

IRREGULARITIES OF THE FETAL HEART*

A PHONOCARDIOGRAPHIC STUDY OF THE FETAL HEART SOUNDS FROM THE FIFTH TO EIGHTH MONTHS OF PREGNANCY

BY ALBERT S. HYMAN, M.D., F.A.C.P., NEW YORK CITY

(Director, Witkin Foundation for the Study and Prevention of Heart Disease, Beth David Hospital)

STUDIES of the fetal heart sounds have been made for at least one hundred years; Kennedy in 1830 described certain sounds and murmurs heard over the pregnant uterus which were not synchronous with the maternal heartbeat. Interest in the examination of the fetal heart sounds has never failed to occupy the attention of the clinician in the century which has followed and from time to time, as new methods have been developed for the investigation of the fetal heart, obstetricians have eagerly seized these procedures.

Amplification of the heart sounds and their graphic registration has made possible further study in regard to the heart and its activities. The past decade has seen a tremendous accumulation of information based upon the electrodynamic manifestations of the heartbeat; the electrocardiograph and the polygraph have become instruments which can reveal the smallest changes from normal. Amplification of the heart sounds now carries forward the possibility of examining the heart under conditions not made available to the electrocardiograph. This is especially true in regard to the study of the fetal heart.

Phonocardiograms, which are the graphic records produced by amplification of the heart sounds, were obtained from the fetus in 1926 by Sampson. He was able to demonstrate that the fetal heart sounds could be easily amplified and recorded graphically for subsequent study. Many fetal heart sounds which were heard with difficulty by the various types of stethoscopes can be readily photographed. Congenital murmurs and anomalous cardiovascular changes can be diagnosed before birth by this method. Irregularities of the fetal heart, however, have not been studied by this method and an attempt has been made to present graphically to the obstetrician the various types of irregularities which may be discovered. This paper is concerned with the more common types of fetal arrhythmias.

FREQUENCY OF FETAL HEART IRREGULARITIES

Irregularities of the fetal heart, especially from the fifth to eighth months, are apparently not uncommon. The available literature does

*From the Witkin Foundation for the Study and Prevention of Heart Disease, Beth David Hospital, New York City.

not, however, record its frequency. A questionnaire sent to 100 obstetricians in the United States whose collective experience probably represented the results of more than 100,000 prenatal examinations, showed that there is apparently no agreement in regard to the frequency and occurrence of the fetal arrhythmias. About one-third of the obstetricians had never heard changes in the rhythm of the fetal heart; one-half of those that answered said that it was very infrequent. The remainder, on the other hand, reported that irregularities of the fetal heart were very common, estimates running as high as from 25 to 33 per cent of all cases examined prenatally.

The reason for the extreme divergence of opinion in men of equally wide experience is probably due to the difficulties frequently encountered in the examination of the fetal heart; most obstetricians are content to establish the mere presence of the fetal heart and do not carry their examination of it further than a few seconds of observation. Other aspects of the prenatal examination naturally are of more interest to them so that detailed and specific information about the character of the fetal heart is not ordinarily made.

In a rather incomplete survey made of the cases coming to the Prenatal Clinics of the Beth David Hospital Dispensary over a period of about one year, irregularities of the fetal heart were discovered in about 9.2 per cent. While this figure cannot be taken as representing the true incidence of fetal arrhythmias, it is suggestive in indicating that the condition may not be an uncommon one. Subsequent study and collective comparison of figures obtained from many such clinics throughout the country will be necessary before any degree of accuracy can be secured in estimating the true frequency of the fetal arrhythmias.

THE FETAL PHONOCARDIOGRAPH AND ITS CLINICAL APPLICATION

Fetal phonocardiographic tracings are photographic records of the fetal heart sounds after they have been converted into electromagnetic waves by radio amplification. The sounds made by the heart in utero are picked up by specially constructed stethoscopes and led to microphones; here the sound waves are transformed into electric impulses which in turn are passed through certain instruments which now change these impulses back to elements of motion. A photographic record of these movements becomes the graphic tracing known as the *fetal phonocardiogram*.

Stripped of its technical details, the apparatus is merely a method of rendering visible to the eye, sounds which are audible to the ear; in addition to this, many sounds not perceived by the human auditory mechanism are readily discovered by this electrical method of amplifying vibrations caused by rhythmic disturbance of air. In Fig. 1 is represented a schematic diagram of the apparatus used for recording

such sound waves; for clinical use a string galvanometer, such as may be found in every electrocardiographic laboratory, is substituted for the glow lamp device which is necessary for the reproduction of synchronized sound moving pictures.

The clinical application of this apparatus for the study of the fetal heart sounds has been reduced to a rather simple procedure requiring

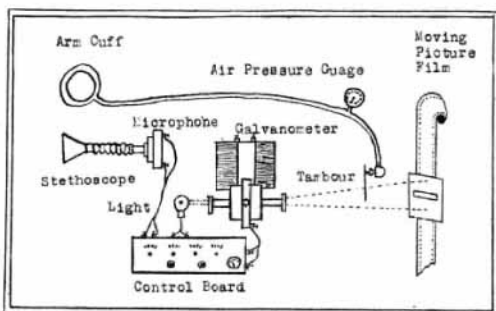


Fig. 1.—Schematic diagram of the fetal phonocardiograph showing how the fetal heart sounds are photographed simultaneously with the maternal pulse beat.

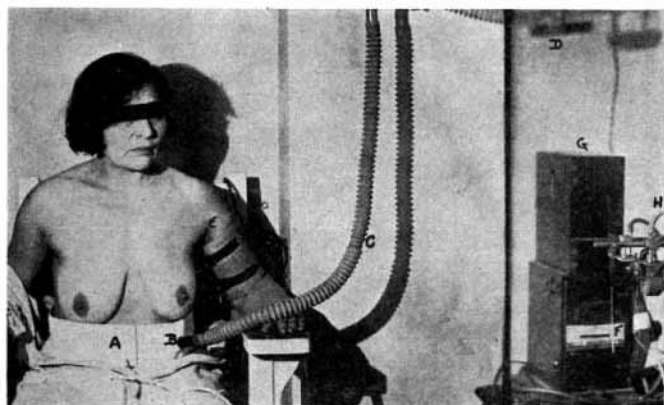


Fig. 2.—Clinical application of the fetal phonocardiogram taken simultaneously with the mother's polygraphic tracing. The important parts of the equipment are as follows: (A) Rubber girdle, (B) stethoscopic receiver, (C) special rubber tubing which carries the sound waves to microphone (D), (E) cuff used to compress mother's brachial artery for recording at tambour (F), (G) moving picture camera, (H) pressure gauge for determining diastolic pressure in polygraphic circuit.

no more than three or four minutes for its entire performance. Details of such an examination are readily seen in Fig. 2; the patient in this case is seen sitting upright in a chair. A wooden stethoscopic receiver is held firmly over the abdomen by a rubber elastic girdle; a large bore, nonexpanding rubber tube conducts the sound waves to the

microphone. From here the electric impulses are led to the galvanometer and the shadow of the oscillating string is recorded by a moving picture camera. A cuff is placed around the mother's arm and after being inflated to diastolic pressure the impulses from her brachial artery are picked up by a mechanical tambour and photographed simultaneously with the oscillations made by the sounds of



Fig. 3.—Clinical application of the fetal phonocardiogram with the mother in the reclining position. The explanatory letters in this figure are the same as in Fig. 2.

the fetal heart. In this way, simultaneous studies of the maternal and fetal circulations can be made; we shall have occasion to consider this more fully at a later time. Occasionally in very obese patients the fetal heart sounds are more readily picked up and amplified when the mother is lying upon her back. Fig. 3 shows the various parts of the equipment in somewhat greater detail; in this case a large collecting stethoscope covers a great part of the abdomen and fetal phonocardi-

grams can be made even when no heart sounds of any kind can be heard by the ordinary methods of auscultation.

Other noises and sounds that rise within the abdomen are filtered out by balanced electric circuits so that only the sounds made by the fetal heart itself are taken. Intestinal as well as uterine and fetal movements are also eliminated from the tracings; ordinarily this is accomplished without great difficulty but occasionally certain sounds may approach the frequencies made by the fetal heart and when this occurs they may render the study of the records somewhat confusing. In general, however, the rhythmic beating of the fetal heart makes it distinguishable even in the midst of louder isolated noises which arise in the abdomen of the mother.

The author's modification of the previous methods of utilizing the phonocardiograph reduces the clinical application of the equipment for the examination of the pregnant woman to a simple and easily performed procedure which is quickly learned by a nurse attendant as it requires no greater skill or dexterity than that necessary for taking electrocardiographic tracings. The attachments are readily added to any electrocardiograph and the patient experiences no more inconvenience or discomfort than that felt by the latter examination. Information secured from the fetal phonocardiogram may come to be a necessary part of every prenatal examination and facilities for the making of such examinations should be made accessible to the prenatal clinic.

THE NORMAL FETAL PHONOCARDIOGRAM

Phonocardiographic records of the heart sounds have been made for many years; Frank¹ in 1904 and Weiss and Joachim² in 1908 were the first to attempt recording these sounds. Einthoven,³ Gerhartz,⁴ Bull,⁵ Battaerd,⁶ Marbe,⁷ Ohm,⁸ DeMeyer,⁹ and Lewis¹⁰ are but a few of the outstanding investigators of this method. The mechanical and technical difficulties encountered in the registration of the heart sounds and the complexity of the apparatus and equipment required, did much to prevent the procedure from attaining the clinical use which the examination merited. With the discoveries and advances made in the field of radioelectrical engineering, many of the previously insurmountable difficulties were disposed of and the last few years have witnessed epoch-making strides in the perfection of the phonocardiographic method.

Scheminzy,¹¹ Lutenbacher,¹² Benatt,¹³ Trendelenburg,¹⁴ and Groedel¹⁵ have within recent times developed phonocardiography to a relatively high degree of accuracy and special studies devoted to heart sounds and murmurs have done much to clarify this interesting but frequently not well understood branch of medicine. A revision of previously existing theories of heart sounds and murmurs is now tak-

ing place and many of the older widely accepted beliefs in cardiovascular disease are in the process of being changed.

Typical phonocardiographic records are shown in Fig. 4. Simultaneous electrocardiographic tracings have been taken to show the relation between the heart sounds and the electrodynamic phenomena of this organ. It will be noted immediately that although the second sound of the heart is usually described clinically as being predominant in that it is apparently the louder and longer of the two heart sounds, it is the first sound, in fact, which causes the greatest graphic oscillation. This is found to be true also in mitral stenosis where clinically the first sound of the heart is accentuated; this is seen in Fig. 10B.

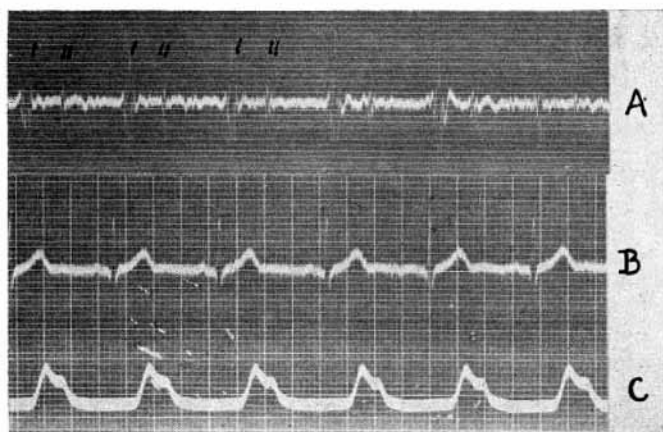


Fig. 4.—Graphic registration of the heartbeat; simultaneous study of the heart sounds, the electrodynamic activity, and the actual mechanical contraction of the heart. *A*, Phonocardiogram of normal heart sounds. Note that the first heart sound displays a greater oscillation than the second. *B*, The electrocardiogram. *C*, Polygraphic tracing of the radial pulse.

Phonocardiographic investigations of the fetal heart sounds were first attempted in 1926 by Sampson and McCalla;¹⁶ they were able to demonstrate not only the fetal heart sounds but also the occurrence of heart murmurs occurring in utero. Certain cases of congenital heart disease were discovered and diagnosed by them prior to birth of the infant. In Fig. 5 are phonocardiographic tracings in such a case together with records made after birth of the child; I am especially indebted to these able investigators for their courtesy in permitting me to reproduce this record which is one of their original epoch-making contributions to the science of modern medicine. Using by-pass filters of different frequencies they were able to study the oscillations made by the fetal band under investigation; their records shown in Fig. 5 reproduce these frequencies from 0 to amplitudes of 1100.

Using the string galvanometer in the method previously described, I have been able to obtain graphic records of the fetal heart which compare very favorably with those secured by Sampson's more complicated apparatus. In Fig. 6 is a typical fetal phonocardiogram made during the eighth month of pregnancy; the first and second heart sounds are easily identified.

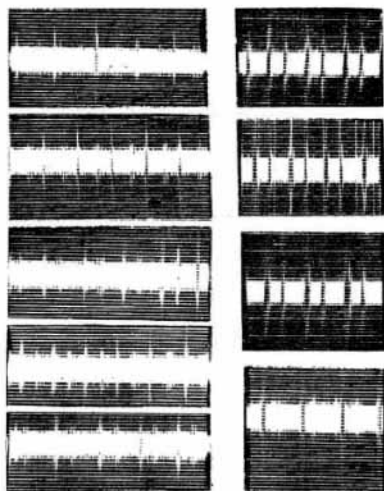


Fig. 5.—Fetal phonocardiogram taken by the Sampson method showing a well-marked sinus arrhythmia as well as a late systolic murmur.



Fig. 6.—Case 7A. Mother, aged thirty-one, para II. Phonocardiographic tracings of the fetal heart made during the eighth month of pregnancy. The fetal rate is very regular and is about 148 beats per minute. Note the periodic differences in amplitude of the sound vibration.

The addition of the polygraphic tracing of the mother's brachial artery to the fetal phonocardiogram presents a method of studying the maternal and fetal circulations at the same time. Fig. 7 is a typical normal record showing the relationships of the two circulations; in this case, for example, the maternal pulse rate is 68 beats per minute while the fetal rate is 134. The opportunity for clinical research opened up by this method can only be suggested here; the influence of drugs, toxic conditions, fetal and maternal diseases, and many other

conditions can be studied in their effect upon one or the other cardiovascular system. Many obscure pathologic conditions which affect either the mother or the fetus may be investigated in regard to their mutual effect upon each other and much new information may be secured. In this connection it may be mentioned at this time that a study of the preeclamptic toxemias by this method is now under way and considerable interesting data in regard to this latter condition have already been secured.

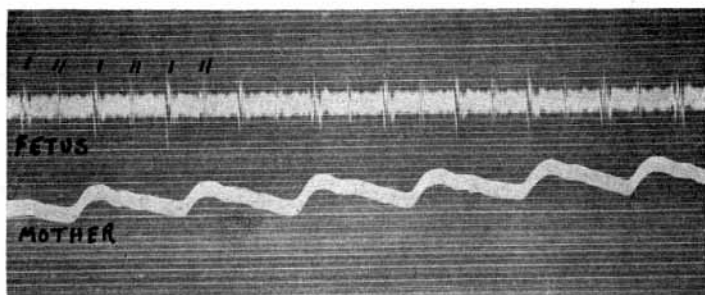


Fig. 7.—Case 21A. Mother, aged twenty-two, para III. Simultaneous phonocardiographic tracings of the fetal heart taken during the eighth month of pregnancy and the polygraphic tracing of the mother's radial artery. Note that the fetal heart rate is regular at 134 beats per minute and the mother's pulse rate is 68 beats per minute.

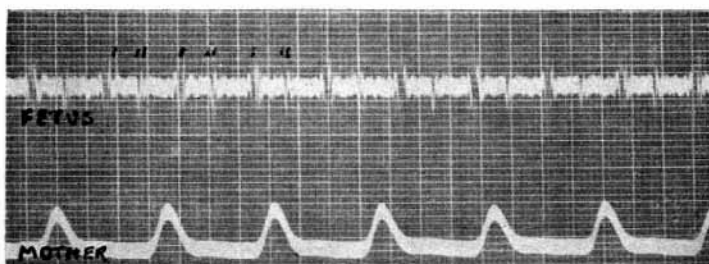


Fig. 8.—Case 41A. Normal fetal phonocardiogram. Fetal heart rate 140 beats per minute. Mother's pulse rate about 84. Tracings taken during the eighth month of pregnancy.

Of especial interest to the obstetrician is the phonocardiographic examination of the fetal heart in very obese patients; ordinarily the fetal heart is never heard during the entire period of pregnancy in such women. This is not an unfamiliar finding in every prenatal clinic; the diagnosis of gestation itself and subsequently of fetal position must be made without the fetal heart ever being heard at all. Fig. 8 represents tracings taken during the eighth month of pregnancy in a very obese patient; this woman weighed 188 pounds and had a tremendously thick abdominal wall through which nothing could be

felt, much less, heard. The tracings taken in a routine method show a regular fetal heartbeat at 150 beats per minute; the mother's pulse rate was 84 beats.

IRREGULARITIES OF THE FETAL RHYTHM

Because of the previous difficulties encountered in examining the fetal heart, no especial attention has apparently been paid to its arrhythmias; the available literature records but few instances where mention has been made of such irregularities. Drosin¹⁷ in 1922 and again in 1925 suggested that the prenatal examination should include a more careful account of the fetal heart beyond that usually made in regard to its rate and position; he was one of the first to suggest that irregularities of the fetal heart could frequently be detected and the diagnosis of possible complications during the later weeks of pregnancy or in labor might be made.

Actual demonstration of fetal cardiac irregularities has, however, apparently been rather infrequent; Schroeder¹⁸ has recently collected

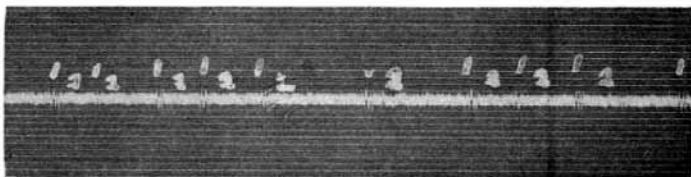


Fig. 9.—Case 12D. Mother aged twenty-six, primipara. Phonocardiogram of fetal heart made during the eighth month of pregnancy. Note the well-marked sinus arrhythmia.

all such cases recorded in the literature. He was able to find but 8 cases not including his own and he concluded that the occurrence of such irregularities must be more common than the situation suggested by the paucity of reported cases would warrant. The finding of only nine instances of fetal arrhythmia in the entire literature on the subject seems to be somewhat inexplicable in view of 21 such cases discovered by us in the past year and a half during which phonocardiographic studies have been made upon pregnant women both in the prenatal clinics and in private practice.

From a study of these 21 cases, irregularities of the fetal heart can be divided into three groups, each of which may be distinguished without difficulty. The first group includes the arrhythmias due to resonance factors within the abdomen; these resonant factors are caused by more or less rhythmic changes in the uterus itself and are most common toward the latter part of pregnancy. They apparently are concerned with uterine contraction which alters the audibility and intensity of the fetal heart sounds. To the unaided ear these changes suggest alterations in the fetal rhythm but graphic investigation has

shown that the differences are due to intensity of sound rather than change of rate. To this group are also added the cases of sinus arrhythmia which occur in utero and which may be so irregular that they might well be mistaken for a true irregularity. Sinus arrhythmia of this type is not infrequently found in infants and young children and it is to be regarded as normal; it suggests an unstable pacemaker mechanism which sooner or later becomes better regulated. It has no clinical significance; Fig. 9 shows such a case of sinus arrhythmia in utero. This record was taken during the eighth month of pregnancy; the mother was a primipara, aged twenty-six. In this connection it is interesting to point out that Sampson (see Fig. 5) previously recorded such types of sinus arrhythmia.

The second group of fetal arrhythmias consists in an interruption of the normal rhythm; this interruption when heard with an ordinary stethoscope suggests a skipped beat. When present it is distinct and recognized without difficulty; it may occur several times a minute but more often it is found only by accident. In the 21 cases of fetal arrhythmia from which this study is made there were six such cases. In Fig. 10 is presented the first case studied by phonocardiographic records and is to my knowledge the first phonocardiographic record ever made of such an irregularity. The case is briefly presented below.

CASE 4A.—Woman, aged twenty-one, primipara, pregnant seven months. The patient had been suffering from mitral stenosis for eight years; she had been decompensated once about four years ago. She was married against her physician's advice and promptly became pregnant. She was a small undeveloped girl weighing about 92 pounds; she presented no especial signs of cardiac decompensation but during the end of the sixth month her physician detected a definite irregularity of the fetal heart which was exceptionally easy to hear because of the thinness of the mother's abdominal wall. In fact the fetal heart was almost as easily heard as the mother's. Alarmed by the irregularity which he heard in the fetal rhythm, the doctor kindly referred the case to me for more complete study. The patient herself showed the usual signs of an old mitral stenosis with a typical mitralized cardiac shadow by orthodiagraphic x-ray examination. The fetal heart could be heard by all of the usual methods and a definite skip could be detected three or four times a minute. A complete graphic survey of both the mother and fetus was made and is presented in Fig. 10.

The phonocardiogram of the fetal heart shows a definite intermission in the cardiac rhythm; it is due to the loss of the second sound and without going into too great cardiologic discussion, is probably due to an extrasystole. The phonocardiogram of the mother's heart sounds is also given for comparison as well as the maternal electrocardiogram and polygraphic tracings of the radial artery; it can be noted in passing that the mother shows a right axis deviation of the heart and alterations of the P-waves seen in advanced mitral stenosis. In this figure is thus presented a complete demonstration of both the fetal and maternal circulations and it is shown here to illustrate the type of record which can be made by this method.

The mother went to full term and was delivered with some difficulty; examination of the baby the day after birth showed the irregularity still present. It was

determined at that time to be an extrasystole arising from the right ventricle; it disappeared entirely at the end of the week.

The identification of this type of fetal arrhythmia was made possible by electrocardiographic examination of the baby after birth; the

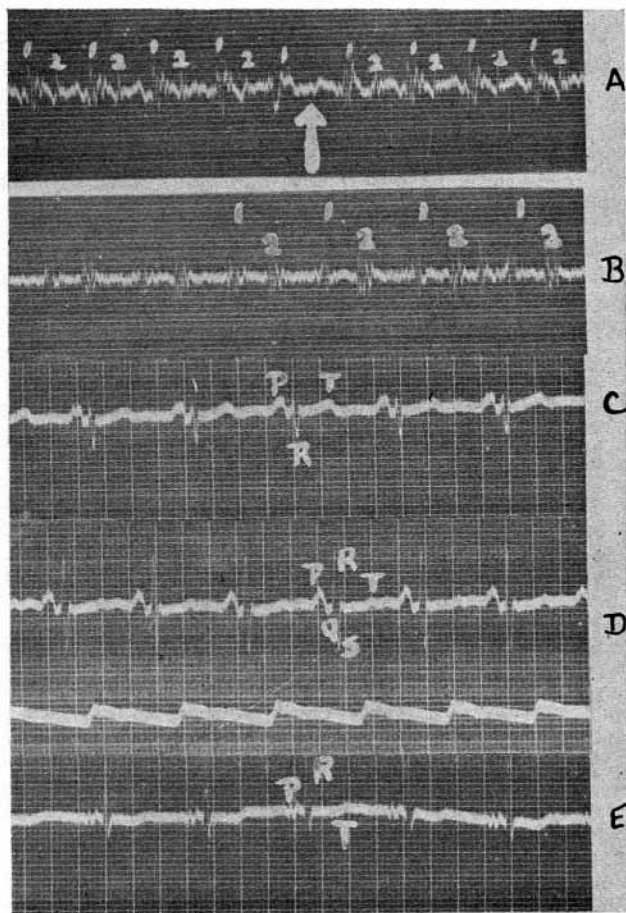


Fig. 10.—Case 4A. Graphic demonstration of fetal and maternal circulations. *A*, Phonocardiogram of fetal heart sounds; the arrow points to the skip in the rhythm heard clinically. *B*, Phonocardiogram of the mother's heart sounds. *C*, Electrocardiogram (maternal) Lead I. *D*, Lead II and polygraphic tracing of the radial artery. *E*, Lead III. The mother's electrocardiogram shows that she has a well-marked mitral stenosis.

skipping of the heartbeat heard both before and after delivery was found to be due to a noneffective right ventricular extrasystole. This finding is interesting in view of the statements made by Schroeder in

his case in which a description of an extrasystolic arrhythmia is given but he definitely states that the irregularity was not due to an ectopic beat. In his case the arrhythmia disappeared a few days after birth; this also occurred in similar cases reported by Seitz,¹⁵ Cohn,¹⁸ and Reihl.¹⁸

The other five cases found in our series presented the same type of cardiovascular disturbance in that the irregularity was due to an extrasystolic arrhythmia of right ventricular origin. In all of the cases the irregularity disappeared in a few days after birth, the longest lasting for about eight days. Of unusual interest was a case in which both mother and fetus had an extrasystolic arrhythmia; this patient, seen through the courtesy of Dr. L. Drosin, was the subject of considerable experimental study, a brief résumé of which is presented below.

CASE 29374.—A para ii, aged twenty-four, small undeveloped woman weighing 118 pounds, was seen during the eighth month of pregnancy because of a distinct irregularity heard in the fetal heart. Examination of the mother showed that

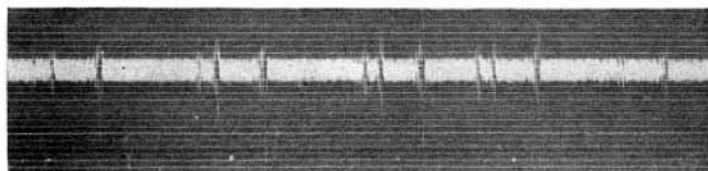


Fig. 11.—Case 29A. Mother aged twenty-six, para ii. Phonocardiographic records taken of the fetal heart during the seventh month. Note the gross irregularity of the fetal heart rhythm; it varies from 92 to 160 beats per minute. Sometimes the second sound of the heart is lost entirely. The mother's physical examination was entirely negative. Her previous pregnancy was uneventful. This patient miscarried about twelve days after these records were taken. The fetal heart sounds in this case could not be heard by the ordinary methods of auscultation due perhaps to the mother's obese abdominal wall and the weak quality of the fetal heart. The heart sounds in this case were amplified three times as much as that seen in Case 21A.

she was also suffering from an extrasystolic arrhythmia, a not especially uncommon finding during pregnancy. A phonocardiogram of the fetal heart showed the same type of irregularity as that seen in Fig. 10. There was no relation, however, between the irregularity in the fetal heart and that of the mother's as they occurred independent of each other. Two days after birth of the child, its irregularity disappeared but the mother's extrasystole still persists.

This type of irregularity apparently has no especial clinical significance as it usually disappears within a few days after birth of the infant. Schroeder thought it was due to certain neurogenic and myogenic factors developing in the fetal heart as the result of obscure metabolic phenomena; Holtermann,¹⁸ on the other hand, believed that toxic disturbances of the maternal circulation were responsible for the condition. Our own belief is that the disturbance is the result of an irritable myocardium and an unstable pacemaker system; its clinical significance is apparently not very great, as all of the cases reported

have cleared up within a few days after delivery. Its discovery by the obstetrician should cause him no undue concern and the diagnosis of the condition is only of interest in differentiating it from the more serious types of fetal arrhythmia to be described later.

The third group of irregularities of the fetal heart are not only more common but also of more sinister significance than the previous two groups. Of the total 21 cases, 11 were found to come within this classification. The irregularity varied from a slight constant change in rhythm to a grossly perverted arrhythmia; from a clinical point of view these latter cases suggest the gross irregularity seen in the rapid auricular fibrillation of decompensated cardiac patients. While such types of auricular fibrillation are seen most commonly in late adolescent life from eighteen to thirty years of age, occasionally it is found in very young children¹⁹ and even infants.²⁰ Auricular fibrillation occurring in utero has, however, never been described but examination of fetal phonocardiograms taken in this third group of cases suggests that this condition may actually be present in uterine life and may be responsible for certain hitherto unexplained abortions.

Three such cases from our series of 11 are herewith presented in some detail to illustrate the type of fetal irregularity found; these three cases are, more or less, representative of the whole group and it is to the study of these that future investigations must be devoted.

CASE 29A.—Para ii, aged twenty-six, seen during the seventh month of pregnancy. The mother's physical examination was entirely negative. Her previous pregnancy and delivery were uneventful. The fetal heart sounds could not be heard by the ordinary methods of auscultation as the patient was a very heavy woman with a large abdominal wall. The phonocardiographic examination was made to establish the presence of the fetal heart. The records obtained (see Fig. 11) showed a gross irregularity in the fetal heart rhythm which varied from 92 to 160 beats per minute; more important, however, than the mere variation in rate was the frequent loss of the second heart sound. These records were repeated on the following day with the same result. A diagnosis of gross irregularity of the fetal heart was made. About twelve days later the patient had a slight uterine hemorrhage which was followed in about an hour by a complete abortion; this occurred during the patient's stay in a near-by city and no examination of the fetus or the heart itself could be made.

CASE 34B.—Primipara, aged twenty-eight, seen during the sixth month of pregnancy. The mother's physical examination was entirely negative except for a large trace of sugar in her urine which appeared for the first time during the fifth month; her blood sugar on two examinations was 155 and 165 mg. Fetal phonocardiograms (see Fig. 12) showed a gross irregularity of rhythm and rate; the latter varied from 148 to 210 beats per minute. This irregularity could be noted also by auscultation as the patient had a thin abdominal wall. Without special treatment, save a moderate reduction of carbohydrate intake, the patient's urine became sugar-free about four days after these records were taken. About ten days later the patient suddenly miscarried and the fetus was very fortunately obtained for postmortem examination. The fetal heart was carefully sectioned but no especial pathologic changes could be detected.

CASE 44B.—Para ii, aged twenty-seven, normal physical examination. Fetal phonocardiograms (see Fig. 13) taken during the ninth month of pregnancy showed a gross irregularity in the fetal rhythm which could also be heard clinically. The rate varied from 120 to 200 beats per minute with frequent pauses of complete asystole of the heart for about a half a second. The mother was delivered without difficulty but the baby failed to breathe, resuscitation of all types including intracardiac injection of adrenalin finally resulted in automatic respiration. The infant's heart examined from time to time during the next few days showed a grossly irregular pulse; no electrocardiographic studies could be made because of inaccessability of the apparatus, the institution not being provided with this equipment. When examined, however, at the end of the third week the heart was apparently normal and the electrocardiographic tracings revealed nothing unusual.



Fig. 12.—Case 34B. Mother aged twenty-eight, primipara. Phonocardiogram of fetal heart made at middle of sixth month of pregnancy. Note that the fetal heart rhythm is grossly irregular and varies from 148 to 210 beats per minute. The rhythm suggests that seen in auricular fibrillation or flutter of the adult heart and can be easily differentiated from the fetal sinus arrhythmia seen in Case 12D. The mother suddenly miscarried about two weeks after this record was taken. The obstetrician reported that no cause for the miscarriage could be found.

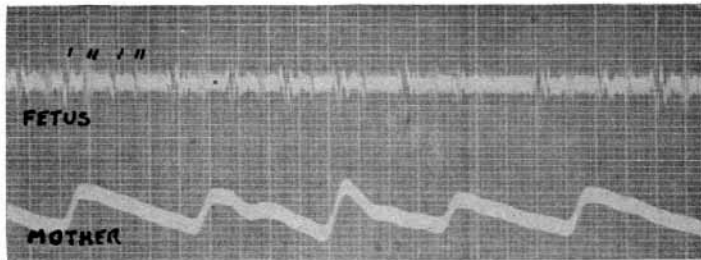


Fig. 13.—Case 44B. Gross irregularity of the fetal heart. Phonocardiogram showing fetal heart varying in rate from 200 to 120 beats per minute. At times the fetal heart shows complete asystole for about one-half second. The mother's pulse is regular at a rate of 72 beats per minute. This record was taken during the ninth month. The mother, a para ii, delivered without difficulty but the baby was resuscitated after thirty minutes.

It is of importance to note that the discovery of gross fetal cardiac irregularities was associated in these cases with either sudden interruption of pregnancy or in difficult resuscitation of the infant after delivery. No discussion of the mechanism responsible for spontaneous abortion in the first two cases so far as it relates to the disturbance of cardiac rhythm in the fetus can be entered into here, but sufficient evidence is at hand to suggest a very definite correlation between the two conditions. Only after the study of many such cases from every angle, both clinical and postmortem, can any true deductions be made

in regard to the relationship between cardiovascular disturbances in utero and the establishment of spontaneous abortion. The purpose of this paper is merely to indicate that gross irregularities of the fetal heart may be responsible for such unexplained miscarriages; from a purely cardiologic point of view, if this irregularity is a true intra-uterine auricular fibrillation the *modus operandi* may not be difficult to explain as somewhat similar disturbances are seen in adult cases suffering from this disease.

SUMMARY

Study of the fetal heart sounds by means of the phonocardiogram has demonstrated that the occurrence of cardiac irregularities in uterine life is not an infrequent discovery. These irregularities can be divided into three general groups, the first two of which constitute about 80 per cent of all the irregularities. The first group consists of an exaggerated physiologic disturbance of the pacemaker mechanism in which a marked sinus arrhythmia develops; this condition persists throughout childhood and finally disappears at the latter end of adolescence. It has no especial clinical significance but it should be recognized in order to make an accurate differential diagnosis from the third and more serious group of irregularities.

The second group of fetal arrhythmias consists of a skipping or alteration in the regular rhythm of the heart; this intermission is probably due to an intrauterine extrasystolic arrhythmia. It has been previously described by several authors under different names, but the general impression seems to be that the condition is relatively unimportant inasmuch as it disappears within a few days after delivery. Our own cases substantiate this opinion and we believe that its occurrence is evidence of a hyperirritable myocardium which may be the result of improper hygiene, poor posture, or an unsuitable dietary on the part of the mother. This type of irregularity is not difficult to discover if present, and it must, like the first group of irregularities, be differentiated from the third type.

The importance of the fetal irregularities lies primarily in the further investigation of the grossly perverted types of fetal heart rhythms seen in the third group. The combined attention of both obstetrician and cardiologist must be focused upon the mechanism responsible for this change in the cardiovascular system of the fetus. If this condition is due to auricular fibrillation as is suggested by graphic studies of this disease when compared to adult types of auricular fibrillation, indications as to therapy may be made and a new avenue of approach to the possible prevention of certain types of abortion may be accomplished.

Widespread clinical application of the phonocardiographic method of examining the fetal heart will undoubtedly add considerable infor-

mation of extreme importance to the obstetrician; the opportunity presented for a simultaneous study of the fetal and maternal circulations opens up many lines of research in regard to the problems attending gestation. Some of these have previously been hinted at; a study of the various toxemias and other insufficiently understood metabolic disturbances accompanying the pregnant state can be investigated by this method. The prevention of abortion when due to heart disease of the fetus may not be unexpected when a fuller comprehension of the basic causes responsible for the condition is more readily understood by the facts brought to light by the clinical utilization of this new method of examination.

REFERENCES

- (1) *Frank, O.*: München. med. Wehnschr. 51: 953, 1904. (2) *Weiss and Joachim*: Deutsches Arch. f. klin. Med. 98: 513, 1910. (3) *Binhoven*: Arch. f. d. ges. Physiol. 117: 461, 1907. (4) *Gerharts*: Die Registrierung des Herzschalles, Berlin, 1911. (5) *Bull, S.*: Quart. J. Exper. Physiol. 6: 289, 1911. (6) *Battaerd*: Heart 6: 121, 1915. (7) *Ohm*: Deutsche med. Wehnschr. 39: 1493, 1913. (8) *DeMeyer*: Méthodes Modernes d'examen du Coeur, Paris, 1914. (9) *Lewis*: Heart 4: 241, 1913. (10) *Scheminsky, F.*: Klin. Wehnschr. 5: 2120, 1926. (11) *Lutenbacher, R.*: Presse med. 36: 286, 1928; Ibid. 34: 1435, 1926. (12) *Benatt, A.*: Klin. Wehnschr. 7: 752, 1928. (13) *Trendelenburg, F.*: Ztschr. f. Kreislaufforsch. 20: 436, 1928. (14) *Groedel, F. M.*: Path. u. Therap. der Zirkulationsstörungen 6: 18, 1929. (15) *Sampson, J. J., and McCalla, E. L.*: Am. Heart J. 1: 717, 1926; Idem., California & West. Med. 25: 494, 1926. (16) *Drosin, L.*: New York Med. J. & Rec., Aug. 16, 1922; Idem., Medical Times, Feb. 1925. (17) *Schroeder, O.*: Zentralbl. f. Gynäk. 53: 1586, 1929. (18) *Cowan and Ritchie*: Diseases of the Heart, London, 1922, p. 175. (19) *Coombs, C. F.*: Rheumatic Heart Disease, London, 1924, p. 112.

1235 PARK AVENUE.