PERIPARTUM ASSESSMENT OF MULTIPLE PREGNANCIES

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Many biophysical techniques are used to assess fetal well being in multiple pregnancy, including ultrasonography, Doppler velocimetry and cardiotocography. Considering the specific characteristics of multiple pregnancies in terms, higher rate of preterm delivery, higher incidence of fetal growth restriction and higher rates of obstetric complications as compared to singleton gestation, as well as specific problems also related to chorionicity and to the number of fetuses, it is difficult to summarize in general terms the usefulness and role of each technique or to provide a general standard of management. Rather it is advisable to individually assess and manage each case on the basis of the presence of recognized risk factors, making use of each technique or of a combination of different techniques according to the specific information desired. These complexities also demand that the information obtained need to be interpreted on the basis of a thorough understanding of the pathophysiological basis involved.

In twin pregnancy the development of chronic and acute hypoxemia is a main contributor to morbidity and mortality.

Aim of this presentation is to summarize the current evidence related to the role of the fetal Doppler velocimetry, biophysical profile and cardiotocographyc evaluation in the diagnosis of fetal oxygen deficiency in twin pregnancy, focusing also on the description of the role of modern techniques for intrapartum fetal monitoring as represented by the analysis of fetal electrocardiogram.

Doppler evaluation of fetal hemodynamic adaptation

Considering the processes which lead to the manifest utero-placental vascular insufficiency the fetal hemodynamic profile might remain "normal" even for a long period of time. In such circumstances the umbilical artery velocity waveform would show a positive blood-flow pattern throughout the whole cardiac cycle and the impedance to flow values expressed as pulsatility index (PI) would be normal with a non significant increase. The Doppler velocimetry of the remaining main fetal vessels and districts (particularly aorta, renal artery, femoral artery, cerebral vessels, etc.) would also be in the range of normality with non significant alterations. Under these so called "normal" conditions, the mean PI of the middle cerebral arteries (MCA) would be higher than that of either the internal carotid (ICA) or the anterior cerebral arteries (ACA), while that of the posterior cerebral artery (PCA) would be lower than that of MCA and ACA and higher than that of the umbilical artery (UA).

In the early stage of fetal blood flow redistribution Fetal Doppler velocimetry shows an increase in the impedance to flow values as expressed by an increase of pulsatility index of the umbilical artery but also of the aorta and the renal artery. The increase of the vascular resistance of the aorta is probably related to different factors, including the increase in vascular impedance in the umbilico-placental vessels and arterial vasoconstriction of peripheral vessels due to progressive hypoxemia. During this phase, it is possible to observe some hemodynamic modifications which involve the whole fetal organism. These are related to the substantial redistribution of the cardiac output that goes in the direction of the tissues which are important for fetal

survival. The inversion of cerebro-placental ratio, called "brain sparing", is the most evident hemodynamic effect. In this stage a statistically significant increase of the blood flow and a decrease of the resistance in all the cerebral vessels examined can be documented. At the some time, due to the hemodynamic redistribution, a decrease of the peripheral flow in the umbilical artery, abdominal aorta, renal artery, femoral artery and other vessels, along with high impedance to flow values can be observed.

During this stage, the pulsatility index of the umbilical artery and of the fetal aorta is elevated but Doppler velocimetry frequency values continue to be positive throughout the whole cardiac cycle, even in the end-diastolic phase. On the other hand, it is possible to find high velocity frequencies during diastole in all cerebral vessels, suggesting an increase of the fetal cerebral blood flow.

The following phase, the so called advanced stage of fetal hemodynamic redistribution, is essentially characterized by a further increase in the impedance to flow in the umbilical artery, the fetal aorta and the renal artery. Looking at the umbilical artery flow velocity profile, a decrease of the diastolic frequencies is observed progressing towards the absence of diastolic flow. End-diastolic frequency disappears first, but subsequently the lack of blood flow is evident in the whole diastolic phase. Usually this occurs when 80% of villi arterioles are occluded.

In the decompensatory phase the cardiac output and the peak velocity of the main arterial trunks gradually decline and, as a consequence, cardiac filling is impaired, suggesting a progressive deterioration of cardiac function. Therefore, these factors cause changes that induce hemodynamic alterations in all cardio-vascular districts (intracardiac, arterial and venous districts). The incipient heart failure produces a decrease cardiac output which causes a decrease in the peak velocity of the outflow tracts leading to the reverse flow in the aorta, in the umbilical artery and, finally, as a terminal sign, in many other arterial vessels such as the cerebral vessels. During this phase, the increased viscosity of the fetal blood, the decrease in cardiac output and, probably the cerebral edema all tend to produce a decrease of brain perfusion, as shown by the decrease of blood velocity especially during diastole and, thus, the disappearance of the "brain sparing effect".

The biophysical profile in multiple pregnancy

The number of reports on the usefulness of the fetal biophysical profile in multiple pregnancy are few. Medina demonstrated that the use of Manning's sonographyc criteria to predict still birth had a sensitivity of 66.7%, a specificity of 98.8%, a positive predictive value of 50% and a negative predictive value of 99.4%.

The biophysical profile has been recommended in high-order multiple gestations when cardiotocography is technically difficult to perform. However, the biophysical profile can be difficult too, because of difficult assessment of the amniotic fluid volume. The presence of synchronous patterns of fetal activity might also interfere in interpretation, because gross body movements, breathing movements and accelerations of the fetal heart independent of chorionocoty may be synchronous in 25, 50 and 50-60% respectively.

One of the more difficult variables to assess in multiple pregnancies is the amniotic fluid volume, because abnormalities occur more frequently than in singletons secondary to placental insufficiency, placental vascular anastomoses and maternal hemodynamic alterations. No agreement exists on the optimal sonographyc method of evaluating amniotic fluid volume in multiple pregnancies, and no method has been validated for predicting perinatal outcome in multiple gestation. Chau and colleagues found that the AFI, the vertical depths and the two diameter pockets measured at 2 week interval were not significantly different between dichorionic and monochorionic pregnancies. Furthermore, the intraobserver variation in evaluating the amniotic fluid volume in diamniotic twin pregnanciy was about 2-3%, approximately the figure cited for singleton pregnancies. The accuracy of the 2 by 2 cm pocket as a cut off value for low amniotic fluid volume in twin pregnancies was studied by Magann and associates. The sensitivity was 6.1%, the specificity 98.8%, the positive predictive value 66.6% and the negative predictive value 73.5%.

Techniques of intrapartum fetal surveillance

Cardiotocography

Continuous fetal heart rate (FHR) and uterine contraction recording (cardiotocography or CTG) is widely used to assess fetal well being during labour. This method has, however, certain limitations. A normal CTG trace reflects optimal fetal oxygenation and is of reassurance regarding fetal conditions. In contrast the significance

of FHR changes is often unclear and therefore difficult to interpret. In the clinical scenario, this can result in unnecessary interventions for suspected fetal hypoxia or inappropriate delay in action with potentially disastrous consequences for the fetus. Some of these difficulties can be overcome by a better training of medical and midwifery staff. Evidences also suggests that the use of expert systems for decision making would provide a valuable contribution in improving the detection and clinical management of cases with abnormal CTG patterns. However, it is also evident that there are situations in which the CTG changes are not specific enough for the presence of fetal hypoxia and additional information is necessary for appropriate decision making.

Thus the limitations of cardiotocography in the term fetus are mainly linked to the difficulty of interpretation of abnormal fetal heart rate patterns and to the poor specificity of the technique in identifying threatening hypoxia. Furthermore, twin pregnancy are often complicated by prematurity. Assessment of fetal well being in the preterm fetus by analysis of the fetal heart rate presents, in addition to the limitations described, further and specific difficulties. The antepartum non-stress test, of recognised value in the term fetuses, is of less well defined value in the preterm fetus, due to greater uncertainty in the relationship between baseline heart rate, reactivity and fetal conditions.

The interpretation of fetal heart rate patterns of the preterm fetus, is also complicated by the impact of specific drugs more frequently used in women with threatened or actual preterm labour. It is well known, for example, that the administration of steroids or magnesium sulphate exert a negative effect on fetal heart rate variability, and that administration of beta-receptor agonists affects both fetal heart rate variability and baseline heart rate. The assessment of fetal well being in the preterm fetus by electronic fetal monitoring therefore requires further studies to develop specific interpretative criteria considering the specific physiological aspects of the maturing fetus.

Another problem related to cardiotocogrphyc fetal monitoring in twin pregnancy is that linked to the difficulty of obtaining a reliable dual tracing. This difficulty can give rise to errors linked to the double recording of the same heart rate or in the inadvertent recording of maternal heart rate that can be erroneously interpreted as fetal. When possible it is advisable to record the heart rate of the first twin by a scalp clip.

The ST waveform analysis of the fetal electrocardiogram

ST analysis has emerged not as an alternative to cardiotocography but as a support tool to allow more accurate interpretation of intrapartum events. The fetal ECG is readily obtainable during labour from the same scalp electrode used to obtain the fetal heart rate utilizing a dedicated CTG plus fetal ECG monitor (STAN® S 21, Neoventa Medical AB, Gothenburg, Sweden).

Numerous experimental animal studies have clarified the pathophysiology of ST waveform changes of the fetal ECG during hypoxia.

The evidence from experimental work indicate that ST waveform elevation reflects compensated myocardial stress and a switch to anaerobic myocardial metabolism. A progressive rise in T/QRS ratio represents continuing anaerobic metabolism with a risk of eventual decompensation due to depletion of myocardial glycogen stores and a progressive metabolic acidosis. Persistently biphasic and negative waveform changes indicate myocardial decompensation as a result of direct myocardial ischemic hypoxia. Clinical analysis of ST waveform changes is assisted by a specifically developed computerized ST log function that provide direct statements on specific significant ST events, to provide additional user support. This pathophysiological model of interpretation has lead to the development of specific clinical action guidelines that have been tested in several observational and randomized control studies. These studies demonstrate the high sensitivity of CTG+ST to predict fetal acidosis, associated with a significant increase in positive predictive values as compared with CTG only.

The results from the recent Swedish randomized trial on CTG alone versus CTG+ST analysis (4495 cases) showed in the CTG+ST arm of the trial a 60% reduction in the number of cases with metabolic acidosis (cord artery pH<7,05 and base deficit >12mmol/l) accompanied by a 25% reduction in operative interventions for fetal distress as compared with the CTG only arm, with no increase in operative deliveries for other reasons. The trial protocol allowed for an interim analysis after 1600 cases. This analysis showed frequent breaches of

protocol as clinical management in the CTG+ST arm was conducted according to the "old" CTG information. The result of this lack of compliance was not only more operative interventions but also babies being exposed to unnecessary intrauterine hypoxia with two babies requiring neonatal intensive care.

After retraining and enhanced experience with ST analysis that allowed a more rigorous application of the CTG+ST clinical action protocol, it was possible to obtain in the second half of the trial an even more pronounced reduction in metabolic acidosis (-75%) with no babies admitted to NICU and a decrease of operative delivery rate for fetal distress of 44%. These results confirm the capacity of ST waveform analysis to provide diagnostic information on developing hypoxia during labour that can lead to a significant improvement in fetal outcome.

Conclusions

The challenge of obstetric surveillance is to identify those fetuses whose physiological defence mechanisms are compromised so that the obstetrician is able to act before decompensation has occurred. During the antenatal period, the evaluation of fetal hemodynamic adaptation to hypoxemia and the assessment of its chronological evolution by Doppler technology is crucial. This assists in planning appropriate obstetrical management and in reducing the risks of fetal damage.

Inadequate data exists to establish the value of the biophysical profile in multiple gestations. It appears that the biophysical score cannot differentiate between distressed and non-distressed fetuses in the same pregnancy. Therefore, an equivocal biophysical profile has limited value in predicting fetal distress in multiple pregnancies despite a high negative predictive value. Accordingly serial assessment of fetal well being should include all methods available: the non-stress test, the biophysical profile and Doppler velocimetry.

During intrapartum period, the relative inaccessibility of the fetus and the complexity of the pathophysiology of fetal oxygenation make it difficult to obtain and interpret information on fetal response to the stress of labor. Due to the limitations of cardiotocography, additional information is required for an appropriate decision making during labor. The results of clinical randomized studies show the capacity of modern technology applied to fetal surveillance, and in particular the analysis of fetal electrocardiogram in term fetuses, to provide useful additional information that can improve our ability to interpret fetal reactions to labor events.
A significant improvement in fetal surveillance, particularly in multiple pregnancies, is related not only to the availability of more specific information but also on the capacity of making the better use of the information available. This requires clinical skills, knowledge of fetal physiology and understanding of the technical basis and limitations of the methodologies of monitoring used.

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