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MACROSCOPIC AND GRAVIMETRIC CHARACTERISTICS OF THE PLACENTA IN PREGNANT WOMEN WITH CARDIAC DEFECTS - MORPHOMETRIC ANALYSIS

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Annotation. *This thesis analyzes macroscopic and gravimetric characteristics of the placenta in pregnant women with cardiac defects through systematic morphometric examination. Reduced placental weight, abnormal umbilical cord insertion patterns, and increased rates of gross placental lesions are identified as reproducible structural correlates of maternal and fetal cardiac hemodynamic compromise.*

Keywords: *cardiac defects in pregnancy, placental weight, umbilical cord insertion, velamentous cord insertion, placental morphometry, placental hypoplasia, placental-to-birth-weight ratio, gross placental lesions, hemodynamic compromise, fetoplacental adaptation*

Today, cardiac defects affect approximately one percent of all liveborn infants and constitute the most common congenital structural malformation encountered in contemporary obstetric practice, with complex and severe subtypes, including tetralogy of Fallot, double-outlet right ventricle, and major ventricular septal defect, demonstrating the most pronounced associations with structural placental abnormalities. Analysis of a nationwide Danish cohort demonstrates that tetralogy of Fallot is associated with a mean placental weight reduction of 0.45 standard deviation score and double-outlet right ventricle with a reduction of 0.48 standard deviation score compared to normocardiac

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pregnancies, quantifying the hemodynamic substrate of placental hypoplasia in these high-risk gestations.

The macroscopic examination of placentas delivered from pregnancies complicated by maternal or fetal cardiac defects reveals a consistent and clinically meaningful pattern of structural abnormalities that can be systematically characterized through standardized gravimetric and morphometric protocols. Placental hypoplasia, defined as a placental weight below the tenth percentile for gestational age, is documented in a substantial proportion of affected pregnancies, with studies reporting placental weight-to-birthweight ratios below the tenth percentile in 78% and below the third percentile in 54% of confirmed cases, indicating profound placental functional insufficiency relative to the metabolic demands of the growing fetus.

Despite this macroscopic hypoplasia, birthweight and head circumference are often preserved within acceptable percentile ranges, a phenomenon termed placental efficiency, which reflects a compensatory upregulation of transplacental nutrient transport mechanisms per unit of functional placental tissue. This adaptive response, however, operates within finite biological limits, and fetuses relying on a hypoplastic and structurally abnormal placenta remain at markedly elevated risk of acute decompensation under the additional hemodynamic and hypoxic stress imposed by labor, intercurrent maternal illness, or progressive deterioration of maternal cardiac function. Abnormal umbilical cord insertion patterns represent another consistently documented macroscopic abnormality in placentas from pregnancies with cardiac defects. Elevated rates of eccentric, marginal, and velamentous cord insertion sites have been reported, with the relative risk of congenital cardiac defect subtypes in the setting of abnormal cord insertion being highest for conotruncal anomalies, reaching a relative risk of 3.08, followed by left heart disease including hypoplastic left heart syndrome and

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coarctation of the aorta with a relative risk of 2.40, and right heart disease at 2.22. Velamentous cord insertion, in which the umbilical vessels traverse the fetal membranes without Wharton's jelly protection before reaching the placental disc, is associated with particularly adverse pregnancy outcomes including emergency cesarean delivery, low birthweight, and intrauterine fetal death, amplifying the obstetric risk in an already high-risk population.

Gross examination further identifies increased rates of placental infarction, intervillous thrombosis, and retroplacental hematoma, lesions that reduce the functional parenchymal mass and further compromise oxygen delivery to a fetus whose cardiac physiology may already be unable to compensate for diminished uteroplacental perfusion. Doppler velocimetric correlation confirms that the degree of macroscopic placental abnormality corresponds closely to the severity of umbilical artery waveform disturbance, providing an *in vivo* surrogate for pathological placental function amenable to serial antenatal monitoring.

Placental hypoplasia, abnormal umbilical cord insertion, and gross parenchymal lesions constitute the principal macroscopic abnormalities in pregnancies with cardiac defects. Systematic placental morphometry at delivery provides indispensable data for perinatal risk stratification and neonatal care planning.

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