Gastric Secretion: Mechanism and Hormones | Digestive System | Biology

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In this article we will discuss about:- 1. Mechanism of Gastric Secretion 2. Hormones of Gastric Secretion 3. Effects of Various Chemicals and Drugs 4. Investigation.

Mechanism of Gastric Secretion:

The mechanism of gastric secretion has been chiefly studied on animals. Some direct evidence has been obtained in man, from cases of accidental gastric fistula through which gastric juice could be collected. In man another method is often applied known as fractional test meal. This method is commonly adopted for investigating gastric functions in man at bedside.

In animals two very important experiments have been done for investigating the mechanism of gastric secretion:

(1) The experiment of sham feeding, and

(2) The preparation of Pavlov's pouch.

1. Sham Feeding:

(Fig. 9.31). The oesophagus of a dog is exposed and divided in the middle of the neck and the two cut ends are brought to the surface. When the dog swallows food, the latter comes out through the upper cut end and does not enter the stomach. This experiment is very important to prove whether the food can stimulate gastric secretion even before entering stomach.

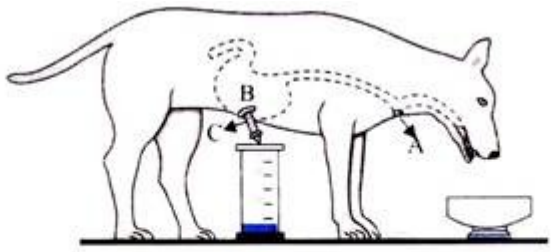


Fig. 9.31 SHAM FEEDING
A = Opening of the divided oesophagus through which swallowed food is dropping out. B = Body of the stomach with fistula through which gastric juice is coming out. C = cannula in the fistula.

2. Pavlov's Pouch (Fig. 9.32):

It is a small diverticulum prepared from the body of the stomach and representing about one-eighth of the whole stomach. The pouch is prepared in such a way that its inner end is shut off from the main cavity of the stomach by two layers of

mucous membrane while the outer end opens outside through an wound in the abdominal wall. During the surgical procedure least injury is done to the vessels and nerves, so that the pouch secretes a juice identical with that secreted by the body of the stomach.

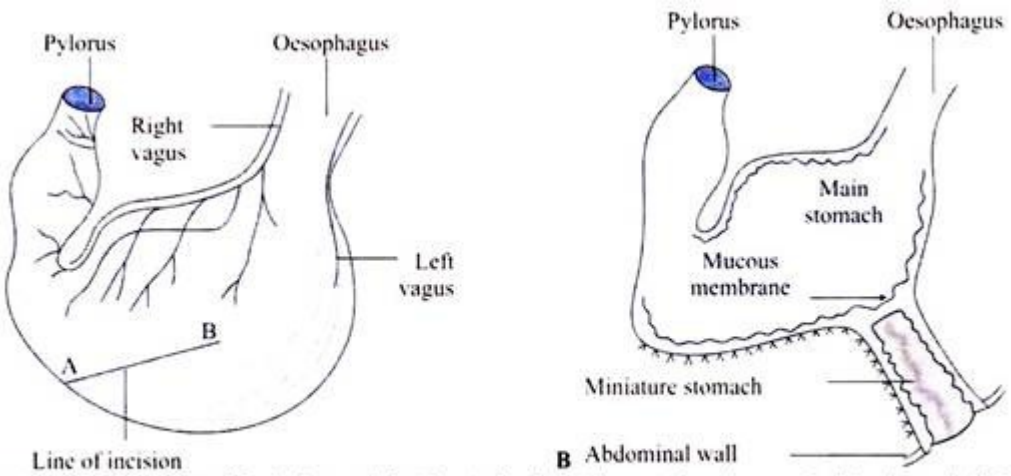


Fig. 9.32 (A) Preparation of Pavlov's pouch for the study of gastric secretion where an incision is made that leaves the innervation intact; (B) Final stage after healing showing abdominal wall through which Pavlov's pouch is opening outside.

This preparation has got the following advantages:

i. Pure gastric juice can be collected from this pouch unmixed with food. This is a great help in studying the variations of gastric secretion—both in quality and quantity—as may be produced by different stimuli.

ii. It is found in dogs, that the juice secreted by the pouch is always a constant fraction of the total amount of juice secreted by the main stomach. From this the total secretion can be found out.

Hormones on Gastric Secretion:

Hormones secreted by different endocrine glands influence gastric secretion.

i. Glucocorticoids secreted by adrenal cortex stimulated by ACTH increases acid and pepsin secretion by the stomach but decrease the mucous secretion, and thus make it more susceptable to ulceration.

ii. Epinephrine and norepinephrine, on the other hand, decrease gastric secretion.

iii. Hypophysectomy causes characteristic changes in the chief cells of the gastric glands, consisting of a decrease in the size of nucleus and loss of most of the pepsinogen granules. Secretion of hydrochloric acid is also reduced.

iv. Serotonin, possibly a hormone secreted by certain enterochromaffin cells in the intestinal mucosa, inhibits gastric secretion particularly that activated reflexly or by cholinergic drugs.

v. Reserpine, which is used as a tranquiliser and in the treatment of high blood pressure, produces increased acid production in the stomach when given in a high dose for a long time. The mode of action is not clear.

vi. Insulin acts through its effect on glucose metabolism and has an effect on the gastric glands similar to that of stimulation of the vagi. Release of gastrin is reduced by insulin.

Effects of Various Chemicals and Drugs on Gastric Secretion:

Numerous chemical agents and various drugs affect gastric secretion.

i. Histamine is a powerful stimulant of gastric secretion. It is thought that it acts directly on the parietal cells. Histalog, an anlog of histamine, is also a powerful gastric stimulant.

ii. Caffeine and alcohol are strong secretory stimulants, producing a juice of high acidity and rich in mucin.

iii. Parasympathetic agents, such as acetylcholine, mecholyl, etc., are secretory stimulants.

iv. Secretory depressants are also known. Alkali and acids depress gastric secretion. Belladona, atropine, hyoscine, etc., are secretory depressants.

Investigation of Gastric Secretion in Man:

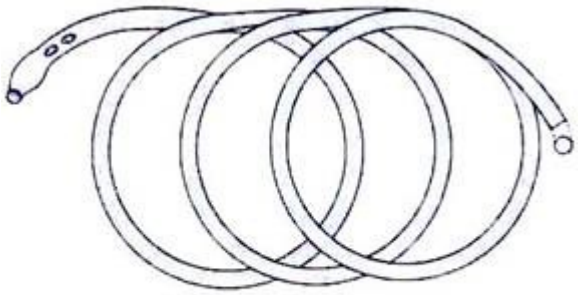
The method which is commonly adopted for investigating gastric secretion in man is called fractional test meal or gastric analysis.

The procedure is as follows:

The subject is given diet on the previous evening. In the next morning the patient is made to swallow a thin flexible rubber tube known as the stomach tube (Ryle's tube, Lyon's tube or some other modification, (Fig. 9.34). The tube has got three markings on it. When swallowed up to the first mark coinciding with incisor teeth (about 30 cm or 12 inches from the end) the end is near the cardiac end of the oesophagus; if up to the second mark the end is within the stomach; when up to the third mark the end has entered the duodenum.

During gastric analysis, the subject swallows the tube up to the second mark. The resting content of the stomach are aspirated out and is preserved. Then the patient takes about a pint of oat meal gruel, the stomach tube remaining swallowed as it was. Every fifteen minutes a sample of about 20 ml is drawn out

and the procedure is continued for three hours. Altogether thirteen samples are obtained, the resting contents being the first sample.



Ryle's stomach tube

Fig. 9.34

Each sample is then tested for the following:

i. Free HCI:

Normally the free HCI of the resting contents lies between 1.5 and 2.0 mEq or 54 – 60 mgm (34.46 mgm = lmEq) of HCI. After the gruel is taken the acidity is reduced by dilution. The free HCI then steadily rises and becomes maximum 40 – 50 mEq of HCI in the second hour. Then it gradually declines. When bile enters due to regurgitation, gastric acidity is reduced (Fig. 9.35). In gastric ulcer the value increases up to 3 times.

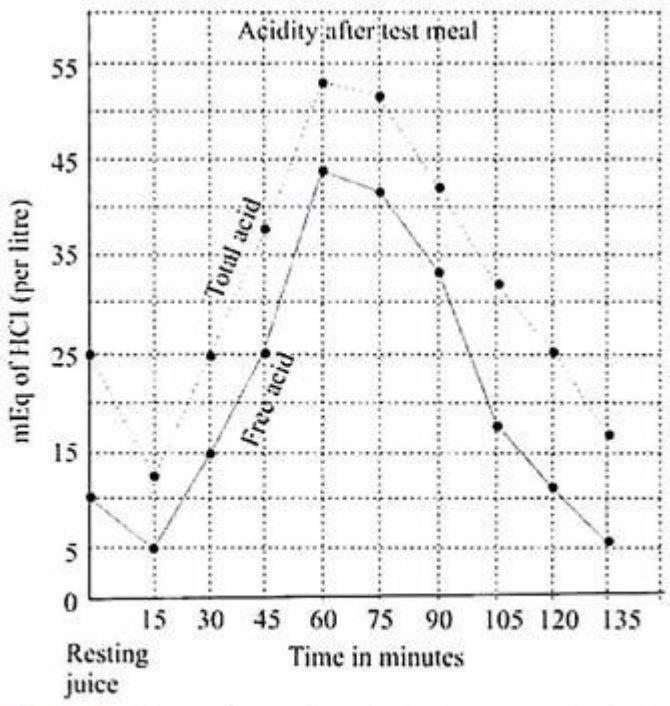


Fig. 9.35 Fractional gastric analysis in a normal subject showing normal curve (after best & Taylor).

ii. Combined Acidity:

This includes HCI combined with protein, mucus, etc., as well as organic acids such as lactic acid, produced by fermentation. Normally it varies from 10-55 mEq of HCI. In hypochlorhydria or achlorhydria the rate of fermentation is more, so that, this Figure becomes high.

iii. Total Acidity:

This is the sum total of free HCI organic acids, combined acid and acid salts.

iv. Total Chloride:

This includes free HCI, combined HCI and inorganic chlorides. Its importance lies in the fact that the free acid level is always disturbed by the entry of bile, but the total chlorides remain unaffected. Hence, estimation of total chlorides, along with estimation of free acidity, will give more correct information about the secreting capacity of stomach.

v. Starch and Sugar:

Sugar is produced by salivary digestion of starch. Presence of sugar and starch indicates that stomach has not yet completely emptied. Their absence, therefore, indicates the emptying time.

vi. Normally:

Normally, they are not found from the tenth or eleventh sample.

vii. Bile:

Presence of bile as indicated by yellow or green colour of the stomach contents shows duodenal regurgitation. It also indicates that pyloric sphincter has opened and gastric emptying has begun. Generally bile first appears in the second hour.

viii. Blood:

It is not a normal constituent. Its presence shows ulcer, cancer or other haemorrhagic conditions of stomach. In case of ulcer the blood might be bright red or brown in colour and in case of cancer it is brownish-black.

ix. Lactic Acid:

Derived mainly from fermentation of carbohydrate when there is a fall in the gastric hydrochloric acid. Hence, if free HCI is low, lactic acid will be high.

x. Mucus:

Excess of mucus indicates an irritated condition of the stomach. [Gastritis, etc.]

xi. Presence of Pepsin:

It indicates the functional condition of the peptic cells.

In addition to this, microscopic examination of each sample is carried out for blood cells, epithelial cells, tumour cells, bacteria, etc. Taking these facts into account a normal gastric analysis curve will be as shown in Fig. 9.36.

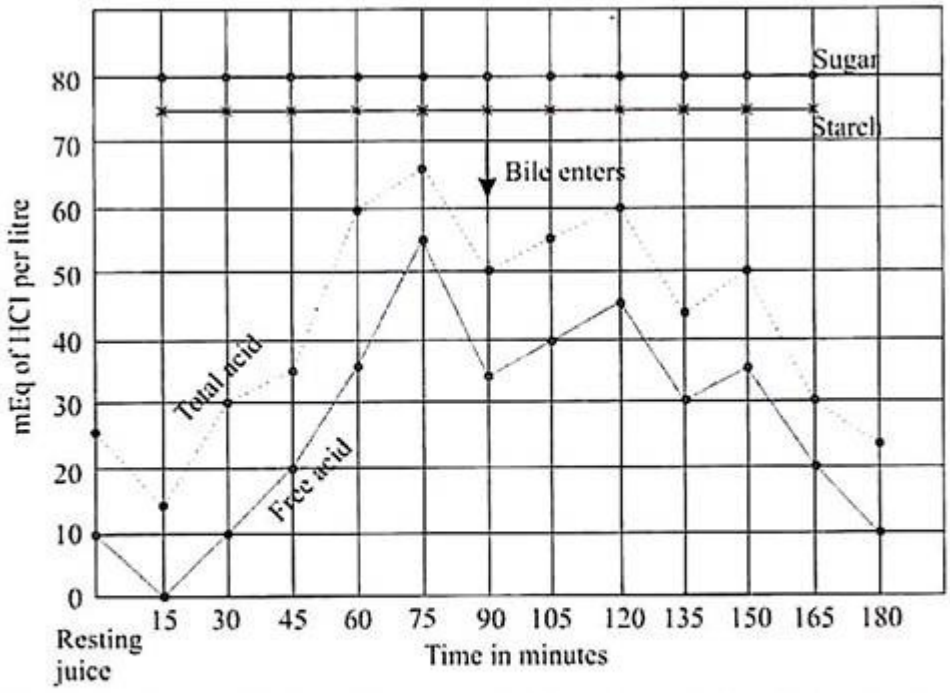


Fig. 9.36 Fractional test meal in a normal subject. Showing free HCI (maxm. 55 ml), total acidity (maxm. 65 ml) entry of bile (7th sample—1½ hours), presence of starch and sugar. Absence of starch and sugar in the 12th sample shows that the emptying time of stomach is 2 hours 45 minutes.

It will be seen from there that, this test not only gives an idea of the secreting capacity of stomach but the degree of motility (to be obtained from the emptying time), opening time of pylorus, duodenal regurgitation, etc., can be also known from it. In certain pathological conditions, characteristic variation of the curve is seen, viz., in gastric cancer and pernicious anaemia there will be achlorhydria, in duodenal ulcer the curve will be high 'climbing' type and so on.

To make a complete investigation of gastric functions only fractional test meal is not enough; radiological examination after barium meal has also to be performed. This will show the size, shape, motility, emptying time, presence of ulcer, etc., in the stomach.

Other Functional Tests:

Other functional tests of stomach are as follows:

i. Histamine Test of Gastric Secretion:

Histamine is a strong stimulant for the oxyntic cells. Only 0.5 mgm histamine chloride, injected subcutaneously, will stimulate gastric secretion at the rate of 200 ml per hour. In those patients who show achlorhydria with ordinary gastric analysis, this histamine test is performed in order to see the condition of the oxyntic cells. If performed in a normal subject, it shows the maximum secretory capacity of the oxyntic cells. Negative response indicates atrophy of oxyntic cells.

ii. Insulin Test of Gastric Secretion:

Insulin reduces blood sugar which in its turn, stimulates vagus and thereby excites gastric secretion. A positive insulin test is proof of the presence of intact vagal fibres but a negative result is less conclusive since some subjects with intact vagi fail to secrete in response to insulin.

However, the test is effective in most cases. Seven units of insulin given subcutaneously produce marked secretion of gastric juice (which is rich in HCI and pepsin content) although reduction of blood glucose by insulin to moderate degree causes inhibition of secretion. The secretion takes place after a latent period of 40 minutes.

This test also shows the secretory capacity of stomach. Since the response does not occur in absence of vagus so the absense of gastric secretion following insulin induced hypoglycaemia is a test for the vagal denervation. A combined insulin-histamine test (7 units of insulin, followed 20 minutes later by 0.5 mgm of histamine) is also advocated by some, to test the maximum secretory power of the gastric mucosa.

In about 2 – 5% of normal healthy people neither any HCI nor any pepsin is found in the gastric juice. This condition is called achylia gastrica. This is a congenital error due to non-development of oxyntic and peptic cells. This condition does not affect health. Because pancreatic enzymes can digest all the ingested foodstuffs. In certain pathological conditions (pernicious anaemia,

cancer of the stomach, etc.), the acidity is very low (hypochlorhydria) or it may be altogether absent (achlorhydria).

On the other hand, some people may have higher acidity in the gastric juice (hyperchlorhydria). In females the acidity is proportionally lower than in males. In the infants and children it is much lower than in adults. In men after thirty and women after fifty both free and total acidity gradually decline. A high gastric acidity is generally associated with hypermotile stomach. In people with poor muscular built and sedentary habits the acidity is low.

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