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Artikel Asli/*Original Article*

The Effectiveness of Two Manual Slim Bristles Toothbrushes Among Fixed Orthodontic Appliance Patients

(Keberkesanan di antara Dua Berus Gigi Manual Berbulu Halus di Kalangan Pesakit Aplians Ortodontik Tetap)

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ABSTRACT

This research aimed to evaluate the oral hygiene status in fixed orthodontic appliance patients when using two different slim bristles toothbrushes and to assess patients' toothbrush perception.Twenty six fixed orthodontic appliance patients participated in the six weeks prospective, crossover clinical trial. All patients used two different slim bristles toothbrushes (Toothbrush A and Toothbrush B) for two weeks each with a washout period in between. Gingival health and plaque value were assessed based on Löe & Silness Gingival Index and Silness & Löe Plaque Index at baseline, week 2, week 4 (washout) and week 6. At the end of the trial, patients' toothbrush perception was assessed through questionnaire. All data were analysed using SPSS version 22.The mean age of the patients was 21.5 ± 4.3 years, with female predominant (n = 17, 65.4%). More than half were Malay (n = 15, 57.7%) and had tertiary education (n = 14, 53.8%). Patients could achieve good oral hygiene when using Toothbrush A (65.4%) and Toothbrush B (69.2%). However, the occurrence of gingivitis was significantly higher when using Toothbrush A (OR = 1.889, 95% CI = 1.207-2.957, p value < 0.05). Toothbrush B was felt to clean better (n = 14, 53.8%) while Toothbrush A was perceived to be easier to use (n = 14, 53.8%). Both toothbrushes maintained patients' oral hygiene status. However, when using Toothbrush B, oral health status was better as it significantly reduced gingivitis occurrence compared to Toothbrush A. As for the toothbrush perception, most patients preferred Toothbrush A to be taken home.

Keywords: Slim bristles toothbrush; oral health; fixed orthodontic appliance; manual toothbrush; dental plaque

ABSTRAK

Kajian ini bertujuan untuk menilai status kebersihan mulut pesakit aplians ortodontik tetap apabila menggunakan dua berus gigi berbulu halus yang berbeza dan menilai persepsi penggunaan berus gigi tersebut. Dua puluh enam pesakit aplians ortodontik tetap mengambil bahagian dalam percubaan klinikal 'crossover' selama enam minggu. Semua pesakit menggunakan dua berus gigi berbulu halus yang berlainan (Berus Gigi A dan Berus Gigi B) selama dua minggu setiap satu dengan tempoh 'washout' di antaranya. Kesihatan mulut dinilai berdasarkan Indeks Gingiva Löe & Silness dan Indeks Plak Silness & Löe pada dasar, minggu ke-2, minggu ke-4 ('washout') dan minggu ke-6. Pada akhir percubaan klinikal, persepsi berus gigi dinilai melalui borang soal selidik . Semua data dianalisa menggunakan SPSS versi 22. Purata umur pesakit adalah 21.5 ± 4.3 tahun, dengan perempuan yang dominan (n = 17, 65.4%). Lebih separuh adalah Melayu (n = 15, 57.7%) dan berpendidikan tinggi (n = 14, 53.8%). Pesakit mencapai kebersihan mulut yang baik dengan Berus Gigi A (65.4%) dan Berus Gigi B (69.2%). Walau bagaimanapun, kejadian gingivitis lebih tinggi apabila menggunakan Berus Gigi A (OR = 1.889, 95% CI = 1.207-2.957, nilai p < 0.05). Berus Gigi B dianggap membersih dengan lebih baik (n = 14, 53.8%) manakala Berus Gigi A dirasakan lebih mudah digunakan (n = 14, 53.8%). Kedua-dua jenis berus gigi mengekalkan status kebersihan mulut pesakit. Walau bagaimanapun, apabila menggunakan Berus Gigi B, status kesihatan mulut adalah lebih baik kerana mengurangkan kejadian gingivitis dengan signifikasinya berbanding Berus Gigi A. Dari segi persepsi berus gigi, kebanyakan pesakit memilih Berus Gigi A.

Kata kunci: Berus gigi berbulu halus; kesihatan mulut; aplians ortodontik tetap; berus gigi manual; plak gigi

INTRODUCTION

Toothbrush is the most common tool to clean the teeth (Zachrisson 1974) as it is simple, user-friendly and affordable to most people (Löe 2000). Toothbrushing is relatively inexpensive compared to other dental procedures (Hedge et al. 2011).

In patients wearing fixed orthodontic appliance, good oral hygiene is more difficult to achieve than non-orthodontic patients. This is because the appliance on

the teeth surfaces makes mechanical brushing and self-cleansing by the tongue, buccal mucosa and saliva more difficult (Sudjalim et al. 2006). Besides toothbrush, other oral hygiene measures common for fixed orthodontic appliance patients were interdental brush, dental floss and fluoride mouthrinse.

The many designs of toothbrushes sold in the market often confused the consumers on choosing a toothbrush that suits their personal oral hygiene need. Therefore, dental professionals should have a high level knowledge on these products so that they can advise the patients appropriately (Hedge et al. 2011). For the toothbrush manufacturers, their challenge is to invent toothbrush that maximize plaque removal but with minimum brushing time and without too dependent on good brushing technique (Warren et al. 2007).

The desirable features of a toothbrush are a relatively small head for easy access, a wide and long handle for firm grip, soft bristles to minimize gingival damage and a multi-tufted head, trimmed flat for optimal cleaning (Park et al. 1985). This is supported by Löe (2000) that an acceptable toothbrush has characteristics of a handle size appropriate to user's age and dexterity, a head size appropriate to the size of the user's mouth, end rounded filaments not larger than 0.009 inches in diameter, soft bristles and bristle patterns which enhance plaque removal (Löe 2000).

As late as 1967, most people preferred hard toothbrushes as they felt cleaned better or the hard toothbrushes lasted longer (Fanning & Henning 1967). The shift in preference to soft toothbrushes was due to the change in oral health care when calculus was identified to cause periodontal disease (Mandel 1993). Stiffness of bristles depends on the filaments' material, diameter and length of the bristles. Toothbrush with thinner bristles are softer while thicker bristles are stiffer and less flexible (Versteeg et al. 2008). Harder bristles may remove more plaque, but can cause more soft tissue trauma than softer bristles (Sunny et al. 2017; Zanatta et al. 2011; Zimmer et al. 2011). Softer bristles may clean better at the crevicular area due to its flexibility to bend. Moreover, patients can brush without fear of discomfort as soft filaments are gentler to gingival tissues. To add more evidence on the cleaning effectiveness between the different bristles stiffness, further research need to be carried out.

Therefore, we aimed to evaluate the oral hygiene status in fixed orthodontic appliance patients when using two different slim bristles toothbrushes and to assess the patients' toothbrush perception.

METHODOLOGY

This prospective, crossover clinical trial comprised of 26 fixed orthodontic appliance patients that attended a postgraduate orthodontic clinic at a university dental setting in Kuala Lumpur. All patients were treated by the same clinician. Ethical approval to conduct this study was obtained from the Research Ethics Committee of the university.

Sample size was calculated using power and sample size calculator statistic online (Brant 2006). Using the finding from the study by William et al. (1987) with α value of 0.05 and effect power of 0.80, the sample size was calculated as 21 patients after considering an anticipated drop-out rate of 10%. Patients were selected using convenient sampling to participate voluntarily in the six weeks clinical trial. Written consent obtained from the patients and information sheet given to them prior to the trial.

The inclusion criteria were patients had been wearing fixed orthodontic appliance since at least three months, had at least 20 permanent teeth and were non-smokers. The exclusion criteria were patients who were pregnant, on antibiotic, anti-inflammatory or immunosuppressant therapy or on drugs (*i.e.*calcium channel blocker, cyclosporine, phenytoin) that will have implication on periodontal status, with history of periodontal disease and with medical conditions (*i.e.*diabetes, Down syndrome).

All patients were instructed to use the two manual slim bristles toothbrushes; Toothbrush A and Toothbrush B for two weeks each, with a washout period in between. The bristles diameter of Toothbrush A was 0.04 mm, while the bristles diameter of Toothbrush B was 0.02 mm. The side, front and top views of the toothbrushes were shown in (Figure 1, Figure 2 and Figure 3).

Patients were instructed to brush twice daily, which was after breakfast and before retiring at night using the allocated toothbrush, with two minutes brushing time. Patients were requested to refrain from using other cleaning tools and methods such as dental floss, mouth wash and interproximal brushes during the trial period. Patients were provided a fluoride toothpaste free from anti-plaque and anti-calculus agents. In order to prevent changes in the pattern of tooth brushing prior to this study, patients were not given additional oral hygiene instructions on tooth brushing method. During the baseline and washout periods, patients used their own habitual toothbrush, which

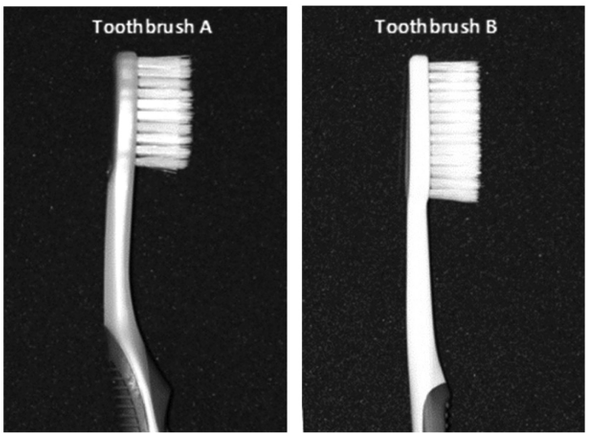

FIGURE 1. Side view of the toothbrushes

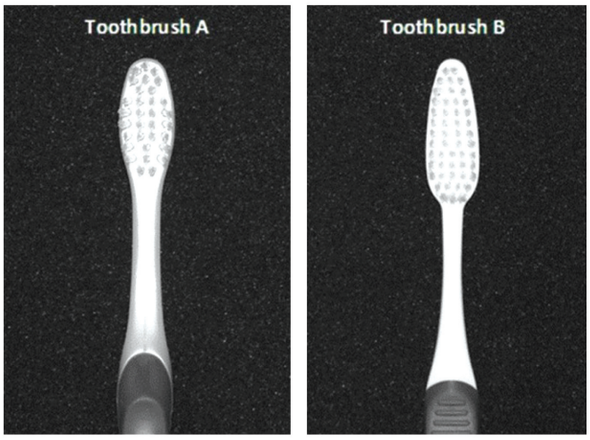

FIGURE 2. Front view of the toothbrushes

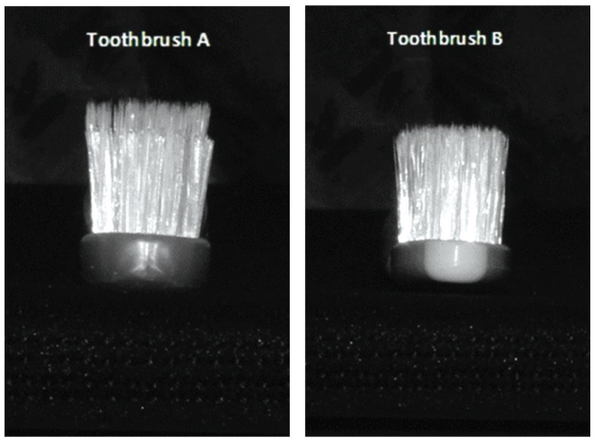

FIGURE 3. Top view of the toothbrushes

was their previous toothbrush used before participated in this study.

The teeth selected were standardized for all patients. The teeth selected were 16, 12, 24, 36, 32 and 44. Gingival health and plaque value were assessed based on Löe & Silness Gingival Index and Silness & Löe Plaque Index. Mean scores of the patients were then decoded into the nearest score.

At the end of the trial, patients were asked to fill up perception questionnaire. In this questionnaire, the patients were asked to choose which toothbrush that they would prefer to take home, easier to use and cleaned better. The flow of the trial was summarized in Figure 4.

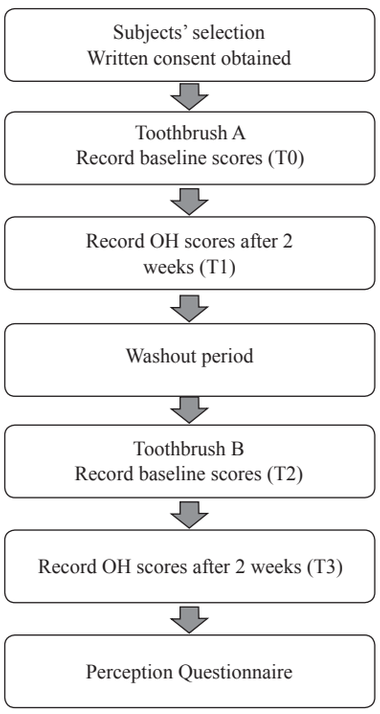

FIGURE 4. Flow chart of the toothbrush trial

All data were analysed descriptively using SPSS (Statistical Package for Social Sciences) version 22. Inferential analysis was used to obtain *p* value, odd ratio and 95% Confidence Interval. Using chi square test, *p* value was obtained. Odd ratio and 95% Confidence Interval were estimated using Risk Analysis. All data were interpreted. Five patients were selected to be checked for intra-examiner reliability. Each of their second scoring was recorded after 30 minutes interval at the same session. The intra-examiner reliability was measured using intra-class correlation coefficient.

RESULTS

Twenty-six patients completed the six weeks toothbrush clinical trial, with one patient drop-out due to non-compliance. Mean age of patients was 21.5 ± 4.3 years. Almost two-thirds of the patients were female (*n* = 17, 65.4%). More than half of the patients were Malay (*n* = 15, 57.7%). Slightly more than half of the patients had tertiary education (*n* = 14, 53.8%), while others had secondary education (*n* = 12, 46.2%) (Table 1). The intra-examiner reliability was 0.998 for gingivitis score and 0.999 for plaque score. In our study, patients only scored 0 and 1 after decodation. Therefore, score 0 was interpreted as no

TABLE 1. Descriptive data of demographic profile of patients

Variables		*n* (%)
Age (mean)	21.5 ± 4.3 years	
Gender	Male	9 (34.6)
	Female	17 (65.4)
Ethnic groups	Malay	15 (57.7)
	Chinese	8 (30.8)
	Indian	3 (11.5)
Education level	Secondary school	12 (46.2)
	Tertiary education	14 (53.8)

gingivitis or no plaque while score 1 was interpreted as gingivitis or plaque.

In the baseline and washout period, the number of patients scored gingivitis or plaque and no gingivitis or no plaque were same. For no gingivitis, both baseline and washout were n = 9, 34.6%. For gingivitis, both baseline and washout were n = 17, 65.4%. For plaque value, the occurrence of plaque and no plaque between baseline and washout period were about same. For no plaque, baseline was n = 17, 65.4% and washout was n = 16, 61.5%. For plaque, baseline was n = 9, 34.6% and washout was n = 10, 38.5%. (Table 2).

In gingival health, during the first three stages of the study (baseline, Toothbrush A and washout), the number of patients scored no gingivitis (n = 9, 34.6%) and gingivitis (n = 17, 65.4%) were consistent. However, the number of patients scored no gingivitis increased after using Toothbrush B (n = 18, 69.2%), while the patients scored gingivitis (n = 8, 30.8%) decreased (Table 2). The line chart for the gingival health of the patients showed a straight line in both scored no gingivitis and gingivitis during the first three stages (baseline, Toothbrush A and washout). At the final stage of the study (Toothbrush B), the number of patients scored no gingivitis (n = 18, 69.2%) were more than number of patients scored gingivitis (n = 8, 30.8%) (Figure 5).

When using Toothbrush A, the occurrence of gingivitis (n = 17, 65.4%) was higher than when using Toothbrush B (n = 8, 30.8%). Patients scored no gingivitis after using Toothbrush B were statistically significant increased compared to Toothbrush A, with $p < 0.05$. The odds ratio (OR) of 1.889, showed that the odds of gingivitis among patients after using Toothbrush A was 1.889 times more

TABLE 2. Descriptive data of comparison of gingivitis and plaque scores between the two toothbrushes

Parameter	Score	Stages in Toothbrush Trial			
		Baseline *n* (%)	Toothbrush A *n* (%)	Washout *n* (%)	Toothbrush B *n* (%)
Gingivitis	No gingivitis	9 (34.6)	9 (34.6)	9 (34.6)	18 (69.2)
	Gingivitis	17 (65.4)	17 (65.4)	17 (65.4)	8 (30.8)
Plaque	No plaque	17 (65.4)	17 (65.4)	16 (61.5)	18 (69.2)
	Plaque	9 (34.6)	9 (34.6)	10 (38.5)	8 (30.8)

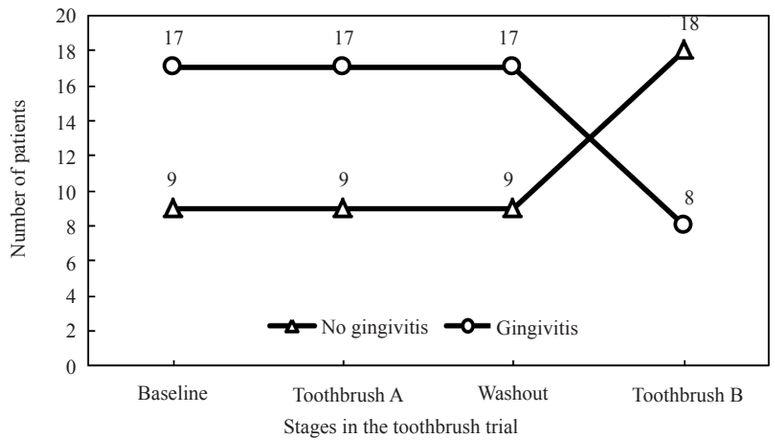

FIGURE 5. Pattern of gingival health of the patients during toothbrush trial

TABLE 3. Inferential data of comparison of the effectiveness between the two toothbrushes in term of gingivitis

Types of toothbrush	Score		Odds ratio	95% CI	*p* value
	No gingivitis *n* (%)	Gingivitis *n* (%)			
Toothbrush A	9 (34.6)	17 (65.4)	1.889	1.207-2.957	0.016*
Toothbrush B	18 (69.2)	8 (30.8)			

*Fisher's Exact Test, $p < 0.05$

compared to the patients after using Toothbrush B. The 95% confidence interval was [1.207-2.957] (Table 3).

For plaque scores, the number of patients scored no plaque and plaque were almost consistent. During baseline and Toothbrush A, the number of patients scored no plaque were n = 17, 65.4% and plaque were n = 9, 34.6%. In washout, the number of patients scored no plaque dropped slightly to n = 16, 61.5%. Finally, after using Toothbrush B, the number of patients scored no plaque increased slightly to n = 18, 69.2% (Table 2). The line chart for the plaque scores of the patients showed rather linear plots for both scored no plaque and plaque. Throughout the four stages in the trial, the number of patients scored no plaque (n = 16-18, 61.5-69.2%) were more than patients scored plaque (n = 8-10, 30.8-38.5%) (Figure 6).

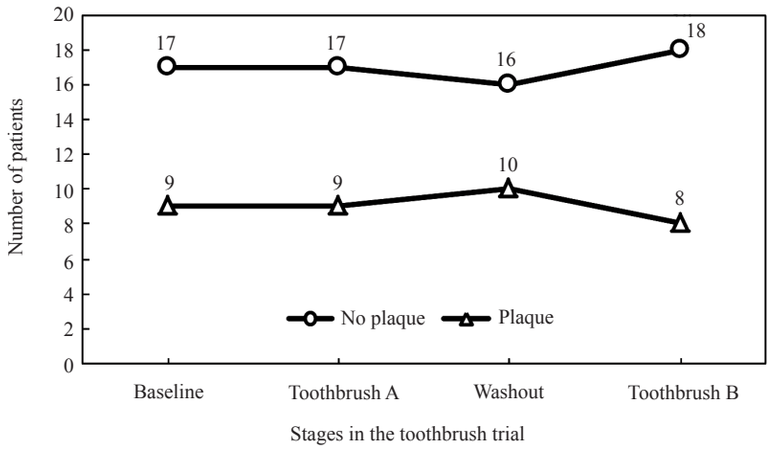

FIGURE 6. Pattern of plaque score of patients during the toothbrush trial

In the perception questionnaire, the patients were asked about their preference between the two toothbrushes. Slightly more than half of the patients preferred Toothbrush A (n = 14, 53.8%) compared to Toothbrush B (n = 12, 46.2%) in term of easier to use. However, slightly more than half of the patients chose Toothbrush B (n = 14, 53.8%) because they felt their teeth cleaner after using it compared to Toothbrush A (n = 12, 46.2%). For overall preference of the toothbrush, when asked which toothbrush they would like to take home, more patients chose Toothbrush A (n = 14, 53.8%) than Toothbrush B (n = 12, 46.2%) (Table 4).

TABLE 4. Descriptive data of patients' toothbrush perception

Toothbrush	Criteria, n (%)		
	Easier to use	Feel teeth cleaner after used	Overall preferrence
Toothbrush A	14 (53.8)	12 (46.2)	14 (53.8)
Toothbrush B	12 (46.2)	14 (53.8)	12 (46.2)
Total	26 (100.0)	26 (100.0)	26 (100.0)

DISCUSSION

The subjects in this clinical trial consisted of twenty-six fixed orthodontic appliance patients who had been wearing the appliance since at least three months ago. This was to ensure that they already adapted to tooth cleaning with the appliance in their mouths. All patients were treated by the same clinician. No additional oral hygiene instruction given prior to the start of this study. This was to ensure that the habitual cleaning of the patients was not changed.

All patients were standardized to brush twice daily with the brushing time of two minutes each time. Two minutes brushing time was the minimum brushing time regardless of type of toothbrush used to ensure proper tooth cleaning (Terézhalmy et al. 2008). All patients were provided with the same fluoride-containing toothpaste because different toothpastes may contain other agents such as anti-plaque or anti-calculus agents. Despite these standardizations, there might be confounding factors such as patients' compliance to the tooth brushing regime.

The bristles diameter of Toothbrush A (0.04 mm) are twice larger than the bristles diameter of Toothbrush B (0.02 mm). Besides the difference of their bristles diameter, the other differences are the length of head and neck design. Toothbrush A has shorter head length (25 mm) and contra-angled neck. Meanwhile Toothbrush B has head length of 35 mm and straight neck. Both toothbrushes had similarities in the aspect of shape of head (diamond-shaped), tip of bristles (tapered), pattern of filaments arrangement (block pattern) and handle design (slip-prevention grip). However, there was scarce literature evidence that head length and neck design of a toothbrush had significant difference on cleaning effectiveness.

In our study, oral hygiene status was assessed using Löe & Silness Gingival Index and Silness & Löe Plaque Index. These indices were chosen because it was one of the most widely used indices to assess plaque (Al-

Anezi & Harradine 2012) and gingival health (Fischman 1986). It was suggested that this index is suitable to be used when plaque and gingival relationships are to be considered (Fischman 1997). This index is flexible to be used according to our study need. It can be used on a whole mouth or selected mouth basis (Fischman 1986; Rebelo & De Queiroz 2011). Therefore, it is suitable to be used in our study as the patients were fixed orthodontic appliance patients that had different extraction pattern or non-extraction. This index was recommended for single examiner clinical trial due to its subjectivity in estimating plaque thickness. Thus, in our study, only one clinician did the oral health assessment. Non-parametric analysis is more suitable to be used as this index does not behave in a linear way (Fischman 1986).

The baseline period represented the patients' habitual oral hygiene status. After using Toothbrush A, a two-week washout period was assigned to eliminate the effect of the intervention from first toothbrush. During this period, the patients were instructed to use their habitual toothbrush. From our data, the plaque and gingival health status were same between baseline and washout period. These showed that the number of patients scored no gingivitis or no plaque and gingivitis or plaque were same. Based on these findings, the gingival health and plaque condition of the patients had returned to their initial condition after washout period. Therefore, the effects from Toothbrush A had been eliminated before starting Toothbrush B.

Oral hygiene was assessed based on the gingival health and plaque value. Our results showed that there were no difference in the plaque scores. Throughout the trial, the number of patients scored no plaque were more than patients with plaque accumulation on teeth. This showed that both toothbrushes equally effective in cleaning the plaque on the tooth surface above the gingival margin. However, this may also be due to the Hawthorne effect, a reaction in which subjects improve their behaviour when they aware of being observed (Adair 1984). Subjects participating in a clinical trial may have lower plaque scores than those unaware they were being studied. This was shown in adolescent orthodontic patients who had poor oral hygiene before participated in the study (Feil et al. 2002).

Gingivitis score is a better indicator of oral health status because patients might purposely clean well only on the days of oral check-up. Gingival health was more difficult to mask as reversal of gingivitis took five days (Löe 1971). In our study, the number of patients with healthy gingival increased significantly after using Toothbrush B. This can be observed when the number of patients with gingivitis after using Toothbrush A was about two times more compared to after using Toothbrush B. Based on the point estimate and confidence interval, there was statistically significant evidence that the occurrence of gingivitis was higher among patients using Toothbrush A. This showed that using Toothbrush B achieved better gingival health than using Toothbrush A.

The bristles diameter of Toothbrush B was 0.02 mm compared to Toothbrush A with bristles diameter 0.04 mm. Smaller bristles diameter was relatively softer than larger bristles diameter (Versteeg et al. 2008). Our finding was contradict with other studies that found that harder bristles cleaned more effectively than softer bristles (Hedge et al. 2011; Sunny et al. 2017; Zimmer et al. 2011). However, there were studies found that softer bristles cleaned better than harder bristles (Gallob et al. 2016; Yankell & Nygaard-Østby 1983). It could be softer bristles more detailed into cleaning the crevicular area of the gingiva. Softer bristles also more flexible to reach the obstructed teeth surfaces of the fixed orthodontic appliance. Our finding that smaller diameter bristles cleaned better could be used as a guide in oral hygiene instructions for the fixed orthodontic appliance patients.

Patient satisfaction is an important indicator for measuring the quality in health care. It affects the clinical outcomes and patient adherence (Prakash 2010). In our study, slightly more patients preferred to take home Toothbrush A as they felt it was easier to use even though Toothbrush B cleaned better. In other study comparing the orthodontic toothbrush that had V-shaped pattern of filaments arrangement with a standard block pattern of filament arrangement, more subjects chose the orthodontic toothbrush that was found significantly removed more plaque on labial surfaces of anterior teeth (Williams et al. 1987). These findings give impression that patients' toothbrush preference is not dependent on certain factors, regardless the toothbrush cleaned better or easier to use. Patients might choose based on the toothbrush's appearance and uncommon design.

In our study, randomization of the patients in the sequence of using the toothbrushes was not done due to time constraint and lack of manpower. For future similar studies, we would like to recommend randomization of the patients in the sequence of using the toothbrushes to reduce bias.

CONCLUSION

Both Toothbrush A and Toothbrush B were able to maintain patients' oral hygiene status. However, when using Toothbrush B, oral health status was better as it significantly reduced gingivitis occurrence compared to when using Toothbrush A. As for the preference of toothbrush, most patients preferred Toothbrush A to be taken home as it is easier to use, even though they felt Toothbrush B cleaned better.

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