

Mucosal Vasculature after Truncal Vagotomy

Vagotomy is continuously gaining importance in the surgical treatment of duodenal ulcer. Few data, however, have been reported up to now about the ultra-structural aspects of vagus section in the gastric wall. It was considered of special interest to investigate the reaction of blood vessels to truncal vagotomy by means of the electron microscope.

In two series of experiments, adult mongrel dogs were vagotomized without drainage procedure and allowed to survive 3 h, 1–7 days, as well as 2 and 4 weeks after denervation.

Subsequently, the animals were laparotomized and after careful examination for signs of ulceration, specimens of the gastric mucosa were taken for electron microscopy.

Tissue blocks were fixed with glutaraldehyde at 0–4 °C. They were then washed in buffer solution and postfixed with a 1% solution of osmic acid. The blocks were dehydrated in ethanol and embedded in Epon 812. Sections were cut with a Reichert-Ultramikrotom, stained with uranyl acetate and lead citrate and examined with a Zeiss electron microscope.

A number of sham-operated animals were run as controls in order to establish the basic features of mucosal vasculature as well as to exclude any influence of narcosis upon blood vessels.

Results. The present results are based on the examination of about 10,000 ultra-thin sections. Figure 1 represents a capillary of a control animal. The lumen is filled with a flocculent material and the nucleus shows invaginations which are typical for endothelial cells. Clusters of ribosomes, pinocytic vesicles, scarce mitochondria and the Golgi-complex are present in the cytoplasm. The whole cell is surrounded by a well developed basement membrane.

As early as 3 h after nerve section, the majority of blood capillaries show a marked constriction which persists until the 14th day, though to a lesser extent. 4 weeks

after vagotomy blood vessels have assumed a normal lumen size. The initial ischemia causes a number of alterations in the endothelial cell. In the majority of capillaries the nucleus is swollen (Figure 2) and the number of pinocytic vesicles is reduced. At places the endoplasmic reticulum is dissociated or dilated and the mitochondrial matrix is swollen. Although these alterations can still be detected up to the 14th day after truncal vagotomy, no complete degeneration or dissociation of blood vessels was ever seen. Swelling of the endothelial cells may persist even after capillaries have assumed a normal width.

Discussion. The present electron microscopic findings correspond strikingly well to the results obtained by previous investigators. There is a unanimous agreement that vagotomy causes a reduction in gastric blood flow.

In 1961 NYLANDER and OLERUD¹ injected histamine into rats which had been vagotomized 4 weeks previously and found that the number of mucosal arterioles was reduced and that the capillaries were practically empty. They concluded that vagotomy reduced mucosal flow by opening submucosal arteriovenous shunts, thereby allowing blood to bypass the mucosa. Later, PETER et al.², using an electromagnetic flowmeter placed around a gastropiploic artery in 3 dogs concluded that vagotomy produced a 30% reduction in total flow. RUDICK et al.^{3,4} reported that in all 6 dogs they had subjected to

¹ G. NYLANDER and S. OLERUD, *Surgery Gynec. Obstet.* 112, 475 (1961).

² E. T. PETER, D. M. NICOLOFF, A. S. LEONARD, A. I. WALDER and O. H. WANGENSTEEN, *J. Am. med. Ass.* 183, 1003 (1963).

³ J. RUDICK, L. S. SEMB, W. G. GUNTHEROTH, G. L. MULLINS, H. N. HARKINS and L. M. NYHUS, *Surgery* 58, 47 (1965).

⁴ J. RUDICK, W. G. GUNTHEROTH and L. M. NYHUS, in *Gastric Secretion*. Symposium Publications Division (Ed. T. K. SHNITKA; Pergamon Press, Oxford 1967).

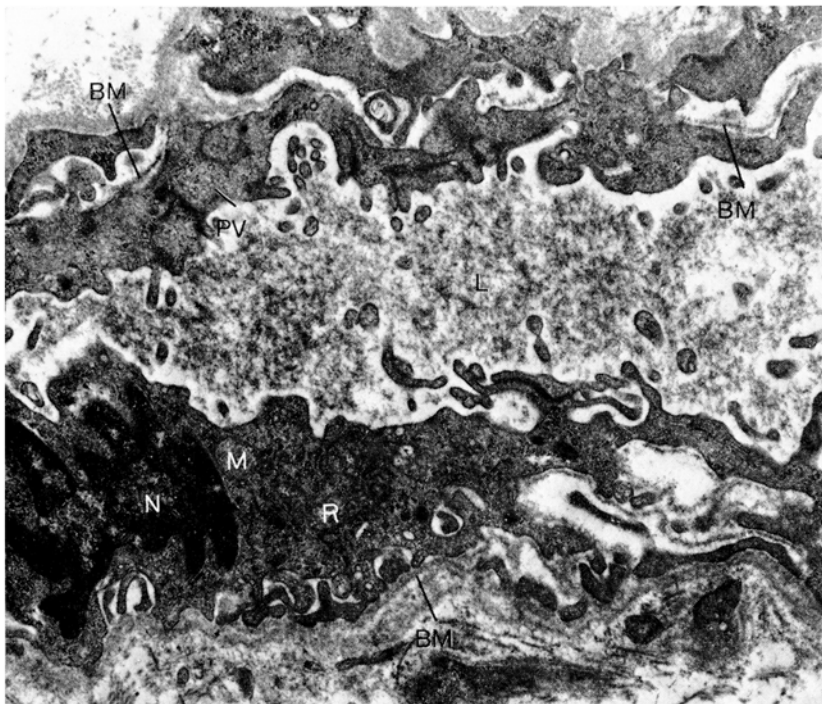


Fig. 1. Capillary in the gastric mucosa of a control animal. L, lumen; N, nucleus; R, ribosomes; PV, pinocytic vesicles; M, mitochondrion; BM, basement membrane. $\times 18,000$.

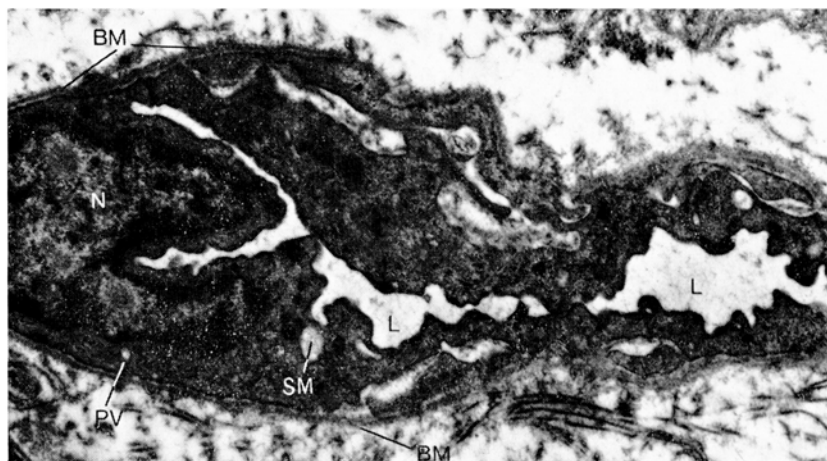


Fig. 2. Capillary in the gastric mucosa 2 days after truncal vagotomy. The nucleus (N) is swollen and the lumen (L) is extremely constricted. PV, pinocytic vesicles; SM, swollen mitochondrion; BM, basement membrane. $\times 18,000$.

vagotomy there was a 45% decrease in gastric blood flow. BALLINGER et al.⁵ found that total subdiaphragmatic vagotomy in 10 dogs resulted in an average reduction of 42% in blood flow through the common mesenteric vein as measured with a noncannulating square-wave electromagnetic flowmeter. They concluded that the mucosal atrophy of the small intestine occurring after division of parasympathetic nerves⁶ is due to a reduction in mesenteric blood flow. This ischemic damage results from unopposed sympathetic activity upon the intestinal vasculature. PADULA et al.⁷ determined the blood flow within the villi of the small intestine of dogs after vagotomy. They found a decrease of 40% while the mucosa became pale and the vessels within the villi contracted. Thus the observed decrease in mesenteric blood flow and vascularity of the mucosa of the small intestine after vagotomy may produce mucosal ischemia and thereby cause atrophy of the villi.

Finally, BELL and BATTERSBY⁸ measured the mucosal flow alone by using the clearance of labelled krypton from the gastric mucosa in the dog as an index of flow. They found that vagotomy caused a reduction in mucosal blood flow which varied from 29% to 74% in 10 of the 12 dogs used. Of particular interest was the sudden nature of the reduction in mucosal flow which regularly occurred within 5 min of nerve section. The measurement was carried out for about 2–3 h after nerve section in which time no recovery was apparent. This is well in accordance with our finding that 3 h after vagotomy capillaries appear constricted, as revealed by the electron microscope.

The question as to whether the above-mentioned acute changes in blood flow and vascularity persist over a long period of time was answered by DELANEY⁹. By using the radiorubidium distribution technique he found

no significant change in mucosal flow 4–6 weeks after truncal vagotomy. His results suggest that vagal section has no long-term effect on mucosal flow. This finding has also been confirmed by the electron microscope.

From the above-mentioned results of different investigators and the present morphological findings, it can be concluded that truncal vagotomy causes a transitory ischemia with reduction in gastric blood flow. To what extent the substructure of secretory cells may be affected by ischemia will be reported in a future publication¹⁰.

Zusammenfassung. Der Einfluss der trunkulären Vagotomie wurde an der gastrischen Mukosa von Hunden elektronenmikroskopisch untersucht. Dabei kommt es zu einer sehr deutlichen Verengung der Kapillaren mit Abweichungen der Endothelzelle von der Normalstruktur. Der ischämische Effekt der Vagotomie setzt sofort ein und ist nach 4 Wochen fast vollständig aufgehoben.

A. E. HALARIS

Max-Planck-Institut für Psychiatrie, Kraepelinstrasse 2, D-8 München 23 (West Germany), 20 August 1970.

⁵ W. F. BALLINGER, R. T. PADULA and R. C. CAMISHION, *Surgery* 57, 409 (1965).

⁶ W. F. BALLINGER II, J. IIDA and G. E. APONTE, *Surg. Forum* 14, 366 (1963).

⁷ R. T. PADULA, P. H. NOBLE and R. C. CAMISHION, *Surgery Gynec. Obstet.* 127, 41 (1968).

⁸ P. F. BELL and C. BATTERSBY, *Gastroenterology* 54, 1032 (1968).

⁹ J. P. DELANEY, *Surgery* 62, 155 (1967).

¹⁰ A. E. HALARIS, in preparation.

About the Transformation of the Interstitium in the Ovary of Mammals and Women during the Age of Prepuberty

As the result of our histogenetic and histochemical studies of the ovary of the guinea-pig during its post-natal period, we observed a phenomenon which we called isofolliculia. This phenomenon is characterized by the evidence of follicles almost of one size and total enzymic

inactivity in the interstitium. It was observed in 30-day-old animals.

427 ovaries taken from guinea-pigs during their post-natal period and ovaries taken from 5 girls whose ages were between 9½–11 years, were studied. Besides the