Effectiveness of different interdental brushes on cleaning the interproximal surfaces of teeth and implants: a randomized controlled, double-blind cross-over study

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Abstract

Objectives: To compare the interproximal cleansing efficacy of the novel, waist-shaped Circum® brush (Topcaredent®, Switzerland; CB) with that of a straight soft interdental brush (IB) (TePe®, Sweden; SB) on posterior surfaces.

Material & methods: Eight patients after completion of initial periodontal therapy abolished oral hygiene for 3 days. Baseline plaque scores (PlI, Silness & Löe 1964) were assessed on eight surfaces of all premolars and molars. Subsequently, an instructed nurse applied at random one of the two IB, three times per interdental space. Following this, registration of the PlI was repeated by the same blinded examiner. After a 2-week recovery, patients abolished oral hygiene practices for another 3 days. Again, pre-and post-brushing PlI were recorded by the same examiner. The second IB was now applied.

Results: Patient mean PlI and site PlI were evaluated before and after application of the SB or CB respectively. Paired t-tests were performed to yield statistically significant differences. The reduction of biofilm from before to after the use of the IB on a subject basis was highly significant (P < 0.0001). The mean PlI after the use of the CB was significantly lower than after the use of the SB (P < 0.0001). Comparing the PlI of the line angles (MB, ML, DB, DL), significantly more biofilm had been removed by applying CB compared with SB (P < 0.0001). Moreover, comparing the PlI of the buccal (MB, DB) or the lingual line angles (DL, ML) yielded a significantly higher reduction of biofilm in favour of the CB (P < 0.0001). The reduction of the PlI in the mid-interproximal portion, both mesially and distally did not differ significantly between CB and ST. No biofilm reduction was seen on the buccal sites with either IB.

Conclusion: The application of the waist-shaped Circum® IB resulted in significantly lower PlI scores than the use of a straight IB. This was predominantly due to the higher cleansing effect of the waist-shaped CB on the buccal and lingual line angles.

Interproximal areas of the dentition are the most difficult areas to clean and to keep clean (Lang et al. 1977; Galgut 1996). Implant sites are even more difficult for cleansing. Toothbrush bristles alone will not penetrate and clean interproximal spaces (Lang et al. 1973; Caton et al. 1993). As a consequence, periodontal disease most commonly develops in interproximal areas (Lövdal et al. 1958; Löe et al. 1965).

The removal of both supra and sub-gingival plaque is important in reducing the onset and severity of gingival disease (Carter et al. 1975; Bergenholtz & Brithon 1980). Regular and complete biofilm removal therefore helps in reducing the severity of periodontal diseases [Ash et al. 1964; Löe et al. 1965; Lindhe & Koch 1967; Löe 1969; Suomi et al. 1971].

The primary cleansing devices for home care biofilm removal are manual toothbrushes [Bass 1954]. Nevertheless, these will not be sufficient to clean the dentition interproximally [Caton et al. 1993]. Today, many devices for cleansing interproximal spaces are available on the market. One of the problems encountered may lie within the patient’s compliance to use these devices for an adequate time necessary for interdental cleansing, usually requiring 4 min or more [Gjermo & Flötra 1970]. Studies have demonstrated...
的重大污垢差异后的牙缝清洁度。结果表明，与单独刷牙或使用该设备相比，菌斑去除效果更加显著。然而，患者的偏好是牙缝清洁剂。

目前，有关缝间清洁与牙缝间空间轴向和根面的牙缝清洁器使用的专利已经记录在案。Meta分析（Gjermo & Florå 1970）表明，在牙缝间空间较窄的情况下，牙缝清洁剂的清洁效果优于常规刷牙。

在过去几年中，研究显示，维护护理和标准的患者的口内护理是影响长期的牙缝刷的稳定性和预防生物并发症的关键因素（Bauman et al. 1991, Silverstein & Kurtzmian 2006, Serino & Ström 2009）。牙缝间菌斑的形成与临床的炎症反应有关。（Zitzmann et al. 2001）。因此，定期和彻底的忠于 removable plaque after usage was found in all three groups. However, both shapes of interdental brushes removed more plaque than did dental floss.

A waist-shaped interdental brush (Circum®) presents with larger diameter at the base and tip and hence, may result in more contact to the teeth or prostheses at the lingual and buccal line angles when passing through the interproximal area. Moreover, when retrieved, the bristles might drag out more biofilm at the tooth angles resulting in a better cleansing effect than that of regular interdental brushes.

Consequently, the purpose of this study was to assess the cleansing capacity of two interdental brushes in cleaning interproximal surfaces in the posterior region of the mouth both at tooth and implant sites: The waist-shaped Top Caredent Circum® brush and the straight Extra soft TePe® Interdental brush. The null hypothesis of this study was that of no difference in interproximal cleansing effect between the two interdental brushes at both implant and tooth sites.

**Material and methods**

The study protocol has been submitted to and was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW IRB) [IRB Ref. UW 10-407].

**Subjects**

Eight patients who had been treated in Centre of Advanced Dental Care in the Prince Philip Dental Hospital at the University of Hong Kong were recruited for the study on the basis of their availability. After having been informed about the study procedures, the patients signed consent forms. Patients were recruited from January 2011 to May 2011.

**Exclusion criteria**

Subjects with any of the following criteria at baseline would be excluded from the study:
- Presence of oral diseases other than periodontitis
- Drugs consumption that may cause gingival enlargement such as Phenytoin®, Cyclosporin etc.
- Presence of uncontrolled Diabetes mellitus
- Tabacco consumption: Heavy smokers (a pack/day or more)
- Presence of gingival tissue swelling or suppuration with impossibility to apply cleaning devices

**Study design**

A cross-over design was used for the present clinical experiment (Fig. 1). Each subject was asked to attend three appointments.

In the first visit, interdental spaces from the distal of the canines to the second molars were assessed, and the size of the interdental brushes to fit the interdental space was determined.

Prior to the application of the brushes, biofilm build-up was allowed for 3 days of abolished oral hygiene practices. The patient’s mouth was used as a model, and all the cleaning procedures were performed by the same trained dental surgery assistant. The interdental brush was guided through the interdental spaces of all molars and premolars three times. The respective sizes of the interdental brushes for the cleansing are indicated in Table 1.

Randomization was performed by the toss of a coin. In Group 1, every interproximal posterior space was cleaned three times applying the Top Caredent waist-shaped Circum® brush first (Fig. 2). Following this, the residual plaque deposits were assessed.
Subsequently, the patients were dismissed and asked to come back for a second performance after another abolishment of oral hygiene practices for 3 days.

In the second test, the patients applied the Extra soft TePe® Interdental brush (Fig. 3) three times in each posterior interdental space, following which the residual plaque deposits were again assessed.

Group 2 performed the same procedures as Group 1, except that the Extra soft TePe® Interdental brush was applied in the first, and the Top Caredent Circum® brushes in the second test period after 3 days of abolished oral hygiene practices.

Clinical parameters
The Plaque Index (Silness & Löe 1964) was assessed by one blinded and calibrated examiner (NPL) at eight areas of the teeth or implants separately (buccomesial, buccodistal, linguomesial, linguodistal, midbuccal, midlingual, mesial, and distal; Fig. 4). The reproducibility of the examiner was 92% (Lang et al. 2010).

Statistical analysis
Microsoft® Excel for Windows® 7 was used for data collection. Statistical analysis was calculated by The Statistical Package for the Social Science for Windows (SPSS v19.0; SPSS Inc, Chicago, IL, USA).

Mean PlI of before and after cleansing were compared using Student’s t-test for paired samples. Level of significance is set at $\alpha = 0.05$.

Mean PlI of between cleansing procedures were compared using Student’s t-test for paired samples. Level of significance is set at $\alpha = 0.05$.

Frequency analyses of individual PlI scores of 0,1 vs. 2,3 were compared using Mc Neamar test for 1. mesio-lingual and disto-lingual line angles, 2. mesio-buccal and disto-buccal line angles, 3. buccal, 4. lingual, 5. Distal, 6. Mesial, 7. mesio-lingual, disto-lingual, mesio-buccal and disto-buccal line angle scores.

Results
The subjects consisted of four men and four women (aged 26–65 years, average age: 46.75 years). Four patients used Circum® brushes size 3 and four patients used Circum® brushes size 5 for the study.
The dentition of the patients merely represents a model to test the efficacy of the IB in removing biofilm in the interproximal area. Both teeth and implants present were used. A total of 102 teeth and implants and 816 sites were assessed.

### Overall mean plaque score (Table 2)

The mean baseline plaque score applying the test device (Circum®) was PlI = 1.89 (SD: 0.03). After intervention, the mean plaque score applying the test device (Circum®) was PlI = 1.02 (SD: 0.21). Again, the difference was highly significant (P < 0.0001).

The mean baseline plaque score applying the control device (TePe®) was PlI = 1.88 (SD: 0.10). After intervention, the mean plaque score applying the control device (TePe®) was PlI = 1.02 (SD: 0.21). Again, the difference was highly significant (P < 0.0001).

### Mean plaque score at buccal sites (Table 2)

The mean baseline buccal plaque score applying the test device (Circum®) was PlI = 1.72 (SD: 0.48). After intervention, the mean buccal plaque score applying the test device (Circum®) was PlI = 1.33 (SD: 0.62). The difference was highly significant (P < 0.0001).

The mean baseline buccal plaque score applying the control device (TePe®) was PlI = 1.67 (SD: 0.53). After intervention, the mean buccal plaque score applying the control device (TePe®) was PlI = 1.42 (SD: 0.42). Again, the difference was highly significant (P < 0.0001).

After intervention, the mean buccal score was PlI = 1.55 (SD: 0.62) for the Circum® IB, and the mean buccal score was PlI = 1.42 (SD: 0.62) for the TePe® IB. This difference, however, was not statistically significant.

### Mean plaque score at lingual sites (Table 2)

The mean baseline lingual plaque score applying the test device (Circum®) was PlI = 1.55 (SD: 0.56). After intervention, the mean lingual plaque score applying the test device (Circum®) was PlI = 0.91 (SD: 0.51). The difference was highly significant (P < 0.0001).

The mean baseline lingual plaque score applying the control device (TePe®) was PlI = 1.55 (SD: 0.52). After intervention, the mean lingual plaque score applying the control device (TePe®) was PlI = 1.21 (SD: 0.53). Again, the difference was highly significant (P < 0.0001).

After intervention, the mean lingual score was PlI = 0.91 (SD: 0.51) for the Circum® IB, and the mean lingual score was PlI = 1.21 (SD: 0.53) of the TePe® IB. There was no statistically significant difference.

### Frequency analyses of sites with PlI = 0 & 1 vs. PlI = 2 & 3

At the line angles (total of 408 sites), the McNemar test revealed a significant improvement of the plaque score categories from before to after the interventions (P < 0.0001) for both test and control devices (Fig. 5).

### Discussion

This study has clearly demonstrated the superiority in cleansing effectiveness of the Circum® interdental brush (IB) over the straight control brush (TePe®) (SB). Eight subjects had been drawn to the study contributing with a total of 816 tooth and implant sites. The subjects merely represented a model for testing the efficacy of the IB brushes. To determine the size of the difference in removing biofilm between the two brushes, a reverse power analysis was performed (Cohen 1988). Following the equation \( \text{Power} = \frac{ES^2}{\Delta^2} \) when \( ES = \text{[the effect size or the mean difference]} \), \( n \) = the number of...
The cleansing effectiveness for both the CB and the SB resulted in significant mean biofilm reductions, when before and after application was compared at the subject and site levels in this study. This cleansing effect is in agreement with previous studies (Kiger et al. 1991; Jared et al. 2005, Jackson et al. 2006; Röising et al. 2006; Yost et al. 2006). However, when the two interdental brushes of the present study were compared after application, there was no significant difference at both mesial and distal sites, both yielding zero scores. This, in turn, means that both CB and SB are effective in purely interproximal cleansing.

However, there were highly significant differences in biofilm removal after the application of the CB compared with SB at the line angles, both buccally and lingually. Hence, the cleaning efficacy of the CB clearly surpasses that of the SB. It has to be kept in mind, however, that the efficacy of the brush itself, and not the capacity of the subject to clean interproximally, was evaluated in the present study. Obviously, better cleaning effects may be obtained with straight IB by well-instructed patients under the correct mind, however, that the efficacy of the brush itself, and not the capacity of the subject to clean interproximally, was evaluated in the present study. Obviously, better cleaning effects may be obtained with straight IB by well-instructed patients under the correct...
Both CB and SB used in the present study were of a super soft type. These characteristics may be addressed when elaborating on the cleansing efficacy of a brush. However, no influence of bristle stiffness on cleansing efficiency has been documented in an *in vitro* study comparing hard and soft bristle IBs (Wolf et al. 2006).

In conclusion, the application of the waist-shaped Circum® IB resulted in significantly lower PI1 scores than the use of a straight IB. This was predominantly due to the much higher cleansing effect of the waist-shaped Circum® brush on the buccal and lingual line angles.

**References**


