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Original Article

Dentistry Section

Evaluating the Effectiveness of Four Brushing Techniques on Children's Oral Hygiene and Dental Issues: A Quasi-experimental Study

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ABSTRACT

Introduction: Oral health is closely linked to effective tooth brushing; however, current guidelines often lack age-specific recommendations, despite the fact that dental development spans from infancy through early adulthood.

Aim: To evaluate the impact of four age-appropriate brushing techniques on children's oral hygiene and the prevalence of dental disorders.

Materials and Methods: This quasi-experimental study was conducted in the Outpatient Department (OPD) of the Paediatric and Preventive Dentistry division at Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India, over a two-month period from July 1, 2022 to August 31, 2022. Participants were divided into four age groups and each group was taught a brushing technique suited to their developmental stage: the Fones technique for children aged 4 to 6 years, the horizontal scrub technique for those aged 6 to 8 years, the Bass technique for children aged 8 to 10 years and the modified Bass technique for those aged 10 to 12 years. Oral health was assessed using the Oral Hygiene Index-Simplified (OHI-S) and the Decayed, Missing and Filled Teeth (DMFT) index, which were recorded before and after the intervention. Statistical analysis, including Pearson's correlation and paired t-tests, revealed a significant association between improved oral hygiene and reduced dental caries, with significant p-values.

Results: A total of 80 children aged 4-12 years (mean age: 8.41±2.45 years) were equally assigned to four age-specific brushing technique groups (n=20 each). The mean OHI-S score of the entire sample significantly decreased from 1.47±0.84 at baseline to 0.81±0.33 after one month (p=0.01). All techniques showed significant improvements in oral hygiene: Group A (Fones), p<0.001; Group B (horizontal scrub), p=0.002; Group C (Bass), p<0.001; and Group D (modified Bass), p=0.001. The modified Bass technique demonstrated the greatest reduction in the 10-12-year age group. A total of 7 (35%) children in Group A (Fones technique, 4-6 years) relied on their parents for brushing instruction. No significant correlation was found between baseline oral hygiene and caries experience (r=0.008, p=0.947).

Conclusion: Personalising brushing techniques according to a child's dental development markedly enhances oral hygiene and lowers the risk of dental diseases. These findings emphasise the importance of establishing age-specific oral hygiene guidelines as a proactive preventive measure. Adopting tailored approaches can promote lifelong oral health from early childhood onward.

Keywords: Child health services, Dental caries prevention, Dental plaque Oral health, Paediatric dentistry, Tooth brushing

INTRODUCTION

Oral health is essential as it reflects general well-being throughout life. Teething begins around six months of age and continues until approximately 23 years, during which individuals pass through three dental stages: primary, mixed and permanent dentition. Maintaining oral hygiene during these stages is challenging due to varying tooth eruption patterns. To ensure good oral health and protect against microbiological diseases such as dental caries and periodontal disease, age-appropriate brushing practices should be implemented at each stage of dental development [1].

The oral microbial flora consists of a wide range of bacteria capable of causing pulpal, periapical, periodontal and opportunistic infections. Oral hygiene is significantly affected by the formation of a pellicle or biofilm, which leads to plaque and calculus accumulation. Effective biofilm management is essential for maintaining oral health and preventing these complications [2].

Over the decades, toothbrushes have evolved from simple twigs and leaves to sophisticated powered devices. However, proper brushing techniques are often neglected despite advancements in toothbrush design. Children who are not adequately educated in correct brushing methods are more likely to develop dental caries. The brushing technique is ultimately more important than the instrument itself, as effective plaque removal depends largely on thorough and appropriate brushing practices [3,4].

The oral cavity hosts a diverse microbial ecosystem comprising bacteria, viruses and fungi. Disruption of this balance can result in dysbiosis. The mouth serves as a gateway to both the respiratory and digestive systems and harbours more than 700 bacterial species. Bacterial colonisation is facilitated by the complex periodontal structure [5]. Poor oral hygiene can lead to periodontitis, dental caries, gum disease, infections and tooth loss. Native oral bacteria contribute to biofilm formation and plaque-induced periodontal disease. Furthermore, inadequate oral health can impair eating, swallowing, speaking, sleep quality and work performance [6].

Systemic complications may arise from bacteraemia associated with oral inflammation. Untreated dental conditions increase the risk of diabetes, cardiovascular disease and overall poor health. Although proper brushing is essential for maintaining oral hygiene, there is a lack of universally accepted age-specific brushing methods [5,6].

Regular plaque removal is critical, as neglecting proper oral care-including the use of fluoride toothpaste-increases the risk of caries and gingivitis. Oral hygiene education should begin with the eruption of the first tooth to prevent dental problems, pain, halitosis and

social stigma related to poor appearance. Maintaining oral health prevents medical, psychological and social complications [7].

Both mechanical and chemical plaque control are necessary for optimal dental health. Mechanical plaque removal depends on technique proficiency and ease of use. Methods such as scrub, Stillman's, Bass and modified Bass techniques help remove plaque and stimulate gingival tissues. However, no single method is universally effective. Many individuals use self-developed methods, such as horizontal, vertical, or circular scrubbing, which may remove plaque but also risk damaging hard tissues [8].

The circular (Fones) technique is commonly recommended for younger children because of its simplicity and ease of learning, making it suitable for preschool-aged children with limited manual dexterity. Evidence supports the use of the horizontal scrub technique for children up to 6-7 years, as it aligns with their stage of motor skill development [9].

Studies show that horizontal scrubbing is frequently used and effective in young children who lack the coordination needed for more complex brushing techniques [10]. Mescher KD et al., reported that the hand functions required for sulcular brushing typically develop around eight years of age or later, indicating that younger children may struggle with advanced techniques [10].

Effective oral hygiene education also emphasises model-based demonstrations and personalised instruction by dental professionals, which significantly improve children's brushing performance and oral health outcomes [10].

Considering these factors, the present study aimed to assess the effectiveness of age-appropriate brushing techniques in children. Four different brushing methods were evaluated for their impact on oral hygiene and dental health. Baseline oral hygiene was assessed using the OHI-S, along with caries prevalence and DMFT scores. After providing brushing instructions, oral hygiene was reassessed using OHI-S. Pre- and post-intervention scores were compared to determine the effectiveness of customised brushing strategies.

MATERIALS AND METHODS

The present quasi-experimental study was conducted in the OPD of the Paediatric and Preventive Dentistry division at Meenakshi Ammal Dental College and Hospital, Chennai, over a two-month period from July 1, 2022 to August 31, 2022. The study evaluated and compared oral hygiene status before and after introducing four standardised brushing techniques to children aged 4 to 12 years who had previously been using unspecified or customised methods. The study received approval from the Institutional Ethics Committee (MADC/IEC-II/70/2022).

A total of 80 participants were selected and allocated into four age-based groups (20 per group): Group A (4-6 years) practised the Fones technique, Group B (6-8 years) used the horizontal scrub method, Group C (8-10 years) followed the Bass technique and Group D (10-12 years) used the modified Bass technique.

Sample size calculation: The sample size for each group was calculated using the sample size considerations for non parametric tests with a 95% confidence interval and 80% power. Considering feasibility, 20 participants were enrolled per group.

Inclusion and exclusion criteria: The study included cooperative children aged 4 to 12 years with no physical or mental disabilities who were willing to participate with parental consent. Children with syndromes, developmental abnormalities, orthodontic treatment, or other oral appliances were excluded. Data collection was carried out using a validated structured proforma.

Study Procedure

Participants were assigned to Groups A, B, C and D based on age. Baseline oral hygiene status using the Oral Hygiene Index-Simplified (OHI-S) and caries experience using the DMFT index were recorded for each child while seated in a dental chair under standard clinical conditions. Participants were gender-matched in a 1:1 male-to-female ratio. Both children and parents were trained in the assigned brushing techniques. The Wilcoxon Signed-Rank Test was used to compare pre- and post-intervention OHI-S scores [11,12].

The OHI-S was used to assess oral hygiene status and consists of two components: the Debris Index-Simplified (DI-S) and the Calculus Index-Simplified (CI-S). Scores were recorded on six tooth surfaces: the buccal or labial surfaces of teeth 16, 11, 26 and 31 and the lingual surfaces of teeth 36 and 46. When index teeth were missing, adjacent teeth were examined. In primary dentition, the buccal surfaces of teeth 54, 61 and 64 and the lingual surfaces of teeth 75, 82 and 85 were used. The OHI-S score was calculated by summing the DI-S and CI-S scores, with total values ranging from 0 to 6 and interpreted as good (0-1.2), fair (1.3-3.0), or poor (3.1-6.0) [13].

The DMFT score for each participant was determined through clinical examination by identifying the number of decayed, missing and filled teeth attributable to dental caries. A cumulative DMFT value was then calculated for the sample [14].

Participants were provided with age-appropriate toothbrushes and toothpaste, followed by instruction in their designated brushing techniques: Group A practised the Fones technique, Group B used the horizontal scrub method, Group C followed the Bass technique and Group D used the modified Bass technique [1,9].

The Fones technique employs broad, gentle circular strokes performed with the teeth closed. The bristles are placed against the buccal surfaces of the posterior teeth and moved in large circles that cover both dental arches, offering simplicity but limited interproximal cleaning [15].

The horizontal scrub technique involves placing the toothbrush on the buccal surfaces and moving it in a straight back-and-forth horizontal motion along the dental arch. While easy and commonly used, excessive pressure may contribute to cervical abrasion [15].

The Bass technique is designed to optimise plaque removal at the gingival margin and within the sulcus by angling the bristles toward the gumline and applying gentle vibratory strokes. This allows the bristle tips to penetrate the sulcus, providing superior gingival cleansing [15].

The modified Bass technique enhances this approach by incorporating a sweeping motion. The bristles are held at a 45° angle toward the gingiva, vibrated lightly to clean the sulcus and then swept toward the occlusal surfaces. This method is particularly effective for individuals with mild gingival recession and sufficient manual dexterity [15].

Weekly phone calls were conducted to assess progress and technique compliance. After one month, participants were re-evaluated and indices were recorded and analysed statistically. Parental involvement was assessed through observation and structured questioning during training and follow-up sessions, documenting the frequency and level of supervision for each age group.

STATISTICAL ANALYSIS

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20.0. OHI-S scores and caries experience (DMFT/dft) were presented as mean±Standard Deviation. The Wilcoxon Signed-Rank Test was used to compare pre- and post-intervention OHI-S scores and Pearson's correlation coefficient was used to assess associations between baseline OHI-S and DMFT/dft scores. Statistical significance was set at $p<0.05$.

RESULTS

A total of 80 children aged 4-12 years were recruited for the present study. Participants were equally allocated into four groups (n=20 each)

according to the assigned brushing technique. The mean age of the study population was 8.41±2.45 years [Table/Fig-1]. Descriptive statistics for age, oral hygiene status and dental caries experience are presented in [Table/Fig-1].

At baseline, the mean OHI-S score for the total sample was 1.47±0.84, indicating fair oral hygiene. After one month of practising the assigned brushing techniques, the mean OHI-S score decreased to 0.81±0.33 [Table/Fig-1].

Dental caries experience: The mean DMFT/dft score at baseline was 3.56±3.18, indicating a moderate caries burden among participants [Table/Fig-1]. DMFT/dft was not reassessed after one month, as dental caries is a cumulative condition and measurable changes are not expected over a short duration.

Variables	N	Minimum	Maximum	Mean±SD
Age (years)	80	4.00	12.00	8.41±2.45
OHI-S (Before)	80	0.00	3.90	1.47±0.84
DMFT/dft	80	0.00	14.00	3.56±3.18
OHI-S (After)	80	0.00	1.50	0.81±0.33

[Table/Fig-1]: Descriptive statistics of study variables (N=80).
Values expressed as mean±Standard Deviation (SD). OHI-S: Oral Hygiene Index-Simplified; DMFT/dft: Decayed, Missing and Filled Teeth (permanent/primary dentition); N: Number of participants

Oral hygiene status: Group wise reductions in mean OHI-S scores were observed as follows [Table/Fig-2]:

Group	Brushing technique	n	OHI-S (Before) Mean±SD	OHI-S (After) Mean±SD
Group A	Fones	20	1.22±0.70	0.72±0.27
Group B	Horizontal scrub	20	1.41±0.74	0.86±0.30
Group C	Bass	20	1.64±1.16	0.76±0.45
Group D	Modified Bass	20	1.60±0.64	0.90±0.27

[Table/Fig-2]: Comparison of OHI-S scores before and after intervention among different brushing techniques.
Lower OHI-S scores indicate better oral hygiene. Values expressed as mean±SD

Group A (Fones, 4-6 years): 1.22±0.70 to 0.72±0.27

Group B (Horizontal scrub, 6-8 years): 1.41±0.74 to 0.86±0.30

Group C (Bass, 8-10 years): 1.64±1.16 to 0.76±0.45

Group D (Modified Bass, 10-12 years): 1.60±0.64 to 0.90±0.27

All groups demonstrated marked improvement in oral hygiene following the intervention.

Correlation between oral hygiene and caries experience: Pearson's correlation analysis between baseline OHI-S scores and DMFT/dft scores revealed a very weak and non significant association (r=0.008, p=0.947) [Table/Fig-3], indicating that baseline oral hygiene status did not correlate with caries experience in this population.

Variables	OHI-S (Before)	DMFT/dft
OHI-S (Before)	1.000	0.008
DMFT/dft	0.008	1.000
p-value (2-tailed)	—	0.947

[Table/Fig-3]: Pearson's correlation between baseline OHI-S and DMFT/dft scores (N=80).
Pearson's correlation applied to assess the relationship between baseline oral hygiene and caries experience. p<0.05 considered statistically significant

Intragroup comparison of OHI-S scores: Paired t-tests were used to compare pre- and post-intervention OHI-S scores within each group [Table/Fig-4]. All groups showed statistically significant reductions:

Group A (Fones): p<0.001

Group B (Horizontal scrub): p=0.002

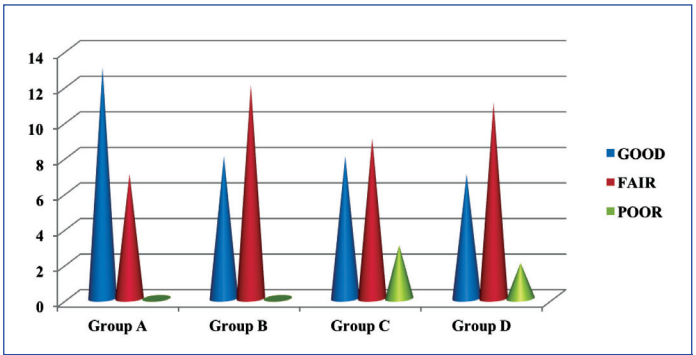
Group C (Bass): p<0.001

Group D (Modified Bass): p=0.001

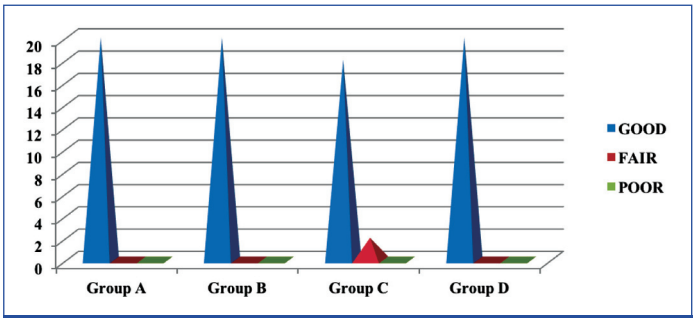
Group	Brushing technique	OHI-S before (Mean±SD)	OHI-S after (Mean±SD)	p-value
Group A	Fones	1.22±0.70	0.72±0.27	<0.001**
Group B	Horizontal scrub	1.41±0.74	0.86±0.30	0.002*
Group C	Bass	1.64±1.16	0.76±0.45	<0.001**
Group D	Modified Bass	1.60±0.64	0.90±0.27	<0.001**
Total	All groups	1.47±0.83	0.81±0.33	0.01*

[Table/Fig-4]: Intragroup comparison of OHI-S scores before and after intervention using paired t-test.
Paired t-test was used for intragroup comparisons, with values expressed as mean±SD. A p-value <0.05 was considered statistically significant, indicating a significant improvement

The combined analysis of all participants also demonstrated a significant improvement in oral hygiene (p=0.01), confirming the effectiveness of all four brushing techniques over one month [Table/Fig-5,6].



[Table/Fig-5]: Comparison of mean OHI-S scores before brushing technique.



[Table/Fig-6]: Comparison of mean OHI-S scores after one month of brushing.

Intervention

This graph illustrates the mean OHI-S scores of the four study groups before introducing age-appropriate brushing techniques. The baseline scores reflect varying levels of oral hygiene across age groups, with higher values indicating poorer hygiene.

Technique Practice

This graph depicts the mean OHI-S scores of the four groups after one month of practising their assigned brushing techniques. The reduction in scores across all groups indicates improved oral hygiene, with differences in effectiveness among techniques.

Parental involvement in brushing instruction: Parental supervision varied by age group. Group A (Fones, 4-6 years) showed the highest reliance on parents, with 7/20 (35%) of children requiring guidance. Group B (Horizontal scrub, 6-8 years) had 3/20 (15%) of children needing supervision. No children in Group C (Bass, 8-10 years) or Group D (Modified Bass, 10-12 years) required parental assistance.

This trend indicates that younger children depend more on parental involvement, which may facilitate learning proper brushing techniques [Table/Fig-7].

Values are presented as number and percentage of children requiring parental supervision (n=20 per group). All groups showed

Group	Brushing technique	Age group (years)	Total participants (n)	Number relying on parents	Percentage (%)
A	Fones	4-6	20	7	35
B	Horizontal Scrub	6-8	20	3	15
C	Bass	8-10	20	0	0
D	Modified Bass	10-12	20	0	0

[Table/Fig-7]: Parental involvement in brushing instruction by group.

significant improvement, with greater reductions observed among younger children, possibly reflecting the influence of parental guidance [Table/Fig-6,7].

DISCUSSION

In the present study, 80 children across four age groups were assigned to age-appropriate brushing techniques: Group A (Fones), Group B (horizontal scrub), Group C (Bass) and Group D (modified Bass). Each group received instruction tailored to their developmental abilities. Baseline DMFT/dft and OHI-S scores were recorded for all participants and OHI-S was reassessed after one month of intervention. DMFT/dft was measured only at baseline due to the cumulative nature of dental caries.

The mean baseline OHI-S scores were 1.22±0.69 for Group A, 1.41±0.73 for Group B, 1.63±1.15 for Group C and 1.59±0.64 for Group D. Post-intervention scores decreased to 0.72±0.27, 0.86±0.29, 0.76±0.44 and 0.89±0.26, respectively, demonstrating substantial improvements in oral hygiene across all groups.

The very weak and non significant correlation between DMFT/dft and baseline OHI-S scores (r=0.008, p=0.947) highlights the multifactorial nature of dental caries. Factors such as dietary habits, fluoride exposure, salivary composition, oral microbiota and genetic predisposition may play a more influential role in caries development than short-term oral hygiene status alone.

Although significant improvements in oral hygiene were achieved within one month, this duration was likely insufficient to produce measurable changes in DMFT/dft values. Longer follow-up periods are necessary to determine the long-term impact of improved brushing techniques on dental caries outcomes.

The paired t-test and Z-test revealed significant improvements in OHI-S scores across all groups, indicating that the implementation of proper brushing techniques led to better oral hygiene. Groups A and B showed complete movement of participants into the "good" oral hygiene category from previously mixed classifications. Groups C and D demonstrated varying outcomes, with most Group C participants shifting to the "fair" category and all Group D participants advancing to the "good" category. These variations may be attributed to differences in brushing duration, comprehension and manual dexterity.

Among participants, 7 (35%) children in Group A (Fones technique, 4-6 years) and 3 (15%) children in Group B (horizontal scrub technique, 6-8 years) required parental assistance for brushing. The higher reliance observed in Group A is likely due to the younger age of the children, who generally require increased supervision to perform effective oral hygiene practices.

Patil SP et al., reported that the horizontal scrub technique and modified Bass technique were the most and least effective, respectively, in plaque removal among toddlers [16]. These findings are consistent with Kremers L et al., who demonstrated that the modified Bass technique is particularly effective in removing plaque from interdental areas [17]. The present study similarly showed that the modified Bass technique yielded superior improvements in oral hygiene among older children.

The Fones technique, which showed comparatively lower plaque removal efficiency, was less effective in cleaning interdental areas. Tavakoli S et al., (2025) demonstrated that school-based supervised tooth-brushing programmes significantly reduce dental caries and improve plaque control, underscoring the importance of continuous supervision and reinforcement [18]. These findings align with the present study, which highlighted significant improvements following instruction in age-appropriate brushing techniques. Importantly, the present study further emphasised the added benefit of educating both children and parents or caregivers, reinforcing proper practices at home and strengthening long-term habit formation.

Age-appropriate brushing methods are essential for effective oral hygiene. Preschool children benefit from simpler techniques such as the horizontal scrub method, while children in mixed dentition stages can effectively adopt Fones and modified Bass techniques. Individualised instruction using dental models, as highlighted by Okada M et al., [19], enhances learning outcomes. Regular plaque removal through both personal oral hygiene and professional periodontal care is vital for maintaining oral health. Continuous patient education and motivation remain central to long-term preventive dental care [20].

Parental education significantly influences children's oral hygiene behaviours and socioeconomic awareness, which in turn affect dental outcomes. Studies have shown positive associations between parental education levels and proper toothbrush replacement practices, as well as reduced caries prevalence. Research conducted in Sudan revealed that mothers' oral health awareness strongly correlates with their educational background and children's oral health behaviours. Prolonged toothbrush use with worn bristles was also linked to increased caries risk due to reduced plaque removal efficiency [21].

Patil SP et al., further observed that children aged 8-11 years benefit most from horizontal scrub and modified Bass techniques, with the Bass method suitable from approximately eight years and the modified Bass method from around ten years of age [16]. This supports the present study's findings that older children more effectively adopted advanced brushing techniques.

Similarly, Tusi SK et al., (2025) demonstrated that structured, individualised brushing education significantly improves plaque control, particularly when one-to-one demonstration-based teaching is used [22]. These results complement the current study by highlighting the combined importance of age-appropriate techniques and effective instructional methods.

Glenny AM et al., (2024) developed brushing recommendations through professional consensus and emphasised that no single technique is universally effective across all age groups. They concluded that brushing efficacy depends largely on age, manual dexterity and instruction quality rather than technique alone [23]. This aligns closely with the present study's findings, particularly the superior outcomes observed with the modified Bass technique in older children.

Limitation(s)

The present study had certain limitations. Intergroup comparisons were not conducted, limiting direct evaluation of relative effectiveness among techniques. The sample size was modest and the follow-up period was limited to one month, which may not reflect long-term outcomes or caries progression. Future studies should incorporate larger populations, extended follow-up durations and direct technique comparisons to establish comprehensive age-specific brushing guidelines.

CONCLUSION(S)

Children were divided into four age groups (4-6, 6-8, 8-10 and 10-12 years) and taught age-appropriate brushing techniques: Fones, horizontal scrub, Bass and modified Bass, respectively.

Oral hygiene (OHI-S) and caries experience (DMFT) were assessed to evaluate effectiveness. All brushing techniques resulted in significant improvements in oral hygiene within their respective age groups, highlighting the importance of developmentally appropriate instruction. The findings support the implementation of age-specific brushing recommendations in routine dental education. Future research should involve larger sample sizes and comparative analyses across techniques to refine evidence-based oral hygiene guidelines. Dental professionals should actively promote age-appropriate brushing strategies to enhance oral health outcomes in children.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Oct 24, 2025
- Manual Googling: Dec 26, 2025
- iThenticate Software: Dec 30, 2025 (3%)

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- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
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