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Histogenesis of pylorus in human fetal stomach

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Abstract

Introduction: The objective of the present study was to know about the microscopic development of the pylorus of stomach and find out how pylorus consisting of same histological layers as that of the body of stomach becomes a sphincter and acts like a valve to control the exit of chyme. This is the region of stomach where muscle fibres arising from antral part are concentrated. **Material and methods**: The present study was carried out on forty human fetuses, ranging from 53mm-310mm crown-rump length obtained over a period of one year. **Result:** Histologically, wall of pylorus consists of serosa, muscularis externa, submucosa and mucosa. The histological differentiation of different layers of pylorus was studied at different crown-rump length. At all developmental stages, the pyloric region shows thicker muscular wall, deep gastric pits and complex mucosal folds. The pyloric glands are predominantly mucous with few parietal cells.

Conclusion: The simple glandular design and thicker muscular wall of pylorus are justifiable as it has to act as gatekeeper of the stomach.

Keywords: Pylorus, Histogenesis, Crown-Rump length

INTRODUCTION

The pylorus, or pyloric part, connects the stomach to the duodenum. The pylorus is considered as having two parts, the pyloric antrum and the pyloric canal. The pyloric canal ends at the pyloric orifice. The orifice is surrounded by a sphincter 'a band of muscle', called the pyloric sphincter. The word pylorus comes from Greek word which means 'gatekeeper'. Stomach starts to develop from spindle-shaped, small dilatation in the distal portion of the pre-enteron by 4th week of development[1] . At 14 weeks of gestation, with parts of stomach and pylorus, characteristic anatomy can be seen[2]. Anatomical description of the pyloric region is based on the increase in muscle thickness in the gastro-duodenal region[3]. Pyloric sphincter is not a separate anatomical structure from the stomach but is a region where the stomach and the sphincteric complex are intertwined and muscle fibres arising from antral part of the stomach are concentrated here[4]. Mean capacity of stomach varies from 30ml at birth, increasing to 1000ml at puberty and about 1500ml in adults[5].

Amongst developmental anomalies of the stomach during the fetal life are pyloric stenosis, pre-pyloric septum, and pyloric atresia. The histological and developmental knowledge of musculature of stomach wall especially the pyloric region is vital for the assessment and management of various associated congenital abnormalities like hypertrophy of pyloric musculature. So, the present study focuses on this region of the stomach.

Materials and methods

The present study was conducted on 40 fetuses of varying gestational age obtained over a period of one year. Fetuses were collected from the Department of

Gynaecology and Obstetrics, Government Medical College Jammu. The fetuses were obtained as the products of still births and abortions.

The collected specimen were put in jars containing 10% formalin. The preservative was made available to the above said collecting centre. The fetuses to be measured were kept on a plane board with knee and hip joints flexed at 90 degree each. With the help of vernier calliper, crow-rump length was measured between the vertex of scalp and buttocks. Assessment of the age of foetuses was done according to the rule as described by Hamilton, Boyd and Mossman (1976) shown in table 1.

Age of fetus/embryo	Crown-Rump Length
32 days	5mm
33-55 days	5mm+ 1mm/day
56 day onwards	Calculated age at 55 days+1.5 mm/day

Table 1

The fetuses obtained were dissected. Blocks of 3-5mm in diameter were collected from pyloric part of stomach. The preparation of tissue for section was done by paraffin wax embedding method.

Various steps used were:

1) Dehydration
2) Clearing
3) Paraffin wax impregnation
4) Casting
5) Sectioning
6) Fixation of slides on slides
7) Staining

a) Harris Haematoxylin and Eosin stain

b) Masson's Trichrome stain

The slides were mounted with DPX solution and covered with cover slips and examined under microscope. Photographic documentation was done to notice important findings.

OBSERVATIONS

Observations were made while working on 40 fetuses, ranging from 53mm-310mm crown-rump length. Pylorus involves both pyloric canal and pyloric antrum. No attempt was made to study the macroscopic structure and rotation of gut.

The fetuses were divided into five groups depending on their stage of histological development as shown in table 2

Group No.	Crown-rum length (mm)	No. of foetuses
1	53	1
2	56-104	12
3	105-162	11
4	164-208	7
5	210-310	9

Table 2

Group 1 (53mm crown-rump length): At this stage the wall of pylorus consists of three layers. The mucosal layer consists of only a single sheet of small cuboidal cells. Deep to it is a thick layer of undifferentiated connective tissue cells. External to this layer are a group of densly placed spindle shaped cells, laying down to form the circular layer.

Group 2 (56mm-104mm crown-rump length): The pylorus of stomach at 56mm crown-rump length shows that mucosal layer has deep and longer pits and there is increased cellular density at the bases of these pits indicating the tendency of formation of lamina propria. The submucosal layer is less broad as compared to the muscular layer.

At 60mm crown-rump length, the pylorus shows that the circular muscle layer is thickest and is a continuous layer. External to this layer scattered layer of longitudinal muscle layer is seen.

Mucosa of pylorus at 70mm crown-rump length shows long mucosal folds lined with small columnar cells. The parietal cells are also seen and muscular layer is thick with blood vessels within muscle fibre bundles as seen in (fig 1).

Volume 4, Issue 4; July-August 2021; Page No 718-721

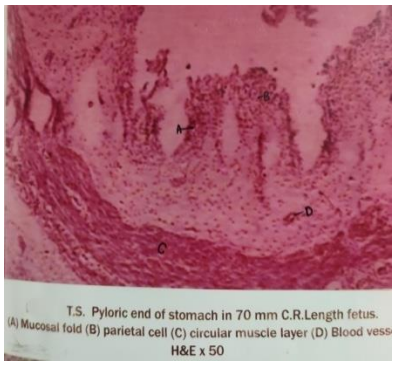

Fig1

By 90mm crown-rump length the muscle layer shows well developed oblique muscle layer.

Group 3 (105mm-162mm crown-rump length): The pylorus at this stage shows bigger mucosal folds and longer pits. The size of columnar cells from surface epithelium towards the walls of the pits show gradual decrease. Two epithelial buds are seen at the base of a single pit. Within the epithelial budding, parietal cells are predominant with few mucous neck cells. Lamina propria is seen projecting into the mucosal folds. Muscularis externa shows traces of all the three layers.

At 110mm crown-rump length the pylorus shows that the number of acinar glands is more and circular muscle layer is also increased in thickness.

At 120mm crown-rump length glands at pylorus (Massons Trichrome) are less in number with more mucous neck cells, few parietal cells and occasional chief cells. Walls of blood vessels are thickened.

The pylorus at 162mm crown-rump length shows that acinar glands are arranged longitudinally within lamina propria. Submucosa shows abundant fibres and muscular layer is the thickest.

Group 4 (164mm-208mm crown-rump length): The pylorus shows pits are longer and surface epithelial cells are taller. Glands are tubular in form. Branching of glands is less and mucous cells are predominantly found. Muscle fibres from muscularis mucosa extending into the core of mucosal folds have increased in number and size. Muscular layer is the thickest of all layers (fig 2)

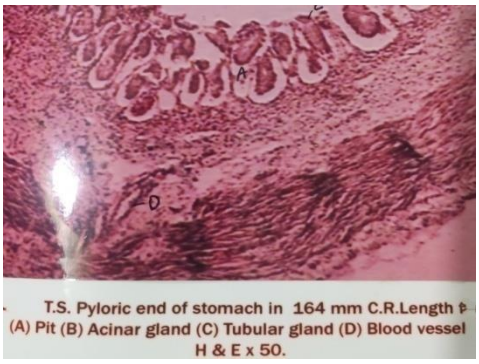

Fig 2

Group 5 (210mm-310mm crown-rump length): At this stage the pylorus of stomach shows more folding of mucosa. Pits are longer and size of the gland is small as compared to the body, with predominance of mucous cells. Mucous cells are seen in groups and are longitudinally arranged. Few parietal cells are also seen. Muscular layer is thickest due to which submucosa is reduced in thickness (fig 3).

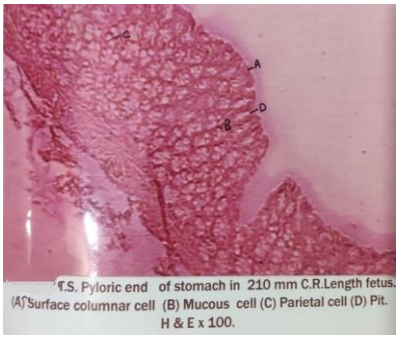

Fig 3

Discussion:

Pylorus is the gastric outlet and various anomalies such as congenital intrinsic obstruction of the antrum or pyloric region and CHPS can cause obstruction. At all developmental stages, the pyloric region of the stomach shows thick muscular wall, deep gastric pits and complex mucosal folds. The pyloric glands are mostly mucous with few parietal cells. The thick muscular wall and simple glandular design are justifiable as it has to act as gatekeeper of the stomach. The data obtained from the present study is preliminary knowledge related to the development of pyloric sphincter.

The present study shows that at 10th week of gestation due to dipping of surface epithelial layer, gastric pits make their first appearance at the pylorus. Authors like Salenius (1962)[6], Boyd (1972)[7], Arey (1974)[8], Marie (1979)[9] and William et al (1995) observed the pits in

Volume 4, Issue 4; July-August 2021; Page No 718-721

the pyloric region of stomach between 10-11 weeks of intrauterine life.

Great diversity of opinion is seen among various authors regarding the shape of pits in pyloric region. Lim (1992) observed the pits at pylorus longer, narrower and funnel shaped. Elias and Pauly (1966)[10] described the pits in pylorus as oblong slits. The present study observed the shape of pits at the pylorus as long and narrow. Though the time of appearance of parietal cells varies in different studies, but the present study and previous literature in date are of common opinion that parietal cells are the first to differentiate among the glandular cells. The present study noticed that gland formation occurs after the cellular differentiation. The glands begin to develop as evaginations from the base of pits into lamina propria as epithelial buds by 14th week of gestation and this is in complete aggrement with Arey (1974) and Marie and Valdes (1979), who also observed these buds at 14th week of gestation. The present study noted acinar glands at 15th week of gestation and tubular form by 20th week of gestation. This is in accord with the view expressed by Chimmalgi M and Sant SM (2005)[11] who observed acinar form by 12-16 weeks and tubular form by 18-20 weeks of gestation. Scott GH (1925)[12] studied the growth in number of the gastric crypts and glands in later fetal life.

Present study shows the presence of parietal cells in the pylorus throughout all developmental stages, which is in complete accord with Grand et al (1976)[11]. The present study observed circular muscle layer at 10th week of gestation and traces of longitudinal muscle layer at 11th week of gestation. Authors like William et at (1995) noted that circular muscle layer develops at 8-9 weeks of gestation and longitudinal muscle layer slightly later. Boyd (1972) observed differentiation of circular muscle layer during 5-9 weeks and longitudinal muscle layer during 6-12 weeks of gestation. The present study observed the circular muscle layer to be thickest at the pylorus, may be because it has to act as sphincter.

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Volume 4, Issue 4; July-August 2021; Page No 718-721