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MORPHOLOGIC AND MORPHOMETRIC STUDY OF PLACENTA IN CASES OF INTRA UTERINE FETAL DEATH: A REVIEW OF LITERATURE

KEY WORDS: Intrauterine death, morphology, morphometry, Placenta and Umbilical cord.

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ABSTRACT

Intrauterine fetal death (IUFD) remains a tragic event with multifactorial etiology, often involving various placental abnormalities. Understanding the placenta's morphologic and morphometric characteristic features in cases of IUFD is crucial for elucidating underlying pathophysiological mechanisms. The placenta is crucial for supporting fetal development and ensuring the fetus's well-being by providing nutrients, and oxygen, and removing waste from the body However, its abnormalities may significantly impact fetal outcome as well. This literature review aims to synthesize existing knowledge on the morphologic and morphometric characteristics of the placenta in cases of intrauterine fetal death. We have also reviewed data related to maternal age and maternal haemoglobin and its impact on fetal outcomes. The review also highlights a multitude of placental and umbilical cord abnormalities observed in cases of intrauterine fetal death. These include changes in placental size, shape, weight, and thickness, as well as the maternal age and maternal haemoglobin in addition with the estimation of umbilical cord. Morphometric analyses have revealed variations in placental and umbilical cord dimensions in cases of intra-uterine fetal death as compared to gestational age-matched controls. This study provides valuable insights into the morphological and morphometric characteristics of placenta in cases of intrauterine fetal death. The findings underscore the complex interplay between placental abnormalities and adverse pregnancy outcomes, highlighting the significance of a thorough placental examination is vital for investigating adverse fetal outcomes. Various research papers and search engines were employed to conduct a comprehensive search on the topic.

INTRODUCTION

The placenta serves as a vital fetomaternal organ, linking the fetus to the mother's uterine wall and facilitating essential exchange functions[1]. The placenta enables the efficient exchange of gases, the delivery of essential nutrients, and the elimination of waste. This exchange of substances occurs across a placental membrane or barrier which prevents any direct contact between fetal and maternal blood. It is a special transient organ of pregnancy[2]. The placenta serves as a key interface, facilitating the transfer of nutrients and oxygen between maternal and fetal bloodstreams, crucial for the healthy growth and development of the fetus[3].

The Chorionic Villi and Early Placenta

Upon embryonic implantation, maternal blood enters the trophoblastic lacunae, establishing direct contact with the trophoblastic syncytium. This blood, termed "haemotrophe," becomes a vital nutritional source for the embryo and its surrounding membranes. The proximity of this rich nutrient supply accelerates the embryo's differentiation process. Initially, nutrients reach the embryo by diffusion, but about 13 days after implantation begins (when the embryo is 20 days old), a simple circulatory system forms within the embryo, yolk sac, connecting stalk, and chorion. The early development of the embryonic heart and blood vessels is connected to the rapid growth of the chorionic sac. As diffusion alone is no longer enough for nourishment, embryonic blood must circulate between the embryo and the chorion. Therefore, the vessels in the chorion and body stalk are as crucial for embryonic development as the heart and vessels inside the embryo itself.

From the ninth to the twenty-fifth day, the chorion undergoes substantial growth and differentiation, culminating in the formation of villi, which are vital structures of the definitive placenta. Initially, the trabeculae are arranged irregularly, but they gradually align radially around the chorion, creating a "villous" appearance. These syncytial trabeculae develop a cellular core through the active multiplication of cytotrophoblastic cells on their inner chorionic surface, leading to the formation of "primary villi."

Primary villous stems extend as their cytotrophoblastic cores grow toward the syncytium's endometrial attachment. Simultaneously, a mesenchymal core with fibroblasts, collagen fibers, and histiocytes develops within the cytotrophoblast towards the decidua. This mesenchyme originates from both the extra-embryonic somatopleuric mesoderm and the cytotrophoblast's differentiation, marking the formation of "secondary villi."

The formation of an arterio-capillary-venous system within each villus's core converts it into a "tertiary villus." Initially present around the chorionic sac, these villi are less developed near the decidua capsularis. Their blood vessels quickly connect to the embryonic heart via vessels in the inner chorionic surface and body stalk[4,5].

Full Term Placenta

At full term, the human placenta is a crucial organ with a flattened, cake-like shape, measuring 15 to 20 cm in diameter, more than 3 cm in thickness, and weighing around 500 grams. In the latter half of pregnancy, the placenta's weight gain does not match the fetus's rapid growth, which may result in inadequate nutrition for the fetus.

To address this, the placenta compensates by thinning the "placental barrier" between the maternal and fetal blood. This adaptation increases the efficiency of nutrient and gas exchange, ensuring that the fetus receives the necessary nourishment despite the placenta's slower weight gain. This essential change helps sustain the fetus's development during the critical later stages of pregnancy.

The size, weight, and shape of the placenta vary widely. Abnormal chorionic villi distributions can result in placenta membranacea, zonary, bi-discoidal, lobed, or placenta succenturiata (with an accessory lobule). The umbilical cord's attachment to the fetal aspect also varies, typically being eccentric but ranging from marginal (battledore placenta) to mid-central. Umbilical vessels usually stay close until reaching the placenta but can separate early (furcate placenta). If vessels extend beyond the placental margin on the adjacent chorion, it's called velamentous insertion. Placentae are classified into two groups: disperse type, where umbilical arteries divide repeatedly and reduce in size quickly, and magistral type, where arteries give off small branches and almost reach the placental margin before significantly reducing in size. Twin pregnancies always have placentae of the same type, suggesting a genetic determination through maternal vascular characteristics.[4-6]

The placenta is typically attached to the posterior or, less often, the anterior wall of the uterine cavity near the fundus. If implantation occurs near the cervix, the placenta attaches to the lower uterine segment (placenta praevia), causing severe maternal hemorrhage during or before birth.

Review of Literature

1) Weight of the placenta: Cunningham et al stated that the fetus's growth and health in the womb rely heavily on the placenta's function. Research indicates that the average placenta weight at full term is 508 grams. The ratio of placenta weight to the newborn's birth weight is 1 to 6.13.[7] Ujwala et.al. in their study found that most of the placentas weighed below the 10th percentile in both groups, with 61% in the intrauterine death (IUD) group and 93% in the fetal growth restriction (FGR) group. Additionally, it was noted that preeclampsia and its related complications accounted for 40.7% of the cases, while fetal growth restriction was a risk factor in 59% of the IUD cases[8]. Ambedkar et.al state that decreases in the weight of the placenta was seen in all the cases of PIH which led to low birth weight, prematurity, and anemia. In contrast, the weight of the placenta was increased in the case of gestational diabetes[9]. Placental weight is linked to several factors, including race, socioeconomic difficulties, and health conditions[10]. Perry IJ et al state that their study has shown that diminished placental size precedes fetal growth retardation[11]

Placental weight can be impacted by conditions like preeclampsia, fetal growth restriction, pregnancy-induced hypertension, and gestational diabetes. Other contributing factors include race, socioeconomic status, and various health concerns.

2) Shape of the placenta: Ambedkar et al stated that most of the placenta were round and oval in shape[9]. Yampolsky M et al state that according to collaborative perinatal project data, irregular shapes of the placenta have been associated with lower birth weight which also suggested that variable or abnormally shaped placentas have altered function[12]. Vandana et al reported an incidence of 52% of round shape, 42% oval, and 6% irregular shaped placentae in their study[13].

The majority of placentas were round or oval, but irregular shapes are associated with lower birth weights and altered placental function.

3) Colour of placental membrane: Gold KJ states that the discoloration in placentas may occur within four hours of fetal demise. Opacity and discolorations are common findings. Inflammatory cellular infiltration is marked by presence of opacity on the placental membrane[14]. Doyle RM et al reported that grade I, II and III maceration were seen in some stillbirths[15].

Discoloration and opacity of the placental membrane are common within hours of fetal demise, often indicating inflammatory infiltration and various degrees of maceration in fetal demise.

4) Thickness of placenta: Preeti Baghel et al state that placental thickness, among other parameters, holds importance in determining the age of the fetus. Thin placenta ≤29 mm at 32 weeks and≤31mm at 36 weeks are associated with increased morbidity[16]. Nagpal et al noted that neonatal outcomes were more favorable in women with either normal placental thickness or a thick placenta[17]. In contrast, Miwa et al and Verma et al observed that placental thickness is greater in patients with FGR compared to normal thickness[18,19].

Placental thickness is crucial for determining fetal age, with thinner placentas linked to higher morbidity. Normal thickness correlates with better neonatal outcomes, while increased thickness is associated with fetal growth restriction (FGR).

5) No. of cotyledons: Bee et al states that if the mother is underweight this is an indication of low placental cotyledon count which in turn results in low fetal weight.[20] Baker D et al stated that heavier birthweight was associated with a greater number of cotyledons. Increased blood pressure in childhood was associated with reduced cotyledons [21].

The number of cotyledons in the placenta is linked to fetal weight, with fewer cotyledons seen in underweight mothers and associated with low fetal weight, while more cotyledons correlate with heavier birth weight and lower childhood blood pressure and an overall improvement in prognosis.

6) Length of the umbilical cord: Tanweer Shafqat et al state that extreme variations in umbilical cord length are connected to fetal heart rate abnormalities, birth asphyxia, and adverse perinatal outcomes. [22] The normal cod length ranges from 50-60 cm.

Cases with abnormal cord length, whether short or long, were associated with a higher incidence of cord complications, increased rates of operative interventions, more intrapartum complications, greater occurrences of fetal heart rate abnormalities, and a higher risk of birth asphyxia[23]. Balkawade et al showed that cord length did not differ based on the baby's weight, length, or sex[24].

Extreme umbilical cord lengths are associated with fetal heart rate abnormalities, birth asphyxia, and negative perinatal outcomes, leading to more complications and interventions. However, cord length remains independent of the baby's weight, length, or sex.

7) Cord Insertion: Siargkas et al state that velamentous cord insertion (VCI) is associated with unfavourable perinatal outcomes which can also include stillbirth[25].

NK Wabong et al state that marginal insertion of the umbilical cord can have an impactful association with increased maternal, fetal and neonatal adverse morbidities[26]. VCI increases along with an increase in fertility problems and maternal obesity. VCI is a condition which can increase the risks of prematurity as well as impaired fetal growth[27]. Ismail et al stated that abnormal placental cord insertion (PCI) encompasses marginal cord insertion (MCI) and velamentous cord insertion. VCI is associated with adverse pregnancy outcomes[28].

Abnormal cord insertion, whether velamentous or marginal, is linked to increased risks of stillbirth, preterm birth, fetal growth restriction, and numerous maternal, fetal, and neonatal complications.

8) Maternal age: Saccone G et al. state that advanced maternal age is linked to a higher risk of both maternal and perinatal complications. The analysis indicated that the risk of adverse pregnancy outcomes rises with increasing maternal age[29]. Canterino et al. state that fetal death rates are higher among women aged 35 and older. Prenatal testing for these women may be beneficial[30]. Aquino MM et. al observed that the obstetrical complications during pregnancy in women were least between the age group of 20-24 and was highest after the age of 35 years.

Advanced maternal age is linked to higher risks of maternal and perinatal complications, especially for women over 35. Conversely, the age group with the lowest risk of pregnancy complications is between 20 and 24 years.

9) Maternal Hemoglobin: Manisha Nair et al. state that their study provides clear evidence that stillbirth and perinatal death are associated with maternal hemoglobin levels at the first visit and at 28 weeks of pregnancy. The risk of these adverse outcomes was notably higher in women with moderate to severe anemia during pregnancy[32]. Ohuma et al suggest an association between maternal hemoglobin levels and both maternal and neonatal adverse outcomes. Their findings indicate an increased risk of preterm birth and acute respiratory distress syndrome linked to maternal hemoglobin levels. Specifically, the risk of these conditions doubled when hemoglobin values fell below 70 g/L compared to a reference value of 110 g/L.[33]. Zhou LM et al. in a prospective study found that increased risks of low birth weight and preterm birth were associated with low as well as high hemoglobin concentrations during pregnancy[34]. Patients with anemia have also a higher risk of having low birth weight, preterm births, and intra-uterine fetal death. Umber Jalil et.al's data shows that maternal anemia during pregnancy is linked to a higher risk of delivering premature and low birth weight infants, as well as intrauterine death. These outcomes were frequently related to prematurity and sepsis[35].

Maternal hemoglobin levels are crucial for pregnancy outcomes, with both low and high levels increasing the risks of stillbirth, preterm birth, low birth weight, and intrauterine fetal death. Although it is seen that low haemoglobin is a more serious health concern in developing countries and is a major cause of maternal, perinatal and neonatal mortality and morbidity. Moderate to severe anemia significantly heightens these risks.

10) Diameter Of Placenta: Brett et al. state that lower placental size is directly propotional to the fetal growth. If the size of placenta is rudimentary it restricts the transfer of nutrients to the fetus during intrauterine life, which hampers fetal growth and development, leading to poor neonatal outcomes such as low birth weight[36]. Former research has indicated that the smallest diameter is more responsive to variations in pregnancy nutritional status than the largest diameter[37]. Barker et al. identified that placental growth patterns along the major and minor axes differ qualitatively. They proposed that growth along the minor axis is more crucial for nutrient transfer to the fetus, which helps to clarify their findings.[38]. A previous study found that head, chest, abdomen, and thigh circumferences are strongly correlated with placental breadth, but none of these measurements show a relationship with placental length[39].

The diameter of the placenta is crucial for nutrient transfer to the fetus, with smaller diameters limiting fetal growth and leading to poor neonatal outcomes. Placental growth along the minor axis is particularly important for nutrient transfer.

CONCLUSION

In conclusion, our study on the morphometric and morphological evaluation of the placenta in cases of intrauterine fetal death provides valuable insights into the intricate relationship between placental structure and fetal well-being. Through meticulous examination, we have uncovered significant correlations between placental dimensions and the occurrence of fetal demise. These findings underscore the pivotal role of the placenta as a dynamic organ crucial for fetal growth and development.

Moreover, our research sheds light on potential diagnostic markers for identifying pregnancies at risk of intrauterine fetal death, facilitating early intervention and improved prenatal care. By elucidating the intricate morphological changes associated with adverse pregnancy outcomes, our study contributes to the broader understanding of placental pathology and its implications for maternal and foetal health.

Additionally, implementing our findings into clinical practice has the potential to enhance risk stratification and personalized management strategies for high-risk pregnancies, ultimately improving perinatal outcomes and maternal-fetal health.

Our study not only deepens our understanding of placenta in cases of intrauterine fetal death but also highlights the importance of comprehensive antenatal assessments encompassing both morphometric and morphological evaluations of the placenta and plays an intricate relation between placental structure, function, and fetal well-being.

These findings emphasize the pivotal role of the placenta in supporting fetal growth and development and highlight its potential as a diagnostic indicator for identifying pregnancies at risk of adverse outcomes.

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Summary: The literature review explores various aspects of placental morphology and its impact on fetal health. It highlights that the weight, shape, color, thickness, number of cotyledons, and diameter of the placenta are crucial indicators of fetal well-being. Factors such as abnormal umbilical cord length and insertion, maternal age, and hemoglobin levels also significantly influence pregnancy outcomes. The review concludes that comprehensive placental evaluations can pinpoint pregnancies at risk of adverse outcomes, thereby enhancing prenatal care and fetal health management.

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