Effects of Gingival Retraction Materials on Gingival Blood Flow

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Purpose: The effects of 2 chemical retraction agents on gingival blood flow and systemic blood pressure in subjects with healthy gingiva were investigated. ***Materials and Methods:*** Thirty volunteer dental students were selected for the study and randomly divided into 2 groups. Aluminium chloride–impregnated cord (right side) and nonimpregnated cord (left side) were placed in the gingival sulcus of group 1. Epinephrine–impregnated cord (right side) and nonimpregnated cord (left side) were placed in group 2. Blood flow in the retracted marginal gingiva was measured by laser Doppler flowmetry, and the systemic blood pressures of subjects were recorded before and after the retraction procedure. ***Results:*** A statistically significant decrease in blood flow was observed in group 2, but there was no significant change in gingival blood flow in group 1. A decrease in diastolic blood pressure of the subjects in group 2 was also observed. However, there was no significant change in blood pressure of the subjects in group 1. ***Conclusion:*** Gingival retraction affects gingival blood flow temporarily. Epinephrine-impregnated cords can be used safely in patients who have healthy gingiva, if patient stress and gingival trauma are avoided during cord placement. *Int J Prosthodont 2007;20:57–62.*

Chemical agent–impregnated retraction cords absorb gingival fluids in the gingival sulcus, and the chemical agents in the cords control hemorrhage and shrink the gingival tissues.[1–5] Various chemical agents such as epinephrine or aluminium chloride are used for this purpose.[6] Although lots of research has been done about the effects of these materials,[2,4,7,8] specific information about gingival microcirculation[9] and systemic blood pressure[10] change is limited.

Baab et al[11] and Fazekas et al[9] have suggested the use of laser Doppler flowmetry (LDF) to measure gingival blood flow. Moreover, Boutault et al[12] evaluated blood flow of the gingiva with LDF and indicated that it is a perfect instrument to evaluate gingival microvascular flow. This technique makes it possible to measure tissue blood flow continuously and noninvasively via an optic probe with a low-powered monochromatic laser beam.[13–16]

The purpose of this study was to determine the effects of different retraction materials on gingival blood flow and systemic blood pressure. Changes in blood flow over time were also investigated.

Materials and Methods

The study was performed at Cumhuriyet University Faculty of Dentistry, Department of Prosthodontics. The protocol was approved by the Ethics Committee of Cumhuriyet University, Faculty of Medicine. Student volunteers of the Faculty of Dentistry were informed about the experiment. The subjects received any preliminary required treatment from the staff of the Department of Periodontology and were approved as periodontally healthy. Only subjects who scored 0 according to the Löe-Sillness[17] Gingival Index were included in the study. The 30 students were divided into 2 groups of 15 members each. Aluminium chloride and epinephrine were used in groups 1 and 2, respectively. The age and gender distribution of the subjects are shown in Table 1.

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Table 1 Age (y) and Gender Distribution of the Subjects

Group	Age (mean ± SE)	Gender	
		Male	Female
Group 1	22.070 ± 0.36	12	3
Group 2	22.270 ± 0.37	9	6

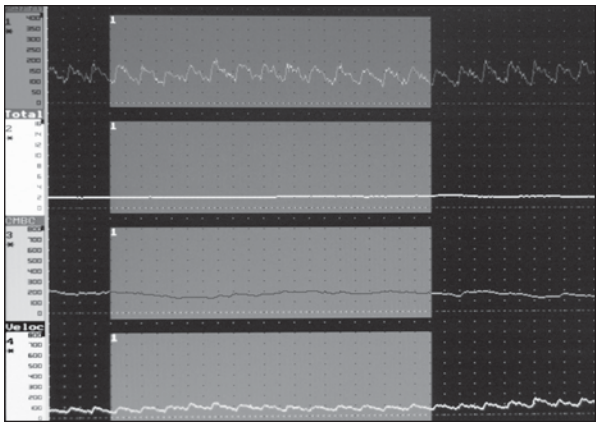

Fig 1 *(right)* Perfusion unit, total backscatter, concentration of moving blood cells, and velocity signals are shown. Perfusion unit and velocity signals were changing in accord with the changes in pulse. Records for at least 10 seconds of time were made.

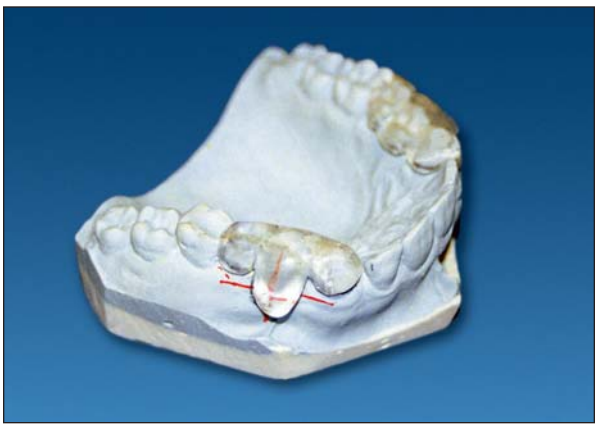

Fig 2 Probe holder on the cast.

In this study, an LDF (Periflux 4001 Master, Perimed) was used to measure gingival blood flow. The LDF emitted light with a 780-nm wavelength, the bandwidth was 20 Hz to 20 kHz, and probe output power was 1 mW. The diameter of the dental probe used was 1 mm. The LDF was calibrated before each measurement with the PF 1000 Calibration Device (Perimed) (zeroing was done automatically in this process). Data [perfusion unit (PU), concentration of moving blood cells (CMBC), velocity, and total backscatter (TB)] were monitored on a computer screen with Perisoft software (version 5.1, Gastrosoft). Because CMBC and TB signals were fixed, after the clinicians were sure that velocity and PU values were changing in accordance with the changes in pulse style, records for at least 10 seconds of time were made (Fig 1), and the average of the PU values was used as the measurement value.

Probe holders, made from transparent acrylic resin on the subjects' stone casts, were prepared to provide stability for the LDF's probe device (Fig 2). These probe holders were designed to avoid touching the soft tissues; they were supported only by the teeth, so that measurements would be more accurate. During the process, metallic wire suitable for the size of the LDF was placed in the middle of the mesiodistal side of the maxillary first premolar buccal marginal gingiva (both sides) on the casts. A thin layer (0.5 mm) of wax was placed to create a gingival relief. Acrylic resin (Vertex Orthoplast, Dentimex) was polymerized according to the manufacturer's instructions. The probe holders were ready to apply just after checking the subjects' mouths. All measurements for every subject were made in the same environment and in the same dental chair. All subjects had rested for at least 15 minutes before the gingival retraction process.

The left first premolar area was planned as the mechanical retraction area, and the right first premolar was planned to be the chemical retraction area. Thin knitted cord was used for retraction (No. 1, Roeko stay-put). In group 1, 0.1/1 g/mL aluminium chloride (Gingiva Liquid, Roeko) was used, and in group 2, 1/1,000 g/mL epinephrine (Adrenalin, Biofarma İlaç San ve Tic) was used. The retraction cord was placed carefully in the gingival sulcus with a mouth spatula to avoid damage to the gingival tissues. Retraction cords were kept in the gingival sulcus for 4 minutes. The measurements were all done in the marginal gingiva of the first premolars of the maxilla. LDF measurements were done just before placing the cords; just after removing the cords; at 4, 12, and 20 minutes after the cords were removed; and 24 hours after the cords removed. The systemic blood pressure of all subjects was also measured before placing and after removing the cords. Blood pressure measurement was performed indirectly on the forearm.

After data collection, means and standard deviations for each group were calculated with SPSS software (version 10.0, SPSS). The level of statistical significance was set at $P = .05$. The gathered data were evaluated by means of variant analysis, Tukey test, and Wilcoxon paired 2-sample test.

Table 2 Paired Comparison of Blood Flow on Both Sides

Time and side	Group 1 PU (mean ± SE)	*P*	Group 2 PU (mean ± SE)	*P*
Before cord placement				
Mechanical	119.79 ± 18.13	> .05	116.47 ± 16.10	> .05
Solution	118.07 ± 26.17		84.06 ± 11.47	
At cord removal				
Mechanical	209.62 ± 33.71	> .05	115.94 ± 17.84	< .05
Solution	163.76 ± 28.81		44.81 ± 7.49	
4 min later				
Mechanical	167.99 ± 30.18	> .05	133.30 ± 16.99	< .05
Solution	176.93 ± 45.11		29.67 ± 3.80	
12 min later				
Mechanical	163.63 ± 26.41	> .05	125.58 ± 17.75	< .05
Solution	147.39 ± 33.31		25.92 ± 2.66	
20 min later				
Mechanical	154.69 ± 22.97	> .05	127.09 ± 14.09	< .05
Solution	155.15 ± 26.19		25.06 ± 2.43	
24 hr later				
Mechanical	158.02 ± 29.37	> .05	163.73 ± 18.92	> .05
Solution	142.24 ± 21.61		139.31 ± 22.94	

PU = perfusion unit.

Table 3 Comparison of Blood Flow in Aluminium Chloride (Group 1) and Epinephrine (Group 2) Retraction Sites

Time	Group 1 PU (mean ± SE)	Group 2 PU (mean ± SE)	*P*
Before cord placement	118.07 ± 26.17	84.06 ± 11.47	> .05
At cord removal	163.76 ± 28.81	44.81 ± 7.49	< .05
4 min later	176.93 ± 45.11	29.67 ±3.80	< .05
12 min later	147.39 ± 33.31	25.92 ± 2.66	< .05
20 min later	155.15 ± 26.19	25.06 ± 2.43	< .05
24 hr later	142.24 ± 21.61	139.31 ± 22.94	> .05
	F = 0.78, *P* > .05	F = 23.18, *P* < .05	

PU = Perfusion unit.

Results

Blood flow values for the gingiva (means and differences between the groups) are summarized in Table 2. In group 1, the differences in values between sides obtained before the process; at the time of cord removal; 4, 12, and 20 minutes later; and 24 hours later were not statistically significant. However, for group 2, the differences were statistically significant ($P < .05$) (Table 3).

The differences in blood flow on the group 2 chemical retraction side, when compared as a paired conjunction, between the measurements obtained before the process and those obtained at all other periods were significant ($P < .05$), except for the 24-hour measurements ($P > .05$). At the moment of cord removal and after cord removal, the blood flow was decreased. However, the measured blood flow on the chemical retraction side at 24 hours after cord removal was higher than all the other measurements. When the values from the moment of cord removal and at 4, 12, and 20 minutes following cord removal were compared with the value at 24 hours as a pair, the differences were statistically significant ($P < .05$) (Table 2).

When the blood flow measurements of the area where chemical agent–impregnated cord was used for the subjects in groups 1 and 2 were compared in paired conjunctions, the differences between the measurements seen before retraction and 24 hours after cord removal were insignificant. On the other hand, the differences between other measurements were significant ($P < .05$) (Table 3).

The differences in blood flow values on the mechanical retraction sides were insignificant for both groups (Table 2). The difference was found to be insignificant when the right side and left side measurements were compared with each other in group 1. When the measurements in group 2 from just before retraction and at 24 hours after cord removal were compared, the differences were insignificant, although the differences among the other measurements were statistically significant ($P < .05$) (Table 2).

The blood pressure changes in the subjects in the group 1 were insignificant (Table 4). On the other hand, the decrease in diastolic blood pressure for group 2 members was significant ($P < .05$) (Table 4).

Table 4 Mean (± SE) Systolic and Diastolic Blood Pressure Values (mmHg) Before and After Gingival Retraction

	Group 1	*P*	Group 2	*P*
Systolic blood pressure before retraction	111.3 ± 3.8	> .05	104.7 ± 3.4	>.05
Systolic blood pressure after retraction	108.0 ± 3.3		103.3 ± 3.2	
Diastolic blood pressure before retraction	66.0 ± 2.5	>.05	64.7 ± 2.7	< .05
Diastolic blood pressure after retraction	64.7 ± 2.4		60.0 ± 2.6	

Discussion

One main problem in LDF is that blood flow decreases significantly with equipment probe pressure on the soft tissues during measurement. As a result, measurements taken on soft tissue will be erroneous.[18] This problem can be eliminated by avoidance of contact of the probe with soft tissues during measurement.[11,19,20] Therefore, the probe holders were prepared so that they could be supported by the teeth and would not touch the gingiva.

Watson et al[21] reported that there was a significant increase in pulpal blood flow during light exercise. For this reason, all the subjects in the present study rested for at least 15 minutes just before the measurements. Shimazaki et al[22] showed that a patient's position could affect blood flow. Therefore, all measurements were made using a stable dental chair so that the subjects would be in the same position.

Time-related measurements in microcirculation were carried out before cord placement, at the time of its removal, and after 4, 12, and 20 minutes. Any effect of retraction lasting for 20 minutes was regarded as clinically relevant from a prosthodontic perspective. An additional measurement was done after 24 hours to assess whether permanent change in the microcirculation had occurred.

Vasoconstrictor agents activate sympathetic $\alpha 1$ receptors, which are present in the peripheral veins. As a result, local vasoconstriction occurs, the blood flow in the area decreases, and then ischemia occurs in the tissues. Local vasoconstriction turn results in transitory gingival shrinkage. Epinephrine, used here as a vasoconstrictor and a substance that is widely used in dentistry, can be used in gingival retraction cords to control bleeding.[6,23] In this study, it was observed that there was a significant decrease in the blood flow of the gingiva where epinephrine was applied. However, in the group in which aluminium chloride was used to control bleeding via the vasoconstrictor effect, no significant change was seen in the blood flow of the gingiva. This result indicated that the vasoconstrictor effect of aluminium chloride was less pronounced than that of epinephrine.[4,5]

Aluminium chloride is an astringent and a widely used agent.[5,6] It acts primarily by precipitation of protein and inhibition of transcapillary movement of plasma proteins.[5] It has relatively low cell permeability, and it acts generally as an irritant in moderate concentrations and is caustic in high concentrations.[5] It may cause local tissue damage in concentrations >10%.[6] The manufactured material used in the study contained 10% aluminium chloride. After gingival retraction, there were no signs or symptoms at the gingiva. There is no indication that aluminium chloride has any systemic manifestations; thus the discussion on systemic effects relates only to epinephrine.[5]

Bowles et al[2] showed that gingival sulcus widths were not much different from each other in retraction performed with epinephrine and aluminium chloride. Moreover, epinephrine usage is more advantageous than aluminium chloride, except for patients with cardiovascular disorders, because it controls bleeding better.

Epinephrine has a vasoconstrictor effect in veins, and experts warn that it should be used very carefully in cardiac patients, because it increases systolic blood pressure and pulse.[1,6,24,25] Some experts suggest that epinephrine should never be used in gingival tissue because of its systemic effects.[26] Aluminium chloride, on the other hand, does not have a systemic effect.

The systemic effects of epinephrine involve many organ systems, although the cardiovascular system is of greatest concern. Epinephrine acts as a potent myocardial stimulant that increases heart rate. It causes vasoconstriction in many vascular beds. These actions result in a rise in blood pressure that is proportional to the dose.[5] The maximum recommended dose for a cardiac patient is 0.04 mg of epinephrine, the amount contained in approximately 2 carpules of local anesthetic of a 1/100,000 dilution. Epinephrine-

impregnated retraction cord contains 0.2 to 1 mg of racemic epinephrine per inch of cord, depending on diameter and brand. One inch of cord with 1 mg of racemic epinephrine contains 2.5 times the maximal dose for healthy patients and more than 12 times the recommended dose for cardiac patients. Therefore, the epinephrine in gingival retraction cord is a potential source of overdose.[5] Kellam et al[24] observed in their practice that 64% to 94% of the epinephrine in cords placed in the gingival sulcus was absorbed by the gingiva.

Studies in the dog concerning tolerance showed spectacular rises in heart rate and blood pressure after cords were placed. The plasmatic rate of epinephrine in one patient ranged from 15 pg/mL to 316 pg/mL after placing cords—and this without a hemodynamic effect. Houston and Coll took interest in the possible hemodynamic effects of these cords. Their results relate to blood pressure and heart rate at various times during impression-taking. They show negligible hemodynamic variations.[27]

The effects of epinephrine-impregnated gingival retraction cord in hypertensive patients have not been reported. However, several studies have reported the effect of retraction cord in normotensive patients. In general, mean effects on blood pressure and heart rate were minimal.[28] Pelzner et al[10] stated that the pulse of patients after application of racemic epinephrine–impregnated retraction cords depended more on the patient's level of anxiety and stress than on the levels of epinephrine.

Some research highlights a significant difference in systemic absorption according to whether the gingival epithelium is intact or whether active gingivitis is present. It is believed that an intact crevicular epithelium constitutes an effective barrier against the plasmatic passage of epinephrine.[10,27]

We observed slight decreases in systolic and diastolic blood pressure in both groups (epinephrine and aluminium chloride). However, the decrease in diastolic blood pressure was statistically significant only in the epinephrine group ($P < .05$). This may very well be a result of the fact that all subjects were informed about the process; their stress levels were very low; the process itself was not disturbing; all subjects were healthy, young, and relaxed in the dental chair; and their gingival tissues were not abused.

The observation that there was a slight decrease rather than an increase in blood pressure suggests that the transfer of a large quantity of epinephrine from healthy gingiva to the systemic circulation was minimal and unlikely to lead to a systemic effect. This confirms the observations of Shillingburg et al[1] regarding the production of minimal physiologic changes associated with epinephrine-impregnated cord.

Conclusion

The effect of retraction on the blood flow in the gingiva was evaluated during different measurement periods in selected areas. The following conclusions may be drawn:

1. Gingival blood flow was affected by the retraction procedure. Epinephrine-impregnated retraction cord decreased gingival blood flow. The maximum decrease was observed 20 minutes after removal of the retraction cord.
2. The effect of gingival retraction on gingival blood flow is reversible.
3. Epinephrine-impregnated cords can be used safely in healthy patients who have healthy gingiva, if patient stress and gingival trauma are avoided during cord placement.

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Literature Abstract

Effect of casting procedures on screw loosening in UCLA-type abutments

The study evaluated the effect of casting procedures on the loss of applied torque (detorque) on cast abutments (premachined cast abutments and plastic cast abutments) compared to those of machined titanium abutments. Forty-eight external hexagonal implants (Brånemark clone; 3.75 mm in diameter) and 48 abutments divided into 4 groups (12 samples each), including machined abutments, premachined palladium abutments (cast with palladium), and plastic abutments (cast with Ni-Cr or Co-Cr alloys), were selected. Titanium abutment screws were used. Abutments in casting groups were waxed to the same dimension as the abutments from the machined abutment group. After casting, titanium screws were tightened to 30 Ncm according to the manufacturer's instruction using a calibrated torque gauge. After 3 minutes, the screws were loosened and the torque required to loosen the screw was recorded. This procedure was repeated 3 times for each sample. Precasting values were recorded for the premachined palladium abutments to provide baseline values prior to casting. Precasting values were not possible in the other 2 casting groups. One-way ANOVA and Tukey LSD test were used, and a paired *t* test was used to evaluate detorque values for premachined palladium abutments before and after casting. The results showed that machined titanium abutments retained a significantly greater percentage of torque (mean detorque value: 92.3 ± 2.9%) when compared to all cast groups ($P < .005$). No differences were found when comparing cast groups. There were statistically significant differences between detorque values for premachined palladium abutments evaluated before and after casting. The possible causes were the presence of some irregularities on the contact surfaces of cast abutments from plastic abutments or premachined abutments or changes of material properties of metal components during casting. Further clinical studies are needed to establish the clinical relevance. From this study, machined titanium abutments, with the specific implant system, retained a significantly greater percentage of the 30 Ncm applied torque than cast abutments, and there was no significant difference in detorque values among cast abutments. However, the fitness between the abutments and implant platforms before and after casting was not reported, nor was the effect of fatigue simulated during the screw loosening.

Kano SC, Binon P, Bofante G, Curtis DA. *J Prosthodont* 2006;15:77–81. **References:** 19. **Correspondence to:** Stefania Kano, Department of Prosthodontics, Bauru School of Dentistry-USP, Al. Otavio Pinheiro Brizola 9-75, Bauru SP 17012-901, Brazil. E-mail: stekano@uol.com.br—*Huong Nguyen, Singapore*