

# Efficacy of a Sonic Toothbrush in Reducing Plaque and Gingivitis in Adolescent Patients

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Orthodontists generally understand the importance of patients' oral hygiene because of its proven relationship with treatment quality.<sup>1,2</sup> Ample evidence indicates, however, that their instructional efforts often fall short of professional expectation and patient need.<sup>3-5</sup>

The usual professional oral hygiene instruction consists in showing patients how to remove supragingival plaque in one way or another. Although the emphasis on plaque removal is strongly supported by research,<sup>6-8</sup> it is difficult to teach any proper brushing technique to patients with inflamed gingivae. Patients are likely to remember the discomfort of "proper brushing" more than the technique, and thus orthodontists often succeed only in teaching avoidance techniques.<sup>9</sup>

Poor oral hygiene has a cumulative effect, and as plaque accrues, gingivitis ensues.<sup>10</sup> Inflammation itself also lowers pain tolerance, and this vicious cycle—from neglect to inflammation and pain and then back to further neglect—contributes greatly to the persistence of poor oral hygiene habits and continued plaque accumulation.<sup>11</sup>

The reluctance of orthodontic patients to practice good toothbrushing has been ascribed to various deficits of human behavior. One of the most interesting and promising behavioral stud-

ies suggested that orthodontic patients with poor oral hygiene tend to be people with low sensitivity thresholds who react to tactile stimuli in an exaggerated way.<sup>2,12</sup> Although such patients were conditioned in this study to improve their plaque removal by using a biofeedback toothbrush, there was little evidence that the better brushing became routine beyond the test period.

Another problem is that most orthodontic patients use manual toothbrushes, even though a variety of electric toothbrushes have been shown to be equally or more efficient than manual brushing in removing plaque.<sup>13-16</sup>

A recently developed sonic toothbrush (Sonicare\*) uses a mechanism that vibrates the bristles at 520 brush strokes per second (260 Hz) and acoustically vibrates the saliva surrounding the bristles. Similar acoustic vibrations have significantly altered the function and structure of bacteria and reduced their ability to adhere to a model dental surface (saliva-treated hydroxyapatite).<sup>17-19</sup> An electron microscopic study of *A. viscosus* showed that exposure to the fluid forces of the sonic toothbrush shortened and/or removed the fimbriae of these bacteria, which substantially decreased their ability to adhere to a model surface.<sup>19</sup> Laboratory studies have shown that the fluid dynamic forces generated by the Sonicare remove plaque bacteria from dental surfaces as far as 4mm beyond the reach of the bristles.<sup>20</sup>

Orthodontic patients presumably would not need to use as much pressure with the Sonicare toothbrush as they do with conventional or electric toothbrushes. Simply keeping the brush in an area for a sufficient time achieves plaque removal that was previously possible only with higher tactile pressures.<sup>12</sup> This article describes a



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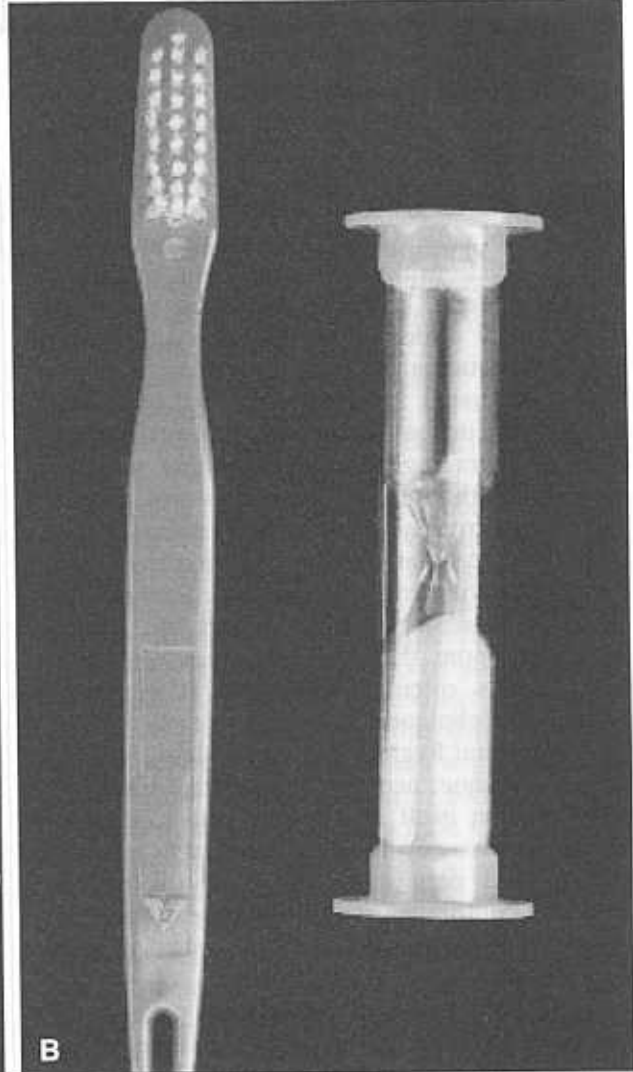
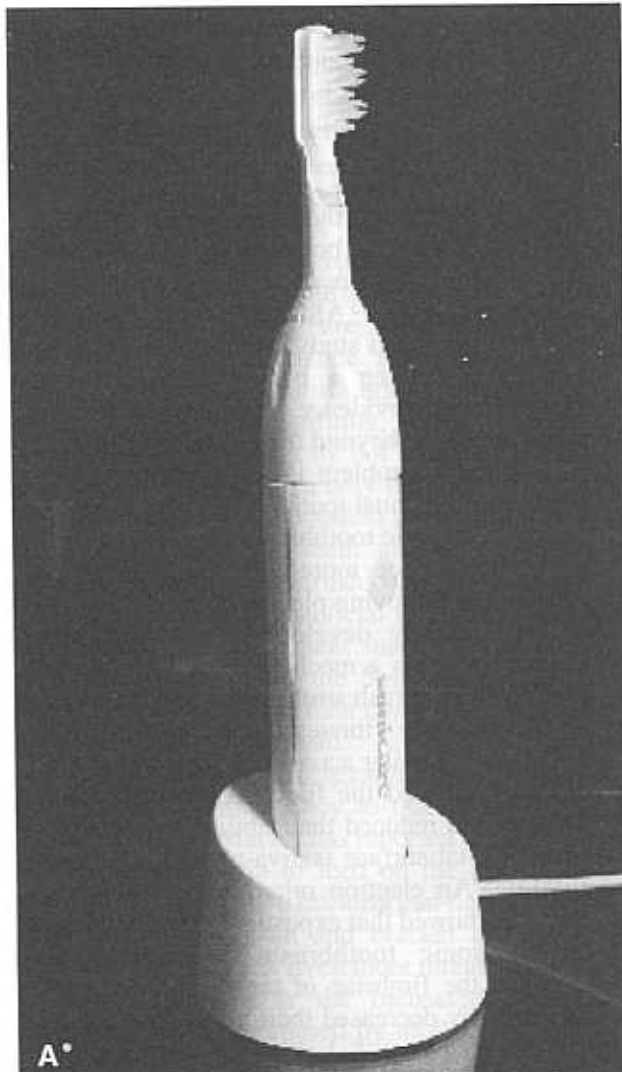


Fig. 1 A. Sonicare toothbrush with built-in two-minute timer. B. Manual toothbrush and two-minute timer.

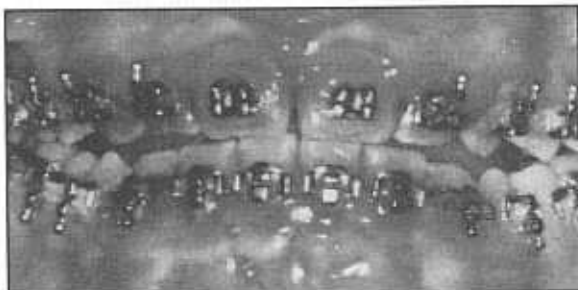


Fig. 2 Plaque stained with disclosing solution prior to evaluation with Hygiene Analysis Index.



Fig. 3 Periodontal probe used in Modified Papillary Bleeding Index.

study designed to measure the efficacy of the Sonicare in patients with chronic oral hygiene deficiencies.

## Materials and Methods

Forty adolescent patients from a private orthodontic practice were selected for the study on the basis of a single behavioral feature— intractable and habitual poor oral hygiene. Only patients with both maxillary and mandibular bonded orthodontic appliances were included; patients with systemic diseases requiring drugs capable of suppressing inflammation, such as corticosteroids, immunosuppressives, and non-steroidal anti-inflammatory drugs, were excluded. None of the patients in the study group were taking antibiotics or using oral chemotherapeutics such as chlorhexidine.

The forty patients were divided into two groups. One group (experimental) received the Sonicare toothbrush, and the other (control) received a manual toothbrush with multitufted .005" bristles that is ordinarily used by patients in this practice (Fig. 1).

Each patient was instructed to brush at home twice daily (morning and evening) using a common dentifrice (Colgate\*\*) for two minutes. The Sonicare has a built-in two-minute timer; the manual brushers were supplied with two-minute timers. The patients were instructed not to use any other oral hygiene aids such as floss, mouthrinses, or oral irrigators. Each person was given thorough instructions in how to use the assigned brush (modified Bass technique<sup>21</sup>), even though this instruction was redundant for the manual toothbrushers.

The Sonicare patients were encouraged to use a plastic ring damper, which significantly reduces the vibratory power of the toothbrush, for one week before brushing with the Sonicare at full power. This gradual build-up, known in behavioral parlance as "shaping", is a proven method of getting individuals to learn a new way

of doing something by taking a small, predictable step rather than a large, uncertain one.<sup>9</sup> Clinical investigators often overwhelm their subjects by expecting them to perform behaviors that are beyond their ability to understand or learn quickly. Use of the "shaping" principle enabled patients with inflamed and sensitive gingivae to acclimate gradually to more power and sonic vibrations, so that the prescribed use of the Sonicare would be more certain.

At the initial visit, the patient and parents read and signed an informed-consent form. The patient was then arbitrarily assigned to one of the groups and provided with brushing instructions, the toothbrush (and timer if applicable), and dentifrice. At the initial and subsequent appointments, a red disclosing solution was applied to the teeth with a light swabbing motion, and photographs were taken for future reference (Fig. 2).

Only the facial surfaces of the maxillary and mandibular six anterior teeth were evaluated in this study, using an abbreviated Hygiene Analysis Index.<sup>22</sup> If there was any stained plaque evident on the surface being examined, it was given a rating of 1; if not, it was given a rating of 0. A percentage score was calculated for each subject by dividing the number of stained surfaces by the number of examined surfaces.

Additionally, the mesial papillae between the anterior teeth of each patient were scored according to the Modified Papillary Bleeding Index.<sup>23</sup> Bleeding from the gingival sulcus elicited by gentle probing is a sensitive, objective indicator of early gingivitis.<sup>24</sup> In this evaluation, a blunt Williams Periodontal Probe\*\*\* was gently placed in the gingival sulcus of the mesial line angle of the tooth surface and carefully swept into the mesial papillary region (Fig. 3). Scores were assigned as follows:

- 0 = no bleeding within 30 seconds
- 1 = bleeding between 3 and 30 seconds
- 2 = bleeding within 2 seconds
- 3 = bleeding immediately upon probe placement

Patients were seen at three-to-four-week intervals and examined, photographed, evaluated, and scored for plaque and sulcular bleeding.

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\*\*\*Hu-Friedy Manufacturing Co., Chicago, IL.

TABLE 1  
PLAQUE AND BLEEDING INDICES AT EACH EVALUATION

	N	Baseline		Visit 2		Visit 3		Visit 4	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
<i>Plaque Index</i>									
Manual	14	0.99	0.02	0.90	0.19	0.92	0.12	0.93	0.13
Sonicare	18	0.98	0.08	0.91	0.17	0.84	0.25	0.80	0.23
<i>Bleeding Index</i>									
Manual	14	1.57	0.42	1.86	0.46	1.79	0.45	1.81	0.24
Sonicare	18	1.74	0.70	1.22	0.55	1.45	0.47	1.34	0.53

The study was originally planned to last only three months, but due to missed appointments, it was extended until each patient had been evaluated four times. Several patients dropped out for various reasons; the final sample included 18 Sonicare subjects and 14 manual subjects.

## Results

The two groups started out with statistically equivalent levels of plaque (Table 1). By the second visit (four weeks), both groups showed a drop in plaque scores. However, while the manual group stayed at this level, the Sonicare group's plaque scores decreased further by the third and fourth visits.

Because the plaque scores were binary (0 or 1), non-parametric statistical analysis was performed with a Kruskal-Wallis test. There was a statistically significant decrease in plaque over time with the Sonicare brush ( $p = .005$ ), but not with the manual brush ( $p = .316$ ). The Sonicare group displayed a plaque reduction of about 20% by the third visit (approximately 12 weeks), compared to 6% for the manual group (Fig. 4).

The mean Modified Papillary Bleeding Index baseline scores were slightly but not significantly different ( $p > .05$ ). Repeated measures multiple analysis of variance indicated a significant device-by-time effect ( $p = .013$ ), meaning the bleeding scores for patients using these two devices followed different patterns over time.

Gingival bleeding actually worsened in the manual group, while there was a significant reduction in bleeding in the Sonicare group (Fig. 5).

## Discussion

The Hygiene Analysis Index and Modified Papillary Bleeding Index are not the most sophisticated instruments available for assessing oral health, but they have proven useful in other studies and permit the evaluation of oral hygiene in an ordinary clinical environment.

One might fault the failure to pair the two groups in this study for plaque and bleeding scores. However, the baseline scores indicated statistical equivalence and therefore obviated identical pairing. One might also criticize the decision to evaluate only anterior teeth, but many of these patients had mixed dentitions with unerupted posterior teeth, and all had fully bonded maxillary and mandibular anterior teeth. These practical considerations made the anterior teeth the most appropriate for a valid comparison.

Although the control group members received additional and more explicit brushing instructions, along with a separate two-minute timer, the neglectful toothbrushing practices that made them eligible for inclusion in this study appeared to continue. The manual group showed no material improvement in plaque scores, along with a significant deterioration in bleeding

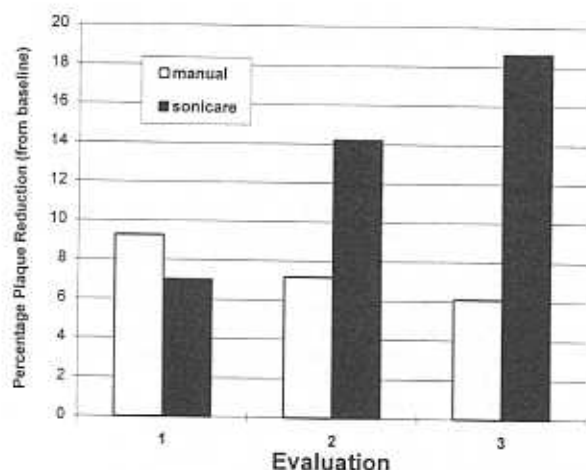


Fig. 4 Percentage reduction in plaque, as measured with Hygiene Analysis Index, compared to baseline, with evaluations performed at approximately one, two, and three months.

scores, while the Sonicare group demonstrated improvement in both.

Any new oral hygiene device must satisfy concerns about its safety. No obvious damage to the teeth or gingivae was observed from either toothbrush during this evaluation. Although the study lasted only a few months, more intensive investigations have also failed to discover any evidence of damage from the Sonicare toothbrush.<sup>16-25</sup> Bond failures were not specifically measured, but there was no obvious difference in the need for rebonding brackets between the two groups.

In this study, the Sonicare brush clearly demonstrated its superiority over manual brushing in removing supragingival plaque and in improving gingival health. A longer study of 12 to 30 months might reveal whether this improvement can be sustained throughout orthodontic therapy.

Patients with good toothbrushing habits may be capable of maintaining proper oral hygiene regardless of the shape, configuration, or type of cleaning device used. Yet there remains in every practice a large number of patients who are unable to properly clean their teeth. The

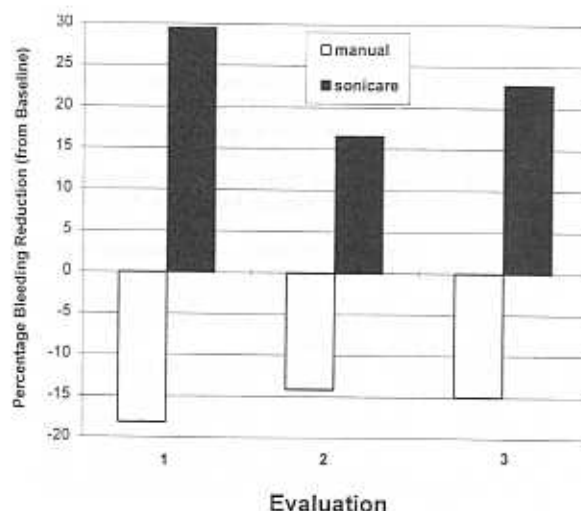


Fig. 5 Percentage reduction in bleeding, as measured with Modified Papillary Bleeding Index, compared to baseline, with evaluations performed at approximately one, two, and three months.

Sonicare toothbrush, with its combination of high-speed brush movement and fluid dynamic activity, appears to circumvent the reluctance of low-sensitivity-threshold patients to apply sufficient effort to remove dental plaque. Thus, the Sonicare may help many orthodontic patients improve their oral health and, consequently, lower their susceptibility to dental diseases.

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