

Variations in the Number of Absorptive Columnar Cells and Goblet Cells in the Human Duodenal Mucosa - An Age Related Study

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Abstract: According to the previous studies in the duodenal mucosa in relation with age, there was no consensus. Goblet cells were seen in the villi and the base of crypts of Lieberkunn. They will appear from 14 weeks of gestation. According to present study, there is definite decrease in the number of absorptive columnar cells in all four parts of duodenum with increasing age.

Keywords: duodenal mucosa, absorptive columnar cells, crypts of Lieberkunn

1. Introduction

Adult duodenum consisted of the layers; mucosa, sub mucosa muscularis externa and Serosa. Mucus membrane is lined by columnar epithelium. Numerous villi are projecting from the mucosal surface. They consist of a core of reticular tissue covered by a surface epithelium. Covering the villi, the surface epithelium consists of mainly two types of cells, the absorptive columnar cells and goblet cells.

2. Aim of the Study

To find out the age related change in the no; of absorptive columnar cells and goblet cells in the human duodenal mucosa.

3. Materials and Methods

3.1 Source

Total 80 Specimens of human duodenum were collected for this study. These were obtained from departments of Anatomy, Forensic medicine, Pathology, Gynaecology and Surgery of Govt. medical college, Kottayam, Kerala. They were of different age groups ranging from still born to 80 years. The interior of the duodenum was examined and tissues collected from each four parts were transferred into separate labeled bottles containing fixative. For this study, 10% formalin and Bouins fluid were used as fixatives.

3.2 Processing for Histological Examination

Fixed specimens were subjected to the process of paraffinisation. The paraffin infiltrated specimens were embedded in paraffin wax using L- blocks. After trimming the blocks, they were cut serially at 6-8 micron thickness and mounted on slides. After that, the slides were kept in incubator for one week.

3.3 Staining

The sections were stained with routine Haematoxylin and Eosin method.

4. Observations

4.1 Microscopic Findings

A. Adult Human Duodenum

Adult duodenum consisted of the layers; mucosa, sub mucosa muscularis externa and Serosa. Mucus membrane is lined by columnar epithelium. Numerous villi are projecting from the mucosal surface. Height of the villus ranges from 0.5 to 1.3 mm in height. Between the bases of the villi are the pit like crypts of Lieberkunn, which extend down to muscularis mucosae. Villi consist of a core of reticular tissue covered by a surface epithelium. Covering the villi, the surface epithelium consists of mainly two types of cells, the absorptive columnar cells and goblet cells. Crypts are lined by columnar type of cells. Goblet cells are seen in the walls and at the base of the crypts. Each villus contains at central lymphatic vessel called a lacteal. Distally, the lacteal ends blindly near the tip of the villus. Size of the columnar cells ranges from 18 to 20 microns in all four parts of duodenum. Muscularis mucosae consists of smooth muscle cells. Sub mucous coat contains loose areolar tissue and cut sections of blood vessels. Cut sections of nerve fibres also seen.

Brunner's glands are seen in the submucosa. They consist of a regular lumen lined with mucous secreting columnar cells. The nuclei of mucous cells are vertically elongated and basally placed. Muscularis externa contains inner circular and outer longitudinal layers of smooth muscle cells. Serosa intact.

B. Foetus

Villi were not well developed in 14 week old foetus. Epithelium lined the villi was composed of flattened cells. Lamina propria mainly contained connective tissue and

fibroblasts. Muscularis mucosae was thin with occasional breaks. Sub mucosa contained connective tissue. Brunner's glands were present. They were lined by flattened cells. Cut sections of blood vessels were also seen. Brunner's glands seen in plenty in full term foetus. They were composed of flattened cells. The 14 weeks old foetus only contained inner circular and full term foetus both inner circular and outer longitudinal layers of smooth muscle cells.

5. Discussion

Adult duodenum consisted of the layers; mucosa, sub mucosa muscularis externa and Serosa. Mucus membrane is lined by columnar epithelium. Numerous villi are projecting from the mucosal surface. They consist of a core of reticular tissue covered by a surface epithelium. Covering the villi, the surface epithelium consists of mainly two types of cells, the absorptive columnar cells and goblet cells. The connective tissue contains numerous blood capillaries forming a plexus. The endothelium lining the capillaries is fenestrated. Each villus contains a central lymphatic vessel called a lacteal. Distally, the lacteal ends blindly near the tip of the villus. Size of the columnar cells ranges from 18 to 20 microns in all four parts of duodenum.

Oppel (1896) found that intestinal glands (Crypts of Lieberkuhn) appear to be a constant feature of all mammalian species. Leblond and Stevens (1948) stated that the production, migration and the mitotic index in the duodenal crypts is very high so that renewal of epithelium is completed in about 2 days in the rat. In (1955) Leblond and Carriere reported that the mitotic index in the duodenal crypts is subjected to hormonal influences. Rompel and Scommozoni (1963) stated that the oxidoreductive enzymes are localized predominantly towards the apical part of the cells of intestinal villi and sides of crypts than in Paneth cells. B.J. Jayne's and G.G. Altmann in (1962) stated that crypt cells are continually produced in the lower crypt. These cells migrate to the villi and affiliate into non proliferating absorptive cells.

Each mitochondrion probably undergoes a division as the crypt cells migrate from the mid crypts to the villus. As a result, the villous epithelial cells contain double the amount of mitochondria. Rita.M. Carriere (1967) stated that growth of the Crypts in duodenum with age is in part due to increase in cell number. She also found out that Thyroid hormone and testosterone positively influence the crypt growth. She also stated that proliferative activity is restricted to the cells localized in the crypts, and from there the chief and the goblet cells migrate upwards along the crypt walls on to the surface of the villi and are discovered at the villous tip. 1983 Calvert et al found that a neutral extract of rat amniotic fluid induces the precocious differentiation of duodenal crypts.

Narranow (1923) found that first appearance of mucus droplets in goblet cells occurs at the region of Golgi apparatus. Similar finding is reported by Brown R (1924). Leblond and Meissier (1958) found that secretory potential of goblet cells becomes greater as the cells migrate from the bottom of the crypts to the tip of the villi. Hallman (1963) described six types of goblet cells.

1. Undifferentiated goblet cells: Refers to the first recognizable form of goblet cells in which there is more abundant Golgi apparatus than the Golgi apparatus characteristics of absorptive columnar cells.
2. Pre-secretory Goblet cells: Refers to the form of cells in which the Golgi apparatus and endoplasmic reticulum are both prominent, but in which mucus droplets have not yet accumulated in the Golgi apparatus
3. Intermediate Goblet cells: Refers to the cell in which the mucus droplets formed in the Golgi apparatus but have not developed to the point where the mucus bulges the cell into the goblet shape
4. Mature Goblet Cell: Refers to the cell in that the position of the secretory cycle that shows mucus droplets bulging the apex of the cell into a 'theca' in which the remainder of organelles are compressed to the base of the cell, forming a 'foot' thus stimulating the shape of a wine goblet.
5. Evacuated goblet cell: Refers to the cell in which the mucus has been expelled or discharged to a point where the basic fine structure of the cellular organelles and ground substance of the mature cell is evident.
6. He also described a different type of goblet cell with a scant reticulum from electron lucid granules of mucigen, and a small amount of Golgi membrane. The secretion is apocrine in type.

The five types were described earlier by Schultz in 1886.

The Muscularis Mucosa is a smooth continuous sheet of smooth muscle cells serving to anchor the configuration of villi and crypts alike. Submucous coat contains loose areolar tissue and cut sections of blood vessels and nerve fibers. It is packed with Brunner's glands.

Collagen and reticulin fibres present in the Lamina propria of the duodenum. Muscularis externa contained inner circular and outer longitudinal layers of smooth muscle cells in the present study. Inner layer was thicker than the outer.

5.1 Age Changes in the Human Duodenum

In the present study foetuses ranging from 14 weeks to full term were studied. Microscopically, villi were not well developed and covered by a flattened epithelium. Brunner's glands were present covered also by a flattened epithelium. Only inner circular layer could be appreciated in the fourteen week foetus and outer longitudinal layer also identified in the full term foetus. Tandler (1900), Fersner (1907), Johnson (1910), Palzet (1931) and Cho (1931) had observed that early in the morphogenesis (between 5th and 8th week of gestation) vacuoles develop in the stratified epithelium of duodenum and luminal occlusion occurs. Following vacuolation and occlusion, a discrete intestinal lumen appears and mucosal folds, then villi and finally crypts form between 8th and 12th weeks of gestation.

Kolliker (1879) and Pamela colony (1978) observed that crypts appeared first in the distal foetal small intestine about one week after the villi had formed. They also observed that intestinal crypts originate as downgrowths of the epithelium to mesenchyme from the base of adjacent villi. Fry et al (1963) of the opinion that the number of cells of the crypts do not change with age. But according to Rita M. Carriere the

growth of the crypts in the duodenum with age is at least in part, to an increase in cell number.

Kelly R.O.(1973) observed that villous and crypt formation proceeds in a craniocaudal direction occurring in the distal small intestine about one week after it begins at the proximal small intestine. Pamela colony (1978) had similar observations. These events occur at 11-12 weeks of gestation. Johnson (1910) stated that goblet cells appear in the intestinal epithelium at 9-10 weeks of gestation. Pamela colony (1978) stated that prior to the villous formation; stratified epithelium contained three cell types mainly undifferentiated cells, goblet cells and entero endocrine cells. J.F.Beruler and R.Calvert (1984) found that in mouse foetus, maturation of absorptive cells begin at 17 days of gestation, two days before birth.

In the present study, there is not much alteration in the height of the villus from the first part to the fourth part of duodenum as age advances. There is not much alteration in the number of columnar cells in all the four parts of duodenal mucosa. But their average population in age groups 1-25, 26-50, 51-75, 76-85 years was 952, 1016, 885 and 830 /HPF Goblet cells are seen in the walls of the villi and bases of the crypts.

They increase in number distally. In the present study the number of goblet cells in the first part is 287 per high power field, 324 per high power field in the second part, 440 per high power field in the third part and 410 in the fourth part of duodenum.

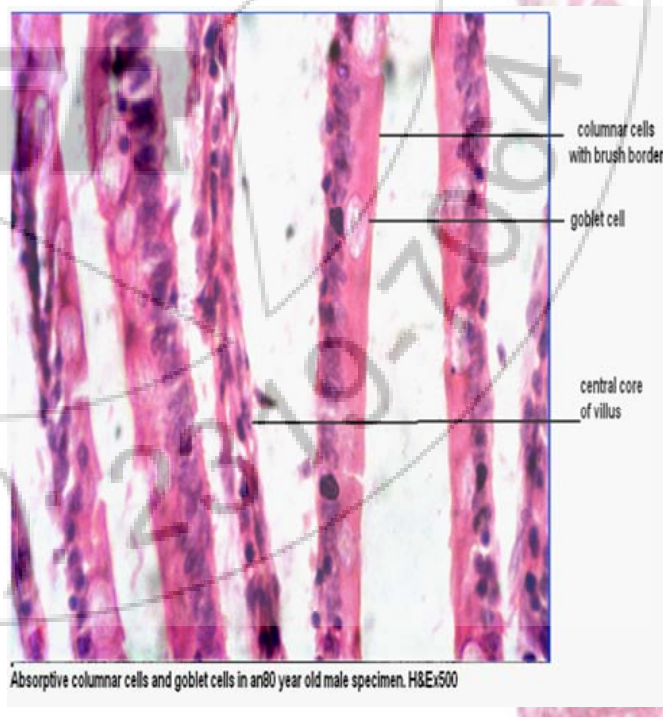
Their average numbers in the four age groups were 435, 458, 335, 252 per high power field. There is a gradual increase in goblet cells from proximal to distal regions of duodenum. But as age advances; there is a definite tendency to decrease in their number.

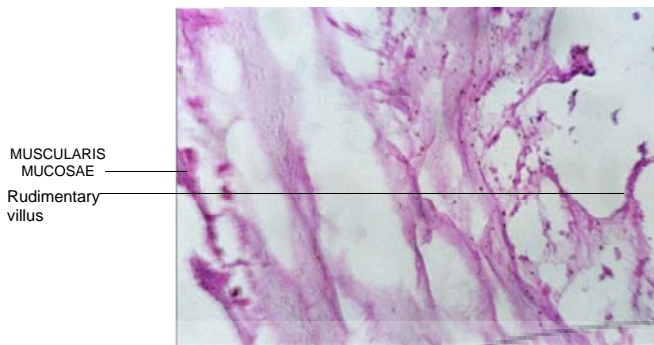
6. Summary and Conclusion

This is the first study of human duodenal mucosal cells in Kerala. 80 specimens were collected. Specimens for microscopic study were fixed in 10% Formalin and paraffin sections were taken, stained with routine Haematoxylin and Eosin staining methods. In the microscopic study, villi began to appear in 14 weeks of gestation. The epithelial cells along the villi are cuboidal in foetus and gradually become columnar in the adult and old specimens. Goblet cells are seen in the villi and the base of crypts of Lieberkunn. They began to appear from 14 weeks of gestation. The gradually increase in number distally so that the fourth part of duodenum contained larger number of goblet cells than the other parts of duodenum. The increment is gradual from first to fourth part. There is a slight but gradual decrease in the number of absorptive columnar cells so also the number of goblet cells as age advances. The decrease in number is especially after middle age in all four parts. i.e. Even though there is constant turnover of the cells in the mucosa of the duodenum there is a definite decrease in the number of absorptive columnar and goblet cells with ageing.

References

- [1] Altman and Enesco 1967. cell number as a measure of distribution and renewal of epithelial cells in the small intestine of growing adult rats .Anat.121:319-336
- [2] D.H.Burkla and P.J.M.Tutton 1979. experimentally induced acceleration and depletion of Paneth cells J.Australia and Newzealand 25-2 pp 389.
- [3] Lee blond C.P. and B.Messier 1958 removal of chief cells and goblet cells in the small intestine as shown by radio autography after injection of thymidine-H3 into mice. Anat.Rec, 132:247-259.
- [4] Atkins, A.M., and W.J.Krause 1971. An unusual basement membrane underlying intestinal epithelium of the duckbilled platypus. Experientia; 53:27-32
- [5] Bartmann, J. (1972). Ultrastructure of human foetal small intestinal mucosa in early gestation. J.Pathol, 106:8-9.
- [6] Bjerknes, M and H.Cheng 1980 a. the stem cell zone of the small intestinal epithelium II. Evidence from Paneth cells in the adult mouse, AM.J.Anat. 160:51-63.
- [7] Bjernes, M., and H.Cheng 1980 c. The stem cell zone of the Small intestinal epithelium of the rat. Delineation of kinetic parameters. Exp. cell. Res., 39:539-553.
- [8] Cairnie, A.B., L.F.Lamerton. and G.G.Steel 1965 a. cell proliferation studies in the small intestinal epithelium of the rat. II. Theoretical aspects, Exp.Cell.Res. 39:539-553.
- [9] Dunn, J.S. (1967). the fine structure of the absorptive epithelial cells of the developing small intestine of rat. J.Anat., 101: 57-68.
- [10] Klein S. 1906. On the nature of the granular cells of Paneth in the intestinal glands of mammals Am.J.Anat. 5.315-330.





14 weeks old foetus:-
villi rudimentary,
Muscularis mucosae
contains only inner
circular fibres x100

**Variations in the Number of Absorptive Columnar Cells and Goblet Cells
With Age in Human Duodenum**

	0-25 Years		26-50 Years		51-75 Years		76-85 Years	
	No. of Cells /HPF		No. of Cells /HPF		No. of Cells /HPF		No. of Cells /HPF	
	ACC	GB	ACC	GB	ACC	GB	ACC	GB
I st Part	930	340	1026	355	910	246	730	208
II nd Part	934	390	1136	443	875	240	900	220
III rd Part	913	410	880	476	873	441	890	320
IV th Part	1030	600	1020	559	880	414	800	260
Average	952	435	1016	458	885	335	830	252

ACC : Absorptive Columnar Cells GB: Goblet Cells

Author Profile

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