

**Effectiveness of Two Different Modifications of Manual Toothbrush on Plaque Control – A Multiple Baseline Trial among 12-17 Year Old Children with Cerebral Palsy**

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**Abstract**

**Background:** Cerebral palsy (CP) is the leading cause of chronic disability in children, making them physically and mentally handicapped and socially aloof. In India, it is estimated at around 3 cases per 1000 live births. The main factor related to gingival/periodontal problems in these disabled individuals is the inadequacy of the plaque removal from the teeth. Hence this study was formulated to assess the effectiveness different modifications of manual tooth brush among 12 to 17 year old children with cerebral palsy.

**Methodology:** A multiple baseline design was adopted among 30 children with cerebral palsy aged 12 to 17 year at the special school, National Institute of Persons with Multiple Disabilities (NIEPMD). A conventional toothbrush was modified both at handle and head. Plaque and gingival index were recorded at baseline, 6 week and 12 weeks. Ethical clearance from the institution was obtained.

**Results:** A significance reduction in plaque and gingival scores ( $p < 0.005$ ) was obtained on using both the

modification. On comparison, the handle modification had a significant statistical difference on plaque index. ( $p = 0.0006$ )

**Conclusion:** Modified manual brushing is shown to be as effective in terms of the removal of plaque.

**Keywords:** Cerebral Palsy, Toothbrush, Modification, Children

**Introduction**

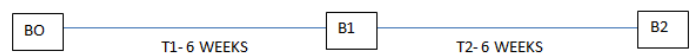
Disabled children are of great concern to a family as well as to the society. When disability is discussed, particularly in children, about a quarter of these chronic childhood problems are neurological in origin.<sup>[1]</sup> Cerebral palsy (CP) is the leading cause of chronic disability in children, making them physically and mentally challenged and socially aloof. In India, it is estimated at around 3 cases per 1000 live births.<sup>[2]</sup> CP is a term used to describe a group of disorders of movement, muscle tone, or other features that reflect abnormal control over motor function by the central nervous system. They are characterized as non-progressive neurological disorders that occur in the fetal or infant brain as it develops. The neuromuscular

problems inherent in CP can affect the oral health significantly, such as changes in structure of the oro-facial region, development of para-functional habits, feeding problems, difficulty with maintaining oral hygiene.<sup>[3]</sup> A systematic review done by Perez et al also states that oral hygiene of these children is poor and suggested that not much attention is given to improve the oral hygiene in these children.<sup>[4]</sup> The main factor related to oral health problems in these disabled individuals is the inadequacy of the plaque removal from the teeth. Motor coordination problems and muscular limitation in CP disabled individuals along with the difficulty in understanding the importance of oral hygiene have resulted in the progression of inflammatory diseases.<sup>[5]</sup> Tooth brushing (using conventional manual/powered toothbrush) being the simplest method to control plaque may be difficult because of motor coordination problems and muscular limitation among these cerebral palsy population.<sup>[6]</sup> Though systematic reviews have proved powered toothbrush to be as effective as manual toothbrush, it is still not a cost effective measure.<sup>[7]</sup> Therefore as a pragmatic approach, modification of conventional manual toothbrush would be one of the best approaches in this regards. Previous literature evidence points out a significant reduction in plaque and gingival scores (13.1%) of teeth when the handle of the toothbrush is modified and also have better efficiency in controlling toothbrush than powered or non- modified manual brushes.<sup>[8,9,10]</sup> Another study done by Bagatalia et al states a reduction in plaque about 14.2% when the shank of the toothbrush is bent at an acute degree less than 40. The author further explains the fact that this angulation will adapt to the dental curvatures of oral cavity thereby increasing the rotation of the bristles along the axis of the handle with minimum wrist movements.<sup>[11]</sup> With this regard, it is also to be noted that several studies have

highlighted that different modification of toothbrush bristles alone have no effect on plaque removal.<sup>[12,13]</sup> So far all the evidences present have evaluated independently the effectiveness of modified toothbrushes on plaque removal and there are hardly any studies which had assessed the synergetic effect of these two different modification of manual toothbrush on plaque removal. Hence, this study was formulated to assess the effectiveness of handle and shank modifications of manual tooth brush in removal of plaque on tooth surface among 12 to 17 year old children with cerebral palsy.

### Materials and Method

We adopted a multiple baseline study design, where the researcher chose to deliver two different interventions on the same population. In the present study, initially at the start of the study (B0) plaque index (Loe and sillness, 1964) and gingival index (Sillness and Loe, 1963) was recorded and the first intervention – the modified handle of toothbrush was provided. After 6 weeks (B1) both indices were recorded again and the second intervention which had a modification at both handle and shank of the toothbrush were given to the study participants. At the end of another 6 weeks (B2), plaque and gingival index were again assessed. For the reference, time period between baseline (B0) and 6 weeks (B1) was considered as T1 (6weeks) and time period between B1 and B2 (another 6 weeks)was considered to be T2. The following figure represents the time period used in our study.



A total of 70 children aged 12 and 17 years from the tertiary care center NIEPMD (National Institute for Empowerment of persons with Multiple Disabilities), who had grade 2,3,4 of cerebral palsy (Based on manual ability system, 2002) with plaque scores between 2 and 3 (Loe

and Sillness index, 1964) were considered for the study . A single calibrated dentist examined all the children under sunlight using ADA type 3 examinations and 30 children were included for the present study. Children with severe neuromuscular incoordination as per the classification given by manual ability system (2002) , children who were unable to cooperate, and those whose parents who were not willing to participate, children with preexisting oral conditions like dental caries were excluded from the study. Written informed consent was obtained from the parents of the included children and permission was sought from the principal of the special school present at NIEPMD. Ethical approval was obtained from the ethical committee of the respective institution.

Tooth brushing technique (Scrub) was demonstrated to the parents and the children through models and their compliance to the instructions were checked by asking them to demonstrate the same. All the participants were instructed to do tooth brushing twice daily (morning and night) for 3 minutes and use Colgate Active salt toothpaste (120g) during the study period. A pea sized toothpaste was instructed to be used by the participants and swish their mouth with water after tooth brushing. Monitoring of tooth brushing among the children was done by parents at home. Every week the principal investigator has interactive session with the parents to reinforce oral hygiene measures and any difficulty encountered in tooth brushing were discussed and rectified. Apart from oral hygiene measure, the parents were instructed to follow a balanced diet, avoid sticky foods so as to eliminate role of diet as confounding factor.

### **Toothbrush Modification**

Thirty conventional manual toothbrushes (Colgate super shine toothbrush™) with dimensions measuring 22.9 x 3.7 x 1.8 cm, medium bristled were purchased from a local departmental store. As suggested by Reenson et al, handle

modification of toothbrush was done using the ethaflex sheet (5mm) until adequate thickness of the sheet (based on the hand grip circumference of the child) was obtained.<sup>[14]</sup> Using dendrite adhesive it was stuck at the handle of the toothbrush in a cylindrical pattern as shown in figure 1. The second modification as stated by Bagatalia et al, the brush was heated using a hot air gun for 15 seconds and then an angulation of 35°- 40° was given using a protractor at the shank<sup>[11]</sup> The final modified toothbrush is seen in figure 2.



Figure 1 – handle modification of tooth brush (first Intervention)



Figure 2 – handle and shank modification of toothbrush (second intervention)

**Statistical analysis**

Descriptive statistics was used to describe the distribution of age, gender and cerebral palsy type .Normality of the data distribution was assessed using Kolmogrov-Shaprowil test. Paired *t*-test was used for comparison of plaque index and gingival index individually for each intervention at baseline and 6 week period. Independent sample t-test was used for the comparing the improvement in plaque and gingival score between the two interventions during the study period. All the values were interpreted at the level of *p* value <0.05 with 95% confidence interval.

**Results**

A total of 30 CP children aged 12 years to 17 years were studied, of whom 18 (60%) were males and 12 (40%) were females. Majority of the children (60%) were of Athetoid type CP, (33%) were flaccid type and rest (6.7%) were spastic type.(table 1) In the sample of 30 children diagnosed with CP, the mean plaque and gingival index score at time B0, time B1 (6 weeks) and B2 (12 weeks) are shown in figure 3. Change in plaque score was higher at T2 time period ( $0.58 \pm 0.27$ ) than T1 ( $0.44 \pm 0.19$ ), similarly gingival scores were also higher during T2 period ( $0.64 \pm 0.27$ ) than during T1 ( $0.41 \pm 0.2$ ). Both the reductions were clinically and statistically significant ( $p < 0.001$ ). Difference between the mean plaque scores at T1 and T2 was 0.14 which were statistically significant ( $p=0.006$ ) whereas as, a prominent decrease in mean gingival scores (0.13) was observed between the two interventions, however this change was not statistically significant ( $P > 0.05$ ).

Table 1 showing the distribution of age, gender and CP type within the study population

CHARACTER	N(%)
AGE	
12-14 yrs	10(33%)
15-17 yrs	20(66.7%)
GENDER	
Male	18(60%)
Female	12(40%)
CP TYPE	
Athetoid	18(60%)
Spastic	2(6.7%)
Flaccid	10(33%)

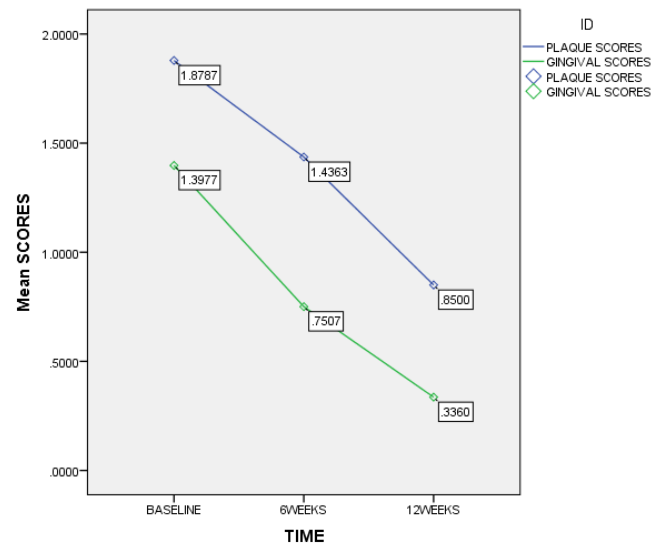


Figure 3 represents the decline in plaque and gingival scores at baseline, 6 weeks and 12 weeks.

**Discussion**

Cerebral palsy children have difficulty in the control of motor movements of their extremities and this can affect the functional performance and have a direct effect on activities of daily living, including personal and oral hygiene. The mechanical control of biofilm (includes tooth brushing) in individuals with a neuromuscular disability is associated with difficulty in maintaining the position of a toothbrush, hand and wrist movements and involuntary facial movements. These characteristics

hinder the insertion and handling of a conventional manual toothbrush in the mouth and may lead to ineffective and time consuming brushing. Hence, it is clear that these disabled individuals require a technique that is easy to use and reliable, in order to achieve some degree of acceptable plaque control.<sup>[15]</sup> Thus this study was designed among a 30 CP children aged 12 years and 17 years which included 18 males and 12 females. In the present study, we compared the two modifications made to the conventional manual toothbrush at 6 weeks interval. We had used a multiple baseline study (MB) because one of the advantages of using MB design is that it does not require withdrawal of the independent variable. In this study design, the independent variable is first applied to the participant and baseline is recorded. After the intervention effect is demonstrated and the second intervention is applied upon the first to the participant. Since the study was formulated to evaluate the synergistic effect of both the modifications on plaque removal efficacy and also withdrawal of independent variable would violate the principle of beneficence in ethics, the same design was preferred for this study.<sup>[16]</sup> The results of the study showed a marked reduction in the plaque and gingival scores(14% and 13%) with both the interventions which was higher to average plaque and gingival reduction(11% and 6%) using a manual toothbrush.<sup>[7]</sup> This is because of the modification done to the toothbrushes provides better efficacy on the part of the participant by virtue of the grip provided to it. A bend provided at the shank of the toothbrush offered an enhanced movement of the toothbrush bristles along the axis of the handle in removing dental plaque than the conventional straight shank toothbrushes.<sup>[11]</sup> The gradual decrease in the scores noticed between two time period (T1 and T2) was clinically evident and statistically significant which is in accordance with the study done by Soncini et al., 1989<sup>[17]</sup>

Inter intervention comparison of plaque and gingival scores following different toothbrush modification showed increased reduction of plaque scores during T2 period than during T1 period, suggesting the synergistic effect of both modification in plaque removal capacity. The advantage of the present modification of the toothbrush provides improved holding capacity and decreased hand – wrist movements among the CP children. The parents/ caregivers of these children also expressed preference of the handle and shank modified toothbrush. Reasons for their preference may be greater ease of performance and cooperation of patients due to decreased gag reflex during brushing and shorter time required to brush teeth.

The present study reveals the generalized reduction of gingivitis and plaque formation independent of the type of modification of toothbrush and the recommends the use of individually modified toothbrush for these populations. This is the first study to explore the synergistic efficacy of toothbrushes when modified at both handle and shank level. The results of the same show that modification done at both levels is better than modification at handle level alone.

#### **Limitation**

The sample size used in the present study is less; hence generalizability of the findings cannot be made. The other limitation is increased efficacy of participant to tooth brushing behavior over long period, which could pose a threat to internal validity of the study.

#### **Conclusion**

The results of the present study enable CP patients to maintain better oral hygiene with a very cost effective approach. Modified manual toothbrushes were shown to be effective in terms of the removal of plaque. There is a need for novel approaches among this population especially in middle - low income countries, as taken up in

our study. Further high quality studies need to be carried out to validate this outcome.

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