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COMPARATIVE EVALUATION OF PLAQUE REMOVAL AND SOFT TISSUE TRAUMA AFTER USE OF MANUAL TOOTHBRUSHES WITH DIFFERENT BRISTLE STIFFNESS

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ABSTRACT

Aim: The aim of this study was to evaluate and compare the efficacy of manual toothbrushes of the same type with different bristle stiffness concerning plaque removal, gingivitis development and soft tissue trauma.

Methods: Three groups with forty subjects each used manual toothbrushes with either hard, medium or soft bristle stiffness. The brushing time was set for 2 minutes twice a day. Four and eight weeks after the baseline examination, clinical parameters for plaque removal : Quigley and Hein index (QHI), Modified approximal plaque index (MAPI); gingivitis: Papillary bleeding index (PBI) and soft tissue damage: Danser gingival abrasion index (DI) were recorded again.

Results: QHI and MAPI index scores showed statistically significant reduction in subjects who used hard bristled toothbrushes after 8 weeks($p<0.05$ and $p<0.001$, respectively). In subjects who used hard bristled toothbrushes showed more gingival lesions ($p<0.01$) and higher PBI scores after 4 and 8 weeks ($p<0.001$) compared to subjects who used soft or medium bristled toothbrushes.

Conclusion: Manual toothbrushes with hard bristles may better remove plaque but they also result in more soft tissue trauma compared to toothbrushes with softer bristles.

INTRODUCTION

Dental plaque is the major etiology of periodontal diseases and is also related to dental caries. Therefore, gaining patient cooperation in daily plaque removal is critical to long term success of all periodontal and dental procedures. The daily use of a toothbrush and the other oral hygiene aids is the most dependable way of achieving oral health benefits for all patients. However, these benefits are also accompanied by an increase of oral soft and hard tissue damage and tooth hypersensitivity caused by tooth brushing (Weinert et al., 2000). Therefore, dental professionals now tend to recommend toothbrushes with soft bristles. Soft bristle toothbrushes of the type described by *Bass* have gained wide acceptance (Bass, 1948). Recently, clinical trials have shown the good performance of soft- tapered toothbrushes in reducing plaque, especially in areas difficult to reach like proximal surfaces (Dorfer et al., 2003). Manual toothbrushes with soft conical filaments were also claimed to clean sub gingival pockets more effectively compared to a standard American Dental Association (ADA) reference toothbrush (Sgan-Cohen et al., 2005).

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The effect of bristle stiffness on the development of gingival abrasion has also been evaluated in many studies (Rajapakse et al., 2007; Niemi et al., 1984). Though there is no doubt that plaque-associated caries and periodontitis are still the main threats to oral health, but the damage of oral hard and soft tissues should also be prevented. To the author's knowledge, until now, there has been no clinical evidence that a toothbrush with soft bristles removes plaque as effectively as the same product with medium or hard bristles. Thus, the aim of this study was to evaluate and compare the efficacy of manual toothbrushes of the same type with different bristle stiffness concerning plaque removal, gingivitis development and soft tissue trauma.

MATERIALS AND METHODS

In this study, a total of 120 systemically healthy volunteers (75 males and 45 females; age ranging from 20 to 55 years) took part. The study was conducted at the Department of Periodontics, Government dental college and hospital, Srinagar. Prior to the commencement of the study, written informed consent and ethical committee clearance were obtained. Subjects were excluded from the study if they were pregnant, had type I or II diabetes or severe periodontal

disease, used antibiotics or drugs with anti-inflammatory effects within 2 weeks before the first examination, had removable prosthesis or had less than 16 natural teeth. All subjects showed a papillary bleeding index (PBI) (Muhlemann,1975) per tooth ≥0.5 and Quigley and Hein plaque index (QHI) (Quigley et al.,1962) per tooth ≥ 2.0 at a screening examination as primary outcomes. The screening examination also included additional indices as secondary outcome measures- the modified approximal plaque index (MAPI) (Zimmer et al., 2005) and Danser gingival abrasion index (DI) (Danser et al., 1998). All 120 participants were randomly assigned to three groups of 40 each by a person not involved in the study. The screening examination was followed by professional tooth cleaning to remove plaque and calculus. Each subject received the same toothpaste and a new manual toothbrush according to the assigned group to achieve standardized conditions. The modified Bass technique was taught to each participant. The brushing time was set for two minutes and frequency for twice a day. Four and eight weeks after the baseline, the indices were recorded again. During the study period, the use of mouthrinses, gels and interdental cleaning aids was prohibited. Statistical analysis was performed with a software program (SPSS v. 17.0, IBM, Chicago, IL). Intergroup analysis among the three groups of toothbrushes were performed using analysis of variance with Bonferroni correction. Analysis of the DI were calculated using the Chi- square test.

RESULTS

All the 120 subjects completed the study. Clinical results have been presented in Tables 1 to 4. The total, vestibular and oral QHI in subjects using hard toothbrushes were statistically significant lower compared to subjects using soft toothbrushes after 8 weeks ($p<0.001$, $p<0.05$ and $p<0.001$, respectively). This means that plaque removal was improved more in subjects using hard toothbrushes. Also, a statistically significant lower QHI was obtained for hard compared to medium toothbrushes after 8 weeks ($p<0.01$). Statistically significant less plaque was found inter proximally as measured by the MAPI for hard toothbrushes versus soft toothbrushes after 8 weeks ($p<0.05$).

Table 1. Changes in QHI after 4 and 8 weeks related to toothbrush bristle stiffness

INDEX	TIME	STIFFNESS	MEAN (SD) CHANGES
QHI total	4 weeks	Hard	-0.18 (0.39)
		Medium	-0.18 (0.38)
		Soft	-0.16 (0.30)
	8 weeks	Hard	-0.38 (0.37)
		Medium	-0.21(0.32)
		Soft	-0.07(0.32)
QHI vestibular	4 weeks	Hard	-0.16(0.50)
		Medium	-0.23(0.48)
		Soft	-0.21(0.34)
	8 weeks	Hard	-0.36(0.46)
		Medium	-0.27(0.40)
		Soft	-0.09(0.40)
QHI oral	4 weeks	Hard	-0.20(0.36)
		Medium	-0.13(0.38)
		Soft	-0.10(0.33)
	8 weeks	Hard	-0.39(0.34)
		Medium	-0.16(0.36)
		Soft	-0.04(0.36)

A negative value indicates a lower index score and thus a clinical improvement of QHI.

Table 2. Changes in PBI after 4 and 8 weeks related to toothbrush bristle stiffness

TIME	STIFFNESS	MEAN (SD) CHANGES
4 weeks	Hard	0.22(0.28)
	Medium	-0.20(0.20)
	Soft	-0.38(0.24)
8 weeks	Hard	0.11(0.21)
	Medium	-0.27(0.26)
	Soft	-0.53(0.24)

A negative value indicates a lower index score and thus a clinical improvement of PBI.
A positive value indicates a higher index score and thus a clinical impairment of PBI.

Table 3. Changes in MAPI after 4 and 8 weeks related to toothbrush bristle stiffness

TIME	STIFFNESS	MEAN (SD) CHANGES
	Hard	-0.15(0.50)
4 weeks	Medium	-0.20(0.34)
	Soft	-0.23(0.40)
	Hard	-0.38(0.50)
8 weeks	Medium	-0.20(0.32)
	Soft	-0.10(0.44)

A negative value indicates a lower index score and thus a clinical improvement of MAPI.

Table 4. DI at baseline and after 4 and 8 weeks (absolute number of lesions in each category)

TIME	NUMBER OF LESIONS	BRISTLE STIFFNESS		
		Hard	Medium	Soft
Baseline	None	35	34	30
	≤1	4	6	8
	≤2	1	0	2
4 weeks	None	23	36	35
	≤1	15	4	5
	≤2	2	0	0
8 weeks	None	22	34	39
	≤1	18	6	1
	≤2	0	0	0

Subjects who used toothbrushes with hard bristles showed higher scores in PBI after 4 and 8 weeks compared to subjects who used medium or soft toothbrushes ($p<0.001$).Soft toothbrushes showed the lowest scores in PBI over the study period compared to medium and hard toothbrushes ($p<0.01$). At baseline, the DI was not statistically significantly different among groups. After 4 and 8 weeks, hard toothbrushes showed more gingival lesions compared to soft and medium toothbrushes ($p<0.01$), whereas there were no statistically significant differences between the soft and medium toothbrushes groups.

DISCUSSION

Since plaque control is an effective method of treating as well as preventing periodontal disease, it forms an important aspect of all procedures involved in the management and prevention of periodontal disease. It is the primary level of prevention of periodontal diseases and caries. Plaque control includes the usage of mechanical procedures as well as chemical agents which retard plaque formation. Mechanical plaque control methods include tooth brushing and interdental cleaning using oral hygiene aids and professional prophylaxis. As of now, mechanical plaque control seems to be most dependable form of plaque control. Toothbrushes are the most widely used oral hygiene aids. These are the principal instruments in general

use for accomplishing the goals of plaque control. Toothbrushes vary in size and design as well as in length hardness and arrangement of bristles. To render home-based oral hygiene more effectively, many types of manual and powered toothbrushes have been developed. In a meta-analysis, it was concluded that powered toothbrushes with a rotation oscillation action reduced more plaque and gingivitis as compared to manual tooth brushing (Robinson et al., 2005). However, powered toothbrushes are popular only with one-third of 25- to 54- year old individuals which implies that manual toothbrushes still represent the most prevalent oral hygiene device for the general population. In the present study, manual toothbrushes with hard bristles removed more plaque on free smooth surfaces (QHI) and on proximal tooth surfaces (MAPI) compared to the same toothbrush type with soft bristles.

The results for the medium hardness toothbrushes were in between. In contrast, the PBI was significantly reduced in the group using soft toothbrushes after 4 and 8 weeks, and increased in the group using hard toothbrushes. This may be due to the fact that the hard bristles abraded the gingival epithelium, which was evident from DI (Table 4) and resulted in elevated bleeding. The results of the present study are in accordance to the study done by Zimmer et al.(2011) which concluded that manual toothbrushes with hard bristles may better remove plaque, but may also cause more soft tissue trauma compared to brushes with softer bristles. In another study, soft toothbrushes were compared to an ADA standard toothbrush, which is different in bristle stiffness and toothbrush design (Versteeg et al., 2008). The present study investigates the effectiveness and potential harmfulness of manual toothbrushes of the same type but with different bristle stiffness. Therefore, it cannot be excluded that both bristle stiffness and toothbrush design had an impact on the study outcome.

Conclusion

It can be concluded from the present study that toothbrushes with hard bristles may better remove plaque but may also result in more soft tissue trauma compared to toothbrushes with softer bristles. Thus the toothbrushes with different bristle stiffness should be recommended focusing on the individual patient. For subjects with poor oral hygiene, a toothbrush with hard bristles should be considered. If the patient already shows soft tissue damage, a soft toothbrush may be recommended. If the patient cannot be classified, a toothbrush with medium stiffness might be the solution.

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