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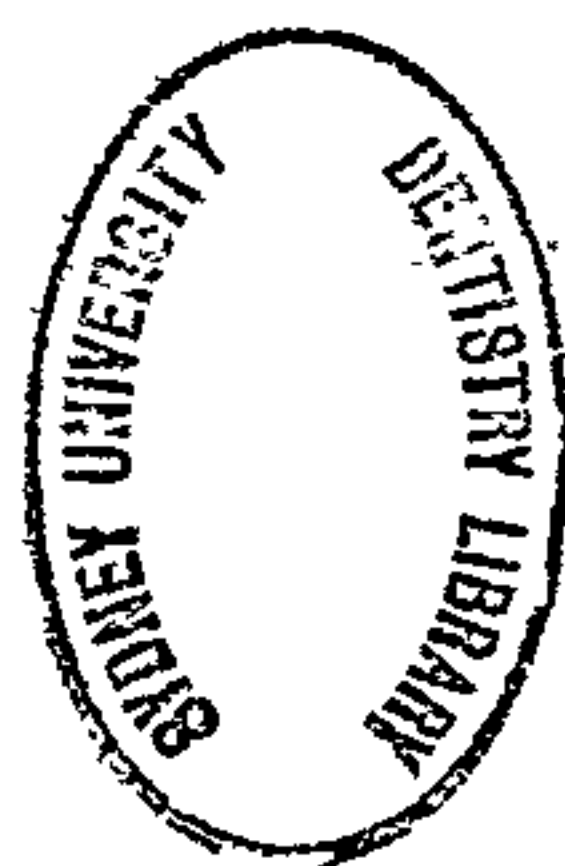
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ORAL CLEANSING



Thesis submitted as part of the
requirements of Diploma in
Public Health Dentistry

D. NARAYAN B.D.Sc. Qld.,
University of Sydney,
September, 1964.

The University of Sydney

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Today when the keynote of all health services is prevention, it is highly important that dentistry should be vitally interested in the development of controlling and preventing disease within its special field of activity.

The control and prevention of dental caries and periodontal disease presents one of the greatest challenges that must be met by the dental profession today. It is not sufficient that we try to perfect techniques to repair damage to the dental apparatus once it has occurred. It has been a general failing of the healing professions that the treatment of disease has been overemphasised and prevention minimised.

There is no doubt that today a larger proportion of people suffer from dental caries and periodontal disease than any other time in history. Not only is this so, it is true that communities where previous decay of the teeth was rare now have a fast increasing caries rate with all the side risks of ill health which go with it.¹

In studies conducted to determine the causes of tooth extraction, Brekhus² (1924) and Allen³ (1944) reached notable comparable conclusions. Caries and periodontal disease accounted for 92.62% of the tooth loss. Up to the end of fourth decade of life most of the teeth were extracted because of caries, with periodontal disease occupying a very

minor rate. However in individuals beyond the age of thirty five, periodontal disease became the major cause of tooth loss. Of additional interest is that caries resulted in extraction of an average of slightly more than three teeth per patient, per visit, while periodontal disease was the cause of mass extractions, accounting for an average loss of slightly more than ten teeth per patient.⁴

The observation that periodontal disease is the major cause of tooth loss in individuals beyond the age of forty is a significant one. However it does not mean that periodontal disease is limited to that age group. For the most part periodontal disease is a chronic condition.⁵ Dental caries and periodontal disease should be detected early and controlled. More important than early detection is prevention.

Fleming (1956)⁸⁹ writes, "The next step in our development is to advance our knowledge to a point, where dental diseases join the other so called preventable diseases. This step is certain as fact that children grow up to be adults, for disease like man goes through certain ages. In the beginning, when we know little of cause, we treat only empirically. As research adds to our knowledge of cause, we can control, then when the cause of disease is fully known we can prevent."

Most investigators writing about caries and periodontal disease control have stressed the importance of oral hygiene. According to Dunning⁶ the first large scale efforts to control dental caries were in the field of oral hygiene. Not until the second quarter of the twentieth century were other factors in the prevention of dental caries given any recognition at all.

In this Thesis I have critically reviewed the available literature on the value of cleansing in the control and prevention of periodontal disease and dental caries. For the purpose of this Thesis the cleansing agents are those measures specifically designed for, and aimed at removal of debris from the oral cavity. The most promising methods of cleansing will be discussed along with experimental evidence upon which their value is based.

PART A

Non Functional Cleansing and Dental Caries

"The origin and formation of the teeth are the work of nature alone. Their preservation depends as a rule upon the help afforded by art."

Pierre Fauchard, 1746.

Historical Background

Some of the earliest references to oral cleansing as a means of controlling dental disease are found in accounts of Arabian civilisation in Southern Europe about the ninth century A.D. The Arabs were leaders in medicine. They were also interested in the care of the teeth rather than in their extraction and replacement, and mouth hygiene was an established technique. The instrument they used was called a siwak, and consisted of a small wooden stick, the end of which was often chewed, the wood fibres being used as a brush.

During the Middle Ages in Europe a fairly definite set of rules for oral cleansing evolved, based on Arab writings. They appear in the fifteenth century, recorded by Giovanni of Arcoli. These rules involve a number of dietary prohibitions, including "viscous food such as figs and confectionery made with honey," and also directions for cleansing the teeth with dentifrice. Peter Foreest a Dutch physician of the sixteenth century, concentrated upon the harmful effects of "sugar and all sweet things."

In France in the 18th century Pierre Fauchard's book, *Le chirurgien dentiste* emphasized the need to keep the teeth clean if disease were to be prevented.¹⁰¹

Several other writers soon afterward stressed preventive measures in the dental field, including the importance of diet.

Another step towards prevention of dental disease was taken by M.L. Rhein in 1884. He coined the term "oral hygiene", which became popular. About the same time Leon Williams introduced the slogan, "A clean tooth never decays."

DENTAL CARIES

DENTAL CARIES is a disease of the calcified tissues of the teeth, characterized by a demineralization of the inorganic portion and a destruction of the organic substance of the tooth.⁶¹ It is the most prevalent chronic disease affecting the modern human race. This disease is unique in respect to all others in that it is unhealing and irreversible. Once it occurs, its manifestations persist throughout life even though the lesion is treated. There are practically no geographic areas in the world whose inhabitants do not exhibit some dental caries. It affects persons of both sexes in all races, in all socio-economic strata and in every age group. It begins usually in early childhood and increases into even late adulthood. Occasional individuals who develop no caries throughout their lives and who are designated as "caries-free" are one of the enigmas of dental science. No satisfactory explanation of their immunity has been found.

Hundreds of dental research investigators for more than a century have studied various aspects of the dental caries problem. Despite this extensive investigation, many aspects of etiology are still obscure, and efforts at prevention have only been partially successful!

Etiology of Dental Caries

In the production of dental caries two entirely different groups of factors are concerned, one predisposing to the disease, the other provoking or promoting it.

The more important of the predisposing factors appear to have their origin in those conditions which influence tooth structure qualitatively and therefore involve developmental and nutritional factors during the pre-eruptive life of the tooth. On the other hand, the caries provoking factors exert their influence upon the oral environment of the erupted tooth and are related to the retention on the tooth surface of fermentable carbohydrate residue of the diet and its subsequent degradation to acid end products by microorganisms and their enzyme systems.

The Miller chemicoparasitic theory focussed sharp attention upon the oral environment by emphasizing the importance of acid formation under mucin plaques on the teeth. This in turn, found its way into the language of the public through the slogan, "A clean tooth never decays."

In spite of ever increasing inadequacies the

Acidogenic theory of causation of dental caries still gives us the rationale for two of our most used methods for preventing dental caries after the teeth are formed. The slogan "A clean tooth never decays," may be impractical to the extent that we never clean our teeth completely of fermentable carbohydrate material, but this theory encourages us first to minimise this carbohydrate by brushing our teeth immediately after eating and second to avoid eating such foodstuffs.

It is generally accepted that dental caries begins on the exposed surfaces of the teeth, and bacteria which accumulate there are involved in the process.^{35,36} Most authorities agree that carious process is initiated by acid action, although proteolysis has been suggested.

The process may be summarised as follows

1. Substrate + $\frac{\text{Bacterial}}{\text{Enzymes}}$ Acid
2. Acid + Susceptible tooth — Caries

Substrate is that part of the food which is left behind in the mouth and which can be converted into acids.

Myriads of other factors such as the rate of acid production, the solubility of enamel, buffering

capacity of saliva must be considered but it is obvious that the presence of bacteria and suitable substrate are necessary for the initiation of dental caries.³⁵

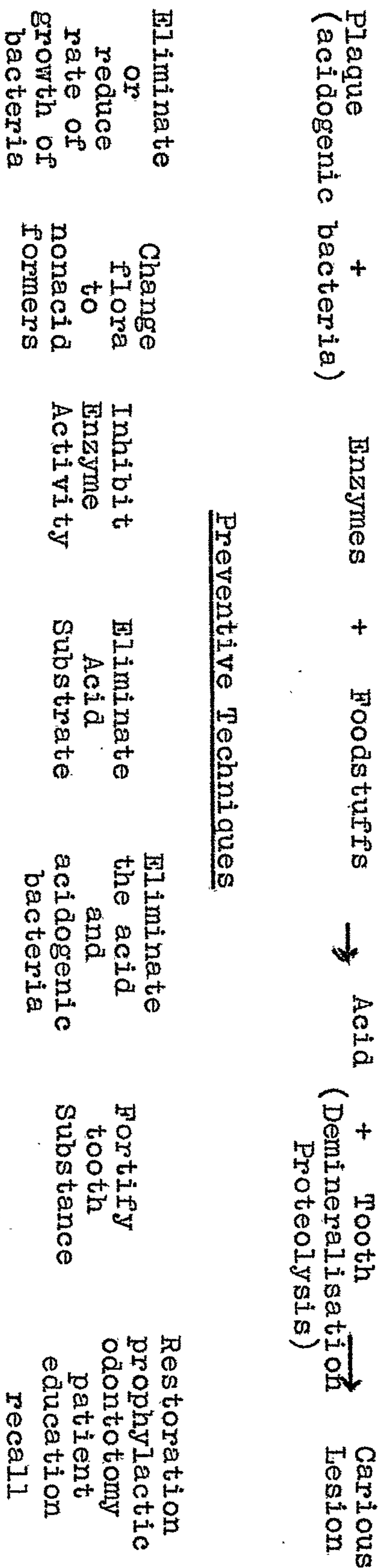
The work of Orland et al⁷ showed, that caries will not occur in the absence of bacteria. Since caries always starts on the outside of a tooth, it can be presumed that these bacteria must act through the oral environment. Kite⁶ et al have carried this line of thought further by removing all food factors from the mouth of experimental animals, thus denying the bacteria a substrate in which to grow. Rats fed a cariogenic diet by stomach tube developed no caries at all, whereas their litter mates fed the same diet by mouth developed considerable caries.

One of the most important provoking factors in dental caries has been shown by Gustafsson et al⁸ (1954) to be the retention of carbohydrates in the mouth of readily fermentable carbohydrate residue; especially when present between meals. Furthermore Gustafsson and his co-workers showed clearly that caries activity could be reduced to a negligible amount by complete restriction of between meal sugars, even although refined sugar was permitted with normal meals. This effect would appear to be related to the length of time that sugar continued to be present in the mouth after eating.

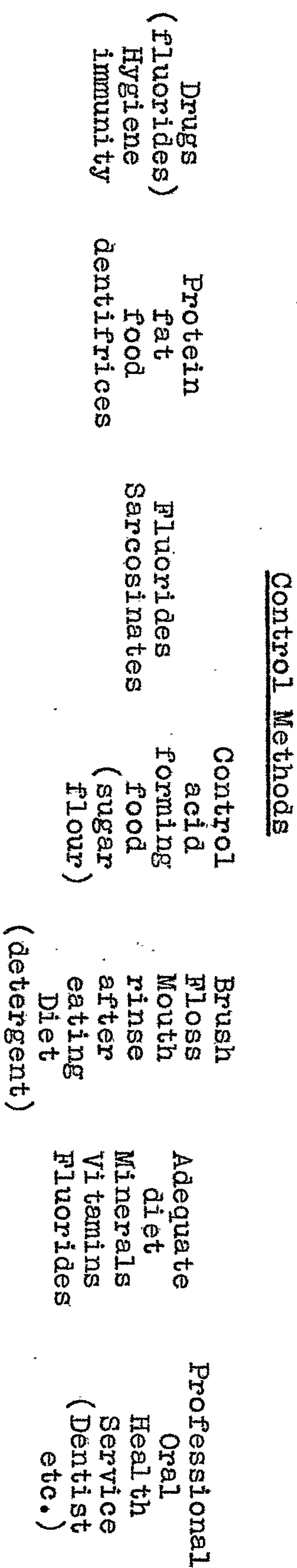
Lundquist⁴⁰ (1952) showed that sugar consumed between meals took longer to clear from the mouth than sugar consumed with meals. Logically any measure which would remove or reduce the amount of fermentable carbohydrate remaining on the tooth surface would be expected to influence dental caries incidence. Thus theoretically oral cleansing could constitute a useful preventive measure but, the rapidity with which fermentable carbohydrates has been shown by Stephan⁹ (1944) and Fosdick⁹⁰ (1942), to be degraded to endproducts has led to the view that, to be effective, cleansing measures must be applied within a period of minutes following eating.

It appears clear from the foregoing that no single method of prevention could be expected to be totally effective and it seems logical to suppose that different measures are required, each aimed to eliminate or reduce the various independent causative factors. Moreover, such measures could be additive in effect. Summary of various measures used in the control and prevention of dental caries is found on the next page.

Control and Prevention of Dental Caries



Preventive Techniques



(After Schafer Hine and Levy 2nd ed. Page 352.)

Toothbrushing

Historical

Man has used some form of brush as an adjunct to oral cleanliness for many years. The ancient scriptures of the Hindus written in Sanskrit as early as 4000 - 3000 B.C. contain references to the use of twigs for this purpose. There are to this day many races in different parts of the world who use a twig,⁴¹ the one end of which has been chewed in order to splay it. The earliest known record of a toothbrush is found in Chinese literature in 1600 but material and construction is not mentioned. During the seventeenth century mention is made of a novelty sold in Paris for the cleaning of the teeth. This was an expensive article made for the rich, because it is described as bound with gold in silver ware. There is some indication that early tooth brushes were expensive novelties in the nature of mop textile.⁸

According to Addis,¹¹ the first toothbrush resembling the modern article was made by William Addis of England, in 1780. This instrument consisted of a bone handle and natural bristles drawn into holes bored into the head and secured by wires. William Addis continued to make brushes of this type which eventually were taken into general use. So by 1840 toothbrushes were being manufactured in France and Germany also. Later in the century French manufacturers

transported the craft to Japan, and very soon Japanese were manufacturing even cheaper toothbrushes than had been made in the past. The first American toothbrush patent was that of H.N. Wadsworth, in 1857.

With the exceptions of variations in size and trim, no departure from original manufacture occurred till the early part of the present century, when celluloid handles were developed.¹⁰ The first radical change in the method of manufacture of toothbrushes resulted from the invention of plastic material now known as celluloid, originally a substitute for costly ivory and tortoise-shell. It eventually became cheap enough for use in making toothbrushes, and by the beginning of the present century considerable numbers were made with plastic handles, though no great change in shape took place.

By this time the spread of popular hygiene and the development of the modern diet made toothbrushes an essential cleansing need of all who could afford them, but the cost was still too high to enable the great bulk of people to become regular users. It was not until after the first World War, as a result of the invention of high speed machinery for the production of celluloid toothbrushes, that they became available to the working class.

Generally, the dental profession appears to have been content to allow the toothbrush to develop at random.¹⁰ For more than fifty years, individual dentists, editors and laymen, with little or no attempt at concerted effort, advanced new designs, suggested improvements, advocated, criticised, condemned and belligerently tolerated the toothbrush. The resulting confusion and lack of progress in the field of oral hygiene prompted Talbot in 1910 to censure an untenable situation in which the "market was full of all size and shapes of handle and bristles ... bought regardless of their adaptability to the mouth and teeth ..."¹⁰

In 1919, a committee of the American Academy of Periodontology prepared a report setting forth specifications for toothbrushes for adults, children more than 3 years of age and children less than 3 years of age. These brushes were characterised chiefly by a linear gradient in the lengths of the tufts descending from shank to extremity. The handle, shank and head were aligned on the same axis. Toothbrushes advocated by the Academy's committee apparently never won widespread recognition by the profession at large. But the action of the committee did serve to attract attention to the existence of a problem in toothbrush design. Subsequent studies particularly by Kauffman, Asgis, Stillman and Hirschfeld,¹⁰ demonstrated that few toothbrushes available

on the market conformed to a scientific standard compatible with the requirements of oral hygiene. These studies and the development of rational procedures for brushing teeth have resulted in preference for two row and three row brushes with a small head and with tufts of equal length.¹⁰

Up to about 1939 nearly all toothbrushes had been manufactured from bristles which are the hairs of swine.¹⁰ Synthetic bristles are manufactured from nylon and this type of bristling was first applied to toothbrushes in 1938. Celluloid for handles has been replaced by acetate, methacrylate and butyrate.

After the second world war power tooth brushes have been introduced on the market with claims of superior cleansing over hand brushes.

Growing recognition of the importance of oral cleansing in the maintenance of oral health and well being has rendered the tooth brush deserving of careful study.

Toothbrushing - Value in Caries Control and Prevention

Definition - Kauffmann³² defines the toothbrush as an "artificial hygienic device used in conjunction with a dentifrice to brush the teeth, consisting usually of a handle and clusters of bristles so arranged as to exert the most beneficial action possible without causing injury to the hard structures or adjacent soft tissue".

Specifications and Requirements

Three different sizes of brush are needed to suit the sizes of the mouth and the hand at different ages. The smallest one should be used from the time when the first tooth has erupted until the age of 6 years when the mouth has grown large enough to accommodate the first permanent molars. From this age, until the eruption of the second molar at 12 years, an intermediate size of brush is used, and finally an adult brush. All three brushes should be of the same pattern and vary only in overall size and the size of the head.

Naturally, every dentist has his own views about brush design and many different styles of brush have been produced. That there is a remarkable degree of uniformity in these views has been shown by a referendum conducted by one of the manufacturing companies and also the fact that there are only minor variations between the brushes which enjoy the largest sales.

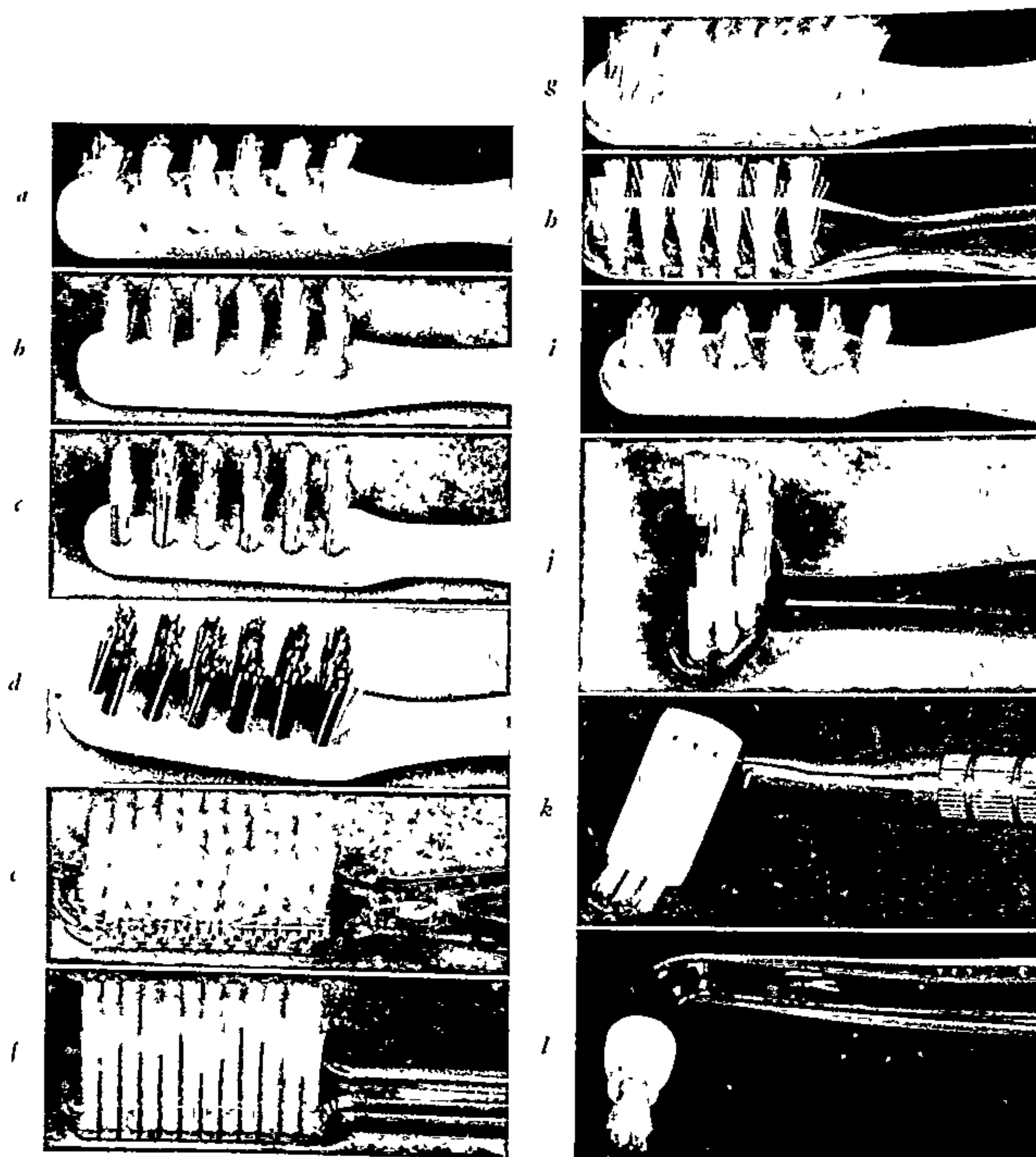


Fig. 173. Different types of brushes. All may be used to advantage if used correctly. *a* and *b*. Two-row, hard, nylon-bristled brushes; *c*, two-row, hard, boar (bleached)-bristled brush; *d*, three-row, hard, boar (unbleached)-bristled brush; *e* and *f*, multitufted, four-row, soft, nylon-bristled brush; *g*, three-row multitufted, soft nylon-bristled brush; *h*, three-row, soft, nylon-bristled brush with spaced tufts; *i*, single-row, hard, boar (bleached) bristles; *j*, curved-head, two-row, nylon-bristled brush; *k*, three-row, nylon-bristled brush with adjustable head; *l*, single-tufted brush tip

FIG. 1 (Ref. 112)

According to Wade⁴¹ suitable specifications for an adult brush are:-

1. Overall length, $5\frac{1}{2}$ - 6 in.
2. Length of head, 1 - $1\frac{1}{2}$ in.
3. Trim height, $\frac{3}{8}$ - $\frac{1}{2}$ in.
4. Trim width, not greater than $\frac{1}{3}$ in.
5. Straight trim
6. Multi-tufted or in bundles, 6 to 1 in.
7. Medium texture
8. Bristle or nylon
9. Head and handle in a straight line

In the intermediate brush these are modified to:†

1. Overall length, 5 - $5\frac{1}{2}$ in.
2. Head length, $\frac{7}{8}$ - 1 in.
3. Trim height, $\frac{3}{8}$ in.
4. Trim width, $\frac{1}{4}$ in.

and in the smallest brush:†

1. Overall length, $4\frac{1}{2}$ in.
2. Head length, $\frac{3}{4}$ in.
3. Trim height, $5/16$ in.
4. Trim width, $3/16$ in.

Small children should in general have brushes one quarter to one third smaller than those for adults, but of the same design. Many different shapes of trim have been suggested from time to time in attempts to obtain better

access to awkward areas, such as the lingual aspect of the mandibular anterior teeth. These designs have, however, invariably led to a decreased efficiency in other parts of the mouth. If extreme difficulty is experienced in gaining access to the area just mentioned the head of the brush may be reduced in size by cutting away rows of bristles or filaments nearest the handle.

In recent years the multi-tufted brush has gained popularity. Formerly it was recommended that bundles of bristles or filaments should not be concentrated in a density greater than 6 to 1 in., thereby ensuring plenty of space between each bundle and making it easier to keep the brush clean. The advantage of multi-tufted brushes, in which the bundles are placed more closely together, 10 per inch, with fewer filaments, 25 instead of 35, in each bundle, is that the overall density of the brush head is increased. In practice these brushes do not seem to harbour more debris and stale tooth paste at the bases of the bundles than those in which the tufts are further apart.⁴¹

There is, unfortunately, no recognized grading standard for bristle brushes and, consequently, the texture of different lots will vary even though given same grading. The British Brush Manufacturers Association have agreed however, upon a grading for nylon filaments. In this grading soft is 0.009 in. diameter, medium 0.011 in. -

0.012 in., hard 0.013 in., and extra hard 0.014 in. Most manufacturers try to make their bristle brushes conform in overall texture to the correspondingly graded nylon brush. For prophylactic and maintenance purposes a medium texture appears to be most suitable.

Many prefer to use natural bristle to nylon. Controversy still exists regarding nylon and bristle and will probably continue for many years. Efforts have been made to devise scientific experiments and clinical assessments have been reported. No strong preference can be stated for one or the other. A good bristle brush is an excellent product but so is a nylon brush. Unfortunately bristle brushes which sell at about the same price as nylon ones are compounded of bristles of varying thickness mixed in suitable proportions to give the desired texture. The result of this is that some of the bristles break off during the first few occasions on which the brush is used and the texture of the brush is changed. For this reason some authorities regard a hard bristle brush as the equivalent of a medium nylon one. There is no evidence whatsoever to show that nylon is any way more harmful to either the gingivae or exposed roots than is bristle. Machine testing has shown no essential difference between the abrasiveness of a nylon bristle and natural bristle,

abrasion in general depends upon the dentifrice used.⁵⁶

Brushing Techniques

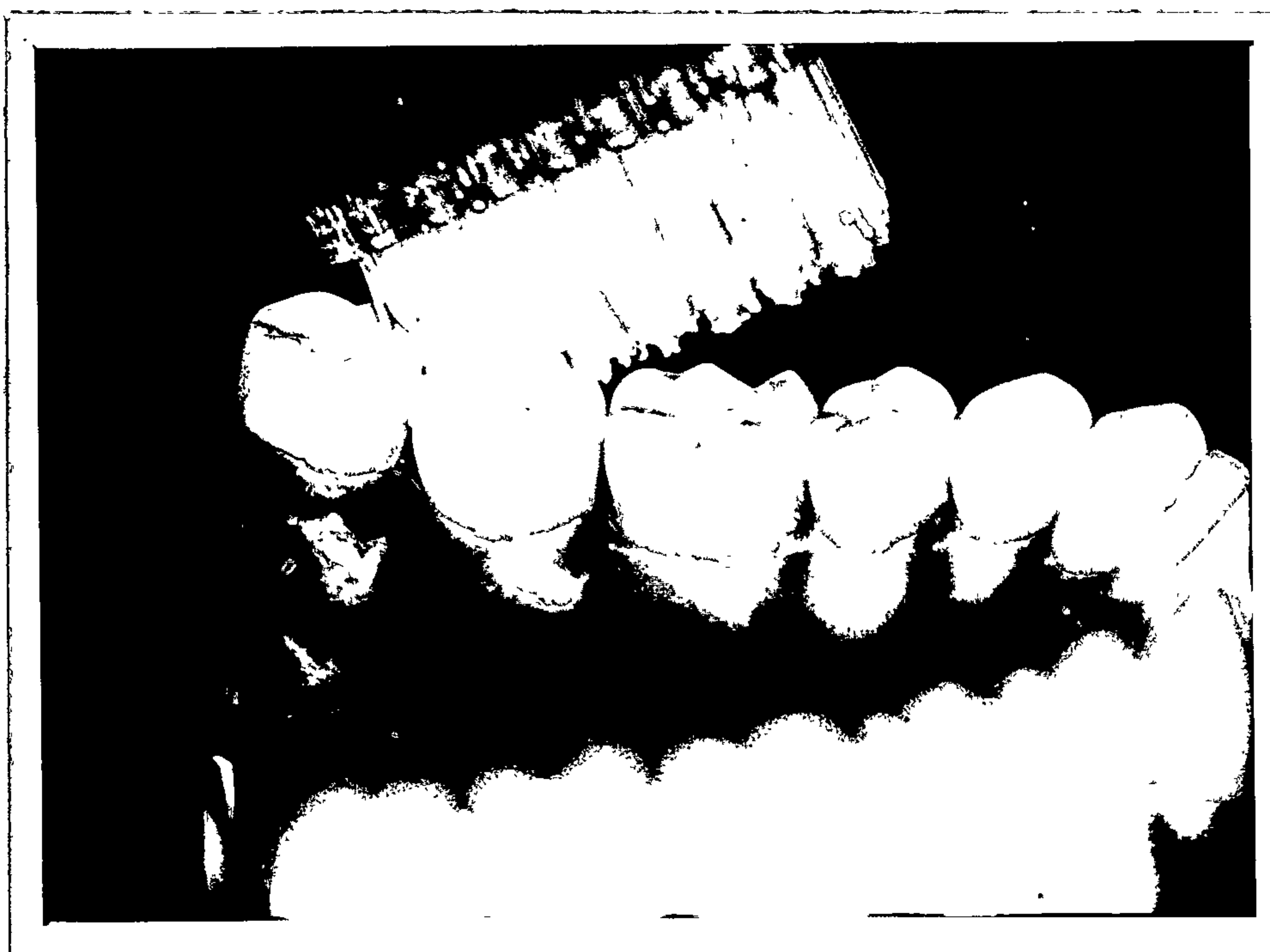
Every conceivable method of brushing the teeth and gingivae has been practised, even though it may not have been advocated. Careful review of the literature indicates that toothbrushing techniques can be grouped into the following eight classes,^{14,41} some adapted for general use, some for special problems such as gingival contours which accompany periodontal disease.

1. Horizontal brushing:-

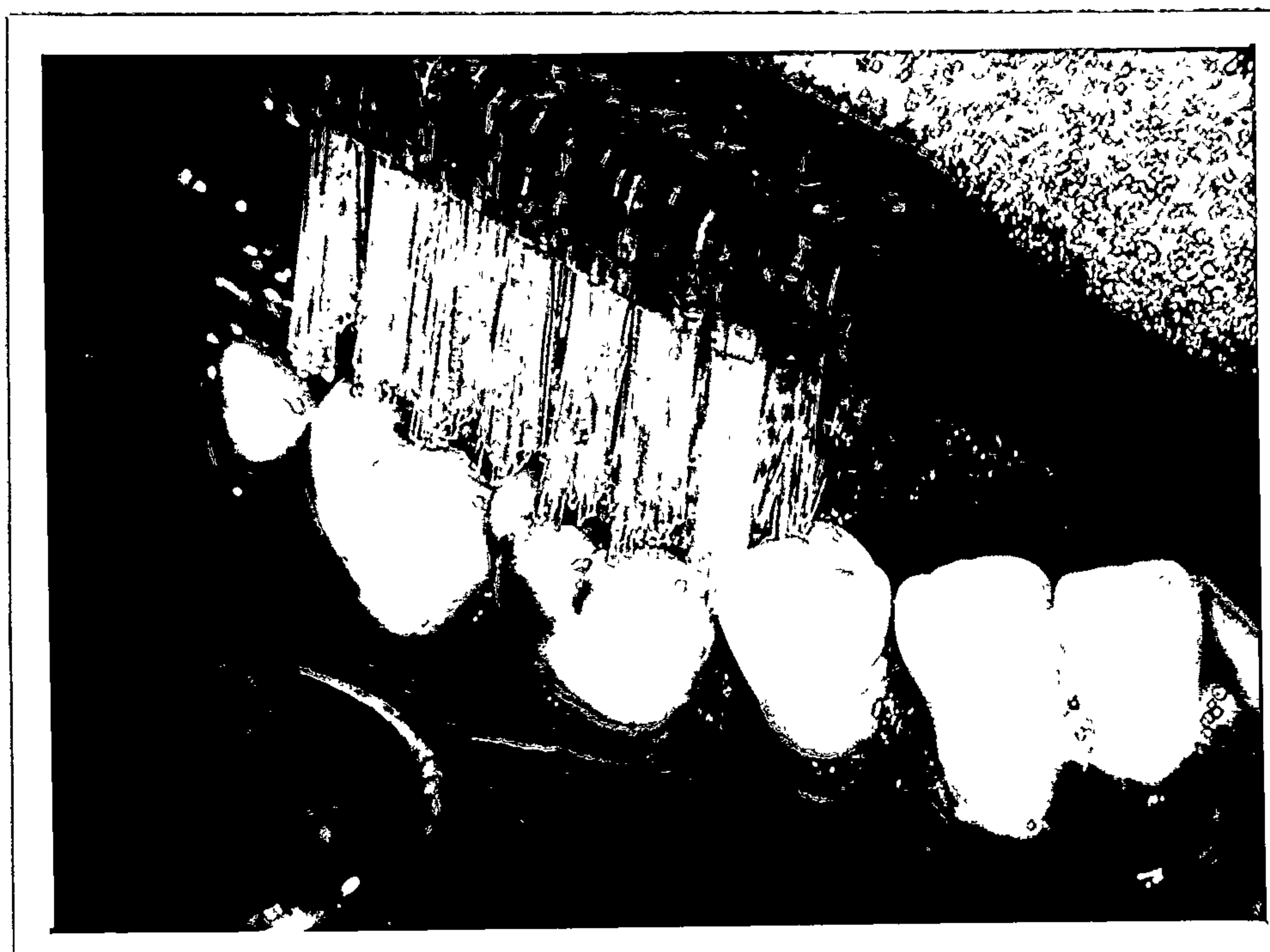
Many individuals, if given no advice, will adopt a horizontal or near horizontal stroke with the brush. This action is particularly harmful to both the gingivae and the teeth (see Fig. 14). In addition the lingual aspect receives no brushing because a horizontal stroke cannot be used easily in this area.

2. Vertical brushing:-

There are some people who have been either misinformed or have failed to understand fully the advice they have been given, yet appreciate that a horizontal method of brushing is not recommended. As an alternative they have adopted a simple vertical stroke. This may also cause atrophy of the periodontal tissues, which is not accompanied as a rule by abrasion of the exposed roots of



A



B

FIG. 2

A Incorrect placement of brush

B Correct placement of brush

Original photograph

FIG. 3

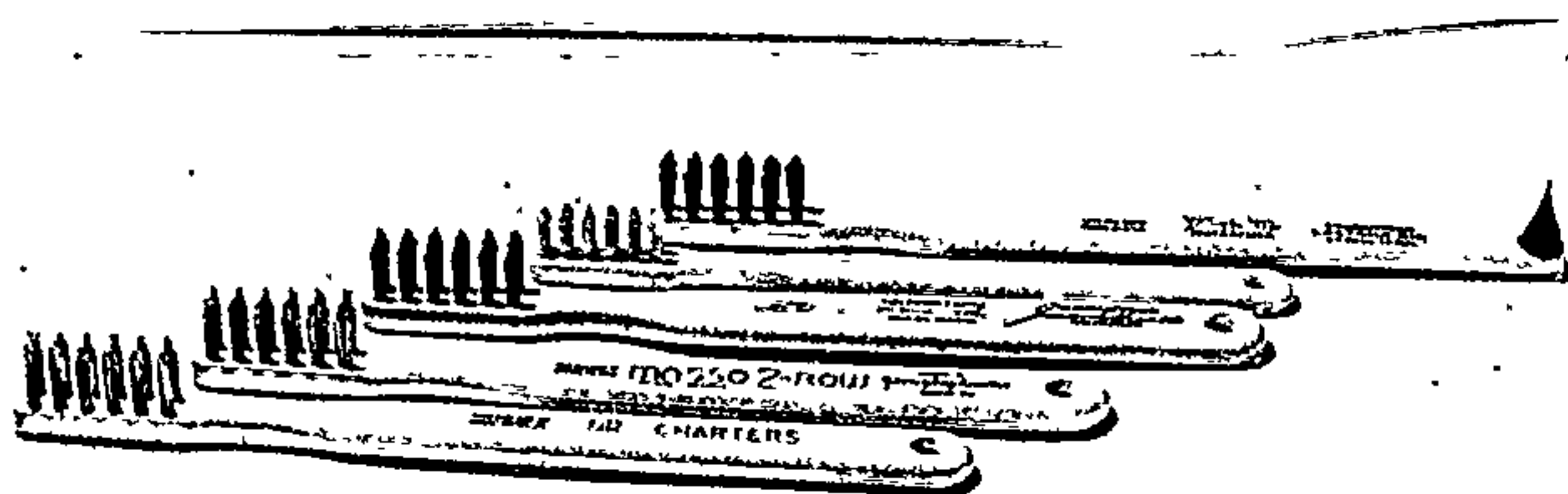


FIG. 262.—Tooth-brushes indicated for the Charters method of interdental brushing. The last one has rubber stimulator for interproximal use where the interproximal spaces have been greatly enlarged by the recession of the gingiva and tissue stimulation is needed.

FIG. 4

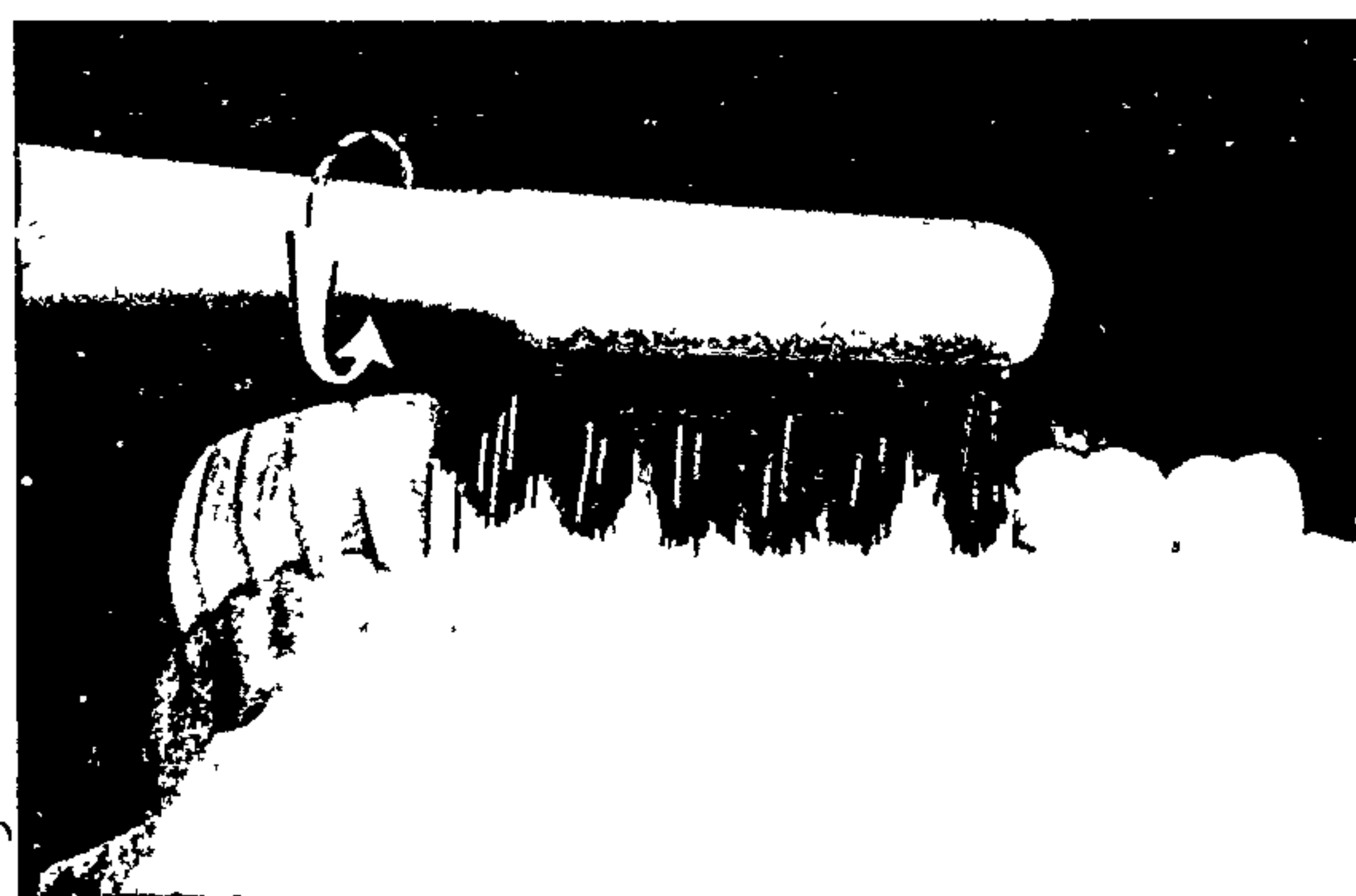


FIG. 263.—“Roll technique.” The brush is placed as far apically as possible, with sides of brushes touching gingival tissues. Using much lateral pressure, the brush is carried occlusally, and the brush is rolled slightly, so that at the end of the stroke the ends of the bristles touch the enamel.

(Ref. 14)

the teeth. It is not a method which can be recommended.

3. Roll (modified Stillman) technique:-

This is the method which is most widely advocated. It is simple yet efficient, and can be used in all parts of the mouth.

The brush is placed in the mouth so that the bristles or filaments have their free ends pointing towards the apices of the teeth with their sides against both the crowns and the gingivae. Sufficient lateral pressure is then applied to produce blanching of the gingivae, after which the head of the brush is turned until the bristles are facing in the opposing direction to that at the beginning of the stroke. These actions not only have a massaging effect on the gingival tissue, but they also assist in the displacement of food particles, particularly from the interproximal areas. Fig. 4

4. Physiological technique:-

There is a school of thought which believes that the object of a brush is to make good the deficiencies resulting from the consumption of soft foods.^{12,13} As the natural shedding of food is from the crowns on to the gingivae, it is suggested that the brushing action should be in this direction. Most advocates of this method advise the use of a soft brush. Fig. 5

FIG. 5

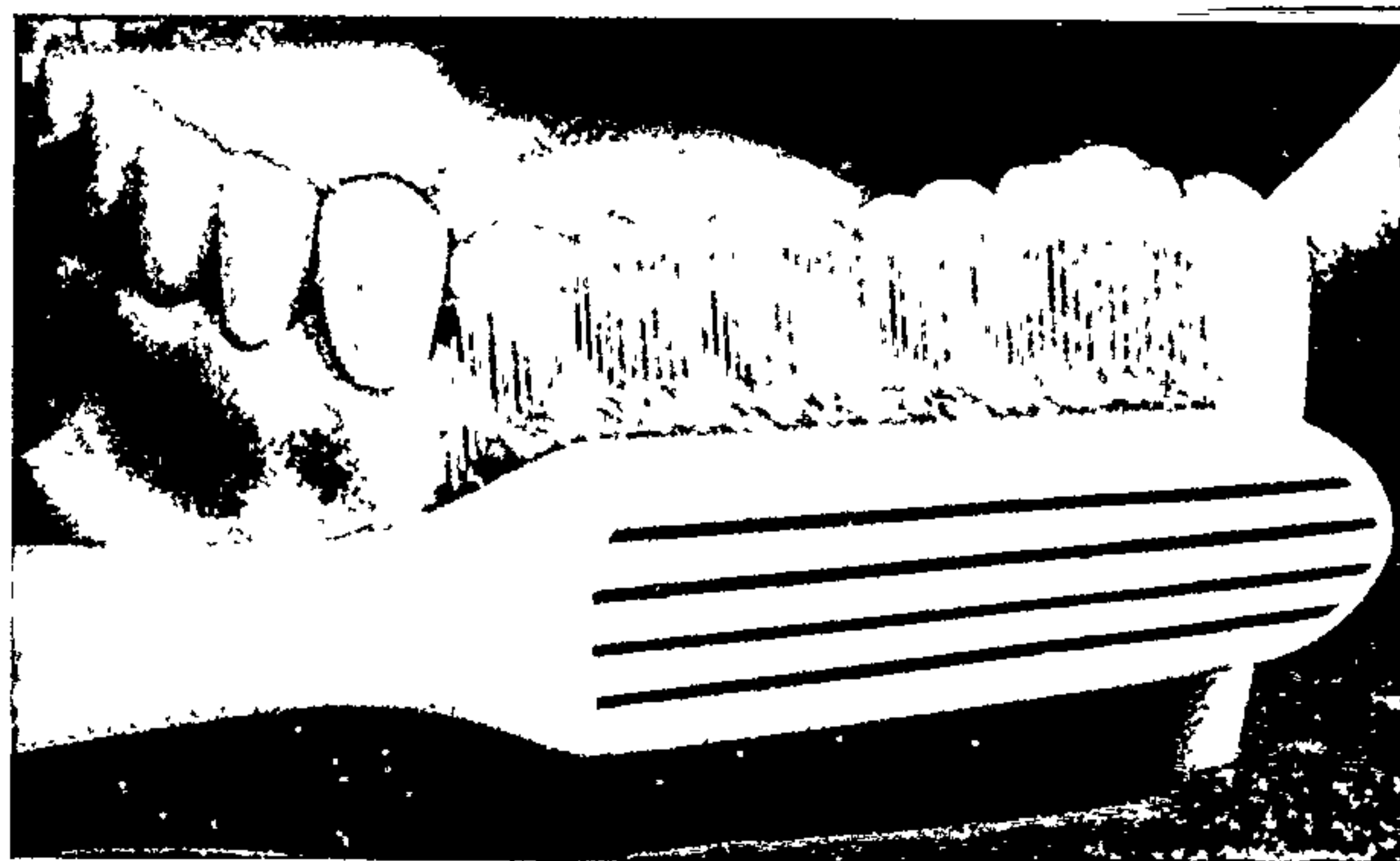


FIG. 266.—“Physiologic” toothbrush technique. Using a soft brush, the teeth and gingival tissues are brushed by using a stroke directed apically.

FIG. 6

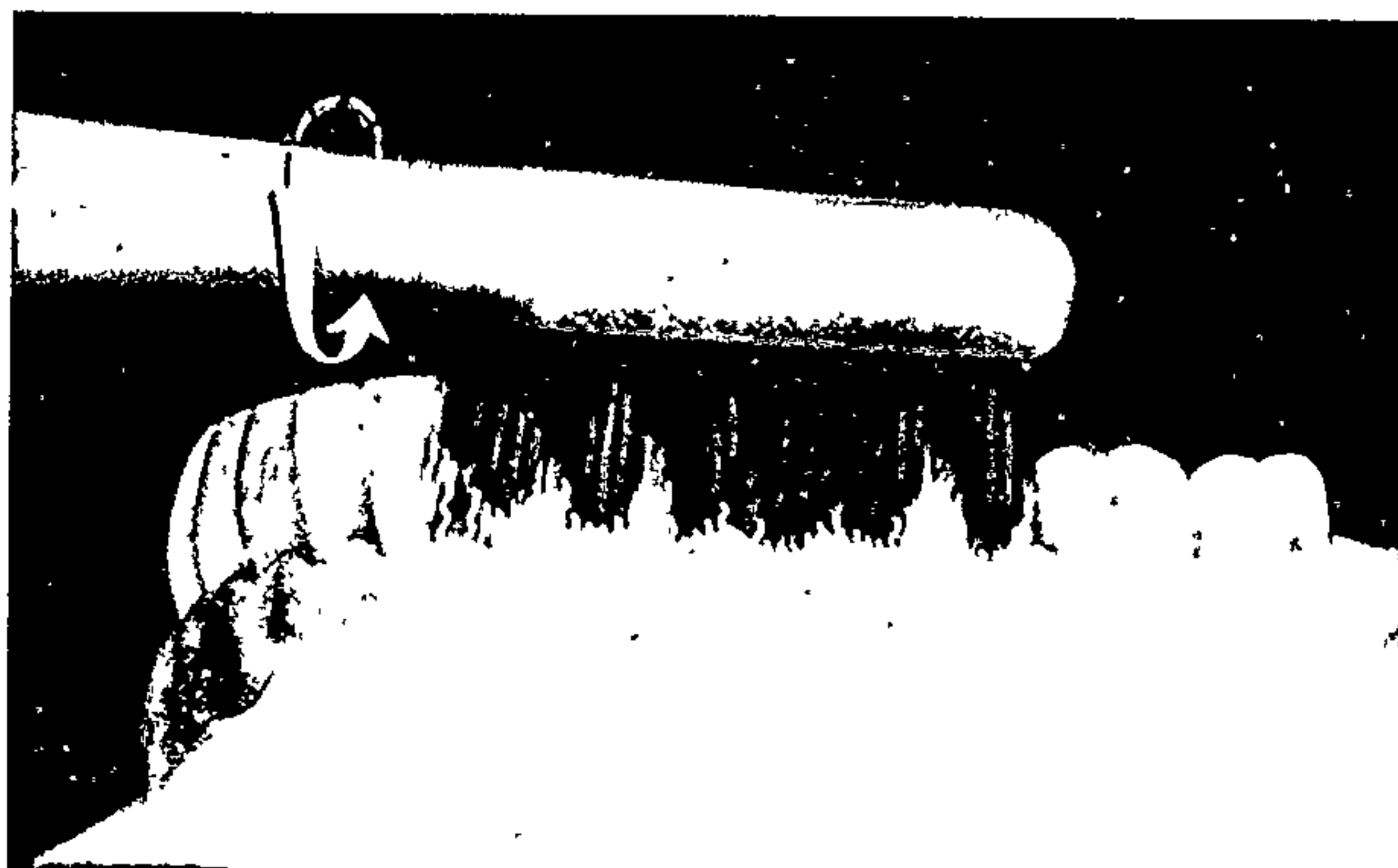


FIG. 267.—Combination “Roll” and “Vibratory” technique.

(Ref., 14)

5. Stillman method:--

In the original Stillman method the brush is positioned so that the bristles or filaments are resting, some with their points on the crown of the tooth and some on the gingivae, at an angle of 45° to the long axis of the tooth pointing apically. Pressure is applied to produce blanching of the gingivae and then released to allow fresh blood to flow into the capillaries. A slight to-and-fro movement and a rotary movement are also made without moving the points of the bristles. These movements produce vibrations along the bristles so stimulating the gingival tissue. Finally, the head of the brush is turned over in the same way as in the roll technique. Fig. 8

6. Charter's method:--

Charter's method is exactly the same as that of Stillman except that the bristles are pointed towards the occlusal surfaces at an angle of 45° . Attaining this position on the lingual aspect of both mandibular and maxillary teeth is very difficult and even impossible with a standard brush.

The great danger of Stillman's and Charter's techniques, which are known as the vibratory techniques, is trauma to the gingivae by the cut ends of the bristles or filaments.⁴¹ Great co-operation is required from a reasonably intelligent patient to ensure that the movements

FIG. 7



FIG. 264.—“Charters’ Vibratory technique.” The brush is placed as illustrated and then vibrated gently to force the bristles into the interproximal spaces. The brush is then moved to another area and the vibrating repeated.

FIG. 8

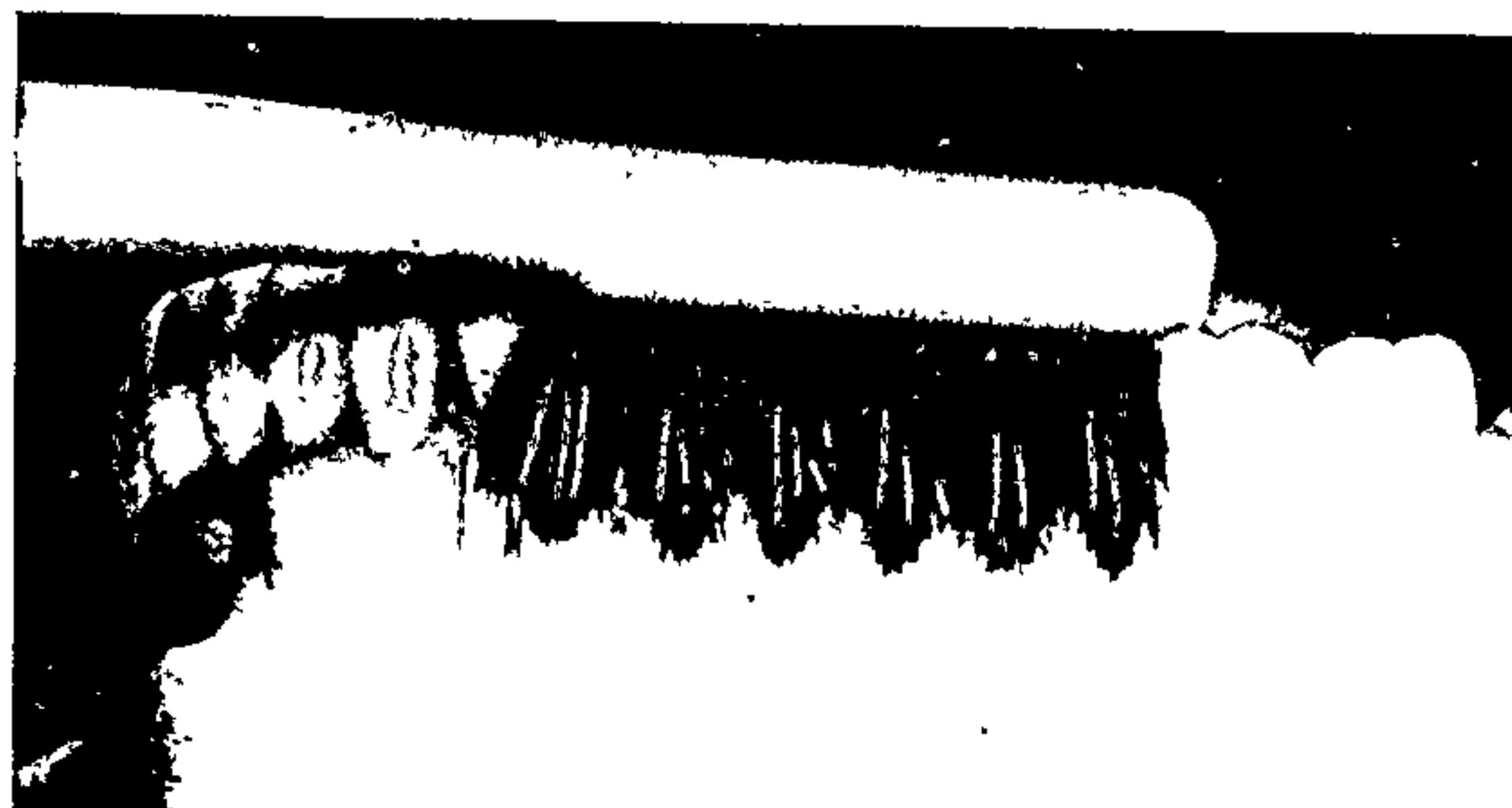


FIG. 265.—“Stillman’s Vibratory technique.” The brush, placed as illustrated, is vibrated gently to force the bristles between the teeth.

(Ref. 14)

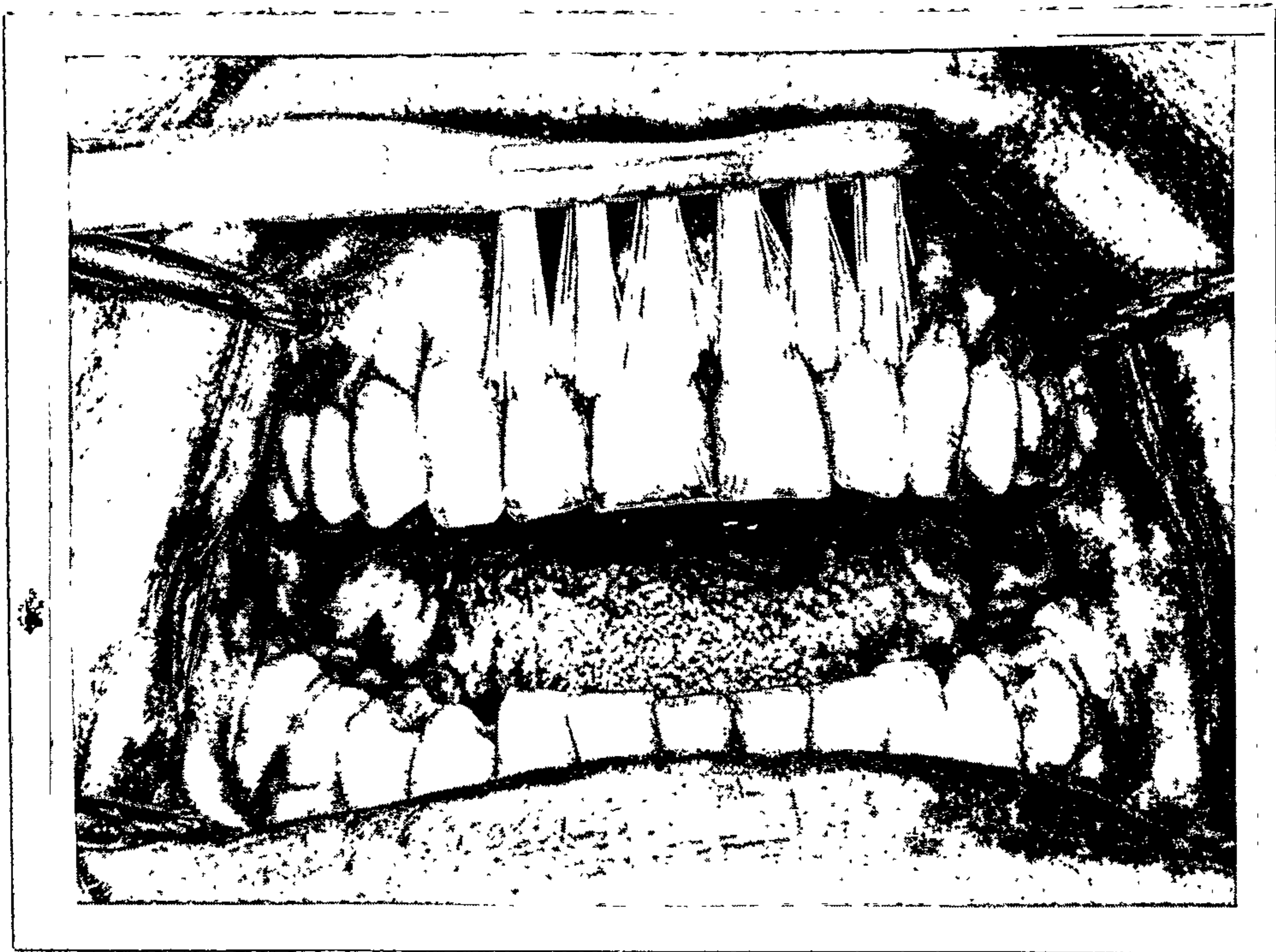


FIG. 9 A Upper anterior teeth
Toothbrush in position showing the angulation used in
the Charters method



FIG. 9 B Lower Posterior teeth original photograph

are sufficiently small to bring about vibrations only. Certain authorities have, however, claimed great success with these two methods.¹¹⁰ Figs. 7 and 9

7. Fone's technique:-

In Fone's technique the teeth are held in occlusion and the brush is positioned with its bristles or filaments in the horizontal plane. The brush is then moved round and round in a series of circles. The advantage claimed for this method is that it employs a more natural action than the other methods, and it has therefore been advocated for children. It seems unwise, however, to teach one method at the beginning and then change to another at a later age. Fone's technique cannot be used on the lingual aspect and this above all must be regarded as its chief disadvantage. Fig. 10

8. Scrub brush method:-

This consists of a series of haphazard strokes similar to those used in scrubbing a floor. Its use is best limited to the occlusal surfaces of the teeth where it is an efficient method for cleaning fissures. Fig. 11

Miscellaneous Techniques:-

Many other techniques are being advocated. For example Leonard⁸⁷ recommends that the teeth be held edge to

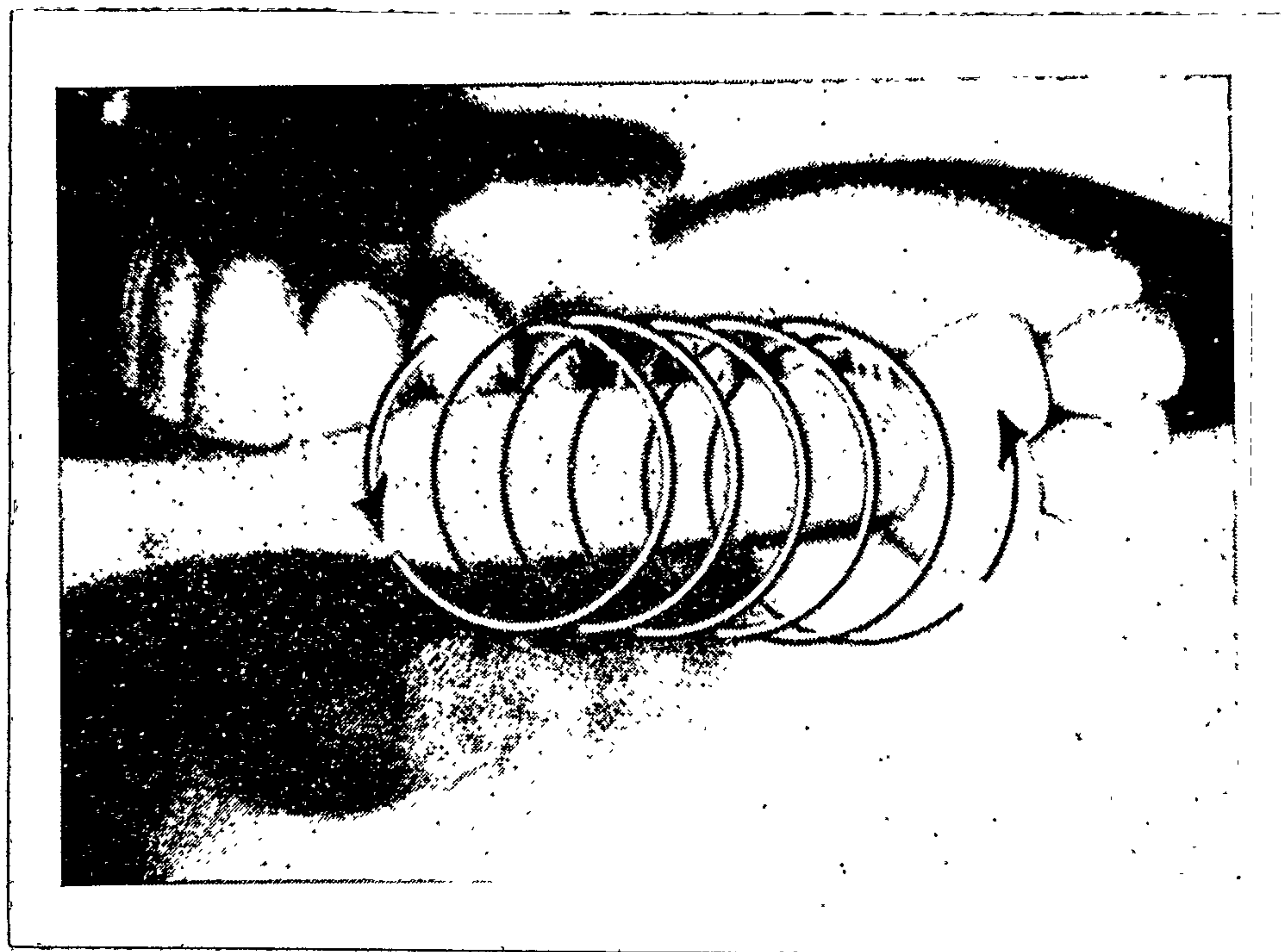


FIG. 10

Fone's technique (Ref. 14)

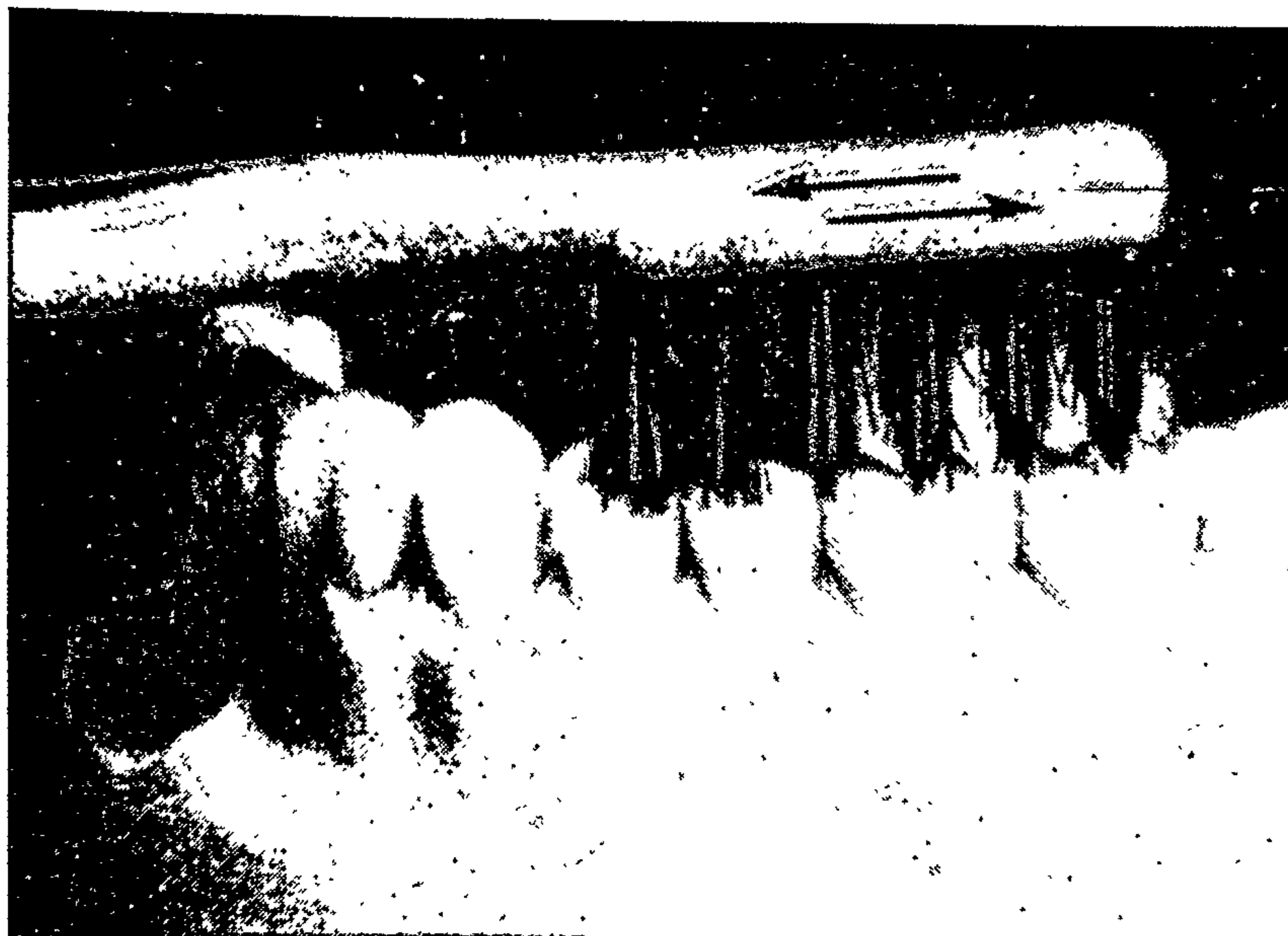


FIG. 11 Scrub technique (Ref. 14)

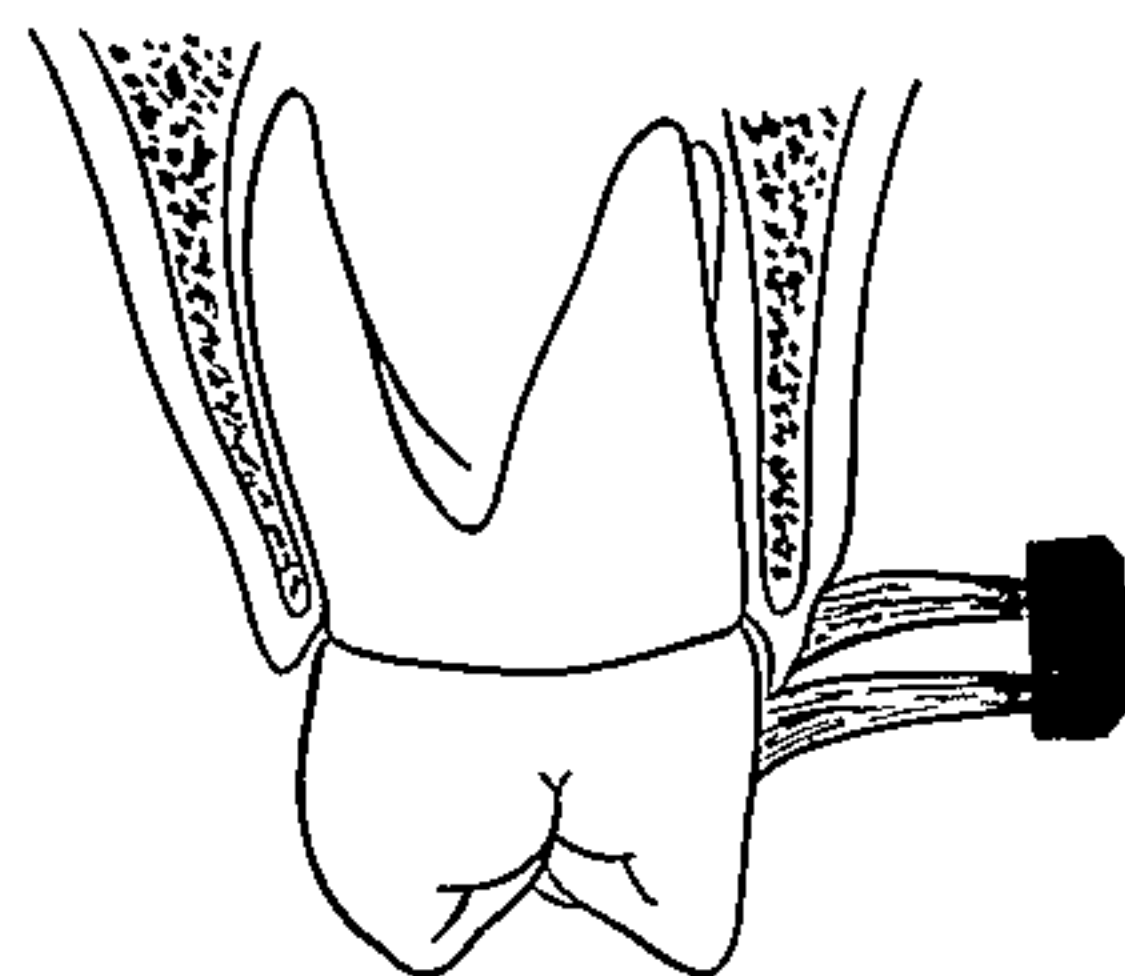


Fig. 708

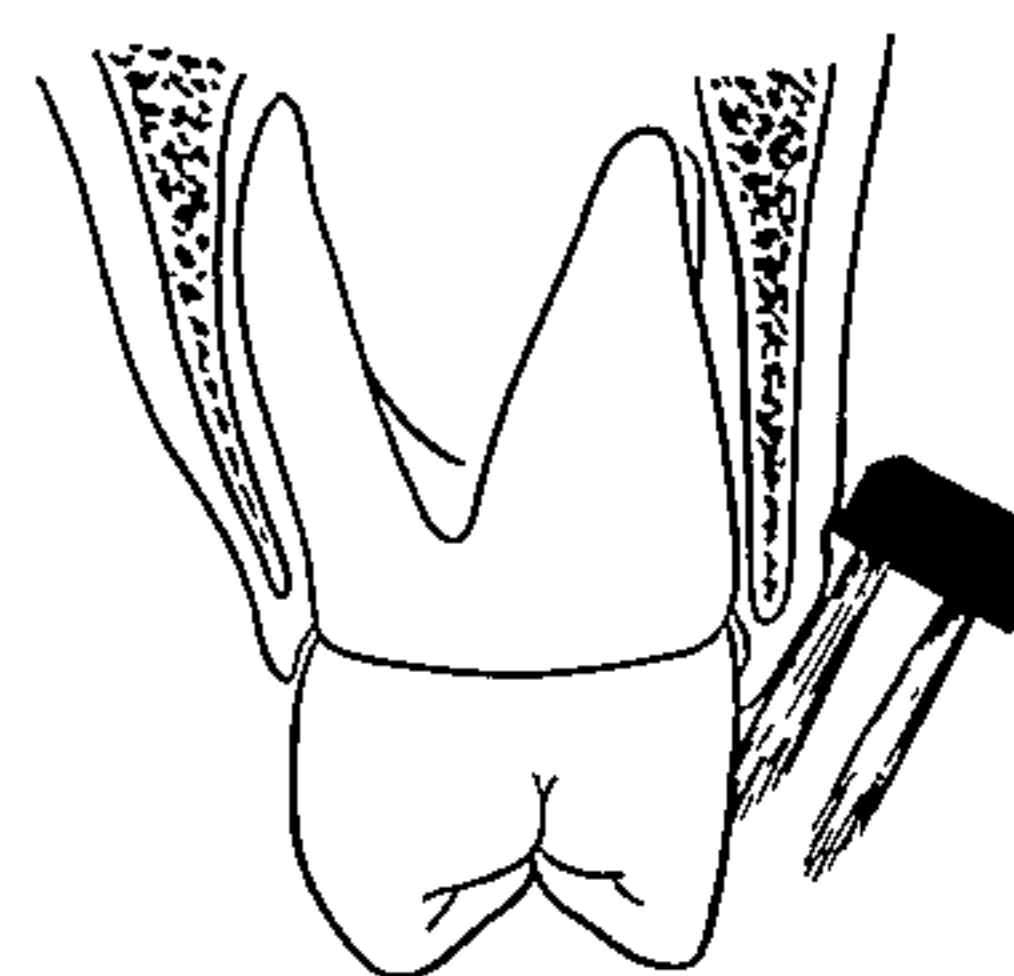


Fig. 709

FIG. 708. INCORRECT USE OF THE BRUSH.
The brush has been moved too far buccally and the ends of the bristles injure the gingiva.
FIG. 709. INCORRECT USE OF THE BRUSH.
The bristles are not flexed and the gingiva is traumatized with the edge of the handle.



FIG. 12

FIG. 13

(Ref. 18)

edge with the bristles against the teeth at right angles to the long axis of the teeth. The brush is then vigorously moved without great pressure and with the stroke that is mostly up and down on the tooth surface with just a slight rotation or circular movement. After striking the gingival margin enough pressure is used to force the bristles into the interproximal area.

Others recommend specific techniques and undoubtedly get good results with them. Use of specially designed brushes¹⁰² with bristles held at an angle, with flexible head, is recommended by some.

Combination of Techniques:-

Perhaps the most effective method of brushing the teeth depends upon the dentist's evaluation of the patient's needs and then adaptation of one or more of the above techniques to the individuals need.

For the young adult roll technique is advisable.¹⁴ If periodontitis is present, the patient can be taught Stillman's vibratory technique in conjunction with the roll technique. As the brush is carried occlusally, and rolled slightly, the handle is gently vibrated to force the bristles between the teeth.

Whichever method is used the mouth must be cleaned and massaged systematically. The individual should always commence his brushing at the same point, which should be an extremity of one of the arches. Each area should be brushed three or four times before moving on to the next one and a degree of overlap should be practised. Special attention should be paid to the posterior regions and the lingual aspects, stress being laid on this point when advising the patient. The time required for adequate brushing will vary according to the need and skill of the patient. Average of 5 - 8 minutes will probably be sufficient. Ideally, brushing should be practised after every meal, but the most important time is unquestionably before going to bed. During sleep the natural cleansing mechanism is inactive and, if the mouth is not thoroughly cleansed, there will be several hours in which food debris can stagnate.

A brush should be used only once daily because, if allowed to dry for a full 24 hours, it will maintain its properties a great deal longer than otherwise.

Care of Brush:-

After use a brush should be washed well under running cold water to remove any residual toothpaste. Nylon filaments do not splay as much nowadays as they did formerly,

but any such tendency may be counteracted by squeezing the head of the brush between finger and thumb. The brush should then be hung in a rack to dry. Placing brushes in a closed container is a bad practice, because it encourages bacterial growth by keeping them warm and moist.

Renewal of Brush:-

A specific time after which a brush must be renewed cannot be laid down, because the effective life varies tremendously from one individual to another. Each brush has to be assessed independently and every patient should be encouraged to bring his brush with him to the surgery so that he may be advised upon its suitability and the effectiveness of his brushing technique.

Very little has been done to analyse the effectiveness of various method of brushing teeth and very few experimental studies have been made giving support to the effectiveness of any brushing method as compared with another.

Curtis et al¹⁵ in 1957 did a clinical study of the relative efficiency of the Roll and Charter's method of brushing teeth. In conclusion they said, "to achieve optimal results from a brushing technique, the method should be carefully adapted to the needs of the individual and through thorough instruction with supervised periods of drill should

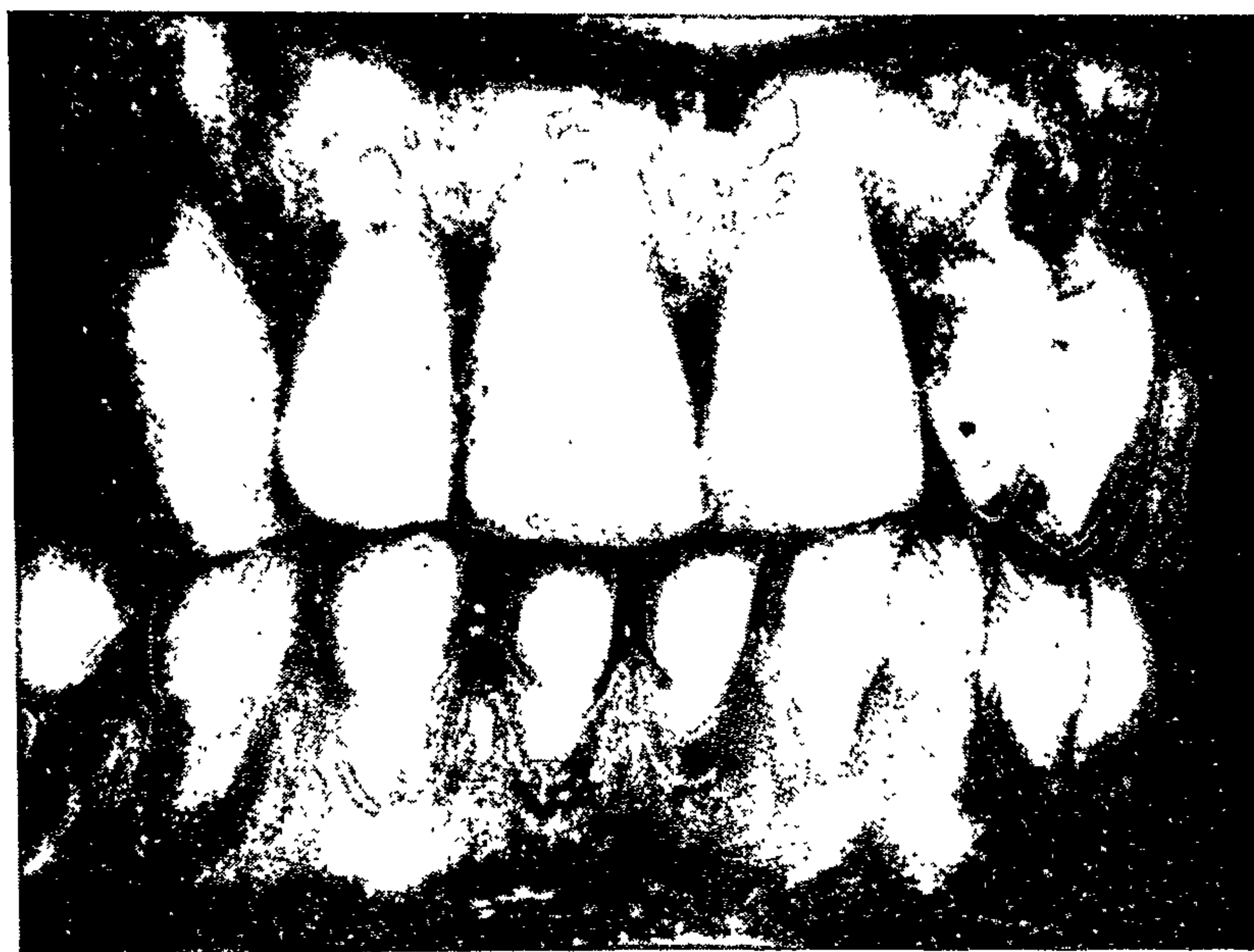


Figure 36. The effect of horizontal tooth-brushing

FIG. 14 (Ref. 62)

The abrasion which can result from
horizontal toothbrushing

be given". They also suggest the use of other mechanical aids to supplement the toothbrush in caring for lower anteriors.

Roth et al¹⁶ suggest that modified Stillman method is satisfactory in most cases, but other methods could be used to supplement this depending on the oral architecture.

No specific method of toothbrushing has been accepted as a standard method. Some writers^{17,18} advocate one method for all the patients, while others^{14,15,19} believe that brushing should be carefully adapted to the need of the individual. Clinical studies have shown Charter's¹⁸, Vertical²⁰, and Roll^{18,20} method of brushing to be equally effective regarding efficiency and effectiveness in preventing and removing soft accretion on the surfaces of the teeth. Roll method is "rather universally used^{11,17} and is often advocated.^{17,15,19}

With the exception of overtly traumatic techniques, it is the thoroughness of application rather than the details of the method, which is the important factor in determining the effectiveness of brushing.

Power Brushes:-

Power brushes should be mentioned because they

seem to be of value for the occasional patient who cannot adequately carry out complex instructions for gingival massage. According to Hine¹⁴ these brushes are a lazy man's way to clean the teeth and massage the gums, although the ones tried were remarkably effective.

Although there are some studies which provide valuable information, there appears to be no general agreement that any electric toothbrush is any more or less effective than a regular handbrush.

In recent years several electric toothbrushes have been introduced, and it has been suggested that the advantages are superior cleansing action and acceptability.²⁸ (Munch, 1962) This view seems to be supported by the work of Lefkowitz and Robinson²¹ (1962), Hoover and Robinson²² (1962) and Phaneuf, Harrington, Dale and Shaklar²³ (1962) all of whom used G.E.C. electric toothbrush.

The Broxodent electric toothbrush has been investigated by Toto and Farchione²⁴ (1961) who found that the home use of this instrument gave similar results as did a conventional toothbrush when considered in terms of reduced amount of *Materia alba*. Cross, Forrest and Wade²⁵ (1962) compared Broxodent with a conventional toothbrush by visual assessment of stained plaque before and after brushing, and

found that the electric brush was slightly more effective. Chilton, Didio and Rothmer²⁶ (1962) found that in 30 dental students the Broxodent did not produce an improvement in either gingival inflammation or cleanliness when compared with a standard toothbrush.

Quigley and Hein²⁷ (1962) compared the G.E.C. type with an unnamed arcuate motion type and found that the mechanical arc motion was not efficient in removing plaque as the reciprocating motion brush or handbrushing.

Birch and Mumford²⁸ (1964) tested the efficiency of Broxodent electric toothbrush on 60 students, in removing biscuit debris as compared with that of a conventional toothbrush. Their results do not support the view that electric toothbrushing was more efficient in removing biscuit debris from the teeth.

Soparkar²⁹ (1964) conducted a study of toothbrushing involving 270 students (non dentally oriented) for 11 weeks. ".... the use of a short stroke reciprocating action, automatic toothbrush as compared with the handbrush was appreciably more effective in reducing gingivitis, in maintaining the health of the gingiva and in the prevention of new lesions in anterior regions of the mouth."

Smith and Ash³⁰ (1964) clinically tested 78 patients for 4 months and concluded, "the electric toothbrush and standard handbrush used in this test were equally effective in preventing or removing dental plaque, both have an equal effect on gingivitis and periodontal scores."

Lobene³¹ (1964) found significant reduction in gingivitis in those using automatic toothbrush as compared to those who used a new soft nylon multitufted hand toothbrush.

The council on dental therapeutics³² of the American Dental Association (1964) has published these remarks, "the council is not aware of published studies or evidence provided otherwise to the council to justify the implied degree of superiority of the advertised product over the manually operated toothbrush. In fact, the data from some studies emphasise the ability of persons to maintain good oral hygiene through effective use of a conventional toothbrush if they possess reasonable dexterity and have been trained adequately in the proper use of the brush."

The A.D.A. Council on Dental Therapeutics¹³ (September, 1964) has recognized two electric toothbrushes - manufactured by General Electric Company and E.R. Squibb and Sons - as "effective cleansing devices."

Journal of A.D.A.

The council has classified the General Electric brush in Group A and has authorized use of the following statement by the company.

The General Electric toothbrush has been accepted (Group A) as an effective cleansing device for use as part of a programme of good oral hygiene to supplement the regular professional care required for oral health.

The council has classified the Squibb toothbrush in Group B and has authorized use of the following statement by the company.

The Broxodent toothbrush has been provisionally accepted as an effective cleansing device for use as part of a programme of good oral hygiene to supplement the regular professional care required for oral health.

The Journal also carries a general report on electric toothbrushes by the Council. "The powered toothbrushes that have appeared on the market have varied widely in their operating characteristics, their construction, their cost and their potential hazard either from electrical shock or from the possibility of traumatizing the oral tissues," the Council reports.

"The competitive promotion of some of these devices has at times displayed a tendency towards exaggerated claims and unwarranted disparagement of the conventional manual toothbrushes in its evaluation program" in order to provide authoritative information to the dental professional and general guidance and protection to the public.

The council report emphasizes that currently available clinical proof shows that the two classified brushes have proven cleansing ability but that there is not yet sufficient evidence for therapeutic claims by any brush.

The following excerpt from the 1963 edition of Accepted Dental Remedies¹⁰³ provides further information:

"There has recently been a wide interest in the use of electric toothbrushes as evidenced by many studies in current dental literature and the large number of these devices appearing on the market Because of the many possible variations, the council is of the opinion, that these devices must be evaluated individually. Each of them should be established as being safe for normal, unsupervised use. The safety should include freedom from hazards of electrical shock and freedom from damage to the soft and hard tissues. The device should also be capable of cleaning the oral cavity effectively and efficiently when used according to directions.

Although the electric toothbrush may be of benefit in maintaining the cleanliness of the oral cavity of the normal individual, it appears to be especially useful for the partially handicapped who cannot readily clean his teeth with the hand toothbrush or for the totally handicapped individual who must have his teeth brushed by an attendant.^{28,30}

Experimental Studies

The value of toothbrushing in the control of dental caries has been argued by many authorities. It cannot be denied that there are some persons who have never used a toothbrush and yet who are perfectly free from caries. These persons are certainly exceptional and probably prove only that the inherent caries immunity of the individual may be of greater importance than local factors.

On the other hand, there are many persons who conscientiously brush their teeth at least twice a day and yet suffer from a serious amount of dental caries. Since most persons delay brushing their teeth after meals for varying periods of time and since, as Stephan⁹ has shown, acid production in the dental plaques occurs within a matter of minutes after the ingestion of carbohydrate, a high caries incidence despite persistent toothbrushing is at least understandable.

Another factor in the explanation of the failure of toothbrushing to prevent dental caries lies in the difficulty of reaching with the brush all exposed surfaces of teeth upon which plaques may form.⁶ The majority of patients do not reach all areas with their toothbrushing

technique. Indeed, it is ironic that most patients spend the greatest amount of time brushing buccal, labial and lingual surfaces, which are not as prone to decay as the more inaccessible interproximals and the deep fissures of occlusal surfaces into which toothbrush bristles will not reach. (See Fig. 15)

A study made by Robinson¹⁹, suggests that the average young adult spends about 67 seconds in brushing his teeth. Certainly this is not enough time to allow thorough cleansing of each interproximal surface.

Several studies have demonstrated that toothbrushing can reduce the number of bacteria in the oral cavity, but no comments were made regarding the effect of this reduction on dental caries.

Kligler³⁵ (1915) after his experiments on three patients showed sharp reductions in numbers of bacteria after toothbrushing and mouth rinsing concluded "the results indicate in accordance with the prevailing opinion in regard to oral hygiene, that washing teeth before retiring is very desirable, and that rinsing the teeth before each meal is just as expedient a habit to cultivate as washing the hands before meals." He made no attempt to determine the effect on dental caries of reducing the number of oral bacteria.

Crowly and Rickert³⁵ (1935) developed an interesting method of determining the numbers of bacteria that can be removed from the oral cavity, their findings, based on application of their method were that 3 hours after brushing there was an average decrease on numbers of bacteria of 12% (twenty counts were made on 4 subjects). In a fifth there was an increase of 27% in numbers of bacteria removed three hours after the original brushing (3 counts were made). Six hours after brushing there was an average decrease of 4% from the number removed at the initial brushing (24 counts were made on 4 subjects). In the fifth case, there was an increase of 21% above the number removed at the first brushing.

Florestano et al³⁵ made several studies to test the effectiveness of different modes in removing micro-organisms from the oral cavity. They found that brushing the teeth with water using Charters' Vibratory technique for 2 minutes, reduced culturable bacteria that could be collected by 46.7%.

These studies indicate that tooth brushing will reduce the number of bacteria in the oral cavity. However, they also indicate that even after thorough brushing of teeth, there are still uncounted millions of bacteria remaining in the oral cavity, and that more appear. In view of this significance of removing a certain, but undoubtedly a small percentage of bacteria is probably negligible.



Figure 273. A ground section of a tooth shows the relative size of an occlusal fissure compared with a single bristle from a standard toothbrush to illustrate the difficulty which may be encountered in attempting to cleanse the depth of these fissures.

FIG. 15

(Ref. 61)

Until recent years there have been no control studies of the effects of tooth brushing on the incidence of caries in the human being.

Fosdick³⁶ (1950) studied a group 523 persons who were instructed to brush their teeth, within 10 minutes after eating, with a neutral dentifrice and to rinse their mouths well with water. The control group consisted of 423 persons who were allowed to continue with their usual brushing habits, in most cases morning and night brushing, groups were similar as far as possible in regard to oral conditions, age and sex.

Clinical examination at the end of one year revealed that the control group had developed an average of 2.21 new carious surfaces, while the experimental group averaged only 0.82 new carious surfaces. Over a two year period, the average number of new carious surfaces was 2.53 in the controls, but only 1.49 for the experimental group. The reduction in caries due to the toothbrushing technique was 62% in the first year, 26% in the second year and 41% over the two year period.

On the basis of his work Fosdick claims that the actual reduction is probably in the neighbourhood of between 50% and 60%.

Weisenstein³⁷ (1954) and his associates have

reported a study of 150 children 9 - 14 years of age, equally divided between a control and experimental group. The experimental group brushed their teeth immediately following each meal, whereas the controls were uninstructed.

After six months, the test exhibited 28% fewer new D.M.F. surfaces than controls, although during the second 6 months period both groups demonstrated 43% fewer new D.M.F. surfaces than during the first period.

Hein³⁸ (1954) found in a limited study that there was no appreciable effect on dental caries in a group of 60 males 21-28 years old; who brushed once or twice a day. While a group of females who brushed 4 times a day showed somewhat less caries than a group who brushed once, twice or three times a day. The frequency of brushing in a group of 155 males had little effect on caries.

Savara and Suher⁴² (1955) found no relationship between frequency of toothbrushing and dental caries experience in preschool children.

Nevin³⁹ (1954) showed experimentally that sticky foods are not easily dislodged from narrow spaces even by vigorous brushing and suggested that inefficient brushing would instead tend to force material into the interproximal space.

Mansbridge⁴⁰ (1960) studied a group of 426 children aged between 12 - 14 years. He found that the standard of oral hygiene is significantly associated with dental caries experience. Moreover the relationship between the frequency of toothbrushing and oral hygiene suggests that the lower prevalence in those with good oral hygiene is due to child's own effort to a considerable extent.

Gilders³³ (1961) states that the toothbrush is an invaluable method of preventing caries, in that it does remove debris and so prevents caries by exposing the tooth surfaces to protective saliva.

Thus, while toothbrushing would seem to be quite important, all clinical studies do not completely support the idea.

If toothbrushing is to be effective, the following requirements must be fulfilled:

1. The toothbrush must remove the food debris immediately after eating. Stephan⁹ and Fosdick⁹⁰ have independently demonstrated that acid formation occurs almost immediately after food has reached the bacterial plaque.
2. Toothbrushing to be effective must be done thoroughly. Casual brushing of exposed surfaces of enamel, already cleaned by excursion of food, will not prevent or reduce

interproximal or pit and fissure caries. All the surfaces of the teeth must be brushed systematically.

Mouth Rinsing

A mouthwash is any fluid suitable for rinsing the oral cavity.¹⁰⁴ Much evidence has been cited to show that the removal of freely fermentable carbohydrates from the mouth tends to limit dental caries. The simplest way in which the natural cleansing mechanism can be augmented is by a mouth rinse.⁴¹ Cleaning is produced by forceful swishing and sucking of the liquid in and about the mouth. Water should be drawn between the teeth and swept along the vestibule by vigorous muscular contractions before being spat out.

The use of mouth rinse for the benefit of its action in loosening food debris from the teeth has been suggested to be of value as caries control measure.

Figure 16 shows the difference in carbohydrate concentration in the saliva in a test group of 50 students and student nurses who were given taffy in connection with the Vipeholm⁴³ studies of dental caries in Sweden. The subjects were tested twice with and without a vigorous rinsing of 20 ml. of water which was later swallowed. It can be seen that after a period of $23\frac{1}{2}$ min. more than 3 times as many of the subjects showed high carbohydrate concentration without rinsing as did the same individuals after rinsing.

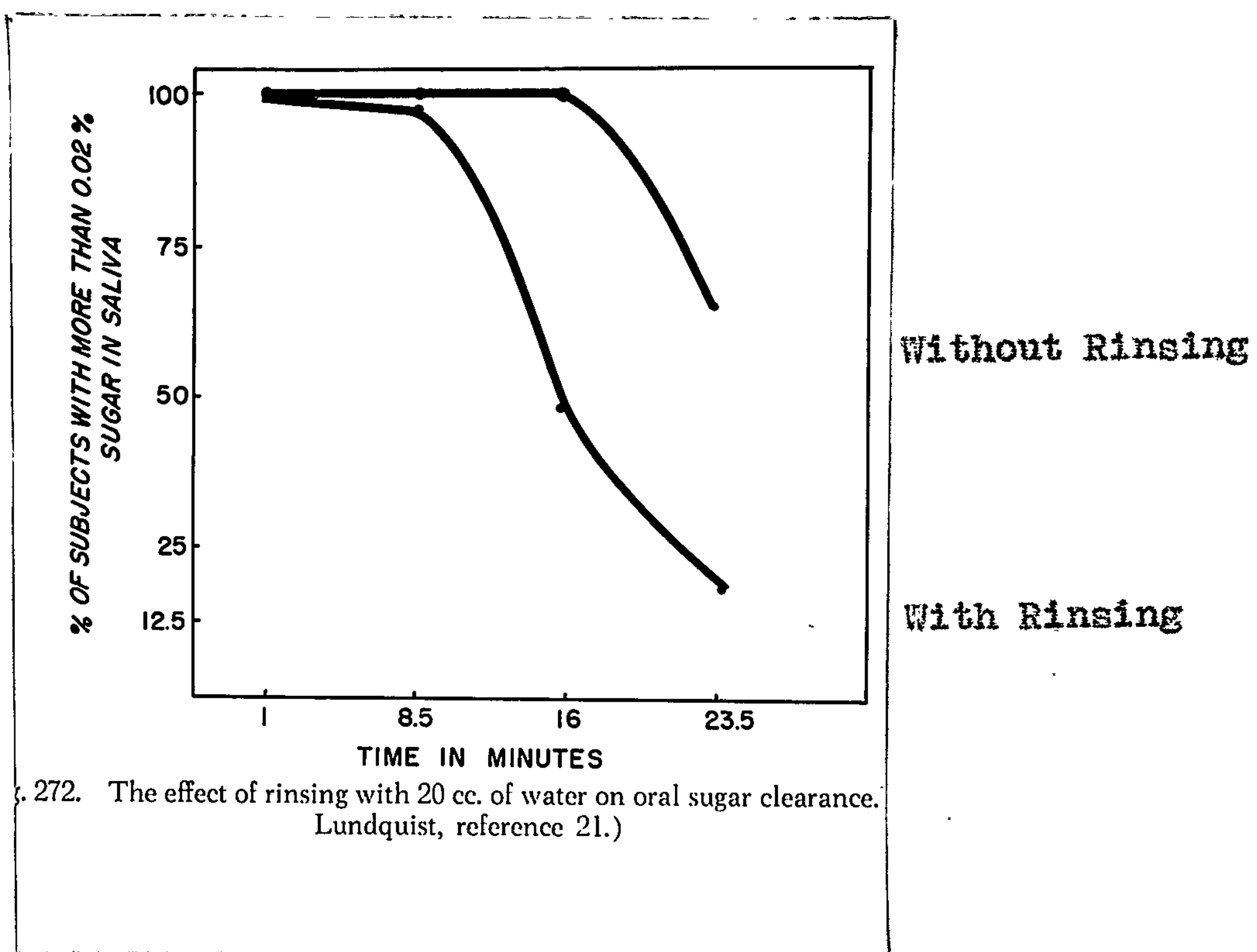


FIG. 16

(Ref. 8)

Detergent Food

The role of the diet deserves special consideration because of the often observed differences in caries incidence of various populations who subsist in dissimilar diets. The physical nature of the diet has been suggested as being one factor responsible for the difference in caries experience between primitive man and modern man. The diet of the primitive man consisted generally of raw refined food containing a great deal of roughage which acted to clean the teeth of adherent debris during the usual masticatory excursions.

Some workers have related the high caries incidence among modern civilised races to the unrestrained use of soft, sticky, refined food which tends to adhere to the teeth. This softness of the diet is thought to be due to removal of natural fibres in foods, either in preparation or in cooking. It has been stated that fibrous food in the diet prevents lodging of food in pits and fissures of teeth and in addition act as detergents. Detergent foods are those, which, by their fibrous or juicy nature tend to clean the surfaces of the teeth.

For many years the dental profession has recommended that fibrous foods should be eaten in order

to maintain oral health. The amount of refined carbohydrates consumed by civilised communities continues to increase each year, so indeed does the incidence of dental diseases, especially dental caries.

Many suggest a return to 'natural' foods, flour prepared by stone grinding, compact grown wheat, unrefined carbohydrates, raw fruits and vegetables, with less cooking and processing of foods. On the other hand it is argued that economic factors make production of sufficient foods of this kind prohibitive, even if it were possible to persuade civilised communities to cease indulging their taste for sweet things.

As mentioned earlier one of the primary factors in dental caries is the retention of food particles in stagnation areas on and around the teeth. Thus theoretically the removal of this debris, can contribute much to the prevention of this disease.

A number of studies have indicated that the act of eating removes a relatively large number of micro-organisms from the oral cavity. Crowly and Rickert³⁵ reported that after eating there was a reduction of as high as 78% in the number of bacteria that could be recovered from the mouth. This finding was also made by Kligler,

Wallace and Knighton,⁴⁶ and suggests that mastication of food is the best way to reduce the bacterial count of the oral cavity.

However, it is apparent that the numbers of oral bacteria quickly return to a high level soon after. It is also not possible to remove all oral bacteria by artificial cleansing procedures alone. Therefore the reduction of bacteria by fibrous foods is not of much use in prevention of caries.

Volker has stated that eating of fibrous foods after meals is to be recommended as a method of caries control.

It is logical that hard fibrous foods would be more beneficial in mechanically cleansing the oral cavity than soft sticky food. It also appears reasonable that adherence of soft food to the teeth would predispose to the development of more caries than would be found in a mouth kept relatively clean by a fibrous diet.

The European apple is the fruit which has been studied by Slack and Martin^{44,45} for its detergent properties. The children of the National Children's Home, Frodsham and the Family Group homes in the city of Liverpool were selected for this investigation. These children were divided into an

FIG. 17



Fig 62.—Boy eating chocolate biscuit.

FIG. 19



Fig. 64.—Same boy with apple.



FIG. 18

Appearance of teeth
of boy in FIG. 17



FIG. 20

Appearance of teeth
after the chewing
of one bite of apple
following FIG. 18

(Ref. Miller B.D.J. 113: 10 July 1962)

Apple group and a control group. Five dental examinations, including the baseline examinations, were carried out at six monthly intervals during a two year period.

Only certain types of apples were found suitable. It was necessary for the flesh of the apple to be firm and crisp with a skin that was not too tough. The acidity of the extracted apple juice was around ph 3.5 for the types used. Instructions were given for the apples to be served at the end of each meal and after eating between each meal. The unpeeled apples were cored and sliced horizontally to give apple rings of about an inch thick. This allowed the smallest number of apples to be used; freshly cut for each serving. The shape of the apple rings made it likely that the younger children, at least, would take a large enough bite to bring the posterior teeth into action.

There were 90 children in the Apple group and 81 in the control. No instructions were given regarding oral hygiene.

They found that the gum condition of the children was significantly better in the apple group. There was some reduction in the incidence of dental caries in those children receiving apples, although in some age groups the difference did not reach statistical significance because of small numbers.

The action of the apples appears to be two fold.

1. Firstly, the low ph of the apples stimulates salivary flow, which is also increased by mastication of fibrous apple fragments.
2. Secondly, the mechanical cleansing action of the apples sweeping over the teeth and gums in the presence of increased salivary flow removes debris and stimulates the gum tissue.

However, after a follow up examination⁴⁵ 18 months after the issue of apples, free of charge had ceased, showed that the original advantage to the apple group was lost. Both the apple and control groups approximated one another in caries experience and gum conditions.

At the present time there is no other scientific evidence based on controlled studies in human beings to indicate that the eating of detergent, either as a part of the diet or simply after meals, is beneficial as a caries control measure.

However, the fact that the areas of teeth exposed to food excursion are so called areas of immunity, suggest that mechanical cleansing by detergent has some value in caries control. They will certainly reduce the volume of media for microorganisms to utilise and massage the gums. Figs. 17,18,19 and 20.

Chewing Gum

It has been suggested that chewing gum would tend to prevent dental caries by its mechanical cleansing action. Chewing gum consists primarily of gum base, flavours and fermentable sugars. In so far as the material is approximately 60% by weight sugar, one would normally expect that the sugar in the gum would be easily available for bacterial substrate.⁵⁴ Due to this sugar content the chewing gums might actually increase caries susceptibility.

The research of Knighton⁴⁶ (1942) and of Turesky and Bibby⁴⁷ (1944) indicates that chewing of gum tends to cleanse the oral cavity mechanically.

Knighton⁴⁶ (1942) conducted his studies concerning the effects of chewing gum after meals on the incidence of lacto bacilli in the mouth of children on carbohydrate restricted diet. A group of children in an orphanage were divided as nearly equally as possible according to control lacto bacillus determination and clinical examinations into two sections. All of the children were placed on a carbohydrate restricted diet for 37 days. Children of one section were given a stick of chewing gum after each meal, except the meals before which salivary samples were taken. With this exception all the children were treated the same. In the twelve children using chewing gum, there was a

definite reduction in lacto bacillus count of eight; while in the eleven children not chewing the gum there was a reduction in the lacto bacillus count of six. The reduction of very high counts (10,000 per c.c.) to zero included two cases in the chewing gum series and one case in the other.

Knighton arrived at the following conclusions:

1. The lactobacillus counts were reduced in more than 50% of the individuals on a carbohydrate restricted diet.
2. Slightly greater percentage of reduced counts in cases of children chewing gum after meals was of little or no significance.
3. It is apparently possible to reduce the lacto bacillus count in some individuals from high count to zero, even when they chew 3 sticks of gum a day.

However, this study of Knighton does not take into consideration the fact that many, if not most, individuals chew gum at times other than after meals. It should be noticed that this experiment was not conducted for sufficient length of time to permit any observations regarding the difference, if any in caries incidence in children whose lacto bacillus counts were not lowered. It would be interesting to learn whether the caries rate was higher or lower in those who

chewed gum than in those whose counts remained high and who did not chew gum.

Turesky and Bibby⁴⁷ (1944) using methods essentially those developed and described by Knighton gave definite confirmation to his conclusions.

However a dissenting view has been advanced by Fleish (1942)⁴⁸ after his clinical observations. He claims that the chewing gum has harmful consequences, at least in so far as it increases susceptibility to dental caries.

Toto⁴⁹ (1960) investigated the effect of chewing gum on caries and gingivitis of school age children over a period of one year. There were 275 children in the experimental group and 276 children in the control group. The experimental group was given instructions to chew for five minutes after three meals three times a day. This was supervised by the teachers in the school. His results showed that the mean increase of D.M.F. in both groups of school children was identical. The P.M.A. index showed a definite increase in the experimental group, while there was a decrease in control group.

Volker⁵⁰ (1948) has studied the effect of gum chewing on the incidence of caries in a group of adults.

Fifty persons were included in the experimental group and a similar number served as control. The gum was chewed for at least ten minutes after morning and evening meals. After eighteen months, no significant differences were found in the caries experience between the experimental group and the control group. As might be expected the gum did remove a great deal of residual oral debris.

The work of Drizen⁵¹ (1951) indicates that a sugar free chewing gum containing Furadroxyl may be of value in the prevention of dental caries. However his work should be considered preliminary in nature because of small sample size. There has not been any further report on this subject.

The available evidence indicates that the chewing of gum in moderate amounts has neither a harmful nor a beneficial effect on the teeth or supporting tissues.

The research committee of the Canadian Dental Association⁵² (1956) made the following statement, "any decision concerning the beneficial or undesirable effect of gum chewing must await comprehensive investigation."

Dentifrice

No discussion on the value of cleansing would be complete without some mention of the effects of dentifrices on tooth surface. The evaluating committee of Michigan Workshop¹⁰⁴ (1948) defines a dentifrice as, "a substance designed to help toothbrush clean the accessible surfaces of the teeth."

Dentifrices consist of flavouring oil, detergents, and sweetening agents, tooth powders and pastes contain abrasives⁹². The function of the abrasive is to remove debris and stain from the teeth and to polish the tooth surface. The abrasive ideally then should effect maximum cleansing with a minimum abrasion.⁵⁶

People vary in their need for an abrasive in a dentifrice.⁹³ Some individuals may prevent stain formation by the use of only a brush and water while others require a more vigorous agent. For those individuals where only a slight degree of abrasion is necessary, a mixture of baking soda and table salt or baking soda alone would suffice.⁹³

The most widely used abrasive in commercial dentifrices are calcium carbonate, anhydrous dibasic calcium phosphate, triphosphate, insoluble metaphosphate and hydrated alumina⁵⁶. The precipitated calcium carbonate may occur in

the following grades, all of which have different characteristics: light, medium, dense and extra dense. Information concerned with abrasiveness of dentifrices is comparatively meagre. This is owing in part to the fact that other ingredients commonly found in the dentifrice may alter the behaviour of the abrasive itself. For example, the abrasiveness of calcium carbonate slurry is reduced to one half when a certain amount of sodium alkyl sulphate⁹⁴ is present. It is also known that the particle size, shape and the presence of impurities influence the behaviour of the abrasive.

The cervical erosion that is often observed clinically may be owing in part to the abrasive effect of the dentifrice. Dentine abrades approximately 25 times faster than enamel and cementum 35 times more rapidly than enamel.

The primary purpose of the dentifrice is to assist the toothbrush in freeing the accessible surfaces of the teeth of newly deposited debris and stain. However even when done effectively the teeth may be relatively clean yet exhibit a dull appearance. Such a tooth is aesthetically undesirable. Therefore a second function of the dentifrice should be to polish the tooth.

The results of a study by Kitchin and Robinson¹⁰⁵ (1948) on the comparative abrasiveness of a number of

popular dentifrices is shown in table i. This indicates wide variation among the commercial products.

Although modern dentifrices are not sufficiently abrasive to damage the enamel severely they cause remarkable wear of the cementum and dentine, if the toothbrush carrying the dentifrice is injudiciously used, particularly in a horizontal rather than vertical direction.

Considerable research has been done upon therapeutic dentifrices, which contain agents designed to inhibit the growth of oral microorganisms or increase the resistance of the dental tissues. The major group of therapeutic dentifrice contains one or more of the following, chlorophyll, urea ammonium compounds, penicillin, sarconsinates, peroxide etc. With most of these the results are inconclusive or negative. The best results so far have been obtained with a dentifrice containing 0.4% of stannous fluoride.^{57,114,115} (1963)

The Council of Dental Therapeutics of the American Dental Association⁴³ has concluded that this dentifrice can be of significant anticaries value when conscientiously used. Fluoride dentifrices possibly exert their major influence through the reducing of the enamel solubility, a method which would seem to have no disadvantageous sequelae. In contrast,

TABLE I

Dentifrice	Period of Years Necessary to cut halfway through cervical of a 7.0 mm Maxillary right canine tooth
Dr. Lyon's Tooth Powder	7.6
Calox Tooth Powder	10.6
Pepsodent Tooth Powder	15
Colgate Tooth Powder	17
Ipana Tooth Paste	27
Listerine Tooth Paste	35
Pycopay Tooth Powder	51
Pepsodent Tooth Paste	61
Salt and soda*	110
Colgate Tooth Paste	110
Tap Water	6,686 (infinity)

* Equal Parts NaCl (GP.) and Arm and Hammer Baking Soda

those dentifrices which aim to inhibit bacterial growth or action are always faced with the disadvantage that, after continuous use for a period of years, different strains of bacteria will appear by mutation that are resistant to the therapeutic compound.

Advertising claims to the contrary notwithstanding, dentifrices are aids, not essentials in oral cleansing. According to Dunning⁶⁰ much good work can be done with a base toothbrush, or one dipped in baking soda powder or a mixture of baking soda and salt. Beyond this dentifrices are useful if they provide a mild abrasive and a pleasant taste.

The following statement appeared in the Editorial of British Dental Journal⁵⁸ (1958), "The claim that a paste can give protection against caries for long periods, or that it has a magic ingredient which can promote the health of soft tissues, is false and against the interest of the public. One of the basic teachings of oral hygiene is that food particles particularly those of fermentable carbohydrates, must be removed from the teeth, as soon as possible, and much time and money has been spent and will be spent in educating the public to this end. For a toothpaste manufacturer to state, even if by implication, that an ingredient of his paste makes this less necessary is an exhibition of business

morality at its lowest, for not one shred of evidence has been produced to show that such a statement is true. The danger lies in the fact that the false claims made induce in the adult a false sense of security, for their children as well as for themselves and undermine the beneficial effect of teaching of proper oral hygiene."

Nancy Dudding et al⁵⁹ have studied the patient reactions to brushing teeth with water, dentifrice and salt and soda combined on a group of 50 college students. They found that the general reaction of the patients who did not use dentifrice was most unfavourable. This was indicated by the fact that 46% of the subjects withdrew and only 4% stated they liked to brush without a dentifrice. By contrast, in the group using a paste dentifrice 88% preferred this procedure and only 5% withdrew. When participants were given a salt and soda powder, 20% withdrew and only 8% said that they liked this powder.

This experiment suggests that considerable number of people will not brush their teeth if they cannot use a dentifrice. Such a finding indicates that an acceptable dentifrice must be used before the majority of people will clean their teeth. Pastes are more widely used than any other forms of dentifrices, due to their smooth texture, which makes the movement of the brush more pleasant. In many respects they act as lubricants for the brush. Paste is a powder

which has been bound together by glycerine or other similar substances. Thickening agents such as tragacanth, starch, algin and cellulose are also included.

So by prescribing an acceptable toothpaste, the patient may more readily and pleasantly be brought to the task of correct toothbrushing.

In the light of present knowledge the most reliable advice is given by the American Dental Association⁶⁰ when it says, "the function of a dentifrice whether it is a paste, powder or liquid is to aid the brush in cleaning the teeth. Don't expect your present dentifrice to do more than this."

Patients will often ask a dentist which dentifrice he recommends. Wade⁴¹ suggests that this question should be countered by asking the patient which he uses, and unless this happens to be one of the few which contain the drugs known to be injurious when used excessively, he should be advised to continue with the preparation of his own choice. On the available evidence fluoride dentifrices could be recommended.^{114,115} The patient should be made to realise the cleansing by dentifrice and toothbrush is important.

Scaling and Polishing

In the control of periodontal disease, the value of routine scaling and polishing of the teeth at periodic intervals of three or six months cannot be denied. However, since dental plaque formation occurs within a matter of hours to a day or two following complete removal of the structure, there is probably little if any value in prophylaxis for the control of dental caries. Hine³⁵ has pointed out that the careful polishing of roughened tooth surfaces and the correction of faulty restorations is probably of more importance than the mechanical cleansing of the tooth by prophylaxis. These procedures might conceivably reduce the retention of food debris and decrease the formation of bacterial plaques, thereby reducing the development of new carious lesions.

There are no studies in the scientific literature with sufficient data definitely to establish the value of dental prophylaxis in the control of caries.

Interdental Cleaners

Dental Floss and Toothpicks

Various instruments such as toothpicks and dental floss are used to relieve food impaction in interproximal spaces and, therefore, conceivably could be of some benefit in isolated cases.

Their value on a widespread basis is probably negligible, although there are no controlled scientific studies reported that deal with the effect of their use on dental caries experience.

Discussion

There has always been doubt in the minds of many people regarding the degree of cleanliness that could be achieved by toothbrushing and also whether in fact such cleanliness would be sufficient to influence the incidence of dental caries. The findings of Slack and Haynes⁸⁵ (1958) suggest that even among the dentists there exists a certain lack of conviction regarding the value of toothbrushing. However the results of most studies show that the standards of oral hygiene are significantly associated with dental caries experience. Moreover the relationship between the frequency of toothbrushing and oral cleansing clearly suggest that the lower prevalence of caries in those with good cleansing is due to child's own efforts to a considerable extent.

Although the frequency of toothbrushing and standards of oral cleansing are clearly related, it is noted that for a few individuals good standards of oral cleanliness can be maintained even when a toothbrush is not so frequently used. Mansbridge⁴⁰ (1960) found that 10% of children who brushed their teeth less than once a day had good oral cleanliness. It seems reasonable to suggest that in these children natural self cleansing may be due to the character of their usual diet.

Most studies in the field of toothbrushing have been done in U.S.A. and U.K. So far no studies of this nature has been done in Australia. A direct comparison with these studies is difficult for many reasons. Environmental difference between these two countries may influence the findings. Moreover, there are considerable differences in the ages of the individuals studied.

Thus Hein³⁸ (1954) found toothbrushing ineffective in influencing dental caries in adults, while Savara and Suher⁴² (1955) reported no relationship between toothbrushing and caries incidence in pre-school children. Weisentein and his associates³⁷ (1954) studied 9-14 year old children and found a lowered dental caries incidence in children receiving toothbrush instructions compared with children receiving no instruction. Fosdick³⁶ (1950) found a considerable evidence of caries in young adults, 22-24 years of age following a prescribed regime of oral hygiene immediately after eating.

Mansbridge⁴⁰ (1960) studied a group of 426 children 12-14 years of age and concluded that the, "toothbrushing and standards of oral hygiene showed in general an association." He suggests that reduced incidence of dental caries would follow a personal regime in which standards of oral cleansing are improved and in which the intake of sweets and chocolates is reduced.

Of these only Fosdick and Weisentein et al tested the effectiveness of brushing immediately after eating. They both reported reduction in incidence of new carious lesions. This is in agreement with Stephens⁹ findings and shows that to be effective oral cleansing must be done immediately after eating.

Hein (1954); Savara and Suher (1955) do not mention immediate brushing after meals. Hein found no appreciable difference in 60 males who brushed once or twice a day. Both of these authors tried to find the relationship between frequency of brushing and dental caries rather than the effect of immediate brushing after eating. In the light of Stephan's⁹ findings their results cannot be expected to be of any great significance. Their sample appears to be small and there is no indication in their report as to thoroughness of instructions given in cleansing.

Therefore the author agrees with Fosdick³⁶ that toothbrushing immediately after any eating can result in a decrease in the incidence of dental caries. However, apart from Fosdick's work there is no data available to show how great a reduction in dental caries could be obtained by brushing immediately after eating.

Mouth rinsing with drinking water could be at least effective on the basis of experimental evidence as shown

by Lundquist (1952) and should form a useful adjunct to oral cleansing measure.

Detergent foods⁴⁴ and fluoride dentifrices would greatly enhance the effect of toothbrushing. A fruit which causes a copious flow of saliva, even though the fruit itself be soft, will wash carbohydrate debris away. Interdental cleansing, scaling and polishing of teeth would be of value in special cases.

Not enough studies have been done to indicate the usefulness of chewing gum.

Because of the influence of provoking and predisposing factors on dental caries no one method of prevention could be expected to be totally effective. On the available evidence therefore oral cleansing, in combination with other available methods namely, chemical and nutritional would play an important role in the control and prevention of dental caries.

Broad Conclusions

1. Widespread cleansing of teeth, with detergent foods, a toothbrush, non medicated mouth wash can be recommended because they can play an important part in the prevention and control of dental caries, although the evidence that such measures are effective is limited.
 2. Because there is no known way of removing mechanically all bacteria and food debris from the mouth for any length of time, cleansing of the teeth alone cannot be expected to prevent dental caries.
 3. It is clear that no single method of prevention could be expected to be totally effective and it seems logical to say that several different measures are required, each aimed to eliminate or reduce the various independent causative factors. By removing the substrate from the mouth the cleansing would contribute toward reduction in the incidence of caries. Therefore different measures could be additive in effect.
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PART B

Non Functional Cleansing and Periodontal Disease

"Preventive measures are concerned with sound structural development of parts and their maintenance in this state through suitable nutrition, function and cleanliness.

Where disease has intervened and been treated measures are needed to prevent further disease and to maintain the benefits of treatment."

Bryan Wade 1960

Historical Background

Diseases of the periodontal structures have been known since antiquity.⁶¹ Skulls of some ancient cave dwellers show evidence of chronic periodontal disease, while an acute form now known as acute necrotizing gingivitis, or "Vincent's infection" was reported at least as early as 400 B.C. in soldiers in the Greek army. Man suffers to a greater extent from periodontal disturbances than lower animals; in fact the lack of animal susceptibility to these affections has hampered research in this field.

In India in 3,000 B.C. loose teeth were being ligated and calculus removed and there survives from 500 B.C. a Phoenician dental appliance for splinting the lower incisors in a case of periodontal disease with generalised alveolar bone loss.⁶² Scaling and ligation of loose teeth were practised widely during the Roman period and many Roman appliances for the splinting of loose teeth survive. Treatment of both caries and gum disease was carried out and further advanced by Arabian physicians from the seventh century onwards, being brought to a particularly high standard in the twelfth century by Albucasis, who developed for his own use a comprehensive set of scaling instruments, and at this time the important connection between calculus and gum disease was certainly recognised. He is credited with the

final recognition of removal of calcareous deposits as an important factor in the control of periodontal disease.

Jacques Guillemeau, whose book, *La Chirurgie Francoise*, on general surgery was published in 1594, was the first writer whose works were available in English to display an understanding of the condition now called chronic periodontitis. He described the disease as especially prevalent in old people, and his treatment was scaling, which he described in detail, and the use of alum; which he says prevents deposits on teeth and fastens the gums onto the teeth when they hang loosely thereon.

In France in 1746, Fauchard⁶³ in *Le Chirurgien Dentiste*, gave a further description of gum disease. In this book he emphasised the need to keep the teeth clean if disease were to be prevented. Chronic periodontitis was for a long time known as Fauchard's disease. In 1778 John Hunter in his *Practical Treatise on Diseases of the Teeth* described periodontal disease, but he wrote he was unaware of any effective treatment.

The modern periodontology really began in the second half of the last century. The most important figure at this time was John Riggs; he was unfortunately reluctant to publish his ideas on the causes and treatment of periodontal disease and it was left to his enthusiastic

disciples to interpret his methods and give them publicity. It is clear, however, that he was one of the first men to recognise the great importance of subgingival calculus in the causation of chronic periodontitis, and his method of treatment was essentially a most careful subgingival curettage, coupled with very careful polishing of the root surface.

Riggs also insisted upon methodical use of toothbrush and the patient was directed to brush the teeth not crossways but "with a rotating motion on the inferior teeth from the gum up and the superior teeth up." Before the end of the century the value of regular prophylaxis in the prevention of periodontal disease was being recognised and practised.

We have seen that the connection between calculus and periodontal disease has been recognised for a long time and this remains the most surely known aetiological factor in chronic gingivitis and chronic periodontitis.

Etiology and Pathogenesis of Periodontal Disease

Prevention is based on the knowledge of etiology and pathogenesis. If the cause of the disease is known, it usually can be prevented. The etiology of marginal gingivitis and periodontitis is in general well established. A W.H.O. Expert committee⁶⁴, found that in general local rather than systemic factors appear to be responsible for initiating periodontal disease. The resistance and reparative properties of periodontal tissues, the character or severity of etiological agent, and the constitutional make up of the patient will modify the effects of the local irritants.

Supra and subgingival calculus and bacterial plaques, consisting of materia alba and many living microorganisms are the most common irritants of the periodontal tissues. Figs. 21, 22 and 23. Few people are free from these accumulations. As the microorganisms multiply, the plaques tend to grow below the gingival margin towards the apex of the tooth. The irritations produced by the bacteria and their toxins lead to degeneration of crevicular epithelium with inflammation of the adjacent connective tissue and formation of a pathologic pocket in the gingival crevice. The damage to the gingivae is slow but progressive. Spontaneous healing does not occur as long as these accretions remain on the teeth. The deeper layers of the bacterial plaque often



Figure 453. *Materia alba.*

FIG. 21

(Ref. 61)



Figure 455. *Supragingival calculus on lingual surface of lower anterior teeth.*

FIG. 22

(Ref. 61)



Figure 457. *Calculus.*

A, Massive amount of calculus in a patient who had not had a prophylaxis for many years. B, Roentgenographic appearance of teeth with a heavy calculus deposit.

FIG. 23

(Ref. 61)

degenerate and become calcified to form calculus which is firmly attached to the tooth. The word calculus means stone. It is the most important single cause of gingival and periodontal disease. Calculus is uniformly associated with the periodontal disease. It is a hard, rough material that is adherent to the tooth surface, therefore it moves with the tooth during function. For this reason, injury to the adjacent or overlying gingival tissues which do not move in unison with teeth may result. Also when pressure is placed on the gingiva during mastication, the underlying calculus irritates the gingival tissue. Calculus with its overlying mat of microorganisms, thus causes a mild inflammatory reaction in the gingiva with resultant oedema, hyperaemia and leucocytic infiltration. The inflammatory reaction increasing the size of the gingiva through the various vascular and cellular phenomena causes a gingival pocket. This pocket allows more debris to collect, more bacteria to form and multiply and more calculus to be deposited. In other words a vicious cycle is instituted. Occasionally, however, supragingival calculus may collect in prodigious amount with little or no pathosis present than superficial inflammation, this is probably due to high tissue resistance.

It is generally agreed that the local factors play the most important role in bringing about marginal



Figure 446. *Normal gingiva in a young adult.*

FIG. 24

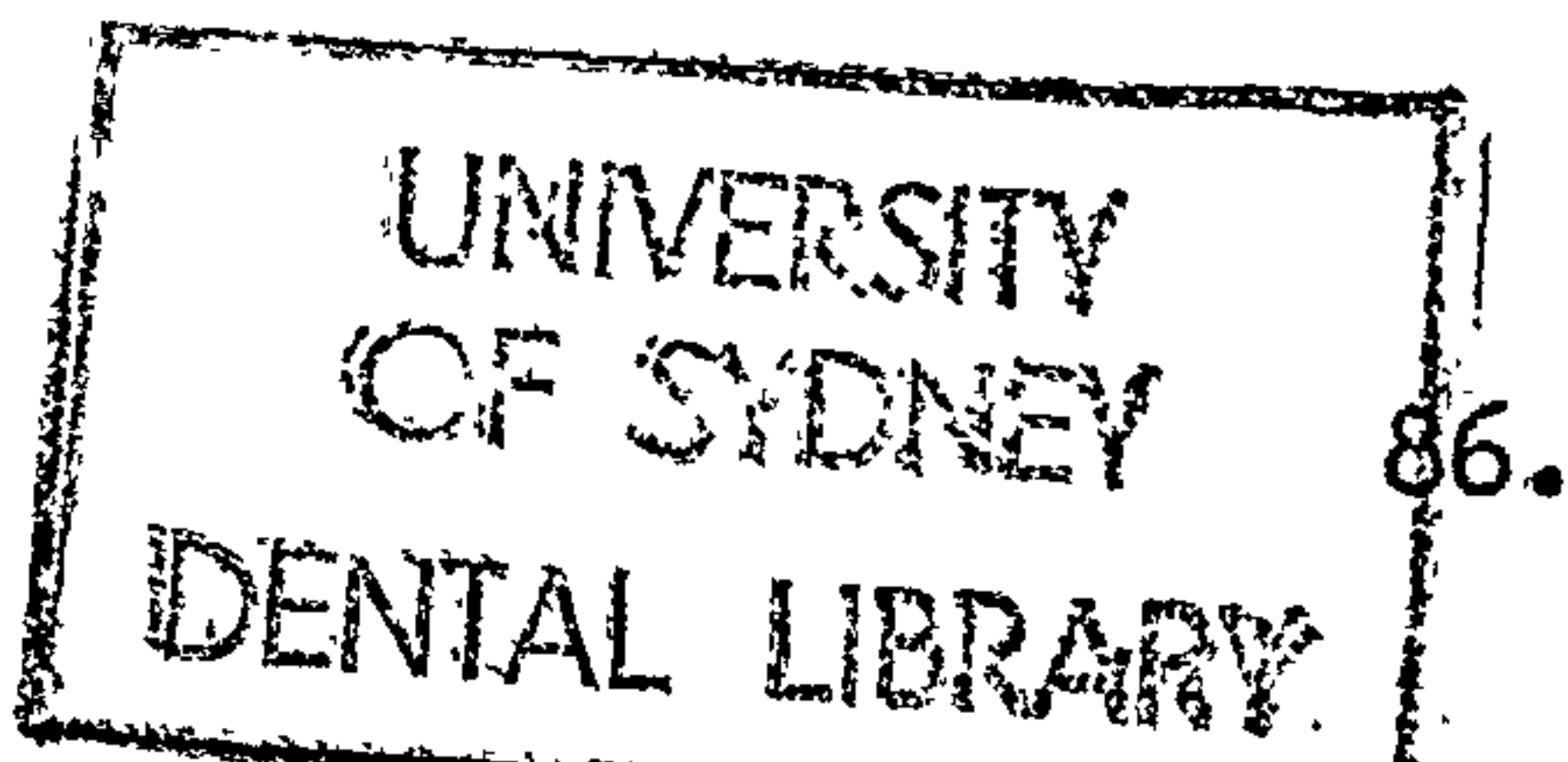
(Ref. 61)



Figure 30. *Chronic diffuse gingivitis associated with complete lack of oral hygiene.*

FIG. 25

(Ref. 62)



gingivitis and periodontitis. At times these factors are of prime importance, on other occasions they are only of significance when they are superimposed on systemic or other primary conditions. Figs. 24, 25

The progress of the damage to the periodontal structures is slow. It usually requires several years of oral neglect by the patient, and accompanying other local irritants, before the crest of the alveolar bone are destroyed. This is significant in that there is ample opportunity for the dentist, who sees his patient at regular intervals, to prevent advanced destruction to the attachment apparatus. The main requisite is to remove the causes which are readily available.

The exact reason for calculus formation is not known, but it appears that the nature of the diet and poor oral hygiene have some association with its formation.

Since damage caused by periodontal disease is irreparable, preventive measures should be instituted early in life. The aim must be to prevent the accumulation of bacterial plaques and to ensure healthy development of periodontal structures so that they are able to resist infection should it occur.

Marginal gingivitis and periodontitis are the most common of periodontal diseases, and fortunately are preventable ones. Necrotising ulcerative gingivitis may also be prevented, but not to the degree of the former two.

Periodontosis is not preventable because the etiology is unknown.

Toothbrushing - General

To clean the teeth is not easy. Numerous types of toothbrushes have been designed and many methods of toothbrushing have been proposed. Some of these methods are efficient, but are too difficult for the ordinary patient. The ordinary methods are easy to perform but do not clean the teeth and commonly cause damage to the gingiva.

Tooth surface debris, consisting of massed organisms undoubtedly cause a gingivitis, but the position of the debris on the surface of the tooth is important. Debris covering the crown of the tooth away from the gingival margin, although it may contribute to caries has little, if any effect at the gingival margin and the pattern of tooth surface debris assessed on tooth surface coverage does not coincide with the pattern of gingivitis. Cleaning the tooth surface close to the rim of the gingival margin and preferably the crevice beneath the gingival margin is of considerable importance for collections of debris at the entrance of the gingival crevice and within the crevice cause gingival inflammation.

The toothbrush chosen by the patient often on the recommendation of their dentist is usually too hard or stiff. The bristles are too stiff in the mistaken assumption that debris will be removed more efficiently

from the tooth surface by a hard brush, and that the gingiva will be beneficially stimulated. The results often show that the bristles of the hard brush do not reach any but the most accessible surfaces of the teeth, which are already kept clean by the mastication of food and by the friction of the soft tissue. The hard brush does not clean interproximally and debris collects between the teeth in relatively exposed positions and also at the gingival margin where the gingiva rests against the surface of the tooth. A soft brush reaches these areas.

An old brush with splayed bristles also causes gingival damage, for in attempting to brush the teeth close to the gingival margin the bristles standing away from the rest pierce the soft tissues and cause pain and bleeding. The patient promptly stops brushing this area with the result that the debris remains and further irritation of marginal tissues takes place.

Some of the difficulties encountered in the proper cleaning of the teeth are due to mal-alignment of the teeth. If teeth are overlapped, tilted or placed inside or outside the line of the dental arch, an area of the tooth is protected from the surface friction of food, and from the bristles of the toothbrush.

Even when the teeth are in perfect alignment a large percentage of the surface of each tooth is inaccessible if the teeth are normally close together. Different parts of the mouth are also more or less easily reached by a toothbrush, so that some parts are easily kept clean and others are almost never brushed. The areas most often brushed are the buccal and labial surfaces of the upper teeth, and to a slightly lesser degree the counterparts of the lower teeth. But the palatal surface of upper teeth and particularly the lingual surface of the lower teeth are rarely cleaned by ordinary patient carrying out his usual routine care.

The last teeth in the dental arches and particularly the distal surfaces of these teeth are difficult to reach with a toothbrush and in almost every patient's mouth debris is found in these locations. In addition the patient's ability to use a toothbrush varies considerably. Most patients spend very little time and clean their teeth once a day, while others spend many minutes cleaning their teeth several times a day.

Patients generally brush their teeth with a scrubbing action and often persist in doing so after instruction. This is quite natural as this procedure requires no manipulation of the brush within the oral

cavity; the brush being pushed into the mouth with the bristles against the teeth and moved back and forth. This procedure not only damages the gingivae but leads to tooth abrasion.

Several methods of toothbrushing^{14,41} have been advised to prevent patients from brushing their teeth in an improper manner, and to provide them with a definite, harmless and efficient procedure.

With the introduction of the electrically driven brush with short reciprocal horizontal motion simulating the vibratory movements recommended by Stillman,⁶⁵ another method of cleaning the teeth at the gingival margin is available.

A tooth brush would more aptly be called a mouth brush; proper use of it not only polishes the teeth, but provides massage for the soft tissues, and it is increasingly becoming recognised that hard firm gums are essential to the preservation of the teeth. A point which is often not realised is that this is beneficial not only for the tissue at the gingival margins, but also, when a denture is worn, for those which carry it.¹⁰⁹

Wade⁴ (1960) suggests that when giving advice it is wise to use the word "brush" rather than toothbrush, for the latter draws attention to the teeth alone; yet the

object of brushing is to clean both teeth and gingivae, while at the same time massaging the gingival tissue.

Toothbrushing - Value in the control and prevention of
Periodontal Disease

The regular, careful use of the toothbrush prevents the retention of soft debris at the junction of gingiva and the teeth. Maximum effectiveness in this regard is obtained by brushing as soon as possible after meals. The soft debris which remains at the cervical and interproximal areas after eating consists of macerated food, in which bacteria flourish. The retention of this material results in gingival inflammation. If the debris is removed shortly after each meal bacterial activity¹⁸ and the irritating effect of food debris can be kept to a minimum. The inflammatory changes associated with persistence of materia alba interferes with the healing process and prevent the attainment of gingival health. Fig. 25

Maintenance of periodontal health depends almost entirely upon removal or correction of the cause of disease. If calculus is not completely removed, if food impaction continues, if diet is inadequate, or if any local and systemic factors which lower the resistance of the periodontium remains uncorrected, healthy oral structures can not be maintained. Even if all known etiologic factors are removed, but oral care is then neglected by the patient, in a few months the oral condition will be unsatisfactory.

After reviewing the literature one sees that most periodontists^{14,41,62,63} agree that proper toothbrushing is an effective, simple and inexpensive measure in maintaining the oral cleanliness so essential to oral health.

It seems reasonable to assume from existing evidence that calculus formation entails first, the occurrence of a non-calcified bacteria laden adherent plaque, and second calcification which converts the plaque to calcified calculus. It is not known whether calcification of the plaque is a selective process, or whether all plaques ultimately become calcified calculus; nor is there understanding of factors which govern the rate of calcification in individual patients. In the absence of definitive information regarding the calcification process, efforts at preventing the accumulation or formation of the calculus must of necessity be directed at its precursor, the initial non-calcified plaque, and would consist of any method which would remove the plaque as quickly as possible after it is formed or would prevent its continued accumulation.

According to Glickman⁵ there appears to be an inherent tendency which governs whether or not calculus formation will be initiated. This tendency varies in different individuals. Variation in this inherent tendency appears to influence the initiation and accumulation of

calculus formation to a greater degree than modifications introduced by the mechanical action of oral hygiene or vigorous chewing. It is reasonable to say that in a patient with a tendency towards calculus formation, oral hygiene measures will diminish the amount of calculus accumulation. It is a common experience, however to encounter patients in whom calculus formation occurs at a rapid rate despite most careful brushing. The latter measures are of some benefit and their value in reducing the accumulation of calculus is not to be deprecated. However, it appears that factors other than mechanical action govern the tendency toward calculus formation.⁵

Cleansing and Massage

The entire subject of home care means various things to various dentists. To some it is only a matter of cleansing teeth, while to others it is also an instrument of gingival stimulation.⁶⁵ To complicate the controversy, one cannot be easily separated from the other, and so the area for verbal differences seems greater than actual practice indicates. Goldman and his associates¹⁰⁶ regard the toothbrush as an invaluable instrument of both gingival stimulation and cleansing.

Lyons,^{66,67} Loeb⁶⁸ and Ziskin¹⁴ have questioned the value of gingival massage in the treatment of periodontal disease, pointing out that acceptable scientific

evidence of it is not available. It is true that massage with a toothbrush can be harmful, if it is improperly performed, if local irritants are present, or if an acute inflammation exists. Toothbrushing is contraindicated in cases of acute gingivitis and acute periodontitis. Even healthy gingivae can be so irritated by improper use of too harsh a brush that gingivitis or recession can result.

However, after all local and systemic factors causing gingivitis or periodontitis have been corrected, gentle massage will hasten the return of gingival tissues to health and will tend to make them more resistant to future irritants.¹⁴

It has been shown by Kitchin and Graham⁶⁷ (1937) that gentle massage will cause keratinisation of the epithelial layer of gingiva in man and in dogs. Robinson and Kitchin⁷⁰ (1948) concluded from their controlled studies that brushing the gingiva increased keratinisation of the surface epithelium. The increased keratinisation will result in an increased resistance - resistance to trauma by the gingival tissues. Clinical observation of the gingivae of patients who have received adequate gingival massage as compared with patients in which massage is poor indicate that gentle massage is helpful.

Clinical studies by Stahl et al⁷¹ (1953) and Stanmeyer⁷² (1957) indicate that massage of the gingiva with a toothbrush increases keratinisation of the surface epithelium, which is interpreted as providing protection against injury, and effects a decrease in gingival inflammation. In animals, controlled gingival massage results in thickening of the gingival epithelium with increased keratinisation was shown by Carter.⁷³

Montgomery (1951)⁸⁶ as well as Miller et al (1951)¹⁰⁷ also studied the keratinisation of the gingiva. They noted that the exfoliative cells of the gingiva showed high degree of keratinisation and the proportion of the keratinised to non keratinised cells was constant in the individual examined.

At least two clinical research experiments suggest that gingival massage is beneficial. Beube⁷⁵ has reported an observation of patients with marginal gingivitis apparently due to poor home care and accumulated irritants. Teeth were scaled daily for several weeks. One side of the mouth was brushed in the patient's usual manner, and the opposite side was brushed using a technique which cleaned and massaged more adequately. The inflammation disappeared on the side that was well brushed, but persisted on the poorly brushed side.

Hines¹⁴ observed that gingivitis could be produced

at will by inadequate toothbrushing.

Merzel et al⁷⁴ (1963) studied the brushing action in relation to the keratinisation of the human gingival epithelium comparing three methods namely, Rotation, Charter's and Stillman's. They concluded, "the quality of stimulus seems to influence keratinisation process, because the Rotation method produced inferior effects to those obtained with the vibratory techniques." On this basis they recommend vibratory techniques.

Many patients have healthy gingival tissues without brushing their teeth. However, many in the adult group need the mechanical aid of a tooth brush to keep their gingival tissues in a healthy condition. Modern diet does not furnish gingivae with the scrubbing action of mastication. Massage and cleansing are therefore desirable, and the tooth brush is the most practical way to furnish it.

Mouth Rinsing

The benefits of the physical cleansing and dislodging action of a mouth rinse are real. The action of mechanical flushing and the pumping of fluid through the teeth exercise a stimulating and cleansing action with practically no chance of traumatising the tissue.¹⁰⁶ When used with a mild solution of salt or baking soda to provide some sort of taste to it as well as a mild disinfectant action, the use of a flushing mouthwash acts as an efficient debriding mechanism. It is particularly valuable after the use of toothbrush and dental floss to flush away loosened debris. In addition it provides a real adjunct to therapy in the treatment of necrotising ulcerative gingivitis.

Removal of small amount of debris is assisted by using a hydrogen peroxide mouth wash of 3 per cent strength, because this will usually effervesce when swished about the mouth.⁴¹ Ordinary water is, however, extremely effective if used forcefully.

Patients should be instructed to flush with great vigour through the teeth for a long enough period to be effective. The effectiveness of this method depends upon its application.

Unfortunately, the advertising claims made for many mouth rinses imply that the mouth can be kept clean with the use of mouth rinses alone. However, germicides strong enough to kill many microorganisms may irritate mucous membranes and of course the oral cavity will be re-infected shortly after the use of a mouth rinse. Consequently, most commercial mouth rinses should be considered as cosmetic agents and used to cleanse the oral cavity mechanically. It should be considered as an adjunct to the use of the toothbrush.

Mouth rinsing may provide a means of cleansing the mouth at times when the use of toothbrush is inconvenient, such as after meals which are eaten away from home. (see Fig. 30 D)

However, there is no scientific evidence to suggest the value of rinsing and mouth rinsing alone would appear to be of limited value.



Scaling and Polishing

The word "prophylaxis" is used by many people for the operation of scaling and polishing the teeth. If performed before a gingivitis has begun it is undoubtedly a most important prophylactic procedure. Frequently, however, scaling is genuine periodontal therapy and for this reason the use of the term "prophylaxis" is misleading and should cease.¹⁰⁸

Scaling is the removal of dental calculus by hand instruments. The presence of rough, heavily infected deposits of calculus on the tooth surface in contact with the delicate crevicular or pocket epithelium is considered to be most important cause of chronic gingival inflammation, and when this material has been removed there is an immediate improvement in the condition of gingiva - the gingiva reverts to the normal pink colour, swelling subsides and the normal shape and appearance is resumed. Because of the reduction of inflammatory swelling, there is a reduction in pocket depth and this may be further encouraged by correct use of toothbrush and interdental stimulation. According to Wade¹⁰⁸ the objects of scaling and polishing are the removal of mucinous plaques, materia alba, and calculus both supragingival and subgingival, followed by the creation of a highly polished tooth surface.

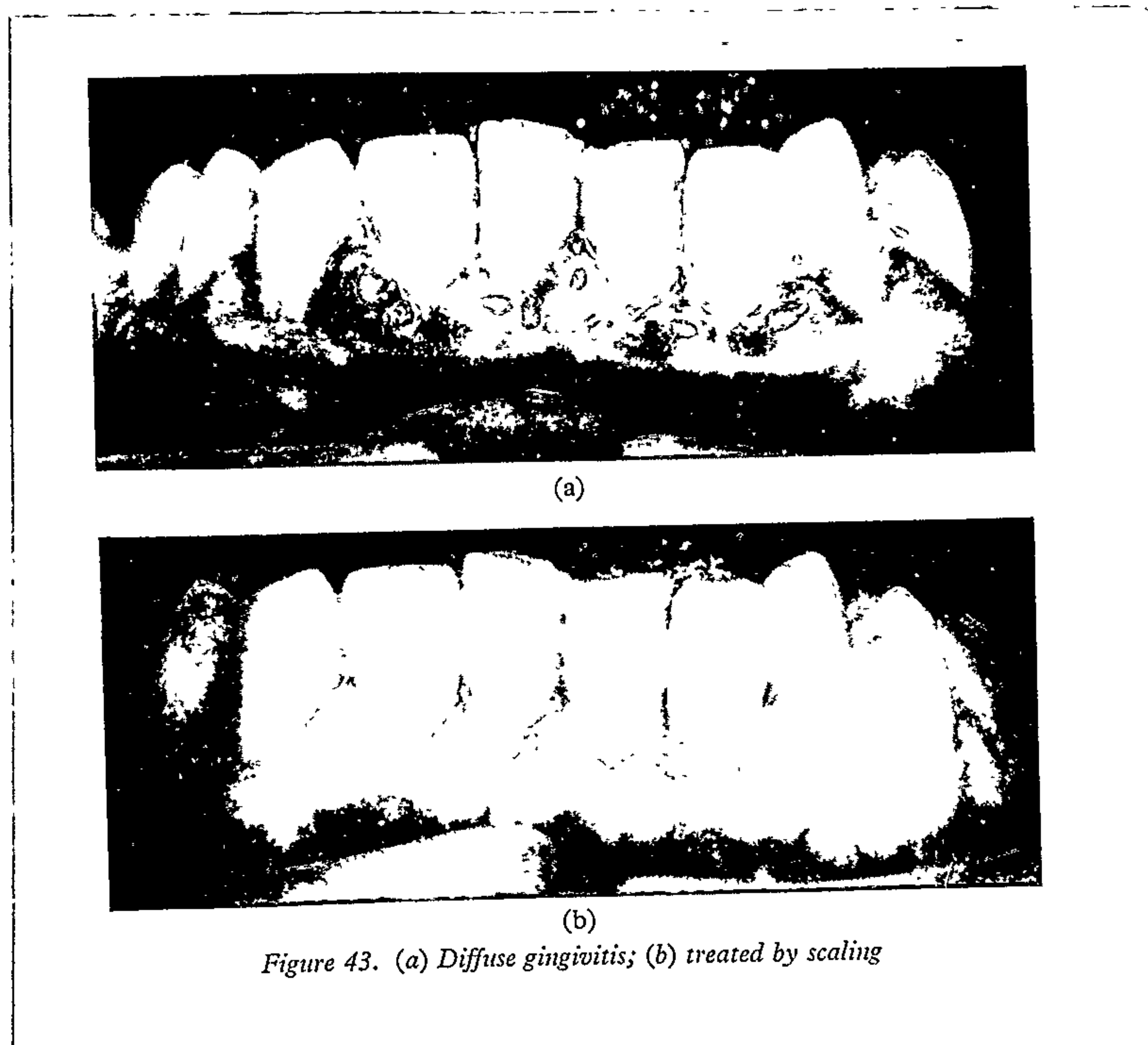


FIG. 26

(Ref. 62)

The operation of scaling and polishing is significant, therefore dentally and periodontally. It is in fact, one of the most important procedures in control and prevention of periodontal diseases. If done early it is the measure whereby many teeth can be saved. Fig. 26

Detergent Foods

There is considerable agreement regarding the beneficial effect of the stimulation from chewing detergent foods. From a study in experimental animals Burwasser and Hill⁷⁶ conclude that the soft diet permits stasis of the gingival circulation and softening of the tissue while the stimulation afforded by hard, coarse foods results in firm gingivae. Pelzer⁷⁷ reaches a similar conclusion from a study in humans and notes well hornified, keratinised epithelium associated with the use of detergent diet. Equally favourable conclusions were drawn by King and Glover⁷⁸ regarding the beneficial effect of vigorous chewing upon the gingiva. These investigators maintained ferrets on a diet of bread and milk or raw meat and milk, with inclusions of vitamins and mineral supplements, and found that animals developed periodontal disease within eight to twelve weeks. There was gingivitis, calculus formation, atrophic changes and loosening of teeth. On the other hand, animals fed this diet plus short lengths of bone with meat attachments, which required vigorous chewing, presented no periodontal disease.

Hydack⁷⁸ and associates reporting on studies in healthy males, fed on a diet of milk and honey for thirty days, found that some of the subjects developed a general hyperaemia of the gingival margin which became worse as the

experiment progressed. The gingival changes were attributed to lack of functional stimulation due to decrease in detergent action, and chemical and bacterial irritation. According to Ivy et al⁷⁸ gastrectomised dogs fed a soft diet show early evidence of periodontal disease and a marked tendency toward calculus formation.

Hard and fibrous foods are of value after calculus has been removed in preventing its reformation. Some experiments of King¹⁰⁰ have shown that the chewing of sugar cane by human subjects greatly influenced the health of the gingivae and periodontal membrane. The mechanism seemed to be chiefly the effect of friction on the removal of calculus and the prevention of its deposition.

On the basis of the experimental evidence and clinical observations it is apparent that the functional stimulation derived from mastication is an essential requirement for the normal metabolic activity of the gingiva and underlying tissues. Soft foods are detrimental to the periodontium, first because they do not afford sufficient functional stimulation, and second, because they foster accumulation of irritating food debris at the gingival margin.

Interdental Cleaners and Stimulators

When spaces are present between the teeth they must be kept clean and free from food debris. The interdental gingival tissue must also receive friction as it misses the stimulation provided by food and brush.

Several different ways of achieving these objectives have been suggested. Some of them only cleanse, while others both cleanse and stimulate. None of them should be used when a gingival irritant such as calculus is present, because their use will aggravate the gingival lesion.

Toothpicks and Dental Floss

Twigs, grasses and seeds were primitive man's first artificial tools for removing food particles from teeth. In early times, toothpicks were accepted as the most reliable means of maintaining a sound dentition.⁷⁹ They date to antiquity - just how far it is not possible to determine with any degree of accuracy.⁸⁰ They were certainly used in ancient China, Japan and other Eastern countries.

The Babylonians had such cosmetic aid as toothpicks, tweezers and ear picks as early as 3500 B.C. The Chinese before 2600 B.C. had both permanent and disposable types of toothpicks.

Gautoma Buddha⁸⁰ (563 - 483 B.C.) provided a sutra (an aphorism) which encouraged the use of toothpicks by all classes of people. From the period of the birth of Buddhism, therefore, oral hygiene and toothpicks had religious significance.

The "Jeju Meibutsa", a small dissertation that reputedly appeared in Japan between 947 - 956 A.D. listed the benefits to be derived from the use of the toothpick, these included - a pure breath, a healthy alimentary tract, improved taste and digestion, and improved eyesight.⁸⁰

Their range is varied. For instance, some consisted of fibrous sticks and quills of a porcupine, hedgehog or vulture⁷⁹ others were of bronze, silver or gold. In fact, more often than not, the choice of a particular metal was determined by the social status of the user.

There have been recurrent periods in the West when the toothpick was not only socially, but professionally taboo, and considered injurious to the teeth. Such does not seem to have been the case with many varieties of toothpicks used in Japan. Here the toothpicks for use in the spring were made from willow tree, summer ones were made from cherry, autumn ones were made from chestnut and winter ones from mandarin orange wood.

Some Japanese shrines gained impressive reputations for effecting dental cures, and as a consequence sold toothpicks which were believed to have special healing qualities. When the sufferer was cured the toothpick was returned to the shrine as a testimonial.

Permanent type of toothpick cases did not gain favour in Japan until the mid eighteenth century, about the time such cases became popular in Europe. Toothpicks have continued to be popular in Japan and are sold at village stalls and toothpick shops.

Patton⁸¹ claims that the toothpick is more efficient than any bristle brush yet devised. His reason is that the toothbrush fails because the teeth are not rigid structures sitting in an elastic bed on bone. Food debris that has become impacted between teeth can be removed only by the use of a force sufficient to overcome the elasticity of the periodontal membrane.

Dental Floss

Dental floss is used to remove small particles of food which have lodged beneath a contact area and also to polish proximal tooth surfaces to eliminate mucous plaques. Much harm can be done by dental floss, particularly to the root of the teeth, if it is pulled horizontally to and fro

instead of being moved vertically while held taut.

For this reason it is unwise to advocate dental floss as routine part of home. It should be used in special cases. In an attempt to overcome the harmful effects of dental floss Richards⁸² suggests the combined use of knitting wool and dental floss. The chief disadvantage of this is that small pieces of wool may be left between the teeth.

Wood Points, Cones and Plastic Stimulators

These have been recommended when interdental space is present, because they clean and stimulate in the same action.⁴¹ They are widely used in postoperative care after a gingivectomy. Facsimiles of wood stocks have been made in plastic materials to give greater flexibility and also allow repeated use after washing. A disadvantage of plastic stimulators is that though they are pliable they are not compressible, so that they must fit the interdental space more accurately than balsa wood sticks. They would seem to merit further investigation. Cones made of wood, rubber or plastic may be inserted in the holes in the handles of toothbrushes or on special applicators. They can be used effectively in any part of the mouth due to their setting in the handles and their compressibility facilitates a massaging effect by alternate application



FIG. 27 The use of pyramidal rubber tip for
Interproximal cleaning and massage (Ref. 104)

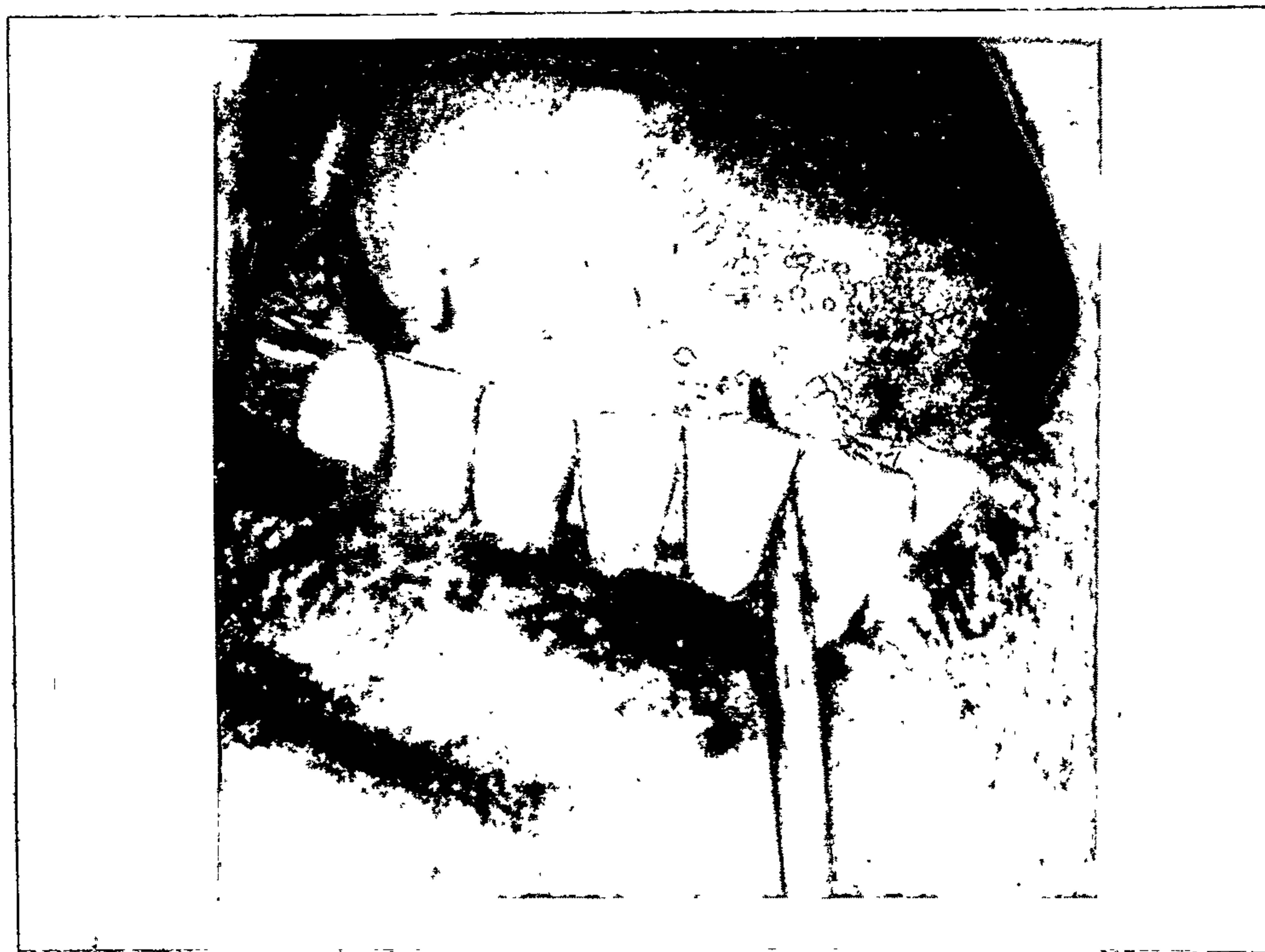


FIG. 28 The use of a balsa wood toothpick for
Interproximal cleaning and massage (Ref. 104)

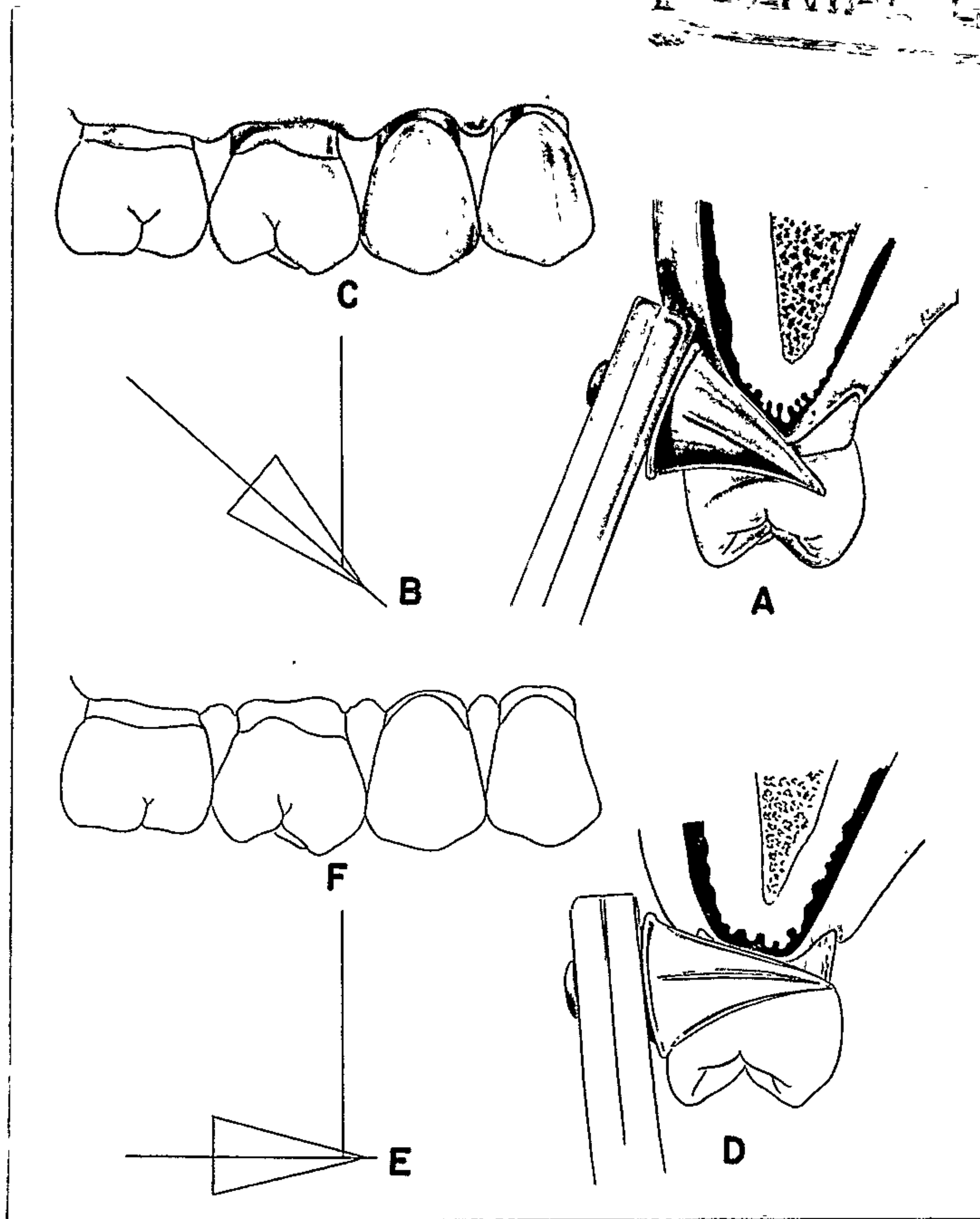


FIG. 29

(Ref. 78)

A = Correct use of interdental stimulator

B = Incorrect use of interdental stimulator

and release of pressure against the interdental gingival tissue.

Waerhaug⁸³ after his experiments concluded that the main part of the bacterial plaque on the teeth can be removed by toothbrushing. In areas inaccessible to the toothbrush there will be some bacterial plaque left that can be removed by toothpick or a dental floss. This indicates the need of a toothpick for a satisfactory oral cleansing in patients who suffer from food impactions.

These instruments are used to relieve food impactions in interproximal spaces and therefore could be of some use in isolated cases. Their value on a widespread basis is probably negligible. There are no controlled scientific studies reported that deal with the effect of their use in dental caries or periodontal disease experience.

Dentifrice

No dentifrice on the market today has proved to be of therapeutic value for periodontal disease. According to Hine¹⁴ most people use dentifrices because of their pleasant taste. Some dentifrices polish the teeth as well therefore have a cosmetic value to the patient.

As mentioned previously the functions of the dentifrice are to aid the toothbrush in cleansing the teeth and to polish the teeth. It makes brushing procedure more pleasant.

The value of medicated dentifrices is negligible or inconclusive. Use of an ammoniated dentifrice has been reported by Kerr and Kessel⁹¹ to keep mouth free of bacterial debris. But there arises the question whether an alkaline reaction around the teeth might predispose the patient to calculus formation.¹⁴ One of the well known theories of the etiology of calculus deposition is that ammonia is liberated in the mouth which alkalizes the saliva and hence allows a precipitation of calcium from saliva. Clinical studies of the use of ammoniated dentifrices so far have not shown an increase in calculus deposition, but the best and most carefully controlled clinical studies of these dentifrices have been made on children who usually show very little tendency toward calculus deposition. We

must watch carefully the effect of ammonia producing dentifrices on calculus depositions, for it would not be desirable to effect a reduction in dental caries at the expense of an increase in calculus in older patients, where dental caries is less prevalent than periodontitis.

One may well suppose that in the future medicaments may be incorporated in toothpastes which will inhibit dental caries, control deposition of calculus and prevent periodontal disease, but as yet toothpastes are principally effective only as an aid in cleansing the oral cavity.

Discussion

Periodontists readily admit that good daily home care by a patient afflicted with periodontitis is an essential part of any satisfactory system of treatment. Most periodontists are convinced also that prevention of periodontal disease and maintenance of reasonable oral cleanliness can be accomplished only if patients are willing and able to perform daily the few simple procedures required to cleanse the oral cavity. Yet most dentists spend little time in teaching their patients how to care for their mouths and even less time in teaching the value of home care.

A critical review of the dental literature leads to the conclusion that healthy gingival tissue can be maintained if any one of the many different toothbrush techniques are used correctly.¹⁴ In fact, analysis of various techniques that have been used indicates that the one important factor common to all procedures is the thoroughness with which a brush is used to free the teeth of debris and to massage gingival tissues lightly.

To get good results, the toothbrush should be used methodically, regularly and carefully. It is generally that the brushing should be done in a manner which will not allow the ends of the bristle to irritate the gingival tissue,

the side of the bristles should be pressed against the soft tissues. The technique of choice will depend on the needs of the individual.

There are no dentifrices today of proved therapeutic value in the treatment and prevention of periodontal disease. One of the several mildly alkaline dentifrices containing an effective polishing agent and of palatable flavour will aid in the cleansing of the teeth, and make brushing more pleasant.

Hard and fibrous foods are of value in the prevention and control of calculus formation.^{76,77,78}

Mouth rinsing⁴¹ is a useful adjunct to toothbrushing in cleansing the mouth of debris. Interdental cleaners and stimulators are of value in special cases.

Scaling and polishing of teeth is of great value in the control of periodontal disease.³⁵

Broad Conclusions

1. The available evidence leads to the conclusion that gentle gingival massage correctly applied is helpful in the control and prevention of periodontal disease.
2. Emphasis should be placed by the dentist on the value of cleansing by toothbrush, scaling and polishing, detergent diet and mouthwashes in the maintenance of oral health. The patient must be motivated to do these.
3. Gingival stimulators and cleaners can be recommended for special patients.
4. There is no universally preferred technique for toothbrushing. The dentist should teach the patient a definite detailed technique which will suit the individual.

PART C

Functional Cleansing

Functional Cleansing

Saliva

The fact that teeth are constantly bathed by saliva would suggest that this "environmental" agent could profoundly influence the states of oral health of a person, including dental caries process. The difficulties involved in studying salivary flow have complicated the problems involved in attempting to determine its role in dental caries experience. That there is a connection between saliva and caries is shown by reports quoted from various authors by Afonsky, of more than 20 cases of high caries activity in persons with xerostomia and gland defect and by reports of unilateral caries associated with unilateral salivary deficiencies.⁹⁵ High caries activity associated with radiation injury of salivary glands can also be included here.

The quantity of saliva secreted in a given period of time may, theoretically at least, influence caries incidence. This is especially evident in cases of salivary gland aplasia in which salivary flow may be entirely lacking and rampant caries is the typical result.

Saliva can influence food retention either by physical properties or its rate of flow. Physical properties such as in surface tension, viscosity etc. will

influence the adhesiveness of the tooth surfaces and modify the carrying capacity of the saliva for foodstuffs and, therefore, play a large part in determining the amount and duration of food deposits on the teeth. Possibly, the viscosity of saliva will play a part in its efficiency in carrying either harmful or beneficial substances to or from interproximal spaces on other sites of caries activity. These aspects of salivary function have not been adequately investigated. Saliva in bulk is protective by its removal of carbohydrate substrate.

A good deal of work has been done on the rate of salivary flow in relation to caries. Becks et al,^{97,98} and Karshan⁹⁶ have compared salivary flow of unstimulated and Becks et al⁹⁷ and Cushman et al⁹⁹ of stimulated saliva of caries free and caries active persons. The variations in flow among the members of various groups were so great that no statistically significant results could be found, although in general, the flow was higher in the low caries groups.

There is some evidence that stimulation of salivary flow caused by eating fruits, chewing gum or drinking acid liquids will speed up the clearance of foodstuffs from the mouth.⁹⁵ Subjective experience supports this view, but clear cut evidence that these effects are related to the

flow of saliva alone and not the physical removal of foodstuffs by stimulating agents is not available.

Action of Lips, Cheeks and Tongue

Most animals keep their teeth and gingivae clean and free from stagnation by eating foods of firm consistency, after which they move their tongue around and contract the buccinator muscles and those of the orbicularis oris to remove any food particles which remain.

Wade⁸² suggests that man can copy these animals without living on an identical diet. Every endeavour should be made to finish all meals with firm fibrous food such as celery or an apple. (Fig. 30 C)

The tongue should always be moved vigorously around the mouth, both within the oral cavity proper and in the vestibule, pressure being applied to the teeth and the gingivae. A sucking action also helps to dislodge soft food debris and the combined effect of these muscular movements is quite surprising. (Fig. 30 A)

When the teeth are malaligned the functional (natural) cleansing mechanism is handicapped. Attainment of good alignment by orthodontic therapy is therefore most important, because it reduces the number of potential

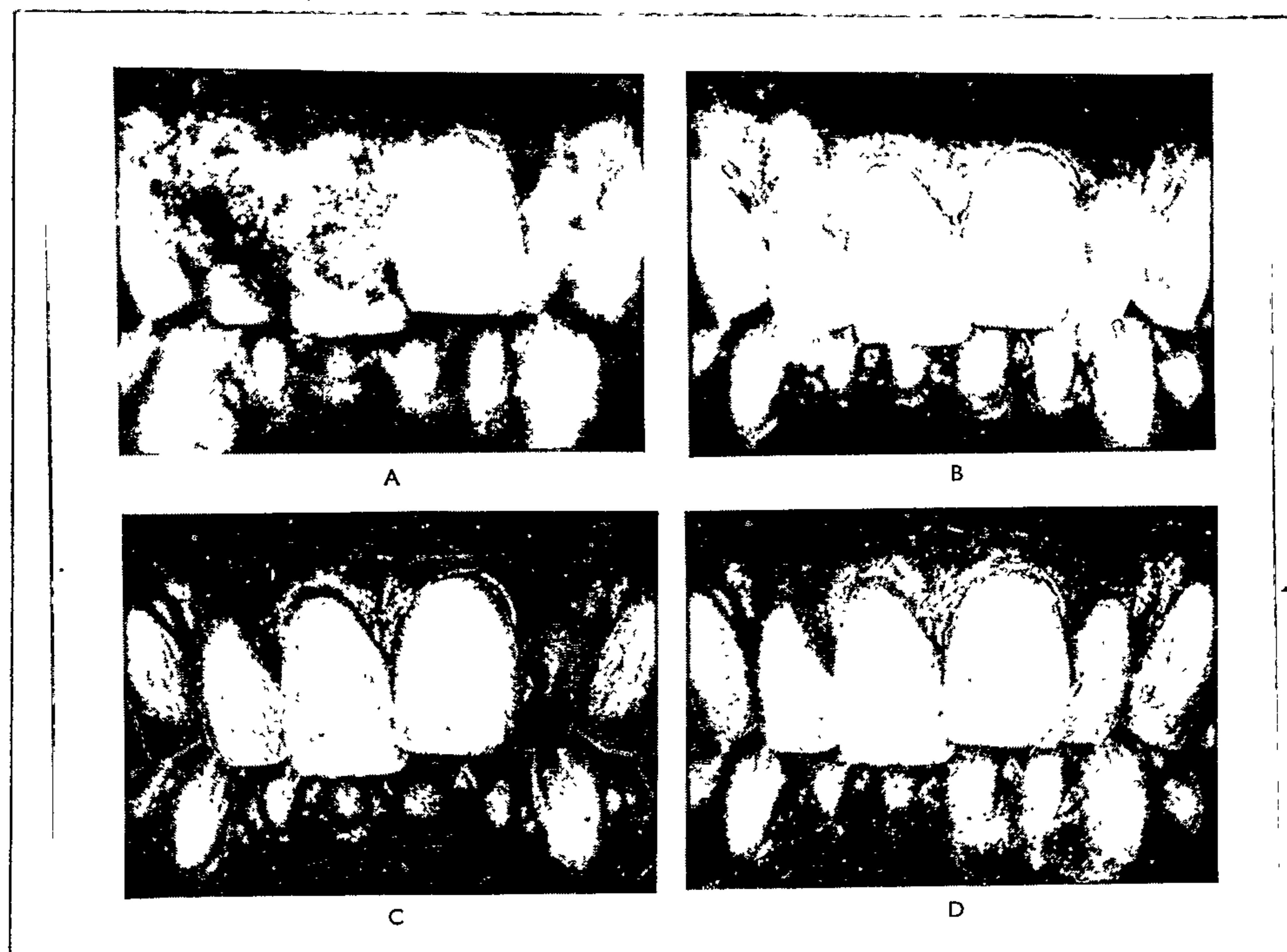


FIG. 30

NATURAL CLEANSING

- A Effect of eating biscuit
- B Cleansing produced by muscular movement of lip and cheek
- C Cleansing effect of chewing one piece of apple after eating another biscuit
- D Result of a vigorous rinse with water after eating a further biscuit

(Ref. 41)

stagnation areas as well as assisting the tongue, cheeks and lips in their action.

However, as far as the author is aware there have not been any statistical studies to see the amount of substrate removed by functional cleansing.

PART D

Summary and Conclusions

"Home care advice, based on objective data might be a potential force in reducing dental caries since it could with patient cooperation, operate 365 days per year."

Paul Kitchen 1954.

Summary

A review of the literature shows that methods whereby food debris is removed from the mouth can result in a decrease in the incidence of dental caries and periodontal disease provided that these procedures are carried out immediately after any eating. Mouth rinsing with drinking water is a useful adjunct to the other oral cleansing measures. Sealing and polishing of teeth is important in the control of periodontal disease.

The merits and demerits of these methods have been discussed. Thus measures exist which could reduce the incidence of caries and periodontal disease, and clearly lie within the scope of the individual's own behaviour. The prevention of dental disease is therefore also a problem of health education of the public and especially children.

Conclusions

1. Functional cleansing in civilised man is inadequate and he must resort to various non functional cleansing measures, not only to keep the mouth clean, but also to provide the superficial stimulation which the gingivae lack when soft diet is eaten.
 2. Widespread cleansing of the teeth with detergent food, a toothbrush and toothpaste and non medicated mouth rinse is recommended.
 3. The use of interdental cleaners and stimulations are advocated in special cases.
 4. Powered toothbrushes may be useful for handicapped children and adults.
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