Monitoring the Foetal Heart - The Foetal E.C.G.

Robert Carachi

The first serious attempts made at recording the foetal heart were in the year 1906. However the results were poor and the matter was dropped for many years. This was due mainly to the small impulse received but also because of the gross amount of interference which made the recordings very difficult to read let alone to decipher and deduce anything from them.

Later, a group at Yale university was achieving considerable success by picking up the abdominal signal of the foetal heart, and feeding the impulses received (both maternal and foetal) into a computer system which amplified the foetal impulse periodically at regular intervals. This was a considerable advance in recording, but it had its limitations. Whenever the foetal heart was irregular the amplification set periodically was out of step with the foetal impulse and failed miserably.

In the last 25 years there has been this tremendous breakthrough in electronics, and the recording of the foetal E.C.G. has come into its own. A whole new field of specialisation has been opened. This is just one of many examples where the progress in medical investigation has had to wait for the advancement of electronical engineering.

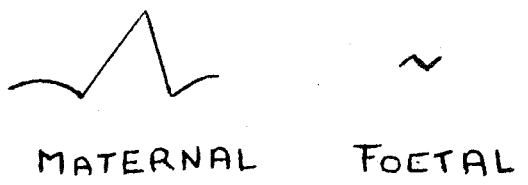
The consultant at the Royal Free Hospital these past 5 years has been actively engaged in this field, carrying out foetal E.C.G. investigations routinely on those who warrant them. The unit has been detecting abnormalities in the foetal heart and the foetus as well as in its immediate environment.

In an attempt to get better recordings rectal and vaginal electrodes have been tried, but were soon given up because of poor readings, and to this day the abdominal electrocardiography where here one places the electrodes on the maternal abdomen, has achieved the best results. The latest type of electrode on the market is one applied to the foetal head by means of a small clip after rupturing of the membranes. It is used for monitoring the foetus during labour.

The main problem that one meets with in recording the foetal heart impulse is the smallness of the impulse recorded from the electrode on the maternal abdomen. Hence the need to amplify the small signal by means of an amplification system utilizing a pre-amplifier.

The frequency response needed is much higher than the normal E.C.G. It is in the region of the range of frequencies used in myographs and electroencephalographs, since it is a known principle that the smaller the organism the higher the frequency required.

Just to compare the strength of the maternal and the foetal E.C.G. A frequency of 50 cycles per second is sufficient to record an adult E.C.G. while a frequency



of at least 200 cycles per second is needed for an adequate recording of the foetal heart.

Another problem encountered is that unlike the normal chest leads which are fixed in a normal E.C.G., the fixed abdominal electrodes in fact are not fixed at all relative to the foetus since it is constantly on the move and changing positions. So one must be able to make allowances for these variations of normal.

Technique

The apparatus essentially consists of a recorder and an amplifier the size of which is slightly larger than the standard E.C.G. recorder. There are knobs to vary the speed at two rates and also to vary the frequency. The main idea is to balance the circuit perfectly in order to minimise and if possible to eliminate the interference caused by the muscles of the maternal wall besides other electronic noise. Each electrode must be screened individually and they must be perfectly applied to balance the circuit.

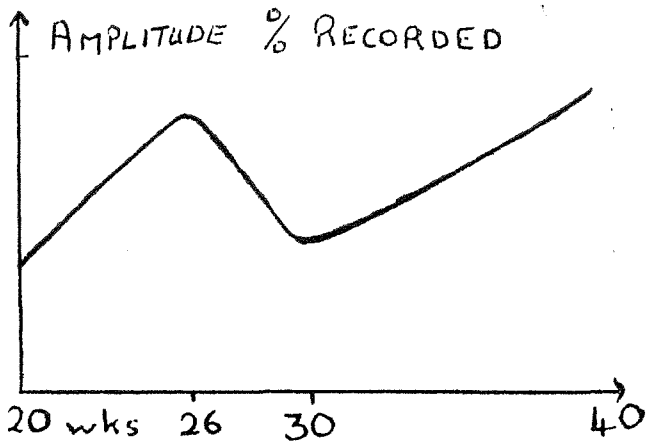
The two types of electrodes in current use are the suction type used for antenatal routine recordings and the permanent plastic type used for monitoring the foetal heart during difficult labours.

Uses of the foetal E.C.G.

- The maturity of the foetus if taken on 2 successive occasions can be pinpointed to +or—7 days.
- The intrauterine state of the foetus can be assessed with accuracy, this method being more sensitive than relying on irregularities of the foetal heart to develop or alter the rate.
- Placental uterine function can be assessed to a certain degree of precision.
- Foetal abnormalities can be detected such as hydrocephalus, hiatus hernia, ectopia cordis, congenital defects of the heart.
- Definitive diagnosis of twins can also be made.
- The diagnosis of normal and abnormal presentations.
- Diagnosis of intra uterine death.

However the major use at present is in the assessment of the maturity of the foetus.

At different stages the foetal E.C.G. shows variations. Starting from 20 weeks one can be certain of the recordings received. Between 22 and 26 weeks one records a poor impulse. Between 28 and 32 weeks in a good percentage the impulse falls, while this impulse now rises steadily till term. There is good conduction and a high amplitude impulse is recorded.



(fig. 1).

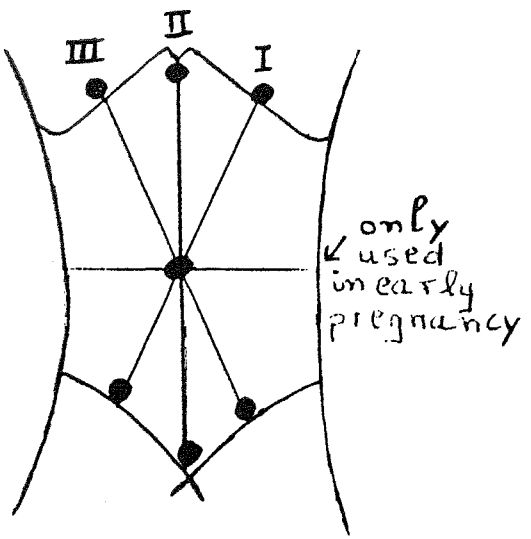
The foetal E.C.G. also reflects the melieur exterior of the foetal environment. An interesting observation is the recording of the E.C.G. during the process of salting out in a foetocide. 60 mls of the liquor is drained and 70 mls of 20% saline are injected in. In such cases it was noticed that the voltage signal doubled initially before it died down due to the good conduction of the sodium chloride. Hence one may infer from this that as the composition of the liquor changes in its ionic content so one sees the variations in the impulses recorded. This may explain the dip and then the rise in the graph above in part.

In a case of hydramnios the signal is dispersed there being so much liquor.

The foetal E.C.G. is mainly a ventriculogram and from it one can read

- The voltage.
- The Q-S time where the presence of any slurring denotes foetal distress and one can also determine the mass of the heart.
- S wave which is seen in early pregnancy whereas the Q waves are not seen in early pregnancy.

Electrode sites used on the maternal abdomen.



(fig. 2).

Discussion

Foetal electrocardiography is a well established sophisticated diagnostic tool with which one can detect foetal abnormalities and distress as also to diagnose hostile environments, where decisions for the precise time for intervention may be vital.

However the main use for it at present is its ability to date a pregnancy to within a week accurately.

This tool undoubtedly removes many hazards of radiography for diagnosis of many of the conditions that the foetal electrocardiograph can detect so innocuously. Besides it would undoubtedly relieve the overburdened staff of any radiological unit.