

From:
The Institute of Dentistry
University of Turku, Finland

THE VASCULAR SUPPLY OF THE GINGIVA AND THE
ALVEOLAR MUCOSA IN THE RAT
II. SPONTANEOUS AND EXPERIMENTALLY INDUCED CHANGES
OF THE MICROCIRCULATION

by

MAUD KINDLOVÁ
ARJE SCHEININ

INTRODUCTION

The first part of this study dealt with the description of the method and with the morphology of the vascular supply of the gingiva and the alveolar mucosa associated with the rat incisor.

In the present communication changes that occurred spontaneously in the vascular supply of the gingiva and of the alveolar mucosa were followed. In addition, changes caused by experimental intervention in the vessels of the gingiva or of the alveolar mucosa were investigated.

MATERIAL AND METHOD

A full description of the vital microscopy method has been given in the first part of this study (*Kindlová & Scheinin, 1968*).

In the present study, spontaneously occurring traumata were followed in 90 Wistar rats. Ten rats of the same strain were additionally used for the observation of experimentally produced changes in the microcirculation of the enamel organ. In these rats the lower incisors were ground every third day, so that contact was lost with the opposing tooth for two weeks. The progress of changes in the vascular supply was examined each time the tooth was ground.

In 5 additional rats, a 6 % hydrogen peroxide solution was applied to the gingiva of the mandibular incisor. The subsequent changes in the blood flow were observed for a one-hour period.

The course of healing of the injured vascular bed was followed both in the gingiva and in the alveolar mucosa in 10 rats, trauma being produced by rapid diathermy coagulation.

The first step was to examine and photograph in each animal the portion destined for traumatization. The diathermy electrode was lightly pressed and fixed in turn to an arteriole, a venule and an area of the capillary net, by using a micromanipulator. Every stage of the experiment was photographed and healing was followed for a two-week period.

RESULTS

General

The most frequent changes observed in the gingival microcirculation were caused by slight traumatic incidents to the gingival margin such as often occur during the life of the rat. These were frequently due to hairs caught in the gingival sulcus around which plaque and food debris accumulated. Such plaques were mostly situated near the interdental papilla, they were minute and not very conspicuous. However, the gingival vascular supply became richer in their vicinity and occasionally the capillaries in such areas appeared coiled. In spite of these changes being slight, they had to be taken into account when studying the gingival microcirculation, since otherwise they could easily have been taken for the sequelae of experimental intervention.

Less often, though not rarely, the edge of the rat incisor was found broken off. The loss of occlusal contact which ensued produced a marked increase in the eruption rate of the fractured tooth. In such instances it was observed, that together with the erupting tooth, also its enamel organ and the supplying vascular bed became visible. This phenomenon was utilized to investigate the physiology of the vessels of the enamel organ and its relationship to the vessels of the gingiva.

Accelerated eruption

The experimentally induced accelerated eruption, produced by shortening of the incisor, was carried out in 10 animals. It was found that the vascular supply of the enamel organ erupted together with the tooth, and that it ceased to exist about 1.2 to 1.5 mm above the gingival margin (Fig. 1). The

vascular bed was formed by long afferent arterioles coursing parallel to the long axis of the tooth and branching off to both sides at right angles to form a dense capillary network. Blood circulated through almost the entire vascular bed and only at the incisal edge of the enamel organ had thrombosis occurred and the vessels together with the enamel organ had disappeared. The vascular supply of the gingiva was followed together with the vessels supplying the enamel organ. The acceleration of eruption failed to affect the vascular supply of the gingiva, either in its anatomical architecture or its blood supply.

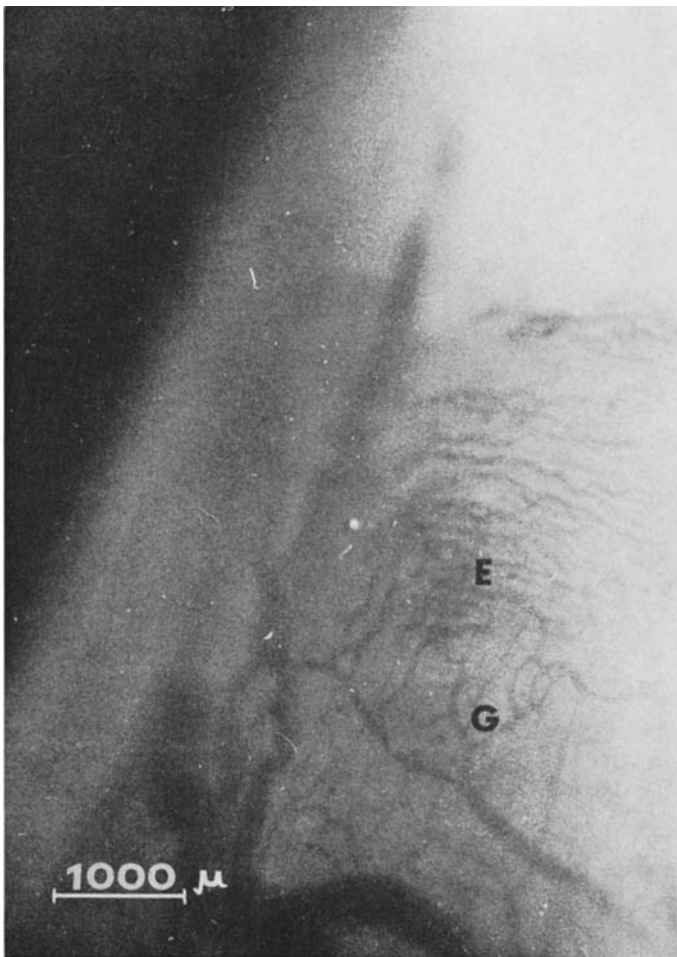


Fig. 1. Microcirculation in the gingiva (G) and in the enamel organ (E) in accelerated eruption. Exposure with electronic flash, duration 1/1000 sec.

Hydrogen peroxide

The effect of a topical application of hydrogen peroxide on the gingival microcirculation was tested as this is a common clinical procedure though the quantity of oxygen penetrating into the tissues and into the circulation is not known.

Immediately after the application of hydrogen peroxide, bubbles started to form within the tissue, these penetrating into the vessels in the first few seconds and promptly carried away by the blood flow. The spread of oxygen

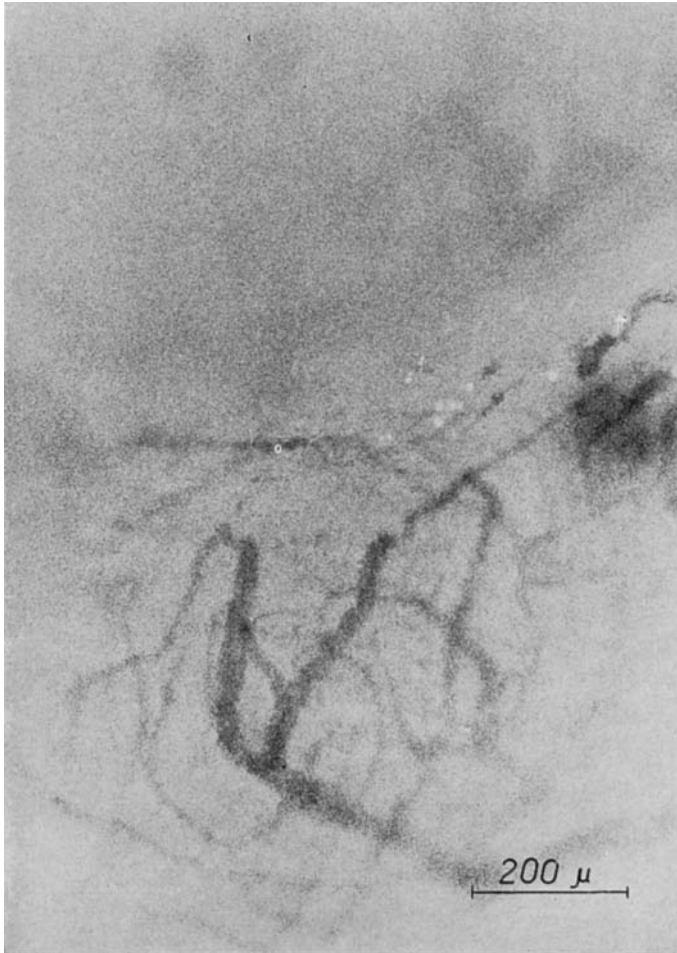


Fig. 2. Arrested gingival microcirculation following topical application of a 6% solution of hydrogen peroxide. Exposure as in Fig. 1.

through the tissue almost immediately resulted in stasis. In the H_2O_2 treated part of the gingiva, circulation ceased rapidly (Fig. 2). These changes reversed themselves slowly, a full restitution of the circulation occurred after 30 to 60 minutes, apparently in proportion to the amount of oxygen which had penetrated. During this period, the penetration of oxygen into the vessels was almost absent.



Fig. 3. A—D. Progress of healing in the microcirculation of the gingiva. Exposures as in Fig. 1.

A. —Prior to coagulation

Diathermy

The course of healing of the injured vascular bed was observed. The rate of restitution of the injured vasculature and the pattern of the newly formed blood supply were investigated with the object of finding out whether there were any differences between the gingiva and the alveolar mucosa with regard to these processes.

Following trauma by diathermy, the following results were obtained. In the center of the injured area there was a zone of coagulation of the entire

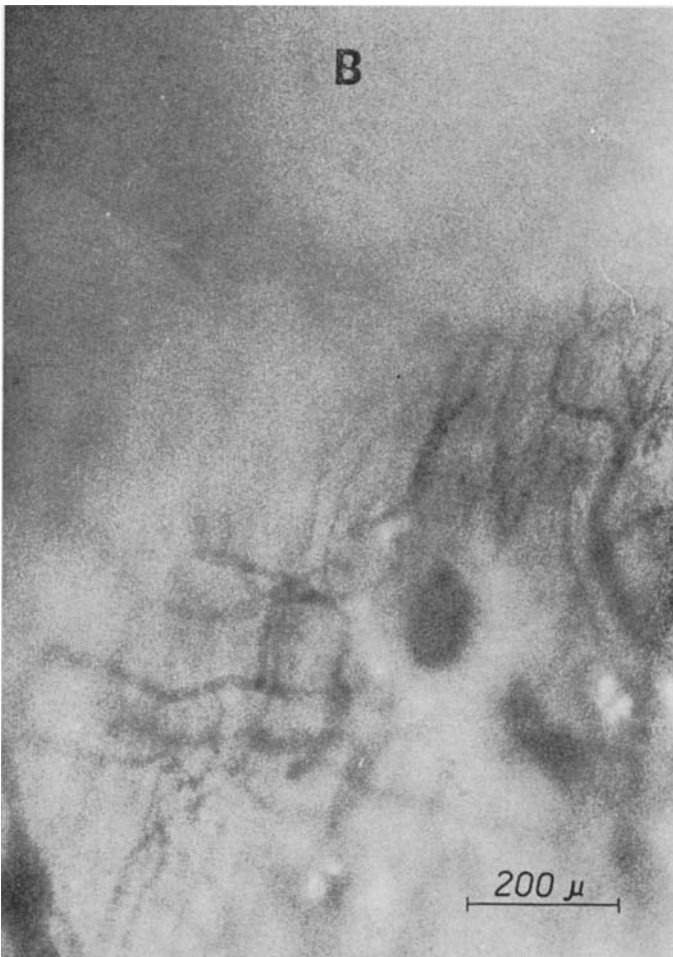


Fig. 3 B. —Immediately after coagulation

tissue including the vascular supply. In close vicinity to this zone the vessels became thrombosed though the circulation of the remainder of the tissue was intact. These defects healed within two weeks and were revascularized by vessels filled with circulating blood (Fig. 3A-D). The new vascular bed was formed by a network of large vessels resembling veins. The character of this network appeared similar whether it substituted a coagulated artery, vein or capillary. During the two weeks in which the healing was followed, no differences in healing patterns between the vascular supply of the gingiva and that of the alveolar mucosa became apparent.



Fig. 3 C. —3d day of healing

DISCUSSION

The most conspicuous characteristic of the gingival vascular supply in the mandibular rat incisor is its stability and nonvariability which is in distinct contrast to the dynamics of the changes in the vascular supply of the enamel organ. This physiological difference was far more pronounced due to the artificial acceleration of eruption so that many factors that would have escaped attention in normal eruption, were observed.

The vascular independence of these two vascular regions was evidently due to the permanent growth of the enamel organ, this conspicuous property



Fig. 3 D. — 2 weeks of healing.

was most probably a finding typical for this region because elsewhere the vessels of the gingiva and those of the periodontium were richly interconnected.

Further, it was ascertained that as a result of accelerated eruption there was a disproportion between the growth and the disappearance of the enamel organ which was elevated for about 1.5 mm above the margin of the gingiva, together with its vascular supply. It started to disappear only at this level and the mode of its disappearance suggested that the destroyed incisal part of the enamel organ was not removed by resorption, as is generally assumed, but due to slow desquamation into the oral cavity. As this process was continuous and as it entered the enamel part of the gingival crevice, it is possible that this relationship represents a protective function. This was confirmed by the finding that extrinsic noxious stimuli have no effect and their sequelae are absent in the area immediately adjacent to the margin of the gingival sulcus.

As the result of topical application of H_2O_2 there occurred in the treated area an arrest of circulation which caused a more significant change in the vascular supply than the mere penetration of oxygen bubbles. The arrest of circulation was of relatively long duration and since it is known from experience that weak H_2O_2 does not permanently damage the tissue, it may be argued that in the period of arrested circulation the tissue utilized the oxygen with which it was liberally pervaded.

There was no difference in the healing of the damaged vascular supply of the gingiva and of the alveolar mucosa. This indicated that both these areas possess identical powers of restitution.

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SUMMARY

The microcirculation in the gingiva and in the alveolar mucosa surrounding the mandibular incisor in the rat was studied in relation to the effects of naturally occurring and experimental trauma.

The most frequent change in the gingival microcirculation was due to slight trauma caused by hairs, plaque and food debris accumulated in the gingival sulcus. Relatively often loss of contact with the antagonist produced

an accelerated eruption of the fractured tooth. In such instances the enamel organ and the supplying vascular bed emerged together with the erupting tooth.

The experimentally induced effects comprised an acceleration of eruption, elicited by shortening of the incisor by grinding. It was found that the microcirculation of the enamel organ becomes visible at 1.2 to 1.5 mm above the gingival margin. The acceleration of eruption failed to affect the vascular supply of the gingiva. It was also observed that the emerging enamel organ was removed by desquamation into the oral cavity.

Application of 6 % hydrogen peroxide solution resulted in a spreading of oxygen bubbles through the soft tissue and in subsequent arrest of the circulation in the gingiva. A full restitution of the blood flow occurred, however, after 30 to 60 minutes.

The course of healing was studied in relation to traumatization produced with short-term diathermy. Healing occurred within a two-week period. The newly formed vascular bed resembled venules. The healing of the damaged microcirculation in the gingiva and in the alveolar mucosa was similar, suggesting an identical power of restitution.

RÉSUMÉ

VASCULARISATION DE LA GENCIVE ET DE LA MUQUEUSE ALVÉOLAIRE CHEZ LE RAT II. MODIFICATIONS SPONTANÉES ET PROVOQUÉES EXPÉRIMENTALEMENT DANS LA MICRO-CIRCULATION

La micro-circulation de la gencive et de la muqueuse alvéolaire autour de l'incisive inférieure du rat a été étudiée en ce qui concerne les effets de traumatismes naturels et expérimentaux.

Les modifications se produisaient le plus souvent dans la micro-circulation gingivale à la suite de légers traumatismes causés par l'accumulation de poils, de plaque et de débris alimentaires dans le sillon gingivo-dentaire. La perte de contact avec l'antagoniste produisait relativement souvent une accélération de l'éruption des dents fracturées. Dans ces cas, l'organe adamantin et le lit vasculaire correspondant montaient à la surface en même temps que la dent en éruption.

Les effets produits expérimentalement comprenaient une accélération de l'éruption, provoquée en raccourcissant l'incisive par meulage. La micro-circulation de l'organe adamantin devenait visible 1,2 à 1,5 mm au-dessus du rebord gingival. L'accélération de l'éruption n'affectait pas la vascularisa-

tion de la gencive. On observait aussi que l'organe adamantin venu à la surface était éliminé dans la cavité buccale par desquamation.

L'application d'une solution de peroxyde d'hydrogène à 6 % a résulté en une dispersion de bulles d'oxygène dans les tissus, ce qui arrêta la circulation dans la gencive. Le flux sanguin était cependant intégralement rétabli au bout de 30 à 60 minutes.

Le cours de la guérison a été étudié en ce qui concerne les traumatismes produits par diathermie de courte durée. La guérison s'est faite en moins de deux semaines. Le lit vasculaire nouvellement formé ressemblait à des veinules. La guérison se faisait de la même manière qu'il se soit agi de lésions de la micro-circulation dans la gencive ou dans la muqueuse alvéolaire, ce qui indiquerait une capacité de restitution identique.

ZUSAMMENFASSUNG

DIE BLUTVERSORGUNG DER GINGIVA UND DER ALVEOLARSCHLEIMHAUT IN DER RATTE

II. SPONTAN- UND EXPERIMENTELLE VERLETZUNGEN DER MIKROZIRKULATION

Die Mikrozirkulation in der Gingiva und in der alveolären Mukosa, die den Unterkieferschneidezahn in der Ratte umgeben, wurde in Bezug auf die Folgen von Spontan- und experimentellen Verletzungen verfolgt.

Die häufigsten Veränderungen in der gingivalen Mikrozirkulation entstanden auf Grund eines leichten Traumas, das durch Haare, Beläge und Nahrungsreste, die sich im Gingivalsulcus angehäuft hatten, verursacht wurde. Relativ häufig rief der Kontaktverlust mit dem Antagonisten einen beschleunigten Durchbruch des frakturierten Zahnes hervor. In diesen Fällen erschienen zusammen mit dem wachsenden Zahn auch das Schmelzorgan und das versorgende Gefäßbett an der Oberfläche.

Im Experiment, das aus einer künstlichen Verkürzung des Schneidezahnes mittels Beschleifung bestand, wurden die Folgen des künstlich beschleunigten Durchbruchs beobachtet. Wir konnten feststellen, dass die Mikrozirkulation des Schmelzorgans 1,2—1,5 mm oberhalb des Gingivalsaums sichtbar wird. Die Beschleunigung des Durchbruchs hatte keinen Einfluss auf die Blutversorgung der Gingiva. Ferner wurde festgestellt, dass das auftauchende Schmelzorgan in die Mundhöhle desquamiert wurde.

Die Anwendung 6 %iger Wasserstoffsperoxydlösung führte zu einer Propagation von Sauerstoffperlen ins Gingivagewebe und zu einem darauffolgenden Stillstand der Zirkulation in der Gingiva. Völlige Wiederherstellung erfolgte im Laufe von 30—60 Min.

Der Heilungsvorgang wurde in Bezug auf ein Trauma, das durch kurzdauernde Diathermie verursacht wurde, verfolgt. Die Heilung erfolgte im Laufe von 2 Wochen. Das neuentstandene Blutbett ähnelte Venolen. Die Heilung der zerstörten Mikrozirkulation in der Gingiva war der in der alveolären Schleimhaut ähnlich, was auf eine gleiche Restitutionsfähigkeit schließen lässt.

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Addresses:

*Maud Kindlová,
Institute of Dental Research,
Vinohradská 48,
Prague,
Czechoslovakia*

*Arje Scheinin,
Institute of Dentistry,
University of Turku,
Turku 3,
Finland*