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Original Article

Study of the Structure of the Gastric Mucosa in the Mouse (Cell Population)

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ABSTRACT

Seven male adult albino mice, each weighing 30-40g and 11months old were used to study the gastric mucosa of the mice. Cell types, their population and percentage densities in the entire gastric mucosa and in each region were determined microscopically. It was observed that mucous producing cells (mucous cells) had the highest population and percentage densities in the gastric mucosa. These were the dominant cell types in both cardiac and pyloric regions of the stomach. In contrast, the body of the stomach is dominated by zymogenic cells. These cells were second in abundance, followed by surface epithelial cells; and parietal cells. Although other cell types were also present in the gastric mucosa but the investigators could not identify them easily. Population and percentage densities of each cell type as calculated by the investigators were as follows: Surface epithelial cells = 99 ± 9.076/200,000cm^3 (13%): Mucous cells = 340 ±4/200,000cm^3 (45.39%): Parietal cells = 51 ± 42/200,000cm^3 (6-8%): Zymogenic cells = 259 ± 17/200,000cm^3 (34.60%).

Key Words: Mice, Gastric Mucosa, Surface Epithelial cells, Mucous Cells, Parietal Cells, Zymogenic Cells.

INTRODUCTION

A good number of researchers have studied the histology of the gastric mucosa of mammals. Histologically, it has been shown that the glands of mammalian stomach contain various types of cells and that these glands and their cell types are grouped into 3 distinct areas in the gastric mucosa [1, 2, 3]. The mucosa of pre-stomach, like that of the oesophagus is composed of keratinized stratified squamous epithelium and that the laminar propria has no glands [4, 5]. They also established that the mucosa of the stomach proper is lined by simple columnar epithelium. The pits of the gastric glands are lined by cells producing mucous. The isthmus contains mucous neck cells and immature undifferentiated cells.

The stomach is designed anatomically into three regions; cardiac, body and pylorus [6, 7]. This division is also applicable to gastric mucosa of the rat and mouse. It has also been established that the cardiac glands contain mucous cells and parietal cells [4, 8]. The glands of the body of the stomach contain zymogenic cells, parietal cells and mucous neck cells. Pyloric glands are characterised by mucous cells [8, 9]. There are about five cell types present in the gastric mucosa and each of these cells performs different functions. These cells are surface epithelial cells which lined the surface of the gastric mucosa; mucous cells found in all regions of the stomach; parietal cells also present in all regions of the gastric mucosa but most numerous in the body; Zymogenic cells which are found in abundance in the base of the glands of the body and enterochromaffin cells present in all regions [8, 10]. This study is aimed at investigating further the structural architecture of the gastric mucosa of the mouse; total and regional cell population and percentage densities of the different cell types.

MATERIALS AND METHODS

Seven male adult albino mice, each weighing 30 – 40 g were obtained from the Animal House of the Faculty of Natural Sciences of the University of Port- Harcourt. The animals were maintained under normal laboratory conditions in a cage in a room with a temperature of 25^{o}C, had free access to water *ad libitum*. In order to avoid diurnal variations, the mice were sacrificed between 9.00am and noon by guillotine decapitation. Midline incisions were made in the abdomen to expose the stomach. The stomach was removed by cutting across both

oesophageal and pyloric orifices and was cut open with a knife along the greater curvature. A saline wash was done to remove food and other debris. Each region of the stomach was fixed in 10% formalin for 3days. On the 3rd day specimen were removed from the fixative and transferred to increasing (ascending) grades of alcohol for dehydration and were cleared with xylene, embedded in a paraffin wax overnight. Each region of the gastric mucosa was serially sectioned at 5cm thickness with a rotary microtome. Every section was mounted on a glass slide and stained with Haematoxylin and Eosin (H&E). Slides were mounted on ocular grid and viewed for structural arrangement and different cell types counted on each region of the gastric mucosa. Statistical analysis was done using mean (m) and standard deviation of mean (s.d.m) to test the observations.

RESULTS

We observed that the gastric mucosa is found to be composed of glands which are simple tubular in shape. These glands contain different types of cells. These cells are: surface epithelial, which lined the entire surface of the gastric mucosa; mucous cells among other cells immediately below the surface epithelial cells; parietal cells scattered among mucous and zymogenic cells. The later cells are found in the base of the glands of the body of the stomach.

Table 1. Showing Mean ± S.D.M. of regional cell population and percentagedensity of cell types in the gastric mucosa of mouse

Cell types	Cardiac region	Fundic (Body) region	Pyloric region
Surface epithelial cells	42±1.41/200,000cm3 9.4%	127±5.19/200,000cm3 21.49%	127± 4.24/200,000cm3 30.60%
Mucous cells	387±48.15/200,000cm3 86.58%	300±105.04/200,000cm3 50.76%	332± 62.46/200,000cm3 80%
Parietal cells	35±16.06/200,000cm3 7.83%	99± 56.87/200,000cm3 16.75%	19± 1.53/200,000cm3 4.58%
Zymogenic cells	Nil 0%	239± 9.98/200,000cm3 100%	Nil 0%

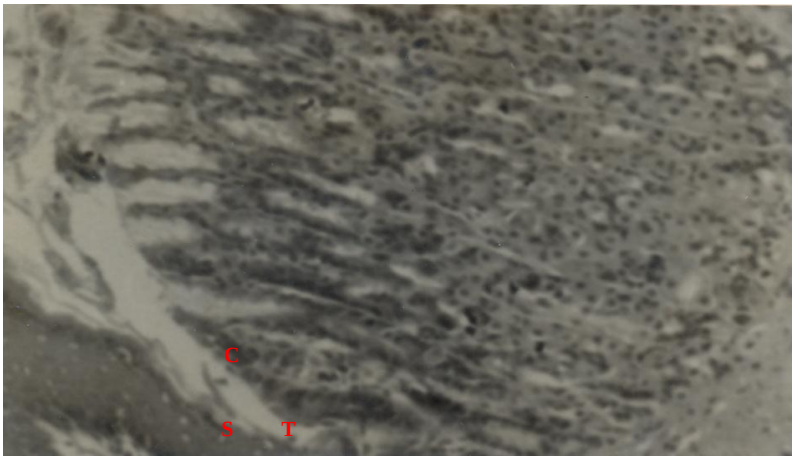

Figure 1. Photomicrograph showing mucous cells, parietal cells and surface epithelial cells of the cardiac glands. Also shown is the transition zone T from stratified squamous epithelium of the esophagus S to columnar type of epithelium C of the stomach proper.

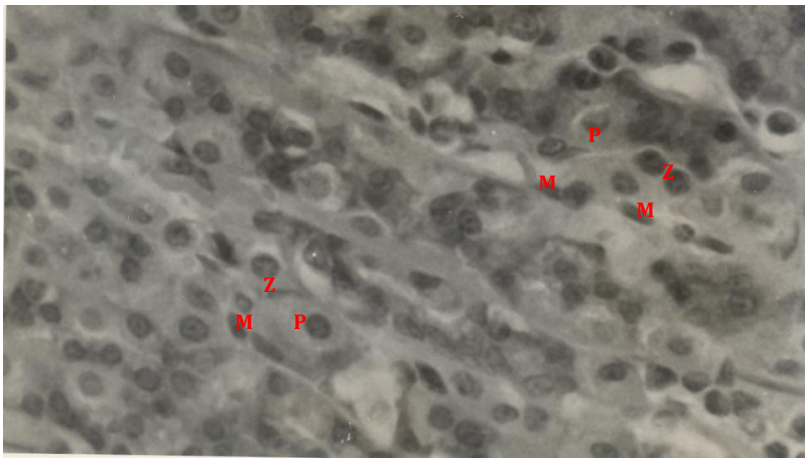

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Figure 2. Photomicrograph of the fundic glands showing zymogenic cells Z, parietal cells P and mucous neck cells M.

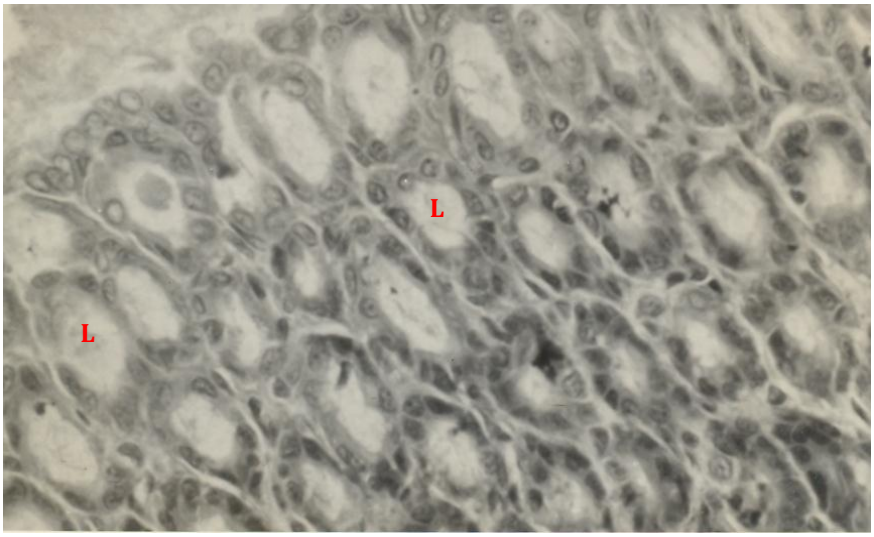

Figure 3. Photomicrographshowing glandular lumen of the zymogenic or fundic glands L cut at right angles. The cells surrounding the lumen are clearly shown.

Surface Epithelial Cells: These cells are tall, columnar in shape, have nuclei placed towards the base, the cytoplasm appears blue with H&E stains. The lateral cell boundaries were not distinct with the light microscope in our investigation. These cells constitute approximately 99 ± 49/ 200,000cm^3 and13% of the total cell population in the gastric mucosa.

Mucous Cells: These cells were also seen as columnar in shape, but shorter and smaller in size than surface epithelial cells. They are not so distinct under the light microscope due to their small size, but were identified by their nuclei. The nuclei of these cells are round and oval in shape and are placed towards the base. The cytoplasm appears whitish with H&E stains. In the body of the stomach, they are known as mucous neck cells because of their large number in the neck of the gland. In other parts of the stomach, cardiac and pyloric regions, they are known as mucous cells (in relation to function) because they produce mucous. The nuclei appear blue with H&E stain. These cells are the most numerous in the gastric mucosa. They constitute approximately 340± 44/200,000cm3 and 45.39% of total number of cells in the gastric mucosa.

Parietal Cells: These cells are round to triangular in shape, most numerous in the glands of the body, especially the neck of the gastric glands. The diameter of these cells at the isthmus and towards the surface of the gland appears to be greater than those found in the neck and base of the glands. The cytoplasm appears pinkish and clear with H&E stain. Granules are not seen in the cytoplasm; the nuclei appear blue. The periphery of the nuclear membrane appears granular and the central region of the nuclei in some of these cells appears vacuolated except the nucleoli. Nucleoli are centrally placed but not visible in some of the cells. A clear whitish region is also present in the cytoplasm of some of the cells. These cells are scattered among other cell types in the body of the stomach. They are the most prominent but fewest cells in the gastric mucosa. They constitute approximately 51± 42/200,000cm3 and (6-8%) of total number of cells in the gastric mucosa (population and percentage densities).

Zymogenic Cells: These cells are found at the base of the zymogenic glands of the body of the stomach with few parietal cells scattered between them. The cytoplasm appears granular under the light microscope but individual granules could not be identified. Their nuclei appear blue, spherical or oval in shape, basally placed, but not touching the basal membrane. They appear darker than other cell types in the gastric mucosa. Closest to the laminar propria at the base, they surround the gland. They constitute population and percentage densities of 259±0.00/200,000cm3 and 34.58% of cells in the gastric mucosa.

DISCUSSION

The writers findings of the distribution of cells in the gastric mucosa of the mouse quite agrees with those of previous investigators who worked on quantitative distribution of the different cell types of this organ, but the absolute values both in terms of density and percentage may differ. Mucous producing and surface epithelial cells

dominate the glands of the cardiac region of the stomach. The abundance of surface epithelial cells on the surface of the entire gastric mucosa could be tied up with their function of absorption of some food substances. The dominance of mucous cells in the cardiac region of the gastric mucosa is an indication that large quantities of mucous is produce in this region to neutralized the damaging corrosive effect of acid produced by the parietal cells in the stomach. Mucous cells does not produce digestive enzymes but mucous. This is evidence that digestion of food does not occur in this part of the stomach. Presence of few parietal cells in this region indicates that little quantity of acid is produced here. The abundance of mucous cells in the entire gastric mucosa is also an evidence of the protective function of these cells; protecting the mucosa from the erosive effect of hydrochloric acid produced by parietal cells. We observed also that mucous cells were fewest in the body of the mucosa. This could be attributed to the most abundant presence of parietal and zymogenic cells in this region. Mucous cells are the most numerous in the gastric mucosa of the mouse; constituting 45% approximately. The pyloric region is also dominated by mucous producing cells. The approximate mucous cell population and percentage densities in this area are 332±62.46/200,000cm3 and 80%. It recorded the fewest parietal cell population of the gastric mucosa. Parietal (oxyntic) cells are most numerous in the glands of the body of the gastric mucosa. This observation in relative terms agrees with the findings of previous investigators [3, 11, 12, 13]. They are most numerous in the neck, fewer in the isthmus and fewest in the base of the gland. The abundance of parietal cells signifies that the greatest volume of hydrochloric acid is produced in this region of the stomach. This is the region most prone to gastric ulcer [14,15]. Hydrochloric acid produces an enzyme precursor which converts pepsinogen to pepsin to commence digestion of protein. These cells constitute 6 - 8% of the entire population of cells in the gastric mucosa and 16.75% of the body region. Fewness of parietal cells in the cardiac and pyloric regions signifies that little acid is produced in these areas [16,17]. It may be that the acid produced in the body region is not enough to carry out complete conversion of pepsinogen to pepsin [18]. Another likely reason may be that when food leaves the body of the mucosa not all the pepsinogen had been converted to pepsin so the few parietal cells in the pyloric region produce little quantity of acid to convert the unconverted pepsinogen to pepsin to continue the digestion of protein [18, 19]. Relatively, parietal cells are most numerous in the body, fewer in the cardiac region and fewest in the pyloric region of the stomach [8]. Zymogenic cells (chief cells) are located at the base of the glands of the body of the gastric mucosa. Reason for these cells being located at the base of the glands is not very clear to the investigators [13, 20, 21, 22]. These cells have large number of granules placed in the supranuclear region of their cytoplasm. These cells are said to secret the digestive enzymes of the stomach. The presence of acid secreting cells (parietal cells) and digestive enzyme secreting cells (zymogenic cells) suggests that the main digestive portion of the stomach is the body. Other regions of the stomach function to neutralize the effect of the acid secreted in the body and help for the lubrication of food for the enzyme to act upon. Electron microscopic reports have revealed that zymogenic cells have all the characteristics of secretory cells [9, 23]. These characteristics are; presence of abundant mitochondria to provide energy for the cell; presence of endoplasmic reticulum to synthesize proteins, that is enzymes in this case; prominent Golgi apparatus etc. Zymogenic cells are hardly seen in both cardiac and the pyloric regions of the stomach. These cells constitute approximately about 34.58% of cells in the gastric mucosa. In conclusion, we observed that the most numerous cell type in the gastric mucosa of mouse are mucous secreting cells (45 %), followed by zymogenic cells (35%), next, surface epithelial cells (13%), and least parietal cells (6 – 8%).

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