

Effect of starvation on gastric mucosa – an experimental study in *rattus norvegicus albinus*

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Abstract

Background: The function governs the structure and a change can be produced experimentally by changing the physiological status. Starvation either produced experimentally, psychologically, or pathologically in conditions such as anorexia nervosa or certain obstructive tumours of oesophagus, or nonavailability of food due to any other means is likely to alter the physiology of the individual.

Objective: To study the effect of starvation in gastric mucosa in albino rats experimentally.

Materials and Methods: An experimental work to study the effects of starvation in albino rats has been carried out. The albino rats weighing 100–120 gm belonging to same strain from the Government Veterinary College, Jabalpur, have been used. The rats have been divided into four groups. One group has been used as a control and the remaining three groups have been subjected to starvation. The samples of three parts of stomach (viz. fundus, body, and pyloric part) have been removed and studied histologically using hematoxylin and eosin stains.

Result: After 7 days of starvation, no appreciable changes are observed in all the three constituents of mucous membrane. After 14 days of starvation, gastric pits are partially destroyed and mucous cells toward the base have their outline distorted and it is difficult to make out the details of most of the cells. Shredding of mucous membrane is observed. After 21 days of starvation, the columnar cells of the epithelium of gastric pits have lost their normal appearance. The phenomenon of shrinkage is more prominent in the basal part of the gastric glands.

Conclusion: It is difficult to keep the majority of rats alive after the second week of starvation because the work was carried out during hot climate (summer). The mucous lining of the stomach under goes fragmentation. The gastric glands undergo shrinkage and fragmentation.

KEY WORDS: Stomach, starvation, gastric mucosa

Introduction

Starvation is observed among animals and also among human beings due to difficulties in the availability of food, pathological conditions, psychological, or deliberately as a means of protest. In the human beings, the eating of food is usually at definite times whereas in the animals if food is available

it is almost a continuous phenomenon. The emptying of the stomach is dependent on the quantity and quality of food, and this may vary from a couple of minutes to 5–6 h. Nonavailability of food or starvation lasting for short period does not affect the alimentary tract or health of the individual. If this starvation is prolonged, it becomes the worry of the medical men for the changes it is likely to produce in structure of mucosa of the alimentary tract and physiological disturbances.^[1] On alimentary tract fall the onus of reception, digestion, absorption, propulsion, and finally the excretion of the undigested part of food as fecal matter. The alimentary tract is, therefore adapted structurally to all these physiological needs. Besides, the normal pattern of the alimentary tract, there are cells or areas meant for special functions. The function and structure of many of these cells are yet to be understood. Availability of human material is, if not impossible, difficult. It is therefore, planned to conduct an

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experimental study in albino rats (*Rattus norvegicus albinus*) to study the effect of starvation, especially when prolonged, on the alimentary tract mucosa.

Objective

To study the effect of starvation in gastric mucosa in albino rats experimentally.

Materials and Methods

The material for this study comprised of 24 albino rats (*Rattus norvegicus albinus*) weighing between 100 and 120 gm, of same strain from the Government Veterinary College, Jabalpur, Madhya Pradesh, India. The rats weighing more or less equal were selected for this study. However, a majority of them were females. The rats were made to starve from the morning of the day of commencement of experiment. They had a free

access to water and care was taken to keep the water container full. They were kept under constant supervision and their physical behavior was watched. The rats were then sacrificed under ether anesthesia on 7th, 14th, and 21st day of starvation. The abdomen was opened by a midline incision and the abdominal cavity was irrigated by fresh Bouin's fluid. Three portions of stomach—viz. fundus, body, and pylorus—were fixed in Bouin's fluid for 24 h. Thereafter they were dehydrated and processed for histological studies. Seven micron thick serial sections were cut and divided in series of 4–5 and alternate groups were mounted, followed by hematoxylin and eosin staining.

Result

Normal architecture of gastrointestinal tract mucosa in hematoxylin and eosin stain:

	Epithelium	Lamina propria	Muscularis mucosae
Fundic part of stomach	Keratinized stratified squamous epithelium	Loose connective tissue separating the muscularis mucosae from epithelium, no glands, small capillaries	The nuclei of the cells are vesicular and elongated. The muscle fibres are cut in practically all the directions
Body of stomach	The mucous membrane is folded to form gastric pits. The gastric glands are branched tubular compactly arranged and characterized by various types of cells	Loose connective tissue with cores of it entering in between the gastric glands	In the folds of the mucous membrane, muscularis mucosae are seen entering and all the three constituents of mucosa are made out
Pyloric part of stomach	Epithelium has got lots of gastric pits lined by columnar cells. Gastric glands are tubular, simple or branched glands, lying parallel to one another and at right angles to the surface	It is made up of loose connective tissue continuous with the connective tissue strands lying in between the pyloric glands. Blood vessels and capillaries frequent the lamina propria	The arrangement of the fibres is the same as in other parts of the stomach

Changes Observed after 7 Days of Starvation

Fundic Part of Stomach

No appreciable changes are observed in all the three constituents of mucous membrane.

Body of Stomach

The outline of epithelium shows patchy destruction but the nuclei do not reveal any change. The mucous neck cells at many places look distorted and are seen merging with each other. The oxyntic cells with central vesicular nuclei and granular cytoplasm are seen with no obvious change in cellular outlines. Chief cells with basal nuclei and clear cytoplasm but indefinite cellular outlines are observed. In short, the pattern of epithelial lining and structure of gastric glands show very slight distortion. However, the overall thickness of the mucous membrane is reduced and the gastric glands appear to be shrunk.

Pyloric Part of Stomach

The lining epithelium shows patchy fragmentation. The cells of the mucus glands of this part show shrinkage and distortion.

Cell margins are not visible throughout. In the deeper layer dividing nuclei or cells with two nuclei are observed (Figure 1).

Changes Observed after 14 Days of Starvation

Fundic Part of Stomach

The epithelial lining appears to be thrown into folds. The lamina propria is flooded with cellular elements, predominantly the eosinophils.

Body of Stomach

The mucous membrane lining is thinned out and fragmented. The gastric pits are partially destroyed. The distortion and disorganization toward luminal half of the gastric mucosa is more than toward the basal half. The mucous neck cells are degenerated and their nuclei are not seen. The chief cells are distorted and shrunken and due to shrinkage, the pericellular spaces around these cells are very much increased. The cell linings are broken in pieces and lying in fragments and at places connected to the core of lamina propria. The fragmented and degenerated mucous membrane along with capillaries is

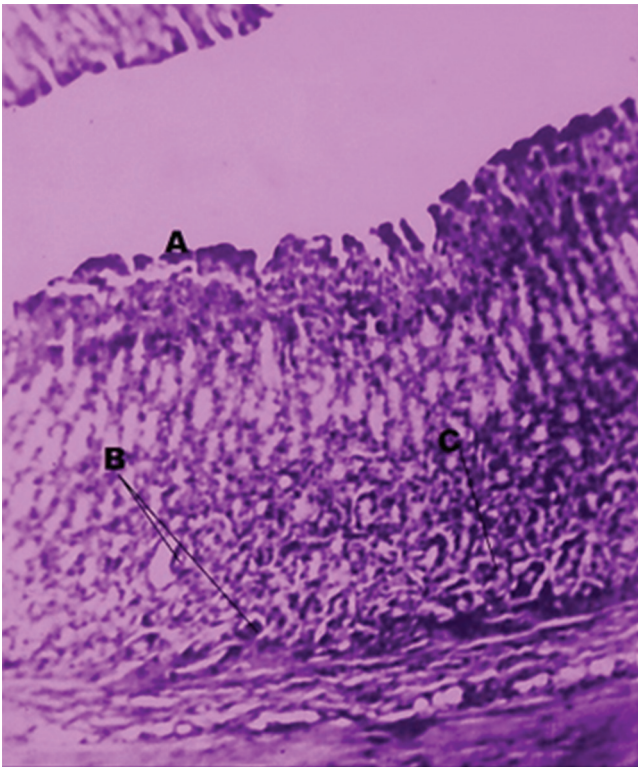


Figure 1: Body of stomach (7 days after starvation): A: Epithelium; B: Chief cells; and C: Pericellular space (H & E stains).

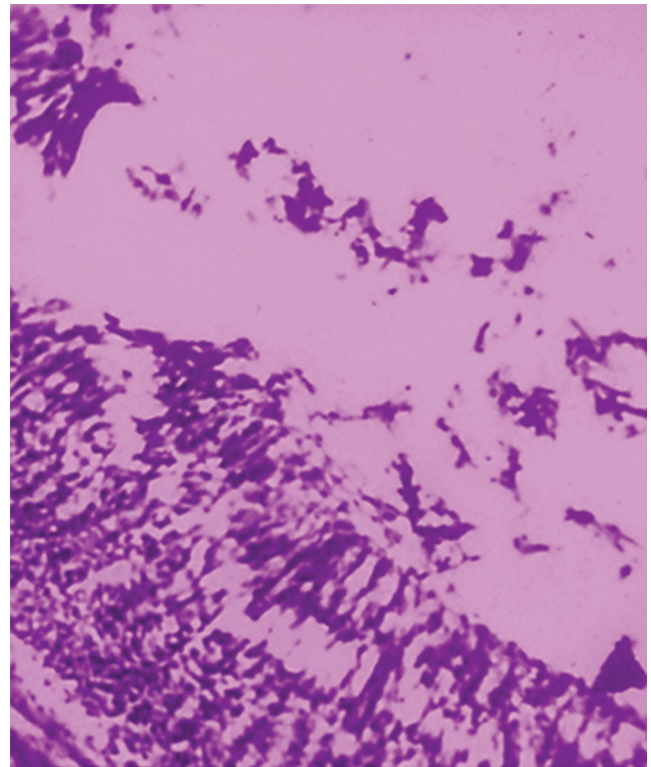


Figure 3: Pyloric part of stomach (14 days after starvation): Patchy destruction of epithelium; and hazy outline of cells (H & E stains).

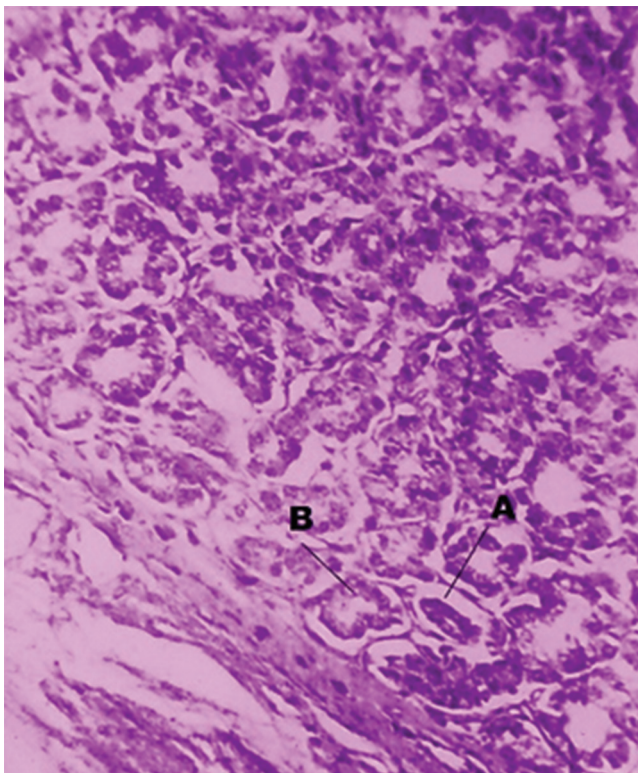


Figure 2: Body of stomach (14 days after starvation): Loss of cellular outline; A: Pericellular space; and B: Hazy outline of cells (H & E stains).

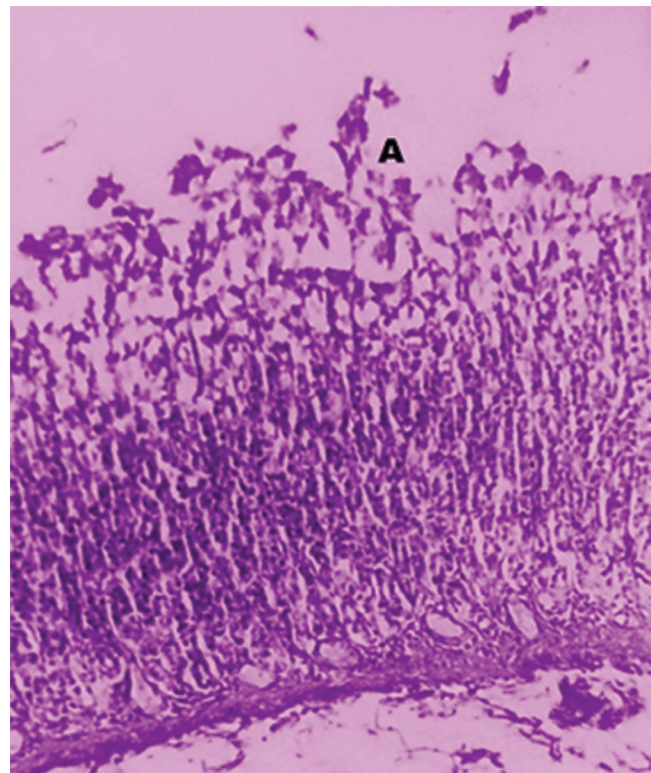


Figure 4: Body of stomach (21 days after starvation): A: Shredded mucosa, shrinkage, and reduced thickness (H & E stains).

collected in the lumen of organ. The other cells of mucosa do not reveal any marked change.

Pyloric Part of Stomach

The cellular outline of pyloric glands is completely lost toward the luminal side. The nuclei are not easily distinguished. Most of the nuclei are drawn into a spindle- or fusiform-like structure. The mucous cells toward the base have their outline distorted and it is difficult to make out the details of most of the cells. Shredding of mucous membrane is observed (Figure 2-3).

Changes Observed after 21 Days of Starvation

Fundic Part of the Stomach

This part again does not reveal any change.

Body of Stomach

The columnar cells of the epithelium of gastric pits have lost their normal appearance. In the gastric glands most of the cells appear to be shrivelled up and lying in the tissue spaces. The histological changes are more apparent toward the free surface of gastric mucosa. The chief cells and the oxyntic cells can be made out in the gastric glands. However their outlines are not well-defined. The phenomenon of shrinkage is more prominent in the basal part of the gastric glands. The pericellular spaces around the chief cells are more marked. The nuclei of the most of the cells have become smaller.

Pyloric Part of Stomach

Dead cells detached from the epithelial lining of the pyloric portion are lying on the luminal surface of pyloric mucosa at places in the form of aggregated masses. Along with this, cellular debris is seen which consists of polymorphs. The pyloric gland except near the bases does not show a normal pattern. Transversely or obliquely cut glandular masses are withdrawn from stroma of the glands. Also a similar appearance is visible where they are cut longitudinally (Figure 4).

Discussion

It is a well known and an established fact that the function governs the structure and a change can be produced experimentally by changing the physiological status.^[2] Starvation either produced experimentally, psychologically, or pathologically in conditions such as anorexia nervosa or certain obstructive tumors of esophagus, or nonavailability of food due to any other means is likely to alter the physiology of the individual. In general it would be reflected in weight loss, sluggish activity, and even apathy. The alimentary tract mucosa which has the onus of physiological adaptation to incoming food, digestion, absorption, and onward transmission is expected to react and get adjusted to the changed physiological state. The rats were starved up to 3 weeks. At the end of 1, 2, or 3 weeks when the abdomen was opened, the stomach was found shrivelled up and reduced in size. The stomach on its surface showed wrinkles.

As the period of starvation got prolonged the succeeding portions of the alimentary tract were found empty.

The mucosa of the fundic region is stratified and covered with keratin layer. As the starvation progresses, the keratin layer is loosely arranged and appears to be shredded. But up to 3 weeks, there is no such shredding except the fibers can be seen in layers. The gastric mucosa in the body of the stomach with the advancement at the time of starvation shows the loss of cellular details of the epithelium. The nucleus remains vesicular. On 14th day and 21st day the epithelium gets denuded and the debris is visible lying detached at many places. The severity increases with the increase of time of starvation. The vesicular nuclei appear probably due to rapid proliferation and their succeeding transfer to the luminal surface. Since the cells do not face death, therefore, darkly staining pyknotic nuclei are not made out.^[3,4]

The disorganization of gastric glands increases with the period of starvation. Fragmentation of gastric mucosa, dissolution of cellular outlines and collapsed chief cells are few, visible characteristics. "After digestion of a meal, the number of these granules (peptic cells or chief cells) is diminished by ejection. Surface mucous cells are renewed in about 3 days and the neck mucous cells in about one week." A similar probability in the human beings can also be thought off. Thus, the epithelial cells exfoliate at the surface are replaced by upward migration from the regions of mitotic activity.^[5,6] In the present series of experiment, it was found that the oxyntic cells do not exhibit any disintegration, it is due to their comparatively long life.

In the pyloric region the cells of pyloric glands are made of one type of cells, which are stained lightly with H & E stain the mucous flakes. As starvation progresses it leads to accumulation of mucous, the cells are distended, and the nuclei which were flat are now swollen and vesicular. In this study it is observed that the cell walls get fragmented and the lumen is occupied by mucous, and the nuclei are freed in the space filled with mucus. The broken cell walls are seen. With the progress of starvation, the mucus remains locked up in the cell leading to distension and finally fragmentation. Due to sudden release of tension the nuclei are displaced.^[7] Like areas of normal structure in gastric mucosa of body, here also patchy areas of normal glands can be seen. In between the meals, when the stomach is empty the pylorus is relaxed. The opening of pylorus is narrowed in response to the presence of food in the cavity of stomach. Naturally, at this time pylorus is required to regulate the flow of contents from stomach to duodenum. The secretion of the pyloric glands is required to ease the passage—hence there is mucous and no effect on the quality of food—thus no enzymic activity. When the stomach is empty this action is not required. The mucous glands remain full and ultimately get distended leading to distortion of the cellular outline of the stomach.^[8] The empty stomach during fasting secretes about 500–1500 mL gastric juice. Though there is no food in the stomach, protection against this acid secretion is required. In response to a meal, the major secretion of gastric

juice is periodical and is about 1000 mL per meal. It, therefore, appears at the conclusion of this little work that the famous dictum "Function justifies the structure" continues to have the relevance. The results of this work have led to the following.

Conclusion

It is difficult to keep the majority of rats alive after the second week of starvation because the work was carried out during hot climate (summer). The mucous lining of the stomach undergoes fragmentation. The gastric glands undergo shrinkage and fragmentation. Almost all the nuclei are vesicular.

References

1. Bloom W, Don F. *Text Book of Histology*, 10th Asian edn. Tokyo: Igaku Shoin Ltd, 1976. p. 656.
2. Clark RM. The effect of starvation upto the mucosal structure and cell production rate in the small intestine of the rat. *Arn J Anat* 1970;107:384.
3. Colakolu N, Kukner A, Canpolat L, Gezen MR, Oner J, Ozan E. Light microscopic observation of gastric mucosa changes at starvation. *Firat Tip Dergisi* 8:575–80. *Res J Biol Sci* 2011; 6(11):569–74.
4. Matsumoto A, Asada S, Saitoh O, Tei H, Okumara Y, Hirata I, et al. A study on gastric ulser induced by long-term fasting in rats. *Scand J Gastroenterol Suppl Nobel Kitapevi, Istanbul Turkey* 1989; 162:75–8.
5. Alvares EP. Circadian rhythms of mitotic activity in gastric mucosa of feeding and fasting rats. *Prog Clin Biol Res* 1987;227: 353–60.
6. Alvares EP. The effects of fasting on cell proliferation in the gastric mucosa of the 14 day old suckling rat. *Braz J Med Biol Res* 1992; 25:641–9.
7. Ham AW. *Text Book of Histology*, 6th Asian edn. Tokyo: Igahy Shoin Ltd, 1969. p. 682.
8. Carleton HM, Leach EH. *Schaffer's Essentials of Histology*. London, New York, Toronto: Longmans, Green and Co. 1950. p. 375.

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