was done in selected half of the mouth where the mentally challenged individuals were asked to brush their teeth on their own under the guidance of caretaker. The recording of the clinical parameters were done on 25th and 45th day of the clinical phases. Compliance of tooth brush was checked with help of a reminder sheet to be filled by the subject or his/her care taker daily after brushing. These compliance sheets were checked by the respective supervisors and by the investigator during subsequent examinations. Individuals whose compliance was poor were reinforced with oral hygiene instructions during subsequent examinations. No adverse effects were observed on the oral tissues. All the toothbrushes and toothpastes were provided to the study individuals during the entire duration of study by the investigator. The schematic representation of randomization and allocation of mentally challenged individuals is shown in Figure 4. The clinical and microbial parameters recorded were subjected to statistical analysis using Mann–Whitney and Pearson correlation tests.

**RESULTS**

The study included 30 individuals of age range between 15 and 30 years [Table 1]. There was no significant difference in baseline data of clinical parameters and microbial parameters of manual brushing (MB) and powered brushing (PB) groups [Graphs 1 and 2]. The study period was for 45 days; In the 1st Phase (0–21 days) brushing was done by the individuals care taker (Aided) throughout study period; In the 2nd Phase (25–45 days) brushing was carried out by the selected individuals under supervision of care taker (Unaided). The microbial parameters were recorded for 0–21 days period.

On intragroup comparison throughout the study period that is (aided [0–21 days], unaided [25–45 days] and overall [0–45 days]), both manual and powered brushing significantly reduced the QPI, gingival bleeding index (GBI), and MGI [Graphs 3-5].

**Table 1: Demographic data**

| Treatment Groups | Sex 15-30 yrs | Age |
|------------------|--------------|-----|
| Manual brushing  (MB) | Males | 20 | 20 |
| Powered brushing (PB) | Females | 10 | 10 |
| Total | | 30 | 30 |

MB: Manual Brushing; PB: Powered Brushing ;Yrs: Years
On intergroup comparison, the mean QPI reduction was significantly higher in MB group during aided, unaided and overall phases [Table 2] and maximum mean reduction of QPI (0.72% ± 40.48%) was seen during overall phase (0–45 days) in manual brushing group. The powered brushing showed a good influence in GBI reduction of 44% at the end of study phase being significantly more than manual brushing. The MGI index reduction was found to be similar in both groups. The Pearson correlation between QPI and GBI showed significant correlation (r: 0.11; P: 0.05) in powered brushing than manual brushing (r: 0.061; P: 0.749) [Table 3].

The baseline data of microbial evaluation of Prevotella intermedia (Pi), Porphyromonas gingivalis (Pg), An, and Fusobacterium nucleatum (Fn) were found to be similar [Graph 2]. The intragroup reduction (0–21 days) of different microorganisms was significant within in both manual and powered brushing [Graph 5]. The intergroup comparison of different microbial reduction showed significant reduction of Pi in powered brushing than manual brushing group, whereas there was no significant reduction of other organisms between the groups [Table 4 and Graph 6]. The Pearson correlation between GBI and periodontal pathogens like Pi, Pg, and Fn showed statistically significant relation in powered brushing group [Table 5].

The acceptability of active Colgate 360° (powered) brush was found to be similar as much as with inactive Colgate 360° (manual) brush.

**DISCUSSION**

Prevention has become the corner stone of the modern dental practice and effective plaque control is the basic password to the meaningful practice of preventive dentistry. Intraoral cleaning devices have been a part of human civilization since long and a strong correlation exists between the severity of gingivitis...
and periodontitis and the accumulation of dental plaque. Dental management of the handicapped child has received scant attention in the literature compared with the normal
Table 3: Pearson correlation between Quigley–Hein plaque index and gingival bleeding index of treatment groups

| Micro organisms | Pl | Mean±SD | % reduction | Pg | Mean±SD | % reduction | Ac | Mean±SD | % reduction | Fn | Mean±SD | % reduction |
|-----------------|----|---------|-------------|----|---------|-------------|----|---------|-------------|----|---------|-------------|
| 0-21 (MB)       | 2.90±9.3 | 8% | 9.77±7.0 | 20% | 10.17±7.1 | 20% | 21.97±24.8 | 24% |
| 0-21 (PB)       | 8.77±5.82 | 24% | 9.77±5.42 | 21% | 10.77±9.94 | 22% | 28.23±28.3 | 32% |
| Mann whitney value | 258.5 | 432.5 | 439.0 | 351.0 |
| P               | 0.004 | 0.795 | 0.870 | 0.143 |
| Result          | S    | NS     | NS         | NS  |

Marin Whitney Test: P<0.05 - significant at 5%(S); P<0.01 - significant at 1% level of significance (HS); P>0.05 - Non-significant (NS); Pi: Prevotella intermedia; Pg: Porphyromonas gingivalis Ac: Actinomyces Fn: Fusobacterium nucleatum, MB: Manual Brushing PB: Powered Brushing ;NS: Non Significant; S: Significant ;Vs: versus; SD: Standard deviation; % -percentage; P: probability value

Table 4: Intergroup analysis of microbial parameters from 0 to 21 day between treatment groups

| INDICES       | QPI versus GBI | Manual brushing (MB) | Powered brushing (PB) |
|---------------|----------------|----------------------|-----------------------|
|               | r              | P                    | r                     | P                |
| QPI versus GBI| 0.061          | 0.749, NS             | 0.11                  | 0.05, S          |

QPI: Quigely Hein plaque Index ;GBI: Gingival Bleeding Index ;MB: Manual Brushing ; PB: Powered Brushing; S: significant NS: Non Significant; P: probability value; r correlation value

who are poorly motivated to brush their teeth. The selection of microbial count done in this study belongs to the red and orange complex according to Socrasky’s criteria for periodontal pathogens. In this study, an attempt has been made to study the microbial profile in mentally challenged individuals for the first time as the earlier studies on mentally challenged individuals have dealt only the clinical parameters.

The results of this study are interpreted as follows: 41% of plaque reduction by the aided manual brushing (0–21 days) improved to 46% (25–45 days) by the unaided manual brushing. However the overall QPI reduction (0–45 days) improved to 48% that is the quantity of plaque levels got reduced after the supervised manual brushing was taken over by mentally challenged individuals. This could be probably due to better adaptation to the new Colgate 360° brush which is convenient and comfortable to use [Graph 3]. However, the MGI reduction showed an improvement from 36% of aided manual brushing to 52% of unaided manual brushing. The overall improvement (0–45 days) of plaque levels at the end of study period was encouraging [Graph 5]. On the other hand, the aided powered tooth brushing (0–21 days) which resulted in 20% QPI reduction improved to 22% by the unaided powered tooth brushing (25–45 days) [Graph 3]. Gradually, the GBI reduction was seen at 45 days. The possibility of bristle action to disrupt plaque matrix and hindrance to plaque formation on daily basis could be the additional beneficial support by the active Colgate 360° tooth brushes serving as powered toothbrush throughout the study period. The enhancement of mechanical plaque removal by the bristle action in active (powered) Colgate 360° could serve as a great advantage over inactive 360° Colgate (manual) despite higher level of QPI reduction in manual brushing. The GBI reduction was significantly higher in powered brushing between 25–45 and 0–45 days.

To confirm the beneficial effect of the powered brushing, the Pearson correlation between QPI and GBI showed significant correlation in powered than manual brushing [Table 3]. This is the greatest advantage of gingival bleeding index recording than MGI to assess any treatment. The ability of GBI index to respond to quality of plaque in terms of microbial reduction can be understood here.

The intragroup microbial reduction for Pg, Pi, An and Fn was highly significant from baseline to 21 days. On intergroup comparison, the Pi reduction was significantly higher in powered brushing than manual (0.004) [Table 4]. The Pearson’s correlation was used to confirm the brushing effects on plaque levels, gingival bleeding and microbial reduction. Both manual and powered brushing showed slight positive correlation.
The current study results further proved the beneficial action of active Colgate 360° (powered) by correlation analysis. There was a gradual and consistent GBI reduction from baseline to end of study period [Graph 4] owing to its dual action of mechanical plaque removal and possible disruption of plaque matrix by the activate bristle motion and thus the quality of plaque would have been targeted. This was obvious by the higher significant GBI reduction in powered brushing group. The quality of plaque in other terms the microbial content is a good measure to ascertain the effect of oral hygiene measures or any treatment per se. The biochemical component or plaque by products such as enzymes, toxins measurement does add to the importance of plaque quality. The evaluation of microbial profile included Pg, Pi, An and Fn found to be nonsignificant in manual brushing group. However, in powered brushing group GBI was significantly correlated with Pi, Pg and Fn reduction [Table 5].

The other related studies pertaining to the current study are presented here. Authors who reported insignificant difference between powered and manual brush in mentally challenged individuals are Bratel (1988),[10] Bratel J and Berggren U (1991),[11] Goyal et al.[12] Bratel et al. indicated that electric toothbrushes may be a valuable tool for moderately mentally challenged adults who are able to brush their teeth themselves. However, the lack of significant differences between groups contradicts any superiority of electric toothbrushes compared with normal brushes. Bratel and Berggren reported that no significant changes were found in or between the groups regarding plaque scores. Thus the study concluded that an electric toothbrush is not superior to a manual toothbrush. Sachin et al. indicated that for mentally challenged individuals manual toothbrushes reinforced with audio visual instructions for brushing may be comparable to the use of powered toothbrushes.

Authors who reported electric brush is more effective than manual brush are Doğan et al.,[8] Chung et al.,[9] Doğan et al. who reported, indicated that electric toothbrush (Braun 3D; Oral B) is the most effective for removing dental plaque in mentally disabled children. Chung et al. showed that brushing with the electric toothbrush over a period of 3 weeks significantly reduce plaque, calculus, and gingivitis index when compared with manual toothbrush.

Based on the National Survey Report NSSO, the number of disabled persons in India are on alarmingly increasing numbers.[13] In this study, the mentally challenged individuals were selected based on their IQ level according to Stanford–Binet Scale.[14] The above studies are not directly comparable to current study results due to variation in methodology and procedural steps. The study duration used for the current study was of 6 weeks which was similar to studies done by Doğan et al.[8] and Jamkhande et al.[9] longer study period was considered in studies by Chung et al.[8] Other studies which has been reported to have long-term study duration includes Bratel,[10] Bratel and Berggren,[11] Sachin et al.[6] In the present study, duration of 45 days and the sample size of 15 in each group was fixed in accordance to the ADA acceptance program clinical study guidelines for toothbrushes. In the present study, a sample size of 30 individuals was used which was similar to studies done by Chung et al.,[8] Bratel,[10] Bratel and Berggren,[11] Doğan et al.[8] Studies have been reported in a review by Walmsley A 1997 in which studies have <20 participants in each group. In the present split mouth design there is concern regarding the independence of samples when all the treatments are done in the same individual, the concern over spillover or cross effects was balanced by giving a 3-day washout period between the clinical phases of this study which is similar to studies done by Doğan et al,[8] where in a 1 week washout period was left while Sripriya and Shaik Hyder Ali[15] had an washout period of 4 days between the test groups. The current study employed the Fones method of tooth brushing and a brushing time of 2–3 min to carry out tooth brushing in mentally challenged individuals which is the recommended method of tooth brushing in these individuals while studies done by Bratel et al., Bratel and Berggren,[11] and Shyama et al.[16] employed brush technique of toothbrushing for 2–3 min. Doğan et al.[8] used Modified Stillman method of toothbrushing for 3 min twice daily for tooth brushing in mentally disabled group. The brush and Stillman brushing technique are not very easy to be used by mentally challenged individuals.

The present study employed tooth brushing to be carried out by both the mentally challenged individuals and their caretakers which are similar to studies done by Bratel et al.,[4] Bratel and Berggren.[11] There was no significant scores of clinical parameters amongst selected individuals at baseline. Hence, they were considered homogenous at baseline.

Until recent years, the management of the mentally challenged child was not even mentioned in the undergraduate curriculum of most dental schools in different parts of the world. This partly explains why the mentally challenged child has not received its fair share of dental management in the community. Oral health has strong biological, psychological, and social projections because it affects esthetics and communication. The quality of life is directly related to oral health status.

CONCLUSION

The study results confirm that the manual brushing and powered brushing are effective in maintaining oral health by use of Colgate 360° sonic brush. However, the qualitative and quantitative microbial reduction by powered brushing whose influence on gum bleeding is worth mentioning as compared to manual brushing. The aided (caretaker) and unaided (mentally challenged individual) brushing was very well supported by

### Table 5: Pearson correlation between gingival bleeding index and periodontal pathogens of treatment groups

| INDICES     | Manual brushing (MB) | Powered brushing (PB) |
|-------------|----------------------|-----------------------|
| GBI versus PI | 0.089 0.639 NS | 0.087 0.042 S |
| GBI versus Pg | 0.016 0.935 NS | 0.164 0.031 S |
| GBI versus Ac | 0.028 0.885 NS | 0.241 0.199 NS |
| GBI versus Fn | 0.088 0.642 NS | 0.119 0.052 S |

| Probability value: | r: correlation value |
|--------------------|---------------------|
| GBI: Gingival Bleeding Index; PI: Prevotella intermedia; Pg: Porphyromonas gingivalis; Ac: Actinomyces; Fn: Fusobacterium nucleatum; MB: Manual Brushing; PB: Powered Brushing; NS: Non Significant; S: significant; |

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the brush to maintain oral health and microbial reduction. The acceptability of the brush because of design in both active and inactive forms is highly appreciable. The same toothbrush design for both active and inactive state is the most appreciable wherein the other related studies have used different brush design for manual and powered brushing. The ease of on/off button option available in the brush was advantageous to both caretakers and mentally challenged individuals themselves. It’s a boon to medically compromised individuals, where the easy manipulation of Colgate 360 brush and current study results are supportive and recommended to medically compromised subjects.

However, the cost of the brush is a hindrance factor to replace them as when required. It is recommended that both government and nongovernment organization should consider to help these mentally challenged children consistently and promptly. Further studies are required to conduct microscopic evaluation of plaque structure before and after manual and powered brushing along with biochemical analysis.

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**Conflicts of interest**
There are no conflicts of interest.

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