This study evaluates the effectiveness of the Collis-Curve toothbrush which has curved bristles in comparison with a control usage of a straight bristle toothbrush in removing oral accumulations of plaque and debris and preventing gingivitis.

A study of the effectiveness of two types of toothbrushes for removal of oral accumulations

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The brushing of the teeth and gingiva has been the home care procedure most widely recommended to promote oral cleanliness.[1] Its purpose is to remove oral accumulations of plaque and debris and thereby assist in the prevention of dental disease. When used with an appropriately abrasive dentifrice, toothbrushing also helps to keep the teeth free of stains that sometimes accumulate.

Toothbrushing is also a method by which fluoride dentifrices are applied to the teeth. The type of toothbrush that should be used depends largely on the method of toothbrushing, positioning of the teeth, and manipulative skills of the person. The brush should conform to the individual requirements in size, shape, and texture and must be easily and efficiently manipulated, readily cleaned and aerated, impervious to moisture, and durable and inexpensive. Important functional qualities include flexibility, softness, and diameter of bristles as well as strength, rigidity, and lightness of the handle.

Design of the toothbrush is secondary to the requirements of usefulness, efficiency, and cleanliness. Limitations in size and shape are dictated by the curvilinear alignment of the teeth and the anatomic characteristics and structures that restrict the concavity of the lingual aspect of the arch, the mandibular ramus, the cheeks, and the lips. On the basis of current research, no specific toothbrush can be recommended as being superior for routine use for the removal of plaque and the control of periodontal disease.[2-8] No difference has been found between multitufted and regular toothbrushes in plaque-removing properties when the roll technique was used.[7] In one study,[8] a soft bristle brush was found more effective in plaque removal.

Several methods of toothbrushing have been recommended. No significant differences in cleaning efficiency have been found in studies of the Bass, Charter's, scrub and roll, and modified roll techniques.[9-12] All studies indicate that any method of brushing is ineffective in removing the proximal plaque. The thoroughness with which a person brushes is more important than any specific technique used, and the instructions, the supervision, the manipulative skill of the person, and the problems of the dental patient are all important factors in how well toothbrushing will remove dental plaque.[1]

A toothbrush recently has been developed and manufactured that has curved monofilament .009-in diameter bristles on the lateral aspects of the brush head and a short row of ⅛ in-long bristles in the center. The brush, named Collis-Curve after its creator Dr. George Collis, is reported to clean interproximal and gingival sulcular areas more effectively than a straight bristled brush when used in a horizontal brushing method.[13] The curved bristles "bunch up" as the toothbrush is moved horizontally along the occlusal surfaces of the teeth. According to the developer of the brush, the curvature of the bristles causes them to enter the interproximal and sulcular areas with a drawing and scaling action if used according to the Bass technique. Because of the softness of the curved bristles, any resistance theoretically causes the bristles to bend back on themselves and not puncture or otherwise injure the gingival tissues or cause as much tooth abrasion as a straight bristle brush.

The purpose of this study was to evaluate the effectiveness of the Collis-Curve brush in removing oral accumulations of plaque and debris and preventing gingivitis when compared with a control group using a straight bristle brush.

Methods and materials

A total of 578 children in middle schools (grades 6, 7, and 8) were examined in 1984 and 1985. For the purpose of this study, both the gingival index and the plaque index scores (Silness and Loe plaque index) were used.[14] In addition, DMF and def examinations were performed on each child. Before the examinations, two examiners performed the examinations on eight children for gingival index and plaque index scores for purposes of calibration at both baseline and subsequent examinations. Differences between examiners were minimal and were resolved at the time of calibration. The same quadrant (mandibular right) was scored by each examiner.

Dental examinations were conducted in the physical education rooms in the schools using modern, portable dental chairs and portable lights of high quality. The children were examined at the same time of day for both the baseline and follow-up examinations.

After being examined, each child was given a toothbrush. Toothbrushes were randomly drawn from a cardboard box containing an equal number of curved and straight bristle brushes. A notation of "C" for a curved or "R" for a regular straight bristle brush was entered on the upper right corner of the examination form by the dental hygienist.

The regular or straight brush issued to the children was an Anchor toothbrush, classified by the manufacturer as an adult toothbrush. It is smaller than most adult toothbrushes on the market today; however, its size was closest to that of the curved bristle brush, and for that reason, it was chosen for this study.

The children in the study were given instructions about the proper use of toothbrushes in cleaning the teeth. All had received varying degrees of oral hygiene teaching as a part of overall health instruction. During National Children's Dental Health Month in February, dentists from the community visit schools to perform dental screening and referral; they also provide a degree of dental health education.

Table 1 ■ Number of children examined; the gingival index score is shown from the baseline and follow-up examinations after the two types of toothbrushes had been provided for 5 weeks.

Score	Baseline (no.)	Reexamination		Total
		Regular brush	Curved brush	
0	117	65	136	201
1	247	106	88	194
2	166	54	16	70
3	48	25	5	30
Total	578	250	245	495
Mean	1.251	2.328	1.815	1.167

Table 2 ■ Number of children examined; the plaque index score is shown from the baseline and follow-up examinations after the two types of toothbrushes had been provided for 5 weeks.

Score	Baseline (no.)	Reexamination		Total
		Regular brush	Curved brush	
0	55	38	123	161
1	242	102	77	179
2	190	67	36	103
3	48	43	9	52
Total	578	250	245	495
Mean	1.325	1.460	0.718	1.093

Table 3 ■ Analysis of variance: gingival index—Fairhope, AL.

Source	Sum of squares	*df*	Mean of squares	Variance ratio
Toothbrush	7.3160	1	7.3160	6.209
Residual	128.4318	109	1.1783	
Total	135.7477	110	1.2341	

Variable	No.	Mean	SD
Curved	57	0.42105	0.98102
Regular	54	−0.09259	1.18590

Pooled SD: 1.08548; pooled standard error: 0.14378; mean of all observations: 0.17117.

Results

The oral health status of the children in these schools was generally fair to good. Both communities are served by fluoridated community water supplies, and children from outlying areas drink water from wells suspected to contain some natural fluorides.

Five weeks after the baseline examinations were recorded, follow-up examinations of only the gingival index and plaque index were performed. Of the initial 578 children, 495 were reexamined, 250 of whom had received a curved bristle brush and 245 a straight bristle brush.

During these reexaminations, neither examiner knew the type of brush issued to the children. Reexaminations were performed on children at random as they appeared in line; thus the two examiners did not know who had performed the initial examination. The recorders for the examinations were seated behind the examiners and had been instructed to cover the corner of the form to prevent the examiner from accidentally discovering the type of brush given to the student. Results of the examinations are given in Tables 1-12.

Statistical analyses were completed by comparing the differences between the individual scores at the two examinations as input data. Scores at the second examination were subtracted from the respective score for each student at the first examination, in accord with the other statistical principles used in the design of the study.

The analysis of variance was supplemented by a *t*-test of the difference between the percentages of students for whom conditions improved during the project. The χ^2 test, the most widely used nonparametric technique, was also applied. The level of significance was set at 5% before the calculations were started.

The gender data were pooled, and the data from the two schools were analyzed independently for both gingivitis and dental plaque.

Tables 3 and 4 indicate the results of an analysis of variance performed on the

scoring of the gingival index in the two schools, one in Fairhope, AL, and the other in Foley, AL.

The data in Tables 3 and 4 indicate that an improvement occurred in the gingival index in both schools for both types of toothbrushes. For each analysis, the difference was statistically significant (5% level) with more improvement for students who used the toothbrushes with curved bristles.

Tables 5 and 6 show the results of an analysis of variance performed on the scoring of the plaque index in the two schools.

Again, the data in Tables 5 and 6 indicate a statistically significant improvement in the plaque index (at the 5% level of significance), regardless of the toothbrush used. However, more improvement is indicated for students who were issued the curved bristle brush.

Tables 7 and 8 relate to data subjected to analysis by a *t*-test, the significance of the differences between the percentages of students whose conditions improved during the project. These two tables indicate that there was a significant improvement in gingival scores (at the 5% level) for all students in the project in both communities. The most improvement, however, occurred among those students using the curved bristle brush, with slightly more improvement in Foley, AL, than in Fairhope, AL.

The *t*-test was also applied to the data collected on scores of the plaque index. The results of this analysis are shown in Tables 9 and 10.

Plaque scores also improved in both groups in both towns, with those students using the curved bristle brushes showing the most improvement.

The χ^2 statistic was used to test independence and goodness of fit between distributions but not between parameters. The tests indicate statistically significant results, in this case, at the 5% level.

Tables 11 and 12 show the results of a test of the hypothesis that the variables (use of regular or curved brushes) are independent, using the χ^2 statistic.

The χ^2 tests in Tables 11 and 12 indicate rejection of the hypothesis of independence of the two characteristics (toothbrushes). The term independent in this context means that the distribution of one characteristic should be the same regardless of the other characteristic. Comparing the data from scores for the gingival and plaque indexes in the actual sample of 495 children with the theoretical proportional distributions in the population, the hypothesis must be rejected because they are significantly different and do not fit. The χ^2 techniques confirm the difference in results in the variables in the sample population of the

Table 4 ■ Analysis of variance: gingival index—Foley, AL.

Source	Sum of squares	*df*	Mean of squares	Variance ratio
Toothbrush	23.6340	1	23.6340	28.981
Residual	208.7691	256	0.8155	
Total	232.4031	257	0.9043	

Variable	No.	Mean	SD
Curved	127	0.82677	0.92663
Regular	131	0.22137	0.87960

Pooled SD: 0.90305; pooled standard error: 0.08013; mean of all observations: 0.51938.

Table 5 ■ Analysis of variance: plaque index—Fairhope, AL.

Source	Sum of squares	*df*	Mean of squares	Variance ratio
Toothbrush	9.3258	1	9.3258	8.003
Residual	127.0166	109	1.1653	
Total	136.3423	110	1.2395	

Variable	No.	Mean	SD
Curved	57	0.89474	0.97622
Regular	54	0.31481	1.17881

Pooled SD: 1.07949; pooled standard error: 0.14298; mean of all observations: 0.61261.

Table 6 ■ Analysis of variance: plaque index—Foley, AL.

Source	Sum of squares	*df*	Mean of squares	Variance ratio
Toothbrush	31.9516	1	31.9516	33.830
Residual	241.7887	256	0.9445	
Total	273.7403	257	1.0651	

Variable	No.	Mean	SD
Curved	127	0.80315	1.03156
Regular	131	0.09924	0.91024

Pooled SD: 0.97185; pooled standard error: 0.08624; mean of all observations: 0.44574.

Table 7 ■ *t*-test: gingival index—Fairhope, AL.

Rate of improvement	Percent	*t*
Curved: 26 of 57	45.61	2.439
Regular: 13 of 54	24.07	

Table 8 ■ *t*-test: gingival index—Foley, AL.

Rate of improvement	Percent	*t*
Curved: 83 of 127	65.35	4.815
Regular: 48 of 131	36.64	

Table 9 ■ *t*-test: plaque index—Fairhope, AL.

Rate of improvement	Percent	*t*
Curved: 36 of 57	63.16	2.425
Regular: 22 of 54	40.74	

Table 10 ■ *t*-test: plaque index—Foley, AL.

Rate of improvement	Percent	*t*
Curved: 80 of 127	62.99	4.945
Regular: 44 of 131	35.59	

Discussion

The scores obtained by using the gingival and plaque indexes create peculiar problems because of the basic nature of the indexes. Such data provide appreciable information, but do not fulfill the stringent requirements for traditional parametric statistical analysis. Accordingly, the aforementioned methods for analysis of the differences in scores were used.

The significant improvement in both gingival and plaque scores in the two communities for students using regular as

Table 11 ■ Gingival index—reexamination total.

Score	Regular brush	Curved brush	Total
0	65 (101.52)*	136 (99.48)*	201
1	106 (97.98)*	88 (96.02)*	194
2	54 (35.35)*	16 (34.65)*	70
3	25 (12.63)*	5 (14.85)*	30
Total	250	245	495

*Theoretical frequencies reject hypothesis of independence.
$\chi^2 = 66.43$; $df = 3$; $\chi_{95}^2 = 7.81$.

Table 12 ■ Plaque index—reexamination total.

Score	Regular brush	Curved brush	Total
0	36 (81.31)*	123 (79.69)*	161
1	102 (90.40)*	77 (88.60)*	179
2	67 (52.02)*	36 (50.98)*	103
3	43 (26.26)*	9 (25.74)*	52
Total	250	245	495

*Theoretical frequencies reject hypothesis of independence.
$\chi^2 = 79.89$; $df = 2$; $\chi_{95}^2 = 7.81$.

well as curved bristle brushes was not completely surprising. An increased awareness of and attention to improved oral health by both students and teachers were noted during the brief periods the programs were being conducted in the schools.

The statistically significant improvement among students using the curved bristle brush would appear to be a direct result of the functional efficiency of the brush over that of the regular brush. No distinctions were made to students or teachers to point out that one kind of brush might be more efficient or require less effort in brushing the teeth, but students were given encouragement to try to maintain a healthy oral condition by brushing the teeth regularly.

Conclusion

On the basis of results obtained in this study, it appears that the use of the curved bristle brush significantly improves the condition of the gingiva and helps in removing dental plaque when used by children of middle school age (grades 6, 7, and 8).

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Information about the manufacturers of the products mentioned in this article may be available from the authors. Neither the authors nor the American Dental Association has any commercial interests in the products mentioned.

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