

# **Efficacy of interdental brushes for cleaning fixed orthodontic appliances: An *in vitro* study**

Li Mei<sup>1</sup>, Abigil Lai<sup>1</sup>, Yunam Lo<sup>1</sup>, Aishah Na<sup>1</sup>, Lei Cheng<sup>2</sup>, Xianglong Han<sup>2</sup>, Guangzhao Guan<sup>3</sup>

1. Department of Oral Sciences, Faculty of Dentistry, University of Otago, Dunedin, New Zealand.
2. State Key Laboratory of Oral Diseases & National Centre for Stomatology & National Clinical Research Centre for Oral Diseases, West China Hospital of Stomatology, Sichuan University, Chengdu, Sichuan, China.
3. Department of Oral Diagnostic and Surgical Sciences, Faculty of Dentistry, University of Otago, Dunedin, New Zealand.

## **Corresponding author: Li Mei**

Department of Oral Sciences  
Faculty of Dentistry  
University of Otago  
Email: [li.mei@otago.ac.nz](mailto:li.mei@otago.ac.nz)

## **Corresponding author: Guangzhao Guan**

Department of Oral Diagnostic and Surgical Sciences  
Faculty of Dentistry  
University of Otago  
Email: [simon.guan@otago.ac.nz](mailto:simon.guan@otago.ac.nz)

## ABSTRACT

**Aim:** To investigate the cleaning efficacy of interdental brushes of different sizes on fixed orthodontic appliances using an *in vitro* typodont model. **Methods:** A typodont model fitted with bonded metal brackets and a stainless-steel arch wire was used and divided into six segments. Artificial plaque was applied to each segment to simulate dental plaque accumulation. Various sizes of interdental brushes (TePe, Sweden) were used to clean the plaques. Plaque removal was assessed using the modified Silness and Loe Plaque Index. The time required to achieve complete plaque removal was recorded for each brush size. **Results:** Overall, the green (0.8mm passage-hole diameter (PHD)) and purple (1.10mm) TePe interdental brushes showed the greatest efficacy for cleaning interdental sites, with mean values of  $42.02 \pm 4.48$  seconds and  $43.16 \pm 8.99$  seconds, respectively, significantly outperforming other interdental brush sizes ( $P < 0.05$  for all). No statistically significant difference was observed between the green and purple interdental brushes. When the oral cavity was divided into six segments, both interdental brushes maintained significantly greater efficacy compared to other sizes ( $p < 0.05$ ). **Conclusion:** In this *in vitro* study, the green (0.8mm) and purple (1.10mm) TePe interdental brushes demonstrated the highest overall cleaning effectiveness across all oral segments. These findings suggest that specific sizes and designs of interdental brushes can significantly influence plaque removal efficiency, indicating the importance of selecting appropriately sized interdental brushes for optimal oral hygiene during fixed orthodontic treatment. Further clinical studies are recommended to validate these results in real-world settings.

**Keywords:** biofilm; braces; dental plaque; enamel demineralization; fixed orthodontic appliances; oral hygiene

**CDHA Research Agenda category:** risk assessment and management

## INTRODUCTION

Fixed orthodontic appliances interfere with conventional oral hygiene practices, not only promoting plaque accumulation but also increasing the cariogenic risk of dental biofilms [1]. The orthodontic brackets and wires create additional sites for plaque retention, complicating hygiene efforts despite having specialised cleaning aids [2, 3]. A common consequence of plaque accumulation in these patients is the development of white spot lesions, affecting 45.8%-68.4% of those patients [4]. White spot lesions are an indicator of enamel demineralisation, which can progress to caries if not addressed [5, 6].

Patients wearing fixed orthodontic appliances show increased levels of *Streptococcus mutans* and *Lactobacilli*, bacteria associated with the formation of white spot lesions and dental caries(7). There is also a higher prevalence of *Porphyromonas gingivalis*, *Prevotella intermedia*, *Tannerella forsythia*, and *Fusobacterium species*, which affect periodontal health [7]. Multiple studies indicated that fixed orthodontic treatment increases the risk of gingivitis, especially in the first few months of the treatment.

Previous research indicates that chemical interventions, such as fluoride-releasing materials and fluoride rinses, are insufficient in effectively preventing the formation of white spot lesions during the prolonged treatment [8]. This highlights the importance of using mechanical cleaning aids to enhance oral hygiene in the orthodontic patients, such as toothbrushing and interdental cleaning aids [2]. Research has demonstrated that routine toothbrushing alone is inadequate for effectively removing plaque around orthodontic brackets and beneath archwires, particularly in reducing gingival inflammation as reflected by the gingival index [2, 9]. This shifts our focus towards interdental cleaning aids, such as interdental brushes.

Interdental brushes have proven more effective than toothbrushing alone for plaque removal in patients with fixed orthodontic appliances [10]. Various brands of interdental brushes are available, including TePe, Curaprox, Colgate, Dental Pro, Tandex, Icon, Piksters, and Procure, with diameters ranging from 0.2 to 1.5 mm [11]. There is a gap in the literature regarding the appropriate sizes of interdental brushes for patients with fixed multibracket orthodontic appliances. Variations in inter-bracket space sizes among individuals complicates the execution of clinical trials regarding the true random assignment of interdental brushes [9]. There lacks an established guideline for selecting appropriately sized interdental brushes for these patient population. Furthermore, inconsistencies in specifications of interdental brushes may lead to improper use, non-usage, and overuse, which can traumatise gingival tissues [12].

The aim of this study was to investigate the cleaning efficacy of interdental brushes of different sizes on fixed orthodontic appliances using an *in vitro* typodont model. The findings may help inform recommendations for selecting appropriate interdental brush sizes for patients with fixed orthodontic appliances.

## **METHODS**

### **Typodont preparation**

The Sore-Spotter for Dentures (Holmes Dental) was used as a plaque simulant based on the literature [13]. A typodont bonded with metal brackets (3M Victory Series, Low Profile MBT) served as the *in vitro* model for the study [14, 15]. Eight sizes of TePe interdental brushes (Original series, TePe, Sweden) were used: pink, orange, red, blue, yellow, green, violet, and grey (Figure 1). The black size was excluded due to incompatibility with the orthodontic brackets, as it was too large to fit.

### **Plaque simulant application**

A standardised amount of Sore-Spotter was applied to each segment using a fine applicator tip to ensure even coverage of the inter-bracket and interdental areas. Care was taken to distribute the material uniformly across all designated surfaces. The applied plaque simulant was allowed to set for a consistent period (e.g., 60 seconds) prior to cleaning to achieve a stable and comparable coating. Visual inspection was performed to confirm uniformity of application before each trial.

### **Measurement of the sizes of interdental brushes and inter-bracket spaces**

Each interdental brush size (passage-hole diameter, PHD) and its corresponding brush diameter (BD) were measured (Table 1). The BD was measured between the filaments on both sides. This measurement allows for comparisons across different interdental brushes' brands when PHD data are unavailable.

The Inter-bracket space in the models was represented by the shape of a triangle (Figure 2). By measuring the three sides of each triangle, the diameter of the inscribed circle (D) within the triangle was calculated. As the inscribed circle represents the largest circle that can fit within a triangle, it was considered a suitable approximation for determining the optimal cross-sectional size of an interdental brush. The average diameter of the inscribed circles within each segment was taken to represent that segment.

### **Measurement of plaque removal efficacy (time taken for cleaning)**

A modified split-mouth design was used in our study by dividing the typodont into 6 segments (Figure 1). Each segment was cleaned with various sizes of TePe interdental brushes. Cleaning was performed by positioning the interdental brush parallel to the tooth surface and moving it in

an occlusal–gingival direction with consistent pressure. All procedures were carried out by a single trained operator who was calibrated prior to the experiment to ensure consistency in brushing technique and pressure application. The same operator performed all cleaning procedures and controlled the digital timer to standardise the start and end points of measurement. The endpoint of “complete cleaning” was defined as the removal of all visible plaque simulant from the tested segment, corresponding to a reduction in the modified Silness and Loe plaque index score from 6 to 0 [2, 16]. This assessment was performed visually by the operator under consistent lighting conditions. No additional magnification or disclosing agents were used after each timed attempt. The time (in seconds) required to achieve complete cleaning for each segment was recorded using a digital timer. Each measurement was repeated ten times to ensure reliability and minimise random error, and the mean cleaning time for each interdental brush size was calculated.

### **Statistical analysis**

Data were analysed and drawn through OriginPro 2025 SR1 10.2.0.196 (Academic) for Windows. Continuous variables were expressed as the mean  $\pm$  standard deviation (SD) if normally distributed, or as the median and interquartile range (IQR) if they had a skewed distribution. A one-way multivariate analysis of variance (MANOVA) was conducted to evaluate the effect of interdental brush size on plaque removal time across the six segments of the typodont model. Post hoc pairwise comparisons were conducted using Tukey’s honestly significant difference (HSD) test to identify differences between interdental brush sizes. Assumptions for MANOVA were assessed prior to analysis. Normality of the data distribution was evaluated using (Shapiro–Wilk test). A P-value of less than 0.05 was considered to be statistical significance.

## RESULTS

Overall, the green (0.8mm) and purple (1.10mm) TePe interdental brushes were most efficacious for cleaning interdental sites *in vitro*, with mean time of  $42.02 \pm 4.48$  seconds and  $43.16 \pm 8.99$  seconds, respectively, significantly outperforming the other brush sizes ( $P = 0.01$ ). However, the difference between the green and purple interdental brushes was not statistically significant (Figure 3).

When the oral cavity was divided into six segments, upper right (UR), upper anterior (UA), upper left (UL), lower right (LR), lower anterior (LA), and lower left (LL), both the green and purple interdental brushes demonstrated statistically significant efficacy compared to the other sizes ( $p < 0.05$ ) (Figure 4) (Supplementary Table 1).

Among the evaluated parameters, including interdental brush size (BD), passage PHD, inter-bracket space (L), and inscribed circle diameter (D), the inter-bracket space (L) seemed to be the most convenient, practical, and balanced criterion for selecting the appropriate interdental brush size for each segment (Figure 2, Figure 4, and Table 2). In most regions, the recommended interdental brush size closely matched the inter-bracket space (L), with the exception of the lower anterior region, where the space was approximately half the size of the selected interdental brush size, reflecting its narrower anatomic structure (Figure 2 and Table 2).

## DISCUSSION

It is a challenge to clean orthodontic fixed appliances. The current study compared different sizes of interdental brushes for cleaning plaque *in vitro*, and suggested that the green (0.8mm) and purple (1.1) TePe interdental brushes showed the highest cleaning efficacy the interdental sites. Further clinical studies are required to validate these results in real-world settings.

Routine toothbrushing remains the most common and widely accepted method for maintaining oral hygiene among patients with fixed orthodontic appliances [17]. However, research indicates that the cleaning efficacy of manual toothbrushes ranges between only 74% and 89% [18]. Various toothbrush designs have emerged to enhance oral hygiene for these individuals. One such design is the single-tufted toothbrush, which is specifically engineered to remove plaque in areas that are difficult for conventional toothbrushes to access [19, 20]. Research suggests that combining a single-tufted toothbrush with a conventional brush can significantly reduce plaque in orthodontic patients [21]. Despite its potential benefits, it is not commonly utilised in orthodontics due to unclear evidence of its clinical superiority. Another design is the orthodontic toothbrush, which features a V-shaped groove along the head. This design incorporates shorter, firmer nylon bristles within the groove to effectively remove debris from mid-bracket areas, while longer, softer bristles are used around the bracket wings [22]. Yet, studies show mixed results regarding its efficacy, for example, one study found no significant difference in plaque removal compared to conventional brushes [23], whereas another study reported that it was less effective than traditional flat-trimmed toothbrushes and orthodontic toothbrushes in conjunction with the Modified Bass technique may be more effective for reducing plaque accumulation in patients with fixed appliances [22].

Tooth brushing technique is also important for effective plaque removal. The Modified Bass technique has demonstrated greater efficacy in plaque removal compared to the Stillman Technique [23]. A systematic review reported that there was insufficient evidence to support the effectiveness of any particular toothbrushing method for orthodontic patients [24]. A recent clinical study evaluated an orthodontic toothbrushing technique specifically designed for patients with fixed appliances and found it to be more effective than the Modified Bass technique [25].

This orthodontic technique incorporated horizontal strokes combined with a ‘bite and wiggle’ motion behind arch wires, allowing the bristles to effectively reach the areas behind the arch wire and brackets. The findings demonstrated that this orthodontic technique resulted in superior plaque control compared to the Modified Bass technique; however, no significant improvements were observed in gingival health.

Electric toothbrushes are generally considered to be more efficient in cleaning plaque and reducing gingival inflammation than manual toothbrushes [21]. Additionally, electric toothbrushes can enhance patient’s motivation to upkeep their oral hygiene should they already have a positive perception of its ease of use and efficacy. This motivation is crucial for orthodontic treatment which typically spans over 2 years, and adherence to oral hygiene practices is essential to prevent complications associated with plaque buildup during this extended period [26].

Compliance regarding routine usage of dental floss among adults is low, varying between 10-30% [27]. This compliance rate can be attributed to the technical difficulty of flossing, which is exacerbated by tight contact points between teeth. This renders it an effective method for interdental cleaning in patients with fixed multibracket orthodontic appliances [28]. Consequently, unsupervised flossing often fails to produce a substantial reduction in gingival inflammation. A Cochrane review conducted in 2019 highlighted “weak and unreliable evidence” supporting the use of flossing as an adjunct to brushing for plaque reduction; however, it did indicate a notable benefit in reducing gingivitis [29].

The oral irrigation device, commonly referred to as a water flosser, has garnered considerable attention due to its user-friendly design and is regarded as a safe and effective method for inter-dental cleaning. Numerous studies have shown the effectiveness of oral irrigation devices in reducing gingival inflammation; however, strong evidence supporting their ability to remove

plaque remains insufficient [30]. For patients undergoing fixed orthodontic treatment, current research suggests that water flossing does not offer significant advantages over traditional dental flossing [31, 32], nor when used in conjunction with manual tooth brushing [33]. A comparative study examined different shapes of interdental brushes, specifically cylindrical-shaped versus waist-shaped brushes. The findings indicated that the waist-shaped interdental brush resulted in significantly greater plaque reduction, particularly around brackets [34]. Although the TePe interdental brushes selected for this study are cylindrical in shape, Erbe, Zanders-Grote [34] also noted that interdental brushes, in general, are a superior choice of maintaining optimal oral hygiene during orthodontic treatment due to its safety profile and effectiveness.

This study has several limitations. First, the experiments were conducted using an *in vitro* simulation model, which may not fully capture the complexity and variability present in human subjects. In particular, the absence of dynamic intraoral factors such as saliva, soft tissues, and patient-related behaviours (e.g., dexterity and compliance) limits direct clinical extrapolation. Second, the study employed a single-operator design without blinding, and inter-examiner reliability was not assessed. This may introduce operator-related bias and limit the reproducibility of the findings. Although efforts were made to standardise the procedure, the potential influence of operator technique cannot be excluded. Third, the artificial plaque simulant used in this study may not fully replicate the viscoelastic properties, structural complexity, or adhesion characteristics of mature orthodontic biofilm, which could affect the generalisability of the cleaning efficacy outcomes. Fourth, the split-mouth design introduced a potential carry-across effect that could have influenced the outcomes [35]. Additionally, measurements for the maxillary and mandibular arches were derived by aggregating findings from individual segments, which may not accurately reflect the actual cleaning times required in a continuous clinical setting. Potential

sources of bias, including experimenter fatigue and human error, could have led to either overestimation or underestimation of cleaning times due to unintended interactions between sites. Furthermore, the findings are specific to the interdental brushes tested (TePe, Sweden; cylindrical design) and the orthodontic system used (metal brackets and archwire configuration consistent with the Victory Series, 3M). Therefore, caution should be exercised when generalising these results to other brush designs, brands, or orthodontic systems. Finally, although the study identified the most effective interdental brush sizes for plaque removal under controlled conditions, it did not evaluate other clinically relevant factors influencing real-world effectiveness and patient adherence. These include patient comfort and preference, ease of use, comparison with alternative interdental cleaning aids, cost-effectiveness, and long-term compliance. Future *in vivo* studies are required to investigate these variables and to validate the present findings in clinical settings.

## **CONCLUSION**

In this *in vitro* study, the green (0.8 mm) and purple (1.1 mm) TePe interdental brushes demonstrated the highest overall cleaning efficacy across all evaluated oral segments. These results highlight the critical role of brush size and design in optimizing plaque removal, emphasizing the importance of selecting appropriately sized interdental brushes to enhance oral hygiene during fixed orthodontic treatment. Further clinical research is required to validate these findings *in vivo* and to assess their applicability in routine patient care.

## **CLINICAL RELEVANCE**

Scientific Rationale: Effective plaque removal around fixed orthodontic appliances is critical for preventing dental diseases, yet optimal interdental brush sizes remain unclear.

Principal Findings: In this study, 0.8 mm (green) and 1.1 mm (purple) TePe interdental brushes demonstrated superior cleaning efficacy compared to other sizes across all oral segments, with no significant difference between the two.

Practical Implications: Selecting appropriately sized interdental brushes enhances plaque removal efficiency in orthodontic patients. Clinicians may consider recommending 0.8 mm or 1.1 mm brushes to improve oral hygiene, while future clinical trials are needed to confirm these findings in vivo.

#### **CONFLICTS OF INTEREST**

The authors have no conflicts of interest to declare.

## REFERENCES

1. Mei L, Chieng J, Wong C, Benic G, Farella M. Factors affecting dental biofilm in patients wearing fixed orthodontic appliances. *Progress in Orthodontics*. 2017;18(1).
2. Mei L, Kang A, Jin C, Farella M. An orthodontic tooth brushing technique to enhance oral hygiene in patients wearing fixed orthodontic appliances: A randomized controlled trial. *International Journal of Dental Hygiene*. 2023;21(3):634-40.
3. Peng Y, Wu R, Qu W, Wu W, Chen J, Fang J, et al. Effect of visual method vs plaque disclosure in enhancing oral hygiene in adolescents and young adults: A single-blind randomized controlled trial. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2014;145(3):280-6.
4. Ren Y, Jongsma MA, Mei L, van der Mei HC, Busscher HJ. Orthodontic treatment with fixed appliances and biofilm formation--a potential public health threat? *Clinical oral investigations*. 2014;18(7):1711-8.
5. Xie Z, Yu L, Li S, Li J, Liu Y. Comparison of therapies of white spot lesions: a systematic review and network meta-analysis. *BMC Oral Health*. 2023;23(1):346.
6. Travess H, Roberts-Harry D, Sandy J. Orthodontics. Part 6: Risks in orthodontic treatment. *British Dental Journal*. 2004;196(2):71-7.
7. Santonocito S, Polizzi A. Oral Microbiota Changes during Orthodontic Treatment. *Front Biosci (Elite Ed)*. 2022;14(3):19.
8. Bock NC, von Bremen J, Kraft M, Ruf S. Plaque control effectiveness and handling of interdental brushes during multibracket treatment—a randomized clinical trial. *European Journal of Orthodontics*. 2009;32(4):408-13.
9. Slot D, Dörfer C, Van der Weijden G. The efficacy of interdental brushes on plaque and parameters of periodontal inflammation: a systematic review. *International Journal of Dental Hygiene*. 2008;6(4):253-64.
10. Baumer C, Schmidtman I, Ohlendorf D, Ferrari Peron P, Wehrbein H, Erbe C. Orthodontists' instructions for oral hygiene in patients with removable and fixed orthodontic appliances. *International Journal of Dental Hygiene*. 2024;22(2):329-36.
11. Turner C. Interdental brushes and ISO standards. *Br Dent J*. 2022;232(11):761-2.
12. Sekundo C, Staehle HJ. Mapping the Product Range of Interdental Brushes: Sizes, Shapes, and Forces. *Oral Health Prev Dent*. 2020;18(2):343-54.
13. Jansiriwattana W, Teparat-Burana T. Laboratory Investigation Comparing Plaque Removal Efficacy of Two Novel-Design Toothbrushes with Different Brushing Techniques. *Dentistry Journal*. 2018;6(2):8.
14. Vogel M, Aßenmacher M, Gubler A, Attin T, Schmidlin PR. Cleaning potential of interdental brushes around orthodontic brackets - an in vitro investigation. *Swiss Dent J*. 2023;133(9):576-83.
15. Wolff D, Joerss D, Rau P, Dörfer CE. In vitro cleaning efficacy and resistance to insertion test of interdental brushes. *Clin Oral Investig*. 2006;10(4):297-304.
16. Al-Anezi SA, Harradine NW. Quantifying plaque during orthodontic treatment. *Angle Orthod*. 2012;82(4):748-53.
17. Khoroushi M, Kachuie M. Prevention and Treatment of White Spot Lesions in Orthodontic Patients. *Contemp Clin Dent*. 2017;8(1):11-9.
18. Schätzle M, Imfeld T, Sener B, Schmidlin PR. In vitro tooth cleaning efficacy of manual toothbrushes around brackets. *Eur J Orthod*. 2009;31(1):103-7.

19. Lee DW, Moon IS. The plaque-removing efficacy of a single-tufted brush on the lingual and buccal surfaces of the molars. *J Periodontal Implant Sci.* 2011;41(3):131-4.
20. Aeran H, Singh Tuli A, Bartwal J, Vishnoi L, Aeran V. Comparison of efficacy of conventional toothbrush and single tuft brush for the control of dental plaque. *International Journal of Oral Health Dentistry.* 2020;5(4):203-7.
21. Aryeetey EJ, Benyahia H, Zaoui F. Oral Hygiene in the Presence of Orthodontic Therapy. *Journal of Biosciences and Medicines.* 2024;12(02):98-110.
22. Hirani J, Geetha K, Sharma A, Chanu TB, Singh N, Sharma M. Comparison of two types of Toothbrushes along with Vertical Brushing Technique and Modified Bass Technique for Efficacy of Plaque Control in Orthodontic Patients - A Randomized Control Trail. *National Research Denticon;* 2022.
23. Nassar PO, Bombardelli CG, Walker CS, Neves KV, Tonet K, Nishi RN, et al. Periodontal evaluation of different toothbrushing techniques in patients with fixed orthodontic appliances. *Dental Press J Orthod.* 2013;18(1):76-80.
24. Rajwani AR, Hawes SND, To A, Quaranta A, Rincon Aguilar JC. Effectiveness of Manual Toothbrushing Techniques on Plaque and Gingivitis: A Systematic Review. *Oral Health Prev Dent.* 2020;18:843-54.
25. Mei L, Kang A, Jin C, Farella M. An orthodontic tooth brushing technique to enhance oral hygiene in patients wearing fixed orthodontic appliances: A randomized controlled trial. *Int J Dent Hyg.* 2023;21(3):634-40.
26. Heintze SD, Jost-Brinkmann PG, Loundos J. Effectiveness of three different types of electric toothbrushes compared with a manual technique in orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1996;110(6):630-8.
27. Guo J, Li L, Guan G, Bennani F, Mei L. Oral health knowledge and practice among orthodontic clients in china and new zealand. *Canadian Journal of Dental Hygiene.* 2020;54(3):124-32.
28. Ng E, Lim LP. An Overview of Different Interdental Cleaning Aids and Their Effectiveness. *Dent J (Basel).* 2019;7(2).
29. Worthington HV, MacDonald L, Poklepovic Pericic T, Sambunjak D, Johnson TM, Imai P, et al. Home use of interdental cleaning devices, in addition to toothbrushing, for preventing and controlling periodontal diseases and dental caries. *Cochrane Database Syst Rev.* 2019;4(4):CD012018.
30. Sarkisova F, Morse Z, Lee K, Bostanci N. Oral Irrigation Devices: A Scoping Review. *Clinical and Experimental Dental Research.* 2024;10(3):e912.
31. Sawan N, Ben Gassem A, Alkhayyal F, Albakri A, Al-Muhareb N, Alsagob E. Effectiveness of Super Floss and Water Flosser in Plaque Removal for Patients Undergoing Orthodontic Treatment: A Randomized Controlled Trial. *Int J Dent.* 2022;2022:1344258.
32. AlMoharib HS, Alqasem A, Almusfer G, Aldosari MA, Almadhoon HW. The effectiveness of water jet flossing and interdental flossing for oral hygiene in orthodontic patients with fixed appliances: a randomized clinical trial. *BMC Oral Health.* 2024;24(1):498.
33. Tyler D, Kang J, Goh HH. Effectiveness of Waterpik((R)) for oral hygiene maintenance in orthodontic fixed appliance patients: A randomised controlled trial. *J Orthod.* 2023;50(4):367-77.
34. Erbe C, Zanders-Grote L, Wagner Y, Schmidtman I, Lang NP, Wehrbein H. Randomized multicenter study on the plaque removal efficacy of 2 interdental brushes around

the base of orthodontic brackets. American Journal of Orthodontics and Dentofacial Orthopedics. 2023;164(4):466-75.

35. Lesaffre E, Philstrom B, Needleman I, Worthington H. The design and analysis of split-mouth studies: what statisticians and clinicians should know. Stat Med. 2009;28(28):3470-82.

CJDH In Press

**Table 1.** The corresponding passage-hole diameter (PHD) and brush diameter (BD) of each size of TePe interdental brush

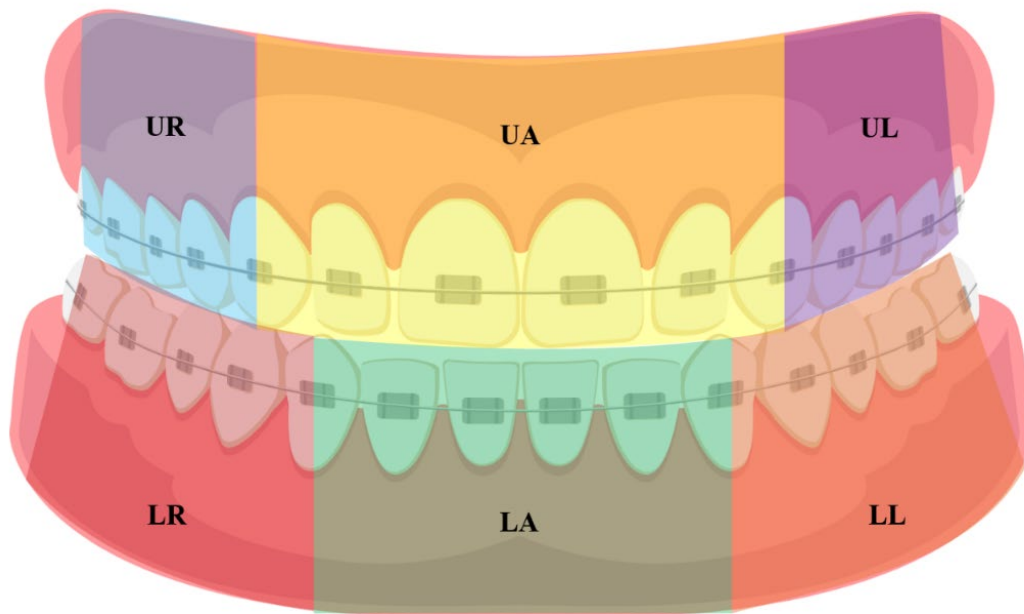
| Interdental brush                                                                                 | Passage hole diameter (mm) | Brush diameter (mm) |
|---------------------------------------------------------------------------------------------------|----------------------------|---------------------|
|  <b>Pink</b>     | 0.40                       | $1.90 \pm 0.20$     |
|  <b>Orange</b>   | 0.45                       | $2.00 \pm 0.20$     |
|  <b>Red</b>      | 0.50                       | $2.30 \pm 0.30$     |
|  <b>Blue</b>    | 0.60                       | $2.90 \pm 0.20$     |
|  <b>Yellow</b> | 0.70                       | $3.50 \pm 0.20$     |
|  <b>Green</b>  | 0.80                       | $5.30 \pm 0.20$     |
|  <b>Purple</b> | 1.10                       | $5.70 \pm 0.20$     |
|  <b>Grey</b>   | 1.30                       | $8.80 \pm 0.20$     |

**Table 2.** Inscribed circle diameter (D), inter-bracket space (L), and the ratios relevant to interdental brush size (BD)

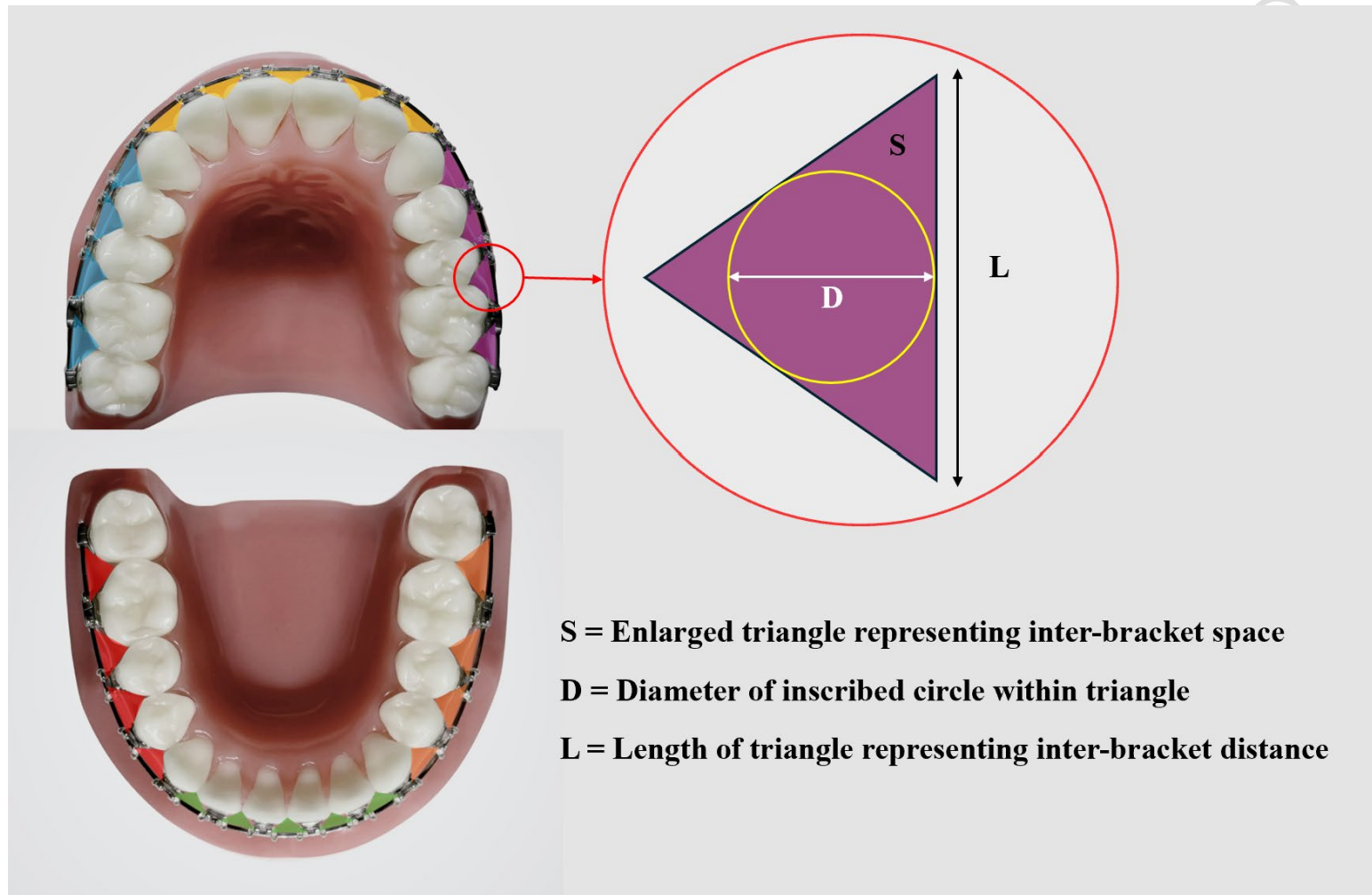
| Segment | Diameter of inscribed circle (mm, D) | Length of inter-bracket space (mm, L) | D:PHD* | D:BD  | L:PHD | L:BD |
|---------|--------------------------------------|---------------------------------------|--------|-------|-------|------|
| UR/UL   | 2.39 ± 0.75                          | 5.38 ± 1.03                           | 1:0.5  | 1:2.4 | 1:0.2 | 1:1  |
| UA      | 1.96 ± 0.17                          | 5.10 ± 0.22                           | 1:0.4  | 1:2.7 | 1:0.2 | 1:1  |
| LA      | 1.50 ± 0.09                          | 2.70 ± 0.27                           | 1:0.5  | 1:3.5 | 1:0.3 | 1:2  |
| LR/LL   | 2.58 ± 0.79                          | 5.75 ± 2.02                           | 1:0.4  | 1:2.2 | 1:0.2 | 1:1  |

\*D: the diameter of the inscribed circle; PHD: passage hole diameter; BD: brush diameter

**Figure 1.** Diagram of the dentition divided into six segments. UR (upper right): from mesial surface of 17 to distal surface of 13. UA (upper anterior): from mesial surface of 13 to mesial surface to 23. UL (upper left): from distal surface of 23 to mesial surface of 27. LL (lower left): from mesial surface of 37 to distal surface of 33. LA (lower anterior) from mesial surface of 33 to mesial surface of 43. LR (lower right): from distal surface of 43 to mesial surface of 47.



**Figure 2.** Triangles illustrated on the models representing the inter-bracket space spaces between teeth.



**Figure 3.** The green (0.8 mm PHD) and purple (1.10mm PHD) interdental brushes demonstrated the highest efficacy in removing artificial plaque *in vitro*.

