PULPAL BLOOD FLOW CHANGES IN ABUTMENT TEETH OF REMOVABLE PARTIAL DENTURES

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Abstract

The purpose of this study was to investigate the effect of tooth supported (TSD) and tooth-tissue supported (TTSD) removable partial denture wearing on pulpal blood flow (PBF) of the abutment teeth by using Laser Doppler Flowmeter (LDF).
Measurements were carried out on 60 teeth of 28 patients (28 teeth and 12 patients of TTSD group, 32 teeth and 16 patients of TSD group) who had not worn any type of removable partial dentures before, had no systemic problems and were non smokers. PBF values were recorded by LDF before insertion (day 0) and after insertion of dentures at day 1, day 7 and day 30. Statistical analysis was performed by student t test and covariance analyses of repeated measurements.
In the group TTSD, the mean values of PBF decreased statistically significantly at day 1 after insertion when compared with PBF values before insertion ($p<0,01$). There was no statistically significant difference among PBF mean values on 1st, 7th and 30th day. However, in the group TSD, there was no statistically significant difference among PBF mean values before insertion and on 1st, 7th and 30th day. In other words, PBF mean values in group TSD continued without changing statistically significant on 1st, 7th and 30th day.
TTSD wearing may show negative effect on the abutment teeth due to decreasing basal PBF.

KEY WORDS: pulpal blood flow, abutment teeth, Laser Doppler Flowmeter.

Introduction

There are two basic types of partial dentures for partially edentulous arch; a) tooth supported removable partial dentures (TSD) and b) tooth tissue supported removable partial dentures (TTSD). The TSDs are self-explanatory in that the forces in function are borne primarily by the remaining natural teeth, which in turn transmit these forces to the periodontal ligament and to the bone structure for support. Cast circumferential clasps are ideally suited for TSD because of the potential for excellent retention and reciprocation. However, circumferential clasps are not usually indicated for TTSD because the retentive tip lies forward of the axis of rotation and has the potential for applying torquing forces to the abutment. In TTSD functional forces applied to the denture base causes its movement towards the tissue. This movement is the result of a rotation movement of the RPD bases around an axis connecting the most distal abutment teeth (1- 3). The rotation can also cause torquing forces to act on the clasped abutment teeth. Stress-releasing clasp designs overcome these effects. RPI, RPA, RPL clasp systems are available systems in TTSD. The RPI is one of these designs (4). The major attributes of infrabulge retainers are their potential for disengaging during functional movements of TTSD.

Understanding any changes, which may occur in the abutment teeth through the wear of TSD and TTSD, is an important process. Since the abutment teeth are exposed to functional forces, one of the measurements to catch change in the abutment teeth is the investigation of pulpal blood flow changes (PBF). The laser Doppler flowmeter (LDF) evaluates dynamic changes in blood flow through noninvasive measurement methods (5,6) by detecting blood cell movement in a small volume of tissue (approximately 1 mm3). The flow in individual microvessels, the number of vessels with active flow, and the vessel diameter cannot be analyzed (7), but total flow can be monitored throughout the tissue. Its use in human teeth was first described by Gazelius et al (8). Distal extension situations, in which no posterior abutments remain, require an entirely different partial denture design than does one in which total abutment support is available. In these situations the greater torque and tipping leverages that the distal extension partial denture will impose on the abutment teeth must be taken into consideration (9). Sufficient differences exist between the TSD and TTSD to justify a distinction between them. While in TSD functional forces are received by teeth, periodontal ligament and the bone structure in TTSD functional forces are received also by the mucosa that covers the bone. So there may be different force distribution in TSD's and TTSD's abutment teeth. This situation may affect the PBF of abutment teeth. However, to date, no study has evaluated the PBF changes in abutment teeth of removable partial dentures. In this prospective clinical study, the purpose is to investigate the effect of TSD and TTSD wearing on the PBF of the abutment teeth by using LDF.

Materials and Methods

This study was performed on 60 healthy abutment teeth (maxiller incisors, canines, premolars) in 28 patients who had not worn any type of removable partial dentures previously. Patients had no systemic problems and were non smokers. The patients were chosen, whose teeth did not need recontouring and preparation for guide surfaces and minor connectors, in order not to affect the PBF of the abutment teeth. Radiographic and clinical (percussion, palpation and mobility tests) examination and electrical pulp stimulation confirmed that the abutment teeth were vital and healthy. Prior to measurement, the purpose and method of the measurement was explained to each participant and written informed consent was obtained. Eighteen patients were planned to be TTSD (28 teeth) (group TTSD) and 10 patients to be TSD (32 teeth) (group TSD) wearers. Measurements were made only on maxiller incisors, canines and premolars. The removable partial dentures in all the patients were planned by the same dentist and the same techniques were used to obtain optimum conditions on abutment teeth (functional impressions, maximum mucosal surface coverage, rigid major connectors, reduction in occlusal surfaces of denture teeth, balanced occlusion, etc.). I bar clasp in TTSDs as an infrabulge retainer and circumferential clasp in TSDs as a suprabulge retainer was used. To minimize the effect of extrapulpal factors on LDF measurements, the teeth were examined by the same investigator under standardized environmental conditions. Blood flow recordings were made from the teeth with a LDF monitor (Periflux 5010 LDFM Unit; Perimed AB, Järfälla, Sweden) which uses infrared light. The instrument's dental probe was 25 mm in length and 1,6 mm in diameter. The probe was fixed to each tooth with a clip-on splint that covered the crown of the abutment teeth. The splint was constructed from self curing acrylic resin (Orthocryl E Q, Dentaurum, Germany) on a plaster model of the teeth. The probe tip was inserted into a stainless-steel tube that was incorporated into the splint over the central long axis of the crown of the tooth, perpendicular to the enamel surface and with its centre 2 mm from the gingival margin. The alignment of the probe around its long axis was kept constant between trials by aligning marks on the probe and the tube. This precaution was necessary to ensure that reproducible results were obtained under each of the experimental conditions. Before the measurements an opaque, black rubber dam (Four D Rubber Co. Ltd., Heanor, England) is applied to the teeth and removed at each step. At each stage, the blood flow signal was allowed to stabilize for several minutes before the measurements were made, then the effect on the signal of covering the gingival and surrounding soft tissue with opaque rubber dam was determined. At each measurement, blood-flow data were collected for 10 seconds at each tooth. Changes of PBF of the abutment teeth were recorded before insertion of dentures and 1, 7 and 30 days after insertion. The means of the perfusion units (PU) are installed to a software (Perisoft version 5.1, Gastrosoft Inc, Perimed AB, Järfälla, Sweden) and calculated. The statistical analyses were performed using Student t test and covariance analysis with Bonferroni correction within the SPSS (13.00 for Windows) program. The results were accepted to be significant when p< 0,05.

Results

The mean ages of the group TTSD was 51,75±7,40 (min. 41, max. 63), and the mean ages of the group TSD was 53,34±6,25 (min. 43, max. 62). There were no statistically significant difference between the mean ages of two groups (p>0,05). There were no statistically significant difference between PBF mean values before the insertion of TTSD and TSD groups (p>0,05). However, there was statistically significant difference between PBF mean values at 1st day (p<0,05), 7th day (p<0,001) and 30th day (p<0,001) of the two groups. It was seen that the statistical significant difference between PBF mean values of the two groups began at day 1 and reached to maximum at day 7 and continued at about this level until day 30 (Table 1, Figure 1).

PBF measurement	Study groups		t-test for Equality of Means	
	TTSD (n=28) Mean±SD	TSD (n=32) Mean±SD	t	p
Before insertion	58,04±21,90	48,69±15,03	1,976	>0,05
Day 1	40,39±19,16	52,53±18,34	-2,962	<0,05
Day 7	34,14±13,36	49,03±16,38	-3,976	<0,001
Day 30	33,69±15,13	51,65±20,66	-7,304	<0,001

TABLE 1. Comparison of PBF mean values before insertion and at day 1 , at day 7 and at day 30 between the groups TTSD and TSD

PBF -Pulpal blood flow
TTSD -Tooth tissue supported denture
TSD -Tooth supported denture

PBF measurement times in the study groups	TTSD (n=32)		TSD (n=28)	
	Mean Difference	Sig,(a)	Mean Difference	Sig,(a)
Before insertion- Day 1	17,643	0,000	-3,844	NS
Before insertion – Day 7	23,893	0,000	-0,344	NS
Before insertion - Day 30	24,339	0,000	-2,969	NS
Day 1- Day 7	6,250	NS	3,500	NS
Day 1- Day 30	6,696	NS	0,875	NS
Day 7-Day 30	0,446	NS	-2,625	NS

TABLE 2. Comparison of the changes in the PBF values of different times in the study groups

Based on estimated marginal means

(a) Adjustment for multiple comparisons: Bonferroni,
(NS) Not significant

In comparing the repeated measurements by covariance analysis, PBF mean values in the group TTSD decreased statistically significantly at day 1 when compared with PBF values before insertion (p<0,01). There was no statistically significant difference between the PBF mean values at 1, 7 and 30 days. However, in the group TSD, there were no statistically significant difference among PBF mean values before insertion and at 1, 7 and 30 days. On the other words, PBF mean values in the group TSD continued without changing statistically significant at day 1, day 7 and day 30 (Table 2, Figure 1). Before the insertion of the dentures, the mean values of the PBF were not statistically different between the groups TTSD and TSD (p>0,05). However after the insertion of the dentures the difference of the mean values of the PBF between the two groups was seen to increase more and more in the measurements at day 1 (p<0,05), 7 (p<0,001) and 30 (p<0,001).

Discussion

There are no literature investigating the PBF of the abutment teeth of TSDs and TTSDs by using LDF. LDF measurements can be affected from extrapulpal factors such as room temperature, recent stimulants/drugs (tea, beta-blokers, etc.), posture (seated, semisupine, supine) or age (10,11). Because the pulps of human teeth decrease in size with age, blood flow records from young human teeth should include a larger pulpal component than those from teeth of

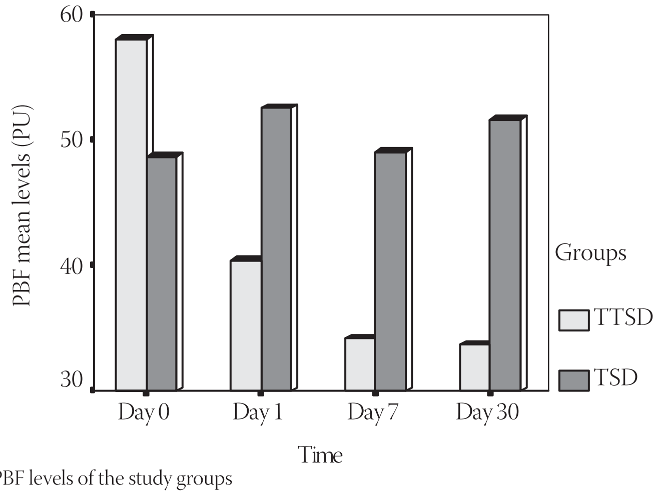

FIGURE 1. Changes in the PBF levels of the study groups

older individuals (11). The data reported in the present study was obtained from old persons aged 41-63 and there was no statistically significant difference between the mean ages of the two study groups (p>0,05).

LDFs are used extensively to monitor changes in blood flow in the skin and other organs. Their advantages are that they are non-invasive, simple to apply, and provide a continuous or near continuous record. Their principal disadvantage is that it is impossible to calibrate them in absolute units and their output may not be linearly related to blood flow (12). Although the measurement depth of LDF is 1mm, the PBF of a permanent teeth with enamel and dentin of 2-3,5 mm thickness can be measured (13). According to Yanpiset et al. (14), LDF is an improved method for the detection of revascularization of reimplanted teeth in dog. In their study, PBF measurements were made from dog incisors and premolars. In the present study, the measurements were made in human maxillary incisors, canines and premolars by LDF because of its validity. When using LDF (15), the tip of the probe must be in contact or very close to the tissue surface. If not, the reflected light from the surface of the reflection area will be received also by the optical fiber, and enlarge the fraction of no frequency changing scattered light. The results of the studies (15-17) show that the signal recorded from a tooth is reduced by up to 80% when gingival and surrounding tissues are covered with black rubber dam. This reduction can be accounted for by two effects of the dam; screening of light from periodontal, gingival and other surrounding tissues, and a reduction in gingival blood flow due to compression of the gingival tissue. Both will have reduced the amount of light picked up by the probe that had been scattered by blood flowing in non pulpal tissues (15). In the present study, we used also black rubber dam. The wavelength of the light will also affect the extent to which the signal is affected by tissues outside the tooth. This is because the light of long wavelength, such as infrared, penetrates into the tissues to a greater depth than the shorter wavelengths, such as red, and particularly green (15). In the present study infrared light was used because of the advantages of long wavelength. Akazawa et al. (18) investigated the influence of the continuous compression assumed as a result of light clenching on the blood flow of the denture underlying mucosa in TSD and TTSD wearers by using LDF. They reported that even if it is light, a continuous clenching results in ischemia and delays the recovery of blood flow in the mucosa underlying the denture after release of compression. Also Atasever et al (19) investigated the effect of wearing complete dentures on human palatal mucosal blood flow by 133Xe (xenon) clearance. They reported that wearing complete dentures hindered the blood supply of the palatal mucosa area. In the present study, the measurements were made at similar intervals with Atasever's (19) study; that is, before the insertion of the dentures on delivery day as control, and 1, 7 and 30 days after insertion. Atasever et al (19) evaluated the effect of wearing complete dentures on human palatal mucosal blood flow in four sessions; before the insertion of complete dentures, 7 and 40 days after the insertion of dentures and 24 h after the removal of dentures.

In TTSD, the abutment tooth is more at risk than that with TSD. TTSDs, in which no posterior abutments remain, require an entirely different partial denture design than does one in which total abutment support is available (9). While in TSD functional forces are being shared by the teeth which are placed at the anterior and posterior sides of the edentulous ridge, in TTSD, these forces are being shared by the mucosa lying on the edentulous ridge and also by the abutment teeth at the anterior of this edentulous ridge. The difference in compression of the periodontal membrane of the abutment tooth and the mucosa under the base means that all loads, even vertical ones, on the base are transmitted to the abutment tooth as torque (3). This compression difference may increase torquing forces as confirmed by the results of the present study. In this study it was found that the PBF of the abutment teeth in TTSDs reduced statistically significantly on the 1st day after insertion in respect to the initial values. This decrease continued on the 7th and 30th days but not statistically significantly different when compared to the 1st day measurements. This study shows that wearing of TTSDs continuously hindered the PBF. The hindrance of blood flow is not an irreversible condition however after 7 and 30 days the decrease of PBF values were not statistically significant (Table 2, Figure 1). This situation can be explained by removing the dentures from the mouth during night to allow the tissues and abutment teeth to rest and to allow the recovery of blood flow to the abutment teeth (1). Permanent effects of the lowering of PBF might, however, result from the wearing of dentures for long periods of time. On the other hand, wearing TSDs did not affect the PBF of the abutment teeth. This situation confirms that in TTSDs, mastication causes torquing forces on abutment teeth and these torquing forces may have a traumatic effect on the periapical tissues causing ischemia.

Conclusion

In the study it's observed that in TTSD group, the PBF decrease may not be enough to affect the vitality of the abutment teeth. It's necessary to perform studies with longer duration to clarify this subject.

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