Variation in Blood Flow of Supporting Tissue During Use of Mandibular Complete Dentures with Hard Acrylic Resin Base and Soft Relining: A Preliminary Study

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Purpose: This study investigated the influence of hard and resilient polymerized acrylic resin base materials on the blood flow of the supporting underlying mucosa of mandibular denture wearers during different denture-wearing periods. ***Materials and Methods:*** Measurements were carried out on 20 complete denture wearers, 10 with hard bases and 10 with soft ones. The mucosal blood flow underlying the dentures was measured bilaterally in the canine and molar regions using a laser Doppler flowmeter. Baseline measurements were performed before denture wearing and after the dentures were worn for 1 week, 1 month, 3 months, and 6 months. ***Results:*** Mean blood flow to the mucosa after 1 week was significantly lower in the measured regions than that obtained before the dentures were worn. Blood flow in the canine region returned to almost normal levels 6 months after beginning to wear complete dentures. However, blood flow in the molar region of the denture wearers in the hard base group increased after 6 months, whereas blood flow values did not return to the levels recorded before denture insertion in the soft lining group. ***Conclusion:*** It appears that wearing dentures hinders blood flow to denture-supporting tissues, even when soft liners are used. *Int J Prosthodont 2005;18:210–213.*

Preservation of alveolar ridge morphology is a cited objective in complete denture treatment.[1] This concern applies in particular to the avoidable reduction in mandibular support, particularly in a time-dependent context.[2] The total area of support from the mandible, anatomically, is significantly less than that from the maxilla. The denture-supporting area becomes progressively smaller as the alveolar ridge resorbs.[2]

Clinical experience suggests that in the presence of advanced residual ridge reduction and nonresilient mucosa,[3,4] resilient denture liners may reduce the load on the supporting tissues[5] and make dentures more comfortable for the patient. Presumably, the load is distributed over the denture-supporting area by minimizing the localized areas of stress concentration. The clinical usefulness of such material in the short term is questionable. However, their deterioration over time demands that these materials be regarded as semipermanent.[6]

In long-standing edentulism, mandibular ridge integrity is frequently compromised both macro- and microscopically.[7,8] Microcirculatory measurements contribute to an understanding of the reported changes, and studies have been performed from both morphologic[7] and functional perspectives.[9–11] Absence of a comparison between blood flow changes under different denture bases (eg, hard vs soft) led to the present investigation. The aim of this study was to determine how the hard and soft denture base materials affect blood flow in a mandibular denture's underlying mucosa during different denture wearing periods.

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Fig 1 Example of a measurement plate; holes were set to permit placement of the laser Doppler flowmeter probe.

Materials and Methods

Subjects

This study was performed on 20 edentulous subjects (10 men, 10 women; mean age 62.2 ± 9.7 years) who needed complete dentures. The following criteria were used in subject selection: *(1)* stable systemic health, including absence of a history of cardiovascular disease; *(2)* no evidence of infection or trauma in the oral region; *(3)* negative history of syndrome in temporomandibular disorders and parafunction; *(4)* presence of favorable residual ridge morphology and tongue position; and *(5)* no smoking. The project was approved by the ethical committee of the university, and informal consent was acquired from each patient. All subjects underwent complete physical examination, oral examination, and blood value determinations.

Construction of Prostheses and Measurement Plates

All complete dentures were made using similar techniques. Final impressions were made with zinc oxide eugenol (Cavex Outline, Cavex), and bilaterally balanced occlusal schemes were provided using semianatomic acrylic resin posterior teeth (Major Dent). Processing consisted of a compression molding technique using an acrylic resin (Meliodent, Bayer). After the delivery of the dentures, the clinical problems caused by wearing new dentures (eg, pressure spots) were eliminated. The occlusion was carefully adjusted to ensure that centric relation and centric occlusion coincided and that occlusal contacts were even and nondeflective around the arch. Contacts in mandibular lateral excursions were removed. The retention, stability, esthetics, and polished surface contours were checked. The subjects were advised to wear their dentures throughout the study period, except for nocturnal removal. Ten of the dentures were then arbitrarily selected for a soft reline procedure in which a heat-polymerized silicone material (Molloplast-B, Molloplast Regneri) was used.[12]

The blood flow evaluation required the fabrication of hard acrylic resin plates that conformed to each denture's border to standardize the measurement points for each patient (Fig 1). Actual fit of the plates was achieved by using replicated original models marked with borderlines. Four bilateral measurement points were marked on the model in the regions of the canines and molars. Wires (5.5-mm length, 1.1-mm diameter) were set to permit placing the probe of the laser Doppler flowmeter (LDF; Periflux 4001, Master Perimed) at a 0.2-mm distance to mucosa. The wires were inserted into the standardized holes (1 mm deep) on the model. After insertion of the wires, dental wax plate was modeled to the tip of the wires at the denture border. The acrylic resin plate was prepared by a compression molding technique on a poured cast of each denture using an acrylic resin (Meliodent). Paying special attention to stopper points for the tip of the LDF probe, the plates were polished. The wires were moved so that the holes were ready made for the probe. The plates were carefully adjusted to the patient's mouth.

Measurement of Blood Flow

Laser Doppler Flowmeter measurements were used to determine blood flow in the underlying supporting tissue of each of the edentulous subjects prior to denture insertion and after 1 week, 1 month, 3 months, and 6 months of denture wearing. All tissues were allowed to rest for 15 minutes before measurement, and the test was explained to the patients during that time. Measurements were made between 10:00 AM and 12:00 PM, and special attention was given to room temperature and brightness. Each measurement plate was placed intraorally without any loading; then, the LDF probe was placed in the prepared holes and measurements were made.

Statistical Analysis

The data were compared for all groups using repeated-measures analysis of variance (ANOVA) and least significant difference (LSD) multiple comparison tests at a level of significance of .05.

Results

In the hard acrylic resin group, the mean blood flow to the mucosa after 1 week of wearing complete dentures

Table 1 Mean Blood Flow (mL/mg/min) to Mucosa Under Mandibular Complete Dentures with Hard Acrylic Resin Base and Soft Relining*

Group/ measuring region	Before wearing	After 1 wk	After 1 mo	After 3 mo	After 6 mo	*F* value
Hard acrylic resin base						
Canines (n = 20)	127.69 ± 56.28	90.16 ± 49.90	95.92 ± 52.08	117.54 ± 37.32	133.14 ± 73.64	7.17
Molars (n = 20)	120.33 ± 63.78	81.33 ± 54.14	90.37 ± 50.37	127.19 ± 52.74	152.86 ± 81.24	4.68
Soft relining						
Canines (n = 20)	160.86 ± 84.25	106.18 ± 50.33	101.93 ± 52.22	95.12 ± 41.84	91.02 ± 34.46	16.23
Molars (n = 20)	148.08 ± 69.19	103.03 ± 42.76	109.47 ± 41.93	102.58 ± 35.11	104.49 ± 41.50	5.90

*All P values $< .05$.

was significantly ($P < .05$) lower than that obtained before denture wearing in the measuring regions (Table 1). In the canine region, blood flow returned to almost normal levels 6 months after the beginning of complete denture wearing. However, in the molar region, higher blood flow levels were observed at the 6-month evaluation in comparison to initially recorded values.

After 1 week of wearing complete dentures with a soft lining, the mean blood flow to the mucosa was significantly ($P < .05$) lower than that obtained before denture insertion (Table 1). At the 6-month evaluation, the blood flow did not return to predenture wearing levels, contrary to the hard acrylic resin base group.

Discussion

Denture-supporting tissues atrophy as a patient ages, and complete denture fabrication per se may even create high stress concentrations.[8,13] In fact, a heavily beaded area may cause partial or complete occlusion of veins and lymph vessels.[8] Presumably, the destruction of supporting structures may occur because of constant heavy pressure and interference with the vascular supply.[8,9] Consequently, it appears important to be able to determine whether hard acrylic resin base and soft lined dentures interfere with the blood supply to supporting tissue underlying dentures.

Investigation of the changes in microcirculation is one of the measures to evaluate the changes in mucosa underlying dentures. The LDF is a noninvasive and highly reproducible device to determine blood flow. The output from the tip of the probe is not harmful to the human body,[10] and the instrument can be standardized to obtain measurements while the probe of the LDF is settled on repeatable experimental points within an acrylic resin baseplate.

In the hard acrylic resin base group, the mean blood flow to the mucosa after 1 week of wearing complete dentures was significantly lower than that obtained before denture wear in the measuring regions. Atasever et al[9] report that mean blood flow (18.9 ± 7.1 mL/100 mg/min) was reduced after 1 week of denture wearing (10.6 ± 4.5 mL/100 mg/min) using 133 Xe clearance. Our results endorse their findings and showed that denture wearing hindered blood supply to mucosal areas under the denture selected for measurements. However, the hindrance of blood supply was a reversible condition, as at the end of the 6-month observation period, the blood flow was significantly increased. Atasever et al[9] also report an increase in blood flow 40 days after wearing complete dentures. Xiao and Den[14] showed that while mucosal blood flow and blood cell velocity of maxillary anterior alveolar ridge crest decrease significantly after 7 days of denture wear, blood flow and cell velocity almost recover to the levels recorded before wearing dentures within 2 weeks. The recovery observed in our findings occured at the 6-month measurement stage for the hard polymerized group and may be explained by occlusal adjustment over the wearing period and by not wearing the complete dentures at night. Our initial findings conform to previous ones showing that pressure from repeated occlusal forces creates vascular changes and inflammation; consequently, the blood flow increases in that region of the denture-underlying mucosa.[5,8,15–17] In the present study, the increased blood flow in the mandibular molar region, which has a particularly narrow supporting area, may be explained by inflammation caused by repeated heavy pressure and interference with the vascular supply.

In the soft relined group, the mean values found at the 6-month evaluation revealed that blood flow levels did not return to those recorded before denture insertion and were virtually unchanged from the 1-week measurements. These findings suggest that the hindrance of blood supply may be an irreversible condition. However, in the hard denture base group, the blood flow was significantly increased after 6 months of wearing the dentures. It has also been reported that after soft liner insertion, mean maximum biting force increases by one-third and mean masticatory performance improves by one-fourth.[13] In addition, the stress intensity at functional force-bearing areas decreases

when a soft denture liner is used; however, the stresses in the bone increase remarkably up to 3 seconds after loading.[5] Because of the time-dependent effect of stresses applied to soft denture liners and increased mean maximum biting force and masticatory performance, the blood flow to mucosa would not return to values recorded before the original denture insertion. The soft denture liner reduces the height of the peak stress and acts as a stress distributor, wherein force can be diverted more evenly to other locations in the supporting structures.[3,5,13] As a result, soft denture liners are reported to improve the comfort of complete dentures and enable patients to chew their food for a longer duration. It has also been reported that the duration of tissue loading is significant because light loads of long duration would deform tissues more than would heavy loads of short duration.[8] Akazawa and Sakurai[10] report that continuous clenching delays the recovery of blood flow in the denture-underlying mucosa. In that region, incremental blood flow occurs after release of compression. When continuous clenching happens frequently, the ischemia and incremental blood flow in the underlying mucosa are repeated.[10]

These studies support our preliminary findings that the blood flow to mucosa is decreased after wearing soft relined dentures. It is tempting to hypothesize that in the induced circulatory disorder, metabolites may appear in the underlying mucosa, with additional osteoclastic bone resorption observed because of interference with vascular supply following denture insertion.[1,10] Mori et al[18] showed that continuous pressure to the palatal mucosa for 3 days to 20 weeks compresses a denture's underlying mucosa, with associated evidence of degenerated epithelial tissue and bone resorption. Those authors also demonstrated histologically that even light long-term clenching is harmful to the mucosa underlying a complete denture.

Conclusions

Laser Doppler flowmetry can be used to study the effect of differences in hard acrylic resin base and soft relined ones on the blood flow to the denture's underlying mucosa. The following conclusions may be drawn within the limitations of this preliminary study:

1. Blood flow in the underlying mandibular denture mucosa was influenced by denture wearing.
2. Hindrance of blood supply under a hard acrylic resin base is a reversible condition, as after a 6-month wearing period, blood flow returned to almost pretreatment levels.
3. Soft lined dentures appeared to hinder the blood supply to the denture-supporting tissue, with an increased risk of time-dependent and adverse tissue change.

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