SOME HISTOLOGICAL PROPERTIES OF THE HUMAN DENTAL PULP

by

D. Hattyasy

Direktor of Clinic for Dental and Oral Diseases Univ. Med. School Szeged, Hungary

Numerous dental pulp studies were made in the last 100 years especially concerning the nerve supply and the distribution of the nerve fibres (5). There remained, however, some questions not alone relating to their physiological role and importance but also to their morphology. Surely one of the major difficulties lies in the proper histological technique as well as in the physico-chemical properties of this tissue. The latter seems to be very different in each of the consecutive ages. After managing some technical difficulties with the help and kind advice by Prof. A. Ábrahám to whom I am very grateful for his stimulating influence and valuable hints too, I used Romanes' technique originally developed for paraffin sections (9) modified for frozen material. I think this method is advantageous because it uses very thin-, nearly isotonic solutions, and therefore the shrinking of the tissue-elements is very little. Consequently the resulting nerve fibres are not so sharp and clearly cut as with other methods but shows a lot of interesting details. After studying the dental pulp of rats and other rodents (4, 5) we found that the human dental pulp nerve can show regressive changes like other tissue elements of the dental pulp in a very early age (8). Therefore we took carefully selected intact teeth (extracted for orthodontical reasons) of healthy young individuals and prepared them immediately after removing.

Histological method

The teeth were, after removing immediately, put in a bath of Ringer's solution at 30 °C and with rotating diamond discs ground up to slices 1—1,5 mm of thickness and fixed in fresh-mode Bouin's a solution for 2 days. Decalcination followed in buffered citric acid- sodium citrate solution or in formic acid- sodium citrate solution sec. Evans and Krasian (3). The material was kept in 80 per cent methanol till cutting and impregnating.

Results concerning distribution of nerve fibres

The nerve fibres are there principally for the crown-pulp especially for the area under the masticatory surface of this dentinal district. As in former papers already mentioned (5, 6) there are morphologically at least 3 different sorts of fibres to be distinguished. Concerning their behaviour in the odontoblastic area they are devided partly into fibres which enter the dentinal ground-substance or the dentinal tubuli, partly, into fibres which end around the odontoblastic cells. As to the latter form we found some instructive pictures (Fig. 1, 2) which show that some fibres may wind itself around some neighbouring cells and end close on or in the cells in a way which remains presently obscure. The „winding" happens in a state when the fibres has already lost the discernible myelin sheath. The „ending" looks like as if the fibre were attached to the cell. Such pictures as shown in Fig. 1, 2, are not common, nor are they rare, but difficult to follow in most of the cases.

Fig. 1.

Fig. 2.

Fig. 1, 2. Detail of the odontoblastic layer. The same side in two depths. There is seen a fibre winding around some cells and ending appearently on the top-cell. See text. Over → in Fig. 2 widening of the fibres. Magn. 1300×.

As mentioned the distribution of the nerve fibres is anything but even and there are also some districts in the mentioned „upper area" which are relatively poor in nerves. Therefore it would be wrong to think that each of the cells gets some special nerve supply. This „negativum" can be shown in Fig. 3. The cut was taken from the subodontoblastic layer and shows no nerve at all.

Consequently the exact topography of the pulp-nerves is a difficult task as it could be solved only with assiduous study; roughly we have it already. The middle part of the crown-pulp shows surprisingly numerous fibres in some spots. (Fig. 4, 8, are from such a middle area.) Some areas are rich and some very poor in fibres. The relatively poor nerve supply of the root part of the pulp is generally known not taken into consideration the transitory fibres.

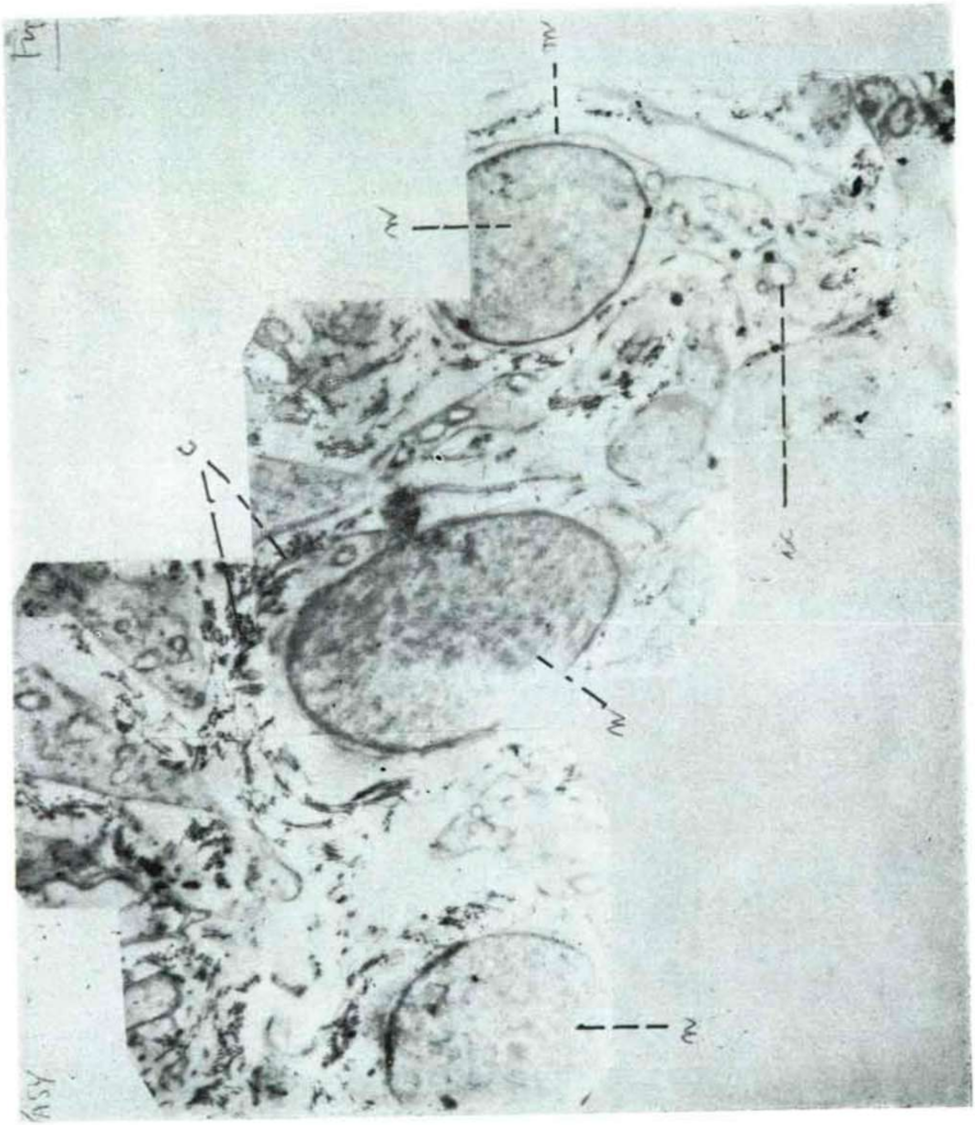


Fig. 3. Detail from the subodontoblastic layer. There are seen 3 cell-nuclei (n), the cell membrane (m), the intracellular canaliculi (ic) and some collagene or praecollagene fibres (c) in the extracellular space of the cellular reticulum. Magn. (orig.) 7200×. (Electronmicroscopic picture).

Occurrence of receptor-plates

In some of the cases a few of not too thin fibres could be found in the middle of the crown-pulp of premolares and incisors which widened to plates of some form and after a while resumed again this fibre-form. It means: these widenings are intercalar or transitory occurences in the pathway of the fibre. They appear in the light microscope as neurofibrillar plates of considerable dimension and irregular form (Fig. 4).

Another form of widening of fibre was found a berry-like corpuscule (Fig. 5) and when opened it looked a vesicular structure (Fig. 6, 7) which has a very thin fibre in the middle (Fig. 6). This structure seems to be very liable to rupture and if so it results in structure shown in Fig. 7.

Fig. 4. Detail of the middle of the crown pulp. By → a nerve fibre wich widens itself to a considerable plate (p_1) and can be followed upward and downward. By p_2 another widened fibre. Magn. 1300×.

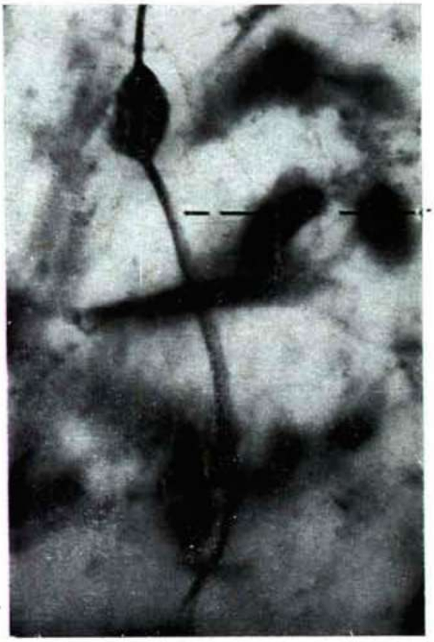
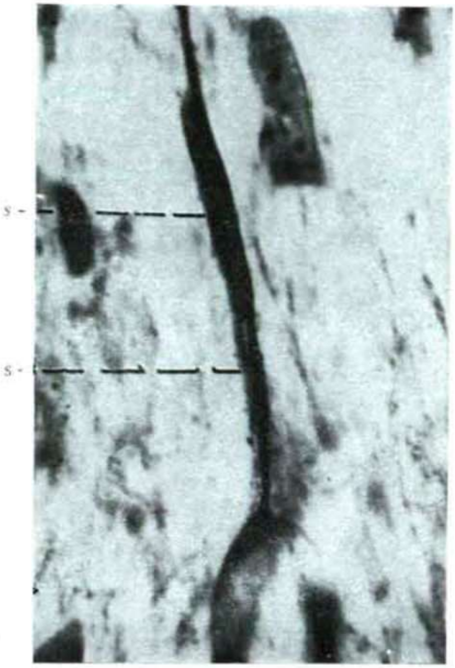


Fig. 5. Detail of the middle of crown pulp. A nerve fibre (n) with a berry-like vesicular corpuscle. Magn. 850×.

Fig. 6. Similar corpuscle as in Fig. 5. but slighter. In the middle of the vesicle there is a fine fibre passing through. Magn. 1100×.

Discussion

The problem of peripheral free nerve endings is still in some cases problematical. Especially in the region of the odontoblasts the rich accumulation of the nerve fibres is long known as RASCHKOW's plexus meaning, however, little. The concentration of the nerve fibres in some cases is so compact as practically impossible to distinguish or to follow some of the fibres. Many of these fibres reach the odontoblastic region forming there a loop and turning back but no trace visible where. Other fibres as mentioned above innerve the dentinal region and others the odontoblasts. It could be seldom seen what these latter fine fibres are for. However we succeeded to follow some of these fine fibres winding around the neighboring cells in close affinity of the cells. (Fig. 1, 2). In Fig. 2. the nerve fibre coming to the top cell from the left seems to end „in the cell". This could be accepted if we had not an other preparation of a deeper layer (Fig. 1) whereon the fibre seemingly ends on the top cell showing that the „ending knot" was only a spot and the fibre is running farther. Fig. 2. shows also a „new" fibre a little more to the left and it is attached also to the former cell. Following the windings in Fig. 2. (over the arrow) there is a shadowy part which is a true neurofibrillar wi-



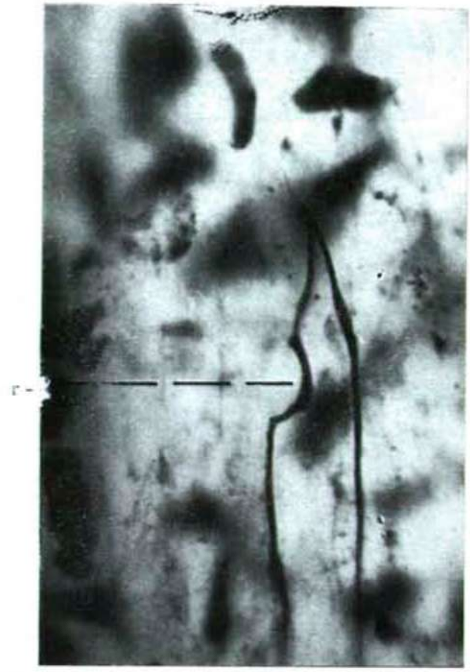


Fig. 7. A nerve fibre with a SCHWANN's cell (s) and its process (s). In the upper part of the fibre a similar corpuscle as shown in Fig. 5 and 6. Magn. 1300×.
Fig. 8. A branching nerve fibre. On the right branch, a ruptured vesicular corpuscle (r) is shown as in Fig. 5, 6, 7. Magn. 850×.

dening. This latter seems to be not an artifical product but from the former mentioned structures it can be only said that the fibres and cells get in a very close connection with each other. It is possible that the nerve fibre lies on the cell membrane that can be very near to the nucleus (see Fig. 3). The very intimate and close relation between cell and nerve fibre is surely there despite the knowledge of the actual form of the attachment.

The systematic neurofibrillar „Auflockerungen" of the vegetative pulp-nerve fibres I had described (4, 5) in rats but they are present in human teeth too. Once I found in the pulp of a rat's molar some structures resembling a branch of a tree with angular leaves like ancient Egyptian fans. This structure was essentially very much like those in the periodontium of the rat described in an earlier paper of mine (7). Looking at it some suspicion struck me „what have they to do there"?

I was rather surprised when I found — in some specimens — the neuro-fibrillar extension (see Fig. 4) on the same spot of two fibres simultanously. The possible functional role of these neurofibrillar plates can be assumed with a certain probability since there are no physiological experimental data available and alas! no technical possibility to investigate it. In comparison to other similar structures the plates are supposed to receive always pressure like the classical pressoreceptors in the aorta (1), in the tooth-periodontium (7) as well as in the region of the palatinal mucosa (2). At first seems difficult to imagine pressure reception in the middle of the tooth cavum. „Cui prodest"? I think the question can not and should not be put in this form. The fact is that there are such structures and so they must have some aim else they would degenerated.

The question of the physiological function of the pulp-nerves is generally vere little known. Morphologically we are able to distinguish a score of different fibres without knowing really their physiological role.

Moreover there are the vesicular structures (Fig. 5—8). Concerning their reality I have no doubt. I do not think they could be artificial products. The Fig. 5 shows clearly it. This is a phasiscontrast picture therefore the upper part of the fibre shows some interference signs and the vesicular uneven surface with the argentophyl outer membrane in quite clearly discernible. Fig. 6, 7 show also this argent affinity of the membrane and Fig. 6 a thin central fibre too. The whole seems to be filled with some fluid. This is eventually corroborated by the fact that this structure is very liable to rupture and we had considerable trouble till we could see the true nature of these peculiar forms. Fig. 8 identifies them as ruptured neural vesiculae. There we can raise again the question „what for"? I suppose it can be said again with some probability that the *vesicula* containing some fluid, in its center with an *axon*, can be also something for the pressure recording. May it have something to do with the pressure equilibrium of the shunt-vessels or some similar function? These fibres in question are not the thinnest ones, there can be seen, below the vesicula a SCHWANN's cell with its process.

I think it is fair to state: sound morphological and structural knowledge renders much easier the physiological research or at least shows the problems to be solved more clearly. At present the dental pulp innervation is still a physiological „riddle".

Literature

1. ÁBRAHÁM, A.: Acta Biol. (Budapest) *4*. 69. (1953).
2. ÁBRAHÁM, A.: C. R. 12 Congr. Internat. Zool. Lisbonne. 373. (1936).
3. EVANS, N. and KRASIAN, A.: Arch. Pathol. *10*. 447. (1930).
4. HATTYASY, D.: Nature (London) *178*. 416. (1956).
5. HATTYASY, D.: D. Zahn-, Mund-, Kieferheilk. *30*. 933. (1960).
6. HATTYASY, D.: Nature (London) *189*. 72. (1961).
7. HATTYASY, D.: Zeitschr. mikr.-anat. Forsch. *65*. 413. (1959)
8. HATTYASY, D.: Zahnmedizin in Bild. *3*. H. 2. (1962).
9. ROMANES, G. I.: Journ. Anat. (London) *87*. 107. (1950).