ARTERIO-VENOUS ANASTOMOSES IN THE HUMAN STOMACH

By T. E. BARLOW

From the Departments of Anatomy and Surgery, University of Durham, Newcastle upon Tyne

The precise distribution of the vessels of the stomach has been a subject of interest to anatomists and clinicians for many years. The common variations of the large arteries supplying this organ have been recorded, and the fate of the vessels after they pierce the muscular layer has been studied by dissection and by radiography.

These methods have shown that the branches of the large named arteries, on reaching the submucous layer of the stomach, break up into a network of channels readily visible to the naked eye, forming a free communication between vessels of the lesser and greater curvatures.

From this submucous plexus of large vessels finer branches arise which pass in an oblique direction through the muscularis mucosae to reach the mucous membrane (Disse, 1904; Reeves, 1920; Jatrou, 1920; Hofman & Nather, 1921; Djørup, 1922; and Babkin, 1940). The venous return is by comparable channels.

The recent work of Barclay & Bentley (1949) suggested that under certain conditions blood flowed directly from arteries into veins through arterio-venous anastomoses in the submucous layer of the stomach wall, so short-circuiting areas of the mucosa from the active circulation.

Arterio-venous anastomoses were first recorded by Lealis (1707), but they have only been regarded as of importance in the control of blood flow in comparatively recent times. Schumacher (1938) described two types of arterio-venous anastomosis. The first is a complicated knot of vessels ('glomus'), the walls of which are characterized by an epithelioid type of cell in the tunica media; these cells replace the typical muscle cell and are said to control the anastomosis by swelling or shrinking.

The other form exists as a sinuous but more direct connexion between artery and vein, and may be controlled by additional plain muscle cells in the tunica media.

These anastomoses are known to be present in many tissues, and there is reason to suppose that they exist in all organs, particularly where function is phasic in nature. Such an organ is the alimentary canal. Spanner (1932) has established the presence of arterio-venous anastomoses in the intestinal villi of man, and has also described arterio-venous anastomoses in the intestinal submucous plexus of other mammals, consisting of vessels arising from large submucous arteries and passing after a long course in the submucosa to venous 'nodes'. The 'nodes' may be in the form of 'rope-ladder' plexuses whose efferent vessels soon enter submucous veins. Spanner claims that the 'nodes' are dilated venous sacs, produced by contraction of muscle elements (sphincters) irregularly spaced along the vein wall.

METHODS

In order to study the precise arrangement of vessels in the human stomach wall, the vessels were injected with suspensions of red or blue pigment, the stomach wall was

cleared, and the vessels were dissected under the microscope. The stomachs were obtained from the cadaver, or at operations of partial gastrectomy for peptic ulcer.

Cannulae were tied into the right gastro-epiploic artery and vein and, in the case of an operation specimen, the cut edges of the stomach were secured by clamps to prevent escape of fluid. Leaking points were ligated, and the injection was continued until the small subserous and muscular branches were seen to be well filled on examination with a hand lens.

The injection mass consisted of 5 % red or blue pigment in 4 % gelatin solution; when capillary filling was not desired, 20 % of rice starch granules were added to the injection mass (Scharrer, 1940). The red or blue pigment is one normally used for colouring neoprene latex (B. B. Chemical Co. Ltd.). A mass of each colour was injected simultaneously into artery and vein respectively through a constant pressure apparatus at pressures not exceeding 150 mm. Hg on the arterial side and 80 mm. Hg in the vein.

After injection, the specimens were fixed for 24 hr. in 10 % formalin, with clamps still in position across the cut edges. The stomachs were then opened through the anterior wall close to the greater curvature, and portions were removed for clearing in 2 % potassium hydroxide solution. After 7 days the pieces were brought through successive strengths of glycerine into pure glycerine, in which they were kept.

The injected vessels were readily visible under the microscope in the cleared specimens, and by suitable dissection could be traced from the submucous plexus to the mucosal capillaries.

OBSERVATIONS

The arrangement of vessels in the submucous layer of the stomach wall is complex, but it is possible to describe two main systems of arteries and veins.

(1) Readily visible to the naked eye is a main submucous plexus of large arteries (Pl. 1, fig. 1) fed by the gastric and gastro-epiploic vessels, giving rise to branches which pass obliquely towards the mucosa and ultimately supply it. These are the mucosal arteries described by Disse (1904) and others. There is a corresponding venous plexus.

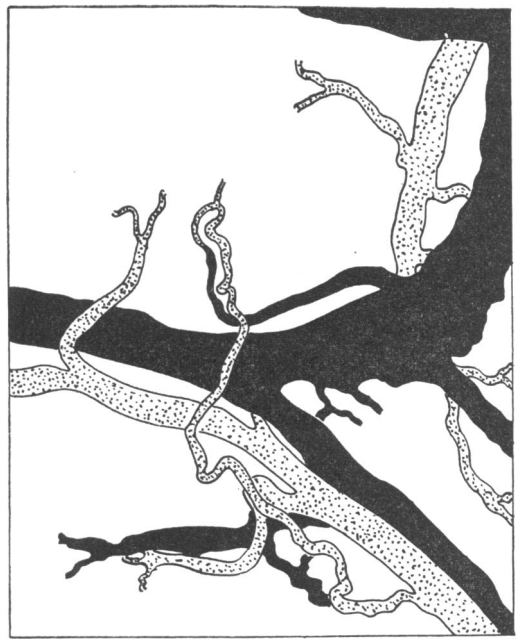
(2) Also lying in the submucosa is a second plexus of arteries and veins which vary in size from 100 μ to capillary diameter; it consists of two parts: (*a*) vessels which arise from and surround the main channels of the submucous plexus, some of the veins showing numerous dilatations which receive cross-branches from other veins; and (*b*) a series of arterial and venous loops of variable size (Pl. 1, fig. 2) which take origin from the main submucous vessels and spread their arcades throughout the submucosa. In places the loops end in capillaries within the connective tissue of the submucosa, but for the most part they remain as an intricate network, not penetrating the muscularis mucosae, though communicating with vessels in the muscular coat of the stomach. Numerous dilatations are seen in the veins of this connective tissue plexus.

Arterio-venous anastomoses

The arteries destined to supply the mucosa arise from the branches of the main submucous plexus and pass obliquely across the submucosa, branching and coiling as they reach the region of the muscularis mucosae, which they pierce to reach the

mucous membrane. From these oblique arterial vessels slender branches are occasionally given off which can be traced directly into neighbouring small veins which drain to the submucous plexus (Text-figs. 1, 2). In the dissections, the red (arterial) injection mass meets the blue (venous) about the middle of these anastomotic channels, but the proof of their arterio-venous anastomotic nature lies in the ability always to show a direct channel, nowhere less than 30μ in diameter, between an unmistakable artery and vein in the submucosa.

These anastomotic channels may follow a straight course, or a tortuous one, and may enter the parent artery at right angles or obliquely, against the direction of blood flow in that vessel (Text-fig. 2).



Text-fig. 1. Projection drawing of an Ektachrome transparency of an arterio-venous anastomosis in the submucosa (artery, stippled; vein, black). Arterial and venous branches of the submucous plexus cross the lower part of the field. Arising from the artery is a tortuous vessel which passes towards the centre of the field where it directly joins a channel which bends underneath it to reach an accompanying vein. ($\times$32.)

The arterio-venous channel usually shows a narrowing at the point of junction of the red and blue injection masses, but the narrowest part in fixed specimens is never less than 30μ in diameter, and the general diameter is from 40 to 60μ. Recent observations by Walder (1950) suggest that many larger arterio-venous channels exist.

The complex arterio-venous anastomoses ('glomus') in the stomach wall described by de Busscher (1948) have not been observed with this technique. Only simple communicating channels between artery and vein in the submucosa have

been noted. The number, distribution and minute structure of these is yet to be determined.

Text-fig. 2. Projection drawing of an Ektachrome transparency of an arterio-venous anastomotic loop in the submucosa (artery, stippled; vein, black). The continuous channel can be readily followed between mucosal artery and vein. (×40.)

SUMMARY

The presence of arterio-venous anastomoses in the human stomach deduced by Barclay & Bentley (1949) has been demonstrated by double-injection technique. These are present in the submucous connective tissue of the gastric wall and are of the direct type.

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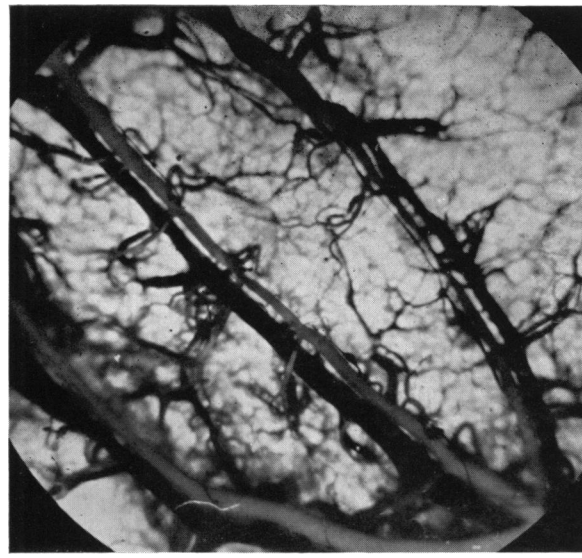

Fig. 1.

Fig. 2.

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EXPLANATION OF PLATE

Fig. 1. Three main arteries of the submucous plexus with the corresponding veins (artery, grey; vein, black). Mucosal branches can be seen leaving the main artery and proceeding towards the mucosa. (×6.)

Fig. 2. A loop of the extensive connective tissue plexus showing arteries and veins. Venous dilatations receive several smaller branches. (×32.)

Photographs and Ektachrome transparencies produced by the University of Durham Photography Department.