A HISTOLOGICAL STUDY ON THE INNERVATION OF THE LARGE BLOOD VESSELS OF THE ABDOMEN

by

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I. INTRODUCTION

In spite of great number of the reports concerning the microscopical observation of the nervous structure in the wall of blood vessels, their innervations have not yet been settled enough.

Histological studies on these problems have been reported by many investigators, i. e. S. Michailow (1908), W. Glaser (1914), L. Hirsch (1926), S. Mitsui (1929), J. Boeke (1932), Ph. Stoehr Jr. (1933), J. F. Nonidez (1935), H. Seto (1937), V. Jabonero (1953) and A. Ábraham (1953), etc.

The autonomic nerve termination forms a fine network which is called "sympathischer Grundplexus" (Boeke), "Terminalreticulum" (Stoehr Jr.) or "nervoeses Synzytium" (Jabonero), etc. Many inverstigators have found these network structures in the wall of various blood vessels.

The afferent nerve terminations are known as presso-receptors and have been found only in certain areas. P. Sunder-Plassmann (1930), Muratori (1932), Stoehr Jr. (1933) and Nonidez, etc., observed the afferent nerve terminations forming specific structure in the carotid sinus. D. F. Tello (1924), Nonidez and Seto, etc., observed them in the adventitia of the aortic arch, and M. Takino (1933) described the afferent nerve fibres in the pulmonary artery and vein. Ábraham found the specific structure as the afferent nerve termination not only in the above mentioned areas, but also in the renal artery.

Recently, in 1957, Y. M. Cheng of our laboratory demonstrated the existence of the thick undulated nerve fibres in the media of the common carotid artery, abdominal aorta and vena cava, and proved that they were the afferent nerve fibres by his degeneration experiment. Moreover, K. Tsunekawa (1958) of our laboratory recognized physiologically that there were nerve fibres which convey the afferent impulse from the blood vessels via the vagus nerve and dorsal roots of the spinal cord.

The author studied the distribution of the nerve fibres in the wall of the abdominal large blood vessels, which had nerver been or had scarcely been studied, i. e. arteria coeliaca, arteria mesenterica superior, arteria mesenterica inferior, arteria renalis and vena portae of the adult dog.

Ⅱ. MATERIALS AND METHODS

All the materials were obtained from adult dogs.

Before the extraction of material, hyaluronidase solution was injected into the area. This method was introduced by G. WEDDELL (1954). According to his opinion, the application of "spreading factors" eliminates artefacts which are known to result from the slow infiltration of fixatives, for it promotes the process of rapid and even tissue fixation, and the staining or impregnation process can be controlled with certainty, and thus the results obtained are always uniform.

Under general anaesthesia with sodium isomytal, the blood vessels were exposed, and 2 to 3 cc hyaluronidase solution (1,000 T. R. units solved in 1.0 cc physiological saline) was injected into their walls. After 20 minutes, the animal was sacrificed by bloodletting, and the injected portions of the blood vessels were taken out and fixed in 15% neutral formol solution. On the 3rd day of fixation, they were sliced with freezing microtome into frozen section of 35～40 μ thickness. The frozen sections were further fixed for several days, and were submitted to impregnation.

For impregnation, JABONERO's silver carbonate method was employed.

This procedure is as follows:

1) Wash the sections with distilled water for 1 hour.

2) Put into 20% silver nitrate solution, being protected from light, for 1 hour.

3) Wash in distilled water for 30 seconds.

4) Place in 20% neutral formol solution; this solution is prepared by diluting the mother neutral formol with running water, and placed in 5～6 plates. The sections are transferred one by one from the first plate to the last until the white precipitation disappears.

This process must be completed within 10 minutes.

5) Wash in distilled water for 1 minute.

6) Put the sections into the silver carbonate solution, to which a certain amount (3～4 drops) of ammonia is added. If the amount of ammonia is proper, the sections take golden yellow colour within 30～60 seconds, and then the yellow colour gradually changes into deep tobacco brown within 5～10 minutes. If the sections change brown too quickly, increase the amount of ammonia; if the contrary, reduce it.

7) Wash in distilled water for 5 minutes.

8) Differentiate in acetic acid (2～3 drops of 30% acetic acid in 1 cc of distilled water) for 2～3 minutes. In this solution, the colour changes into golden yellow from dark brown.

9) Wash in distilled water 3 times.

10) Put into 0.2% gold chloride solution, to which 2～3 drops of acetic acid are added, for 10 minutes.

11) Wash in distilled water.

12) Fix in 5% sodium thiosulfate solution.

13) Wash, dehydrate and mount in balsam.

The silver carbonate solution is prepared in the following way: Add an excess amount of saturated solution of sodium carbonate to 50 cc of 20% silver nitrate

solution, and a milky yellow precipitate of silver carbonate is produced. Wash the precipitate well with distilled water, decant and dissolve all the precipitate with the least necessary amount of ammonia. Add 250 cc of distilled water to the solution, and preserve in a brown flask. The solution must be stored in a dark, cool place, and there it is stable for several months. If a black precipitate is produced after a few months, filter the solution before use.

An important point in the preparation of this solution is that the addition of ammonia should be stopped just before all the silver carbonate precipitate dissolves completely.

Ⅲ. MICROSCOPICAL OBSERVATION

1) Abdominal arteries (arteria coeliaca, arteria mesenterica superior, arteria mesenterica inferior and arteria renalis).

Thick myelinated nerve fibres run in the adventitia, giving off branches several times. Some branches terminate in the connective tissue of the adventitia, and the others traverse the border between the adventitia and media (Figs. 1, 2 and 3). Additionally, slender nerve fibres which form a fine network, are observed (Figs. 4, 5 and 6). This network is considered as the autonomic nerve termination, JABONERO's "nervoeses Synzytium". But neither the ganglionic cells reported by GLASER and STOEHR JR., etc., nor encapsulated endings (Pacinian corpuscle) reported by HIRSCH and STOEHR JR., etc., are observable in these regions of blood vessels.

In the media, two kinds of nerve fibres are observed; one is a nerve fibre which runs alone and terminates as a free-ending, and the other is a nerve fibre which runs with special cells along its course. The nucleus of this cell is impregnated lightly and observed chiefly at the ramifying point of the nerve fibre (Figs. 7, 8, 9 and 10). The nucleus is round or oval, and it is clearly distinguished from the spindle shaped nucleus of smooth muscle cell. This cell is considered as "interstitielle Zelle" described by BOEKE, STOEHR JR. and JABONERO, etc.

The nerve fibres which penetrate into the media from the adventitia continue their course in the media (Figs. 11, 12 and 13), and often give off branches along the elastic fibres (Figs. 14, 15 and 16). They proceed further toward the inner layer of the media and gradually decrease in diameter, and finally terminate freely in the connective tissue between the smooth muscle cells, without forming any specific terminal structures. They terminate usually as tapering endings (Figs. 17, 18 and 19), but rarely form a loop near the termination (Figs. 20 and 21). The direct contact between the termination and the smooth muscle cell can not be demonstrated.

A complicated ramification which has a plexiform nervous structure is observable, and it accompanies the interstitial cells (Figs. 22, 23, 24 and 25).

On the other hand, the nerve fibre shows a localized expansion along the way, wherein a fine network is observable (Figs. 26 and 27). Sometimes the interstitial cells are scattered in the network, but their appearance are clearly different from "nervoeses Synzytium" in the adventitia (Figs. 28, 29 and 30).

Most of these intrinsic vascular nerves are found in the outer layer of the

media, and rarely traced in the far inner layer or in the intima.

2) Portal vein.

The adventitia is far thicker than the media in the portal vein. In this thick adventitia, the nerve bundles run abundantly and each nerve fibre arises from the bundle (Figs. 31 and 32). Some nerve fibres terminate in the connective tissue of the adventitia and the others penetrate into the media from the adventitia (Fig. 33). In the adventitia of the portal vein, abundance of "nervoese Synzytia" are observable as well as in the artery (Figs. 34 and 35).

The media is far thinner in the portal vein than in the artery. Therefore, the nerve fibres in the media of the portal vein are more sparsely distributed than those of the artery. The nerve fibres, after entering the media (Fig. 36), never give off branches, and terminate in the connective tissue between the smooth muscle cells (Figs. 37, 38, 39, 40 and 41). Neither the arborization of the nerve fibre nor the network is observable, and no interstitial cell is found there.

Some nerve fibres mentioned above, may be considered as sensory in nature, but from the morphological point of view only, it is difficult to determine which are sensory or autonomic. Accordingly, the author carried out the following experimental observation to investigate the afferent nerve fibres in the media of these blood vessels.

IV. EXPERIMENTAL OBSERVATIONS ON THE AFFERENT VASCULAR INNERVATION

A. Otsu of our laboratory has revealed the fact that visceral sensory nerve fibres have their nerve cells in the spinal ganglia of the dorsal roots of the spinal cord, or in the jugular and nodular ganglions of the vagus nerve; and the postganglionic fibres have no interposing nerve cells till their termination. If the dorsal roots or the vagus nerves are resected at a point distal to each ganglion, sensory nerve fibres would degenerate due to Waller's law. But the autonomic nerve fibres have interposing nerve cells in their course to the effector tissues. Therefore, after such operation, only their preganglionic fibres degenerate and their postganglionic fibres never degenerate. Accordingly, degenerated nerve fibres in the media where preganglionic fibres are no longer found, must be considered as sensory in nature.

The process of degeneration of the axis-cylinder in the media of blood vessels shows the following appearance. In the early stage of the degeneration, the axis-cylinder shows marked argyrophilic swelling, and it gradually begins to be broken down as the degeneration progresses. When the degeneration reaches its optimal stage, the axis-cylinder gives an appearance of a string of beads or scattered granules, and thereafter, degenerated axis-cylinder particles begin to disappear.

The author performed vagotomy and posterior rhizotomy to prove the sensory nerve fibres in the media of blood vessels, and also to determine their source.

Adult dogs were used as experimental animals.

1) Vagotomy:

Under general anaesthesia with sodium isomytal, about 2 cm of the right vagus trunk was resected distal to the nodular ganglion. Specimens were taken 5½~7

days after operation, and prepared as described previously.

Degenerated nerve fibres were found in the media of coeliac artery, superior mesenteric artery and portal vein, but none in the media of renal artery. In the case of specimens taken 5½ days after vagotomy, marked argyrophilic swelling of the axis-cylinder was observed (Figs. 42, 43 and 44), and 6½～7 days after vagotomy there was typical bead-like or granular degeneration (Figs. 45, 46 and 47).

2) Posterior rhizotomy:

Under general anaesthesia with sodium isomytal, laminectomy was performed, and the spinal canal was opened. The dorsal roots were carefully seperated from the ventral roots, and only the former were resected bilaterally at the point distal to the spinal ganglia. Specimens were taken 4 days after operation.

a) Th. 6～Th. 8 bilateral posterior rhizotomy:

A few degenerated nerve fibres were found in the media of coeliac artery (Fig. 48), but none in the media of the other blood vessels.

b) Th. 9～Th. 11 bilateral posterior rhizotomy:

Many degenerated nerve fibres were found in the media of coeliac artery (Figs. 49 and 50), and a few in the media of superior mesenteric artery and portal vein (Figs. 51 and 52).

c) Th. 11～Th. 13 bilateral posterior rhizotomy:

Many degenerated nerve fibres were found in the media of superior mesenteric artery and portal vein, and a few in the media of renal artery and coeliac artery (Figs. 53, 54, 55 and 56).

d) Th. 13～L. 2 bilateral posterior rhizotomy:

Many degenerated nerve fibres were found in the media of renal artery, and a few in the media of superior mesenteric artery and portal vein (Figs. 57 and 58).

e) L. 3～L. 5 bilateral posterior rhizotomy:

A few degenerated nerve fibres were found in the media of renal artery (Fig. 59), but none in the media of the other blood vessels.

From these results, the following facts are obtained.

(1) The afferent nerve fibres in the vagus nerve are recognized in the media of the coeliac artery, superior mesenteric artery and portal vein.

(2) The afferent nerve fibres of spinal origin in the media of the coeliac artery are mainly derived from the dorsal roots between Th. 9～Th. 11.

(3) The afferent nerve fibres in the media of the superior mesenteric artery and portal vein are mainly derived from the dorsal roots of the spinal segment between Th. 11～Th. 13.

(4) The afferent nerve fibres in the media of the renal artery are mainly derived from the dorsal roots of the spinal segment between Th. 13～L. 2.

In all the specimens, there were nerve fibres which remained intact in the media. Degenerated nerve fibres were those which ran alone, without forming any complicated nervous structure, and the nerve fibres which formed a network along the way, did not degenerate. Accordingly the former are considered as sensory in nature and the latter autonomic.

The distribution of the afferent nerve fibres in the abdominal large blood vessels according to the secondary degeneration after vagotomy and posterior rhizotomy

	A. coeliaca	A. mesent. sup.	A. renalis.	V. portae
right vagotomy	+	+	−	+
bilat. post. rhiz. Th. 6~Th. 8	÷	−	−	−
bilat. post. rhiz. Th. 9~Th. 11	+	÷	−	÷
bilat. post. rhiz. Th. 11~Th. 13	÷	+	÷	+
bilat. post. rhiz. Th. 13~L. 2	−	÷	+	÷
bilat. post. rhiz. L. 3~L. 5	−	−	÷	−

V. DISCUSSION

Histological studies concerning the nerve distribution in the wall of blood vessels have been reported by many investigators.

Michailow described 3 zones of nerve plexus; the first distributed in the adventitia,—"adventitial Nervengeflecht"—, the second in the border between adventitia and media,—"Grenznervengeflecht"—, and the third in the media,—"Muskelnervengeflecht"—.

Glaser and Mitsui found the same nerve fibres in the wall of the blood vessels, and furthermore described a few in the intima. Hirsch and Nonidez reported nerve fibres on the surface of the musculature, but denied the presence of nerve fibres in the inner layer of the media and in the intima. The author also found the nerve fibres only in the outer layer of the media.

Stoehr Jr. and Reiser (1932) assert that the autonomic nerve termination forms a fine network, i. e. "Terminalreticulum", and they found it in the adventitia of blood vessels. Jabonero describes a fine network structure enclosed in the band of protoplasm, i. e. "nervoeses Synzytium", as the autonomic nerve termination. He maintains that "nervoese Synzytia" are distributed numerously through the adventitia, but never enter the media. The author found "nervoeses Synzytium" only in the adventitia; none in the media.

The interstitial cell is usually existent in the network structure, the autonomic nerve termination. But Boeke (1934) maintains that the interstitial cell is found not only in "sympathischer Grundplexus", but also in the sensory encapsulated endings, and "Nebenzelle" of the sensory ending belongs to the interstitial cell. Jabonero mentions that the interstitial cell lies also in the territory of the sensory ending, and it performs the humoral conveyance of the nervous impulse.

Seto describes sensory nerve endings, which end in one tapering ending or in a few branches, in the aortic arch, pulmonary artery and abdominal aorta of the human foetus. According to his opinion, the nerve fibres which terminate freely in the periphery without forming the "Terminalreticulum", must be considered as sensory nerves, and these sensory nerves can be easily differentiated from the autonomic nerves by their thickness.

M. CLARA (1953) indicates that the morphologic characteristics of the sensory nerve endings are the specific structures which tend to expand their terminal surface. But WEDDELL (1953) emphasizes that the structures of the sensory nerve terminations are usually free-ending arborizations, and the complicated termination may be considered as artefacts in the staining process. The author observed freely terminated nerve fibres without forming any specific terminal structure in the media.

ĀBRAHAM observed various nerve plexi in the media of the aorta. He maintains that all the nerve fibres in the media are autonomic nerves, even though the connection between the nerve termination and the smooth muscle cell can not be clearly observed.

J. NICOLESCO (1956) recognizes sensory nerve fibres in the media, and R. FONTAINE (1957) describes the fine nervous networks in the media without explaining their nature.

The author observes the nerve fibres which run alone without forming any complicated nervous structure and others which form the network along the way in the media; he considers the former as sensory nerves, because they degenerated to the media after vagotomy or posterior rhizotomy, and the latter as autonomic nerves, because they did not degenerate. As described by FONTAINE, the author also observes the network of the nerve fibres in which interstitial cells are scattered, but this morphological appearance is clearly distinguishable from "nervoeses Synzytium".

As for physiological studies on the vascular sensitivity, W. ODERMATT (1922) reported that the vascular pain was provoked by expanding the arterial wall mechanically, and this pain was due to traction of the sensory terminals in the adventitia. HELLWIG (1924) reported that strong vascular pain was provoked immediately after the injection of barium chloride solution into the femoral artery.

Recently, K. TSUNEKAWA of our laboratory has succeeded in provoking vascular pain by inserting a cardiac catheter with bipolar electrodes at the end into the blood vessels to stimulate electrically from inside. By his physiological experiment, the afferent impulse in the coeliac artery is conveyed through the vagus as well as dorsal roots of the spinal segment between Th. 7～Th. 13, and those in the superior mesenteric artery either through the vagus nerve or the dorsal roots of the spinal segment between Th. 9～L. 2. These physiological results quite agree with the histological results which were obtained in the present experimental study. The blood pressure is known to be regulated through the presso-receptor in the special area, but the above mentioned sensory nerves in the media will also play some role in the regulation of blood circulation.

VI. SUMMARY AND CONCLUSION

The author has studied the nerve distribution in the wall of the abdominal large blood vessels, i. e. arteria coeliaca, arteria mesenterica superior, arteria mesenterica inferior, arteria renalis and vena portae in the adult dog.

The results are summerized as follows:

1) Numerous "nervoese Synzytia" are observed in the adventitia.

3) Ganglionic cells and Paccinian corpuscles are never observed.

3) Many interstitial cells are observed not only in the "nervoeses Synzytium" in the adventitia, but also in the media.

4) In the media, two kinds of nerve fibres are observed; one runs alone and terminates as a free-ending, and the other runs with interstitial cells along its course.

5) The network of the nerve fibres is observed in the media, but its appearance is very different from "nervoeses Synzytium".

6) Both the degenerated nerve fibres and the non-degenerated nerve fibres are observed after vagotomy or posterior rhizotomy.

7) Sensory nerve fibres run alone without forming any complicated nervous structure, and terminate freely in the connective tissue between the smooth muscle cells.

8) The afferent nerve fibres in the vagus nerve are recognized in the media of the coeliac artery, superior mesenteric artery and portal vein.

9) The afferent nerve fibres of spinal origin in the coeliac artery are mainly derived from the dorsal roots between Th.9～Th.11 ; those in the superior mesenteric artery and portal vein between Th.11～Th.13 ; and those in the renal artery between Th.13～L.2.

10) Autonomic nerve fibres form the network along the way, but their terminal structures can not be clearly observed.

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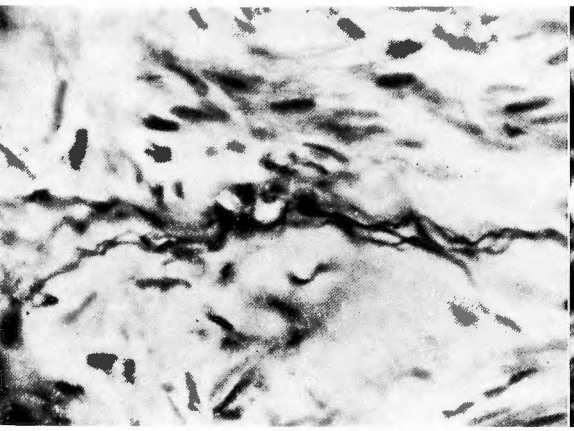

Fig. 1 Bundle of nerve fibres in adventitia. A.mesent. sup. × 400

Fig. 2 Nerve fibre in adventitia. A. coeliaca. × 400

Fig. 3 Nerve fibre running from adventitia into media in oblique direction. A. coeliaca. × 200

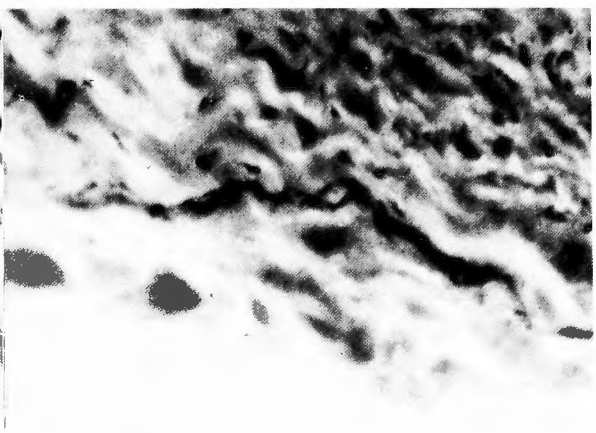

Fig. 4 "Nervoeses Synzytium" in adventitia. A. coeliaca. × 400

Fig. 5 "Nervoeses Synzytium" in adventitia. A. mesent. sup. × 900

Fig. 6 "Nervoeses Synzytium" in adventitia. A. mesent. sup. × 900

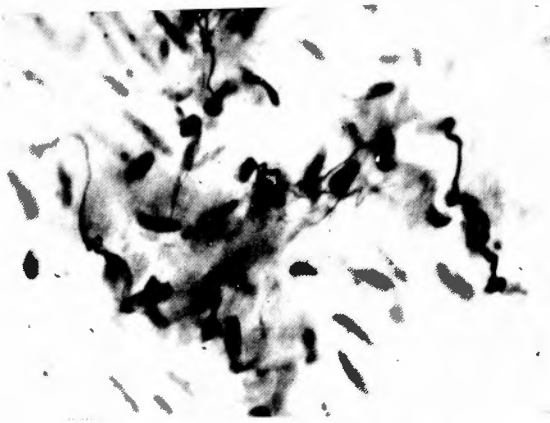

Fig. 7 Many interstitial cells are scattered in the complicated ramification of the nerve fibres in the media. A. coeliaca. × 400

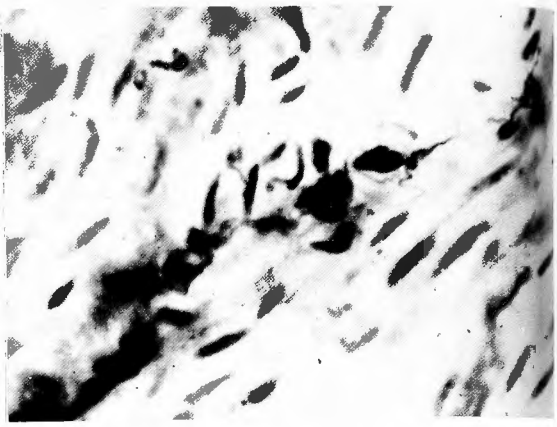

Fig. 8 Nerve fibres running in the media with the interstitial cells. A. coeliaca. × 400

Fig. 9 Nerve ramification accompanying the interstitial cells in the media. A. mesent. sup. × 400

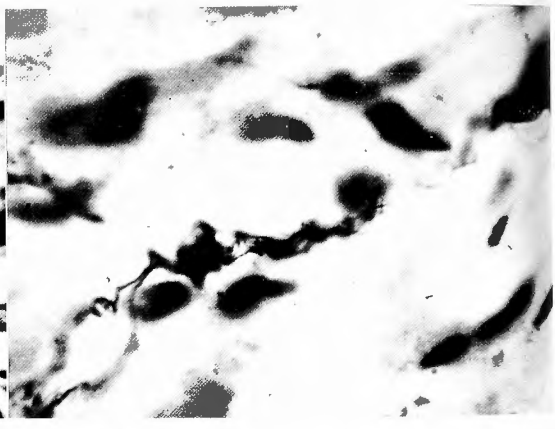

Fig. 10 The same preparation as Fig. 9. × 900

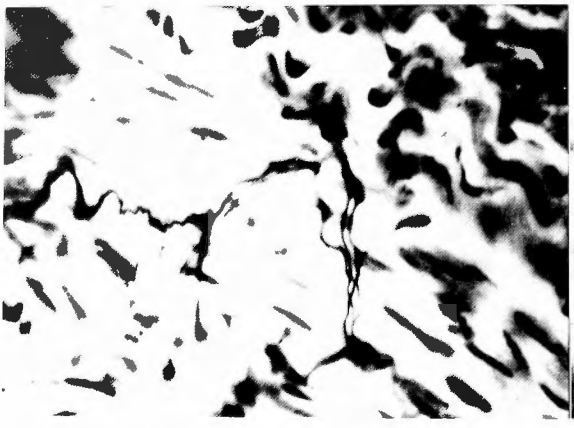

Fig. 11 Nerve fibre penetrating into media from adventitia. A. coeliaca. × 400

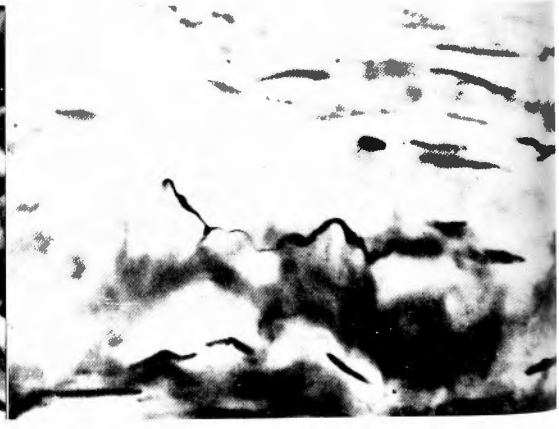

Fig. 12 Circular running nerve fibre in the media. A. mesent. sup. × 400

Fig. 13 Nerve fibre running alone in the media. A. renalis. × 400

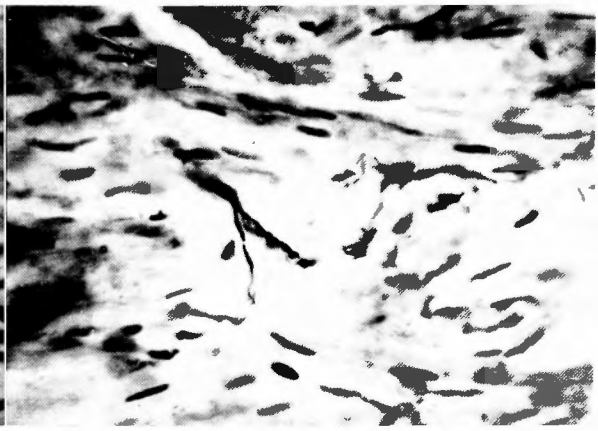

Fig. 14 Nerve fibre giving off branches along the elastic fibres of the media. A. coeliaca. × 400

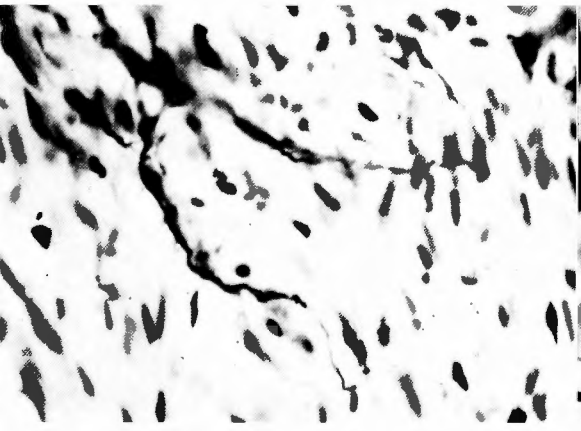

Fig. 15 Radial running nerve fibre with branches in circular direction along the elastic fibres of the media. A. coeliaca. × 400

Fig. 16 Nerve fibre in the media giving off branches. A. mesent. sup. × 400

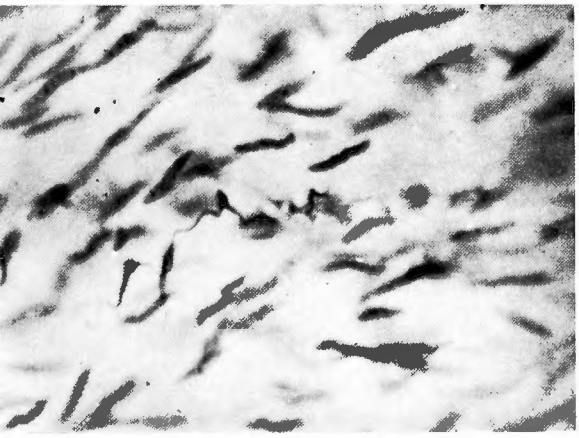

Fig. 17 Nerve termination in tapering ending in the connective tissue of the media. A. mesent. sup. × 400

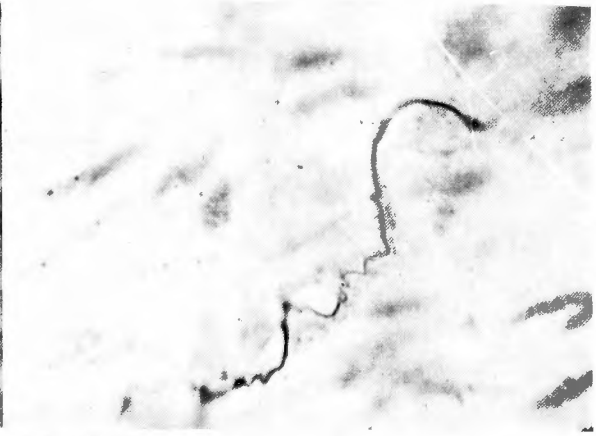

Fig. 18 Nerve termination in tapering ending in the connective tissue of the media. A. mesent. inf. × 900

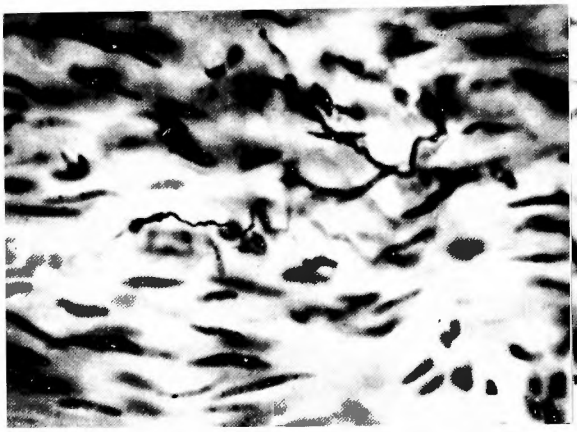

Fig. 19 Nerve termination in tapering ending in the media. A. renalis. × 400

Fig. 20 Nerve fibres forming a loop near the termination in the media. A. mesent. sup. × 400

Fig. 21 Nerve fibre terminates in loop-like ending in the media. A. mesent. sup. × 400

Fig. 22 Complicated ramification of nerve fibres accompanies many interstitial cells in the media. A. coeliaca. × 100

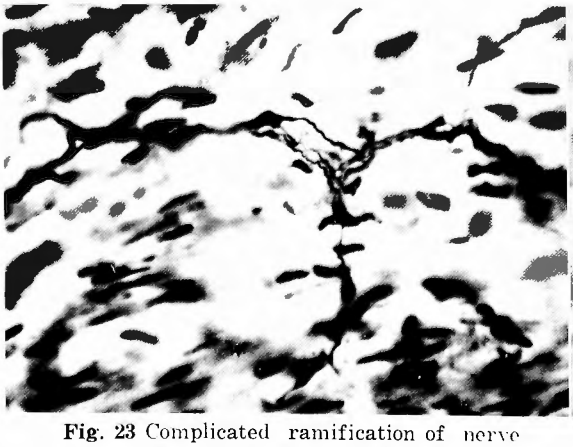

Fig. 23 Complicated ramification of nerve fibres in the media. A. coeliaca. ×400

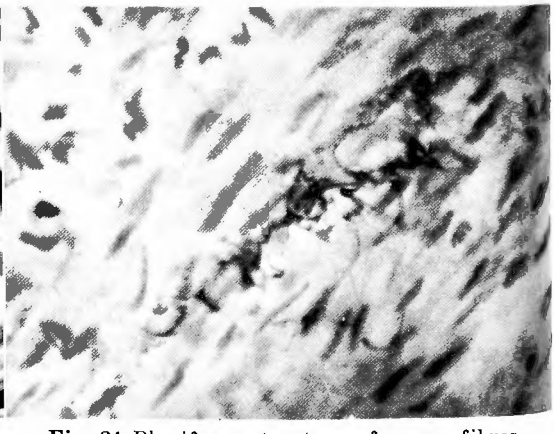

Fig. 24 Plexiform structure of nerve fibres accompanies many interstitial cells in the media. A. mesent. sup. × 400

Fig. 25 Plexiform structure of nerve fibres in the border between media and adventitia. A. mesent. sup. × 400

Fig. 26 Localized expansion of nerve fibre shows a network in the media. A. coeliaca. × 400

Fig. 27 The same preparation as Fig. 26. × 900

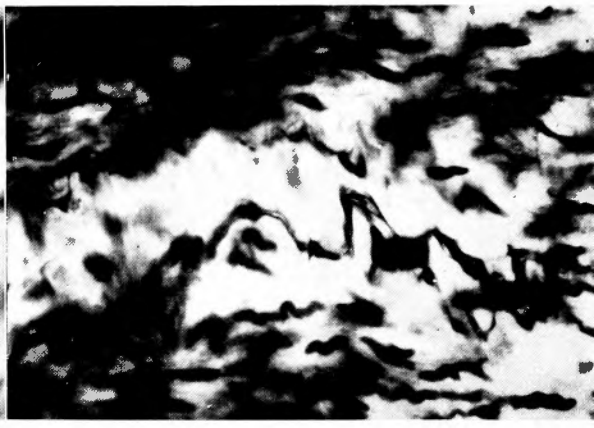

Fig. 28 Network structure of nerve fibres in which the interstitial cells are scattered. A. coeliaca. × 400

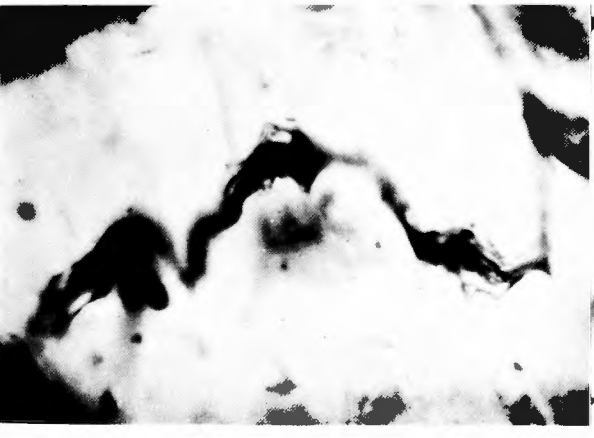

Fig. 29 The same preparation as Fig. 28. × 900

Fig. 30 Network structure of nerve fibre in which the interstitial cells are scattered. A. mesent. sup. × 900

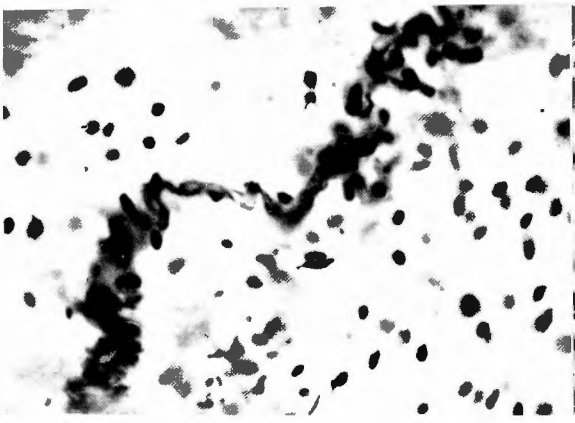

Fig. 31 Bundle of nerve fibres in adventitia. V. portae. × 400

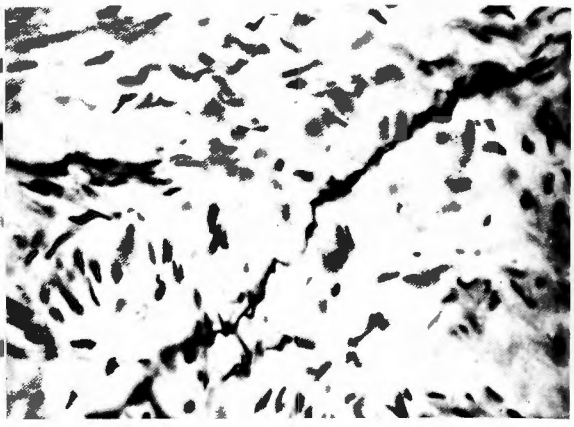

Fig. 32 Nerve fibre arises from the bundle in adventitia. V. portae. × 400

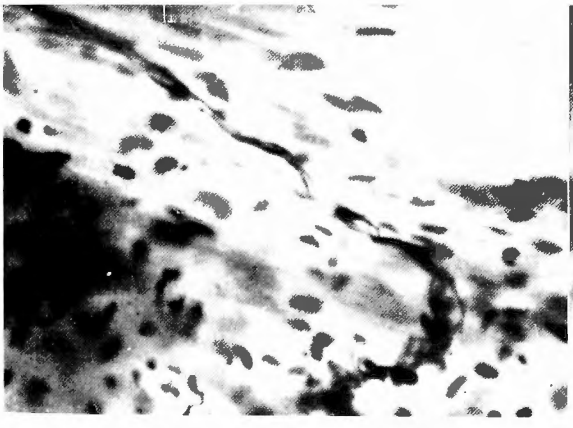

Fig. 33 Nerve bundle penetrates into media from adventitia. V. portae. × 400

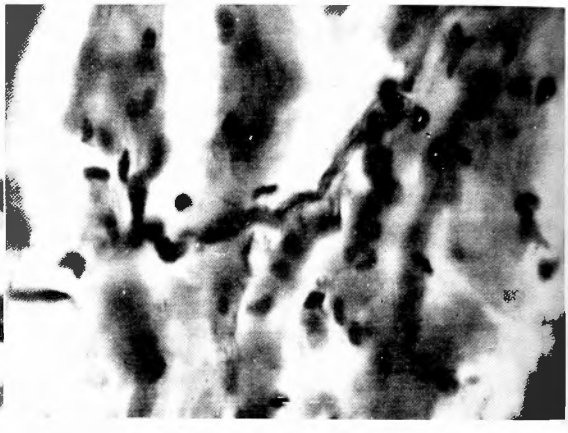

Fig. 34 "Nervoeses Synzytium" in adventitia. V. portae. × 400

Fig. 35 "Nervoeses Synzytium in adventitia. V. portae. × 900

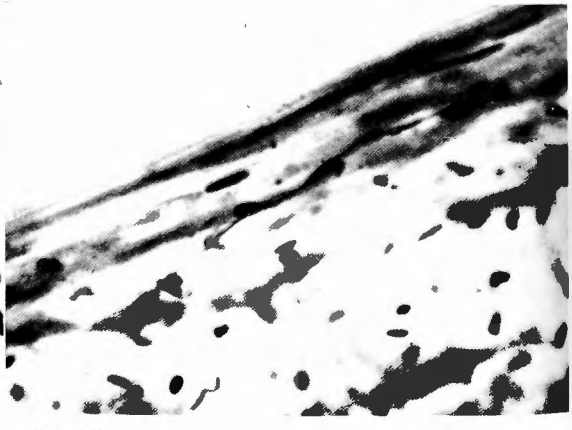

Fig. 36 Nerve fibre entering the media from adventitia. V. portae. × 400

Fig. 37 Nerve bundle in the media. V. portae. × 900

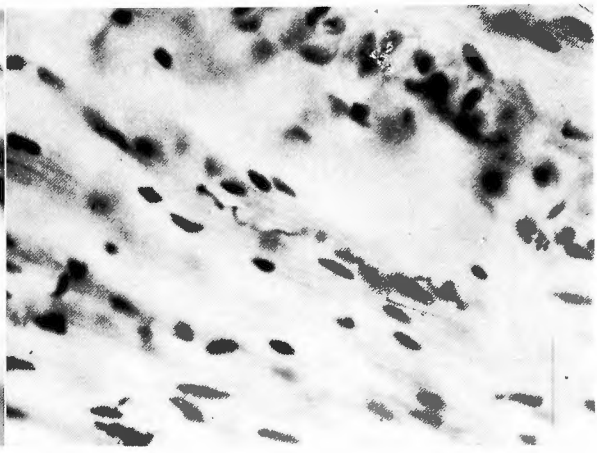

Fig. 38 Nerve termination in tapering ending in the connective tissue of the media. V. portae. × 400

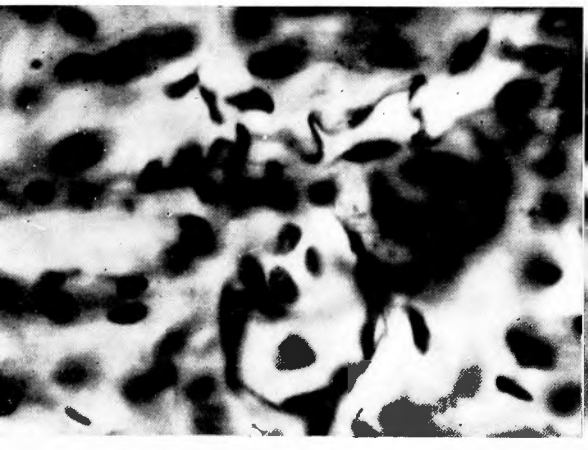

Fig. 39 Nerve fibre terminates in tapering ending in the connective tissue of the media. V. portae. × 400

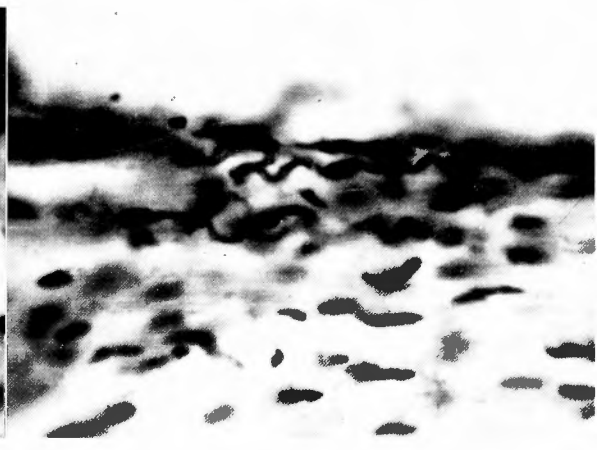

Fig. 40 Circular running nerve fibre in the meda. V. portae. × 400

Fig. 41 Nerve fibre forming a loop near the termination in the media. V. portae. × 400

Fig. 42 Degenerated nerve fibre showing marked argyrophilic swelling in the media, 5½ days after vagotomy. A. coeliaca. × 400

Fig. 43 Degenerated nerve fibre showing marked argyrophilic swelling in the media, 5½ days after vagotomy. A. coeliaca. × 400

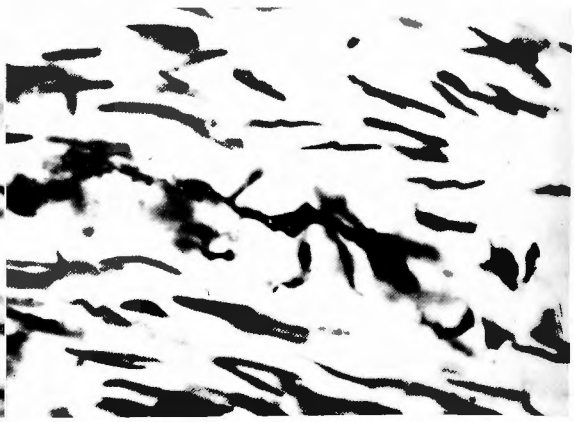

Fig. 44 Degenerated nerve fibre showing marked argyrophilic swelling in the media, 5½ days after vagotomy. A. mesent. sup. × 400

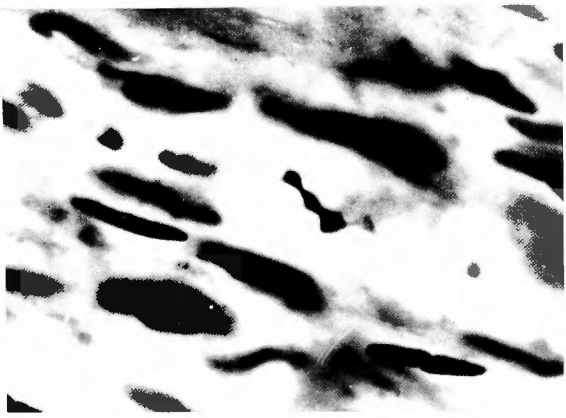

Fig. 45 Bead-like degeneration of axis-cylinder in the media, 6½ days after vagotomy. A. coeliaca. × 900

Fig. 46 Granular degeneration of axis-cylinder in the media, 7 days after vagotomy. A. mesent. sup. × 900

Fig. 47 Granular degeneration of axis-cylinder in the media, 7 days after vagotomy. V. portae. × 900

Fig. 48 Granular degeneration of axis-cylinder in the media, 4 days after post. rhizotomy. (Th. 6～Th. 8). A. coeliaca. ×900

Fig. 49 Bead-like degeneration of axis-cylnder in the media, 4 days after post. rhizotomy (Th. 9～Th. 11). A. coeliaca. × 900

Fig. 50 Bead-like degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 9～Th. 11). A. coeliaca. × 900

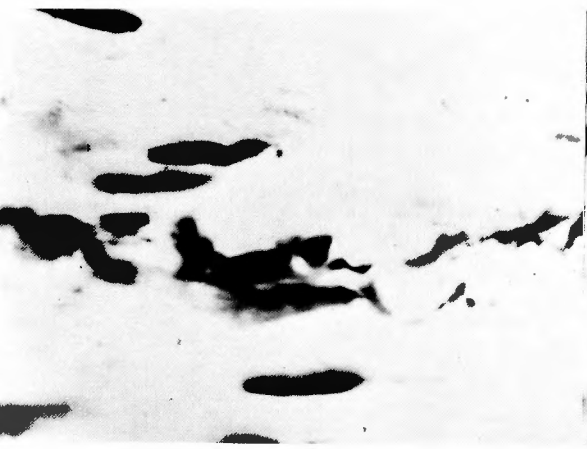

Fig. 51 Granular degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 9～Th. 11). A. mesent.sup. × 900

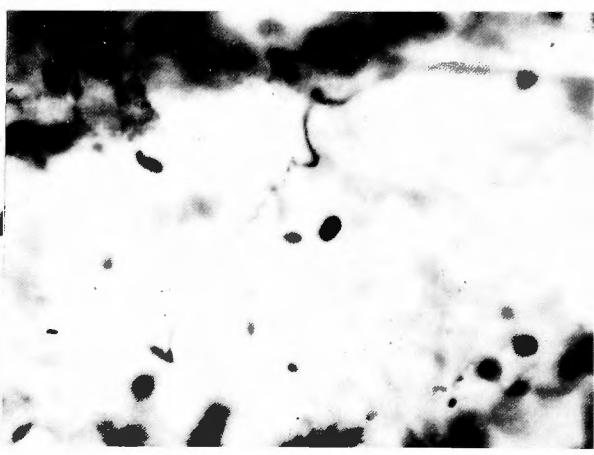

Fig. 52 Degenerated nerve fibre is broken down in the media, 4 days after post. rhizotomy (Th. 9～Th. 11). V. portae. × 400

Fig. 53 Granular degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 11～Th. 13). A. mesent. sup. × 900

Fig. 54 Granular degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 11～Th. 13). A. mesent. sup. × 900

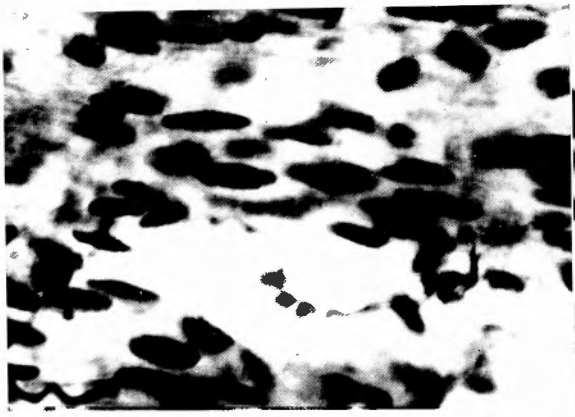

Fig. 55 Bead-like degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 11～Th. 13). V. portae. × 900

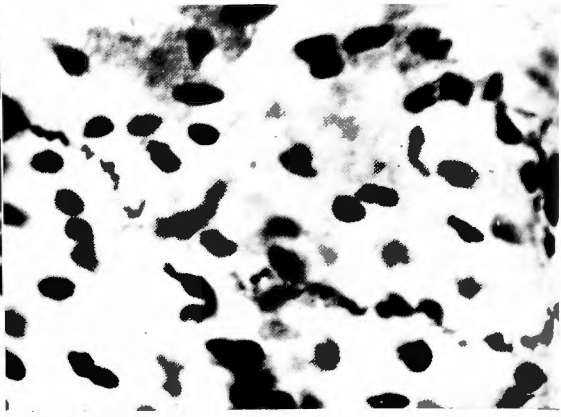

Fig. 56 Bead-like degeneration of axis-cylinder in the media, 4 days after pos. rhizotomy (Th. 11～Th. 13). V. portae. × 900

Fig. 57 Granular degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (Th. 13.～L. 2). A. renalis. × 900

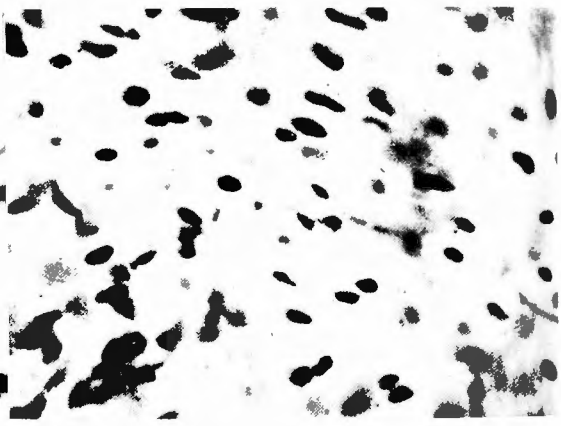

Fig. 58 Degenerated nerve fibre is broken down in the media, 4 days after post. rhizotomy (Th. 13～L. 2). V. portae. × 400

Fig. 59 Bead-like degeneration of axis-cylinder in the media, 4 days after post. rhizotomy (L. 3～L. 5). A renalis. × 900

和 文 抄 録

腹腔大血管の神経支配に関する組織学的研究

京都大学医学部外科学教室第2講座 (指導：青柳安誠教授)

喜 多 幅 知 郎

Jabonero 氏鍍銀法を用い，Weddell 氏によつて招介された「拡散因子」の応用により，成犬の腹腔大血管（腹腔動脈・上腸間膜動脈・下腸間膜動脈・腎動脈及び門脈）の壁内に於ける神経の形態及び分布を検索した．更にまた成犬の迷走神経並びに脊髄後根を実験的に切断し，血管壁内末梢神経軸索の二次的変性を追求し，その求心性神経支配に関して次の結論を得た．

1) 外膜内に於て，Jabonero の "nervoeses Synzytium" を多数認めた．

2) 血管壁内に於て，神経節細胞及び Paccini 氏小体は認められなかつた．

3) 多数の間質細胞が外膜内の "nervoeses Synzytium" 内に於てのみならず，中膜内に於ても認められた．

4) 中膜内に於ては，二種の神経線維が認められたが，その一は単独に走行し游離終末を以て終り，他は間質細胞を伴つて走行している．

5) 中膜内に於て，神経線維の網状構造を認めたがその外観は "nervoeses Synzytium" とは著しく異つていた．

6) 迷走神経切断術及び脊髄後根切断術施行後に於て，変性した神経線維及び変性しない神経線維の両方共が認められた．

7) 知覚神経線維は複雑な神経構造を形成することなく単独に走行し，滑平筋細胞間の結締織内に游離性に終つている．

8) 迷走神経性の求心性神経線維は，腹腔動脈・上腸間膜動脈及び門脈の中膜内に於て認められた．

9) 脊髄性の求心性神経線維は，腹腔動脈に於ては主として Th. 9～Th. 11 の後根を通り，上腸間膜動脈及び門脈に於ては主として Th. 11～Th. 13 の後根を通り，腎動脈に於ては主として Th. 13～L. 2 の後根を通つている．

10) 自律神経線維は中途に於て網状構造を形成するが，その終末の構造は明らかにすることが出来なかつた．