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Microvascular characteristics of the human filiform papillae: a videocapillaroscopic study

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Summary

The aim of this study was to observe the microcirculation characteristics of the human filiform papillae in healthy patients in vivo.

Twenty healthy patients were examined using lingual capillaroscopy to investigate the characteristics of microcirculation of the human filiform papillae.

Visibility, course, tortuosity, as well as the possible presence of microhemorrhages, the average caliber of the capillary loops and the number of visible capillary loops per square millimeter were evaluated for each patient.

The investigation was simple, non-invasive and repeatable for each patient. Microcirculation architecture was characterized by a network of capillaries in polygonal mesh with parallel orientation in regard to the surface. Rare microhemorrhages were observed. The caliber of visible capillary loops was $12.50 \pm 1.46\,\mu m$ (mean $\pm$ SD). The number of visible capillaries was 9.88 ± 1.06 (mean $\pm$ SD).

Our study shows that capillaroscopy of lingual filiform papillae is a practicable method. Future studies might evaluate whether microcirculation in that area is compromised or not during systemic pathologies involving peripheral microcirculation alterations. This method could also be applied to the study of microcirculation in pathologies which strictly pertain to the dental stomatological field.
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Introduction

Several studies have been carried out over the years to describe the microcirculation characteristics of the oral mucosa, and especially of lingual papillae (Groner et al., 1999; Lopes et al., 2002; Miniati et al., 2001; Motoyama and Watanabe, 2001; Ojima, 2000, 2001; Ojima et al., 2000). To our knowledge, a simple, non-invasive method, such as videocapillaroscopy, has never been used.

Capillaroscopy is a non-invasive diagnostic technique, fundamental in viewing peripheral circulation and in studying microangiopathies, which are

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the manifestations of numerous pathologies in both the diagnostic and monitoring phases of the disease (Cantatore et al., 2000; Cinti et al., 1984; Grassi et al., 1993).

The alterations in the capillaroscopic picture can represent, in fact, the only documented evidence of an incipient disease (Pizzorni et al., 2000; Scardina and Messina, 2004).

Capillaroscpy permits monitoring in time of any disease compromising microcirculation (Pizzorni et al., 2000).

The aim of this study has been to observe the microcirculation of the lingual filiform papillae in healthy patients, and therefore to evaluate whether this method is practicable and can eventually be used in the diagnosis and monitoring of the systemic pathologies involving the oral cavity, and the pathologies strictly pertaining to the dental stomatological field.

Materials and methods

Twenty healthy patients (10 men and 10 women; mean $\pm$ SD age: 42.68 $\pm$ 1.05 years; range: 24–48 years) were examined in our laboratory.

The healthy patients were included in the study only if an accurate exam of their medical history revealed that they were non-smokers. The patients who reported conditions known to compromise microcirculation, such as diabetes, hypertension, pharmacological treatments, were excluded from the study.

All the patients gave their informed consent for the processing and use of their personal medical data in scientific papers, according to Italian law.

They were examined using computerized video-microscopic techniques and related software (DS Medigroup, Milan, Italy). The optical probe video-microscope is composed of a main unit, to which an optical probe with a video-optical terminal is connected, and by a high-resolution color monitor to view the examined area. The main unit consists of: - a cold halogen light source emitted by a 100 W lamp with an electronic device which controls light intensity; a processing unit for the high-definition video signal (420,000 pixels) with a color calibration device. The probe is equipped with a video-optical terminal containing a high-definition video sensor, on which different variable magnification optics from 10 $\times$ to 1000 $\times$ can be applied. A technological characteristic of the video-optical terminal is the possibility of focusing directly from the handpiece.

Image digitalization allows for the analysis of the fundamental parameters of microcirculation (caliber and vessel length), and the calculation of the number of capillaries per mm^2 of the mucosa examined.

The capillaroscopic investigation was carried out with the patients in a sitting position, with the same light source, at the same room temperature (23 °C), in the morning, by the same operator and repeated twice for each examined area.

The examined area was always the same for each patient – the lingual filiform papillae.

Two independent observers examined all the images. The intraobserver and interobserver variability was assessed with the two observers evaluating the same randomly selected images twice.

The following statistic parameters were used:

(A) Non-parametric data: capillary loop visibility (marks from 1 to 4): (1) simple focusing – within 30 s from the beginning of the examination; (2) average focusing – over 30 s and within 2 min; (3) difficult focusing – over 2 min; and (4) impossible focusing; orientation regarding the surface (marks A, B or AB): (A) capillary loop course parallel to the surface; (B) capillary loop course perpendicular to the surface; and (AB) both parallel and perpendicular; capillary tortuosity (marks from 0 to 3): (0) absence of crossing in the capillary loops; (1) presence of crossing; (2) greater presence of crossing; and (3) complete distortion of the capillary loops; microhemorrhages (marks 0 or 1): (0) absence; and (1) presence; and characteristics of the capillary loops (marks 0 or 1): (0) absence; and (1) presence.

(B) Parametric data: number of visible capillary loops per square millimeter (value obtained from the average of the two observations for each examined area); capillary loop caliber (values obtained from the average of the two observations for each examined area).

As regards the parametric data, it must be underlined that they originate from the software connected to the videocapillaroscope. The system is specifically calibrated: to every optical magnification corresponds an exact metric pixel value in the digitalized image; therefore, the capillary caliber can be measured with a high degree of precision.

All the patients involved in the study kept a dietary diary for a period of 1 month, to evaluate any dietary differences which could affect the periodontal capillary pattern observed.

Data analysis was carried out with StatView 5.0.1 (SAS Institute Inc., Cary, NC).

The results obtained from each examined area represent the average values of the two observations.

Results

Intrasubject variability satisfied the a priori hypothesis of limited dispersion. For the parametric data, variability ranged from +2% to −2% with respect to the mean value. For the non-parametric data, 1 mark difference was observed at most.

Microcirculation visibility was clear.

Microcirculation architecture was characterized by a network of capillaries in a polygonal mesh with parallel orientation (type A) as regards the surface.

Capillary tortuosity obtained a mark of: 0 in 7 patients, 1 in 6 patients, 2 in 5 patients, and 3 in 2 patients.

Rare microhemorrhages (mark 1) were observed. These were identified as reddish stains, possibly caused by microtraumas.

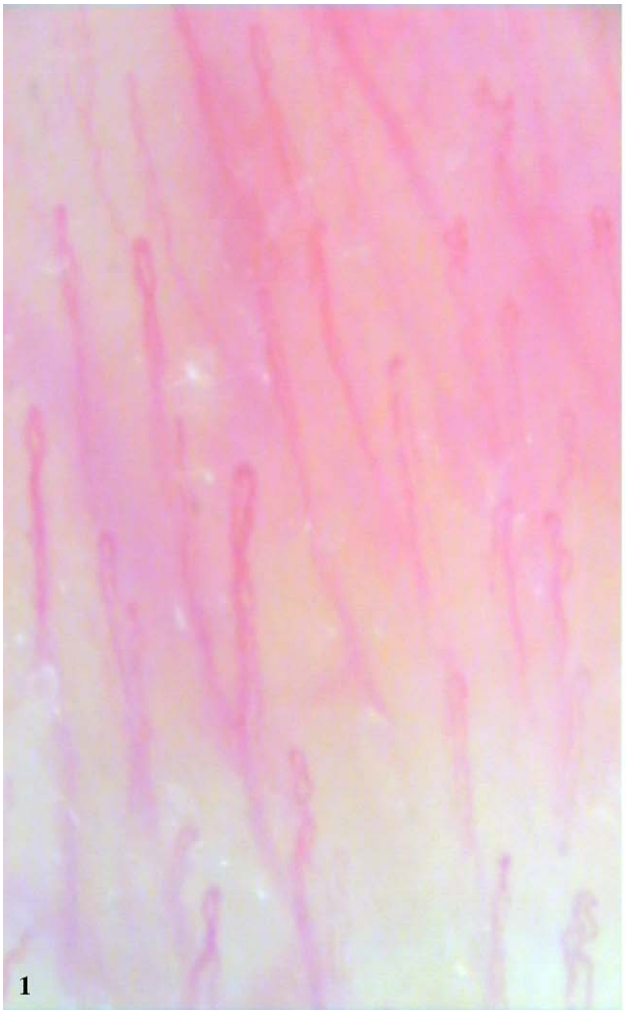
The caliber of the visible capillary loops was $12.50 \pm 1.46\ \mu m$ (mean $\pm$ SD). The number of visible capillaries was 9.88 ± 1.06 (mean $\pm$ SD) (Figs. 1 and 2).

No significant differences in the dietary habits of the patients were detected.

Discussion

Capillaroscopy is a very stimulating method for studying microcirculation, because of the possibility of studying small vessels in vivo by means of a microscope. Today, it is becoming more reliable thanks to the improvement of the observation tools (photography, videomicroscopy) (Grassi et al., 1993; Lova et al., 2002; Miniati et al., 2001).

The morphological study of microcirculation is of fundamental importance; in fact, the microvascular



Figures 1 and 2. Microcirculation characteristics of the human lingual filiform papillae (magnification: 200 ×).

bed is directly involved both in autoimmune etiopathogenesis pathologies, and in acute and chronic inflammatory etiopathogenesis pathologies (Pizzorni et al., 2000; Scardina and Messina, 2004).

The value of capillaroscopic investigation as a diagnostic means for peripheral microcirculation damage has been confirmed by numerous studies. With the use of this method, Halfoun showed that diabetic patients have capillary flow regulation abnormalities (Halfoun et al., 2003); with the same investigation technique, Haak showed that, in diabetic patients, the nervous reflex arcs are impaired (Haak et al., 1998). It must be said, however, that other studies have used capillaroscopic investigation to evaluate microcirculation damage not as a complication of a disease (diabetes), but as its beginning, and therefore to make a diagnosis (SSc) (Pizzorni et al., 2000; Scardina and Messina, 2004).

Most of the capillaroscopic studies have mainly examined the nalfold bed.

Our study is basically characterized by the originality of the investigation site. Study input has been given by the limits often shown by nalfold capillaroscopy; these are mainly represented by the difficulty in nalfold microcirculation visibility in some patients, linked to either their manual activities or the use of cosmetics in the case of women (Grassi et al., 1993; Scardina and Messina, 2004).

Such limits can be overcome if the investigation site is represented by the oral mucosa.

Our study, in fact, shows that the observation of oral microcirculation, and particularly that of lingual filiform papillae, can be easily carried out. This study must not be seen as merely descriptive research on lingual papillae microcirculation, but the potentialities of our intuition must be strongly underlined.

In fact, future studies might evaluate whether microcirculation in that area is compromised or not during systemic pathologies involving peripheral microcirculation alterations. This method could be also applied to the study of microcirculation in pathologies which strictly pertain to the dental stomatological field. The method could be useful for the evaluation of some risk factors for oral health, such as smoking and alcohol. Microcirculation monitoring in some pathologies involving an oral neoplastic risk might also be extremely useful. In fact, many studies have shown how neoangiogenesis and microcirculation modifications are closely linked to the fatal evolution of certain pathologies. Finally, in our opinion, our method, although simple, paves the way for many interesting future investigations.

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