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ORIGINAL ARTICLE

Evaluation of tongue coating indices

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AIM: The purpose of this study was to determine inter-examiner reproducibility of two modified Winkel tongue coating indices and to study the relationship between each of these two indices and the amount of tongue coating as determined by wet weight of scrapings from the dorsum of the tongue.

MATERIALS AND METHODS: Twenty-five participants were selected for the study from among dental students. The selection was made to assure that a wide range of degrees of tongue coating were represented. Two independent examiners scored the tongue coatings using the two modified Winkel tongue coating indices (mWTCI 1 + 2 and mWTCI 2). After completion of index recordings, tongue scrapings were performed by one of the examiners.

RESULTS: Inter-examiner reproducibility of mWTCI 1 + 2 and mWTCI 2 using Pearson's coefficients of correlation amounted to $r = 0.48$ and 0.93 respectively. Overall, mWTCI 2 showed higher correlations to wet weight of tongue scrapings than mWTCI 1 + 2.

CONCLUSION: The mWTCI 2 was found to be highly reproducible and also valid as related to wet weight of tongue scrapings. This index would seem suitable for further studies on tongue coatings; effect of tongue cleaning; and rate of reformation of coatings after cleaning.

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Keywords: tongue coating; tongue coating index; wet weight of tongue scrapings

Introduction

Tongue coating is a visible white-brownish layer adherent to the dorsum of the tongue comprised of desquamated epithelial cells, blood cells, metabolites, nutrients and bacteria (Yaegaki and Sanada, 1992; Roldan *et al*, 2003). There is substantial evidence to indicate that tongue coatings may contribute to oral malodor (Tonzetich and Ng, 1976; Yaegaki and Sanada, 1992; Bosy *et al*, 1994; Suarez *et al*, 2000; Morita and Wang, 2001; Oho *et al*, 2001; Hinode *et al*, 2003; Lee *et al*, 2003). Microorganisms harbored in the tongue coatings have the capacity to produce odorous, volatile sulfur compounds through putrefaction of sulfur-containing proteins, peptides and amino acids (see reviews by Loesche and Kazor, 2002 and Roldan *et al*, 2003). Considering this background, cleaning of the tongue using a toothbrush or a tongue scraper is often recommended as part of regular oral hygiene for the purpose of reducing or preventing oral malodor. However, there seems to be limited information in the literature evaluating if regular tongue cleaning is effective in eliminating or reducing tongue coatings, and to what extent regular tongue cleaning will affect oral malodor (Tonzetich and Ng, 1976; Suarez *et al*, 2000; Seemann *et al*, 2001).

In future studies, we intend to evaluate the effect of tongue cleaning on the degree of tongue coating and the rate of reformation of coatings after removal. For these studies, it is imperative to use a valid and reliable method to measure the amounts of tongue coating. Reviewing the literature, there seems to be no consensus about the most appropriate method to determine the degree of tongue coating. Clinical examination and use of different tongue coating indices have been employed. Quirynen *et al* (1998) and Amir *et al* (1999) recorded tongue coating as present or absent. Bosy *et al* (1994), De Boever and Loesche (1995) and Awano *et al* (2002) scored the coatings as none, light, medium or heavy. Miyazaki *et al* (1995) and Morita and Wang (2001) used an index scoring the extension of the tongue coatings in thirds of the surface of the tongue dorsum. Oho *et al* (2001), Hinode *et al* (2003) and Tanaka *et al* (2003) used indices that considered both the extension and the thickness of the tongue coatings. The degree of tongue coating can also be determined by measuring the wet weight of scrapings collected from the dorsum of the tongue (Yaegaki and Sanada, 1992; Lee *et al*, 2003). Use of wet weight of scrapings from the dorsum of the tongue would probably be the most appropriate method to study different degrees of tongue coating. However, in studies evaluating the effect of tongue cleaning, wet weight cannot be used, as removal of the tongue coating

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for measurement purposes will interfere with experimental tongue cleaning protocols.

A detailed index was proposed by Winkel and used by Gomez *et al* (2001). With this index, the dorsum of the tongue is notionally divided into nine sections, one middle and two lateral areas for each of the posterior, middle and anterior thirds of the tongue. Presence of tongue coating is recorded for each of these sections, provided the coating is covering more than 1/3 of each section. No coating is given score 0. A light-thin coating is given score 1 (the pink color underneath the coating is still visible). Heavy-thick coating is given score 2 (no pink color can be observed under the coating). The tongue coating value is obtained by adding all nine scores, obtaining a total score of a 0–18 range. In subsequent publications, the number of notional sections was reduced to six, scoring three areas for the posterior and anterior parts of the tongue, thus obtaining a total score of a 0–12 range (Winkel *et al*, 2003; Roldan *et al*, 2004).

The scoring system of the Winkel index appears useful, as the scores of this index are comparatively easy to interpret because of the clear criterion: 'if the pink color underneath the coating is visible or not'. However, during calibration exercises which included scrapings of the coating with the tip of a small disposable dental spatula at a couple of spots, we discovered that Winkel score 1 often seems to represent an increased keratinization of the papillae of the tongue rather than tongue coating. This possibility may affect the validity of the Winkel index. Therefore, we decided to compare results using Winkel score 2 only with results using both scores 1 and 2, and also to modify the segmentation scores of the tongue. In addition, these two modified Winkel indices were analyzed relative to tongue coating measurement using wet weight of scrapings collected from the dorsum of the tongue. Specifically, the aims were:

- to determine the inter-examiner reproducibility of modified Winkel tongue coating indices using both Winkel scores 1 and 2 as well as using Winkel score 2 only; and
- to study the relationship between each of these two tongue coating indices and the amount of tongue coating as determined by wet weight of tongue scrapings.

Materials and methods

Subjects

Twenty-five participants (16 males and nine females, mean age 27 years) were recruited for the study from among dental students at the School of Dentistry, Loma Linda University. Subject selection was made to assure that wide ranges in degrees of tongue coating were represented in the study group. All recordings were made in the afternoon, without prior instructions to the participants. The Institutional Review Board of Loma Linda University granted approval for the study based upon the principles of the Declaration of Helsinki. The participants signed an informed consent prior to examination.

Measurements

Tongue coating index using both Winkel scores 1 and 2 (modified Winkel tongue coating index (mWTCI) 1 + 2)

The dorsum of the tongue was divided into three parts: a posterior, a middle and an anterior part. Ink marks were placed on the tongue surface at two locations, indicating the anterior–posterior width of each third (Color Transfer Applicator; Great Plains Dental Products, Kingman, KS, USA). For each third, the extent of tongue coating within the area was estimated to the nearest 5%. If the pink color was visible through the coating, it was recorded as score 1, and if the coating concealed the pink color score 2 was recorded. The score for the entire tongue was obtained by adding the scores for each third, followed by division of the sum by three.

Tongue coating index using Winkel score 2 only (mWTCI 2)

For calculation of this index only coating having a thickness concealing the pink color of the tongue was considered. Thus, score 2 only from the above scorings of each third was used.

Wet weight of tongue scrapings

The saliva on the dorsum of the tongue was removed by blotting the surface with absorbent paper for 5 s (Gel Blot paper; Schleicher & Schuell, Keene, NH, USA). The side of a disposable plastic spatula was then used to scrape and collect the tongue coating. Repeated scrapings starting at the posterior part of the tongue were performed until no more coating could be dislodged. The scrapings continued towards the tip of the tongue, gradually moving dislodged material towards the tip, followed by collection in a $2'' \times 2''$ gauze. The wet weight of the collected tongue coating was measured to nearest 0.01 g by subtracting the pre-scraping from the post-scraping weight of the gauze (XS-410; Denver Instrument Company, Denver, CO, USA).

Examiners

Prior to the start of the study, two examiners (authors T.L. and A.M.) performed a series of calibration exercises. In order to ascertain a score of 2 during these calibration exercises, the examiners scraped the coating with the tip of a small disposable dental spatula at a couple of spots. In this way, the examiners confirmed that the coating could be dislodged. The calibration efforts continued until the examiners experienced that no further improvement of agreement could be accomplished. The study was then started and for each participant the two examiners first agreed upon where the ink marks should be placed to indicate the anterior–posterior width of each third of the tongue. Thereafter, the examiners scored the tongue coating independently and without any confirmatory scraping. After the completion of the index recordings, examiner A.M. performed tongue scrapings.

Results

The extent of tongue coating using mWTCI 1 + 2 and mWTCI 2 for posterior, middle and anterior thirds of the tongue, and for the entire dorsum of the tongue for examiners 1 and 2 is presented in Table 1. For both indices the posterior third of the tongue showed the highest scores. Using mWTCI 2 no coating was observed for the anterior third. Using mWTCI 1 + 2 resulted in a twofold increase of the scores compared with use of mWTCI 2 for the entire dorsum of the tongue. Mean scores for examiners 1 and 2 were comparable, although examiner 2 tended to have slightly higher scores.

Inter-examiner reproducibility of scores for mWTCI 1 + 2 and mWTCI 2 for the entire dorsum of the tongue as expressed by Pearson's coefficients of correlation is presented in Table 2. The mWTCI 2 showed a superior reproducibility ($r = 0.93$) as compared with the mWTCI 1 + 2 ($r = 0.48$). A scatter plot for the inter-examiner relationship of the mWTCI 2 is shown in Figure 1.

Correlations between the two indices for both examiners and wet weight of scrapings from the dorsum of the tongue are also presented in Table 2. Overall, mWTCI 2 showed higher correlations to wet weight than mWTCI 1 + 2. The wet weights of the tongue scrapings among the 25 subjects amounted to 0.09 ± 0.08 g (range 0.01–0.29 g).

Discussion

The results of the present study confirmed that eliminating score 1 of the Winkel tongue coating index improved the inter-examiner reproducibility from a Pearson's coefficient of correlation of $r = 0.48$ to $r = 0.93$. Also, the exclusion of score 1 tended to increase the correlation to wet weight of tongue scrapings. It could be argued that eliminating score 1 might decrease the sensitivity of the scoring system. However, our findings show that inclusion of score 1 decreased the more essential aspects of the measurements, i.e. the reproducibility and the validity of the scoring method.

In interpreting the findings of this study, it needs to be kept in mind that the division of the tongue into thirds was made by having the two examiners agree upon where the demarcations should be placed. Probably, the inter-examiner coefficient of correlation of mWTCI 2 would have been somewhat lower if the division of the tongue in thirds had been made separately by the two examiners. However, this would have similarly affected the inter-examiner coefficient of correlation of the mWTCI 1 + 2. Study design reasons dictated the joint placement of the demarcations. Inter-examiner comparisons performed at two different time points was not an option, as the degree of tongue coating may have been different at these two examinations.

The coefficient of correlation between mWTCI 2 and wet weight of tongue scrapings reached values amounting to 0.69–0.75. Although higher correlations would have been desirable, this may not be a realistic expectation because of different sizes of tongues, different thickness of coatings and differences in composition of the coatings.

The mean wet weight of the tongue scrapings among the 25 subjects amounted to 0.09 g. In two previous studies wet weights of tongue coatings have also been recorded. Yaegaki and Sanada (1992) reported a mean wet weight of 0.01 g in 14 subjects with probing

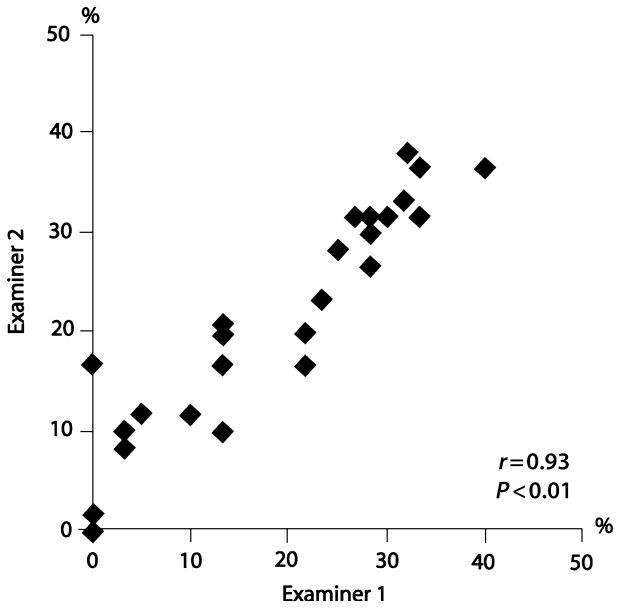

Figure 1 Scatter plot for inter-examiner relationship of modified Winkel tongue coating index (mWTCI) 2. Tongue coating scores for examiners 1 and 2 expressed as percentages of the entire dorsum of the tongue

Table 1 Extent of tongue coating in percentage (mean ± s.d.) for posterior (PT), middle (MT), anterior (AT) thirds, and the entire dorsum of the tongue (Entire) for examiners 1 and 2 using modified Winkel tongue coating index (mWTCI) 1 + 2 and mWTCI 2. $n = 25$

	PT	*MT*	*AT*	*Entire*
mWTCI 1 + 2				
Examiner 1	80.0 ± 20.8	33.0 ± 23.3	2.4 ± 6.1	38.5 ± 12.9
Examiner 2	87.0 ± 12.3	50.0 ± 18.3	3.8 ± 6.1	46.9 ± 10.6
mWTCI 2				
Examiner 1	50.6 ± 31.9	6.8 ± 8.9	0 ± 0	19.1 ± 12.4
Examiner 2	54.0 ± 27.8	11.2 ± 7.8	0 ± 0	21.7 ± 11.2

Table 2 Inter-examiner coefficients of correlation (Pearson's *r*) for modified Winkel tongue coating index (mWTCI) 1 + 2 and mWTCI 2 for the entire dorsum of the tongue, and correlations (Pearson's *r*) between the two indices and wet weight of tongue scrapings. $n = 25$

	mWTCI 1 + 2	*mWTCI 2*
Examiner 1 *vs* 2	0.48*	0.93**
Examiner 1 *vs* wet weight	0.20[†]	0.69**
Examiner 2 *vs* wet weight	0.60**	0.75**

[†]Not significant, $*P < 0.05$, $**P < 0.01$.

depth < 4 mm, and 0.09 g in 17 subjects with probing depth ≥4 mm. Lee *et al* (2003) reported a mean wet weight of 0.19 g in 40 individuals visiting a malodor clinic.

In conclusion, the modified Winkel tongue coating index developed in this study was found to be highly reproducible and also valid as compared with wet weight of tongue scrapings. The mWTCI 2 would seem suitable to be used in further studies on tongue coatings; effect of tongue cleaning; and rate of re-formation of coatings after tongue cleaning.

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