Effectiveness of low cost toothbrushes, with or without dentifrice, in the removal of bacterial plaque in deciduous teeth

Efetividade de escovas dentais de baixo custo, com ou sem o uso de dentifrício, na remoção da placa bacteriana em dentes decíduos

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ABSTRACT: The main objective of this study was to compare the effectiveness of a low cost toothbrush ("monoblock") to that of a conventional toothbrush with and without addition of dentifrice with respect to the removal of dental plaque. Thirty-two 4- to 6-year-old children took part in this study: they were evaluated under four experimental conditions defined by the combinations of the values of two factors, toothbrush (conventional or monoblock) and use of dentifrice (with or without). The effectiveness of the treatments was defined in terms of the reduction of a bacterial plaque index evaluated before and after toothbrushing. No statistically significant differences were detected between the two types of toothbrushes with respect to the reduction of the bacterial plaque index. Similarly, there were no statistical evidences that the use of dentifrice improves the mechanical control of dental plaque. These results are important from a public health point of view, specially in developing countries, where the dissemination of educational and preventive techniques of low cost are fundamental.
DESCRIPTORS: Toothbrushing; Dental plaque; Prevention & control.

RESUMO: O principal objetivo deste estudo foi comparar a efetividade de uma escova dental de baixo custo (monobloco) à efetividade de uma escova convencional, com ou sem adição de dentifrício, em relação à remoção da placa dentária. Participaram deste estudo trinta e duas crianças de 4 a 6 anos de idade, que foram avaliadas sob quatro condições experimentais, definidas pela combinação de dois fatores: escova dental (convencional ou monobloco) e uso de dentifrício (com ou sem dentifrício). A efetividade dos tratamentos foi definida em termos de redução do índice de placa bacteriana, avaliado antes e após a escovação. Não foram encontradas diferenças estatisticamente significativas entre os dois tipos de escovas no que diz respeito à redução de placa bacteriana. Similarmente, não houve evidências estatísticas de que o uso de dentifrício aumenta o controle mecânico da placa. Esses resultados são importantes do ponto de vista de saúde pública, principalmente em países em desenvolvimento, onde a disseminação de técnicas educacionais e preventivas de baixo custo são fundamentais.
DESCRITORES: Escovação dentária; Placa dentária; Prevenção & controle.

INTRODUCTION

Several countries have high rates of cavities and periodontal diseases and, in spite of many technological advances which have lately been incorporated into dental practice, there are no evidences of a substantial improvement in the oral health of those countries' population. Even taking into account that dental plaque, one of the etiological agents of caries and periodontal disease, can be removed or at least decreased by the simple systematic use of toothbrushes and dental floss, there is still the need for lower costs in home care, owing to the present economic situation in underdeveloped countries. To highlight this fact, we note that the widespread distribution of a basic oral hygiene kit to students in the public educational system has been discontinued for economic reasons as noticed by a recent article published in the Journal of the Federal Council of Dentistry[15] (1998).

The reversal of such a picture constitutes a point of honor for Public Health authorities and, to this extent, research aiming at the development of low cost preventive methods has been thoroughly encouraged. In particular, development of low cost toothbrushes, accessible to public health programs and needy populations, has been addressed by many investigations[3-12]. In this study, we focus

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our attention on a monoblock toothbrush conceived by Bignelli[4] (1994); both its angled handle and its bristles are made of the same material, a thermoplastic polymer, and are manufactured in a single industrial operation by means of an injection process into a cooled automatic complex matrix with a cost of approximately 10% of that of a conventional toothbrush.

Although toothbrushes and dental floss are essential for dental plaque control, other auxiliary products for such purposes are available. Among them, dentifrices stand out, mainly because they are frequently considered essential to oral hygiene. The use of dentifrice can inhibit the growth of dental plaque by decreasing its adhesion to treated surfaces and also by the reduction of the bacterial population via the absorption of its components by the teeth surfaces[6]. Notwithstanding the role of dentifrices in oral hygiene, particularly as a means for application of fluoride, the literature is scarce in clinical comparative studies directed at evaluating its effects in the reduction of bacterial plaque from dental surfaces[7-26]. Given that the cost of dentifrices can constitute an inhibiting factor regarding oral hygiene habits for low income populations, an evaluation of its real importance also deserves attention.

In this study, we have compared the performance of the monoblock toothbrush conceived by Bignelli[4] (1994) with that of a conventional toothbrush with respect to control of dental plaque in deciduous dentition. The additional effect of the use of dentifrices is also evaluated.

MATERIALS AND METHODS

This study involved thirty-two 4- to 6-year-old children (only during the deciduous dentition phase), living in a day nursery in Campo Grande, MS, Brazil. Although ideally an adult should brush the child's teeth within this age group, this is not possible in community health programs, especially in Third World countries like Brazil. In this context, it is imperative that the children be taught and trained to brush their own teeth. This work was submitted to the Commitee for Research Ethics for evaluation, and informed consent was obtained from the individuals responsible for the children.

Two types of toothbrushes, a monoblock toothbrush described above and a conventional toothbrush with nylon bristles (Johnson's change color®, Johnson & Johnson, São Paulo, Brazil) were evaluated with and without the addition of the dentifrice (Kolynos Tandy®, Kolynos do Brasil Ltda., São Paulo, Brazil) used regularly by the children from that institution.

Children were submitted to all four treatments (monoblock toothbrush with or without dentifrice and conventional toothbrush with or without dentifrice) with an interval of 1 week between them in order to eliminate possible residual effects. The children were divided into four groups of 8 elements, and to each group the four treatments were applied in a different order according to the scheme presented in Table 1.

Each child was examined twice at each of the four sessions, generating separate pre- and post-brushing bacterial plaque indices for the anterior teeth (from the right canine tooth to the left one) and posterior teeth (molar teeth from both sides). The dental plaque indices were computed as in Greene, Vermillion[12] (1964).

Under their proposal, a score was attributed to each dyed vestibular and lingual surface according to the following criterion:

0 = No deposit present.

1 = Deposits of soft residues that do not cover more than a third of the dental surface.

2 = Deposits of soft residues that cover more than one third but not more than two thirds of the dental surface.

3 = Deposits of soft residues that cover more than two thirds of the dental surface.

The Greene and Vermillion bacterial plaque index is the average score across all surfaces examined[12].

In each of the four sessions, after having the pre-brushing plaque index evaluated, each child brushed his/her own teeth for 3 minutes, under

TABLE 1 - Order of treatment application.

Toothbrush	Dentifrice	Day 1	Day 2	Day 3	Day 4
Conventional	Without	Group 3	Group 4	Group 1	Group 2
Conventional	With	Group 1	Group 2	Group 3	Group 4
Monoblock	Without	Group 2	Group 3	Group 4	Group 1
Monoblock	With	Group 4	Group 1	Group 2	Group 3

the supervision of a dental practitioner. Subsequently, he/she rinsed his/her mouth with water for one minute and was reexamined so that a post-brushing plaque index could be obtained. The exams were carried out by a single examiner with the help of an annotator. The study was masked, in the sense that the examiner was not aware of what experimental group each child belonged to.

Evaluation of the effectiveness of each treatment with respect to the reduction of the dental plaque indices was carried out according to the regression technique for pre-test/post-test studies, which essentially involves the fitting of models of the form:

Expected post-brushing index = β x (pre-brushing index)$^\gamma$, where β (> 0) can be interpreted as a residual post-brushing dental plaque coefficient and γ (> 0) is a uniformity coefficient of the expected residual dental plaque. The smaller the coefficient β, the bigger the expected reduction in the dental plaque index. Moreover, when $\gamma = 1$, the expected residual dental plaque rate (expected post-brushing index/pre-brushing index) is constant and equal to β. When $\gamma < 1$, the expected residual dental plaque rate decreases, i.e., the higher the pre-brushing dental plaque index, the less efficient is the treatment. When $\gamma > 1$, the expected residual dental plaque rate increases, i.e., the higher the pre-brushing dental plaque index, the more efficient is the treatment. A more detailed explanation can be found in Singer, Andrade[20] (1997).

The analysis strategy involved the adjustment of a model of this kind for each treatment, as well as the comparison of the respective residual dental plaque coefficients (β) and uniformity coefficients (γ). A possible effect of the treatment application order was also investigated. The models were fit by usual linear models methodology[17] after considering the logarithms of both sides.

Furthermore, as each child was evaluated 4 times, the models should allow possible correlations between the individual observations. Statistical techniques with these features are studied under the general denomination of "repeated measurements"[8,21]. Among the available models for such purposes, the so-called random effects models are natural candidates for the analysis and were considered in this study.

RESULTS

The averages and standard deviations for pre- and post-brushing dental plaque indices are presented in Table 2.

An analysis of the dispersion diagrams presented in Graphs 1 and 2 suggests an association between pre- and post-brushing dental plaque indices in such a way that higher pre-brushing dental plaque indices are associated to larger post-brushing dental plaque indices, indicating that the models described above seem appropriate.

Based on such models, residual dental plaque coefficients (β) and uniformity coefficients (γ) were estimated for each treatment. The results are displayed in Table 3.

The statistical analysis suggests that:
i) there was no effect of the day of application on the treatment (p = 0.731 for the anterior teeth and p = 0.551 for the posterior teeth);
ii) there were no significant differences among the uniformity coefficients (p = 0.604 for the anterior teeth and p = 0.537 for the posterior teeth);
iii) the uniformity coefficients were significantly different from 1 (p < 0.050 for the anterior and posterior teeth);
iv) there was no indication that the use of dentifrice could reduce the dental plaque index in a statistically significant way (p = 0.513 for the anterior teeth and p = 0.231 for the posterior teeth);

TABLE 2 - Averages ± standard deviation for pre- and post-brushing indices.

Toothbrush	Dentifrice	Teeth			
		Anterior		Posterior	
		Pre	Post	Pre	Post
Conventional	Without	0.82 ± 0.38	0.52 ± 0.29	1.14 ± 0.38	0.93 ± 0.38
Conventional	With	0.68 ± 0.38	0.40 ± 0.27	1.08 ± 0.39	0.88 ± 0.41
Monoblock	Without	0.79 ± 0.45	0.61 ± 0.42	1.23 ± 0.38	1.10 ± 0.38
Monoblock	With	0.73 ± 0.33	0.54 ± 0.31	1.12 ± 0.42	0.91 ± 0.43
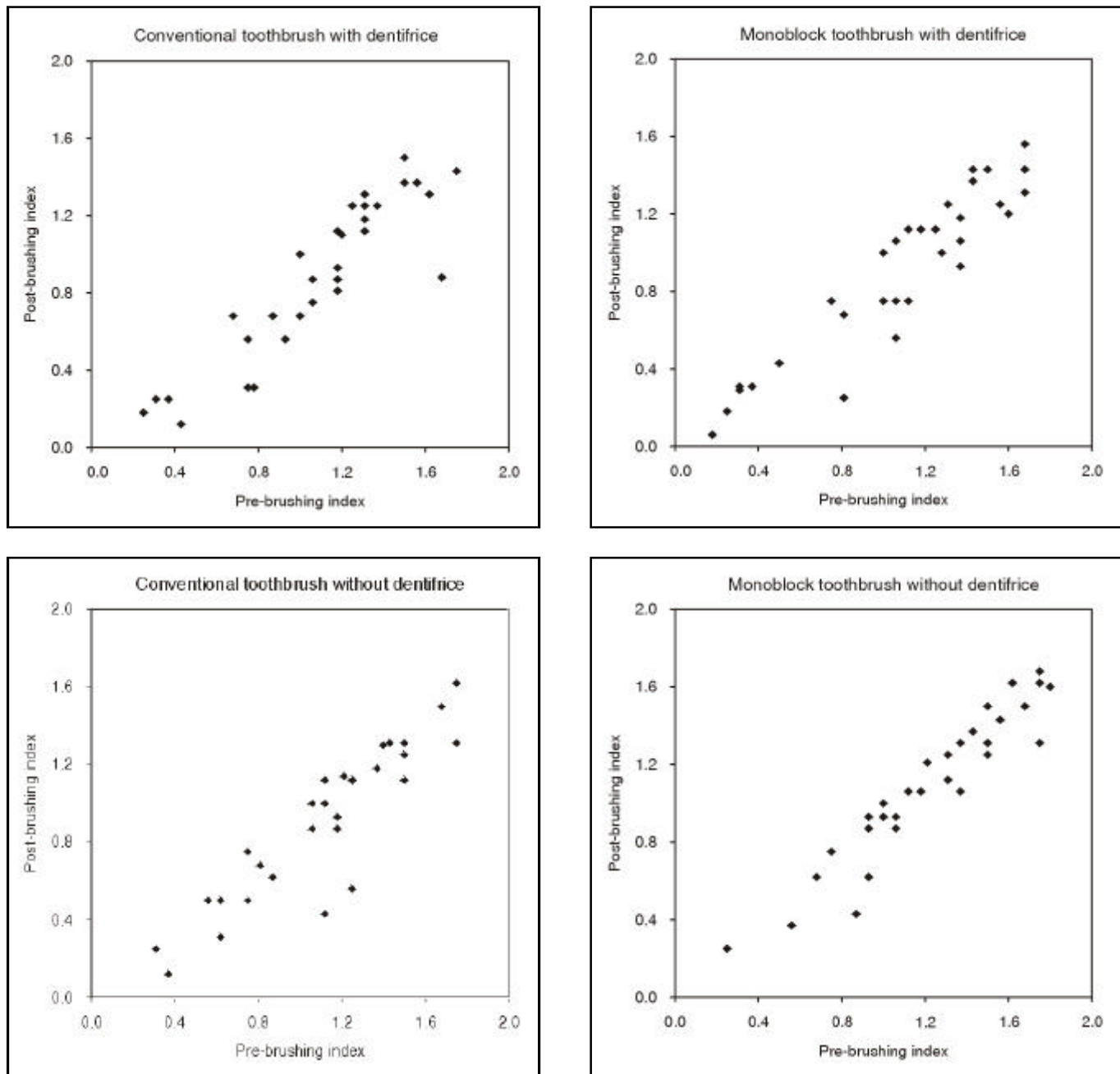
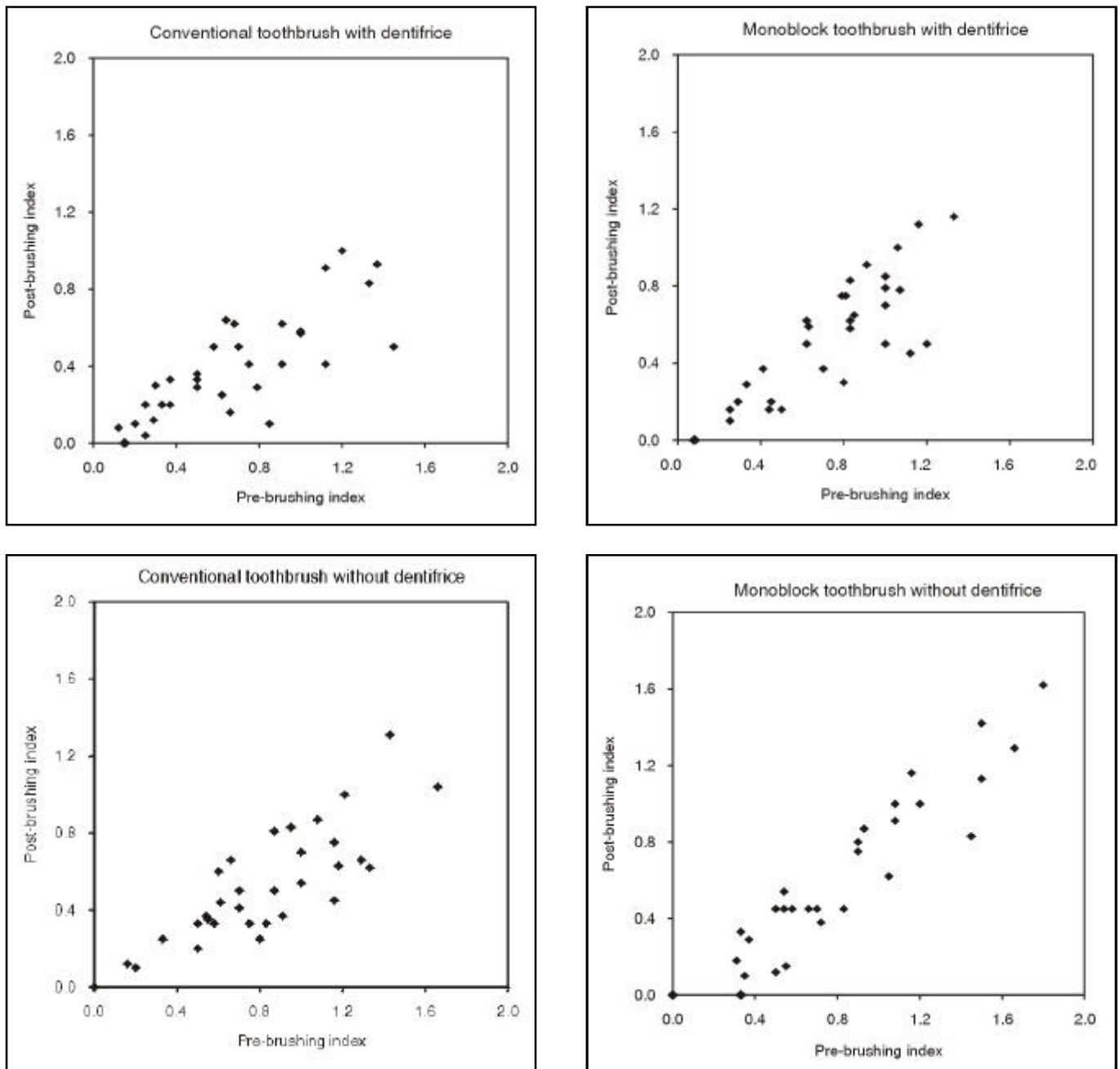**GRAPH 1 -** Dispersion diagrams between the pre- and post-brushing indices for posterior teeth.

v) there were no significant differences between the monoblock and the conventional tooth-brushes with respect to the reduction of the dental plaque indices (p = 0.121 for the anterior teeth and p = 0.073 for the posterior teeth).

These results were incorporated in a model for which an estimate (± standard error) of the common coefficient of uniformity (γ) was 1.26 ± 0.08 for the anterior teeth and 1.17 ± 0.05 for the posterior teeth. Additionally, the common residual dental plaque coefficient (β) was 0.67 ± 0.03 for the anterior teeth and 0.80 ± 0.02 for the posterior teeth.

DISCUSSION

Because of the underdeveloped countries economic situation, a considerable portion of the population does not have access to suitable health care and, in many cases, children do not control

GRAPH 2 - Dispersion diagrams between the pre- and post-brushing indices for anterior teeth.

dental plaque in an adequate way because they do not have toothbrushes or because the available ones are worn out or old or even because they share the same toothbrush with other members of the family[19]. A study conducted with university students[24] showed that the low cost monoblock toothbrush conceived by Bignelli[4] (1994) may be considered as effective as other conventional toothbrushes with respect to the efficacy in removing dental plaque, and thus could be a candidate for public health prevention programs. Encouraged by such results, we conducted a comparative clinical study to verify whether those results would hold for children in an age group similar to that at which many prevention programs are directed. Although the study was not designed for such purposes, the integrity of the gingival tissue was also observed. No identifiable harm was detected.

TABLE 3 - Estimates ± standard errors for residual (β) and uniformity coefficients (γ).

Toothbrush	Dentifrice	Anterior teeth		Posterior teeth	
		β	γ	β	γ
Conventional	With	0.56 ± 0.04	1.16 ± 0.12	0.75 ± 0.02	1.21 ± 0.09
Conventional	Without	0.63 ± 0.04	1.10 ± 0.16	0.77 ± 0.03	1.25 ± 0.11
Monoblock	With	0.73 ± 0.06	1.28 ± 0.13	0.80 ± 0.03	1.14 ± 0.07
Monoblock	Without	0.73 ± 0.06	1.36 ± 0.16	0.88 ± 0.04	1.03 ± 0.11

TABLE 4 - Estimated post-brushing plaque indices.

Pre-brushing dental plaque index	Estimated post-brushing index	
	Anterior teeth	Posterior teeth
0.40	0.24	0.28
0.80	0.58	0.64
1.20	0.97	1.02
1.60	1.39	1.43

The results observed in Tables 2 and 3 suggest a small superiority of the conventional toothbrush. However, the statistical analysis showed that these differences are not statistically significant (p = 0.121 for the anterior teeth and p = 0.073 for the posterior teeth), suggesting that for practical purposes, both the monoblock and the conventional toothbrushes may be considered equivalent with respect to the removal of dental plaque. Furthermore, the results indicate that the expected post-brushing dental plaque index depends on the magnitude of the pre-brushing dental plaque index. Expected post-brushing dental plaque indices for different values of the pre-brushing plaque index for the anterior and posterior teeth are exemplified in Table 4.

There is no doubt that the level of plaque removal presented by both toothbrushes is not adequate from the clinical point of view. Ideally, the dental residual post-brushing plaque index should not correspond to more than 10% of the pre-brushing value[18]. In our study, these values range from 60% on the anterior region (= 0.24/0.40) to 90% (= 1.43/1.60) on the posterior region. It must be emphasized that this study was conducted with 4- to 6-year-old children, who have little motor control and consequently do not have enough ability for an acceptable quality of toothbrushing[22,25]. On the other hand, these results were in line with those obtained with university students in Dentistry and Speech, Language and Hearing Sciences, for whom the residual (post-brus-

hing) dental plaque indices varied from 71% to 85%[24]. Furthermore, although the pure and simple use of a toothbrush can ideally lead to the reduction of dental plaque to clinically acceptable levels, its use should be encouraged even under non-ideal conditions since it is fundamental as a motivational agent for an adequate oral health care[13]. Although the dental plaque reduction was not substantial, its disorganization can produce some benefits[23]. As noted by Finkelstein et al.[9] (1990), for example, even though the use of the dental floss did not reduce meaningfully dental plaque, it did diminish gingival inflammation in the interdental region.

We also investigated whether the use of dentifrice would produce further reduction in the plaque indices, since that is not well established in literature. In this context, the stimulus to the public interest in oral hygiene is generally associated with the increase in the dentifrice market[5]. Dentifrices are considered agents with antibacterial potential which could have a beneficial effect on plaque and gum infection prevention and, if those preparations were clinically effective, some effect on the bacteria could be expected[16]. Also, dentifrices might have important functions in the removal of spots and in the sensation of freshness and cleanliness besides acting as transporting agents for chemoprophylactic agents such as fluoride[23]. It is thus suggested that by using toothbrushes and dentifrice, it would be possible to get a combination of chemical and mechanical action in the oral prophylaxis[2]. Such action would be related to the presence of detergent substances in the formulation of dentifrices, more commonly represented by sodium lauryl sulfate[14], which help the removal of plaque by increasing friction in the location and by protecting against the rapid recolonization of the dental surface by the residual presence of adherent microrganisms[6]. The results of this study showed that the use of dentifrices is not associated with a more efficient plaque control by children in the 4- to 6-year-old age group. The few

studies reported in the literature in this area agree with these results[10,26]. On the other hand, it was observed that the growth level of dental plaque in a group of adolescents brushing their teeth with dentifrice was 27% lower than in the group which did not use dentifrice[7]. However, we must point out that a possible motivational effect, particularly in relation to the freshness sensation, is more likely in adolescents than in children in the age group under investigation here. Finally, we mention that, although not essential for plaque removal, the use of dentifrice must be considered as the most efficient means of conveying topic fluoride, and its use is desirable for caries prevention. Nevertheless, its use by young children, who may ingest toothpaste regularly, could be questioned because of an increased risk of fluorosis[1]. The associated risk/benefit ratio is still a topic for further research.

CONCLUSIONS

1. Both monoblock and conventional brushes were equivalent for dental plaque removal.
2. Both brushes were equally efficient in relation to plaque removal during the period they were evaluated (60 days), although the monoblock has suffered higher deformation of the tips.
3. Dentifrices do not have a preponderant role on the mechanical control of plaque.

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