From:
The College of Dentistry,
University of Iowa, U.S.A.,
and the Institute of Dentistry,
University of Turku, Finland

INNERVATION OF THE DENTAL PULP
II. A FLUORESCENCE MICROSCOPY STUDY IN THE RAT INCISOR

by

ARJE SCHEININ
ERNEST I. LIGHT

INTRODUCTION

The innervation of the dental pulp has generally been studied primarly with regard to the neural elements in the coronal parts of the pulp and their relationship to the odontoblasts, predentine and dentine. Little attention has been paid to the neural control of the circulation in the dental pulp.

M. Pohto and *Scheinin* (1962), however, demonstrated that the injection of local analgesic solutions resulted in a marked decrease of the velocity of the blood flow in the rat incisor pulp. This observation thus suggests the existence of a control mechanism of the blood flow in the dental pulp. In these experiments minimal changes in the vessel diameter were observed, although the occurrence of a conspicuous retardation phase in the blood flow was readily observed. This finding thus additionally implemented the occurrence of a vascular constriction close to the site of the injection of the analgesic solution.

It was thus considered worthwile to examine the innervation of the dental pulp, particularly in the apical region of the rat incisor pulp.

MATERIAL AND METHODS

54 white rats of the Sprague-Dawley strain were used in these experiments. The dental pulps were examined by using the method previously described

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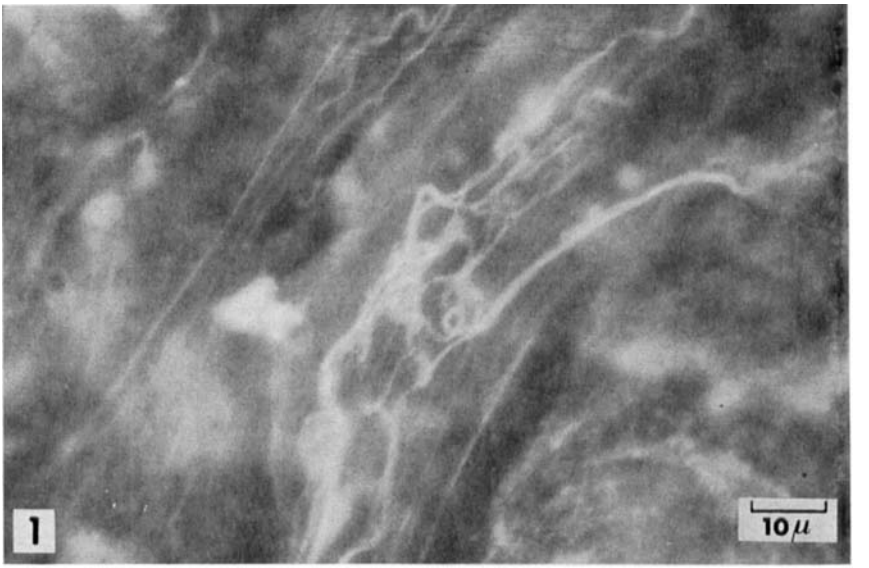

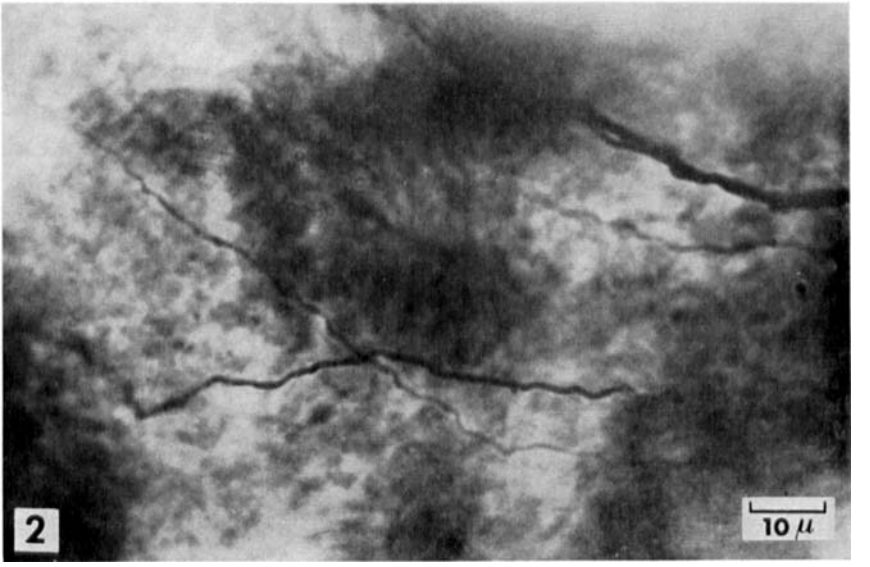

Fig. 1. Fine fibers in apical part of the mandibular incisor of a rat. Incident UV-light, supravital fluorochromation with Thioflavine S, 1:5000 in Ringer's solution.

Fig. 2. Fine fibers in apical part of a mandibular incisor of a rat. Bielschowsky-stained section in ordinary transmitted light.

by *Scheinin* and *Light* (1969). Particular emphasis was laid on the dissection and examination of the dental pulp in the apical and immediate periapical region. Additionally 6 mandibular incisor pulps were fixed in neutral formalin, cut to 20 μ sections, embedded in paraffin and silver-impregnated by the Bielschowsky-method.

RESULTS

Solely in the apical part of the pulp numerous fine fibers (Fig. 1), frequently connected with bead-like structures were observed (Figs. 4 and 5). These structures were limited to the area corresponding to the open *foramen apicale* of these teeth. Close to that site the pulp in the lower incisor made an almost 180-degree bend, as previously illustrated (Fig. 2, *Scheinin & Light*, 1969).

The major part of these fibers had a dimension between 1—2 μ (Figs. 1 and 3) as also seen in the Bielschowsky-stained sections (Fig. 2). In addi-

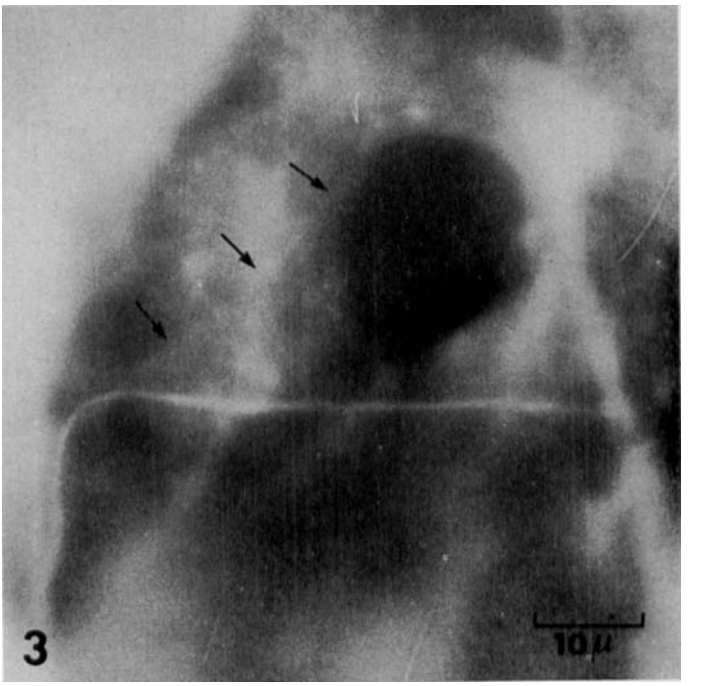

Fig. 3. Fine fibers, close to the resolving power of the microscope (arrows) in the vicinity of a small blood vessel. Supravitally stained (Thioflavine S, 1:5000 in Sörensen's buffer, pH 6.0), cryostat-cut section in transmitted UV-light.

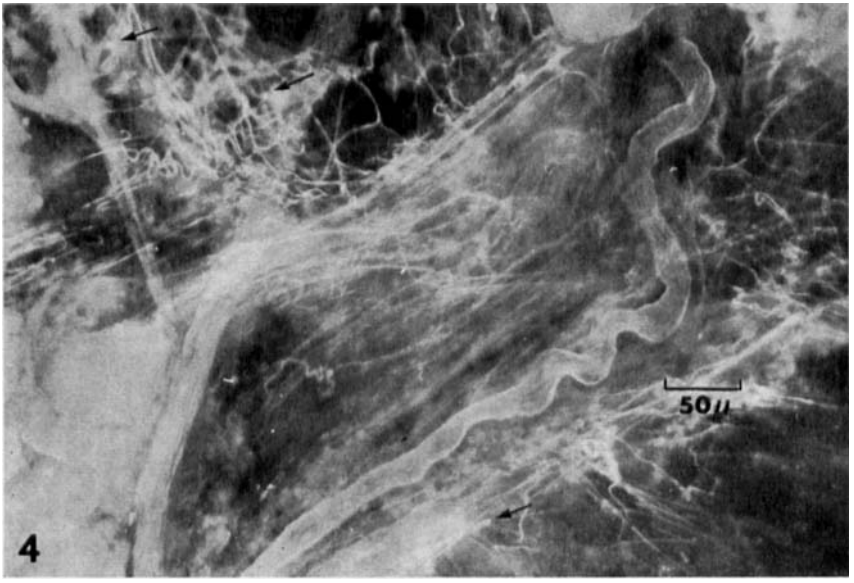

Fig. 4. Microphotograph of supravitally stained section (Thioflavine S, 1:5000 in Sörensen's buffer, pH 5.5) in incident UV-light. Note the lamellar appearance of the myelinated nerve fiber bundles, and also the numerous fine-caliber fibers connected to the bead-like structures (arrows).

tion, very fine fibers with a diameter close to the resolving power of the fluorescence microscope were observed in the same region (Figs. 1 and 3).

The bead-like structures, having a diameter of 2—3 μ, were found in paravascular areas (Figs. 4 and 5).

Thick myelinated nerve fiber bundles were observed in the apical part of the pulp. The individual myelin sheaths were separately recognizable, these bundles thus showing a lamellar appearance (Figs. 4 and 5).

DISCUSSION

The fine-caliber nerve fibers found only in the immediate apical region of the mandibular incisor pulp strongly suggests the existence of the neural regulation of the blood circulation in the dental pulp. The marked retardation of the pulpal circulation caused by local analgesic solutions injected as a mandibular block was thought to be the result of a constriction occurring at the site of the injection (*M. Pohto & Scheinin*, 1962), i.e. close to the apex of the incisor.

Fig. 5. Composite microphotograph of the apical part of a mandibular incisor pulp. Note the myelinated nerve fiber bundles, and the paravascular fine-caliber fibers connected to the bead-like structures (arrows). Staining as in Fig. 4.

On the other hand it should be noted that *P. Pohto* and *Antila* (1968) showed that there were no adrenergic fibers in the rat incisor pulp, and also that the existence of myelinated nerve fibers in the rat incisor pulp has previously been declined (*Hattyasy*, 1959). The apparent contradiction might, however, be readily explained by the localization of the fine fibers, the bead-like structures and the myelinated nerve fiber bundles being limited to the apical part of the pulp only. These elements might thus readily have escaped detection due to the restricted area in which they were observed.

Other authors have indicated the relative importance of the pH of the fluorochromation material and the iso-electric point of the tissue which is to accept the fluorochrome as it effects the intensity and color of the secondary fluorescence (*Hals*, 1953; *Bennett*, 1953; *Hileman*, 1959). It should be noted that in this study, variation of the pH of Sörensen's buffer solution from pH 5,5 to 9,0 did not significantly alter the appearance of the neural elements *per se*, but at the lower pH values the background substance was altered to provide a greater contrast which allowed for a better definition of the nerve fibers themselves.

The exact nature of the fine fibers and the bead-like structures will be examined in a subsequent study.

SUMMARY

The mandibular incisor pulp of the rat was examined with particular emphasis on the apical part of the pulp. The dental pulps were stained intra- or supravitally with Thioflavine S, 1:5000 in Ringer's or Sörensen's buffer solutions.

Fluorescence microscopy revealed the presence of myelinated nerve fibers especially in the apical part of the pulp. In addition fine-caliber fibers connected with bead-like structures were observed solely in the apical part of the pulp. The findings were interpreted to suggest the possibility of the neural regulation of the pulpal circulation being limited close to the apex of the incisor teeth.

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RÉSUMÉ

INNERVATION DE LA PULPE DENTAIRE

II. ÉTUDE PAR MICROFLUOROSCOPIE DANS L'INCISIVE DU RAT

La pulpe de l'incisive du rat a été examinée, l'attention étant plus particulièrement portée sur la partie apicale de la pulpe. Les pulpes dentaires ont subi une imprégnation vitale (intra-vitale ou supra-vitale) à la Thioflavine S à 1:5000 dans une solution tampon de Ringer ou de Sörensen.

La microfluoroscopie a mis en évidence la présence de fibres à myéline, en particulier à la partie apicale de la pulpe. De plus, de fines fibres reliées par des formations en forme de boutons pouvaient être observées, uniquement à la partie apicale de la pulpe. L'interprétation de ces résultats permettrait d'envisager la possibilité que la régulation nerveuse de la circulation pulpaire soit limitée aux environs de l'apex des incisives.

ZUSAMMENFASSUNG

DIE INNERVATION DER ZAHNPULPA

II. EINE FLUORESZENZMIKROSKOPISCHE STUDIE AN RATTENINZISIVEN

Die Pulpa der unteren Inzisiven der Ratte wurde unter spezieller Berücksichtigung der apikalen Pulpa untersucht. Die Pulpen wurden intra- oder supravital mit Thioflavin S 1:5.000 in Ringer- oder Sörensen Pufferlösung gefärbt. Fluoreszenzmikroskopisch ergab sich die Anwesenheit von myelinhaltigen Nervenfasern speziell im apikalen Gebiete der Pulpa. Ferner wurden dünne Fasern mit perlähnlichen Strukturen nur im apikalen Teil der Pulpa beobachtet. Die Ergebnisse wurden so interpretiert, dass man an die Möglichkeit glaubt, die neurale Regulation der Zirkulation in der Pulpa sei auf den Apex des Inzisiven bechränkt.

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Addresses:

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

Ernest I. Light,
College of Dentistry,
University of Iowa,
Iowa City, Iowa 52240,
U.S.A.