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Original Article

Anatomy Section

Morphological and Morphometric Analysis of the Human Placenta: A Cross-sectional Study

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ABSTRACT

Introduction: The placenta is a large organ that acts as an interface between the pregnant mother and the foetus, facilitating the maternal and foetal circulation. Morphology and morphometric analysis form the base for ultrasonography examination of the placenta.

Aim: To study the morphology and the morphometry of the placenta.

Materials and Methods: A cross-sectional study was conducted in the Department of Anatomy, Kanyakumari Government Medical College, Asaripallam, Kanyakumari, Tamil Nadu, India, between November 2024 and December 2025. A total of 50 freshly delivered placenta specimens fixed with formalin were collected. Gross examination included assessment of shape and measurement of diameter and thickness, along with evaluation of membrane attachment, umbilical cord insertion and vascular pattern, type of attachment of membranes, type of attachment of umbilical cord, pattern of blood vessels on the foetal surface and the intactness of both the foetal and maternal surfaces. Descriptive statistics were primarily employed. Categorical variables were expressed as frequencies and percentages. Continuous variables were summarised using mean, Standard Deviation (SD), and range (minimum-maximum values).

Results: Of the placentae studied, 19 (38%) were discoid, 8 (16%) were oval, 8 (16%) were triangular, 14 (28%) were irregular, and 1 (2%) had a succenturiate lobe; placental diameter ranged from 10-26 cm and a mean diameter of 16.27±2.12 cm, while thickness ranged from 2-4 cm with a mean of 2.68±0.68 cm; 43 (86%) placentae showed marginal membrane attachment, 5 (10%) circummarginate, and 2 (4%) circumvallate; 23 (46%) placentae had paracentral cord insertion, 13 (26%) central, 8 (16%) eccentric, 5 (10%) marginal, and 1 (2%) velamentous, and 37 (74%) placentae exhibited a dispersed vascular pattern, 7 (14%) furcate, 4 (8%) magistral, and 2 (4%) mixed.

Conclusion: The gross examination of the placenta reflects the intrauterine pathological conditions associated with stillbirth, intrauterine growth retardation, gestational diabetes mellitus, and hypertension.

Keywords: Pattern of blood vessels, Placental diameter, Placental insufficiency, Umbilical cord

INTRODUCTION

The Placenta is a Latin variant of the Greek term, 'Plakous,' meaning 'a flat disc-like cake'. The placenta is a highly vascularised organ that performs crucial functions to facilitate exchange between the maternal and foetal circulations. The placenta transports nutrients from the mother to the foetus and removes carbon dioxide and other harmful metabolic waste products generated by the foetus [1]. The placenta also has endocrine roles, including the secretion of Human Chorionic Gonadotropin (hCG), produced by the syncytiotrophoblast after implantation [2].

The placenta undergoes significant morphological and functional changes during gestation, and its examination provides valuable insights into maternal and foetal health. Despite extensive research, there is a paucity of information on the spectrum of placental morphological variations and their prevalence in specific populations. The present study is novel in that it systematically evaluates placental shape, umbilical cord insertion, and membrane attachment patterns in the gross placental specimens, thereby adding to the existing body of knowledge and providing baseline data for future clinical correlation [3,4].

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Anatomy, Kanyakumari Government Medical College, Asaripallam, Kanyakumari, Tamil Nadu, India, between November 2024 and December 2025. A total of 50 placentae were included in the study, selected by consecutive sampling during the study period, based on predefined inclusion and exclusion criteria. Ethical clearance was granted under approval number Ref. No. UG-006/IEC/2024, dated 25.05.2024.

Sample Size: A total of 50 freshly delivered placenta specimens were collected. The collected placentae were washed under running water and preserved in 10% formalin immediately after delivery.

Inclusion criteria: Inclusion criteria included placentas that had intact maternal and foetal surfaces with discernible morphological features.

Exclusion criteria: Exclusion criteria included placentas in which the maternal cotyledons were fragmented during parturition.

Study Procedure

All the specimens were tagged for identification. Representative gross specimens were photographed using standardised positioning under uniform lighting conditions. The placentae were first analysed for the type of membrane attachment and the pattern of blood vessels.

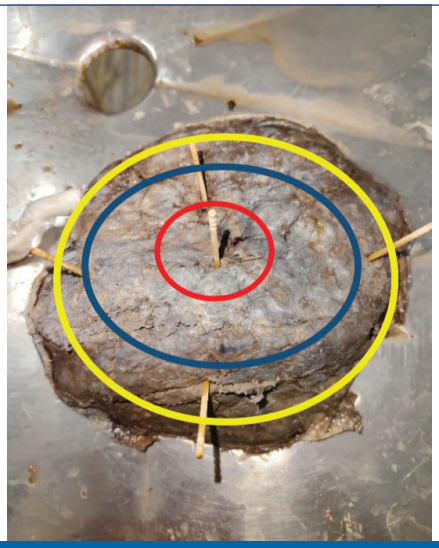
The membranes were trimmed to begin analysis of the morphology and morphometry of the placental specimens.

The assessment of the following parameters was carried out in the placenta specimens:

Shape: The shape of the placenta was inspected and observed, and the presence of accessory placental lobes was noted, by following the Benirschke Classification of Placental Lobation [5].

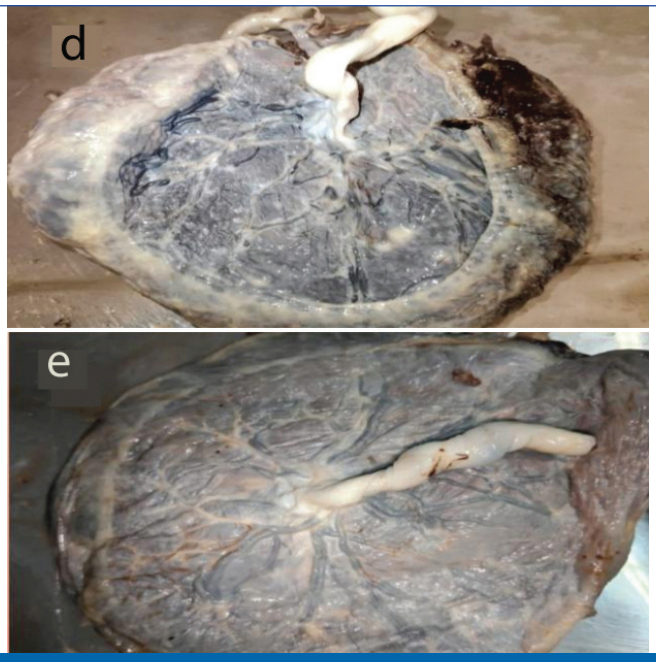
Diameter: The diameter of the placenta was measured using a metallic scale graduated in centimetres. The maximum diameter was measured across the widest zone of the placental disc.The second largest diameter was measured perpendicular to the maximum diameter of the placental disc. The mean of the perpendicular measurements was calculated and this was recorded as the placental diameter (in centimetres) [6].

Thickness: The maternal surface of the placenta was divided into three concentric zones: central, middle, and peripheral. Placental thickness was measured at five points: one at the centre, two in the middle zone, and two in the peripheral zone. The measurements were taken perpendicular to the placental surface using a steel scale calibrated in centimetres and the average of the five readings was recorded as the placental thickness [Table/Fig-1] [6,7].



[Table/Fig-1]: Measuring placental thickness at five points by dividing placenta into central, middle and peripheral zones [6,7].

Type of attachment of membranes: The type of attachment of membranes was inspected and observed. The attachment of the membranes, whether marginal, circummarginate or circumvallate, was observed based on the folding of the membranes. In a circummarginate placenta, the chorionic membranes insert onto the foetal surface of the placenta, with no folding of the membranes. A flat transition from the membrane to the chorionic villi is observed. In a circumvallate placenta, the chorionic membranes insert onto the foetal surface of the placenta by folding back on themselves. So, a raised edge of the placenta is observed [Table/Fig-2] [8].

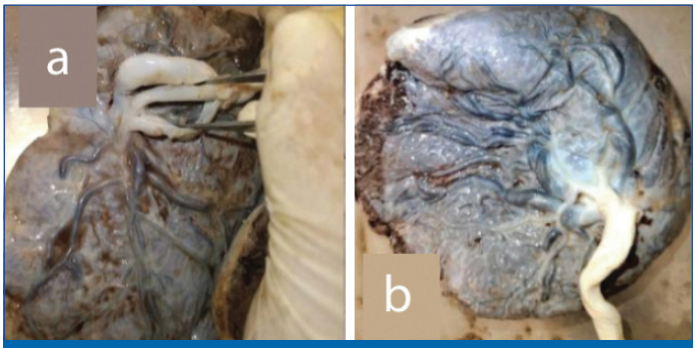


[Table/Fig-2]: Attachment of membranes: d) Circumvallate; e) Circummarginate [8].

Type of attachment of umbilical cord: Umbilical cord insertion was classified based on its location on the placental disc. Central insertion was defined when the cord was attached near the centre of the placenta. Eccentric insertion was seen when the cord was attached away from the centre but not reaching the placental margin. Marginal insertion (battledore placenta) was noted when the cord was inserted at or within 2 cm of the placental margin. Velamentous insertion was categorised when the umbilical vessels traversed through the foetal membranes before reaching the placental disc [Table/Fig-3] [7].

[Table/Fig-3]: Type of attachment of umbilical cord: j) Central; k) Marginal; l) Paracentral; m) Eccentric [7].

Pattern of Blood Vessels on the Foetal Surface: When the pattern of the blood vessels was distributed like a branching pattern of a tree across the foetal surface, it was known as a dispersed pattern. When the pattern of the blood vessels comprised of a thick main trunk from where there was a branching pattern of smaller blood vessels, it was magistral. When there was a branching of the umbilical vessels before reaching the placenta with a further branching of the blood vessels on the foetal surface, the pattern of the blood vessels was called furcate [Table/Fig-4] [9].



[Table/Fig-4]: Pattern of blood vessels: a) Furcate; b) Magistral [9].

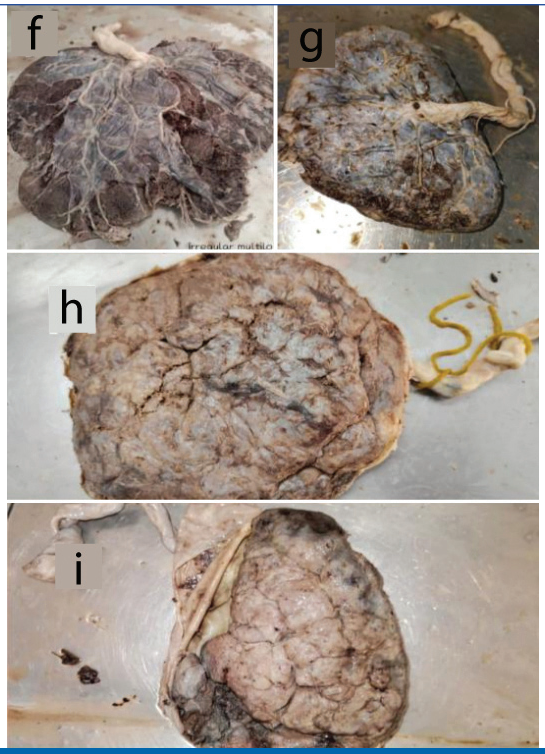
STATISTICAL ANALYSIS

All data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software, version 30.0.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were primarily employed. Categorical variables were expressed as frequencies and percentages. Continuous variables were summarised using mean, SD, and range (minimum–maximum values).

RESULTS

Shape: Out of 50 placentae, 38% were discoid in shape. 16% were oval in shape. 16% were triangular in shape, 28% were irregular in shape, 2% had a succenturiate lobe [Table/Fig-5,6].

The placental diameter ranged from 10 to 26 cm, with the majority of placentae 22 (44%) measuring between 16 and 19 cm. Mean diameter= 16.27±2.12 cm [Table/Fig-7].



[Table/Fig-5]: Shapes: f) Irregular-multilobed; g) Triangular; h) Discoid; i) Oval.

Placental shape	n (%)
Discoid	19 (38%)
Oval	8 (16%)
Triangular	8 (16%)
Irregular	14 (28%)
Succenturiate	1 (2%)
Total	50 (100%)

[Table/Fig-6]: Distribution of placental shape (morphology).

Diameter range (cm)	n (%)
10-13	2 (4%)
13-16	21 (42%)
16-19	22 (44%)
19-22	4 (8%)
22-26	1 (2%)
Total	50 (100%)

[Table/Fig-7]: Distribution of placental diameters.

Among the 50 placentae studied, the mean placental thickness was 2.68±0.68 cm, with a range of 2-4 cm [Table/Fig-8].

Thickness range (cm)	n (%)
2-3	32 (64%)
3-4	18 (36%)
Total	50 (100%)

[Table/Fig-8]: Distribution of placental thickness.

About 86% had a marginal membrane attachment. Five (10%) placentae had a circummarginate type of attachment. 4% had a circumvallate-type attachment [Table/Fig-9].

Out of the 50 placentae that were analysed, 46% had a paracentral type of attachment [Table/Fig-10].

Out of the 50 placentae that were analysed, 74% placentae had a dispersed pattern [Table/Fig-11].

Type	n (%)
Marginal	43 (86%)
Circummarginate	5 (10%)
Circumvallate	2 (4%)
Total	50 (100%)

[Table/Fig-9]: Distribution of attachment of membranes.

Type	n (%)
Paracentral	23 (46%)
Central	13 (26%)
Eccentric	8 (16%)
Marginal	5 (10%)
Velamentous	1 (2%)
Total	50 (100%)

[Table/Fig-10]: Distribution of types of attachments of umbilical cord.

Pattern	n (%)
Dispersed	37 (74%)
Furcate	7 (14%)
Magistral	4 (8%)
Mixed	2 (4%)
Total	50 (100%)

[Table/Fig-11]: Distribution of patterns of blood vessels.

DISCUSSION

The normal human placenta is typically discoid in shape. Variations such as oval, irregular, bilobed, or multilobed placentae have been attributed to abnormalities in placental development and vascularisation. These variations may reflect altered uteroplacental blood flow. They have increasingly been associated with adverse maternal and foetal conditions such as maternal malnutrition, hypertensive disorders of pregnancy, and intrauterine growth restriction [10].

In another study by Panuganti PK and Boddeti RK, all 50 placentae were discoid [11]. In a study by Malathi K et al., placental shapes were reported as circular (55.45%), oval (18.18%), irregular (10.9%), triangular (7.27%), discoid (4.54%), bilobed (2.72%), and succenturiate (0.9%) [12]. In a study by Kulandaivelu AR et al., 48 of 51 placentae were discoidal in shape, while three were oval [13].

However, in the present study, 38% of placentae were discoidal in shape. 16% were oval in shape, 16% were triangular and 28% were irregular, 2% were succenturiate.

Panuganti PK and Boddeti RK reported that the placental diameter ranged from 12.2 cm to 15.8 cm [11]. Kulandaivelu AR et al., observed the mean placental diameter to be 14.65 cm, while Wang LJ et al., reported mean placental dimensions of approximately 18-19 cm [13,14]. In the present study, the placental diameter ranged from 10 cm to 26 cm, with a mean diameter of 16.27 cm.

Kulandaivelu AR et al., reported mean placental thicknesses of 2.1 cm and 1.42 cm, respectively [13]. Panuganti PK and Boddeti RK reported that the placental thickness ranged from 1.8 cm to 3.8 cm [11]. In a study by Tankala M et al., placental thickness ranged between 2 cm and 3 cm [15]. However, in the present study, we found that the thickness ranged from 2 cm to 4 cm.

Panuganti PK and Boddeti RK found that out of 50 placentae, the central attachment was observed in 60% of the cases, eccentric attachment in 20%, and marginal attachment in 20%, while velamentous attachment was not observed in their study [11]. In the study by Sudhakarbabu C and Indira M central cord insertion was observed in 77% of cases, and marginal insertion in 21% [16]. In their study, velamentous cord insertion was found in 2% of cases [16].

In the study by Sirikonda P et al., the magistral pattern of blood vessels was found in 17.9% of placentae [17]. In a study by Verma R et al., a dispersed pattern of blood vessels was observed in 63% of the specimens, while 37% exhibited a magistral pattern [9]. In

the present study 46% had a paracentral type of attachment of umbilical cord and 74% of placentae had a dispersed pattern of blood vessels?

Limitation(s)

The study was limited by its relatively small sample size and single-centre design, which may affect the generalisability of the findings. Its descriptive, cross-sectional design precluded assessment of causal relationships between placental parameters and foetal outcomes. Histopathological and molecular analyses were not performed, limiting detailed evaluation of placental tissue changes. Manual measurements may have introduced observer bias and measurement variability.

CONCLUSION(S)

The present study highlights significant variations in placental morphology and morphometry, including differences in shape, diameter, thickness, and vascular patterns.

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