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Original article

Foetal cardiac morphology and function: overview

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In humans, the morphogenesis influences the function of the foetal heart, and therefore congenital heart malformations may affect foetal circulation.

The first cardiac contractions start at 22 days and the stage of morphogenesis is the straight tube.

Evolving from the straight tube to the loop and chamber formation, the heart function is developed as a suction pump model.

As soon as ventricular trabeculae increase myocardial mass, the trabeculated heart observes the Frank–Starling relationship.

The earliest stages for evaluating foetal circulation is around 12 weeks; however, many interesting things happen after septation, such as the coronary supply to the ventricular myocardium and the myocardial compaction.

On the other side, the foetal heart development depends on haemodynamic loading, being accelerated by increased preload.

In the settings of twin–twin transfusion syndrome, it is possible to confirm the role of haemodynamic loading by monitorising myocardial changes and valve maturation, mostly linked to volume overload in the recipient twin.

Abnormal cardiac development in monochorionic pregnancies can be divided into primary structural cardiac lesions and acquired cardiac lesions. Although the aetiology of primary structural congenital heart lesions in monochorionic twins is poorly understood, acquired cardiac lesions are the consequence of haemodynamic abnormalities, which can occur as a result of twin–twin transfusion syndrome. In general, there is a volume-depleted donor twin and a volume-overloaded recipient twin. The diagnosis of twin–twin transfusion syndrome is based on strict sonographic criteria, reflecting severe intertwin fluid discordance, and the disease is currently staged based on the "Quintero system".

Normally an ultrasound examination is carried out at 11–14 weeks to assess viability, gestational age, chorionicity, major congenital malformations using nuchal translucency, and ductus venosus blood flow evaluation. Detailed anatomy scan is performed between 18 and 22 weeks of gestational age for detections of congenital anomalies and malformations.

Echocardiographic techniques combined with Doppler of both the arterial, umbilical artery and middle cerebral artery, and the venous compartments, ductus venosus and umbilical vein, are applied to assess cardiac structure and function.

The basic principles of cardiac physiology to provide for adequate cardiac output to allow for growth and maturations are the same in comparison with the mature postnatal heart: preload, afterload heart rate, and contractility.

The foetal heart, however, is less dependent on preload variations and much more dependent on the heart rate to achive an adequate cardiac output.

Long-term neurodevelopmental deficits observed in newborns and children with congenital heart malformations cannot be attributed solely to abnormalities in cerebral blood flow associated with cardiopulmonary bypass.

In fact, newborns with certain forms of CHDs are born with smaller head circumferences, possibly indicating impaired brain growth. The developing brain is highy metabolic and dependent on the heart for delivery of oxygen and nutrients.

The heart, in turn, receives innervation and control from the autonomic nervous system, and therefore the disruption of organogenesis in one organ will have significant effects for the other.

We will discuss the form and function by evaluating the foetal heart and circulation. I am sure that the reasons for this association are well understood.

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