

## Placental Villous Volume at Different Stages of Gestation

Ratesh K.<sup>1</sup>, Thakur A.<sup>2</sup>, Nene A.<sup>3</sup>

### Abstract

*Introduction:* Placenta makes connection between mother and foetus through umbilical cord. A healthy placenta is single most important factor producing healthy baby. Main mass of placenta is formed by villous and intervillous spaces. Volume of villi gradually increases with advancement of pregnancy. *Aim and objective:* The purpose of study was to correlate fetal birth weight with villous volume. *Material and Methods:* Twenty two placentae were obtained. Volume of placenta was obtained by fluid displacement method. Histological examination was done after staining with haemotoxylin & eosin, Van Gieson and Masson's trichrome method. Size of villi was obtained by Micrometry technique and percentage of villous volume was obtained by Point Counting technique. *Result and Conclusion:* Volume of villi in second trimester and third trimester placentae was 70ml and 317ml respectively. The present study provided data of placental villous volume/fetal weight is better indicator of fetal well being than conventionally used placental/fetal weight ratio. Pathologist can use provided data for comparison of villous volume with diabetic and hypertensive mother.

**Keywords:** Placenta; Villi; Villous Volume; Placental Weight.

### Introduction

Villi are the functional unit of placenta. Its average size at term is 35-40mm. Maternal blood enters the placenta and continuously bathes the surface of chorionic villi. Each terminal villus has 1. central stroma 2. basement membrane 3. cytotrophoblast and 4. syncytiotrophoblast from central core to outer layer. Central stroma contains foetal capillaries, mesenchymal cells, small and large reticular cells, fibroblasts and Hofbauer cells. Volume of villous tissue gradually increases with advancement of pregnancy due to continuous branching of villous tree that progressively fills up intervillous space [1]. Until the end of 16<sup>th</sup> week the placenta grows both in thickness and circumference but after that there is little increase in thickness. Placenta increases circumferentially till term.

Adverse pregnancy outcomes are associated with either placental growth restriction or placental hypertrophy [2].

Placental weight is frequently used in assessment of fetal well being. Apart from villous and intervillous space, placenta contains other structures like chorionic plate, amnion and part of umbilical cord etc.). Since it is the villous volume that is mainly responsible for fetal growth, the present study provides data for villous volume at different stages of gestation [3].

### Material and Methods

The present study was done in a Govt Medical College. Study material included placentae from normal deliveries and cesarean sections. Mothers of the age group 20-35 years and gestational age ranging from 12-40 weeks were included. Study sample included 22 specimens. Exclusion criteria was mother suffering from Diabetes Mellitus, Hypertension and any disease affecting growth/development of placenta. Placentae were divided into two groups i.e second and third trimester. Placentae of second trimester were obtained from patients with spontaneous/accidental abortion.

---

**Author's Affiliation:** <sup>1</sup>Associate Professor <sup>2</sup>Assistant Professor <sup>3</sup>Professor, Department of Anatomy, ESIC Medical College, Faridabad, Haryana 121012, India.

**Corresponding Author:** Thakur A., Assistant Professor, Department of Anatomy, ESIC Medical College, Faridabad, Haryana 121012, India.

E-mail: [thakuravns@gmail.com](mailto:thakuravns@gmail.com)

Received | 17.07.2018, Accepted | 28.07.2018

Placentae of third trimester were obtained after normal vaginal delivery/caesarian section. Informed and written consent was taken.

Morphological examination was carried out and characters like weight, volume, size, shape, diameter, site of attachment of umbilical cord, cotyledon structure etc from each specimen of second and third trimester were noted. Volume of placenta was obtained by fluid displacement method and surface area of placenta was measured by following formula:

$$\text{Surface area} = p \times L \times B$$

L = Radius of placenta along the length.

B = Radius of placenta along the breadth.

The data obtained was tabulated in different groups. The mean average value along with standard deviation and error was calculated for each parameter. Different parameters were correlated statistically using 't' test.

Specimen was taken from maternal surface of placenta after removal of deciduas and specimen were fixed in 10 percent formal saline solution for 48 hours. Histological examination was done after staining with haematoxylin & eosin (Harris's alum haematoxylin), Van Gieson and Masson's trichrome method.

Slides were studied under light microscope. Size of villous diameter was measured with the help of micrometer eye piece.

Relative component of villous and intervillous space were calculated by a modified point counting technique, as described by Mathur[4]. When a composite organ is examined with a grid, the relative volumes of the components are equivalent numerically to their relative areas on cut surface. A grid was prepared by drawing 25 points at equal distance on a white sheet (Fig.1). Image of slide was projected on the white sheet marked with grid. This was made possible by attaching a mirror to the monocular eye piece of microscope. Points on grid were used as counting unit. If a point lay on a measured component, it was counted as a hit for that component. 20 different fields were examined in each section, and in all, a minimum of 500 points were counted in each slide. The proportion of grid points falling on the image of the placenta components indicates the proportion volume of that component. Proportion of villous and intervillous space was determined (Fig.2). The observations were computed and analysed statistically.

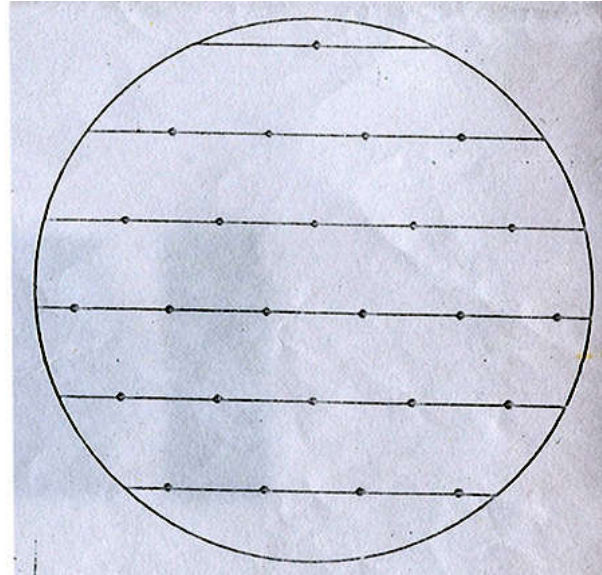


Fig. 1: Grid for Point counting

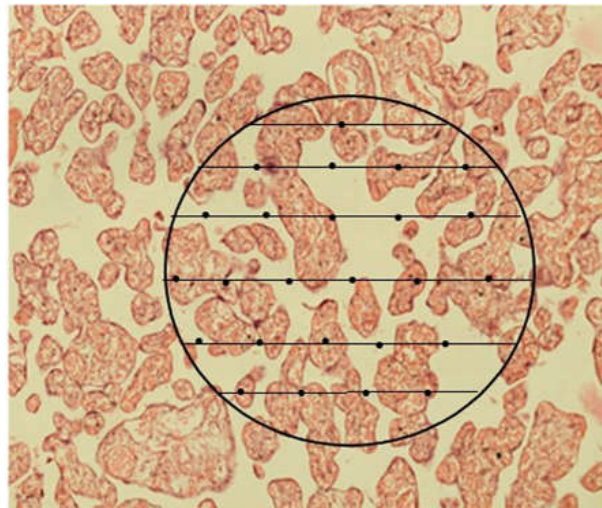


Fig. 2: Grid used to determine percentage of villous component as by Mathur technique

## Result

Cases of second trimester were between ages of 20-28 years with mean age of 24 years. Mean length of umbilical cord was  $16.63 \pm 8.22$  and range was 5-37 cm. The mean diameter of umbilical cord was  $2.69 \pm 0.58$  cm and range was 1.2-3.3 cm. Out of 11 specimens, 9 had eccentric attachment and 2 had central of umbilical cord attachment to the placenta. Ten placentae from the third trimester were studied, as in one case umbilical cord was not available for study. The mean length of umbilical cord was 35.6 cm and range was 19-50 cm. The mean diameter of umbilical cord was  $3.37 \pm 0.86$  cm with range between 2.3-5.0 cm. Out of 10



specimens, 7 had eccentric attachment and 2 had central attachment to the placenta and 1 had marginal attachment.

The average length of umbilical cord was 16.63 in 2<sup>nd</sup> trimester which increased to 35.60 cm in third trimester. Similarly diameter also increased from 2.69 cm in 2<sup>nd</sup> trimester to 3.37 in 3<sup>rd</sup> trimester.

The mean weight of placenta in second trimester was  $171.36 \pm 75.73$  grams with range between 20-250 grams. The mean foetal weight was  $400.45 \pm 262.50$  grams with range between 50-925 grams. The mean placenta/foetal weight ratio was  $0.48 \pm 0.18$  with range between 0.24-0.76.

The mean weight of placenta in third trimester was  $570.45 \pm 76.50$  grams with range between 425-700 grams. The mean foetal weight was  $2686.36 \pm 670.10$  grams with range between 1600-3800 grams. The mean placenta/foetal weight ratio was  $0.21 \pm 0.03$  with range between 0.16-0.28.

In second trimester the mean surface area was 64.0 cm<sup>2</sup>, it increased to 184.7 cm<sup>2</sup> in third trimester. As the gestation period increased, the placental as well as foetal weight showed an increased trend. However, the ratio between placental and foetal weight was not constant; the values decreased from 0.48 to 0.21. It is apparent that after 22<sup>nd</sup> weeks of gestation, the increase in foetal weight was more than placental weight.

The number of villi seen per field increased constantly with increasing age of gestation. Concurrently the intervillous space decreased with increasing period of gestation. The comparison between each trimester was best seen at 50X and 100X magnification, as only few villi were seen at 400X magnifications.

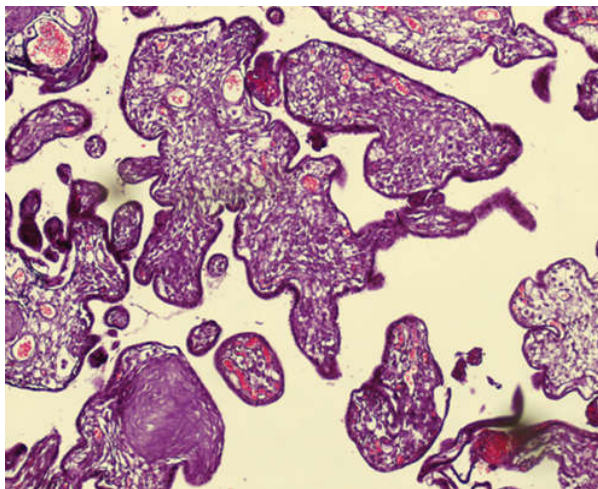


Fig. 3: Section of placenta at 20<sup>th</sup> weeks. Masson's trichrome X 100

Parenchyma of the placenta consists of villous and intervillous space. Villous volume can be further divided into trophoblast in the outer layer and stroma in the centre. All the sections of placentae were analysed for percentage volume of villous and intervillous space by modified point counting technique. Minimum of 500 points were counted in each section. In second trimester percentage of volume occupied by the villi was 56.72% (Fig.3). Volume occupied by intervillous space was 43.28% (Fig.4,5). In third trimester volume occupied by villous space was 69.10% and 30.90% by intervillous space. (Tables 1,2).

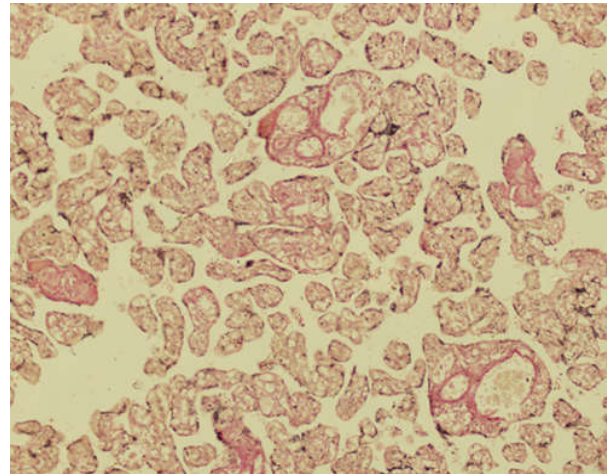


Fig. 4: Section of placenta at 39<sup>th</sup> weeks showing increase in villous volume. Van Gieson X 100

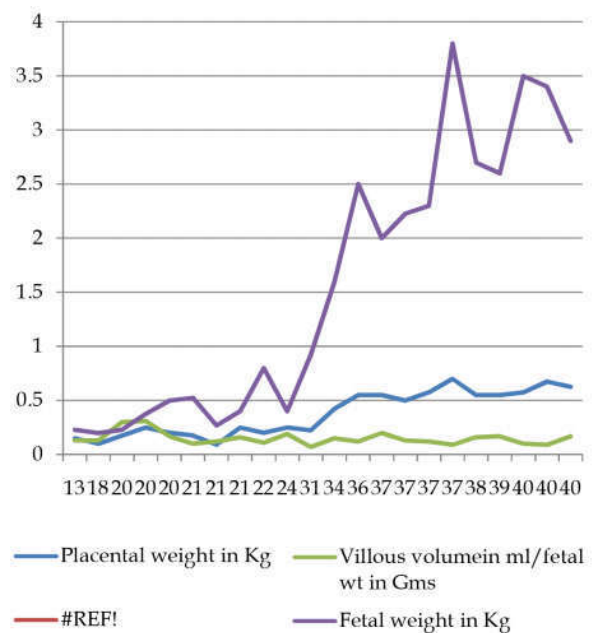


Fig. 5: A graph showing relative changes of parameters with advancement of gestation. X axis showing period of gestation in weeks and Y axis values

**Table 1:** Mean measurements of placenta in second and third trimester

Trimester	Second trimester		Third trimester	
	Mean± S.D	Range	Mean± S.D	Range
Period of gestation (in weeks)	20.64± 2.73	13.8-24.0	37.43±2.63	31.80-40.14
Placenta weight (in grams)	171.36±75.73	20-250	570.45±76.50	425-700
Foetal weight (in grams)	400.45±262.50	50-925	2686.36±670.10	1600-3800
Placental/foetal weight ratio	0.48± 0.18	0.24-0.76	0.21± 0.03	0.16-0.28
Surface area (in cm <sup>2</sup> )	64.00±18.2	29-98	184.70±27	160-227
Placental volume (in ml)	123±10	82-210	460±35	320-528

**Table 2:** Mean volume of villous and intervillous space

Parameters	Second Trimester (n=11)		Third Trimester (n=11)	
	Mean ± S.D.	Range	Mean±S.D.	Range
Size of villi in microns	95.80 ±36.61	41-180	47.4±13.12	31-70
Percentage of villous tissue	56.72± 9.49	42.60-68-60	69.10± 13.23	51.20-84.80
Percentage of intervillous space	43.28± 8.42	31.40-57.40	30.90±13.32	15.20-48.80
Placental volume (in ml)	123±10	82-210	460±35	320-528
Villous volume (in ml)	70.01±15.42	16-116	317.76±21.71	210-360
Placental volume/foetal weight ratio	0.21±0.8	0.17-0.31	0.12±0.2	0.09-0.20

## Discussion

The mean weight of placentae in second trimester (171.36 grams) in present study was less than that described by Hirano (266.8 grams)[5]. The mean weight in third trimester (570.45 grams) was more than that described by Beck (505 grams)[6], Hirano (524.8 grams) and Rath (438 grams)[7]. The placental weight in present study was taken from fresh specimen without removal of umbilical cord and blood clots, while Rath had taken the weight after removal of umbilical cord and blood clots.

The mean placental/foetal weight ratios in second and third trimester were 0.48 and 0.21. The present finding at third trimester is similar to Kalra (0.20)[8] but more than that described by Beck (0.14) and Rath (0.16). Surface area of placenta increased from 44 cm<sup>2</sup> to 240 cm<sup>2</sup> from 38<sup>th</sup> day to 281<sup>st</sup> day of POG. The present finding at third trimester (240 cm<sup>2</sup>) is less than that described by Rath (254.63 cm<sup>2</sup>).

With increase in period of gestation an increase in placental weight, placental surface area and foetal weight was seen. The rate of placental growth was maximum between 24 to 34 weeks of gestation; whereas the growth of foetus was maximum between 32 weeks to 34 weeks. The present finding is similar to Jackson, who had described maximum placental growth at 29 weeks and maximum foetal weight at 33 weeks. On comparison with third trimester, the foetal/placental weight ratio was much more in second trimester. It indicates that in early gestation main contribution to foetal-placental unit is by the placenta. In the present study the contribution of placenta to the foeto-placental unit

was maximum at 20<sup>th</sup> weeks (76%). Contribution of placenta to foeto-placental unit was lowest at 40<sup>th</sup> weeks (16%).

In third trimester the mean diameter of villi decreased from 95.8mm to 47.4mm. In a similar study Jackson [9] had described the decrease in villous size from 90mm to 58mm from 10 weeks to term period. In third trimester, volumes of villous and intervillous space (69.10 and 30.90%) were similar to that reported by Mathur (60 and 40 %) and Teasdale (61.7 and 38.3 %).

## Conclusion

With advancement of pregnancy, fetal growth rate increases far more in later part of trimester than placental growth. However placenta grows in villous volume rather than its size. Ratio between villous volume and fetal weight is maintained throughout the pregnancy; hence, it is better indicator of fetal well being. In spite of normal weight of placenta, IUGR can occur with decrease in villous volume. Available data of normal cases can be helpful for pathologist in comparing the data with cases of hypertension, diabetes and IUGR.

## References

1. Thomas I. Implantation, placentation, pregnancy and parturition In: Standing S, Ellis H, Healy JC, Johnson D, William A, Collins P et al, editors. 39<sup>th</sup> ed. Gray's anatomy. Edinburgh: Elsevier Churchill Livingstone; 2005.p.1339-1352.

2. Novak RF. A brief review of the anatomy, histology, and ultrastructure of the full-term placenta. *Arch Pathol Lab Med* 1991;115:654-59.
  3. Young B, Heath JW. *Wheater's functional histology*. 4<sup>th</sup> ed. London: Churchill Livingstone; 2001.p.359-62.
  4. Mathur S, Dasgupta P. A simple morphometric method for the study of placentae. *Indian J Pathol Bacteriol* 1974;17(4):205-210.
  5. Hirano H, Imai Y, Ito H. Spiral artery of placenta: development and pathology- immunohistochemical, microscopic and electron microscopic study. *Kobe J Med Sci* 2002;48:13-23.
  6. Kalra K, Kalra A, Gupta RK, Bhatia R, Singh K, Prasad R et al Placental morphology and histopathology in low birth weight. *Indian Pediatr* 1986;23:611-615.
  7. Beck T. Placental morphometry using a computer assisted measuring programme: reference values for normal pregnancies at term. *Arch Gynaecol Obstet* 1991;249:135-47.
  8. Rath G, Garg K, Sood M. Insertion of umbilical cord on the placenta in hypertensive mother. *J Anat Soc India* 2000;49(2):149-52.
  9. Jackson MR, Mayhew TM, Boyd PA. Quantitative description of the elaboration and maturation of villi from 10 weeks of gestation to term. *Placenta* 1992;13: 357-370.
-