



## Light Microscopic Analysis of Toothbrush Bristle End Morphology - An *In Vitro* Study.

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### Abstract

**Objective:** The aim of the study was to analyse the toothbrush bristle end morphology of various commercially available brands using Light microscope and to estimate the percentage for acceptable and non-acceptable toothbrush bristle ends.

**Methods:** Fifty manual toothbrushes were selected of five different leading brands. Each brand consists of five soft and five medium consistency toothbrushes. Bristles were excised carefully with a surgical scissor and magnifying loupes. Excised bristles were placed in the microscopic glass slide, secured with cover slip and analysed under Light Microscopy at 45x.

**Results:** The results showed mean acceptable and non-acceptable percentage for all brands that is in Ajanta 25.1% bristles were acceptable 74.9% was not acceptable, in Colgate 18.5% bristles were acceptable, 81.5% was not acceptable, in Cibaca 16.5% bristles were acceptable 83.5% was not acceptable, in ORAL B 26.7% bristles were acceptable 73.3% was not acceptable, in Pepsodent 19.4% bristles were acceptable 80.6% was not acceptable.

**Conclusion:** In the present study the acceptability percentage ranges from 16.5% - 26.7% which shows very minimal percentage for a recommended toothbrush. Hence the currently available toothbrush does not fall under the category as put forth by American Dental Association.

**Keywords:** Dental Plaque; Toothbrush; Bristle Morphology; Light Microscope

### Introduction

Dental plaque is considered as the major etiologic factor in the development and progression of periodontal diseases and dental caries. Loe., *et al.* showed the occurrence of gingival inflammation as a result of accumulation of dental plaque [1]. Carefully performed daily oral hygiene practices combined with periodic professional plaque control (Scaling and Root planing) is considered as the standard care when reduction of dental plaque is considered [2].

Tooth brush, dentifrices and other recommended interdental aids form the fundamentals of daily mechanical plaque control measure. Tooth brush is the most common device which is used for effective plaque removal. Types of toothbrushes which are currently available are manual, powered, sonic and ionic. Brushes can also be soft, hard or medium based on their bristle thickness. Factors that determine the thoroughness of plaque control are bristle type and brushing technique. Studies have shown that tooth brush

with hard, stiff bristles and pointed edges can cause cervical abrasion and gingival recession [3,4].

In order to prevent gingival and hard tissue injury caused by toothbrush bristles. Brushes free from sharp or pointed edges and having rounded bristle ends are graded as acceptable [5]. Studies support that bristles with rounded tips cause minimal soft tissue trauma and abrasions [6,7]. With numerous brands of tooth brush available in market, standardization of the end morphology of the bristles regardless of the type of bristle is questionable. In lieu with this the present study aims in assessing the bristle end morphology of few common commercially available toothbrushes in the market.

There are several methods for analysing the toothbrush bristle morphology ranging from simple light microscopy<sup>8</sup> to Scanning electron Microscopy<sup>9</sup> and Stereomicroscopy [10]. Since light microscopy is more suited to assess the bristle end morphology, we chose the same over other methods.

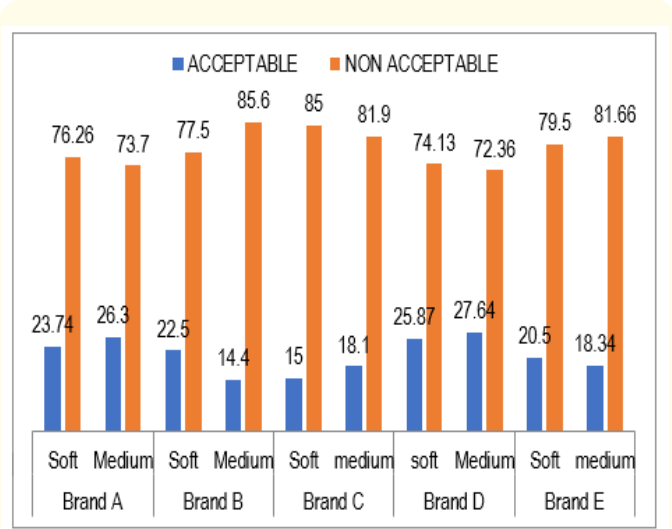
**Material and Methods**

This study was conducted in the Department of Periodontology and Department of Oral Pathology and Microbiology, the study was approved by institutional ethical committee, Indira Gandhi Institute of Dental Sciences, Puducherry. Five brands of tooth brushes were selected Ajanta (Bombay Marketing Company Mumbai), Colgate (Colgate-Palmolive Company United States), Cibaca (Colgate-Palmolive Company, Canada), Oral B (Procter & Gamble Company United States) and Pepsodent (Hindustan Unilever Company, India) based on sales demand in supermarkets of Puducherry. It was ensured that all the toothbrushes had same batch number and date of manufacture. In each brand brush with soft and medium bristles were selected. Five brushes in each brand were taken as sample. A single tuft was selected from the centre of the brush head and was removed using surgical scissors under magnifying loupes. The cut portion of the bristle was marked using a indelible marker to eliminate the error of visualising the wrong end. The bristles were arranged parallel in a microscopic glass slide. Using mounting solution distyrene plasticizer and xylene DPX the cover slip was secured over the bristles. After 5 minutes the slides were mounted in the light microscope and visualised at 45x resolution. Based on visual observation bristle end morphology was categorized as acceptable or non-acceptable based on Silverstone and Featherstone classification. 11 He classified the bristle ends based on morphology, that if bristles with round tips without any sharp point has been categorised into acceptable bristle end morphology and bristle ends with sharp tips, jagged and ununiformed margins are categorised into non-acceptable bristle end morphology.

**Results**

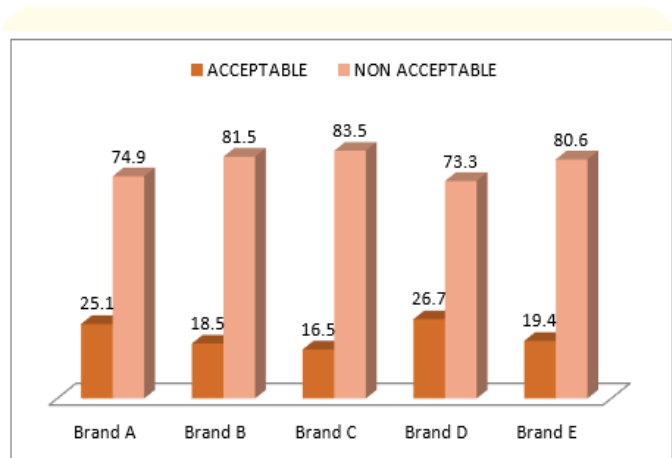
Total number of rows and columns in each brush was calculated. All the brushes had 10 rows and 4 columns. The number of bristles in each tuft was also counted and tabulated which ranged from 32 - 36. The total number of bristles in AJANTA, COLGATE and CIBACA was 1280 and in ORAL B was 1360 and in PEPSODENT was 1440.

Mean acceptable and non-acceptable percentage for all the brands were calculated. The acceptable percentage for bristles of AJANTA soft was 23.74% medium was 26.3%, COLGATE soft was 22.5% medium 14.4%, CIBACA soft was 15% medium was 18.1%, ORAL B soft was 25.8% medium was 27.64%, PEPSODENT soft was 20.5% medium was 18.34%. The non-acceptable percentage for bristles of AJANTA soft was 76.26% medium was 73.7%, COLGATE soft was 77.5% medium was 85.6%, CIBACA soft was 85% medium was 81.9%, ORAL B soft was 74.13% medium was 72.36%, PEPSODENT soft was 79.5% medium was 81.66%. The results are summarized in [Table 1, Graph 1].



**Graph 1:** Consistency Based Percentage Acceptability of Bristles.  
 Brand A Ajantha  
 Brand B Colgate  
 Brand C Cibaca  
 Brand D Oral B  
 Brand E Pepsodent

**The mean acceptable and non-acceptable for each brand regardless of bristle type are as follows:** in AJANTA 25.1% bristles were acceptable 74.9% was not acceptable, in COLGATE 18.5% bristles were acceptable, 81.5% was not acceptable, in CIBACA 16.5% bristles were acceptable 83.5% was not acceptable, in ORAL B 26.7% bristles were acceptable 73.3% was not acceptable, in PEPSODENT 19.4% bristles were acceptable 80.6% was not acceptable. Results are summarized in [Table 2, Graph 2].



**Graph 2:** Acceptable Percentage of All Brands.  
 BRAND A AJANTHA  
 BRAND B COLGATE  
 BRAND C CIBACA  
 BRAND D ORAL B  
 BRAND E PEPSODENT

Brand	Consistency	Total bristles	Bristles/tuft	Acceptable %	Non-acceptable %
AJANTHA	Soft	1280	32	23.74	76.26
	Medium	1280	32	26.3	73.7
COLGATE	Soft	1280	32	22.5	77.5
	Medium	1280	32	14.4	85.6
CIBACA	Soft	1280	32	15	85
	medium	1280	32	18.1	81.9
ORAL B	Soft	1360	34	25.87	74.13
	Medium	1360	34	27.64	72.36
PEPSODENT	Soft	1440	36	20.5	79.5
	medium	1440	36	18.34	81.66

**Table 1:** Mean Percentage Bristle End - Acceptable and Non-Acceptable.

Brands	Mean acceptable Bristle %	Mean non-acceptable Bristle %
Ajanta	25.1	74.9
Colgate	18.5	81.5
Cibaca	16.5	83.5
Oral B	26.7	73.3
Pepsodent	19.4	80.6

**Table 2:** Overall Percentage of all Brands.

## Discussion

Dental Plaque is defined as clinically structured, resilient, yellow greyish substance that adhere tenaciously to the intra oral hard surfaces including removable and fixed restoration which gives rise to dental caries, periodontal problems such as gingivitis and chronic periodontitis [2,9]. Loe, et al. through his experimental gingivitis study demonstrated the relationship between plaque accumulation and the development of gingivitis in humans and concluded that dental plaque is the major etiology for gingival inflammation and periodontal diseases [1]. Bacterial products from dental plaque can enter circulation and can exert an adverse effect elsewhere in the body [12]. Maintenance of oral health without plaque, aids in proper systemic function [13].

Meticulous plaque control measures will reduce gingival inflammation which will alter the quality of subgingival plaque [14]. Tooth brush plays a vital role in mechanical plaque control by eliminating dental plaque from the teeth surface [15]. Though it is said that, the efficacy of plaque removal depends on the technique of brushing and the type of the tooth brush [16]. Studies have also shown no differences in efficacy of plaque removal among differences in brushes with different bristles [17].

But the type of bristle and the bristle morphology play a major role in determining extent of injury caused to the tooth like abrasions in gingiva, gingival ulcers and recession due to brushing [16]. However, all the designs are safe as long as nylon is used and the

bristle ends are round enough. Generally, tooth brush with round end bristles decrease the incidence of tissue trauma [14].

American Dental Association claims that bristle filaments will be acceptable if it is round ended and did not show any sharp and jagged edges [5]. Silverstone, *et al.* also categorised tooth brushes into two types based on the bristle end morphology as, acceptable and non-acceptable [16].

Though various techniques like Light Microscope [8], Scanning electron Microscope [9] and Stereomicroscope [10] for analysing bristle end morphology are available, we chose light microscopy since it was less technique sensitive. Moreover, scanning electron microscopy required utilization of metallisation process with gold palladium coating which can cause morphological changes to the bristles [19]. Since it did not cause any alterations to bristle end morphology, light microscopy to visualise the toothbrush bristle end changes was found to be a more reliable method [8,20].

In the current study five most sold tooth brushes brands were selected. Five Brands Of toothbrush were selected and in each brand five soft and five medium toothbrushes (total of fifty samples). Toothbrush is freshly opened before examination; care should be taken to prevent any distortion to the bristles. Bristles from centre row was randomly selected, carefully cut and arranged in glass slide using mounting solution (distyrene plasticizer and xylene DPX). The glass slide was mounted on the microscope and

bristle morphology was carefully assessed. By visual observation, the bristles were categorized as acceptable or non-acceptable and the observed values were converted in percentage.

All varieties of toothbrush showed equal number of rows, columns and bristles per tuft ranging from 32 to 36. In AJANTA 23.74% of soft bristles and 26.3% of medium bristles showed acceptable morphology. In COLGATE 22.5% of soft bristles and 14.4% of medium bristles showed acceptable morphology. In CIBACA 15% of soft bristles and 18.1% of medium bristles showed acceptable morphology. In ORAL B 25.8% of soft bristles and 27% of medium bristles showed acceptable morphology and In PEPSODENT 20.5% of soft bristles and 18.34% of medium bristles showed acceptable morphology.

On comparing soft brushes of all the brands, ORAL B had the highest acceptable percentage (25.8%) and CIBACA had the lowest (15 %). In the medium brushes category ORAL B with 27.64% showed higher acceptable percentage while COLGATE with 14.4% showed minimum results. However, when all brands including both soft and medium brushes category were compared ORAL B was most acceptable. Study by Silverstone., *et al.* also revealed similar results. He showed that Oral B Plus/Ultra had 88% of bristle acceptability and concluded that Oral B was the least damaging of all tooth brush available.

In the present study, on comparing all the three brands irrespective of the category, the acceptable percentage ranged between 14.4% to 27.5%. Nandha Balan [8] conducted a similar study using three different brands and found the range of acceptable percentage to be 87% - 93.3% which was much higher than present study.

For a tooth brush to be least damaging to oral tissues, acceptable bristle end morphology should be higher than non-acceptable. But in the present study Non-acceptable bristle end morphology (73.3% - 83.5% with a mean of 78.7%) was greater than acceptable (16.5% - 26.7% with a mean of 21.3%). These results show that manufacturing protocol for bristles has to be improved in order to manufacture tooth brushes with acceptable bristle end morphologies.

However, the bristles of the toothbrush alone are not a factor that results in gingival recession or hard tissue abrasions. Other factors could be tensile strength of the bristles and the bristle length [21]. Moreover, individuals brushing habit like the force of brushing, type of brushing technique used also plays a key role. Hence further longitudinal studies are required to evaluate the hard and soft tissue abrasion for longer periods of time by usage of manual toothbrushes to prove the results of the present study.

## Conclusions

In the present study, the toothbrushes available in commercial market had only minimum acceptable bristle end morphology and did not satisfy ADA specification and hence suggest more strict manufacturing protocols to be followed. Still, study with larger sample sizes are required to support the current evidence.

## Clinical Relevance

This study analysed bristle end morphology of Five Most Sold Toothbrushes in Puducherry, India. The findings of this study showed that Brand D (Oral B) was the most acceptable according to ADA standards.

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