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Toothbrush pressures of orthodontic patients

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The intention of this study was to determine whether toothbrushing pressures varied significantly between groups of orthodontic patients who were good toothbrushers and those who were poor toothbrushers. Seventy-two patients undergoing full-banded orthodontic treatment were selected from the author's practice and were subjectively paired by him according to their habitual oral hygiene. One group of thirty-six patients who habitually displayed poor oral hygiene was compared to a group of thirty-six patients who habitually displayed good oral hygiene. A specially designed strain gauge with a force-averaging feedback mechanism was attached to each patient's manual toothbrush, and the force with which that patient brushed was averaged and recorded in pounds. The poor brushers averaged 0.20 pound, whereas the average pressure of the good brushers was 0.89 pound. The statistical evidence indicates that the difference between the two groups is highly significant and is unlikely to be due to chance alone. This study has shown that toothbrush pressures can be easily and accurately measured. The attempt to objectify a single characteristic of toothbrushing behavior in an orthodontic population is an effort to avoid the medical model explanation of behavior vis-a-vis the nonspecific and subjective word *attitude*. Future studies will determine whether poor toothbrushers can be changed into good toothbrushers through the progressive acquisition of greater toothbrushing forces.

Key words: Oral hygiene, toothbrush pressure, feedback, strain gauge, behaviorism, medical model, attitude

Toothbrushing seems to be such a mundane, simple task that dentists are universally frustrated when patients fail to learn how to do it. Occasionally patients are found who do not have sufficient motor skills to brush well, but ordinarily most patients who do not brush well fall into the category of "plenty of skill, but not enough will." That is; orthodontists have considered these patients to be those who could overcome their poor toothbrushing habits if they just wanted to.

For these patients, orthodontists have used various and sundry techniques, such as cajolery, insult, encouragement, ridicule, and exhortation, but on balance these techniques have never produced the kind of result that have encouraged orthodontists to claim success.

It is very tempting for orthodontists to describe poor brushers as persons with severe character defects that are beyond remedy and to mutter something like "I can't help them if they don't wanna." Once this point is reached, there are few attempts to alter the patient's oral hygiene behavior and a mutual pessimistic resignation settles in.

A clearer definition of the problem might perhaps be the best place to begin in a search for a solution to the problem of poor oral hygiene by orthodontic patients. The feeling among orthodontists that poor brushers are just ornery has not helped to produce a technique that reliably corrects poor toothbrushing.

This kind of generalization has, in fact, obscured a rational, objective search for a solution.

This particular study was designed to determine whether toothbrush pressures might somehow be related to the toothbrushing problem because, clinically, it seems that poor brushers are more reluctant to brush vigorously than those patients who consistently have clean mouths.

REVIEW OF THE LITERATURE

The compilation of a bibliography of articles concerning the desirability and necessity of good oral hygiene by the orthodontic patient would be an exhausting task. Hundreds of articles have been published relating to the oral hygiene of orthodontic patients. These articles have emphasized various aspects of oral hygiene, such as dietary requirements,¹ brushing techniques,²⁻⁵ flossing regimens,⁶ water irrigation,⁷ etc. An excellent article on oral hygiene techniques for orthodontic patients was published by Zachrisson⁸ in 1974 and still remains an ideal source for references and review of oral hygiene techniques.

This enormous emphasis by the profession is perhaps well taken since, clinically, there seems to be such a direct relationship between the quality of orthodontic treatment and the oral hygiene that a patient habitually practices.⁹⁻¹³ Efficient orthodontic treatment



Fig. 1. Representative of the good-brushing group. Note absence of plaque, gingival hemorrhage, and hypertrophy.

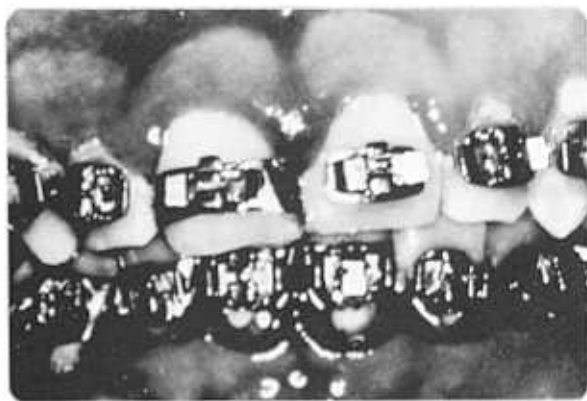


Fig. 2. Representative of the poor-brushing group. Note presence of plaque, gingival hemorrhage, and hypertrophy.

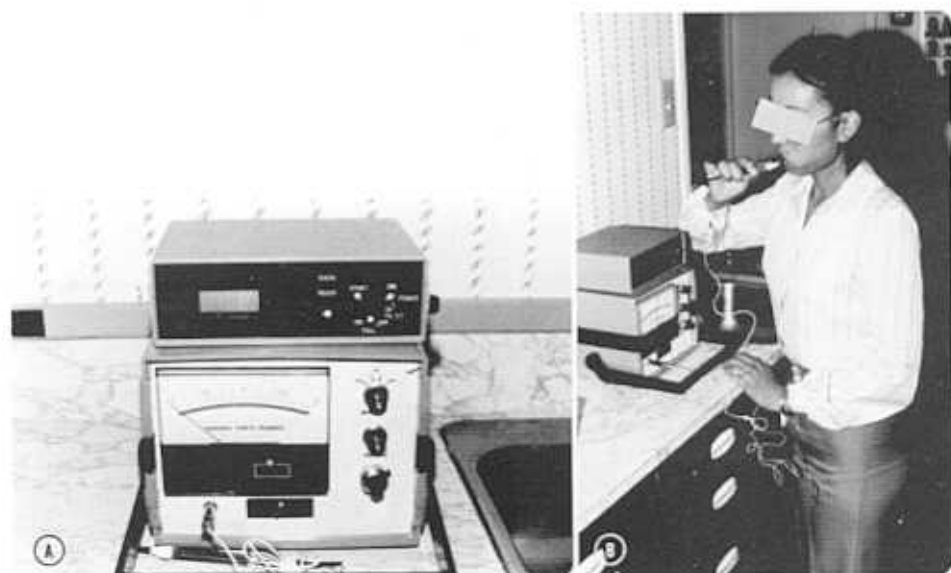


Fig. 3. A, Toothbrush-feedback unit. B, Patient using strain-gauge toothbrush.

is the norm for patients who practice good oral hygiene, whereas it is rare for those patients whose oral hygiene is typically poor.

A review of the literature reveals very few studies conducted with strain gauges or transducers attached to manual toothbrushes.¹⁴⁻¹⁶ None of the above-mentioned articles sought to differentiate the amount of force that orthodontic patients habitually use.

Muhlemann was trying to discover the abrasiveness of different kinds of toothbrush bristles while patients used a transducer type of toothbrush that allowed continuous visual feedback. This feedback mechanism permitted a degree of force standardization during the study.

The study by Allen and Nahodil¹⁴ was an effort to discover toothbrushing forces with a manual toothbrush

in a random human sample. No attempt to differentiate patients as to quality of oral hygiene was made, but the forces they measured ranged from 2.5 to 11 Newtons.

The study by Fraleigh, McElhaney, and Heiser¹⁶ measured the forces delivered by eight kinds of toothbrushes. The maximum normal forces ranged from 70 Gm. to 1,310 Gm. They did not try to differentiate the quality of the habitual oral hygiene practiced by the test group and so concluded that, since the forces varied so much, no standards of force could be hypothetically set.

MATERIALS AND METHODS

Seventy-two patients undergoing full-banded orthodontic treatment were selected from my own practice for this study. The patients were selected according to a

Table I. Good oral hygiene toothbrushing scores

Patient no.	Average brushing score (pounds)
1	0.64
2	1.67
3	0.96
4	0.92
5	0.63
6	0.99
7	1.14
8	1.30
9	1.03
10	1.04
11	0.88
12	0.80
13	0.58
14	0.60
15	0.87
16	0.94
17	0.75
18	0.61
19	0.73
20	0.90
21	0.82
22	1.04
23	1.13
24	0.72
25	0.82
26	0.64
27	1.27
28	0.79
29	1.14
30	1.34
31	0.73
32	0.54
33	0.61
34	0.61
35	0.60
36	1.27
Mean score =	0.89 pounds
Standard deviation =	0.26
Standard error =	0.043
Range =	1.13
Mode =	0.61
Median =	0.845

Table II. Poor oral hygiene toothbrushing scores

Patient no.	Average brushing score (pounds)
1	0.40
2	0.34
3	0.28
4	0.34
5	0.23
6	0.35
7	0.18
8	0.04
9	0.19
10	0.21
11	0.11
12	0.01
13	0.17
14	0.28
15	0.11
16	0.14
17	0.34
18	0.37
19	0.15
20	0.08
21	0.14
22	0.37
23	0.29
24	0.27
25	0.28
26	0.07
27	0.05
28	0.14
29	0.21
30	0.17
31	0.16
32	0.17
33	0.22
34	0.34
35	0.24
36	0.01
Mean score =	0.206 pounds
Standard deviation =	0.108
Standard error =	0.018
Range =	0.39
Mode =	0.34
Median =	0.20

subjective assessment of their toothbrushing effectiveness during several months of orthodontic treatment. Thirty-six patients who were among the best brushers in the entire practice were selected as the good toothbrushing group, while thirty-six patients who were among the worst toothbrushers made up the poor toothbrushing group (Figs. 1 and 2).

All the participants in this study had been given the same oral hygiene instruction at the beginning of their orthodontic treatment, and this technique was described in an earlier publication. It is enough to say at this point that the toothbrushing technique taught was a marginal

scrub method, with strong emphasis on behavioristic techniques of learning.¹⁷

Assignment to one of the two groups was made during a routine clinical visit. The patient was asked to brush with a personal toothbrush (Dental H Bi Po orthodontic toothbrush) which was habitually used at each clinic visit. This personal toothbrush was attached to a special strain gauge that was adapted to measure and average the amount of force, in pounds, that a patient used over a 30-second period of uninterrupted toothbrushing. The 30-second period of time was selected because previous experiments with the apparatus using

times of 180 seconds, 120 seconds, 60 seconds, and 30 seconds showed that the 30-second interval was the best for permitting an uninterrupted testing session.

It was surprising to find how quickly patients' arms fatigued with the time intervals greater than 30 seconds. It became obvious that ordinary brushing times do not approach even 60 seconds, and this seemed to be as true for good brushers as for bad ones. The duration of brushing may not be as important as previously thought.¹⁸

The instrument used in this study was designed to my specification by Ouroboros Engineering Company of Albuquerque, New Mexico. A strain-gauge unit that quantifies force with a range of 0 to 2 pounds was developed so that it could be attached to each patient's toothbrush. A force-averaging mechanism was also a part of this toothbrush-feedback unit so that the various forces that were used by the patient during the 30-second test period could be given an average score (Fig. 3).

RESULTS

The average toothbrushing scores achieved by the patients in the good and poor toothbrushing groups are shown in Tables I and II.

There was a wide difference in the average scores of the two groups. While the good toothbrushing group scored close to 1 pound of force with an average of 0.89 pound, the poor toothbrushing group scored an average of only 0.206 pound or four and one-half times less. The results were subjected to a t test for statistical significance. The t test is based upon the hypothesis that the mean toothbrushing score of one group is not significantly different from the mean score of another group. The t test formula is $t = \frac{X_p - X_g}{\sqrt{S.E._p^2 + S.E._g^2}}$ where

X_p = the mean of the poor brushing group

X_g = the mean of the good brushing group

$S.E._p$ = the standard error for the poor brushing group

$S.E._g$ = the standard error for the good brushing group

The 0.995 level of significance with 72 degrees of freedom is 2.576, and the t score achieved in this experiment was 3.495. Thus, there is an extremely high confidence level that the scores achieved by the two groups in this experiment are not due to chance alone. We could expect chance alone to explain these results in less than one experiment out of 1,000.

DISCUSSION OF RESULTS

There has been a tendency among orthodontists to attribute noncooperative orthodontic behavior to patient

stubbornness or obstinacy, but this presumes that non-cooperative behavior is a function of some kind of inner mental conflict or mind set. That approach has been historically known as the medical model, and its basic characteristics are the ideas of inner cause and outer symptoms.

The medical model has served those in the healing arts well when they were dealing with physical diseases, but its success in dealing with problems of behavior has been, at best, equivocal.¹⁹

From the medical model viewpoint, all of our outer behaviors are an indication of our inner mental state. If the inner state is in conflict, then the outer behavior reflects this inner stress. One of the popular buzz words that have evolved from this idea of inner cause and outer behavior is *attitude*, and this word has come to serve as both an explanation and an excuse for orthodontic patient behavior. That is, good patients have "good" attitudes and bad patients have "bad" attitudes.^{20, 21} Changing the attitudes of bad orthodontic patients is seemingly the focus of patient motivation in many orthodontic offices.

This current study has purposely avoided attitude as a motivational feature of patient cooperation, since this has been extensively studied by others.²²⁻²⁴ Rather, the present study has sought to differentiate a single behavior of good toothbrushers and bad toothbrushers vis-a-vis the amount of pressure used when brushing the teeth.

This study seems to show that there is a significant difference in the average toothbrushing pressure used by good brushers and that used by bad brushers. If this is true, then the next logical step would be to see if poor brushers can be turned into good brushers and subsequently into good orthodontic patients through the gradual acquisition of more brushing pressure. This will be the focus of future research.

SUMMARY

A study of toothbrushing pressures used by good orthodontic toothbrushers and poor orthodontic toothbrushers has been completed with a special strain-gauge toothbrush. The good orthodontic toothbrushers used a significantly greater amount of pressure when they brushed than did the poor orthodontic toothbrushers. The average difference of pressure is more than 0.5 pound. Future research will be confined to discovering whether poor toothbrushers can be changed into good toothbrushers by gradually increasing brushing pressures.

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