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Gingival and labial vestibular temperature in young individuals

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ABSTRACT

The objective of this investigation was to test a small thermistor for oral use and to study temperature variation in non-inflamed oral mucosa. Gingival and labial vestibular or sulcus temperatures were measured in 30 young dental undergraduate students with teeth with a gingival index score of 1 or less. Four sites of measurement, mesial, labial, distal and lingual, were made around the six selected teeth and at 2-mm intervals extending down the buccal or labial sulcus into the sulcus itself. For each subject the gingival temperature was subtracted from the sublingual temperature to obtain a temperature differential and the gingival temperature differential was greater in the maxilla than in the mandible.

The method used in this study was reproducible. Temperature increased from the gingival margin to the labial sulcus, and there was an increase in temperature from incisor to molar in both jaws, and the maxillary sites were cooler than those in the mandible. An irregular variation in temperature differential was seen between mesial, labial, distal and lingual measurement sites.

INTRODUCTION

The commonest site for the measurement of body temperature is the oral cavity, where the sublingual temperature is measured either by means of a mercury thermometer or more modern electronic apparatus. As electronic research progresses and temperature-measuring devices are made smaller, a number of investigators have attempted to measure temperature changes in various areas of the oral cavity under different conditions.

The measurement of human gingival sulcus temperature has been carried out by Ng et al. (1978) and Mukherjee (1978). These authors found that gingival sulcus temperature increased from anterior to posterior in the mouth and that mandibular gingival sulci display higher temperatures than comparable maxillary sites. Brill et al. (1978) showed that there is a temperature difference across the mucogingival junction, the oral mucosa displaying a slightly higher temperature. Toothbrush stimulation (Kroone et al., 1980) produced temperature changes in the gingival crevice and the attached gingiva. The presence of plaque in the gingival crevice caused an increase in crevice temperature (Maeda et al., 1979a, 1980). Maeda et al. (1979b) also investigated the oral temperatures in young and old people, noting that there was no difference between young and old females, but that a difference did exist between the two male counterparts. The temperature of periodontal pockets was measured by Mukherjee (1981), who found that the temperature of periodontal pockets did not vary significantly with

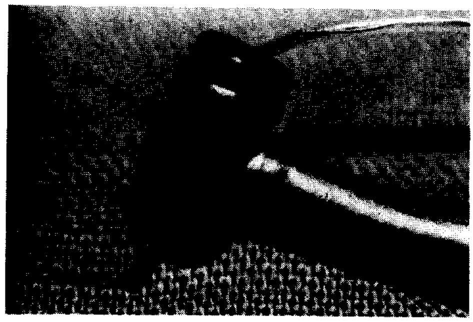

Fig. 1. The thermistor (arrowed) has been embedded in a tube of Araldite epoxy resin to give it rigidity and has a cross-sectional area of 0·4 mm at the tip.

the increase in pocket depths. Holthuis et al. (1981) found that there was an increase in temperature from non-inflamed non-bleeding sites to inflamed, bleeding sites and that there was a correlation between gingival sulcular temperature and crevicular fluid flow.

More recently, Chebib and Holthuis (1983) and Holthuis and Chebib (1983) studied temperature patterns of the gingival sulcus confirming previous observations relating to arch differences and presence of inflammation.

The purpose of this investigation was to test a sensitive temperature-measuring device and to examine gingival and labial vestibular and sulcus temperature variations in young individuals.

MATERIALS AND METHODS

The temperature-measuring device was a Stantel U23 US thermistor (Standard Telephone and Cable, Ltd) fitted into a right-angled holder. The thermistor itself was embedded in a tube of Araldite epoxy resin to give it rigidity, and it had a cross-sectional area of 0·4 mm at the tip (*Fig. 1*). The thermistor probe was connected to a processing coupler (FC110, BioScience) and the analogue output was recorded on an oscillograph (MX216, Lectromed Ltd). The thermistor was calibrated against a mercury-in-glass full immersion thermometer, for each subject. In addition, the characteristics of the temperature-measuring system were examined through repeated measurements at the same mucosal site, the mouth being closed for 10 s between measurements. An example of the temperature reproducibility of the system, in five subjects, is shown in *Table I*.

Following approval of the protocol by the University of the Witwatersrand's Committee for Research on Human Subjects, the teeth of 30 undergraduate male dental students whose mean age was 20·9 years were used for the study. All the students had gingival indices of 1 or less (Löe, 1967) for the six teeth selected for measurement, namely tooth 22, 14 and 26 in the maxilla and tooth 42, 34 and 46 in the mandible (World Health Organization, 1979). All measurements were taken between 14·00 and 16·00 h.

The probe was placed on the site to be examined at right angles to the surface, and was kept in place until such time as the deflection had stabilized on the recording paper. The sites of

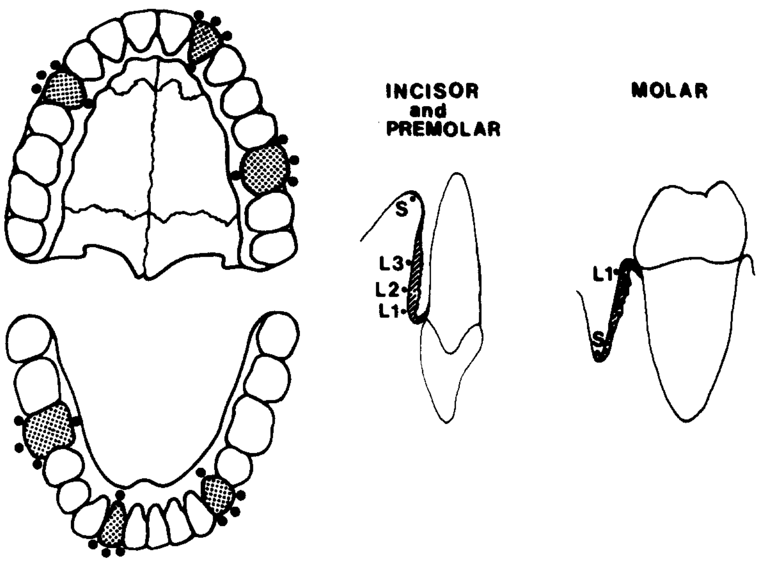

Fig. 2. The dots indicate the sites at which the temperature measurements were made. A, Mesial, labial, distal and lingual gingival sites. B, Labial or buccal crest to sulcus sites.

Table I. Temperature reproducibility: tooth 42, labial aspects 2 mm below gingival crest for 5 subjects, 10 sequential recordings

Subject	*Temperature range (°C)*	*Mean temperature (°C)*	*s.d.*	*c.v. (%)*
1	34·4–35·0	34·7	0·2	0·6
2	32·1–32·7	32·5	0·2	0·6
3	34·6–35·7	35·1	0·4	1·1
4	33·8–34·3	34·0	0·1	0·4
5	34·3–35·3	34·8	0·3	1·0

c.v., Coefficient of variation.

measurement were at the crest of the gingival margin, at the buccal, lingual, mesial and distal ends of the teeth. The interdental measurements were on the buccal surface. The very first measurement made in each case was the sublingual temperature which was used as the baseline reference mark for future calculations. After recording around each tooth, the patient's mouth was closed for approximately 10 s before recording on the next tooth was started. *Fig. 2* shows diagrammatically the site measured. In addition, measurements were made at 2-mm intervals from the gingival crest extending down the buccal sulcus into the vestibule itself (*Fig. 2*). The final measurement was in the labial or buccal sulcus. Four temperature measurements were taken for the incisors and premolars and two for the molars because of the varying amount of gingival tissue available.

As the sublingual temperature may vary from individual to individual, relative changes in temperature will be shown. For each subject the gingival temperature was subtracted from the

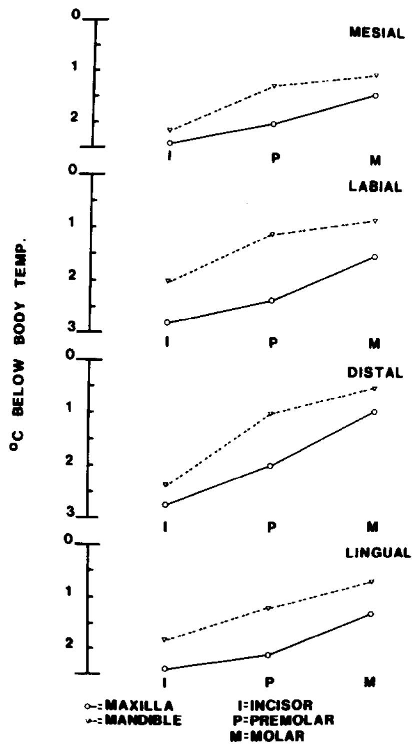

Fig. 3. Mean temperature differentials for the mesial, labial, distal and lingual gingival measurements by tooth type and jaw.

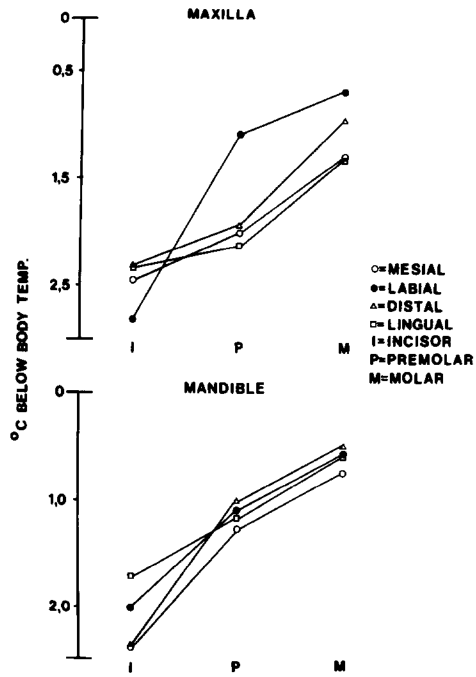

Fig. 4. Mean maxillary and mandibular gingival temperatures, by tooth type and position around the tooth.

sublingual temperature to obtain a temperature differential which was recorded. The higher the temperature differential the lower is the actual temperature of the area measured; the lower the temperature differential the higher is the actual temperature measured. The results were recorded on computer-coding sheets, then transferred to punch cards and analysed using SAS (SAS Institute, 1982) in a 370/148 IBM computer. A four-way ANOVA was performed for the gingival site measurements.

RESULTS

The mean temperature differentials, standard deviations and coefficients of variation are shown in *Tables II* and *III.* The temperature differentials for the mesial, labial, distal and lingual gingival measurements are indicated in *Fig. 3.* The temperature differential was higher in the maxilla than in the mandible. There was also a reduction in temperature differential from incisor to molar indicating that the gingival tissue around the incisors had a lower temperature than around the molars. The highest temperature differential was 4·8 °C and the lowest differential was 0·1 °C.

In *Fig. 4* the results have been arranged so that all the maxillary gingival temperature differentials are indicated on the upper graph and the mandibular differentials on the lower

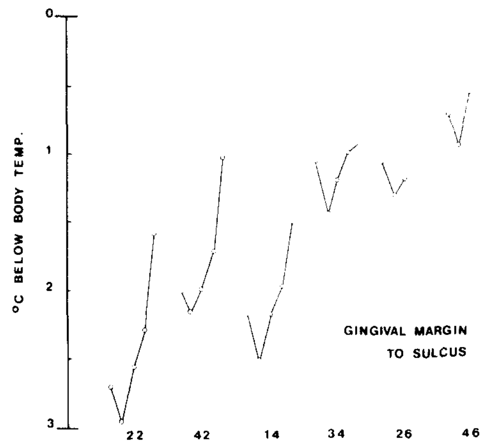

Fig. 5. Mean temperature differentials from the gingival margin to sulcus by tooth.

Table II. Mean temperature differentials, standard deviation and coefficients of variation for the mesial, labial, distal and lingual gingival sites

	Mean	*s.d.*	*c.v. (%)*
Tooth 14			
Mesial	1·96	0·65	32·8
Labial	2·22	0·79	35·6
Distal	1·97	0·68	34·6
Lingual	2·11	0·66	31·1
Tooth 34			
Mesial	1·33	0·33	25·1
Labial	1·12	0·29	26·0
Distal	0·95	0·31	32·7
Lingual	1·17	0·38	32·4
Tooth 22			
Mesial	2·44	0·51	20·8
Labial	2·65	0·68	25·6
Distal	2·62	0·53	20·1
Lingual	2·37	0·58	24·7
Tooth 42			
Mesial	2·27	0·69	30·4
Labial	2·03	0·60	29·4
Distal	2·29	0·69	30·3
Lingual	1·72	0·54	31·4
Tooth 26			
Mesial	1·27	0·39	30·6
Labial	1·11	0·39	35·4
Distal	0·88	0·39	43·8
Lingual	1·34	0·53	39·9
Tooth 46			
Mesial	0·84	0·27	32·5
Labial	0·70	0·29	41·7
Distal	0·52	0·25	48·1
Lingual	0·72	0·29	39·6

$n = 30$ for each recording.

Table III. Mean temperature differentials, standard deviation and coefficients of variation for labial or buccal crest to sulcus sites

	Mean	*s.d.*	*c.v. (%)*
Tooth 14			
Labial crest			
1	2·47	0·86	34·7
2	2·19	0·81	37·0
3	1·90	0·70	37·1
Sulcus	1·46	0·51	34·6
Tooth 34			
Labial crest			
1	1·39	0·34	24·8
2	1·20	0·31	25·9
3	1·05	0·31	29·3
Sulcus	0·90	0·29	32·5
Tooth 22			
Labial crest			
1	2·91	0·65	27·3
2	2·57	0·63	24·7
3	2·26	0·58	25·8
Sulcus	1·16	0·47	28·9
Tooth 42			
Labial crest			
1	2·22	0·51	23·0
2	1·98	0·48	24·1
3	1·69	0·46	27·3
Sulcus	1·14	0·36	31·2
Tooth 26			
Labial crest 1	1·31	0·41	31·3
Sulcus	1·16	0·37	32·2
Tooth 46			
Labial crest 1	0·92	0·38	41·6
Sulcus	0·63	0·35	54·4

graph. These mean temperature differentials vary from tooth to tooth and between mesial, labial, distal and lingual. It can, however, be seen that there was a reduction in temperature differential from the incisor to the molar region.

The results of the temperature taken from the gingival margin to the sulcus (*Fig.* 5) show a consistent pattern. The temperature differential at the gingival crest was higher than 2 mm below the crest and continued to increase towards the sulcus. As was the case around the teeth, the maxilla was cooler than the mandible and the incisor was cooler than the premolar, which in turn was cooler than the molar area.

The four-way ANOVA for the gingival sites (*Table IV*) indicated that there were highly significant differences for each of the variables, particularly for tooth and jaw. The strength of this test is influenced by the large number of observations. The much lower F values for gingival site and even subject suggest that these are less clinically relevant differences than the tooth type and jaw.

The lowest coefficient of variation of 20·1 was for the distal aspect of tooth 22 and the highest, 54·4, was for the sulcular measurement of tooth 46. This wide range of variation could

Table IV. Results of four-way ANOVA

Variable	*Degrees of freedom*	F *value*	P *value*
Tooth	2	1020·8	0·0001
Gingival site	3	7·0	0·0002
Jaw	2	594·6	0·0001
Subject	29	23·9	0·0001

be attributed to the subjects under study since the low coefficient of variation and small range, from 0·4 to 1·1, seen for the device indicates its precision.

DISCUSSION

This study has shown that the small thermistor used could successfully measure temperature in various parts of the mouth. The statistically significant differential between the teeth indicates that in future studies of pathological conditions, individual teeth must be examined; in other words it is not permissible to compare incisors to molars, but only incisor to incisor and molar to molar. It may also be necessary to compare a specific area, for example the distal area to the distal area of the same tooth and not to pool temperatures around the same tooth.

The gingival temperature is dependent on local blood flow and the temperature of the perfusing arterial blood. We assume that arterial blood temperature is the same as body core temperature which will be different between individuals as well as be subject to diurnal variation in any individual. Therefore in order to compare gingival temperatures at different sites in an individual, and between individuals, we have subtracted the local temperature from the body core temperature as measured sublingually. This value in each case reflects the local circulatory condition and if there is a standard pattern in normal individuals then a variation from it in any patient may indicate the need for further investigation. An increased local gingival temperature indicates an increased local blood flow which may be due to local pathology.

No other investigators have used temperature differences so that we cannot make direct comparisons, but this study has confirmed that there is a temperature gradient from the anterior to the posterior of the mouth, and from maxilla to mandible. We were also unable to compare our findings of gingival crest temperatures as this has not been reported by other authors.

Acknowledgements

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ERRATUM

Due to an oversight, the review of *A Colour Atlas of Oral Pathology* (*Journal of Dentistry,* 1985, Vol. 13, No. 3, p. 262) was attributed to the wrong reviewer. The book was reviewed by Dr T. Palmer.