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FETAL GROWTH AND WELL-BEING MONITORING

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ABSTRACT
Monitoring fetal well-being and growth is the key component of antenatal care. Fetal monitoring is critical to prevent fetal deaths by detecting and managing IUGR (Intrauterine Growth Restriction), congenital malformation, or genetic abnormalities of the fetus, This research uses qualitative methods with a literature review approach. Literature review is a systematic, explicit and reproducible method for identifying, evaluating and synthesizing research works and thoughts that have been produced by researchers and practitioners, Cardiotocography monitors fetal well-being by analyzing the fetal heart rate to prevent irreversible brain injury due to fetal hypoxia. CTG interpretation can help improve pregnancy outcomes by diagnosing fetal CTG abnormalities and suggesting the proper management. For example, a hypoxic fetus may exhibit abnormalities such as decreased variability of FHR onset of deceleration and no acceleration in CTG due to decreased fetal movement. In conclusion, there are several methods of monitoring fetal well-being and growth that has clinical or scientific evidence and have been used in clinical practice for years, such as cardiotocography, doppler ultrasound, fetal pulse oximetry, fetal scalp blood sampling, and fetal electrocardiogram

INTRODUCTION

Monitoring fetal well-being and growth is the key component of antenatal care (Narain and McEwan, 2023). Fetal monitoring is critical to prevent fetal deaths by detecting and managing IUGR (Intrauterine Growth Restriction), congenital malformation, or genetic abnormalities of the fetus (Lees *et al.*, 2022). Many clinical methods in fetal assessment requires high accuracy of diagnostic technology, and accurate fetal well-being and growth diagnosis may prevent long-term complications and mortality (McCowan, Figueras and Anderson, 2018). The methods of fetal well-being and growth monitoring will be discussed, highlighting the impact of methods on pregnancy outcomes (Matvienko-Sikar and Dockray, 2017).

RESEARCH METHODS

This research uses qualitative methods with a literature review approach. Literature review is a systematic, explicit and reproducible method for identifying, evaluating and synthesizing research works and thoughts that have been produced by researchers and practitioners . The step in writing this review literature begins with the selection of topics. Search libraries or sources to gather relevant information from Google Scholar, CINAHL, Proquest, Ebsco, or National Library databases.

Determine keywords or keywords for journal searches. After the data is collected, it is processed, analyzed and conclusions drawn.

RESULTS AND DISCUSSION

Cardiotocography or Continous Electronic Fetal Monitoring

Cardiotocography monitors fetal well-being by analyzing the fetal heart rate to prevent irreversible brain injury due to fetal hypoxia (Pinas and Chandraharan, 2016). CTG interpretation can help improve pregnancy outcomes by diagnosing fetal CTG abnormalities and suggesting the proper management (Martins *et al.*, 2020). For example, a hypoxic fetus may exhibit abnormalities such as decreased variability of FHR onset of deceleration and no acceleration in CTG due to decreased fetal movement (Pinas and Chandraharan, 2016).

Every interpretation of CTG abnormalities has a clinical consequence that can be managed (Pinas and Chandraharan, 2016). The rise of baseline fetal heart rate in fetal hypoxia is caused by catecholamine release (Lear *et al.*, 2020). The parasympathetic nervous system then regulates it (de Vries *et al.*, 2023). Meanwhile, the reduced variability of basal heart rate may be caused by a depressant or disorder within the central nervous system, such as acidosis (Munguia-Galaviz *et al.*, 2023). This condition comes after the decompensation of deceleration and baseline fetal heart rate increase (Chandraharan *et al.*, 2023). In improving the pregnancy outcomes, some findings, such as deceleration, may suggest the tocolytic regimen for uterine contraction to prevent the heart decompensation that may cause fetal hypoxia. Further, caesarian delivery is the most suggested management in chronic fetal hypoxia and a research found that CTG is significantly associated with the increase of caesarian section around 63% and 15% on normal labor.

In addition, on pregnancy outcomes some studies found that CTG monitoring has no effect on fetal deaths (Atkinson *et al.*, 2023). However, CTG is significantly related to the reduced rates of neonatal seizure but not with cerebral palsy (Wilkinson *et al.*, 2023). We need to better understand how CTG monitoring would be beneficial in improving the neurodevelopmental outcomes of the fetus (Narain and McEwan, 2023).

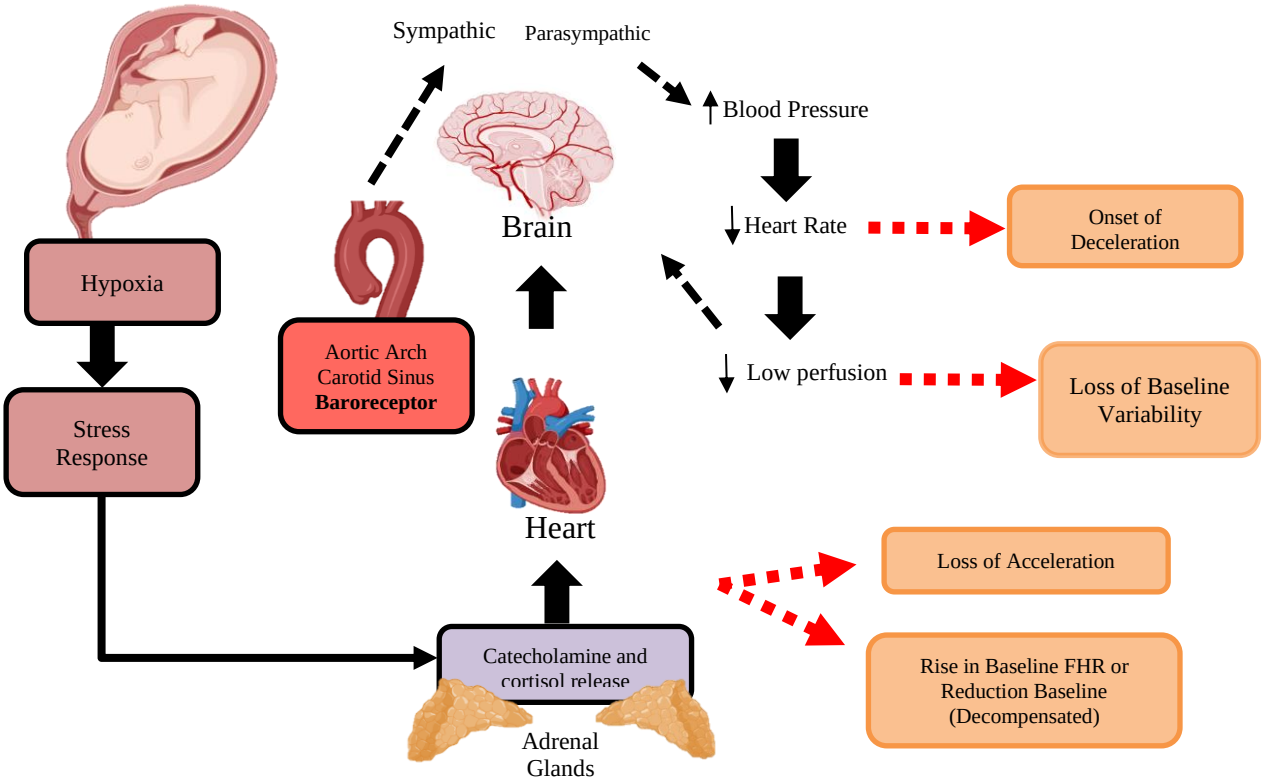

Figure 1. The Schematic of Cardiotocography Interpretation in monitoring Fetal

Heart Rate Change of Fetal Hypoxic (Chandraharan *et al.*, 2023). High baseline, deceleration, and reduced variability are the most common CTG patterns in fetal hypoxia (Ugwumadu and Arulkumaran, 2023). As a result of low circulating oxygen during labor, catecholamines and cortisol are released from the fetal adrenal glands to increase heart rate (Sai Kumar, 2023). But only for several vital organs (brain, heart and adrenal glands), this mechanism causes a loss of acceleration (Jia *et al.*, 2023). The baroreceptors in the aortic arch and carotid sinus regulate parasympathetic activation, which raises blood pressure and lowers heart rate, resulting in deceleration (van Weperen, Ripplinger and Vaseghi, 2023). Because of the low perfusion, the loss of baseline variability may cause acidosis in the central nervous system (Chandraharan *et al.*, 2023).

Doppler Ultrasound

Doppler ultrasound monitors the waveform that targets different circulating blood, both maternal and fetal. It identifies the risk of early onset fetal growth restriction and may improve the pregnancy outcomes where some management of FGR is according to the doppler ultrasound findings (Bruin *et al*, 2021).

Doppler ultrasound of uterine artery shows the resistance of spiral arteries, commonly used in screening high-risk FGR pregnancy (Leslie *et a*l, 2015). Doppler ultrasound of the umbilical artery indicates uteroplacental insufficiency, explicitly showing the abnormal umbilical artery flow velocity waveforms, such as increased PI and absence of reversed end-diastolic flow (ARED) (Schreurs *et al*, 2018). Doppler

ultrasound of the middle cerebral artery (MCA) identifies the low impedance in fetal brain circulation. Vasodilatation of MCA is a sign of fetal hypoxia. Ductus venosus indicate fetal hypoxemia in abnormal measurement and pulsations, which are associated with FGR and commonly used in determining when to deliver (Bruin *et al*, 2021).

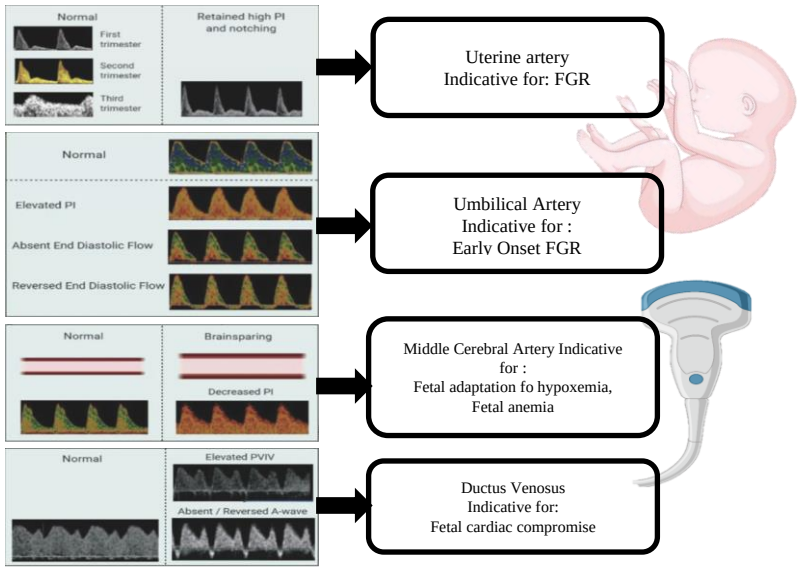

Figure 2. The Doppler Ultrasound Monitoring, the flow pattern and the Fetal outcomes.

Fetal pulse oximetry

Fetal pulse oximetry (FPO) has been known as a modality in fetal monitoring that is safe, easy to use, less invasive, and also accurate. FPO can continuously report the saturation of oxygen from hemoglobin measurement (Tekin *et al*, 2008).

When compared to other modalities such as fetal skull blood sampling, fetal pulse oximetry is less invasive (Bakr *et al*, 2005). Also unline Cardiotocography, which from some studies shows increases in the caesarian delivery rate. Fetal pulse oximetry may decrease the number of caesarian by confirming fetal acidosis when the CTG shows non-reassuring results (Eszto *et al*, 2007). FPO is a promising tool to detect the acidosis of fetuses and reduce the caesarian section (Gunther *et al*, 2022).

However, the fetal pulse oximetry also have a few lackness such as risk of infection, interrupting the delivery, and might dropping to the fetus face. Some condition would also lower the effect of fetal pulse oximetry such as cord compression, caput succedaneum that lower SpO2 compared to other area, contraction, anesthesia, meconium, and oxygen maternal (Uchida *et al*, 2018)

Fetal scalp blood sampling

Fetal scalp blood sampling is one of the most widely used methods for ensuring fetal well-being secondary to CTG. The fetal scalp blood sampling in some studies reduced the high rate of caesarian section due to the CTG non-re-assuring pattern (Chandraharan and Wiberg, 2014). This invasive method uses pH and lactate to verify

the acidosis of the fetus and further may predict perinatal outcomes such as fetal hypoxic or specifically hypoxic-ischemic encephalopathy (HIE) (Cummins *et al*, 2018) This method aims to detect the acidosis in fetal's blood by analyzing pH or lactate by performing a tiny incision on the fetal scalp with the help of an amnioscope. This method is invasive and has some complications both for the fetus and the maternal, for the fetus is bleeding on the sampling site, cerebrospinal fluid leakage, or scalp infection and abscess (Sabir *et al*, 2010). For the maternal, when the delivery is prolonged, multiple sampling is required which would make patients feel uncomfortable (Tekin *et al*, 2008)

Fetal Electrocardiogram (ECG)

The fetal electrocardiogram (ECG) can be altered during fetal hypoxemia in labor. In this condition, the most common feature shown is the interval of PR to RR and ST-segment elevation or depression. The use of fetal ECG is less common than CTG, it is due to the disadvantage of a fetal electrocardiogram that it requires the internal scalp electrode to record the ECG wave during labor (Neilson, 2013). The difference between CTG and ECG should be highlighted since the CTG measures the baby's heart and uterine contractions, while the Electrocardiogram only measures the fetus's cardiac function. Further, monitoring fetal heart is required when the CTG has shown an unsatisfactory result. Because the attachment of the internal scalp electrode should wait until after the membrane ruptures, which increases the risk of infection (Amer-Wahlin et al, 2005). The use of fetal ECG may improve fetal well-being, but the advantage and disadvantages should be first considered.

CONCLUSION

In conclusion, there are several methods of monitoring fetal well-being and growth that has clinical or scientific evidence and have been used in clinical practice for years, such as cardiotocography, doppler ultrasound, fetal pulse oximetry, fetal scalp blood sampling, and fetal electrocardiogram. The method's invasiveness, as well as any complications that may occur, should be considered. Some methods are less invasive but also less accurate in predicting pregnancy outcomes.

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