Human foetal stomach : a morphological study

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Abstract

Background and aims: The morphology of human stomach is subjected to wide variations and changes during developmental stage. Congenital anomalies of stomach like hypertrophic pyloric stenosis and thoracic stomach are common in new borns. Some rare anomalies like duplication, diverticula and hypoplasia of stomach also may occur. The present study attempts to analyze the morphological changes like change in shape, height, width, length of greater and lesser curvatures, capacity and localization of stomach in the quadrants of abdomen in different age groups of human foetuses and also to look for congenital anomalies. Materials and methods: Fifty normal fresh still born foetuses of age varying from 15 to 40 weeks were dissected and morphological study was carried out. Parameters like height, width, length of greater and lesser curvature, capacity of stomach were measured and location, shape, internal appearance of stomach were noted. Results: Significant changes in shape and in location of stomach in different quadrants of the abdomen were found in different foetal age groups. Localization of stomach is seen as that in adults by 25th week of foetal age. Typical 'J' shaped stomach is seen by 28th week of foetal age. Height, width, length of greater and lesser curvatures and capacity of stomach increased with increasing foetal age. A sudden increase in width was seen at 17th week and a sudden increase in height was noted at 25th week. Well developed rugae and gastric canal were seen in inner surface of stomach by 28th week. Capacity of stomach increased from 1 ml at 15th week to 32 ml at 40th week. Conclusion: The observations of the present study show that morphology and location of the stomach in different age groups show great variations. This study may help in study of development of stomach and in diagnosis of different developmental anomalies, ailments and pathology of stomach.

Key words: greater curvature, gastric rugae, crown rump length, incisura angularis, gastric canal.

Introduction

Stomach, the widest part of the alimentary tract appears as a fusiform dilatation of the foregut in the fourth week of development. It begins its development at the 3rd to 5th cervical vertebral level. Because of the marked cephalic growth of the foregut, descent of the stomach occurs so that its eventual final location is in the region between the 10th thoracic and 3rd lumbar vertebral level. During the period of descent, stomach undergoes certain changes in shape, size and orientation. During 7th and 8th week, stomach rotates around a crano-caudal axis so that the greater curvature lies to the left and lesser curvature lies to the right. During further growth, stomach rotates around an antero-posterior axis such that the caudal part moves to the right and upward and the cephalic or cardiac portion moves to the left and slightly downwards. The stomach thus assumes its final position with it's axis running from above left to below right. Congenital anomalies of stomach like hypertrophic pyloric stenosis and thoracic stomach are common in new borns. Some rare anomalies like duplication, diverticula and hypoplasia of stomach also may occur. Knowledge regarding normal changes in morphology of stomach may help in diagnosis and treatment of various congenital anomalies of stomach. The aim of the present study was to observe the changes in shape, height, width, length of greater and lesser curvatures, capacity and location of the stomach in human foetuses of different age groups.
Materials and methods

Fifty normal fresh foetuses, 18 males and 32 females of different age groups ranging from 15 weeks to 40 weeks were collected from the Department of Obstetrics and Gynaecology, Regional Institute of Medical Sciences, Imphal. The study was conducted over a period of 2 years. The foetuses were products of terminated pregnancies under Medical Termination of Pregnancy (MTP) Act of India, 1971 and stillbirths. Only those foetuses which were free from any gross anatomical abnormality were selected for the study.

The age of the foetuses were calculated from obstetrical history and crown rump length (CRL). The foetuses were divided into different age groups according to their gestational age:

- Group 1: 15 to 18 weeks (CRL 80mm to 130mm)
- Group 2: 19 to 22 weeks (CRL 131mm to 175mm)
- Group 3: 23 to 27 weeks (CRL 176 mm to 250mm)
- Group 4: 28 to 40 weeks (CRL 251mm to 450mm)

Abdomen was opened by subcostal incision and along the inguinal folds. The lateral end of the subcostal incision was extended vertically down to the lateral ends of incision along the inguinal folds thereby opening the abdominal cavity.

After removal of anterior abdominal wall and portion of left lobe of liver, appearance of stomach to the naked eye, position and relation with surrounding viscera were noted and relevant specimens were photographed. After gross study, stomach was gently taken out and height, width, length of curvatures (greater and lesser) and capacity of stomach were measured.

Results

Stomach was present in all the 50 foetuses dissected. In earliest specimen of the present study, stomach was found to be very small and as the foetal age advanced the size of the stomach also increased. The significant changes in different age groups as noted are as follows:

GROUP 1 (15-18 weeks):

At this stage, stomach was found to be situated below the diaphragm mainly in the epigastrium and umbilical region. Small part of the stomach was seen in left hypochondrium. Anterior surface of stomach was completely hidden by the liver. Mean height of the stomach in this age group was 14.7mm and mean width was 9.1mm. Mean length of greater curvature and lesser curvature were 24.3mm and 11.3 mm respectively.

At 15 - 16 weeks, the shape of the stomach was almost tubular. Cardia, fundus, body and curvatures could be identified but pyloric part could not be distinguished from the body because incisura angularis was not developed. Lumen of the stomach was very narrow and capacity at this stage was one ml. (fig. 1).

At 17 -18 weeks, stomach looked wider and almost 'C' shaped (fig. 4). The cardiac and pyloric orifices were almost in the midline. Cardiac incisura was well developed. Incisura angularis was seen but not very deep. The height of the stomach varied from 14mm to 15mm. A sudden increase in width was seen at 17th week. The width varied from 10mm to 12 mm. Lumen was wider than before and capacity increased upto 1.5 ml.

GROUP 2 (19-22 weeks):

Position of the stomach in abdomen was slightly changed at this stage. Body and fundus were shifted little more towards the left hypochondrium. Cardiac orifice was still in the midline. Pyloric orifice was slightly shifted to the right. Incisura angularis was very much prominent and body and pyloric part of stomach could be easily distinguished from each other (fig. 2). Fundus was found to be more projecting than before. Few blood vessels were seen along the greater curvature. Internal surface of the stomach showed some indistinct rugae.

Height of the stomach varied from 18mm to 25 mm with a mean of 21.7mm and width varied from 12mm to 16mm with a mean of 14.2mm. Length of greater curvature ranged from 34mm to 48mm and length of lesser curvature ranged from 12mm to 18mm. Mean length of greater and lesser curvature at this stage were 43.3 mm and 14.9mm respectively. Capacity of the
stomach in the earliest specimen of the series i.e at 22 weeks was 2.6ml. Mean capacity at this stage was 2.3ml.

**GROUP 3 (23-27 weeks):**

Stomach was found to occupy more of the left hypochondrium. Cardiac orifice was shifted a little left from the midline. Dome shaped fundus was seen at this stage. Greater curvature was more curved and blood vessels were more prominent. Rugae were also more prominent than previous stage (fig. 3).

Height of the stomach varied from 24mm to 44mm with a mean of 33.9mm. A sudden increase in height was seen at 25th week. Height of stomach increased from 25mm (24th week) to 40mm (25th week). Width of stomach varied from 16mm to 22mm with a mean of 20.1mm. Length of greater curvature ranged from 50mm to 62mm and length of lesser curvature ranged from 20mm to 25mm. Mean length of greater and lesser curvature were 56.6 and 22.6mm respectively. Capacity of the stomach in the earliest specimen i.e at 23 weeks was 2.8ml and increased to 10ml at 27 weeks. Mean capacity of the stomach at this stage was 5.7ml.

**GROUP 4 (28-40 weeks):**

Stomach was significantly bigger at this stage. Size of the stomach had increased in all dimensions. Stomach assumed the typical 'J' shape (fig. 5). It was found to lie more horizontally with it's long axis running from left above to right below. It was situated in the epigastrum, left hypochondrium and umbilical region. By 36th week, lower part of the stomach reached umbilical level. Uptil 36th week, it was hidden by liver. From 37th week, small part of anterior surface was found not to be covered by liver. Rugae were very prominent at this stage resembling those in adults. They were more longitudinal and marked along the greater curvature (fig. 6). Along the lesser curvature, a canal resembling the 'gastric canal' in adults was seen.

Mean height and width of stomach at this stage were 58.7mm and 30.6mm respectively. Mean length of greater and lesser curvature were 90.3mm and 32.3mm respectively. Mean length of greater curvature was almost triple to that of lesser curvature at this stage. Mean capacity of the stomach was 22.8ml which indicated a significant increase in capacity at this age group. At 28th week the capacity was found to be 15ml and increased upto 30ml to 32ml by 40th week.

**Discussion**

Cetin et al\(^4\) observed that there is significant difference in localization of stomach of human foetuses in quadrants of abdomen in different age groups. Cegarra et al\(^5\) stated that stomach of human embryos undergoes heterogenous and multifactorial rotation as a consequence of the overall increase in the gastric wall growth mainly of the left and increase of gastric motility produced by the previous mesenteric enlargement and that the rotational direction results from the forces exerted on the stomach and gastric mesenteries by the adjacent organs. At 4th week of intrauterine life stomach is recognized as fusiform dilatation and is oriented in mid plane. In course of time stomach undergoes a 90 degree rotation around cranio-caudal axis and during further growth stomach again rotates around an anteroposterior axis to obtain its final position in abdomen\(^1,3,4\). However O'rahilly and Muller\(^7\) stated that there is no evidence that the stomach rotates around a longitudinal axis. In the present study at 15 to 18 weeks, stomach is found to be mainly in epigastrum and umbilical region. During 19 to 22 weeks of foetal age, stomach is shifted more towards left hypochondrium. At 23 to 27 weeks, pylorus is seen to be shifted upwards and to the right and cardiac orifice lies slightly to the left of the midline. By 36th week, stomach reaches umbilical level. So observations of the present study certainly supports the theory of rotation of stomach around its axis.

At birth stomach is small and hidden by liver\(^8\). English\(^9\)has observed that at birth stomach is little more than a straight tube continuous with the oesophagus.
Fig.1: Human Foetus - 15 weeks; CRL - 85mm

Fig.2: Human Foetus - 22 weeks; CRL - 175mm

Fig.3: Human Foetus - 26 weeks; CRL - 225mm

Fig.4: Human foetal stomachs at different weeks of gestation

Fig.5: Human foetal stomachs at 28 & 40 weeks of gestation

Fig.6: Internal surface of human foetal stomach at 40 weeks of gestation

above and duodenum below and hangs nearly vertically in abdomen. It is elastic and easily distended and more or less compressed by the other abdominal viscera and the diaphragm. There is slight fullness on one side where the greater curvature and fundus are present. At birth
stomach is generally covered by the left lobe of liver\textsuperscript{10}. The present study has found that stomach is under cover of liver upto 36th week of gestation. From 37th week a small portion of lower part of anterior surface along the greater curvature is not covered by the liver.

Pyloric region becomes distinguishable in the 3rd month of intrauterine life but the pyloric sphincter is still weakly developed at birth\textsuperscript{11}. Koyuncu et al\textsuperscript{12} observed that position of pylorus of stomach varied form right upper quadrant, median plane and left upper quadrant of abdomen in different gestational age of human foetuses. The rate of thickness of muscular coat is higher in first and first half of second trimester than in term foetuses. In the present study, it is found that pyloric canal can be distinguished from the body from 19th week onwards.

The inner surface of empty stomach reveals a number of longitudinal folds or ridges which are poorly developed in upper portion and prominent in the lower region of the stomach\textsuperscript{13}. The rugae of the fundus are more marked along the greater curvature and gradually diminishes towards the pylorus\textsuperscript{14}. In the present study few indistinct rugae are seen along the inner surface of the stomach of 20th week foetuses. They increase in number as the foetal age advances. Prominent rugae resembling those of adults are seen by 28th week of age.

Hollinshead\textsuperscript{15} describes a subdivision of the stomach along the lesser curvature. It is called the gastric canal. 'Magenstrasse' is a canal created by two longitudinal rugae near the lesser curvature of the stomach\textsuperscript{16}. In the present study, such canal was seen between the longitudinal ridges along the lesser curvature by 28th week of gestational age.

Sanz et al\textsuperscript{17} observe that in the beginning human foetal stomach grows due to predominant growth of it's wall mainly of the left and at later stage gastric volume increases rapidly because of the predominant expansion of the cavity which may be related to the capacity to swallow the amniotic fluid. The mean capacity of the stomach is approximately 30 ml at birth\textsuperscript{10}. England\textsuperscript{18} opines that the stomach of the neonate has a capacity of 30 to 35 ml. In the present study, at 15th week, lumen of foetal stomach is seen to be narrow and capacity is found to be approximately one ml. The capacity increases upto 15ml by 28th week . Maximum increase of capacity occurs from 28th week. At 40th week, the capacity of the stomach reaches 30ml to 32ml.

Hollinshead\textsuperscript{15} has described that the active stomach may present a number of variations in shape. Moore and Dalley\textsuperscript{19} mention that in most people the shape of the stomach resembles the letter 'J'. In human foetuses final 'J' shaped stomach is not seen until 22 weeks\textsuperscript{20}. Hawass et al\textsuperscript{21} have reported that final shape of the human foetal stomach was not assumed at least until the age of 22 weeks. In the present study it is found that the shape of the stomach is almost tubular at 15th week and 'C' shaped at 18th week. Dome shaped fundus is seen from 23rd week and by 28th week 'J' shaped stomach is seen as that in adults.

Collins and Borley\textsuperscript{10} mention that in human embryos of 10mm CRL, the characteristic greater curvature is recognizable and in adults, greater curvature is 4 or 5 times longer than the lesser curvature of stomach. Hawass et al\textsuperscript{21} observed in their study that greater curvature grows at a much faster rate than lesser curvature. In the present study, in 15th week foetus, convex greater curvature and concave lesser curvature were seen and length of greater curvature is almost double the length of lesser curvature at this stage. A sudden increase in length of greater curvature was seen at 19 to 22 weeks. At 40th week greater curvature was seen to be almost three times longer than the lesser curvature.

Cetin et al\textsuperscript{4} observed that in human foetal stomach height increased more than the width after 24 weeks. Chroszcz et al\textsuperscript{22} observed that the highest growth rate of stomach in pig foetuses was in third (70-76 days) and fourth (82- 86 days) age group that is in the middle of
gestational period. The mean value of length of stomach was twice larger than the width and thickness of the stomach. In the present study, a sudden increase in height of stomach is seen as the foetal age advances from 24th week to 25th week. Width of the stomach is seen to increase suddenly as the foetal age advances from 16th week to 17th week. In other stages increase in height and width is gradual. Increase in height is seen to be more than the increase in width after 22nd week.

Hollinshead\textsuperscript{13} states that pyloric or prepyloric atresia may cause congenital obstruction. Diverticula of the stomach is a rare condition which can occur in cardia or pyloric region. Godlewski et al\textsuperscript{23} observed that in human foetuses gastric duplication occurred more in spherical form than in tubular form. De La Torre Mondragon et al\textsuperscript{24} state that tripodation of stomach can occur but is a very rare malformation. A part of the stomach may be displaced superiorly through the oesophageal hiatus into the thorax. This condition is called congenital hiatal hernia\textsuperscript{a}. In congenital diaphragmatic hernia, part of the stomach herniate through a large posterolateral defect in the diaphragm. This type of hernia occurs in one of every 2200 new borns\textsuperscript{19}. In the present study, no case of congenital hernia or any developmental anomaly of stomach was detected.

**Conclusion**

A morphological study of stomach was conducted on 50 normal fresh still born human foetuses of different age groups. The findings were compared with those of similar studies.

In this study stomach was found to be very small and occupying mainly part of epigastrum and part of left hypochondrium at 15 to 18 weeks of foetal age. Height, width, length of greater and lesser curvature and capacity of stomach were seen to increase with increasing foetal age. The shape of the stomach was also found to change in different age groups. Typical 'J' shaped stomach was seen by 28th week of foetal age. Well developed rugae and gastric canal were seen in inner surface of stomach by 28th week of foetal age.

Findings of this study regarding the changes in size, shape, localization and capacity of human foetal stomach of different ages are expected to be helpful in study of development of human foetal stomach and in diagnosis and treatment of various congenital anomalies of stomach.

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