

STUDIES ON FOETAL ELECTROCARDIOGRAPHY

by

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Introduction

Early in twentieth century, foetal electrocardiogram (FECG) was recorded by Cremer (1903). Since then Bell (1938), Goodyear *et al* (1942), Hon *et al* (1961) and others were interested in monitoring the foetal heart rate by electronic equipment during the antepartum and intrapartum periods. This method has been of practical help to determine foetal viability, presentation and multiple pregnancy (Larks, 1958). In addition, endeavour had been made to note its value in the detection of foetal distress, congenital heart disease and maturity of the foetus. Foetal electrocardiography could be used by the abdominal, transcervical and transabdominal routes. The latter two methods reduce interference from maternal ECG and electrical noises. In the present series the authors made an attempt to obtain FECG in different clinical conditions during pregnancy and labour.

Material and Methods

Foetal electrocardiography was studied in 16 cases in this series. The cases were selected at random from the antenatal clinic or from those admitted in the hospital. Tracings were obtained during the last trimester of pregnancy or during labour.

The electronic equipment used had a two channel system, one for the FECG and the other for the phonocardiograph. By the phonocardiograph, the weak and distant foetal heart sounds could be audible in an accentuated form. This FECG is a valuable guide to detect foetal life in some cases of hydramnios and twin pregnancy in later months of gestation. Moreover, it may be used to isolate the foetal complex which is synchronous with phono-cardiogram from the maternal ones. The first sound was recorded as broad and irregular spikes and the second sound followed immediately after the first sound, with short and sharp markings. The recording was practised in an isolated room free from noise to prevent the extraneous disturbances.

The two methods, abdominal and transabdominal or intrauterine, were carried out in these cases. In the abdominal technique the bipolar

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leads were used. The ground lead was fixed to the right thigh or leg of the mother and the other two leads were affixed to the different parts of the abdominal wall depending on the height of the fundus and presentation and position of the foetus. The tracings were obtained at 25 mm paper speed, with the filter on, and at different sensitivity.

Electrocardiography was taken in two cases during lower segment caesarean section. The foetal complex was very distinct and different components could be easily identified. The authors had to spend considerable time and energy trying different means before satisfactory recordings were made and foetal ECG could be distinctly differentiated from the maternal ones.

Results

Sixteen cases studied in the series included eight cases with vertex presentations, one breech presentation, two multiple pregnancies, two cases of intra-uterine death and two cases of foetal distress.

Neither phonocardiograph nor foetal ECG could record foetal heart rate in one case of triplets at 28 weeks' gestation, complicated with hydramnios, by the abdominal or transabdominal technique. In all other cases the FEKG could be identified, with or without corroborative evidence of phonocardiograph.

In two cases, one of multiple pregnancy and the other of hydramnios, the electrocardiography could prove the presence of foetal life when the phonocardiograph could not pick it up (Fig. 3). It appears that the electrocardiograph is much more sensi-

tive than its counterpart, the phonocardiograph.

In two cases, of intrauterine death of the foetus, the ECG could confirm the death of the foetus. One patient was 38 years old, 2nd gravida, who conceived after 12 years of infertility and could not feel foetal movements at 38 weeks' gestation. Skiagram of the foetus, 7 days later, did not project any evidence of foetal death. The second case was a 3rd gravida, at 42 weeks' gestation. The x-ray picture showed confirmatory evidence of foetal death.

In two cases, tracings were obtained by the transabdominal (direct) technique during caesarean section, before the delivery of the foetus. This method improved signal to noise ratio and the base line details figured very clearly. Apart from the QRS complex, the P wave was visible. The heart rate and complex under anaesthesia did not materially change when compared with that recorded immediately before the patient was anaesthetised.

The foetal ECG in the case of breech presentation was characterised by the upright 'R'. The "R" usually was directed downwards in case of vertex presentation. The phonocardiograph and FEKG, specially the latter, were very distinct (Fig. 2).

In two cases of multiple pregnancy the foetal ECG was studied. The first case of triplets at 28 weeks' gestation, associated with hydramnios, was diagnosed by the skiagram. The abdominal and transabdominal methods (by paracentesis) both failed to detect the presence of foetal life. The other was a 2nd gravida, twin

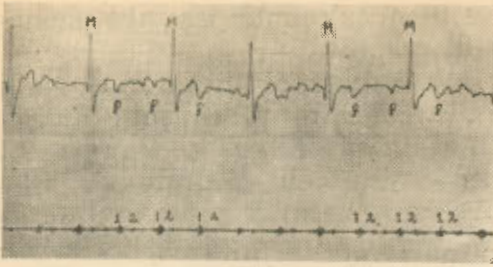


Fig. 1

Vertex presentation.

P.P. 1st gravida vertex, L.O.H., at term, clinically foetal heart sounds were indistinct. The picture shows downward foetal QRS complex (indicating vertex presentation) first and second sounds in the phonocardiograph quite distinct. Foetal heart rate 150 per minute.

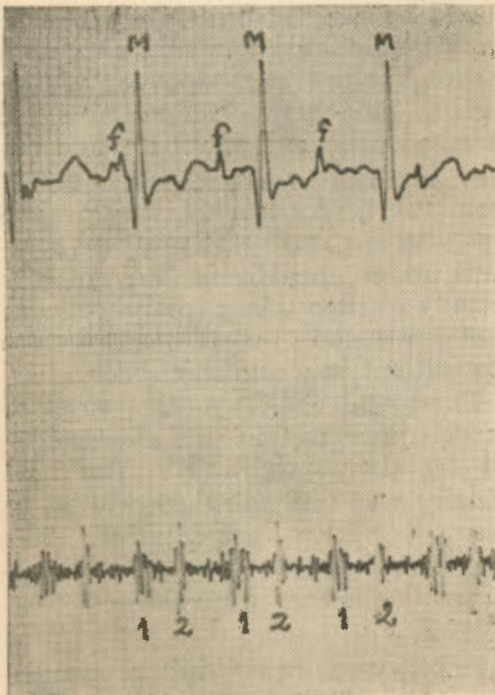


Fig. 2

Breech presentation.

Primigravida, breech presentation at 39 weeks' gestation. Figure shows upright foetal QRS complex corresponding with the broad first sound of the foetal phonocardiograph; foetal heart rate was 150 per minute, regular. Maternal heart rate 115 per minute.

pregnancy, at 36 weeks' gestation; both foetuses were presenting by breech, with slight excess of liquor amnii. Foetal heart sounds were faintly audible by means of stethoscope only over one foetus. The two foetal heart complexes could be clearly demarcated in the electrocardiograph (Fig. 3).

Foetal tachycardia of 168 and 150 per min. were noted in two cases by transabdominal methods. The first case, a primigravida, 26 years, at 38

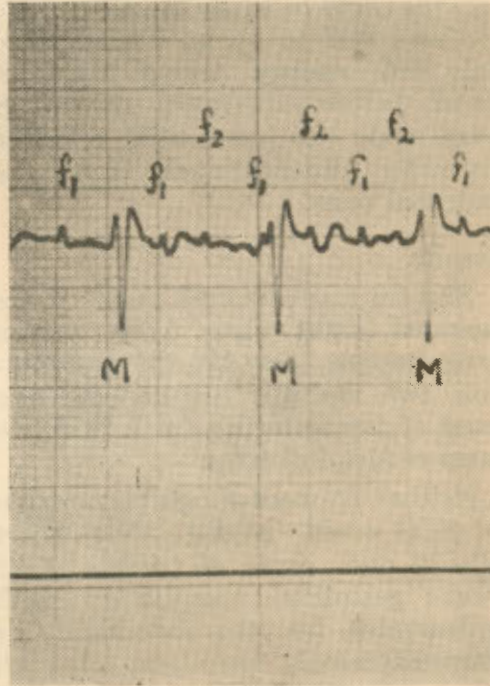


Fig. 3

Twin pregnancy

R.D., 2nd gravida, at 36 weeks gestation, twin pregnancy. Both were presenting by breech; there was associated hydramnios, foetal heart sounds were inaudible. The figure shows F_1 & F_2 upright QRS complexes. The complexes of both the foetuses were distinct and could be easily differentiated from maternal ones. Foetal heart rate was 150 and 145 per minute.

weeks, was in labour for 12 hrs. 30 min. The os was 4 c.m. dilated. The foetal heart rate gradually went up to 168 per minute. The foetal ECG was within normal limits. The baby was delivered by abdominal section. The Apgar score counted 7 one minute after birth and the baby's weight 2 kg. 650 gm. The second

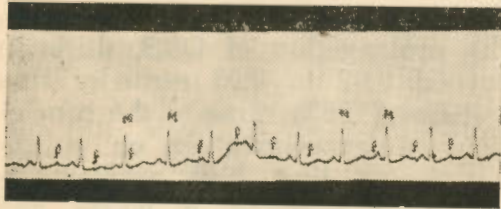


Fig. 4

Foetal tachycardia.

N. G., 26 years, primigravida in labour at 38 weeks' gestation. F.E.C.G. recorded by ordinary electrocardiographic machine during caesarean section for foetal tachycardia. The picture shows the biphasic foetal QRS complex. Foetal heart rate 168 per minute. Normal QRS duration—Apgar score—7, Baby's weight 2 Kg. 650 gm.

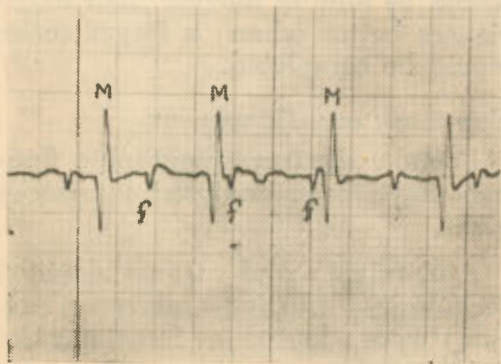


Fig. 5

Foetal tachycardia

D. C., 18 years, primigravida at 42 weeks' gestation in labour for 9 hours. F.E.C.G. was taken during caesarean section. Indication, prolonged pregnancy and foetal tachycardia. Duration QRS complex was 0.04 second. Foetal heart rate was 150 per minute. Baby—Apgar score 8; weight 2 Kg. 750 gm.

case, a primigravida of 22 years went into labour at 42 weeks' gestation. She weighed 65 kg. Her post-prandial blood sugar during pregnancy was 130 mgm%. The pregnancy was complicated by labile hypertension upto 140/90 mm. of Hg. At times she had oedema of legs; labour was retarded due to uterine dysfunction. The cervix dilated only upto 2 cm. after 8 hours' labour. So caesarean section had to be undertaken to deliver the baby. Foetal ECG tracings were obtained before and during anaesthesia. Though the rate was high FECG was within normal limits. The P wave was normal. QRS complex was not prolonged. The Apgar score of the baby was 7. The baby cried within one minute of birth and weighed 2 Kg. 750 gm.

Discussion

In the present series a false negative result was found in one case only at 22 weeks of pregnancy. False negative findings vary from 5 to 40 per cent (Hon 1965). This is particularly high at about twenty-eight to thirty weeks' gestation (Larks 1959). The high false negative findings around 30 weeks gestation might have resulted from a drop in voltage, which had been attributed to different reasons (Caughway and Krohn 1963). FECG can pick up foetal heart rate as early as 16 weeks of pregnancy.

FECG plays a definite role in the diagnosis of intrauterine death of the foetus. In one case in the present series, the absence of phonocardiograph and FECG went in favour of intrauterine death although x-ray of the foetus did not produce any posi-

tive evidence of death. The equipment was also found to be of value in order to detect the presence of foetal life, when clinically the foetal heart was inaudible or indistinct in association with certain abnormalities like hydramnios and twin pregnancy.

Breech presentation could be diagnosed when the R wave was concordant with the maternal one, as against the discordant R waves in case of vertex presentation. Accuracy of diagnosing presentation ranged from 80 to 95% (Hon 1965); prominent and distinct waves, in comparison with that in vertex presentation were recorded as the foetal heart was stationed higher and closer to the anterior abdominal wall.

Twin pregnancy was diagnosed in one case. However, one should be careful in interpreting twin pregnancy as electronic interferences are sometimes difficult to be differentiated. False negative results might be found in 10 to 20 per cent cases. FECG is of special value to detect the presence of foetal life in multiple pregnancy. Both the foetal hearts are not always clinically audible and when audible it may not always be possible to determine whether they belong to single or double fetuses. The FECG was found to be a good diagnostic tool for the diagnosis of the different conditions discussed above. X-rays with their consequent irradiation hazards can be avoided in these conditions.

The findings were in agreement with the view that foetal tachycardia is not always an evidence of foetal asphyxia, for the FECG or Apgar

score after birth remained within normal limits in these cases. Kendall *et al* (1964) described the following changes in FECG criteria of foetal distress and verified them by the development of foetal bradycardia, a definite signal of foetal distress or birth of a depressed infant. The changes were as follows: (1) Prolongation of ST segment, duration above the normal of 0.01 to 0.03 seconds, (2) prolongation of QRS, duration beyond 0.02 to 0.05 seconds. Hon and Lee (1963) came to the conclusion on experimenting on a dying foetus that high peaked biphasic or inverted P waves and shortened PR intervals were the most consistent changes in foetal distress. Brady *et al* (1963), on the other hand, commenting on electrocardiographic findings, stated that only persistent tachycardia during labour between contractions appeared to be a sign of foetal distress. The authors would be able to narrate their experiences better when a larger series would be completed.

Summary and Conclusion

Foetal electrocardiographic findings have been analysed in sixteen cases.

Abdominal and transabdominal techniques (during caesarean section) were adopted for foetal electrocardiography.

The method gave a clue to the diagnosis of intrauterine death of the foetus, breech presentation and multiple pregnancy.

Future studies might reveal the importance of fetal electrocardiography in diagnosing foetal distress.

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