GASTRIC EMPTYING IN RELATION TO SURGERY FOR DUODENAL ULCER

ESSAY

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بسم الله الرحمن الرحيم

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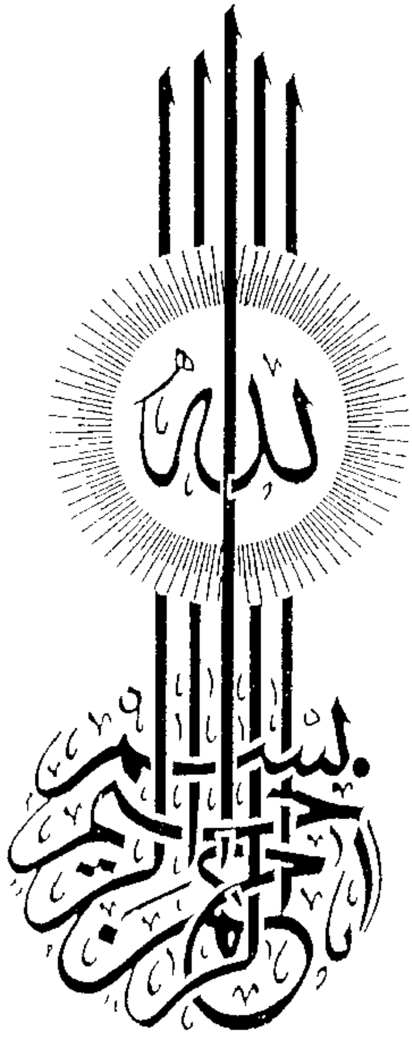
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INTRODUCTION

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Significant advances in the study of gastric motility have been made in recent years. Before the clinical problems of gastric motility after surgery for duodenal ulcer are considered, the morphophysiological aspects of emptying of the stomach must be reviewed. The concept of different anatomic areas of the stomach handling different physical phases of gastric contents has allowed new pathophysiologic insight into gastric dysmotility. New diagnostic techniques are clarifying many clinical and postsurgical emptying disorders. The significance of these pathophysiologic and diagnostic advances has become enhanced by the advent of prokinetic therapeutic agents. A number of studies attribute some of the unpleasant sequelae following gastric surgery to changes in gastric emptying. (Minami, 1984).

FUNCTIONAL ANATOMY OF INTRINSIC AND EXTRINSIC INNERVATION OF THE STOMACH

For many years a relationship has been assumed to exist between abnormal gastric emptying and dyspeptic symptoms. Recent advances have revealed clear-cut patterns of organization and specific control mechanisms in the stomach. The mixing and storage function of the stomach must be continually capable of precise adaptation to an input which is highly variable in volume, consistency and content. It is clear that there must be a highly sophisticated control system. The neurogenic mechanism depends on an intrinsic nervous system modulated by extrinsic nervous controls. (Cooke, 1975).

The precise mechanism of control of the activity of the smooth muscle cells remains unclear. Neural input seems to be of major importance. The intrinsic and extrinsic innervation is exceedingly complex. The classic view was that of an extrinsic innervation of excitatory cholinergic parasymphatic vagal input and an inhibitory adrenergic sympathetic splanchnic input. However, recent advances have revealed a very rich intrinsic innervation, with in addition to traditional cholinergic and adrenergic nerves. Non-adrenergic non-cholinergic (NANC) nerves, with many candidate neurotransmitters. The immediate level of control of the smooth muscle is by the myenteric plexus which serves as a link between receptor and effector and embodies an intrinsic programme of organised activity. The myenteric plexus responds to neural output from both local receptors and higher cortical controls by selecting the appropriate programme. Whilst the initiation and propagation of gastric motor activity is intrinsic to the stomach; the control of the response to food is dependent upon extrinsic influences. Vagotomy, stimulation of brain stem vagal nuclei and acute vagal blockade can all affect established post-prandial activity. (Bennett et al., 1975).

The patterns of contraction of the orad part of the stomach differ from those of the caudal part and the secretory functions of the stomach also differ in different parts. The nerves of the stomach affect both secretory and motor functions; thus, differences in the intramural nerves could exist between the parts of the stomach. (Christensen, et al., 1983).

The myenteric plexus is generally thought of as a reasonably uniform matrix of intersecting nerve bundles, with ganglia at the points of intersection, and thus as a continuum throughout the gastrointestinal viscera. This idea of the structure of the plexus underlies current thought about its function. The myenteric plexus of the stomach is a matrix of large stellate ganglia connected by nerve liber bundles. Heterogenesity in this plexus has been sought in the comparative densities of intrinsic nerve cell bodies (ganglion cells) in orad and caudal parts of the stomach, in rodents and primates: ganglion all density increases caudally. (Irwin, 1931).

In the orad stomach, a neural structures were discovered, these were thick argyrophilic nerve bundles, running through the myenteric plexus, radiating from the cardia toward the greater curvature, by passing ganglia proximally but giving off thick branches to adjacent ganglia distally. They were therefore called shunt fascicles. Shunt fascicles enter the stomach at the cardia descending from the esophageal myenteric plexus, at their distal ends, they ramified along the ganglia of the greater curvature, shunt fascicles were found in all parts of the cranial part of the stomach but were less often found in the caudal part of the stomach. They lay beneath the longitudinal muscle layer throughout their course. They lay on the front and back of the proximal stomach. They are more abundant in the gastric fundus and body than in the antrum. About 1 percent of the fiberes are myelinated. Arterioles and venules follow shunt fascicles and give rise to perifascicular capillary networks. (Christensen, et al., 1985).

In the proximal stomach, the myenteric plexus consisted of thin intersecting nerve bundles with conspicuous large ganglia at the intersections. The ganglia were nearly all of intermediate type, except for a few parafascicular ganglia just below the cardia. The plexus was regular in that ganglia were distributed fairly uniformly. Upon this basic pattern there were superimposed several thick, conspicuous, and darkly stained nerve fascicles i.e. shunt fascicles. (Christensen, et al., 1983).

In the distal stomach, the myenteric plexus consisted of thicker nerve bundles with large ganglia at the intersections. These ganglia were all intrafascicular. No shunt fascicles were found in this region.

The plexus was regular in that ganglia were distributed fairly uniformly. (Christensen et al., 1983).

In the pylorus, easily identified by a thick ring of circular muscle, there was an abrupt change from the relatively dense myenteric plexus of the distal stomach to the relatively sparse plexus of the duodenum. At this intersection, one to three very thick, darkly stained fascicles encircled the pylorus and gave branches on either side to the antrum and the duodenum. Separating the two patterns of the plexus, that of the stomach above and the duodenum below. (Christensen et al., 1983).

The extrinsic nerves enter the musculature and communicate with the subserous, myenteric, submucosal and mucosal plexuses. These plexuses intercommunicate and are denser in the stomach than in other gastro-intestinal viscera. The nerve plexuses of the stomach are connected to the central nervous system via the vagi and the splanchnic nerves and their plexuses. (Jansson, 1969).

Anatomy of the vagus nerve:

The vagus nerve arises within the cranium by eight to ten vagal rootlets from four nuclei of the medulla, namely, the dorsal nucleus of the vagus, nucleus ambiguus, nucleus of the tractus soliterius and the spinal nucleus of the trigeminal nerve. It passes through the Jugular foramen of the cranium. It descends in the neck in the carotid sheath. Within the neck each nerve gives rise to five branches, the pharyngeal nerve, a branch to the carotid body, superior laryngeal nerve, recurrent laryngeal nerve and the cardiac nerve. The right vagus continues on the posterior surface of the esophagus and breaks up into the posterior esophageal plexus which also receives the left vagus. The left vagus descends on the anterior surface of the esophagus, its fibres join those of the right vagus to form the esophageal plexus. Distally the fibres of the plexus reunite to form two divisions, the anterior trunk forms the hepatic division and the anterior gastric division, while the posterior trunk forms the coeliac and posterior gastric division. About 90 percent of the vagal fibres are sensory afferent, the remaining 10 percent are efferent (Skandalakis et al., 1986).

Two vagal trunks at the hiatus is the simplest and most frequent condition. 91 percent of the anterior and 86 percent of the posterior trunks were on the right. The anterior trunk lies closer to the esophagus than does the posterior trunk which lies closer to the aorta, in loose connective tissue some distance behind the back of the esophagus, even as far as some centimeters away on the front of the right crus. (Carter, et al., 1986).

The anterior gastric division follows the lesser curvature of the stomach, giving 2 to 12 branches to the anterior gastric wall. In most instances, a major branch of the anterior gastric division forms the principal anterior nerve of the lesser curvature (the anterior nerve of laterjet) which lies 0.5 to 1 cm from the lesser curvature and can be traced to the level of the incisura (Skandalakis et al., 1986).

The posterior vagal trunk gives off the posterior nerve of Laterjet which descends along the lesser curvature suppling the posterior aspect of the stomach, and the coeliac division which leads to the coeliac plexus. (Skandalakis, et al., 1986).

Both nerves of Laterjet, at the pyloric antral area fan out into branches forming the"Crow's foot" that is generally within 7 cm of the pyloro duodenal area (Rossi et al., 1980).

The most proximal posterior gastric branch, the "criminal nerve" of Grassi, arises at, or above the origin of the coeliac division, and due to the dificulty in locating it, becomes instrumental in subsequent recurrent ulceration. (Skandalakis, 1986).

Grassi (1977) demonsterated the criminal nerve in 91 percent of patients (in 19 percent it was double), and varies greatly in its position and caliber, sometimes it is intraluminal in location. In 16 percent it originates from the posterior vagal trunk at the level of, or above the diaphragmatic oesoplageal hiatus. Depending on its level of origin, it runs an oblique course on the posterior aspect of the cardia and fundus.

The sympathetic supply of the stomach:

The sympathetic supply of the stomach is by perivascular plexuses (left gastric, hepatic, and splenic) which arise from the coeliac plexus. These are composed primarily of postganglionic sympathetic fibres, the cell bodies of which form the coeliac ganglia. The preganglionic fibres concerned reach the coeliac gangsia by means of the greater splanchnic nerve from thoracic cord segments five to nine or ten. The perivascular plexuses may also conduct to the stomach some parasympathetic fibres reaching the coeliac plexus through the posterior vagal trunk (Woodburn, 1974).

The splanchnic nerves and their plexuses constitute mainly sympathetic fibers and sensory fibers. The sympathetic innervation is largely postganglionic coming from neurons of the paravertebral ganglia, the paravertabral abdominal ganglia (mainly the coeliacganglion), terminal ganglia lying near or in the stomach wall, and ganglia somewhere in the vagal system. The transmitters of the postganglionic sympathetic fibers, are catecholamines. Excitation of vagal motor fibers may cause either contraction or inhibition suggesting two kinds of motor fibers. Those mediating inhibition require stronger electrical stimulation of the vagi than those which are excitatory. The inhibition is most prominent in the proximal stomach and is probably due to the "purinergic" fibers. Excitation of the sympathetic motor fibers may cause contraction or inhibition. The excitatory fibers have a lower threshold to electrical stimulation and may be cholinergic. The inhibitory fibers appear to be adrenergic. The sensory fibers carry impulses from stimulation of the intestinal (chemoreceptors) and gastric (mechanoreceptors) receptors and these travel in the vagi. Pain sensations are carried via splanchnic afferents which enter the spinal cord from about T_8-T_{13} dorsal nerve roots. Impulses travelling over sensory and motor fibers to and from the stomach are integrated in the central nervous system and may involve a complex of circuits within the spinal cord, medulla, midbrain, subcortex and cortex (Thomas et al, 1968).

PHYSIOLOGY OF GASTRIC EMPTYING

PHYSIOLOGY OF GASTRIC EMPTYING

The present understanding of the normal control and regulation of gastric emptying has been established by investigations spanning more than 100 years. A number of studies attribute some of the unpleasant sequelae following gastric surgery to changes in emptying. (Humphrey et al., 1972).

The stomach receives and stores food, mixes it with gastric secretions, and then delivers it to the duodenum in an orderly fashion. It empties liquids faster than solids and may use different mechanisms to do so. As a motor unit the stomach is classically considered as having two functional areas; a proximal receptacle: the fundus and body: and a distal pump, the antrum which mixes and churns gastric contents and delivers them to the duodenum. At the end of the antrum is the pylorus, the function of which is not clear. The pylorus may have a sphincteric function to impede emptying or may act as an antireflux mechanism (Kelly, 1980).

The Gastric pace-maker:

The concept of a pace-maker in the stomach was first proposed by Alvaraz (1948) who observed that strips of longitudinal muscle taken from different parts of the stomach had different spontaneous rates of contraction, the higher rates being found in muscle strips taken from near cardia. He suggested that at the proximal end of the stomach, there was a gastric pace-maker, and more recent studies indicate that this is situated in the greater curvature. The greater curvature