The Role of Toothbrushing in the Prevention and Treatment of Periodontal Disease: Personal Experience of Both Clinical and Experimental Observation for More than Thirty Years

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What is This?
THE ROLE OF TOOTHBRUSHING IN THE PREVENTION AND TREATMENT OF PERIODONTAL DISEASE: PERSONAL EXPERIENCE OF BOTH CLINICAL AND EXPERIMENTAL OBSERVATION FOR MORE THAN THIRTY YEARS

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ABSTRACT

There have been dramatic developments in the theory and therapy of periodontal disease in the last few decades. This paper focuses on the role of toothbrushing in the treatment and prevention of periodontal disease, based on the author's personal experience gained from both clinical and experimental observations for more than 30 years.

Even in the recent past, periodontal disease was considered to be untreatable because of various misconceptions regarding its etiology. Attention was concentrated mainly on systemic factors. As a result, periodontally-involved teeth were extracted mostly due to lack of technical know-how. The author devoted his primary investigative efforts to systemic factors and found that those were only minimally significant. Later, after using wild and captive monkeys to make extensive experimental studies on local factors, he was convinced that food habit (hard, fibrous, or soft) contributes directly to the etiology of periodontal disease which is restricted in the oral environment itself.

Today it is well-established that accumulation of bacterial plaque on the tooth surface is the most important single factor responsible for periodontal disease, and systemic influence can merely modify the condition. Therefore, the accumulated plaque should be mechanically removed by toothbrushing. The essence of mechanical toothbrushing is not only to remove the plaque but also to compensate for the mechanical stimulation of the gingiva (gingival massage), which is lacking with modern soft food. This lecture reviews the effect of methodical toothbrushing obtained from both clinical and experimental studies in animals.

INTRODUCTION

I appreciate this opportunity to address, in this keynote lecture, clinicians and researchers from home and abroad who are keenly interested in periodontal disease. This is a great honor, and I would offer my cordial thanks for this invitation.

To date, much research has been carried out to attempt to establish the relation between toothbrushing and the periodontal diseases. My lecture will include some of that work, but I would like to place special emphasis on the history of periodontology from the perspective of my personal experience. I think this will be more appealing, because there have been dramatic developments in the theory and practice of periodontology in the last three to four decades.

I started my dental career in 1941, forty-six years ago. At that time, the term so-called "alveolar pyorrhoea" was used instead of modern terms like "periodontal diseases" or periodontology, in the available texts in Japan, and only a little was taught regarding these important diseases in our dental classes.
The treatment of alveolar pyorrhoea was limited to scaling of tooth surfaces, irrigation of the mouth, gum massage with a finger tip, gingival surgery, lessening of occlusal load, and splinting of mobile teeth.

However, these procedures were only minimally effective and could not stop the progression of the disease. This ultimately led to the extraction of the involved teeth, which were then replaced by artificial dentures. The origin of this disease was believed to be due not only to local factors, such as food debris or calculus, but also to other important systemic factors influenced by nutrition, hormonal or autonomic nervous system imbalance, allergy, heredity, aging, and so on, which probably caused alterations in the body constituents by some unknown mechanisms and gave rise to periodontal disorders.

After graduating from Dental School, I enrolled in Medical School. After finishing my studies in medicine, I decided to return to dentistry to investigate the role of those alleged systemic factors on alveolar pyorrhoea by applying knowledge gained in Medical School.

**Local and Systemic Factors: Which are More Important?**

The main theme of my research work was to observe gingival hyperplasia associated with systemic administration of Dilantin, an excellent anticonvulsant used daily for the long-term treatment of epilepsy. Even repeated surgical treatments did not control the gingival hyperplastic condition if use of the drug was continued. For this reason, I believed that Dilantin was the best tracer to analyze the effects of systemic factors on local pathology. I studied the mechanism of initiation of this condition in both epileptic patients and in experimental animals.

In this clinical study (Ishikawa, 1959a), 887 epileptic patients who had been taking Dilantin were examined; in 56% of them, gingival hyperplasia of various degrees was found. Evaluation of the oral hygienic condition of those patients at that time would have been most appropriate for assessing the initiation of local pathology, but plaque- or calculus-scoring was not yet popular 30 years ago, and my concentration was mainly on systemic factors.

At first, rats (Ishikawa, 1959b) were used in the animal experiments, and Dilantin was administered daily at levels ten times that of the human dosage. No response was evident in the gingival condition. Having failed in rats, I selected cats as the alternative experimental animal. This was during the time of food scarcity in Japan; the cats were fed with the leftovers collected from the hospital. Administration of Dilantin in these cats (Ishikawa, 1959b) showed the same gingival changes as those seen in human beings.

**Consistency of Food and Gingival Health**

After our initial success, I had the opportunity to visit Tufts University in Boston from 1958 through 1960, where I carried out detailed experiments with the cat. In the United States, Purina Chow was the food of choice for experimental animals; this is an extremely hard, dried food pellet. Since I was sympathetic toward the animals, I mixed canned tuna fish with the hard food to make them eat more easily and satisfactorily.

A few weeks after the start of the experiment, Professor Glickman made me aware of the research article by Burwasser and Hill (1939), entitled "The effect of hard and soft diet on the gingival tissue in dogs". In this experiment, six dogs were divided into two groups: One group was fed the dried, hard Purina Chow, while in the other, Purina Chow was softened with water and served. After one year on these diets, the oral cavities of the hard-diet group were clean, and the gums remained healthy. On the contrary, in the soft-diet group, surfaces of the teeth were covered with an abundance of dental plaque and calculus, and the gums showed severe inflammation. Despite the fact I was both a medical and dental graduate, never did I imagine that the consistency of diet might have such a tremendous influence upon gingival health.

**Japan and the U.S. 30 Years Ago**

Thirty years ago at Tufts University, most of the graduate students from all over the world, including me, felt that the system of the University Hospital was strange because no dental patients were treated before they could master toothbrushing effectively. This system was followed more strictly in the Periodontology Department. Thus, various periodontal treatments were performed in absolutely clean mouths, and the results were excellent. [It may be mentioned here that 30 years ago, American dentistry was ahead of that of all other countries of the world.]

In 1960, after returning to Japan, I explained the importance of toothbrushing, particularly in the treatment of periodontal disease, to my University staff. Unfortunately, only a few colleagues of my Department seemed to grasp the importance of this new information; many of my fellow dentists in school found it uninteresting and ignored it. At that time, toothbrushing in Japan was utilized merely to whiten the tooth surface by scrubbing. It was assumed to be effective in the prevention of dental decay but to have no impact on alveolar pyorrhoea, because of the dentist’s strong belief that this disease was caused mainly by systemic factors. Under these conditions, I had to prove the effect of toothbrushing in the prevention and treatment of periodontal diseases.
WHY CIVILIZED PEOPLE
SHOULD BRUSH THEIR TEETH

I felt the necessity for the importance of toothbrushing to be properly understood by the dental student, dentist, and dental hygienist, so that they could educate their patients.

To demonstrate the importance of toothbrushing, I carried out some field studies on wild, semi-wild, and captive monkeys (Ishikawa and Yamazaki, 1964; Yamazaki, 1968; Ishikawa and Yamazaki, 1974). Group A consisted of 150 wild monkeys living on Mt. Taka-saki and depending upon natural food, namely, leaves, nuts, bark, buds, flowers, insects, and so on. Group B consisted of 113 semi-wild monkeys living in the natural environment of Mt. Iwata and feeding on raw vegetables, raw wheat, fruits, and so on. Group C consisted of 46 captive monkeys housed at the Inuyama Monkey Center for more than five years and fed with semi-solid food pellets and raw vegetables. A total of 309 Japanese monkeys' mouths was examined for this epidemiological study. For this purpose, an evaluation was made from the PMA index, pocket depth, radiograms, and oral hygiene index (OHI). When the PMA index was applied, a Gingival Inflammation Quotient (GIQ) was calculated for the three groups separately, with the following principle:

\[
GIQ = \frac{\text{No. of inflamed gingival units}}{\text{No. of elevated gingival units}}
\]

By this evaluation, GIQ was lowest in Group A, 17.7, followed by Group B, 41.6, and highest in Group C, 50.2 (Figs. 1 and 2). It was found that the prevalence of gingival inflammation was associated with the changes of eating habits from natural to artificial. Moreover, a significant correlation was found between GIQ and OHI in each group. The prevalence of tooth decay in deciduous or permanent dentition was also parallel to the gingival inflammation rate.

Today, many civilized people no longer have hard fibrous foods in their diets. Soft and cooked foods do not require vigorous chewing, which is essential to maintain good oral hygiene. Soft foods remain in the oral cavity and serve as substrate for the growth of micro-organisms which pollute the oral environment.

EFFECT OF TOOTHBRUSHING

I conducted the first clinical experiments (Imagawa et al., 1961; Okawara, 1965) on the effects of toothbrushing in collaboration with my colleagues at University Hospital. The patients taking part in the experiment were given brushing instructions without any dental paste. During the two months of the experimental period, all periodontal treatment was deliberately avoided. Brushing technique was checked from time to time and reinforced whenever necessary. The effect of toothbrushing was remarkably evident during the experimental period, and it further impressed everyone when the histopathological changes of gingiva, before and after the experiment, were presented at academic meetings.

Clinical effects of toothbrushing were monitored not only in common periodontal patients but also in the disease associated with systemic factors, namely, Dilantin administration for epilepsy, gingivitis in puberty or pregnancy, acute leukemia, etc. (Ishikawa et al., 1965; Ishikawa, 1965; Ishikawa, 1986). The results of those clinical experiments were also excellent. Hyperplastic gingivitis, which was associated with Dilantin and which did not regress even after repeated surgical removals, responded well to toothbrushing. Other types of gingivitis believed to be related to sys-
temic factors similarly showed excellent response to toothbrushing.

These results made everyone understand that diseases of the gingiva are mainly due to local causative factors. The disease is initiated in the presence of local irritants, and it may be further aggravated by systemic influences. In other words, systemic factors are never causative of gingival inflammation but merely modify the condition.

**Analysis of the Effect of Toothbrushing**

As described earlier, toothbrushing is the most fundamental therapeutic procedure to be followed in the management of periodontal diseases, but the mechanism by which it works was not sufficiently demonstrated before (Leonard, 1948). In order for the effect of brushing to be analyzed, an animal experiment was undertaken with four monkeys (Ishikawa, 1986; Uchiyama, 1981). The animals were fed a soft diet throughout the experimental period to establish and maintain gingival inflammation. After the establishment of gingivitis, their dentition was divided into quadrants according to the following experimental design:

1. One section served as the control area with no treatment at all (C).
2. One section received daily toothbrushing on tooth surfaces and the gums (B).
3. One section served as a stringent plaque control area, with use of a fine scaler and dental floss (P).
4. The last quadrant received only gingival massage with a toothbrush by careful covering of the teeth with a resin plate during brushing to avoid plaque removal from the tooth surface (M).

The gingival condition was evaluated regularly during four weeks of the experimental period. At the termination of the experiment, the animals were killed, and samples were taken for histometrical study. The results of this experiment demonstrated that in the control area (C), there were signs of severe inflammation with an abundance of cell infiltration and exudation, and no epithelial cornification was observed.

In the brushing area (B), there were almost no signs of inflammation, and the tissue was covered with cornified epithelium. The massage area (M) was also well-cornified, and inflammatory signs (including exudation and cell infiltration) were rarely found. The plaque control area (P) showed more distinct inflammatory signs in comparison with the massaging area (M). In the epithelial layer, cornification was almost missing, and vacuolization and intercellular edema were detected. The subepithelial layer showed dilatation of capillaries, exudation, and inflammatory cell infiltration. If the host-tissue resistance is of sufficient strength, parasites, even present in abundance, cannot cause severe inflammation.

In summary, from the results of these experiments, it may be suggested that plaque control alone should not be sufficient to control gingivitis. To maintain periodontal health, plaque control should be accompanied by sufficient gingival massage. That the host-parasite relationship plays a distinct role in gingival inflammation cannot be disputed.

**Conclusion**

In ancient times, people used to brush their teeth with wooden sticks. One end of a fibrous branch was crushed between the teeth to form bristles for brushing. Such wooden toothbrushes have a history of more than ten thousand years and are believed to have been employed soon after agriculture started. Later, this habit was combined with religious rituals and thus became more widespread. For instance, the Mohammedans pray five times a day, and brushing their teeth each time is compulsory before prayer. This kind of indigenous habit undoubtedly helps to maintain good oral hygiene. But now these habits are almost eliminated with the progression of civilization and development of science. Mechanical toothbrushing needs humble efforts, and it is time-consuming. Modern civilized man has a tendency to find a simpler and easier solution for everything; this is also the case with oral hygiene.

Recently, various chemical agents including chlorhexidine have been tested for dental plaque control. One disadvantage that comes to our attention is that prolonged exposure to any chemical agent would certainly be injurious to our health. However, the most important disadvantage in chemical plaque control is the complete absence of mechanical stimulation, which is physiologically needed for the gingivae.

We should keep in mind an old principle of biology that a developed organ or tissue lacking mechanical and physiological stimulation regresses quickly, and its recovery is often very difficult.

Finally, to treat and prevent periodontal diseases, in fact all oral disease, effectively, we dentists should approach our patients in such a way as to restrain them from drifting along the stream of civilization, since it is our sacred duty to keep them on a healthy course.

**References**
