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EFFECT OF CHEWING ON FLOW OF TISSUE FLUID INTO HUMAN GINGIVAL POCKETS

by

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Chewing a toy rubber bone enhances the flow of tissue fluid through the epithelium of the gingival pocket in dog (*Brill & Krasse* 1959). As this flow of tissue fluid may have a cleansing effect upon the pocket, and thus may be effective in maintaining gingival health, it is of interest to know whether human gingival pockets react in a similar way. The present study was designed to elucidate this problem.

As in previous papers (*Brill & Krasse* 1958, *Brill & Björn* 1959) the term pocket is used to designate the space limited on the one side by clinically healthy epithelium and on the other by tooth substance and often ending at the cemento-enamel junction. In this paper the term pocket will be used as defined above, irrespective of the content of a pocket (i.e. the term pocket will be used though English usage reserves this term for a pathological formation). A pocket may contain a fluid, or according to *Orban* (1956) there may be found an organic continuum from epithelium to enamel.

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MATERIAL AND METHODS

Fifteen females, aged 18—22, were selected for the experiments. Being dental nurses in the department of operative dentistry they were familiar with and practised mouth hygiene thoroughly. The health of their marginal gingivae was generally good. In a few instances papillitis and marginal gingivitis were detected. Such inflamed areas were excluded from the study. Only clinically healthy structures were included.

Each subject was requested to chew a piece of paraffinum molle, energetically in the right side of the mouth. This paraffin has a melting point at about 42°—44°. The pieces weighed about 8 grammes and had a volume of about 20 cc. This volume was decided upon, because pilot studies had revealed that smaller pieces failed to produce the desired effect, probably because they were not big enough to reach and touch the gums. During chewing, the paraffin was thoroughly kneeded but did not crumble.

The gingival pockets of the following teeth were used for the experiments: the upper and lower molars, premolars, canines and incisors on the right side, and only those parts of the pockets facing the vestibular surfaces of the teeth were studied. The total number of pockets investigated was 156.

Previous to and immediately after mastication samples of fluid were recovered from the pockets by means of strips of filter paper, similar to those used in earlier experiments (*Brill & Kasse* 1958, *Brill & Björn* 1959). The strips were inserted into the gingival pockets, and left there for three minutes in order to absorb satisfactory amounts of fluid entering the pockets from subepithelial compartments. When a difference could be recorded between the amounts of fluid recovered from the same pockets before and after mastication, it was believed to be a result of the stimulation produced during chewing.

Before collection of samples, the mouth was prepared in the following manner: cotton rolls were inserted sublingually and into the oral vestibule. The facial and lingual surfaces of the teeth and gingivae were carefully dried with gauze. As it was very important to prevent the filter paper strips, gingivae, and teeth from being contaminated by saliva, it was necessary to use saliva ejectors. Cotton rolls were renewed when required. The

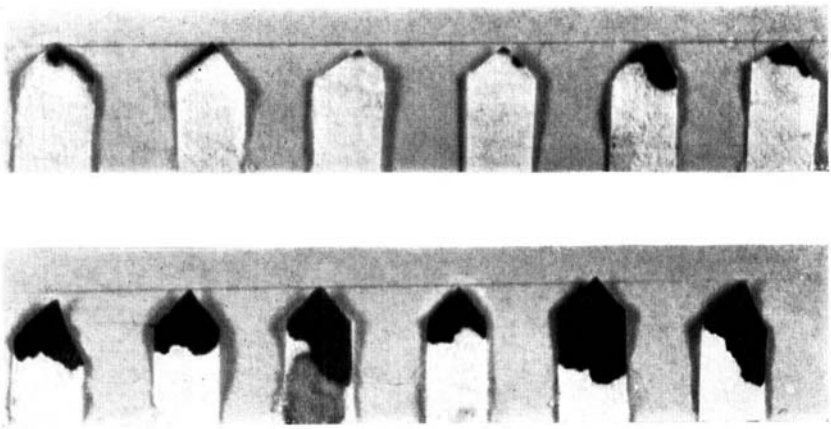

Fig. 1. Filter paper strips containing fluid recovered from gingival pockets and treated with ninhydrin.

Upper row: Samples from unstimulated pockets.

Lower row: Samples from the same pockets after chewing of paraffin.

experimental procedure lasted no longer than 45 minutes, including ten minutes for chewing.

The strips were tested for amino acids. In order to make sure that such material did not come from sources other than the pockets, the paper from which the strips were made was handled by clean metal instruments (tweezers and scissors) only. After fabrication the strips were stored in glass containers. When handled during the recording procedure and later, the strips were likewise exclusively handled by metal and glass instruments. Care was taken that the mucosa of the cheeks and lips did not come into contact with the strips. In spite of all precautions, however, some parts of a few strips were contaminated. In Fig. 1 strip No. 3 from the left in the lower row shows two different degrees of staining. The paler parts have been touched by buccal mucosa. Such contaminated areas were excluded, when later the areas containing amino acids were measured by means of a planimeter.

Amino acids on the strips were demonstrated by means of a 0.2 % ninhydrin solution in 95 % butanol and 5 % 2.0 normal

acetic acid (Fig. 1). Amino acids react with ninhydrin (triketohydrindene hydrate). The reaction is specific for α-amino groups and gives a blue or purple colour (*White, Handler, Smith & Stetten* 1954). Thus, this stain may be used as a qualitative demonstration notably of amino acids. Strips removed from pockets were placed in a glass container and soaked with ninhydrin. The container with the strips was then transferred to a heating cabinet and left there for 15 minutes at 75° (centigrades) for the strips to dry. Heating also intensifies the staining of the protein material (*Cramer,* 1954).

The areas of the strips, which had taken up tissue fluid and reacted with ninhydrin, were assessed planimetrically. The stained areas, however, were too small for direct planimetry. Therefore, all strips were photographed and enlarged (×6). All samples collected from an individual before and after chewing were in every case photographed on one and the same plate from which the magnified reproduction was made; thus both series from the same person were treated identically.

The areas, which had reacted with ninhydrin, were measured on the photographical reproductions. Each series was measured three times, and the mean value was calculated. Table I gives for each case the mean values of the recordings before and after chewing, and the difference between these values.

Application of the planimetric method to magnifications does not permit assessment of the exact amounts of fluid taken up by the strips. Relative values were, however, considered acceptable, because the aim of the investigation was to demonstrate only differences between series of samples.

RESULTS

The experimental data are given in Table I and in Fig. 2, from which it is clear that mastication of the paraffin had enhanced the flow of fluid into the gingival pockets.

A statistical analysis has shown the increase to be highly significant ($t = 6.33$ and $P < 0.001$). Another important finding was the heavy staining of the strips, when treated with ninhydrin. This reaction reveals the presence of α-amino groups in the fluid taken up by the strips from the gingival pockets.

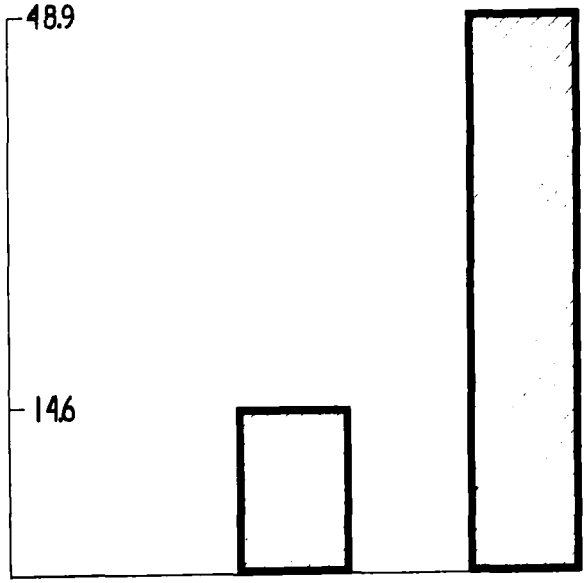

Fig. 2. Diagrammatic presentation of stained areas; to the left before chewing, to the right after chewing.

Table 1. Planimetric data illustrating the effect of chewing on the flow of tissue fluid into gingival pockets in 15 individuals.

Person	Before chewing	After chewing	Diff.	Increase
W.	0.165	0.493	+ 0.328	3.0 ×
B. M.	1.330	4.150	+ 2.820	3.1 ×
A. U-B.	0.643	2.610	+ 1.967	4.1 ×
N. N.	0.826	2.963	+ 2.137	3.6 ×
M.	0.820	2.053	+ 1.233	2.5 ×
A. M.	0.577	1.023	+ 0.446	1.8 ×
B. L.	0.767	1.837	+ 1.070	2.4 ×
A. I-B.	2.193	5.883	+ 3.690	2.7 ×
S. B.	2.050	6.253	+ 4.203	3.1 ×
N. L.	0.283	1.537	+ 1.254	5.4 ×
N. Y.	0.734	4.337	+ 3.603	5.9 ×
H.	2.506	6.110	+ 3.604	2.4 ×
U. E.	0.357	0.928	+ 0.571	2.6 ×
H. M-I.	0.907	4.300	+ 3.393	4.7 ×
J. B.	0.473	4.430	+ 3.957	9.4 ×
S.	14.630	48.907		
M	0.975	3.261	+ 2.29	
ε			0.36	
t			6.33	
P			< 0.001	

DISCUSSION

The data presented indicate that vigorous chewing enhances the flow of tissue fluid into gingival pockets, and it is reasonable to believe that such chewing has bearing upon gingival health. *Brill & Krasse* (1958) and *Brill & Björn* (1959) suggest that the stream of fluid, which ordinarily oozes through pocket epithelium from subepithelial compartments has a mechanical cleansing effect upon gingival pockets. Chewing hard and rather large boli will therefore probably enhance this cleansing effect. Hence, the last course of a meal should be such as to utilize the self-cleansing capacities of gingival pockets.

This defence mechanism may also be effective chemically. *Brill & Krasse* (1958) suggest that tissue fluid entering unstimulated gingival pockets contains antibodies. Perhaps other antimicrobial systems may also be active, e.g. enzymes, complement, properdin; for reviews see *Dubos* (1954), *Pillemer* (1956), and *Skarnes & Watson* (1957).

At least in part these various substances contain amino acids. In the present study it was shown that fluid in resting as well as stimulated gingival pockets contains amino acids; the material recovered may therefore comprise substances with antimicrobial and/or detoxifying properties.

When gingival structures are stimulated by chewing, the antimicrobial effect may be increased, because mechanical stimulation of the gingival vascular bed stimulates escape of fluid from the vessels *(Brill,* 1959), and plasma contains several antimicrobial substances. Thus, a variety of humoral defence factors may be mobilized by vigorous chewing and come into play on both sides of the epithelial lining of gingival pockets. These sites are thus equipped to take care of invading bacteria and toxins chemically, and the local neutralization of such matter may therefore be enhanced considerably by mastication.

SUMMARY

Chewing paraffin wax for ten minutes produces a statistically significant increase in the flow of tissue fluid into human gingival pockets. The fluid reacts with ninhydrin, which reveals

the presence of amino acids. The significance of vigorous chewing and its possible beneficial effects on marginal gingival structures are discussed.

RÉSUMÉ

EFFET DE LA MASTICATION SUR L'ÉCOULEMENT DE FLUIDES TISSULAIRES DANS LES CULS-DE-SAC GINGIVAUX HUMAINS

La mastication de paraffine pendant 10 minutes provoque une augmentation de l'écoulement de fluides tissulaires dans les culs-de-sac gingivaux humains, augmentation significative du point de vue statistique. Le liquide réagit à la ninhydrine, ce qui révèle la présence d'acides aminés. La valeur d'une mastication énergique et l'action bienfaisante qu'elle aurait sur les tissus gingivaux marginaux se trouvent discutées.

ZUSAMMENFASSUNG

DIE EINWIRKUNG DES KAUENS AUF DEN STROM VON GEWEBSFLÜSSIGKEIT IN DIE GINGIVALEN TASCHE BEIM MENSCHEN

Beim Kauen von Paraffinwachs während zehn Minuten ergab sich ein statistisch signifikantes Anwachsen des Gewebsflüssigkeitsstromes in die Zahnfleischtasche. Die Flüssigkeit reagierte mit Ninhydrin, was auf die Anwesenheit von Aminosäuren hinweist. Die Bedeutung des kräftigen Kauens und dessen mögliche günstige Wirkung auf das marginale Gewebe wird besprochen.

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