

STUDY OF MORPHOMETRIC CHANGES OF FOETAL STOMACH

Mohammed Aneesur Rahman¹, Yogesh Galphade², Chaya Vijay Diwan³

¹Associate Professor, Department of Anatomy, Dr. Shankarrao Chavan Government Medical College, Nanded.

²Assistant Professor, Department of Anatomy, MIMSR, Latur.

³Professor, Department of Anatomy, Dr. Shankarrao Chavan Government Medical College, Nanded.

ABSTRACT**BACKGROUND**

Interest in human development is very widespread largely because of the curiosity about our beginnings and desire to improve the quality of life. Understanding of the processes involved in the formation of various organs and systems has unveiled most cryptic secrets of the nature. Human development begins at fertilisation when a male gamete or sperm unites with a female gamete or oocyte to form a single cell, a zygote. With the formation of zygote (single-celled stage), foetal development begins. The aim of the study is to-

- 1) Study the morphometric parameters of foetal stomach at various gestational ages.
- 2) Compare these observations with the previous studies.

MATERIALS AND METHODS

Present work was the cross-sectional study carried out in the Department of Anatomy in collaboration with the Department of Obstetrics and Gynaecology at SRTRGMC and Hospital, Ambajogai Dist., Beed, Maharashtra. For this, approval of Institutional Ethical Committee was taken. 30 aborted human foetuses of different age groups ranging from 12 to 36 weeks of fertilisation were taken from the Department of OB-GYN. Foetuses were preserved by using 10% formalin. Age of foetuses were determined by crown-rump length and history given by mother. Foetuses were dissected after preservation for 15 days and morphometric studies were done on stomach.

RESULTS

Various quantitative parameters like weight of foetus, crown-rump length, total length of stomach, weight of stomach, length of greater curvature, lesser curvature, width of cardia and width of pylorus were used. For the purpose of study and comparison with other researchers, the foetuses were divided into 3 groups. Morphometric changes were observed in different groups and compared with previous studies.

CONCLUSION

With the increase in the body weight, crown-rump length and gestational age of the foetus, there is gradual increase on various parameters of stomach.

KEYWORDS

Foetal Stomach, Morphometric Parameters, Crown-Rump Length.

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BACKGROUND

Interest in human development is very widespread largely because of the curiosity about our beginnings and desire to improve the quality of life. The intricate process by which a baby develops from a single cell is miraculous. Understanding of the processes involved in the formation of various organs and systems has unveiled most cryptic secrets of nature. Human development begins at fertilisation

when a male gamete or sperm unites with a female gamete or oocyte to form a single cell, a zygote. With the formation of zygote (single-celled stage), foetal development begins. Cell division, cell migration, programmed cell death, differentiation, growth and cell rearrangement transforms this zygote into a multicellular human being.¹

The stomach, J-shaped dilation of the alimentary canal is continuous with oesophagus proximally and duodenum distally. It functions primarily as a reservoir to store large quantities of recently ingested food, thus allowing intermittent feedings, initiating the digestive process and releasing its contents in a controlled fashion to accommodate much smaller capacity of duodenum. Apart from its function as receiver and digester of food, stomach is of special importance to man because of normal regenerative phenomena occurring there quickly.²

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Corresponding Author:

Dr. Mohammed Aneesur Rahman,

Associate Professor, Department of Anatomy,

Dr. Shankarrao Chavan Government Medical College,

Nanded, Maharashtra-431604.

E-mail: aneesurrahman72@gmail.com

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Aims and Objectives

1. To study the morphometric parameters of foetal stomach at various gestational ages.
2. To compare these observations with the previous studies.

MATERIALS AND METHODS

Present work of morphometric study of stomach in human fetuses of various gestational ages was a cross-sectional study carried out in the Department of Anatomy in collaboration with the Department of Obstetrics and Gynaecology at SRTR Government Medical College, Ambajogai, District Beed, Maharashtra. Approval of Institutional Ethics Committee was taken. 30 aborted human fetuses of different age group ranging from 12 to 36 weeks of gestational age were procured from the Department of Obstetrics and Gynaecology of the SRTR Hospital for research work with due permission from the Professor and Head of the Department and consent from parents.

Inclusion Criteria- Only the fetuses free from detectable abnormalities were included in the study.

Exclusion Criteria- Twins and fetuses with gross congenital anomalies and visible postmortem decomposition changes were excluded from the study.

Fetuses were obtained within 3-4 hours of abortions to avoid postmortem changes and are immediately kept in 10% formalin.

Criteria Used for Case Selection-

A complete anatomical examination was performed in all specimens to document normal anatomical development. A standard proforma was designed and used to maintain a protocol in selecting only the normal fetuses from the Department of Obstetrics and Gynaecology. The consent from the parents were also taken in proper format. Thus, this helped avoiding any kind of bias in current study.

All fetuses were structurally normal for their gestational age on postmortem examination.

Preservation of Collected Fetuses-

The fixation of fetuses was ensured by injecting 10% formalin locally into the various body cavities with the help of 10 mL syringe and #20 needle for better preservation. All fetuses were carefully dissected after allowing them to fix for a period of 7-15 days after undertaking the process of embalming.

Determination of Age-

The Crown-Rump Length (CRL) is the measurement of the length of human embryos and fetuses from the top of the head (crown) to the bottom of the buttocks (rump). It was measured by using thread and scale in centimetres. Gestational age was calculated from crown-rump length.

Materials Used-

1. Electronic weighing machine, measuring scale, Vernier caliper.
2. Magnifying lens, metal probe and permanent marker.
3. Rubber gloves and filter paper.
4. Plastic tags, scissors, scalpel and forceps.

Dissection-

1. A midline incision was taken from xiphisternum to the pubic symphysis below and extended upto anterior superior iliac spine.
2. Skin was reflected laterally and exposes the visceral organs by removing superficial and deep fascia.
3. The stomach was exposed and removed with ligating at cardioesophageal end and pyloric end.

Examination of Stomach-

First of all, stomach was removed from the fetuses with proper dissection. The developing stomach was isolated and preserved in 10% formalin.

All the dimensions of stomach such as weight, length and thickness of greater and lesser curvature were measured using electronic weighing machine and vernier caliper. The length of stomach was measured from highest point on body part of stomach to lowest point on pyloric part of stomach. Also, the thickness at greater and lesser curvature at the midpoint was taken by vernier caliper. The weight of the stomach was measured by weighing machine in grams.

Formulas Used in the Study-

For observational purpose and for comparison with other studies, the fetuses were arranged in 13 groups and mean of each parameter was calculated for each group.

Mean was calculated as follows-

$$\text{Mean} = \frac{\sum x}{n}$$

Where, x is observation and n is number of observations.

Standard deviation was calculated as follows-

$$\text{S.D.} = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

Where, x=observation, \bar{x} =mean of values of observations and n=number of observations.

OBSERVATIONS AND RESULTS

The present study was carried out in the Department of Anatomy. The study was carried out on 30 fetuses between 12th and 36th weeks of gestational age. In the present study, the development of stomach was studied by considering different parameters of development. The parameters considered were-

1. Foetal body weight.
2. Foetal crown-rump length.
3. Total length of stomach.
4. Weight of stomach.
5. Greater curvature length.
6. Lesser curvature length.
7. Width of cardia.
8. Width of pylorus.

For the purpose of study and comparison with other researchers, the foetuses were divided into 13 groups initially. When there was more than one foetus in a particular group, the average was calculated for that group. The parameters were studied in the normal foetuses, which were procured and the data was collected, tabulated and analysed statistically.

Body Weight- The body weight of the foetuses was recorded in grams. When there was more than one foetus from a particular age group, the average weight represented that age group. The obtained data was tabulated (Table No. 1). This table showed that the mean body weight of 12 weeks foetus was 44 grams and that of 36 weeks foetus was 2910 grams.

Gestational Age (Weeks)	Average Body Weight (Grams)
12	44
14	130.83
16	200
18	300.25
20	420.5
22	610
24	802
26	950
28	1290
30	1650
32	1924
34	2480
36	2910

Table 1. Showing Average Body Weight of Foetuses at Different Gestational Ages in Weeks

Crown-Rump Length- The crown-rump length of all foetuses was recorded in millimetres (mm). When there was more than one foetus from a particular age group, average crown-rump length represented that age group. Again, this data was tabulated as shown in Table No. 2. The table shows that mean CRL of 12 weeks foetus was 75 mm and that of 36 weeks foetus was 324.50 mm.

Gestational Age (Weeks)	Average Crown-Rump Length (mm)
12	75
14	115
16	122
18	150
20	172
22	185
24	202
26	224
28	270.5
30	276
32	295
34	300
36	324.5

Table 2. Crown-Rump Length

Total Length of Stomach- The total length of stomach of all foetuses was recorded in millimetres (mm). Again, this data was tabulated as shown in Table No. 3. The table shows

that mean length of stomach of 12 weeks foetus was 8.64 mm and that of 36 weeks foetus was 25.20 mm.

Gestational Age (Weeks)	Total Length of Stomach (mm)
12	8.64
14	11.50
16	13.23
18	14.00
20	20.15
22	21
24	21.13
26	22
28	22.10
30	23.75
32	24.10
34	24.50
36	25.20

Table 3. Total Length of Stomach

Weight of Stomach- The weight of stomach of all foetuses was recorded in grams. Again, this data was tabulated as shown in Table No. 4. The table shows that mean weight of stomach of 12 weeks foetus was 0.55 gm and that of 36 weeks foetus was 14.10 gm. A graph No. 4 was plotted.

Gestational Age (Weeks)	Weight of Stomach (Grams)
12	0.55
14	1.18
16	3.50
18	4.00
20	7.20
22	8.50
24	11.30
26	11.90
28	12.50
30	13.40
32	13.90
34	14.00
36	14.10

Table 4. Weight of Stomach

Greater Curvature of Stomach- The greater curvature of stomach of all foetuses was recorded in millimetres (mm). Again, this data was tabulated as shown in Table No. 5. The table shows that greater curvature of stomach of 12 weeks foetus was 17.60 mm and that of 36 weeks foetus was 62.10 mm.

Gestational Age (Weeks)	Greater Curvature of Stomach (mm)
12	17.60
14	21.00
16	39.80
18	47.08
20	48.39
22	49.20
24	54.60
26	56.10
28	58.30
30	59.30

32	61.10
34	61.80
36	62.10

Table 5. Greater Curvature of Stomach

Lesser Curvature of Stomach- The lesser curvature of stomach of all foetuses was recorded in millimeter (mm). Again, this data was tabulated as shown in No. 6. The table shows that lesser curvature of stomach of 12 weeks foetus was 8 mm and that of 36 weeks foetus was 21 mm. A graph No. 5 was plotted showing both greater and lesser curvature.

Gestational Age (Weeks)	Lesser Curvature of Stomach (mm)
12	8.00
14	8.75
16	11.08
18	11.37
20	15.31
22	15.50
24	18.11
26	18.23
28	19.30
30	19.45
32	20.50
34	20.90
36	21.00

Table 6. Lesser Curvature of Stomach

Width of Cardia-

The width of cardia of stomach of all foetuses was recorded in millimeter (mm). Again, this data was tabulated as shown in Table No. 7. The table shows that the width of cardia of stomach of 12 weeks foetus was 0.70 mm and that of 36 weeks foetus was 3.80 mm.

Gestational Age (Weeks)	Width of Cardia (mm)
12	0.70
14	1.50
16	2.10
18	2.30
20	2.90
22	3.00
24	3.14
26	3.25
28	3.40
30	3.45
32	3.64
34	3.70
36	3.80

Table 7. Width of Cardia

Width of Pylorus-

The width of pylorus of all foetuses was recorded in millimetres (mm). Again, this data was tabulated as shown in Table No. 8. The table shows that width of pylorus of stomach of 12 weeks foetus was 1.00 mm and that of 36 weeks foetus was 5.20 mm.

Gestational Age (Weeks)	Width of Pylorus
12	1.00
14	1.60
16	1.75
18	2.45
20	3.17
22	3.56
24	4.10
26	4.25
28	4.50
30	4.65
32	4.80
34	5.10
36	5.20

Table 8. Width of Pylorus

DISCUSSION

The present study was carried out with an attempt to delineate the proper development of stomach from a period of 12 weeks of gestation to 36 weeks. Different morphometric parameters were included in the study in order to elaborate the developmental changes in stomach. These features were discussed on the basis of observations and results obtained during the course of study. Further, these findings were compared with the established literature and with the observations of researchers who have undertaken the study of morphometric changes of foetal stomach in past. As mentioned earlier, the various parameters, which were studied are analysed in relation to stomach development. These are-

1. The weight and crown-rump length of the foetus in relation to the gestational age of the collected foetuses.
2. Total length and weight of stomach.
3. Dimensions of stomach, i.e. greater and lesser curvature length, width of cardia and pylorus.

The morphometric study was done by dividing the collected foetuses into three gestational age groups. These are-

- Group 1- 12 weeks to 20 weeks.
- Group 2- 21 weeks to 28 weeks.
- Group 3- 29 weeks to 36 weeks.

Morphometric parameters of foetal stomach.

Body Weight of Foetuses- In the present study, body weight of foetuses showed gradual increase from 44 grams at 12 weeks to 2910 grams at 36th weeks of gestation. So, these findings were compared with findings of other workers (Table No. 9). From the Table No. 9, it is clear that rise in the body weight of the foetuses collected were consistent with the findings presented by Moore and Persaud.¹ Throughout the period of study, i.e. from 12 weeks to 36 weeks, at the same time, the data of current study was comparable with the data given by Langman³ only till the 26 weeks beyond which the data was in concurrent. But, in the entire study, the changes in the weight of the foetuses did not match with the figures presented by Hamilton and Boyd.⁴

Gestational Age (Weeks)	Hamilton and Boyd	Langman	Moore and Persaud	Present Study
12				44
14		60-200	110	130.83
16	120		200	200
18		250-450	320	300.25
20	300		460	420.5
22		500-820	630	610
24	635		820	802
26		900-1300	1000	950
28	1220		1300	1290
30		1400-2100	1700	1650
32	1700		2100	1924
34		2200-2900	2900	2480
36	2400		3400	2910

Table 9. Showing Comparison of Foetal Body Weight in Grams of Present Study with Findings of Other Workers

Crown-Rump Length of Foetuses

In the present study, the crown-rump length showed gradual increase as the gestational age of the foetuses increased. The least measured CR length was 75 mm of 12th weeks and highest being 324.50 mm in 36th weeks of foetuses. These findings were compared with findings of the other worker (Table No. 10). The measurement of CR length of present study substantially matched with findings provided by both Moore and Persaud¹ and Hamilton-Boyd.⁴ But, the findings reported by Potter and Craig⁵ were found to be slightly different than that of present study.

Gestational Age (Weeks)	Moore and Persaud	Hamilton and Boyd	Potter and Craig	Present Study (mm)
12	87	57-84		75
14	120			115
16	140	61-100		122
18	160			150
20	190	101-200		172
22	210			185
24	230	151-200	209	202
26	250		234	224
28	270	201-260	254	270.5
30	280		271	276
32	300	261-320	284	295
34			298	300
36	340	321-390	334	324.5

Table 10. Showing Comparison of Crown-Rump Length (in mm) of Present Study with the Findings of Other Workers

Length of Foetal Stomach

In Table No. 11, the mean length of foetal stomach in the first group is 14.36 mm; it is 21.47 mm in the second group and finally 24.38 in the third group.

Group (Gestational Age)	N	Mean Length of Stomach	Range (in mm)	Standard Deviation (S.D.)
Group 1 - (12 weeks - 20 weeks)	10	14.36	11.19-17.54	4.434
Group 2 - (21 weeks - 28 weeks)	12	21.47	21.15-21.79	0.501
Group 3 - (29 weeks - 36 weeks)	8	24.38	23.90-24.86	0.576

Table 11. Length of Foetal Stomach

From Table No. 11, it is seen that there is gradual and irregular increase in the length of foetal stomach from 12th week to 36th week of gestation. The findings of our study mostly coincide with the findings of Gworys B et al⁶ as tabulated in Table No. 12 for comparison.

Present Study (12 th to 36 th weeks)	Gworys et al (12 th to 40 th weeks)
19.33	21.09

Table 12. Showing Comparison between Mean Length of Foetal Stomach at Different Gestational Age Groups with Previous Workers

The present study findings were more or less similar to the Gworys study.

Weight of Foetal Stomach

In the present study, weight of foetal stomach was calculated with electronic weighing machine. Weight of the stomach increased with the increasing gestational age. This increase was relatively harmonic throughout the whole gestational period. Mean values of weight in groups 1, 2 and 3 are 3.88, 10.95 and 13.85 gms, respectively as shown in Table No. 13. These findings were the findings of other workers in Table No. 14. This showed that the increase in weight of stomach substantially matched with findings provided by Gworys B et al.⁶

Group (Gestational Age)	N	Weight of Stomach (Grams)	Range (in Grams)	Standard Deviation (S.D.)
Group 1 (12 weeks to 20 weeks)	10	3.88	1.99-5.77	2.642
Group 2 (21 weeks to 28 weeks)	12	10.95	9.97-11.92	1.537
Group 3 (29 weeks to 36 weeks)	8	13.85	13.60-14.09	0.287

Table 13. Showing the Mean Weight of Foetal Stomach (in grams) Studied in Three Groups along with the Range Values in that Group and the Standard Deviation

Present Study (12 th to 36 th Weeks)	Gworys et al (12 th to 40 th Weeks)
9.36	10.10

Table 14. Showing Comparison between Mean Weight of Foetal Stomach at Different Gestational Age Groups with Previous Workers

Findings of the present study and study of Gworys are more or less similar.

Curvatures of Foetal Stomach

We studied lengths of curvatures of stomach (both greater and lesser), which increased with increasing gestational age. Mean values of greater curvature in groups 1, 2 and 3 are 35.76, 54.24, and 61.07, respectively as shown in Table No. 15. This increase was much greater in early gestation, but showed relatively constant values in late gestation. While mean values of lesser curvature in groups I, II and III are 11.45, 17.68 and 20.46, respectively as shown in Table No. 16. Lesser curvature length also increased throughout whole gestational period, but this increase in the length of lesser curvature was more harmonic than greater curvature throughout gestational period.

Group (Gestational Age)	N	Greater Curvature of Stomach (mm)	Range (in mm)	Standard Deviation (S.D.)
Group I (12 Weeks - 20 Weeks)	10	35.76	27.04 - 44.47	12.182
Group I (21 Weeks - 28 Weeks)	12	54.24	52.14 - 56.34	3.303
Group I (29 Weeks - 36 Weeks)	8	61.07	60.10 - 62.04	1.162

Table 15. Showing the Mean Greater Curvature of Foetal Stomach (in mm) Studied in Three Groups along with the Range Values in that Group and the Standard Deviation

Group (Gestational Age)	N	Lesser Curvature of Stomach (mm)	Range (in mm)	Standard Deviation (S.D.)
Group I (12 Weeks-20 Weeks)	10	11.45	9.29 - 13.62	3.027
Group I (21 Weeks-28 Weeks)	12	17.68	16.80 - 18.56	1.386
Group I (29 Weeks-36 Weeks)	8	20.46	19.91 - 21.01	0.656

Table 16. Showing the Mean Lesser Curvature of Foetal Stomach (in mm) Studied in Three Groups along with the Range Values in that Group and the Standard Deviation

The findings of our study mostly coincide with the findings of Gworys B et al⁶ as tabulated in the Table No. 17 for comparison.

Curvatures of Foetal Stomach (mm)	Present Study (12 th to 36 th Week)	Gworys et al (12 th to 40 th Week)
Greater curvature	49.90	49.36
Lesser curvature	16.35	16.28

Table 17. Showing Comparison between Mean Curvatures of Foetal Stomach at Different Gestational Age Groups with Previous Workers

Width of Foetal Stomach

In the present study, stomach width at the cardiac end and pyloric end was calculated with Vernier caliper. As in Table No. 18, the mean width of the stomach at cardiac end in groups I, II and III are 2.04, 3.17 and 3.64 mm, respectively. While the width of the stomach at pyloric part in groups I, II and III are 2.15, 4.06 and 4.93 mm respectively in Table No. 19. Width of the stomach increases with gestational age, the cardiac width increases gradually, but at pyloric part, it increased more intensively. The findings of our study mostly coincide with the findings of Gworys B et al⁶ as tabulated in the Table No. 20 for comparison.

Group (Gestational Age)	N	Width of Cardiac End of Stomach (mm)	Range (in mm)	Standard Deviation (S.D.)
Group I (12 Weeks - 20 Weeks)	10	2.04	1.44 - 2.63	0.832
Group I (21 Weeks - 28 Weeks)	12	3.17	3.08 - 3.26	0.139
Group I (29 Weeks - 36 Weeks)	8	3.64	3.53 - 3.76	0.136

Table 18. Showing the Mean Width of Cardiac End of Foetal Stomach (in mm) Studied in Three Groups along with the Range Values in that Group and the Standard Deviation

Group (Gestational Age)	N	Width of Pyloric End of Stomach (mm)	Range (in mm)	Standard Deviation (S.D.)
Group I (12 Weeks - 20 Weeks)	10	2.15	1.53 - 2.76	0.854
Group I (21 Weeks - 28 Weeks)	12	4.06	3.85 - 4.28	0.337
Group I (29 Weeks - 36 Weeks)	8	4.93	4.73 - 5.13	0.237

Table 19. Showing the Mean Width of Pyloric End of Foetal Stomach (in mm) Studied in Three Groups along with the Range Values in that Group and the Standard Deviation

Width of Foetal Stomach (mm)	Present Study (12 th to 36 th Week)	Gworys et al (12 th to 40 th Week)
Cardiac end	2.92	3.27
Pyloric end	3.66	4.30

Table 20. Showing Comparison between Mean Width of Foetal Stomach at Different Gestational Age Groups with Previous Workers

Findings of the present study and study of Gworys are more or less similar.

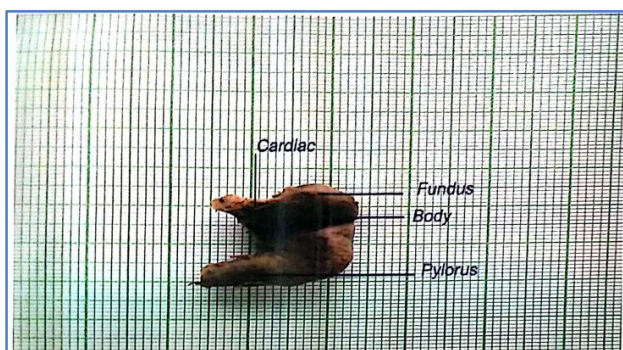


Photo 1. 26 Weeks Foetal Stomach on Graph Paper

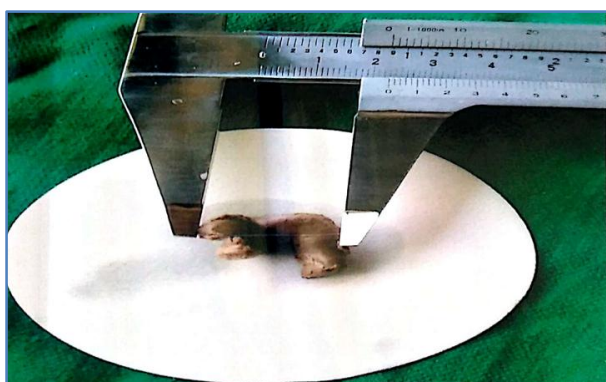


Photo 2. 26 Weeks Foetal Stomach Measurement with Vernier Caliper

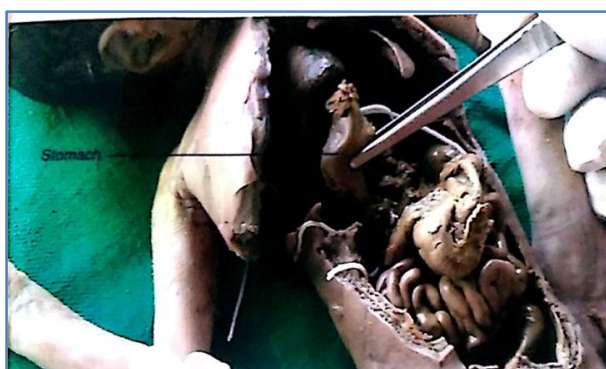


Photo 3. Foetal Stomach of 26 Weeks in Situ



Photo 4. 26 Weeks Foetal Stomach



1. Rotary microtome with knife
2. Weighing machine
3. Light microscope
4. Vernier caliper
5. Plastic tag
6. Hand lens
7. Measuring tape
8. Measuring scale
9. Marker pen
10. Probe
11. Scalpel and blade
12. Forceps
13. Scissors
14. Spirit lamp
15. Filter paper
16. Cover slips
17. Slides
18. Diamond pencil
19. Tissue cassettes
20. L Moulds

Photo 5

Summary and Conclusion

The present study, study of morphometric changes of foetal stomach was carried out on the 30 fetuses in order to observe the important morphological parameter.

This study was carried out on the obtained fetuses and morphometric parameters of human fetuses was taken. These were the weight of foetus, crown-rump length and weight of stomach.

Similar groups were used to study the length, curvatures (both greater and lesser), width (at cardia and pylorus). Measurements were taken for the different parameters of stomach.

CONCLUSION

Following conclusions were drawn from this study-

- 1) With the increase in the body weight, crown-rump length and gestational age of the foetus, there is gradual increase in the weight of the stomach.
- 2) As the gestational age increases, the length of the stomach increases.
- 3) As the stomach grows in size, its greater and lesser curvature also increases.
- 4) Width of pylorus increases more intensively than width of the cardia of the stomach.

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