The implication of the vascular factor in mucosal pathology induced by the removable partial dentures

Ioana Roxana Constantinescu[1], Dan Zaharia[2], Norina Forna[3], Maria Ursache[4]

Iasi Romania

Summary

The oral mucosa plays an important role in the modulation of interactions between external factors and human organism. The purpose of the study was to determine the changes in microcirculation of the oral mucosa induced by the removable dentures.

Material and method. We selected 34 patients wearing partially removable dentures, with age range between 45-75 years. For the investigation we used the photopletysmographic technique. The photopletysmography is a method which records the variations in optical density of a territory passed by blood vessels.

Results: The vasomotion is disturbed by the inflammation where appears the vasodilatation which increases the blood flow. In ischemic conditions the vasomotion increases in amplitude and frequency, probably to compensate the low blood flow in the microcirculation of mucosa.

Conclusions: The study showed changes in frequency and amplitude of the vasomotion. This fact denotes that the presence of traumatic dentures has a negative influence on the vascular dynamic.

Key words: oral mucosa, vasomotion, blood flow

Introduction

The oral mucosa plays an important role in the modulation of interreactions between external factors and the human organism. Although the mucosa has the capacity to react to different pathogens because of the histological features, it has been remarked evident changes which are the expressions of the structural and functional changes. It is well know the fact that traumatic actions of the removable dentures prevent vascular changes, especially when the mucosa is stressed by the forces. The pressures exerted by the denture base induce frequently a low tolerance of the denture because of the vascular fragility [1]. In literature had been achieved a lot of studies about the microcirculation of the oral mucosa from morphological [2] and functionally point of view [3].

It's important to recognize the reactions and the changes of microcirculation of oral mucosa associated with the influences of removable dentures.

The aim of the study was to determine the changes in microcirculation of oral mucosa induced by the removable dentures.

Material and method

We selected 34 patients wearing partially removable dentures, with age range between 45-75 years. From the study were excluded the patients with systemic diseases. Also, we selected 10 healthy subjects. For the investigation we used photopletysmographic technique. The photopletysmography is a method which records the variations in optical density of a territory passed by blood vessels. The photopletysmograph has a transducer (TSD 200), amplifier (PPPG 100C) and software. The amplifier *(Figure 1)* records the pulse waves and offers indications about the blood pressure, blood density or vasoconstriction. The amplifier is coupled with a photoelectrical transducer which measures the infrared reflectance resulted from the blood flow variations. The transducer records the blood flow variation from the palatal mucosa. This contains an infrared emitter and a photo diode that transmits the changes of infrared reflectance. The transducer was applied to the palatal mucosa and was fixed with two polyethylene mobile pieces *(Figure 2).*

[1] PhD, MD, Iasi, Romania

[2] Assoc. Professor Dr., Faculty of Bioengineering, ''Gr.T.Popa" University Of Medicine and Pharmacy, Universitatii street no 16, Iasi, Romania

[3] Professor, Faculty of Dentistry, ''Gr.T.Popa" University Of Medicine and Pharmacy, Universitatii street no 16, Iasi, Romania

[4] Professor, Faculty of Dentistry, ''Gr.T.Popa" University Of Medicine and Pharmacy, Universitatii street no 16, Iasi, Romania

Figure 1. The amplifier

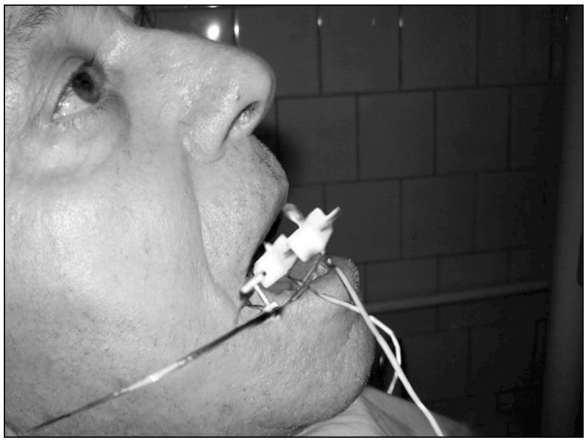

Figure 2. The transducer fixed on palatal mucosa

The time of data acquisition was performed for three minutes. The rate of the signals was 200 samples/seconds. To determine the low components frequencies we used FFT (Fast Fourier Transformation) with which we obtain the power-frequency spectrum. Every peak identifies the presence of an oscillatory component. The frequency of the spectrum component was measured for every peak. The band frequency was covered the interval between 0.01-1.6 Hz, according to the study of RT de Jong in 2004 [4]. In normal conditions, the frequency of spontaneous oscillations ranges between 0.01-0.05 Hz.

Results

The study of the tacks showed interesting data about the microcirculation in palatal mucosa. *Figure 3* presents the coarse signal in the previous phase of the recording. The segment of the signal ranges between 5-60 seconds with the average of amplitude waves smaller than 1 volt.

The records obtained from the control patients *(Figure 4),* show low frequency components 0.03 Hz and 0,3 Hz, frequencies that indicate a normal vasomotor activity. Those features plead for the existence of a vasomotor equilibrium, without changes in vascular dynamics.

Comparatively, it had been showed the disappearance of very low frequency component, thus remaining the frequency component of 0.3 Hz but appears a new component of 0.7 Hz *(Figure 5).* This frequency component is associated with the myogenic response of the smooth cells from the vessel wall induced by the stress from the vascular wall. The local response to the trauma induced by

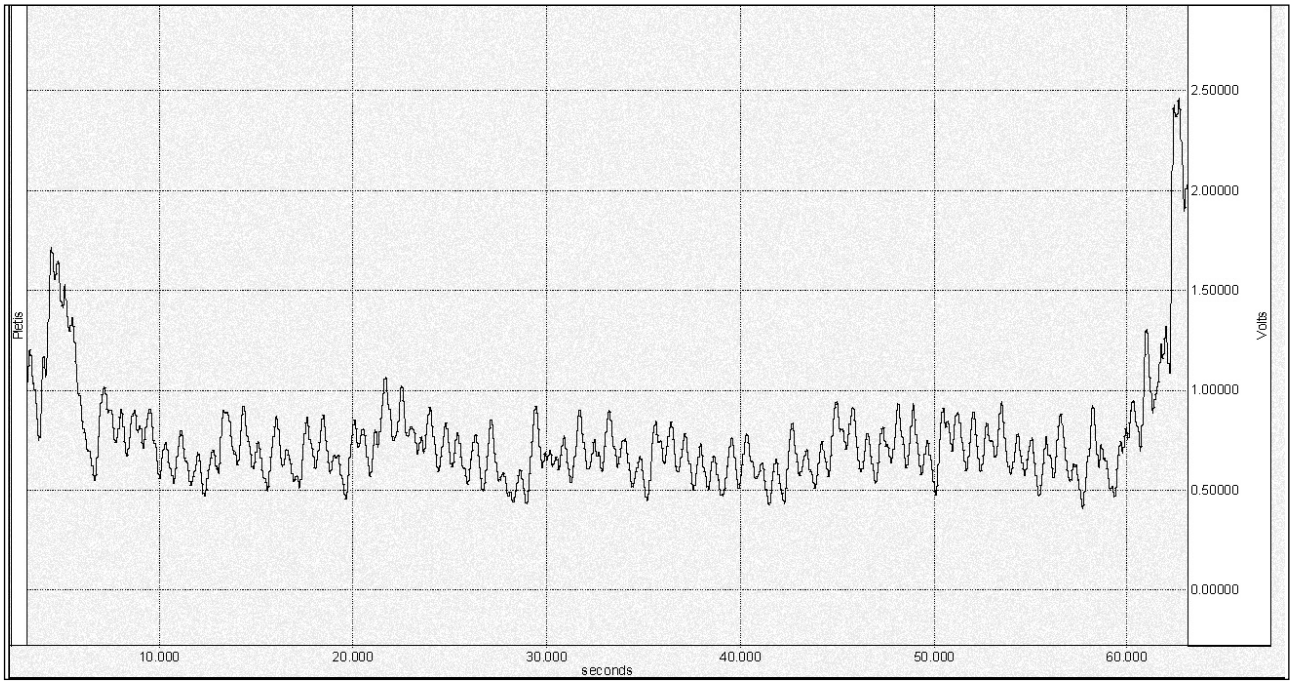

Figure 3. The coarse signal in the previous phase of the recording

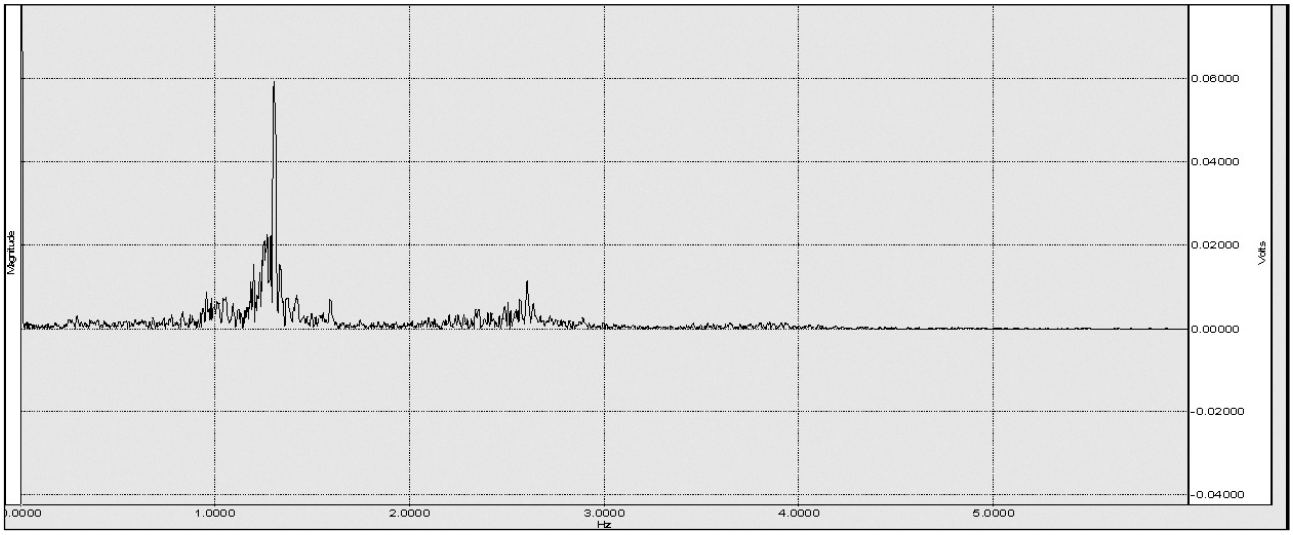

Figure 4. Normal vasomotor activity

removable dentures is represented by the increase of blood flow and the number of the opened capillaries. It is a hyperaemic reaction that is generated near the microtraumatism. The tissular trauma is followed by changes in the permaeabillity of the capillary wall.

The vasomotion is disturbed by the inflammation where appears the vasodilatation which increases the blood flow. *Figure 6* shows a lot of frequencies and a large scale of variations in the caliber of the palatal vessels that denote the presence of irregular vasomotions phenomena.

In ischemic conditions the vasomotion increases in amplitude and frequency, probably to compensate the low blood flow in the microcirculation of the mucosa.

Discussions

The vasomotion represents the vascular tone oscillations generated by the vessels wall and caused by changes of constriction and dilatation of the smooth muscles. In small arteries and arterioles, vasomotion influences perfusion, enhances filtration through the wall and lymphatic drainage. In ischemic conditions, the vasomotion could serve like a protective mechanism. The generation of this phenomenon is dependent by an array of individual

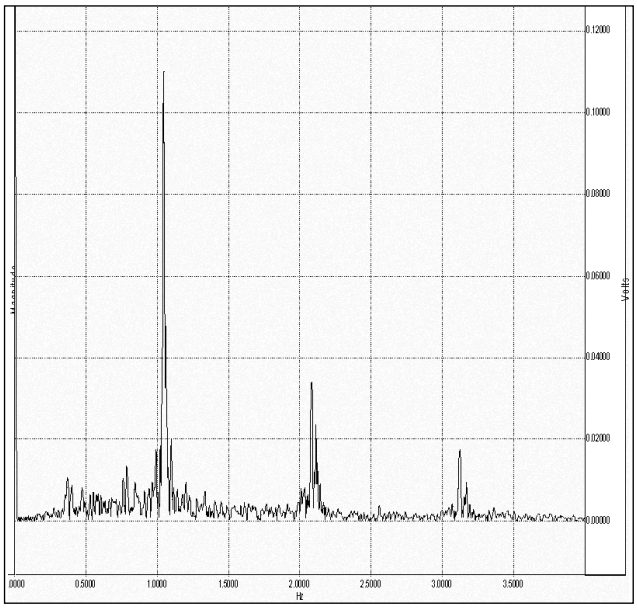

Figure 5. Changes in frequency and amplitude of vasomotion

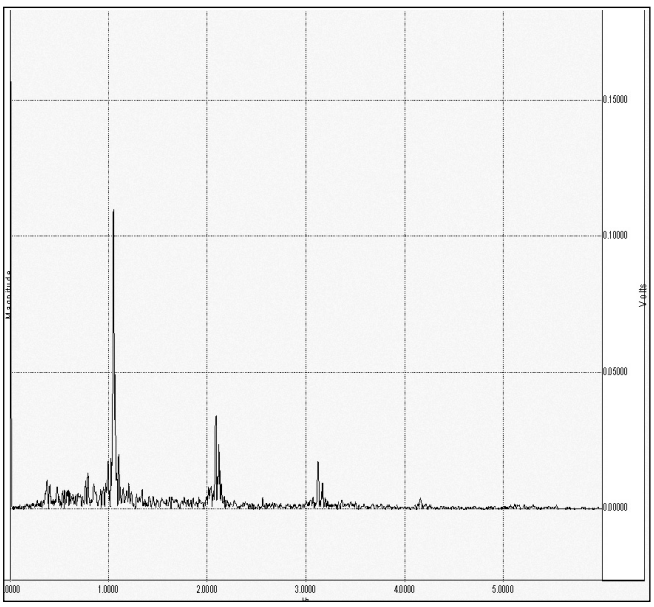

Figure 6. Irregular vasomotion

oscillatory. In experimental conditions this phenomenon is problematic because it is difficult to define specific amounts of tone in an oscillating vessel. It had been shown that the vasomotion is most prevalent under conditions of reduced perfusion [5].

In vivo studies revealed that the changes in vascular tone concur to the appearance of the blood flow changes. The blood flow changes are not only generated by the extern regulation. There are determinate by the local vasomotion factor. Mechanical factors such as wall stress appear to modulate vasomotion [6], but it has been suggested that these mechanical factors are not control variables of the system that generates vasomotion [7]. The vasomotion induces the coordination of the smooth muscles cells on the vascular wall. This coordination is achieved by electrical communication.

There are little opinions in the literature concerning the functional consequences of vasmotion. It seems that this phenomenon is an inoffensive result of the smooth muscle constriction that are oscillating in particular conditions. Flow oscillations might arise from oscillations based on the phase delay in the myogenic response [8]. The situations in which the response of the blood vessels is belated, a short pressure pulse can initiate the oscillation of the vascular tone. On the other hand, vasomotion may be beneficial under certain conditions. A vessel with an oscillating diameter has higher conductance and therefore greater flow, than a vessel with a constant diameter [9].

The prosthetic trauma, fungical infections and the failure of oral hygiene grow the susceptibility for the appearance of the mucosal inflammation [10]. In these situations, the presence of the dentures is the trigger of this phenomenon. The inflammatory reactions induce changes in permeability of the vascular wall, which progressively becomes abnormal. The small arteries commence to dilate and all the muscular elements inside the terminal vascular bad become completely dilated. The vascular wall seems to lose some of elastic properties.

The compressions exerted by the base of the partially removable dentures on the mucosa can lead to reduction of the blood flow. This requirement encourages the ischemia. After the ischemia period there will appear a reactive hyperemia represented by the increment of the blood flow. This reaction induces the reduction of the vascular resistance. The vascular wall can't resist to hydrostatic pressure and will be broke. This situation will bring to the appearance of the microhaemorrhages on mucosal tissues *(Figure 7).*

Figure 7. Microhaemorrhages on palatal mucosa

The capillary resistance can be considered the resultant of the mechanical force exerted by the capillary wall and associated factors: perivascular tissues resistance, blood viscosity, vasomotion and stasis acidosis. In the cases where the compressions induced by the impropers removable dentures have long duration, the vasodilatatory stimuli lead to the increase of hypereactive peaks and duration of hiperaemia. The myogenic response can contribute to reactive hiperaemic phenomenon. Using this mechanism, the micro trauma released by the compression of the denture base on the oral mucosa will determine the reduction of the blood pressure, a phenomenon which will determine vasodilatation. In opposition, the alternate short compressions do not induce changes in microcirculation although determine the reduction of the blood flow. In ischemiac conditions, there are changes of vasomotion, but the vascular tone is not fully eliminated by the metabolites.

Conclusions

The photopletysmography based on infrared reflectance is a non invasive method, objective and precise used for the dynamic study of the mucosal microcirculation. This method gives us relations, concerning the influences of the removable dentures on blood perfusion. The study of mucosal vascularization is often difficult to release, because so far we have not had a simple and efficient method for the functional investigation of the capillary circulation.

Because in the dynamic circulation of the

blood changes appear, the severity of lesions induced by the partially removable dentures are difficult to be quantified only using the intraoral examination of the oral cavity.

Our study showed changes in frequency and amplitude of the vasomotion. This fact denotes that the presence of traumatic dentures has a negative influence on the vascular dynamic.

References

1,. Ursache M, Vataman M, Stadoleanu C, Purdu A, Scutariu M, Mocanu C, Plenovici L. *In vivo* exploration of the sanguine vascularization of the denture bearing mucosa by photopletismographic methods. *Volum de rezumate. 4-th Congress of the Bass, Istanbul, Turkey,* 1999.

2. Hock J, Nuki K. A vital microscopy study of normal and inflamed gingiva. *J Periodontol Research* 1971; **6**:81.

3. Atasever NB, Ercan MT, Ulutuncel N. Effect of wearing complete dentures on human palatal blood flow measured by ^{113} Xe Clearance. *Archives of Oral Biology* 1991; **36**: 627.

4. RT de Jongh, Clark ADH, Ijzerman RG, Serene EH, Vries de G, Stehouwer CDA. Pysiological hyperinsulinaemia increases intramuscular microvascular reactive hyperaemia and vasomotion in healthy volunteers. *Diabetologia* 2004; **47**:978-986.

5. Schmidt J.A. A comprehensive review of vasomotion, including the foundation for this group's view that vasomotion is primarily associated with ischemia. *Periodic hemodynamics in health and disease,* 1996, Springer, Heidelberg, Berlin.

6. Achakri H, Stergiopulos N, Hoogerwerf N, Hayoz D, Brunner HR, Meister JJ. Intraluminal pressure modulates the magnitude and the frequency of induced vasomotion in rat arteries. *J Vasc Res* 1995; **32**: 237-246.

7. Griffith TM, Edwards DH. Complexity of chaotic vasomotion is insensitive to flow and pressure but can be regulated by external control. *Heart Circ Physiol* 1995; **38:** H: 656-668.

8. Ursino M, Cavalcanti S, Bertuglia S, Colantuoni A**.** Theoretical analysis of complex oscillations in multibranched microvascular networks. *Microvasc Res* 1996; **51**(4): 229-249.

9. Meyer C, de Vries G, Davidge ST, Mayes DC. Reassesing the mathematical modeling of the contribution of vasomotion to vascular resistance. *J Appl Pysiol* 2002; **92**:888-889.

10. Ursache Maria. Stomatopatiile paraprotetice. *Editura ANKAROM* - Iasi 1996; p89-91.

***

Correspondence to: Ph.D.Dr Ioana Roxana Constantinescu. E-mail roxana23_ro@yahoo.com