

## Assessment of Gingival Inflammation by Measuring the Capacitance of the Gingival Fluid Using the Periometer

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### Summary

This study was undertaken to determine a practical method for detection of gingival inflammation by measuring the capacitance of the gingival fluid. The capacitance of gingival fluid was measured in 25 patients with periodontal disease and 13 normal healthy students. The examinations were performed by the author. The correlation between various clinical findings and the capacitance of the gingival fluid was as follows.

1. Statistically significant correlations were observed between the capacitance of the gingival fluid and the plaque index, gingival index, gingival bleeding index, and pocket depths ( $p < 0.001$ ).

2. The capacitance of the gingival fluid of the periodontal disease group was markedly higher than for the normal group, and increased with the progression of the disease ( $p < 0.01$ ).

3. This new device features automatic digital display of the capacitance of the gingival fluid by simply inserting the tip of the probe into the periodontal pocket. Further, it is capable of accurately measuring the fluid, and has been shown to be fast, easy, precise and convenient.

### Introduction

Gingival fluid is a component excreted from the gingival sulcus and pocket. It has already been reported in a number of studies since Bill<sup>1)</sup> (1958) that the amount and composition of gingival fluid changes with the progression of gingival disease and inflammation. Løe and Holm-pedersen<sup>2)</sup> (1965) reported that the existence of gingival fluid was evidence of latent periodontal disease and that gingival fluid could be used to determine periodontal disease.

Recently, measuring the amount of fluid is considered quite effective for the objective diagnosis in determining periodontal disease in its initial as well as advanced stages. Though various procedures have been studied, accurate measurements were difficult since the amount of fluid was

too small. The development of an effective, easy to use instrument has been desired.

An apparatus meeting these requirements was recently developed. The Perimeter<sup>®</sup> is an apparatus<sup>3,4)</sup> for measuring the capacitance of gingival fluid excreted during a short period. It uses the principle that the electrolytes in gingival fluid, similar to that in serums, increase in proportion to the progression of periodontal disease.

The author had an opportunity to clinically use this "Perimeter," which is very compact and light in weight, and would like to report his findings.

## Materials and Methods

### 1. Subjects

Twenty-five otherwise healthy outpatients of the Periodontal Department of Matsumoto Dental College and 13 students were selected as subjects.

### 2. Measurement apparatus

The capacitance measuring apparatus having a 9V battery power source was used. Measurement was made by inserting a sensor tip into the gingival sulcus. The unit of measurement for the capacitance between the terminals of the sensor was read in Pf units and appeared on a digital display. The apparatus is shown on Fig. 1. (Perimeter, Yamaura Seisakusho, Ltd.)

### 3. Measurement method

The measurements were made at three points, i.e., mesial, center and distal of the labial gingival sulcus of non-restored central incisors (1|1). First, the area was gently washed and dried for 5 seconds in a dry field. The sensor tip was inserted into the gingival sulcus and the capacitance checked. After ten seconds, the hold circuit began functioning and registered a readout on the digital display.

### 4. Clinical observations

Evaluations of clinical findings in the measurement of gingival fluid were done using the following items. The Löe and Silness<sup>5)</sup> gingival index (G. I.), and Silness and Löe<sup>6)</sup> plaque index (PL. I.) were used. The Mühlmanns<sup>7)</sup> gingival bleeding index (G. B. I.) was also used in this study. The

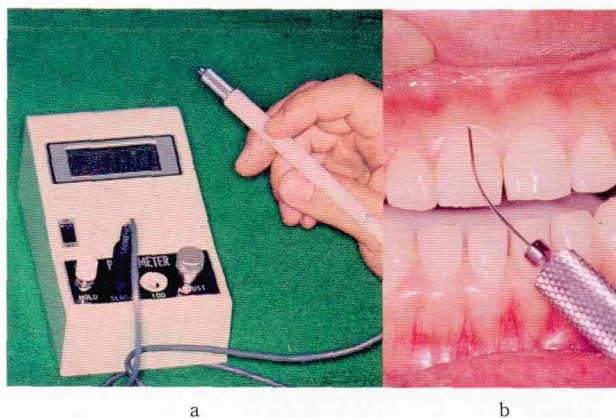


Fig. 1. Measurement of capacitance of gingival fluid using perimeter

a : Perimeter

b : Sensor tip of perimeter inserted into gingival sulcus

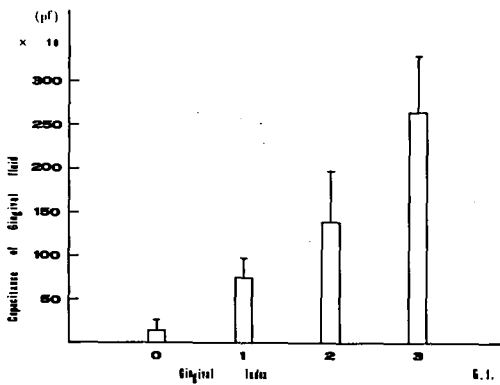
pocket depth (P. D.) was measured using a periodontal pocket probe with a scale. For each item, the average of the total for each tooth was calculated and recorded.

### 5. Clinical classification

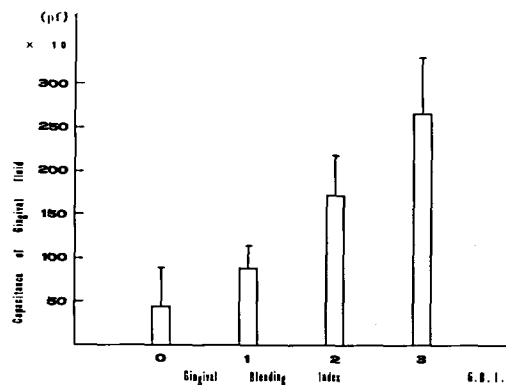
The clinical classification of the Japanese Association of Periodontology (1981) was used. The significant clinical observations were combined, evaluated and divided into the three groups of clinically healthy, slightly diseased or severely diseased teeth.

**Table 1.** Analysis of correlation between capacitance (p. f.) in gingival fluid and clinical findings

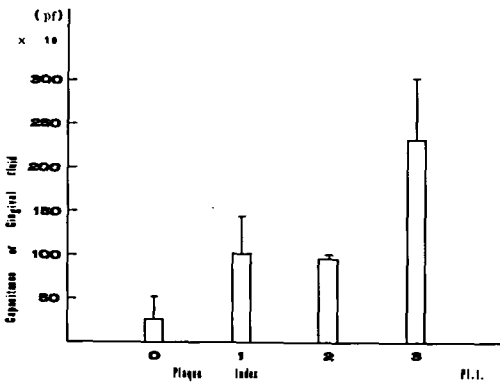
A			B		
Capitance	(p. f.)	VS	G.I.	r	p
"	( " )	VS	G.B.I.	0.84	p<0,001
"	( " )	VS	PL.I.	0.83	p<0,001
"	( " )	VS	P.D.	0.86	p<0,001



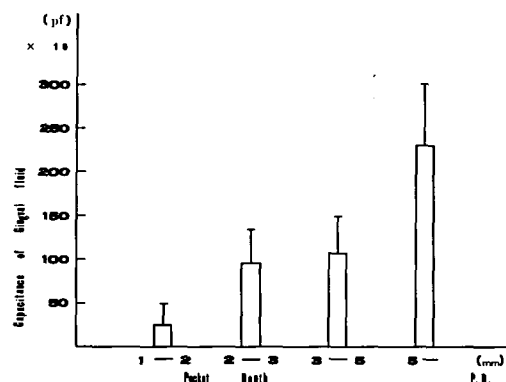
**Fig. 2.** Relationship between the capacitance of gingival fluid and gingival index



**Fig. 3.** Relationship between the capacitance of gingival fluid and gingival bleeding index



**Fig. 4.** Relationship between the capacitance of gingival fluid and plaque index



**Fig. 5.** Relationship between the capacitance of gingival fluid and pocket depth

## Results

The relationship between the capacitance of gingival fluid excreted during 10 seconds and clinical observations are shown on Table I and Figs. 2-5. The correlation is also shown in Table I.

1. Statistically significant differences were observed between the capacitance of the gingival fluid and gingival index, gingival bleeding index, plaque index and pocket depth ( $p < 0.001$ ).

2. The average total of the capacitance of gingival fluid on both clinically healthy and diseased teeth is shown on Table 2 and Fig. 6. The capacitance of each diseased tooth showed a higher total than that of healthy teeth and, it was observed that the capacitance significantly increased with the progression of the disease ( $p < 0.01$ ).

## Discussion

Changes in the amount of gingival fluid indicate the extent of the periodontal tissue disease. It is clear from a number of reports that changes of the amount of gingival fluid have significant correlation with gingival inflammation, oral cleanliness and pocket depth. This gingival fluid is considered an important factor in determining disease. However, the quantity is too small for accurate measurements.

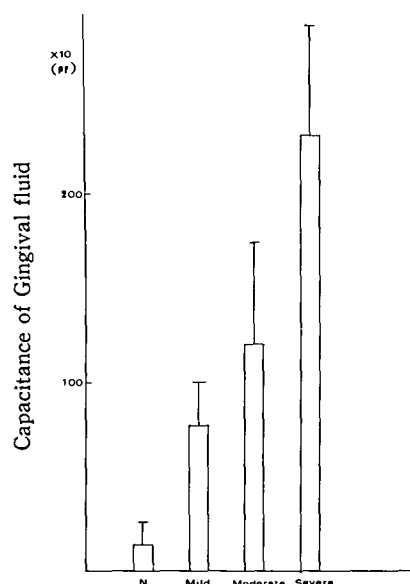
There was no easy, accurate method, even though various procedures were tried. Typical procedures were :

1. Measurement of changes in the weight of filter paper or thread inserted into the gingival sulcus.
2. Measurement of colored areas on filter paper strips. The paper strips were inserted such that they extended outside of the gingival sulcus, and were then colored by a Ninhydrin (Triketohydrindene Hydrate) alcohol solution.

**Table 2.** Statistical difference of capacitance (p. f.) in gingival fluid among each clinical groups [F-test]

Normal	* *	* *	* *
	Mild	—	* *
		Moderate	* *
			Severe

\* \*  $p < 0.01$



**Fig. 6.** Relationship between the capacitance of gingival fluid and various clinical groups

3. Measurement of the amount of gingival fluid using a capillary tube inserted directly into the gingival sulcus.

However, there were weak points which need eliminating with every procedure. For example, the examination time to collect the gingival fluid should be shortened from the present 10-15 minutes. Also, there is a possibility of fluid-evaporation.

Hayashi et al<sup>8)</sup>, Suppipate et al<sup>9)</sup> and Kamoi et al<sup>10)</sup> reported that the electric analysis of the gingival fluid is possible in the examination and diagnosis of periodontal disease using an effective and simplified method.

The Periometer, which was used in this study, has a sensor tip which is inserted directly into the gingival sulcus. It is not an indirect method such as filter paper. It allows shortening the chair time to only 10 seconds, repeat sampling, accurate and simple measuring, and is better than any former apparatus in all respects. In studies by Krasse<sup>11)</sup>, Matsue<sup>12)</sup> and Bang et al<sup>13)</sup>, it was reported that the electrolytes in the gingival fluid had similar components to serum. Each electrolyte in the gingival fluid of diseased gingiva is known to differ with that in normal gingiva.

It has been stated in a number of reports that there is an increase in sodium in the gingival fluid of diseased gingiva compared to that of the normal state<sup>12,13)</sup>. Also, it has been reported that potassium increases when periodontal disease becomes severe. Bang<sup>13)</sup> explains this phenomenon as the result of the leakage of intracellular potassium by destructive metabolites of inflammation. It is clear that large components of electrolytes in the gingival fluid from diseased gingiva increase when compared to clinically normal gingiva.

For these reasons, measuring these electrolytes in the gingival fluid is an important factor in determining periodontal disease and is effective in clinical examinations.

Yoshinaga et al<sup>4)</sup> reported a significant correlation between the capacitance measured during 10 seconds and clinical observations of G. I. and G. B. I. ( $p < 0.01$ ). He also reported a significant correlation between PL. I. and P. D. He mentioned that G. B. I. had a higher correlation than G. I. and that this measurement indicates disease in the deep part of gingival sulcus around the cemento-enamel junction.

The results of this study showed a high correlation between capacitance and clinical observations ( $p < 0.001$ ). However, no difference in correlation between G. I. and G. B. I. were observed as reported by Yoshinaga<sup>4)</sup>. Also, Kamoi et al<sup>10)</sup> divided gingival conditions into 4 classes, reported their relationship to capacitance, and introduced this apparatus for the measurement of gingivitis.

Gingival condition	Capacitance (x10PF)
Normal gingiva	0
Clinically healthy gingiva	0—30
Slightly diseased gingiva	30—80
Moderately diseased gingiva	80—150
Severely diseased gingiva	150 and more

Comparing the author's results for each classification, the capacitance in normal gingiva showed an average of  $14.4 \pm 12.0$  (x10PF). Slightly diseased gingiva show an average of  $77 \pm 22.69$ , moderately diseased gingiva show an average of  $120.53 \pm 44.13$  and severely diseased gingiva show an average of  $232.1 \pm 69.5$ . Each measurement in these groups was done using the criterion in Kamoi's report<sup>10)</sup>.

From the point of view that each classification allows a significant difference ( $p < 0.01$ ), it is seen that the capacitance increases with the progression of disease. Consequently, this measurement method is confirmed to be quite effective in determining periodontal tissue disease during the initial and advanced stages.

### Conclusion

By using a newly developed, compact and light weight capacitance measuring apparatus, the author measured the capacitance of gingival fluid excreted from the labial gingival sulcus of the central incisors during 10 seconds for 13 clinically healthy patients and 25 patients with periodontal disease, and compared the totals with significant clinical observations.

The results were as follows :

1. Statistically significant correlations were observed between the capacitance of gingival fluid excreted during a short period and gingival index, gingival bleeding index, pocket depth, and plaque index ( $p < 0.001$ ).

2. The capacitance of gingival fluid excreted during a short period of the group with periodontal disease was remarkably higher than that of the normal group, and increased with the progression of the disease ( $p < 0.01$ ).

Measuring the capacitance of gingival fluid is an effective method of determining the extent of periodontal tissue disease and monitoring its progress. The fluid can be measured accurately and the method has proven to be quick, easy, precise, and convenient.

### Acknowledgment

I would like to express my appreciation to the staff of the Department of Periodontics of Matsumoto Dental College and to Mr. Mikami in Yamaura Seisakusho, Ltd. for their kind cooperation in this study.

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