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Fetal scalp sampling : an aid in the diagnosis of fetal distress

John Robert Burnett
University of Nebraska Medical Center

Fetal Scalp Sampling:
An Aid in the Diagnosis of Fetal Distress

By

John R. Burnett

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The task of deciding when intervention of a pregnancy is warranted when signs of fetal distress present themselves has been a difficult one because there are no pathonomonic signs of fetal distress except those associated with intra-uterine death. To diagnose fetal distress in time to be of assistance to the fetus has demanded careful observation of two perameters: the fetal heart rate and the passage of meconium from the vertex presenting infant. These, however, have proven to be misleading more often than not. With advancements in the understanding of fetal physiology and the nature of the fetal-meternal association, the ground work has been laid for a better assessment of fetal distress. This method is a direct measurement taken from the fetal circulation unaltered by maternal compensation, and it has been shown to be a much more accurate measure of fetal well-being. This

diagnostic procedure has been described by several investigators and involves direct sampling of capillary blood from the presenting part of the fetus, usually during the first and second stages of labor. The technique is without serious complications when precautions against fetal hemorrhage are taken. The blood values most helpful can be determined in a very short time. This information can be supplied to the obstetrician to aid him in his dicision as to his treatment of that case of fetal distress on a more informed basis.

Fetal Distress--the Conventional Diagnosis.

Observations made of fetal distress and the signs associated with it have been recorded for over a century. The classical signs of fetal distress are the passage of meconium from the cervical os when the vertex is the presenting part and a bradycardia under one hundred beats per minute. Tachycardia over one hundred sixty beats per minute has also been related to fetal distress. Much work has been done regarding the accuracy of bradycardia and meconium passage in the diagnosis of anoxia in the fetus. Refinement in techniques of observation as well as correlation of these signs with intra-uterine pressures and changes on fetal electrocardiograms has lead to a greater understanding of the relevance of these signs. It is clear from most of the data

accumulated that the classical signs of fetal distress looked for by obstetricians correlates very poorly with the true status of the fetus in utero. This poor correlation tends to foster a wait-and-see attitude when the signs appear.

Approximately 8.4% of all 40 week gestations have one or the other or both of the two classical signs of fetal distress.[23] There are high risk groups, however, that have a much higher incidence of fetal distress. At 44 weeks, for example, 25.9% of all labors will show some sign of fetal distress.[23] There is also an increase in incidence of fetal distress with higher maternal age and in several other situations. The correlation of Apgar ratings with the signs of fetal distress are quite poor. Only 18.4% of one study had a correlation between bradycardia below one hundred beats per minute and fetal anoxia.[20] The correlation with meconium passage from a vertex is equally as bad.[8] Even when both signs are present the correlation is only 32.2%.[20]

Other causes of bradycardia besides anoxia are an increase in vagal tone with increased cranial pressure. Fetal movement alone can cause fetal tachycardia. Above all, the timing of the observation of the fetal heart rate in relationship to contractions can cause a variation in the rate recorded.[11]

Attempts have been made to standardize and sophistocate the observation of fetal heart rate in an

attempt to give this important observation more clinical weight. From these efforts the important differation between type I and type II dips have been made. It has been recognized that bradycardia immédiately after a contraction is a normal occurance, but that a different kind of bradycardia seen around twelve seconds after a contraction with a slower rate of heart rate decrease, , a longer duration of bradycardia, and a slower return to normal is indicative of fetal anoxia.

There are many other newer inovations now in use or being developed for following the fetus in utero. Among these are the fetal electrocardiogram, aminiótic fluid samples for optical density, in cases of RH sensitization, and assay of maternal blood for hormones and enzymes as an indication of fetal well being. Discussion of any of these is beyond the scope of this paper, but all add in some way to the management of fetal distress.

Indications for Fetal Scalp Samplings.

The indications for taking fetal blood for analysis are fairly clear cut. In the hands of an experienced obstetrician, the procedure is not much more difficult than rupturing the fetal membranes, and it takes only a few minutes more. This presumes that the necessary equipment is available. The indications then for this procedure can be divided into two categories. The first

consists of those patients in which fetal distress is suspected by other signs. These signs are, of course, the passage of meconium in a vertex presentation or a bradycardia of under one hundred and twenty beats per minute or a tachycardia of one hundred and sixty or more beats per minute. The second category of patients indicated for sampling are those mothers who fall into one or more of the several groups associated with higher incidence of fetal distress. These groups included diabetics, post maturity patients (over 43 weeks), pre eclamptics and eclamptics, elderly primagravidas, patients with a history of previous still borns, RH sensitized pregnancies and third Trimesters bleeders, except in case of placenta previa.[15,20,14,16] The contra-indications to sampling the infant are prolapse of the cord and placenta previa.

The question arises when and how often should the samples be taken. The patients whose indication for sampling is some sign of fetal distress should of course be sampled at the time the distress is noted. The sample should be repeated at once if the pH value is below 7.25. If the first sample is all right a second sample should be taken during the second stage of labor or if the heart rate drops. In the high risk groups the samples should be taken at the start or during the second stage of labor and repeated if the first sampling has a pH less than 7.25 or if there are any signs of

distress.[14]

The Technique and Complications of Fetal Scalp Sampling.

The technique for obtaining the small amount of fetal blood necessary for analysis has been worked out by several investigators.[18,3] The technique described here is the one used by Beard et al in 1967.[3] The patient is placed in a lithotomy position with the sacrum elevated and the perineum prepped. Stirrups may be necessary for adequate exposure. Dilitation, level, and position are then determined. The endoscope is then introduced into the cervical canal over the palm and middle finger of the vaginal hand. When in position the obturator is removed and the light is attached. External pressere may be necessary to keep the engaged head or breech in the os. With the presenting part below the zero station a vaginal speculum, rather than an endoscope, is more practical to use. The scalp or breech, as the case may be, is cleaned and then sprayed with ethyl chloride. This causes a local capillary dilitation in a fetus whose general condition is good. Silicone jelly is smeared on the sight for the incision to facilitate droplet formation and after fifteen seconds following the ethyl chloride spray an incision 2mm. deep and 2mm. wide is made with a blade pre set so that only that small amount of blade is exposed. The

incision is made a short while before the onset of a contraction so as to increase the blood flow rate. No more than three incisions should be made and one usually suffices. The degree of hyperemia with the ethyl chloride spray and the promptness of the blood flow should be noted as they are good signs of well being of the fetus.

The blood is collected in heparinized capillary tubes. It may be necessary to use a holder and some suction if tubes long enough to reach the presenting part are not available. If more than 2 to 3 minutes is required to collect the sample it cannot be considered representative for the acid-base values obtained. After the sample is obtained the incision site should be compressed with a dry swab. The site should be observed during one further contraction period to see that bleeding does not occur with an increase in intrauterine pressure. All of the equipment used, of course, should be sterile. At the same time the fetal sample is taken a maternal sample of blood should also be drawn for chemical comparison.

The complications arising when the above described technique is followed are few. However Beard et al[5] described fetal hemorrhage after scalp samplings with two fetal deaths resulting. These two deaths were caused by a greater than 2mm. stab and an infant sampled who had a clotting disorder. To prevent fetal

death due to hemorrhage swift and effective action can and should be taken. To determine whether vaginal bleeding after a sampling is fetal an analysis for fetal hemoglobin by the method of Singer[22] can be quickly done if more direct means are not conclusive. Other complications that can occur are caput hematomas and scalp infections. The incidence of complications has not been estimated but in practiced hands less than one percent incidence of complications has been the rule.

Micro Method for Acid Base Value Determination.

Once the fetal blood is drawn, there must be available rapid determination of some values in the blood chemistry that will reflect accurately the status of the fetus. Because of the nature of fetal distress the values most important in gaging fetal well being are the ones that demonstrate the degree of anoxia in the infant. Rapid determination of these values was impossible without large amounts of blood until 1960 when Siggaard Anderson introduced a micromethod for the determination of pH, pCO_2, standard bicarbonate, and base excess.[2] It is only with this technical advance that the whole idea of fetal scalp sampling became feasable. Before scalp capillary blood could be measured, anoxia in the fetal system was compared with

the clinical status of the new born by sampling cord blood. The obvious disadvantage here was that cord blood sample could not aid in diagnosing fetal distress. Furthermore there was an influx of hydrogen ion from the tissue causing a drop in pH. Scalp sampling is not without its complicating factors, however. There has been noted an increase in fetal pH with maternal breath holding and also there is some error attached to sampling a scalp after a caput has formed.[20]

The equipment required for bedside diagnosis has been described by Astrup and Siggaard Andersen et al in 1960.[2] There are also other commercially available apparatuses which work on comparable principles. The equipment consists essentially in a pH meter, a circulating thermostate, a suction pump, a micro electrode and a micro equilibration chamber. All these parts can be mounted on a portable table together with two small cylenders containing mixtures of oxygen and carbon dioxide.

The theoretical background for the calculation of pCO_2, standard bicarbonate, and base excess is that graphs showing the relations between log pCO_2 and pH are approximately straight lines. The slope of the lines depends on the buffer capacity of the blood. By equilibrating a blood sample at two known CO_2 tensions and measuring the pH values a line for the sample is determined. If the actual pH of the blood

sample is known then the actual pCO_2 can easily be found (fig. 1).[2] When fixed acid is added to the blood the line is displaced to the left. When base is added, the line is displaced to the right. A graph (fig. 2) can be constructed expressing the displacement caused by any amount of acid or base independent of the hemoglobin concentration.[2] The point of this curve and a found pH/log pCO_2 line for a blood sample thus indicates in m Eq. the base excess per litre blood. (fig. 3).[2]

It is not difficult to see the usefulness of a pH value and pCO_2 value in judging the degree of fetal acidosis. Two other values have been accertained, however, by filling pCO_2 and pH values into a pre existing nomogram. These two values are the standard bicarbonate and the base excess or deficits. The standard bicarbonate is defined as the plasma bicarbonate level at standardized conditions of fully oxygenated hemoglobin, a pCO_2 of 40 mm., and a temperature of 38° C. The normal value for this is 22.9 m Eq/Liter. This is an important value since plasma bicarbonate accounts for 75% of theblood buffering. The second extra value obtained is the base excess or deficit. It is a measure of the surplus of non volatile base or acid in m Eq/Liter compared with the value found at a normal standard bicarbonate. This value gives some insight into the degree of buffering that has gone on

to keep the pH at normal levels. It also gives the observer some measure of the buffering reserve that remains in the blood. This value is obtained by multiplying 1.2 times the difference between the standard base of a sample and the normal standard bicarbonate of 22.9 m Eq/Liter. In practice, of course, both standard base and base excess or deficit are arrived at from the Siggaard Andersen Nomogram (fig. 3). The normal value for the base excess is ± 2.3 m Eq/Liter from the standard base. Base excess is measured as positive while acid excess or base deficit is measured as negative.[2]

The technique for finding these values requires only ninety micro liters of blood in two capillary tubes and twenty five micro liters of blood sucked into a capillary electrode for an instantaneous pH reading of the sample. Next the two capillary tubes are placed in the two chambers of the equilibration apparatus (described above). This is then shaken at 2600 RPM and after three minutes pH values of the two samples are measured. These two samples having been equilibrated at known pCO_2 levels enables a line to be drawn and the pCO_2 of the sample to be ascertained (fig. 1).[2] This method is highly accurate as the three values can be found with an error of less than ± 2%.[2] The same analysis is done on the sample of maternal blood drawn at the same time. This gives a comparison between maternal and fetal

acid base balance. This is necessary because either can effect the other since the placenta equilibrates the two.

Summary.

This paper has presented a description of a relatively new technique which is beginning to be used when the diagnosis of fetal distress is made or when there is a greater than normal danger of fetal anoxia during labor. A new technique was needed because of the inaccuracy of the conventional methods of diagnosing fetal distress. A format for sampling the fetus was given and the indications for the procedure were listed. Also a micro method of blood analysis was described. Without this micro technique the whole procedure is impossible.

A large number of fetal samples have been done with mean values determined for pH at every stage of labor (see table 1)[21] and it has been observed that a pH of 7.25 constitutes a highly suspicious sample and should be repeated. A pH of 7.20 is indication for termination of labor by a Ceasarian section. Using these criteria Saling has reduced significantly his prenatal mortality rate.[20] The technique sampling gives the obstetrician another tool to decide whether or not to interupt a labor and this method has proven to be much more accurate than the clinical signs he had to

rely on before.

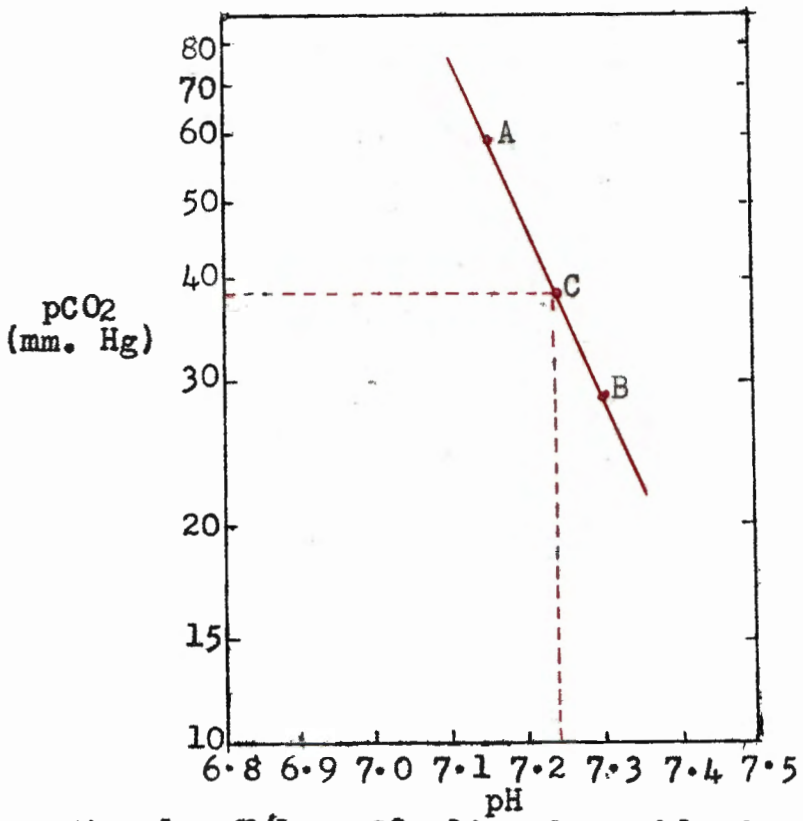

Fig. 1--pH/log pCO_2 line for a blood sample.

Point A indicates the measured pH value 7·12 after equilibration at pCO_2=60mm. Hg. Similarly point B indicates pH 7·30 at pCO_2=30 mm. Hg. If, for instance, the actual pH of the anaerobically drawn blood had been measured to 7·24, the actual pCO_2 would be read as 38 mm. Hg. (point C).[2]

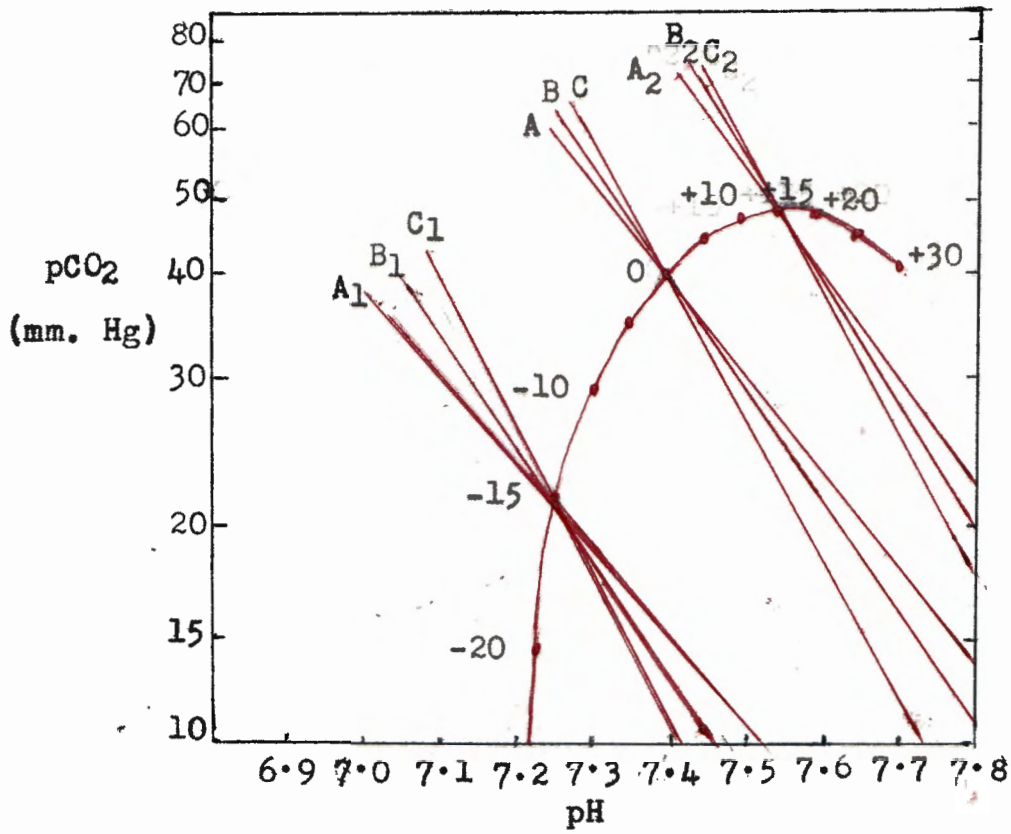

Fig. 2--pH/log pCO_2 lines for blood samples with different hemoglobin concentration and different concentration and different content of base.

A, B, and C represent samples of normal blood with a haemoglobin concentration of 0, 10, and 20 g. per 100 ml. respectively. A_1, B_1, and C_1 show the displacement after addition of fixed acid (15 mEq. acetic acid per litre blood); and A_2, B_2, and C_2 after addition of base (15 mEq. sodium carbonate per litre blood). The points of intersection of these lines form a curve (the base-excess curve) which indicates the amount of base excess (positive values) and base deficit (negative values) in any blood sample.[2]

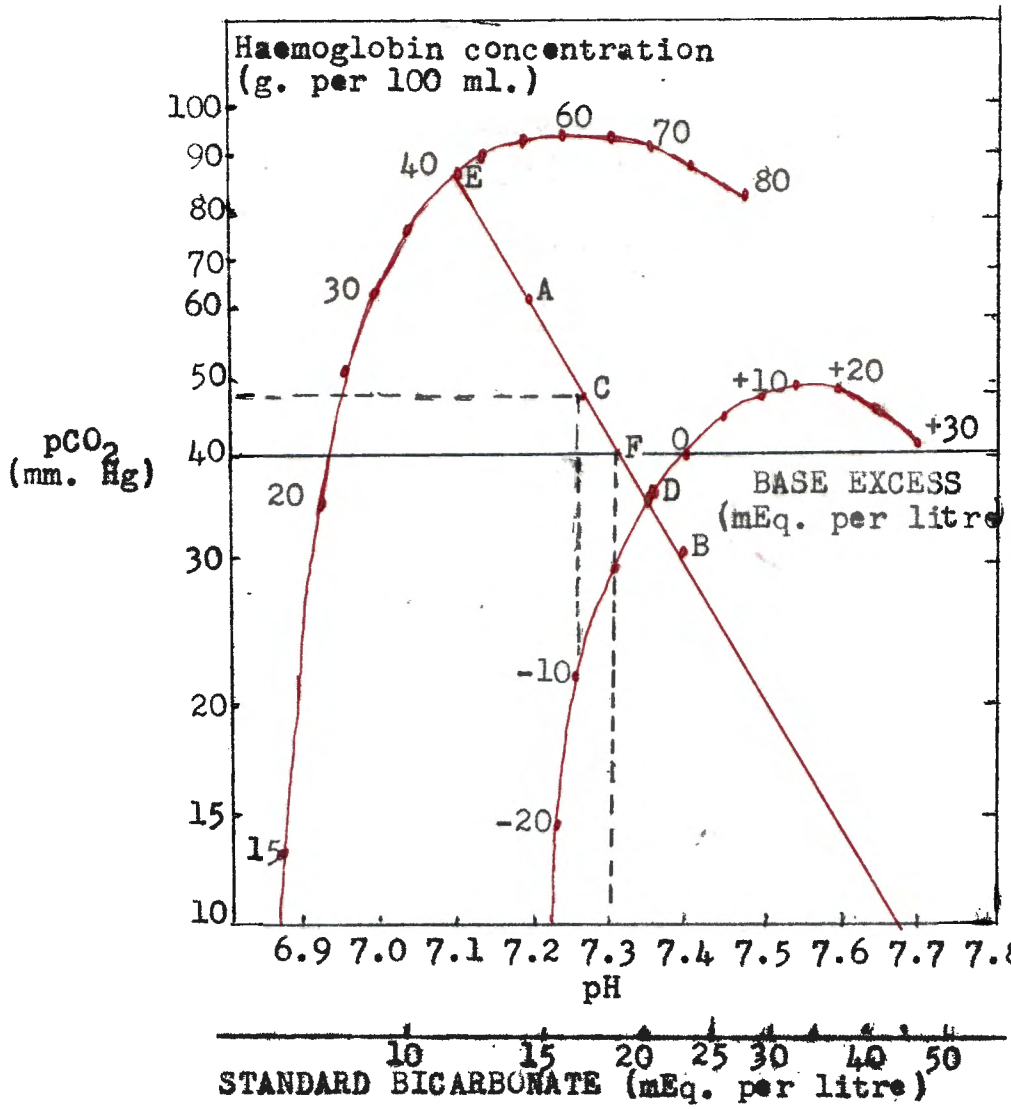

Fig. 3--pH/log pCO_2 line for a blood sample, determined as decribed in fig. 1.

The point of intersection (D) with the base-excess curve indicates the amount of base excess to be -6.0 mEq. per litre blood, while point E indicates the buffer base (=40 mEq. per litre). The standard bicarbonate (18.6 mEq. per litre) can be derived from the pH value corresponding to pCO_2=40 mm. Hg (F). The abscissa shows pH values and standard bicarbonate. The total CO_2 of the plasma from the anaerobically drawn blood and the CO_2-combining power can be found from the figure. (For this calculation see Seggaard Andersen and Engel 1960.)[2]

Stage of Labor	PH Values
Before labor No contractions	7.305 ± .124
First stage in cervical dilation	
1-2 cm.	7.328 ± .122
3-4 cm.	7.333 ± .110
5-8 cm.	7.348 ± .124
9-10 cm.	7.331 ± .126
Second stage Early	7.337 ± .110
Late	7.295 ± .096
After labor Umbilical artery	7.270 ± .146
Umbilical vein	7.331 ± .134

TABLE I

The mean pH values plus and minus one standard deviation at different stages of labor.[21]

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