Journal of the Dental Association of South Africa, **42**, 399-401

Diurnal mucosal temperature variations

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Keywords: mucosa

SUMMARY

In order to investigate diurnal mucosal temperature variations, a digital thermometer with 0,4 mm² tip was used to measure mucosal temperature at mesial, distal, buccal and lingual sites around teeth 14, 22, 26, 34, 42, 46 in five females, at 08h00, 10h00, 12h00, 14h00 and 15h00 on three occasions at weekly intervals. These results obtained were subtracted from sublingual temperature to correct for variations in body core temperature between subjects. A five-way analysis of variance was performed to determine which of tooth type, jaw position around tooth and subject most influenced mucosal temperature. The factors of greatest significance were choice of tooth and jaw while time of examination was the least important. It is suggested that in future studies only comparable sites around the same tooth type should be compared within and between patients.

OPSOMMING

Daaglikse veranderinge in mondslymvliestemperatuur is ondersoek. 'n Digitale termometer met 'n 0,4 mm² punt is gebruik om die temperatuur van die slymvlies op plekke mesiaal, distaal, bukkaal en linguaal met betrekking tot tande 14, 22, 26, 34, 42 en 46 in vyf vroulike persone te meet. Metings is uitgevoer om 08h00, 10h00, 12h00, 14h00 en 15h00 by drie weeklikse geleenthede. Die resultate is afgetrek van sublinguale temperatuur om voorsiening te maak vir verskille in liggaamskerntemperature van elke proefpersoon. 'n Vyfrigtinganalise van variansie is uitgevoer om te bepaal watter een van die volgende die meeste invloed op slymvliestemperatuur het: tandtipe, die posisie van die kakebeen rondom die tand, en die persoon. Die tandtipe en kakebeen was die faktore met die meeste betekenis, terwyl die tyd van meting die minste invloed gehad het. Dit word voorgestel dat slegs temperature van vergelykbare areas rondom dieselfde tandtipe in toekomstige studies in en tussen pasiënte vergelyk word.

Gingival sulcus absolute temperature in man has been shown to be lower in incisor compared to molar teeth and in the mandible compared to the maxilla (Ng, Compton and Walker, 1978; Mukherjee, 1978; Holthuis and Chebib, 1983. Using sensitive methods, Volchansky *et al* (1985) determined temperature differentials (sublingual temperature minus temperature at an oral mucosal site) and confirmed the earlier observations. They noted, however, that there was an irregular variation in temperature differentials in healthy gingiva between mesial, labial, distal and lingual sites around teeth. The variation between teeth was sufficient to suggest that comparisons between individuals should only be between similar sites on similar teeth, that is, a mesial site adjacent to a maxillary incisor tooth should only be compared to the same site in another individual.

Besides anatomical site variation, gingival temperature is dependent upon local blood flow and body core temperature and will differ between individuals as well as be subject to the diurnal or circadian variation within individuals described for blood pressure, body temperature and cortisol production (Lamb *et al*, 1984). Evidence on diurnal temperature variation in oral mucosa is lacking. In particular, it is not known whether the time of examination, for between person comparisons, should be standardized. The present study was undertaken to clarify this.

MATERIALS AND METHODS

Before beginning the study the protocol was approved by the University of the Witwatersrand's Committee for Research on Human Subjects. The temperature measuring device was a Bailey Instruments digital thermometer (model BAT 12), with a 0,4 mm² measuring point (Fig. 1), which was calibrated against a mercury-in-glass full immersion thermometer and found to be accurate to 0,05°C. The characteristics of the temperature measuring system were examined through 10 repeated measurements at the same mucosal site on four subjects, the mouth being closed for 10 sec between measurements at each site. The coefficient of variation for each subject ranged from 0,8-1,3 per cent indicating the high reproducibility of the measuring technique.

The subjects in the definitive study were five females ranging in age from 18-34 y. All had gingival index scores of 1 or less (Löe, 1967) for the six teeth selected for measurement, namely teeth 22, 14 and 26 in the maxilla and teeth 42, 34 and 46 in the mandible, which are those recommended for periodontal disease investigation by the World Health Organization (1979). At each tooth the sites of 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 tip of the thermometer was placed

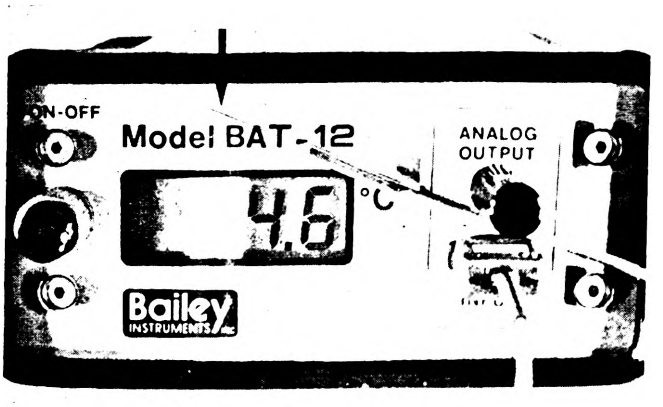

Fig 1: **Digital thermometer used, the measuring point is arrowed.**

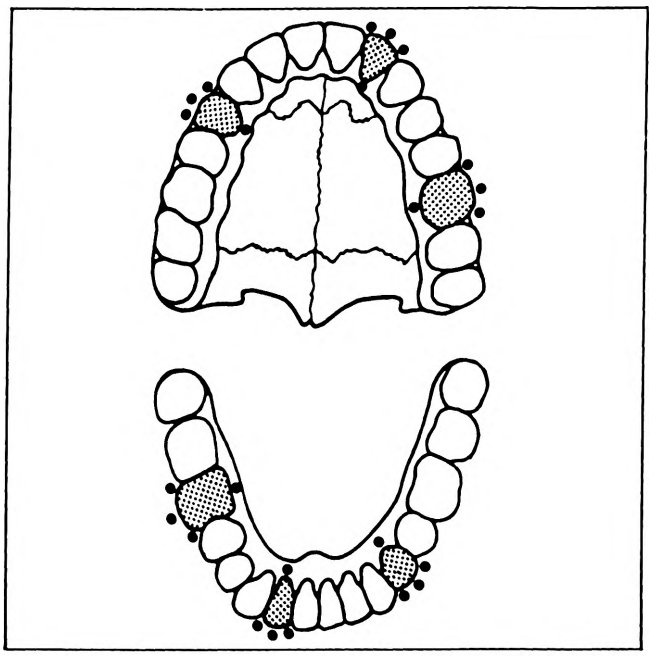

Fig 2: **Measurement sites.**

on the site to be examined at right angles to the surface, and was kept in place until the digital recording had stabilized. On each measuring occasion the first measurement was the sublingual temperature which was used as a baseline for future calculations.

After recording around each tooth the subject's mouth was closed for approximately 10 sec before recordings on the next tooth were started.

Temperatures were measured at the 24 gingival sites in each of the five subjects at weekly intervals for 3 wk, at 08h00, 10h00, 12h00, 14h00 and 15h00 which were convenient times for the subjects. A total of 360 temperature measurements was thus obtained for each individual. Then, in order to minimize the effect of variations in body core temperature on the various measuring occasions and between subjects, for each subject the gingival temperature at each measurement site was subtracted from the sublingual temperature obtained at the time to give a temperature differential. Since the sublingual temperature tends to be higher than the gingival temperature, the differential will on average be positive; the higher its value, the lower is the temperature of the area measured below the gingival temperature, and conversely.

Statistical analysis

The data were entered into an IBM 3058 model J24 computer and analyzed using SAS (Statistical Analysis System Inc, 1985). A five-way analysis of variance (ANOVA) was carried out for the five factors studied (tooth, position around the tooth, jaw, subject and time of examination) as well as for all two-way interactions. The critical level of statistical significance chosen was $p < 0{,}01$.

RESULTS

The analysis of variance (ANOVA) was undertaken to determine which of the chosen factors most influenced the mucosal temperature. In Table I the nine statistically significant F values from the ANOVA are listed in descending order. Because of the similarity in recordings from day to day for each subject, each day of the study was treated as a replicate. It is clear that the factors of greatest clinical significance are choice of tooth and jaw for measurement. The time of examination, although statistically significant, was the least important of the factors studied.

In Table II the ANOVA mean values for each measurement site, as well as the 1 per cent least significant difference for each factor are shown. The general trends within each factor can be seen, and of particular note is that the greatest differences in mean temperature within each factor is between teeth, as would be expected from the highest F value (Table I). In order to highlight these variations in the five subjects, the variation in temperature differential between teeth (the most significant variable) is shown in Fig. 3 and that for time of examination (the least significant variable) in Fig. 4. From these figures it is clear that one subject had a consistently cooler oral mucosa than the other four people. The slope of the graphs in Fig. 3 is consistent with the high statistical significance of the results, in contrast to the almost flat graphs for time of examination.

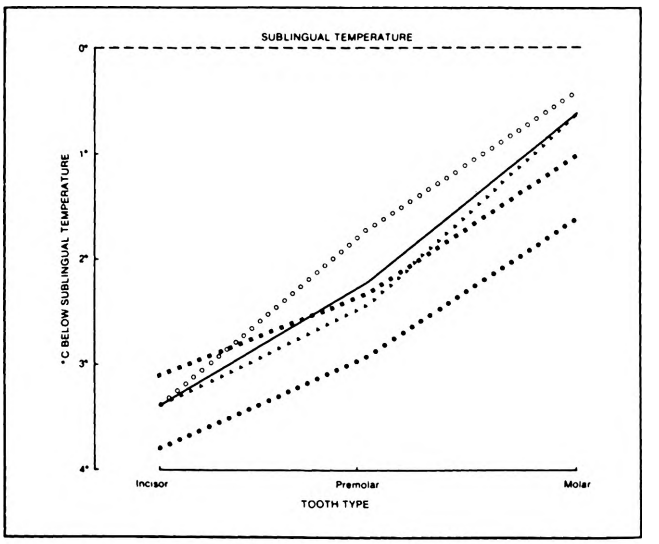

Fig 3: **Plot of mucosaltemperature by tooth type for each subject.**

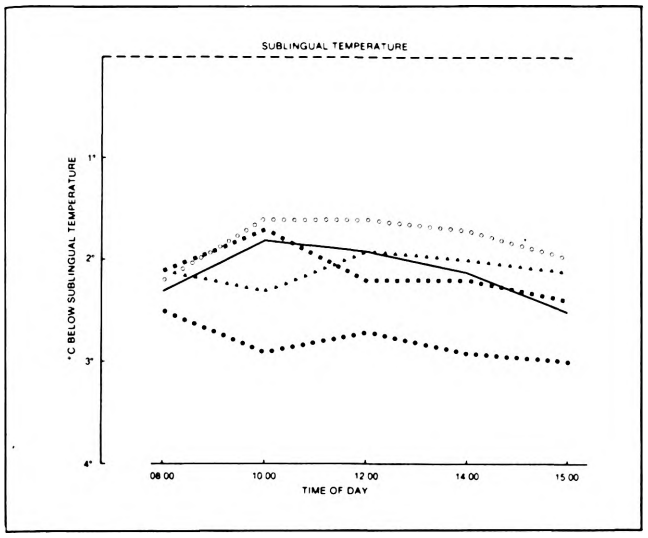

Fig 4: **Plot of mucosal temperature by tooth type for each subject.**

Table I: **Summary of statistically significant ANOVA F values for single factors and for two-way interactions**

Source	Degrees of Freedom	F value	Probability
Tooth	2	834,01	0,0001
Jaw	1	267,53	0,0001
Position	3	66,76	0,0001
Subject	4	39,38	0,0001
Tooth x Jaw	2	39,25	0,0001
Tooth x Position	6	22,60	0,0001
Tooth x Subject	8	6,30	0,0001
Time of Examination	5	5,13	0,0004
Jaw x Subject	4	3,16	0,0135
Subject x Time of Examination	16	2,79	0,0002

DISCUSSION

The digital thermometer, with small tip, chosen was accurate and easy to use and can be recommended for future studies. This observation was also made by Holthuis and Chebib (1983) in their study of temperature related to pocket depth. The general trends noted in this investigation confirm our earlier observations that mucosa is warmest alongside posterior teeth and in mandible compared to maxilla (Volchansky *et al*, 1985). The present study has also added evidence that since mucosal temperature varies significantly between teeth, between jaws and between sites around teeth, comparisons between individuals or within the same mouth should be between similar anatomical sites.

Diurnal fluctuation in gingival temperature, at the times studied, was noted. This factor was the least statistically significant however, and between 08h00 and 14h00 the mean values varied only 0,1 °C. The statistical significance has been favourably influenced by the large number (360) of recordings made per subject. We suggest therefore that between 08h00 and 14h00 time of temperature recording can be ignored in comparisons between subjects and within mouths. More data are required to determine the effect of time of measurement from 15h00 onwards.

Table II: **ANOVA mean values of temperature differentials (sublingual temperature — temperature at site measured) in degrees Celsius**

Tooth	Mean temperature differential (°C)	1% Least significant difference
Incisor	3,4	0,17
Premolar	2,3	
Molar	0,9	
Jaw		
Maxilla	2,6	0,13
Mandible	1,8	
Position around the tooth		
Mesial	2,7	0,19
Labial	2,4	
Distal	2,1	
Lingual	1,7	
Individuals		
1	2,1	0,21
2	1,8	
3	2,1	
4	2,8	
5	2,1	
Time of examination		
08h00	2,2	0,21
10h00	2,1	
12h00	2,1	
14h00	2,2	
15h00	2,4	

ACKNOWLEDGEMENTS

The word processing skill of Mrs H. Ball is gratefully acknowledged.

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