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Gingival blood flow changes following periodontal access flap surgery using laser Doppler flowmetry

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Abstract

Aim: To investigate the pattern of gingival blood flow changes following periodontal access flap surgery by laser Doppler flowmetry (LDF).

Material and methods: Fourteen patients with chronic periodontitis presenting upper anterior sites with pocket depth $\geqslant 5$ mm after initial treatment were included in the study. Periodontal access flap surgery was performed on the experimental areas and LDF recordings were taken at baseline, following anaesthesia, immediately postoperatively and on days 1, 2, 3, 4, 7, 15, 30 and 60 of healing, at nine predetermined sites per flap.

Results: Significant ischaemia was observed at all flap sites following anaesthesia and immediately postoperatively. At the alveolar mucosal sites, a peak increase of the gingival blood flow was observed on postoperative day 1 ($p < 0.001$), which persisted until day 7 ($p = 0.012$) and resolved by day 15. The mucosal sites close to the flap periphery presented higher blood perfusion compared with the sites located centrally in the flap. The microcirculatory perfusion of the buccal and palatal papillae was maximum on postoperative day 7 ($p = 0.013$ and < 0.001, respectively) and returned to baseline by day 15.

Conclusion: Topographically distinct areas of the periodontal access flap consistently present different patterns of microvascular blood flow alterations during the wound-healing period.

Key words: blood flow; laser Doppler flowmetry; periodontal flap surgery; wound healing

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Periodontal access flaps are commonly used in surgical periodontal treatment in order to gain access for professional scaling and root planing (Wennström et al. 2003). It is well known that, during the early-healing period, the blood reperfusion of the flap is a critical determinant in achieving optimal wound healing and avoiding partial flap necrosis, especially in areas located distally from the flap basis (Grace 1994). Post-operative reperfusion of the flap ultimately depends on the preservation of the microcirculatory inflow, which will supply oxygen and nutrients to the wound area (Carroll & Esclamado 2000). In the early post-operative days, newly formed blood vessels in the provisional granulation tissue will re-establish the microvascular network in the connective tissue and supply nutrients and oxygen to the wound area (Folkman & Shing 1992).

The blood supply of human gingivae is not homogenous and main gingival vessels may be severed and the blood flow of the wound area disrupted following flap incision and elevation (Donos et al. 2005). Furthermore, in animal experiments, it has been demonstrated that the simple act of raising a mucoperiosteal flap initiates significant vascular trauma (McLean et al. 1995). This is in agreement with other investigations in animals, where it was shown

Conflict of interest and source of funding statement

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that the rate of healing may vary among closely adjacent locations in the oral tissues (Selvig & Torabinejad 1996).

The laser Doppler flowmetry (LDF) technique provides non-invasive means for monitoring tissue blood perfusion. It has been widely used in the field of plastic surgery for monitoring the microvascular blood flow in skin transplants and flaps, in order to detect early signs of impaired circulation and thus predict and possibly prevent surgical complications (Svensson et al. 1985, Yuen & Feng 2000). In the field of dentistry, the LDF has been used, among other applications, in order to evaluate the gingival blood flow variations related to periodontal disease (Baab et al. 1986) and smoking (Meekin et al. 2000, Mavropoulos et al. 2003), as well as following periosteal stimulation (Ambrosini et al. 2002) and LeFort I osteotomy (Justus et al. 2001). The results of a recent pilot study from our team have indicated that LDF presents clinical applicability in order to assess the gingival blood flow changes following Modified Widman Flap procedure (Donos et al. 2005).

The aim of the present study was to evaluate the gingival blood flow changes of the alveolar mucosa and the buccal and palatal inter-dental papillae, during the healing period following periodontal access flap surgery, in patients with chronic periodontal disease.

Material and Methods

Subject population

Fourteen patients referred to the Department of Periodontology, Eastman Dental Institute for the treatment of chronic generalized periodontitis participated in the study (six males, eight females, mean age 48.7 ± 6.5 years). Further inclusion criteria were as follows:

- presence of at least one site with probing pocket depth of 5 mm or more and bleeding on probing in anterior or premolar teeth at the re-evaluation appointment 3 months following completion of the initial periodontal treatment;
- good systemic health;
- age between 35 and 65 years;
- lack of previous treatment of periodontal disease;
- no systemic antibiotics intake for at least 6 months before the start of the study.

Signed informed consent was obtained from all subjects. The study was approved by the Eastman Dental Institute and Hospital Joint Research and Ethics Committee.

Clinical measures

The following clinical parameters were assessed by the same calibrated examiner (M. R.) at the baseline visit and 2 months following the surgical procedure:

- percentage of total surfaces (four aspects per tooth) that revealed presence of plaque (FMPS);
- percentage of total surfaces (four aspects per tooth) that presented bleeding on probing from the base of the pocket (FMBS);
- pocket probing depth (PPD), gingival recession (REC) and clinical attachment level (CAL) in six aspects per tooth were recorded to the nearest millimetre with a standard manual periodontal probe (UNC15, Hu-Friedy, Chicago, IL, USA).

Surgical procedures and post-operative care

Local anaesthesia was performed buccally and palatally with delivery of 3.6 and 1.8 ml, respectively, of lidocaine 2% with epinephrine 1:80,000 (Xylocain; Astra, Söderlälje, Sweden). Periodontal access flap surgery was performed on the experimental area, with intra-sulcular incisions performed and preservation of buccal and palatal aspects of the papillae (Kirkland 1931). Vertical incisions were not included in the flap design. A full-thickness flap was raised and the exposed defects were carefully scaled and root planed using a combination of mechanical and hand instrumentation. The flap was then repositioned and single inter-dental sutures were placed employing resorbable 5.0 sutures (Vicryl, Ethicon, Germany). The patients were asked to refrain from oral hygiene for the first 7 days following the operation. The sutures were removed on the seventh day following the surgical procedure. The patients were instructed to rinse with 0.2% chlorhexidine digluconate twice per day throughout the 2 months follow-up period. The patients received professional tooth polishing at days 15, 30 and 60 following the operation.

LDF measurements

Equipment

The LDF technique is based on the Doppler principle. Specifically, a laser beam is emitted by an optical fibre to the tissue to be studied. The light hitting moving erythrocytes is scattered back in shifted frequency (Doppler effect) and is captured by one or more optical fibres. The light signals are then converted into electric signals and the resulting photocurrent is processed to provide a recording of the blood flow (Stern et al. 1977). Although the multiple scattering events that determine the propagation of light in tissue prevent absolute velocity measurements when used in vivo, relative blood flow measurements can be obtained. Therefore, the term used to describe blood flow is flux – a quantity proportional to the average speed of the blood cells and their concentration. This is expressed in arbitrary perfusion units (PU), which are linearly related to flux.

A commercially available laser Doppler flowmeter (5010 Periflux, Perimed, Jarfalla, Sweden) with wavelength 780 nm equipped with a standard probe (PF416 with outside diameter 1.0 mm and fibre separation 0.25 mm) was used for all measurements. The flowmeter time constant was 0.2 s, with an upper bandwidth at 20 kHz and lower bandwidth at 20 Hz. The instruments and fibre-optic probes were calibrated by means of the Perimed PF 1000 Motility Standard according to the manufacturers' specifications before each measurement.

The signals were recorded in arbitrary perfusion units and monitored using the Perisoft software (Version 2.10, Perimed AB).

LDF measurements

The LDF measurements in the experimental area were performed as described previously (Donos et al. 2005). Briefly, a 2 min. LDF recording was performed in each of nine selected measurement sites including:

- three sites located in the mucosal flap basis (one centrally located, one close to the mesial and one close to the distal flap edge);
- three buccal papillary sites, one at each of three adjacent inter-dental papillae included in the flap design (distal, centre and mesial) and;

- three corresponding palatal papillary sites.

The LDF measurements were performed on the day of the surgery owing to the injection of the local anaesthesia (baseline), 5 min. following local anaesthesia induction, immediately following completion of the surgical procedure and on post-operative days 1, 2, 3, 4, 7, 15, 30 and 60.

Standardization and reproducibility of the LDF recordings

The LDF measurements were performed with the tip of the fibre optic probe inserted into the holes of an individual acrylic stent prepared on dental casts as described previously (Donos et al. 2005). Thus, the LDF probe was placed at a standardized location perpendicularly to the tissues and at a distance of 0.5 mm from the gingivae and remained motionless during repetitive LDF measurements.

During all LDF measurements, the subjects were comfortably seated and relaxed in a standardized semi-reclined position on the same dental chair, in a quiet room with a constantly stable temperature.

All the LDF measurements were performed by the same previously calibrated examiner (M. R.). The reproducibility of the LDF measurements was tested owing to the start of the study on seven periodontally healthy volunteers to whom two sets of LDF measurements were performed at nine gingival areas. A paired samples *t*-test was performed and revealed no significant differences between the two sets of recordings.

Statistical analysis

All recording periods impaired by the artefacts caused by the relative motion of the probe were excluded. An average of the 2 min. period of each individual recording was calculated by the Perisoft computer program (Version 2.10, Perimed, Stockholm, Sweden). All values were transferred to the Microsoft Excel program for further calculations. Changes of blood flux values in the alveolar mucosa, palate and papillae were expressed as the difference (ΔPU) between the PU value at a specific site at a specific observation time point (PU_t) and the individual baseline value of the same site (PU_0):$\Delta PU = PU_t - PU_0$.

Descriptive statistics were performed using the SPSS statistical software (SPSS 11.0, Chicago, IL). The ΔPU values in the alveolar mucosa, palate and buccal papillae were analysed using the general linear model (GLM) univariate test, after verification of the assumptions of homogeneity of variance and normality of the residuals distribution. The observation time point and the position (mesial, middle, distal in the flap design) were modelled as fixed factors and the patient as a random factor with the ΔPU as the dependent variable. The Dunett two-sided *t*-test was used, in order to evaluate the differences between baseline and subsequent time points and between different positions in the flap design during the overall observation period. Data are presented as mean SE. The significance of the difference between baseline and 2-months post-therapy was evaluated with the paired samples *t*-test for PPD, REC and CAL and with the Wilcoxon signed-rank test for the percentage-based measures of FMPS and FMBS. Statistical significance was accepted at $p < 0.05$.

Results

LDF measurements

Alveolar mucosal areas

The GLM revealed a significant effect of the time point ($p < 0.001$) and the position ($p = 0.001$) on the ΔPU values recorded in the mucosal areas.

Overall, the blood flow decreased immediately following anaesthesia ($p < 0.001$) and remained at lower values, compared with baseline, also immediately following the surgical procedure ($p < 0.001$). On the first post-operative day, a prompt peak hyperaemic response was indicated by a sharp increase of the blood flow compared with baseline ($p < 0.001$). The PU values remained increased until the fourth post-operative day, but not significantly. On the seventh post-operative day, a significant increase was noted compared with baseline ($p = 0.012$). The perfusion values returned to baseline values by the 15th post-operative day (Fig. 1, Table 1).

The increase in blood flow post-operatively was overall higher at the mesial ($p = 0.001$) and the distal ($p = 0.005$) flap periphery, compared with the mucosal areas located centrally in the flap.

Buccal papillary areas

The GLM revealed a significant effect of the time point ($p < 0.001$) on the ΔPU values recorded at the buccal papillary areas.

Following anaesthesia, the gingival blood flow presented significantly decreased compared with baseline

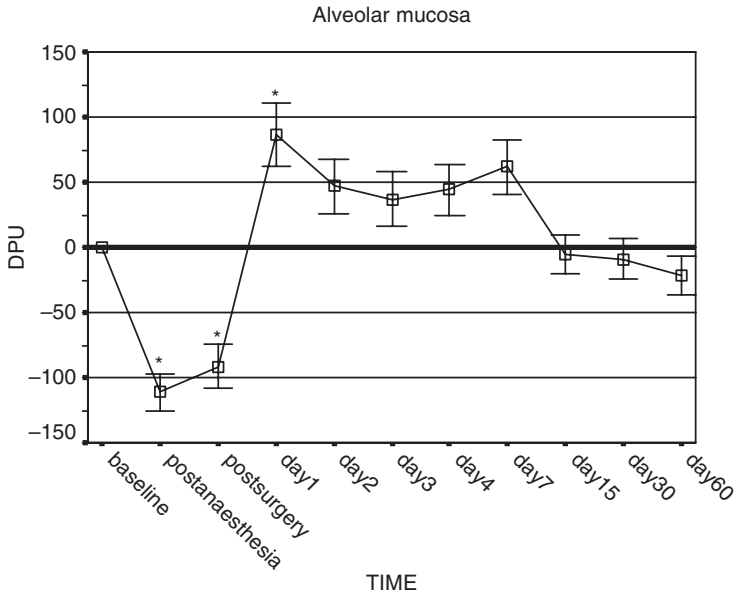

Fig. 1. Plot of the time course of the microvascular blood flux changes at the alveolar mucosal areas of the flap, expressed as difference in perfusion units from baseline (ΔPU). Plotted points include measurements taken pre-operatively (baseline), following anaesthesia, immediately post-operatively and on post-operative days 1, 2, 3, 4, 7, 15, 30 and 60. *Statistically significant differences in perfusion units from baseline (ΔPU). Error bars = SEM, ($p < 0.05$).

($p<0.001$) and remained significantly reduced immediately after the surgery ($p<0.001$). The perfusion values presented a significant increase on the seventh post-operative day ($p=0.013$). By the 15th post-operative day, the gingival blood flow changes had returned to baseline levels (Fig. 2, Table 2).

The effect of the position in the model was not significant for the buccal papillary sites.

Palatal papillary areas

The GLM revealed a significant effect of the time point ($p<0.001$) and the position ($p=0.005$) on the ΔPU values recorded on the palatal sites.

The gingival blood flow presented significantly decreased compared with baseline by following anaesthesia and remained significantly decreased immediately following surgery ($p<0.001$). During the first four post-operative days the palatal papillae presented an increase in the blood flow compared with baseline, which reached statistical significance on days 2 ($p=0.026$) and 4 ($p=0.01$). A maximum increase was observed on the seventh day following operation ($p<0.001$), whereas the perfusion values recorded at the palatal papillary areas of the flap had returned to baseline levels by the 30th post-operative day (Fig. 3, Table 3).

The distal palatal papillary sites at the flap periphery presented overall significantly higher increases in the perfusion values during the post-operative observation period than the mesial papillae ($p=0.005$) and the central papillae ($p=0.003$) included in the flap design.

Clinical outcomes

Healing was uneventful in all cases. Table 4 displays the full-mouth clinical variables and Table 5 displays the clinical variables at sites with baseline PPD $\geqslant 5$ mm recorded at baseline and 2 months, as well as the mean changes of clinical parameters between baseline and 2 months post-therapy. The mean PPD reduction was 2.7 ± 1.2 mm ($p<0.001$), the mean REC increase was 2.0 ± 0.1 mm ($p<0.001$) and the mean CAL gain was 0.7 ± 0.2 mm ($p<0.001$).

Discussion

The present study assessed the topographic and temporal pattern of the

Table 1. Temporal evolution of the microvascular blood flux values at the alveolar mucosal areas of the flap

	PU	ΔPU	*p*-value
Baseline	162.4 (15.87)	0 (0.0)	
Post-anaesthesia	51.4 (9.5)	− 111.0 (14.3)	0.000
Post-surgery	68.8 (12.4)	− 91.6 (17.0)	0.000
Day 1	248.5 (24.8)	86.2 (24.3)	0.000
Day 2	210.0 (21.4)	47.0 (21.2)	0.059
Day 3	198.9 (16.8)	36.5 (20.9)	0.135
Day 4	206.6 (20.0)	44.2 (19.3)	0.070
Day 7	223.9 (19.5)	61.6 (20.4)	0.012
Day 15	156.9 (14.1)	− 5.5 (14.9)	0.823
Day 30	153.5 (16.9)	− 8.9 (15.7)	0.717
Day 60	132.8 (20.0)	− 21.4 (15.3)	0.389

PU, perfusion units in absolute values at each time point; ΔPU, difference in perfusion units between the PU value at a specific site and the baseline PU value. Data presented in mean (standard error of mean). Univariate ANOVA with least significant differences test.

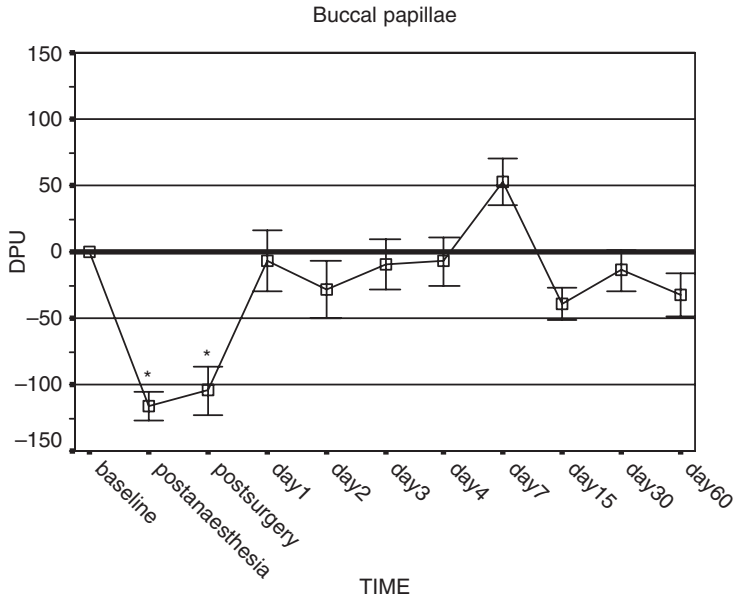

Fig. 2. Plot of the time course of the microvascular blood flux changes at the buccal papillary areas of the flap, expressed as difference in perfusion units from baseline (ΔPU). Plotted points include measurements taken pre-operatively (baseline), following anaesthesia, immediately post-operatively and on post-operative days 1, 2, 3, 4, 7, 15, 30 and 60. *Statistically significant differences in perfusion units from baseline (ΔPU). Error bars = SEM, ($p<0.05$).

Table 2. Temporal evolution of the microvascular blood flux values at the buccal papillary areas of the flap

	PU	ΔPU	*p*-value
Baseline	151.2 (12.4)	0.0	
Post-anaesthesia	34.6 (4.0)	− 116.6 (10.7)	0.000
Post-surgery	46.5 (12.4)	− 104.6 (18.1)	0.000
Day 1	144.7 (19.6)	− 6.5 (22.7)	0.758
Day 2	125.4 (19.7)	− 28.2 (21.2)	0.189
Day 3	141.9 (15.8)	− 9.3 (18.5)	0.659
Day 4	144.1 (14.6)	− 7.1 (18.3)	0.735
Day 7	203.8 (17.6)	52.6 (17.1)	0.013
Day 15	112.2 (11.1)	− 39.0 (12.1)	0.064
Day 30	137.1 (12.5)	− 14.1 (16.0)	0.501
Day 60	113.0 (12.7)	− 32.7 (16.4)	0.128

PU, perfusion units in absolute values at each time point; ΔPU, difference in perfusion units between the PU value at a specific site and the baseline PU value. Data presented in mean (standard error of mean). Univariate ANOVA with least significant differences test.

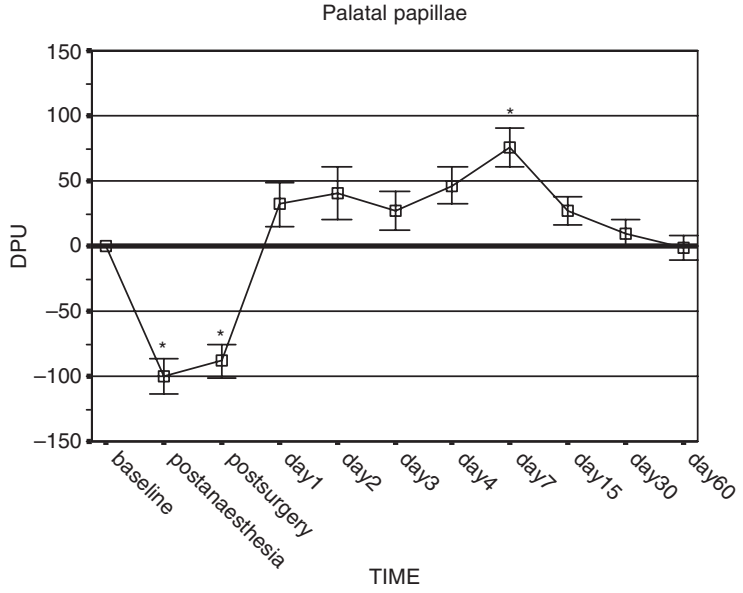

Fig. 3. Plot of the time course of the microvascular blood flux changes at the palatal papillary areas of the flap, expressed as difference in perfusion units from baseline (ΔPU). Plotted points include measurements taken preoperatively (baseline), following anaesthesia, immediately post-operatively and on post-operative days 1, 2, 3, 4, 7, 15, 30 and 60. *Statistically significant differences in perfusion units from baseline (ΔPU). Error bars = SEM, ($p < 0.05$).

Table 3. Temporal evolution of the microvascular blood flux values at the palatal papillary areas of the flap

	PU	ΔPU	*p*-value
Baseline	141.4 (10.4)	0	
Post-anaesthesia	41.4 (10.2)	− 100.0 (13.6)	0.000
Post-surgery	55.1 (8.7)	− 88.1 (12.8)	0.000
Day 1	173.7 (16.5)	32.2 (16.7)	0.073
Day 2	181.5 (19.0)	41.2 (20.2)	0.026
Day 3	168.9 (14.8)	27.5 (14.7)	0.126
Day 4	187.9 (15.6)	46.4 (14.1)	0.010
Day 7	217.0 (16.1)	75.5 (15.3)	0.000
Day 15	168.9 (13.4)	27.5 (11.0)	0.127
Day 30	151.4 (13.2)	9.9 (9.7)	0.580
Day 60	137.6 (9.5)	− 1.5 (9.0)	0.935

PU, perfusion units in absolute values at each time point; ΔPU, difference in perfusion units between the PU value at a specific site and the baseline PU value. Data presented in mean (standard error of mean). Univariate ANOVA with least significant differences test.

Table 4. Probing pocket depth, recession of gingival margin and clinical attachment level values at baseline, 2 months post-surgery and difference compared with baseline (Δ), at sites with initial PPD $\geqslant 5$ mm

Outcome variable	Baseline	2 months	Δ baseline 2 months	*p*-value
PPD	5.7 ± 0.1 (1.0)	3.0 ± 0.1 (1.1)	2.7 ± 0.2 (1.4)	<0.001
REC	1.4 ± 0.2 (1.3)	3.4 ± 0.2 (1.6)	− 2.0 ± 0.1 (1.0)	<0.001
CAL	7.1 ± 0.2 (1.6)	6.3 ± 0.2 (2.0)	0.7 ± 0.2 (1.5)	<0.001

PPD, probing pocket depth; REC, recession of the gingival margin; CAL, clinical attachment level. Data presented in mm; mean ± standard error (standard deviation). Student's *t*-test for paired observations.

haemodynamic changes of periodontal access flap surgery using LDF in patients with chronic periodontitis. The results indicate that the anatomically distinct mucosal and papillary areas, as well as sites with differential proximity to the mesial–distal and apical flap periphery, present variations in the microvascular blood flow responses during the early wound healing period. Furthermore, our observations indicate that the LDF technique may be a useful tool in order to evaluate the temporal course of the microvascular blood flow changes at different areas of the periodontal flap.The injection of local anaesthetic with vasoconstrictor induced a decrease in the microvascular blood flow by 66–75% compared with baseline in the alveolar mucosa and interdental papillae. Furthermore, the decrease in blood flux was similar in the buccal compared with the palatal intedental papillae, immediately after anaesthesia and following surgery. Therefore the different volume of the anaesthetic delivered may not account for the differences observed in the blood flux pattern during the first post-operative week. These results are in line with similar previous reports (Ketabi & Hirsch 1997, Ambrosini et al. 2002, Donos et al. 2005). Interestingly, the flap ischaemia induced by the injection of local anaesthetic with vasoconstrictor to the alveolar mucosa lasted for at least 2 hours, as evidenced by the significantly decreased perfusion observed following completion of the surgical procedure. Therefore, the periodontal access flap could be considered as an ischaemia-reperfusion flap model (Carroll & Esclamado 2000).

Post-operatively, the microvascular blood flow at the alveolar mucosal sites located at the periphery of the flap-mesially and distally-presented a peak increase of 82% above the presurgical baseline on the first day of healing. Furthermore, the microvascular blood flow remained increased during the first post-operative week. These results are in accordance with evidence showing increased blood perfusion in skin flaps during the first 4 post-operative days (Place et al. 1996). Furthermore, the current LDF observations are in line with previous data on the revascularization of the Modified Widman Flap operation, reporting that on the first post-operative day, the vascular network within mucoperiosteal flaps presents a hyperaemic response, which continues in both buccal and lingual flaps until the third day with simultaneous vascular proliferation of the blood clot in areas of close flap adaptation (Caffesse et al. 1981). This prompt hyperaemic response of the microcirculation could be attributed to the action of vasoregulatory factors at the flap periphery, inducing

Table 5. Full-mouth plaque scores and full-mouth bleeding on probing scores at baseline and 2 months after surgery

Outcome variable	Baseline	2-months	*p*-value
FMPS (%)	13.0 (8.5–23.7)	6.0 (2.0–16.0)	0.124
FMBS (%)	26.0 (16.5–32.0)	15.0 (7.0–27.0)	0.006

Data presented in percent: median (interquartile range). FMPS, full mouth plaque score; FMBS, full mouth bleeding score. Wilcoxon's signed-rank test.

vasodilation as the predominant microvascular response to a wound (Rendell et al. 2002).

The increased blood flow observed at the mucosal flap basis was also significant on post-operative day 7, where an average increase of the blood flow by 68% above baseline was observed. These results are in agreement with a previous report of increased gingival blood flux on the seventh day following periosteal stimulation (Ambrosini et al. 2002). However, no increase of the microvascular blood flow was noted at the central mucosal flap area. Taking into consideration that the periosteum of the alveolar mucosa has a dense network structure of arterioles, capillaries and venules (Nobuto et al. 1989), our results are in accordance with data from animal experimentation following creation of a wound at the paw, an area with high density of arterioles and venules (Rendell et al. 1998). The authors reported that on the seventh day of healing, the blood flux was moderately increased at the perimeter of the wound, due to the effect of vasoregulatory factors. However, in the wound central area, the blood perfusion levels were similar to baseline, presumably because the vascularization density of the newly formed granulation tissue would be high, but still similar to the presurgical levels for this naturally highly vascularized tissue. The LDF measurements at the alveolar mucosal areas returned to baseline levels by the 15th post-operative day, which is in line with reports of normal microvascularization by the 14th to 21st post-operative day following mucoperiosteal flap elevation in animals (Caffesse et al. 1981, Kon et al. 1984).

The blood flow at the buccal papillary areas during the first post-operative days remained at the presurgical baseline levels and an increase in blood flux of 55% over the baseline was observed on post-operative day 7. The free gingivae receive their blood supply from the gingivo-periosteal plexus and the periodontal ligament plexus, which are connected with the Volkman canals passing through the alveolar bone (Lindhe et al. 2003). When a full-thickness flap is elevated, this connection is severed. However, as the light of LDF penetrates the tissues variably to a depth of about 0.6 mm (Fullerton et al. 2002), it should be assumed that the LDF readings from the free gingivae of the papillae reflect blood perfusion changes of the supraperiosteal gingival plexus only, which is a coarse network structure consisting mainly of small arterioles and venules (Nobuto et al. 1989). In this context, our results, as well as our previous pilot data (Donos et al. 2005), are in line with data from animal experiments reporting a substantial increase of blood flow observed on the seventh day of healing in the centre of wounds created at sites perfused by small capillaries, similarly to the free gingivae (Rendell et al. 1998).

The increased blood perfusion of the buccal papillae observed on the seventh post-operative day may be associated with active angiogenesis, i.e. formation of new blood vasculature from preexisting vessels, which is known to occur at the newly formed, highly vascularized provisional granulation tissue during the wound healing process (Folkman & Shing 1992). This assumption is also supported from pertinent histological observations of the angiogenic process following elevation of a gingival mucoperiosteal flap (Nobuto et al. 2005a, b). The authors reported that the sprouting of new blood vessels from the periosteal vascular plexus begun on post-operative day 3 and that by post-operative days 5–7, marked angiogenesis was observed in the region in which the mucoperiosteal flap contacted the alveolar bone, i.e. in the adhering layer of new granulation tissue, whereas the periosteal vascular plexus was filled with newly developed sinusoidal blood vessels with increased maturity.

In the palatal papillary areas of the flap, a gradual increase of the blood flow was observed from the second post-operative day and, similarly to the buccal papillae, a peak increase of 79.6% above baseline was observed on day 7. The peak increase of the perfusion values observed on the seventh day could be again associated with the development of new, highly vascularized granulation tissue.

In conclusion, our study showed a significant regional variation in the temporal course of the capillary microcirculation response of a periodontal access flap. The LDF technique may be useful in depicting the dynamic nature of the periodontal flap blood perfusion and in testing the effect of periodontal flap design and management on the revascularization process.

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Clinical Relevance

Scientific rationale for the study: The successful outcome of periodontal surgery depends on the revascularization of the operated area.

Principal findings: The periodontal access flap represents an ischaemia-reperfusion surgical flap model. Furthermore, a significant hyperaemic response occurs at the mucosal flap periphery during the first postoperative days, which may be associated with adequate blood provision to the papillary areas located distantly from the flap mucosal basis.

Practical implications: The LDF technique may be a useful tool in depicting the dynamic nature of the periodontal flap blood perfusion.