IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 9 Ver. 6 (September. 2018), PP 62-66
www.iosrjournals.org

Morphogenesis of colon in human foetuses

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Abstract*:*
Objective: *An attempt is made to histologically and morphologically study the development of colon in foetuses of different gestational ages at Regional Institute of Medical Sciences, Imphal and to compare the findings with those described in the literature.*
Methods: *Fifty foetuses of different gestational ages ranging from eleven weeks to term were fixed for two weeks and dissected. The length, development and position of different parts of colon were charted. Sections were made of the parts and stained with haematoxylin eosin, Masson's trichrome, plasma stain, Van Giesons stain, Cresyl fast violet stain and were studied for development of various layers of colon.*
Result:*Return of the gut is complete at 11 weeks. Caecum was found to be placed at the iliac crest at 11 weeks, but goes up cranially with relative decrease in size of liver later to descend to lumbar region at 22 weeks. By 24 weeks ascending and descending colon are retroperitonealand transverse colon attains new line of attachment. Sacculations appear at 24 weeks. Sigmoid colon becomes S shaped at 25 weeks. Colon attains its adult position at 31-35 weeks.*
Histologically lining epithelium was stratified columnar with 2 layered cell thickness with goblet cells at 11 weeks. Mucosal villi like folds are seen at 13 weeks but disappear at 22 weeks. Muscularis mucosa is completely formed at 20 weeks. Taenia coli are seen at 27 weeks.Neurons start appearing in the mesentery by 11 weeks.
Conclusion*: 50 foetuses from 11 weeks to term were studied morphologically and historically. The foetuses were products of medical termination of pregnancy and still birth.The findings in this study were compared were compared with findings of other authors and were found to be similar.*
Key words: *embryology of colon, colon development, taenia coli, haustrations*

Date of Submission: 01-09-2018 Date of acceptance: 17-09-2018

I. Introduction:

The development of colon during foetal period is very important in order to evaluate the anomalies of colon and to understand the anatomy in adult more thoroughly.

In postnatal period the large intestine extends from ileocaecal valve to the anus and is about 1.5 meter long. It arises from right iliac fossa as caecum, passes up in the lumbar region till the hepatic flexure to become transverse colon at transtubercular plane. The transverse colon has an anteroinferior convexity till it reaches splenic flexure to descend as the descending colon which descends in the left lumbar region to become sigmoid colon. The sigmoid colon descends deep in the pelvis to become the rectum and the anal canal.[1]

The principal functions of the large intestine are recovery of salt and water from the faeces and propulsion of faeces to rectum.[2] The large intestine has taenia coli, appendices epiploecae and haustrations which is absent in small intestine.[3] The colonic wall is puckered into sacculations, which may be partly due to taenia coli. In neonates the haustra and the sacculations are absent, it appears in the first 6 months after birth.[4]

The primitive gut is formed as a result of head tail and lateral folds of the embryo and the resulting incorporation of the dorsal aspect of the yolk sac into the intra embryonic coelom. [5] It develops from a simple tube of undifferentiated cells which develops into a complex, highly differentiated organ with a self-renewing epithelium.[6,7]

The primitive large intestine arises from midgut and hindgut. Midgut forms the Caecum, Appendix, Ascending colon and right two third of Transverse Colon. The hind gut forms the rest of the colon till the anorectal line.[8,9]

Due to rapid development the gut at 6 weeks, the gut herniates through the umbilicus to return later at 10 weeks. It also rotates by 270 degrees in an axis formed by superior mesenteric artery[5]

A double layer mesothelium suspends the gut which later becomes the mesentery. The splanchnoplure gives rise to mucosa, submucosa and two muscle layers.[9 10]

A series of folds develops forming villi early on but they later disappear.[11] Muscular layers develop and start functioning by 8th week. Taenia appears at 12 weeks. Aurbachs and Meissners Plexus appear by 12 weeks.[8]Circular muscle layer develops earlier than the longitudinal layer. Muscularis mucosae appear laer. Aggregation of lymphocytes are seen at 15-20 weeks. [11 12]

The study aims to find in gross study the localisation of colon parts at different weeks, study gross visual appearance, attachment of mesocolon, development of blood supply, In histological study an attempt will be made to study the appearance of different layers at different stages of development, presence and appearance enteric neurons in the mucosa and submucosa.

II. Materials and Methods:

The study was conducted at the Regional Institute of Medical Sciences Hospital, Imphal. 50 foetuses of different gestational ages were collected from Department of Obstetrics and Gynaecology after getting consent from the parents. The foetuses were products of termination of pregnancy and still births. The termination of pregnancy followed MTP act of India 1971 and study was conducted after getting clearance from the ethical committee of the Institute. Only those foetuses that did not have gross anomalies were selected. Age of the foetuses was calculated from crown rump length and obstetrical history.

The foetuses were fixed in formalin 10% for 10-15 days prior to study. The foetuses were divided into 6 groups (11-15, 16-20, 21-25, 26-30,31-35 and 36-40 weeks).The abdomen of the fixed foetuses was opened by a rooftop incision extending along the midaxillary line and converging at the pubic symphysis. Figure 1 shows foetuses whose abdominal wall has been removed for study. Appearance of the colon to the naked eye and its relations were recorded. The size, length and position of different parts of colon were noted and recorded photographically

Figure 1. Showing fixed foetuses being dissected

Slides were prepared from the different parts of different weeks and were stained with Harris haematoxylin, 1% Eosin, Massons trichrome, Plasma stain, Fibre stain, Van Giesons Stain, Weigerts iron haematoxylin and Nissl stain. The slides were examined under a trinocular research light microscope in 4X, 10X, 40X and 100X and findings were photographed and recorded.

III. Results and observation:

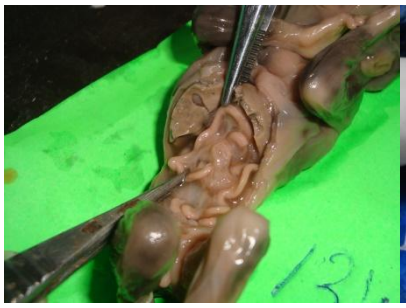
All colons were intraperitoneal in all fifty foetuses showing the complete return of gut following physiological herniation by 11 weeks. The number of foetuses in each age group is shown in table 1. The important gross and histological findings in each group are described hereafter.

At 11 weeks, the outer surface of the gut is smooth. Taenia coli, appendices epiploecae and sacculations were not seen. Most of the intestine both large and small was seen under the liver as liver is found extending upto the lumbar and umbilical region and caecum is placed just below the liver above the right iliac crest.

Histologically villi like folds filled the lumen of the intestine. Lining epithelium was found to be stratified columnar with two layer cell thickness with numerous goblet cells. Lamina propia was seen extending along the folds of mucosa (Figure 1a)..Muscularis mucosa was not visible and submucosa cannot be differentiated from the lamina propia (Figure.2). Both layers of muscularis externa, inner circular and outer longitudinal are defined but taeniacannot be traced. In Cresylfast violet stain multipolar neurons are seen

migrating along the dorsal mesentery. Some neurons can be identified in between the layers of muscularis externa.

At 13 weeks Caecum is at right lumbar region, Ascending and transverse colon follows an oblique course and hepatic flexure is not identified. Sigmoid colon is curved and is at left iliac fossa region. Histologically Myenteric plexus and Meissners plexus are formed. The villi are still visible (figure 2).



Figrure.2

figure 3

In group II, 17 week foetuses, hepatic flexure was just below the pyloric region of stomach, ascending colon was oblique and retroperitoneal in position. Transverse colon was placed transversely with concavity upward (Figure 3). Descending colon was seen along the convexity of left kidney and was partially fixed. Sigmoid colon was curved with concavity upwards and was seen in left iliac fossa and suprapubic region. Histologically villi like formation were found to be reduced. Lining epithelium was simple columnar with increased number of goblet cells. Some areas were turning into pseudostratified columnar type. There was lymphocytic infiltration in the lamina propia. Submucosa was separated from the lamina propia by the formation of muscularis mucosa. There was increase in thickness of muscularis externa with more prominent taenia coli (Figure 3a).

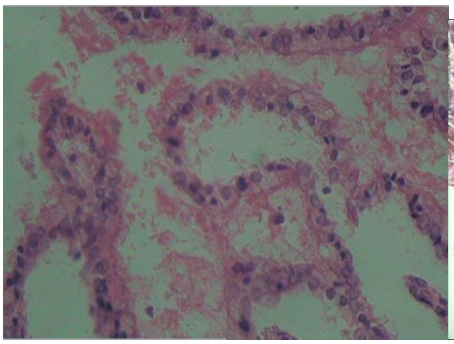


Figure 3a

figure 4

In 20 week foetus there were minimal changes in gross findings and histology. Crescentic folds were seen the mucosa (Figure 4).

In 22 week foetus, caecum was seen at the lower pole of kidney and sigmoid colon in the left iliac fossa and suprapubic region. Histologically Villi completely disappeared.

In 24 week foetus Hepatic flexure was seen below the liver and splenic in left hypochondrium attached to spleen by a peritoneum in the mid axillary line. Descending colon was found coiled and plastered to the posterior abdominal wall. No sacculations can be seen till this time. Histologically medium sized multipolar neurons with Nissls granules were seen in the muscularis externa and smaller size neurons could be seen in the muscularis mucosa. In the 27 week foetus there were no significant changes in gross finding. Histologically prominent crescentic fold containing lamina propria, muscularis mucosa and submucosa were seen. Submucosa has now become distinct with prominent collagen fibres. Muscularis externa show circular and longitudinal layer with increased neurons

In a 28 week foetus colon is now smooth and glistening with noticeable sacculations (Figure 5).

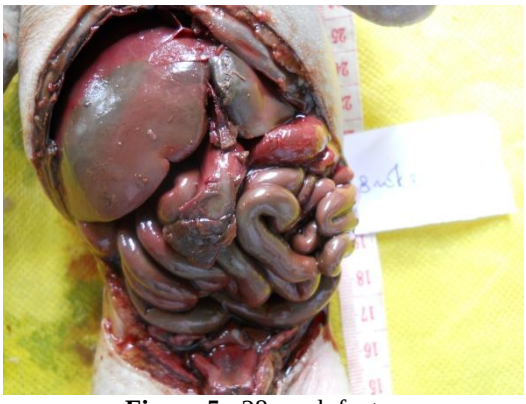


Figure 5 : 28 week foetus

In a 34 week foetus caecum is in lumbar region. Transverse colon showsaccculations. Sigmoid colon was S shaped with concavity to the right and was in the left iliac fossa. Arterial supply of the colon arising fossa right, left,middle colic, ileocolic artery can been seen at 34weeks. Histologically , they are like adult colon.
In 37 week foetus, sacculation and haustration are well seen with naked eye but no distinct appendices epiploicae could be seen. Histologically all features were like that of an adult colon. Mucosa showed intestinal gland lined by simple columnar cells with plenty of goblet cell. Submuscosa was distinct with plenty of collagen fibres.

IV. Discussion

In this study of colon of 50 foetuses ofdifferent gestational ages were examined for morphological features and histological appearance. The loop of intestine return to the abdominal cavity by 10 week as none of the foetuses has incomplete return of umbilical herniation.[5,13] The ileocecal part of intestine is sub hepatic at three months.[5,14,15] The caecum lies close the iliac crest and becomes fixed in its permanent position. Ascending colon passes obliquely up to the left of the stomach where it recurves sharply to the future descending colon. The ascending colon and hepatic flexure become defined due to caudal migration of cecum and relative diminution of liver.[5,12,16.] In this study intestinal return is complete at 11 weeks. Caecum remains at the right lumbar region from 13 to 17 weeks and reaches its normal position by 20 to 25 weeks. Adult type of transverse colon is seen at 17 weeks. Splenic flexure becomes defined at 21 to 25 weeks. The extent of descending colon was associated with wavy form at 13 weeks, arched at 15 weeks, oblique at 16 weeks and becomes straight at 17 weeks. Sigmoid colon became S shaped at 25 weeks. The haustra and appendices epiploicae are absent in first 6 months of life but becomes more pronounced later on. In the present study taenia coli was seen at full term, sacculation start by 24 weeks and fully formed at 28 weeks. No appendices epiploicae were seen till full term.

Regarding fixation to the posterior abdominal wall there are varieties of opinion. In our study by 20 weeks the mesentery of descending of colon is fused with the peritoneum of the left posterior abdominal wall and hence becomes retro peritoneal.

Histologically lining epithelium was stratified columnar with two layered cell thickness at 11 weeks. In 13 weeks it becomes stratified columnar in some areas. Whole of lining epithelium becomes simple columnar by 20 weeks full of goblet cells. Low crescentic folds are seen 17 weeks and by 23 to 30 weeks the crescentic fold contain lamina propia, muscularis mucosa and submucosa. Temporary villi appear at the 1st and 2nd trimester and disappear at the birth. The muscularismucosa appears around 17 weeks and becomes prominent at 26 to 30 weeks and attains adult type at 31 to 35 weeks. The submucosa becomes separated from lamina propia at 20 weeks. The muscularis externa could be seen at 11 weeks, formation of taenia coli at 13 weeks. The serosa can be seen at 11 weeks.

Between the inner circular and outer longitudinal the zone of highly cellular area could be noticed at 16 weeks suggesting of multi polar neurons. At 24 weeks medium size multi polar neuron with nissls granules could be detected.

V. Summary

50 foetuses from 11 weeks to term were studied morphologically and historically. The foetuses were products of medical termination of pregnancy and still birth .
The findings in this study were compared were compared with findings of other authors and were found to be similar. The return of gut was complete by 11 weeks. The rotation and fixation of colon complete by 28 weeks and histologically becomes adult like at 31 weeks.

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