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Non-invasive continuous fetal transcutaneous pO₂ and pCO₂ monitoring during labor

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1 Introduction

The fetal heart rate (FHR) pattern has been clinically used as a significant clue to evaluate fetal well-being in labor, especially to diagnose fetal distress. However, fetal heart rate monitoring is an indirect method for this purpose, and is affected by many other factors, for example fetal arrhythmia, or infection of fetus or mother. Until recently, the method used routinely for monitoring of the fetus has been limited to fetal heart rate evaluation.

On the other hand, fetal blood sampling and determination of the pH value of the blood during labor was introduced by SALING et al (1961) [15, 17], to obtain direct information about fetal distress. Later, microelectrodes for fetal blood gas monitoring were developed by STAMM (1974) [21] for pH, HUCH (1969) [3], and KANEOKA (1968) [7] for pO₂, and SEVERINGHAUS (1978) [20] for pCO₂, and since then continuous measurements of fetal tissue pH (t-pH) (STURBOIS et al, 1977) [22], transcutaneous pO₂ (tcpO₂) (HUCH et al, 1973) [3], and transcutaneous pCO₂ (tcpCO₂) (HANSEN & THOMSEN, 1984 and LÖFGREN, 1981) [6, 11] have been performed.

Continuous pH measurements directly indicate fetal acidosis caused by fetal distress, but up to now the disadvantages of tissue pH measurement have been due to the invasiveness of the sensor to the fetal vertex [18, 23]. Single measurements of pO₂ or pCO₂ are more sensitive and less invasive than that of pH, but fetal brain damage depends upon not only fetal hypoxia but also fetal acidosis [12]; thus combined measurement

Curriculum vitae

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of these two parameters, pH and tcpCO₂ (C. NICKELSEN et al, 1985) [13], and pH and tcpO₂ (C. ANTOINE et al, 1984) [1] have been performed.

In this study, a tcpO₂ electrode would be more informative for measuring tcpO₂ for two fetuses who had fetal arrhythmia (fetal bradycardia). A newly developed tcpO₂/CO₂ electrode [28] was applied to continuous measurements during labor, and its clinical efficacy is discussed.

2 Materials and methods

After receiving the informed consent of the patient, tcpO₂ and tcpCO₂ of the fetuses were monitored during labor for 49 patients who went into spontaneous labor. The electrode was attached to the fetal scalp when the cervical os was dilated more than 4 cm and the membranes were ruptured (figure 1).

Equipment : transcutaneous pO₂/pCO₂ monitor
Micro Gas 7640 (KONTRON, Switzerland)

Method : sensor fixed to fetal head with suction ring

Figure 1. Practice of tcpO₂/pCO₂ monitoring.

Equipment: transcutaneous pO₂/pCO₂ monitor, Micro Gas 7640 (KONTRON, Switzerland).

Method: sensor fixed to fetal head with suction ring.

Figure 2. Transcutaneous pO₂/pCO₂ sensor (above) and suction ring (below).

The equipment used was transcutaneous pO₂/pCO₂ monitor Micro Gas 7640 (KONTRON, Switzerland). After calibration at 5 and 10% CO₂ gas mixture, the electrode was disinfected in chlorhexide for at least five minutes. The tcpO₂/pCO₂ electrode was inserted through the vagina and was attached to the fetal scalp with a specially designed suction ring (figure 2). Before application, the temperature of the electrode was in all cases calibrated to be maintained at 44 °C. The suction ring was fixed by 200–300 mmHg negative pressure. Fetal heads were unshaven.

As usual tcpO₂/pCO₂ monitoring was carried out at the end stage of delivery. Immediately after birth and before the first gasp of the neonate, the umbilical cord was double clamped, and blood specimens were anaerobically collected into preheparinized syringes from the umbilical artery and vein respectively. These specimens were analyzed using an ABL-3 Acid Base laboratory apparatus (Radiometer, Denmark).

It was considered that the electrode was correctly applied if the recordings were stable or if temporary changes occurred only in connection with vaginal examination. The minimum value of the last 30 minutes of measurements was taken for the tcpO₂ value, the maximum value of the last 30 minutes of measurements for the tcpCO₂ value (figure 3).

Figure 3. Definition of tcpO₂ and tcpCO₂ in the study.

In this study diagnosis of fetal distress was made based on CTG, not on pO₂/pCO₂ monitoring during labor, except in two cases of fetal bradycardia. Thus, we measured tcpO₂ and tcpCO₂ levels during delivery, and analyzed these results from three points of view:

1. The values of tcpO₂ and tcpCO₂ at the end of the recording were compared with the pO₂ and pCO₂ values of the umbilical artery respectively.
2. TcpO₂ monitoring was done to two fetuses which were affected with fetal arrhythmia but not with heart failure. Their heart rates were 70–80 bpm continuously, but we could not regard the FHR pattern as a sign of fetal distress.
3. CTGs were compared with the records of tcpO₂/pCO₂ monitoring, and abnormal patterns of CTG were discussed from the view of the results of blood gas analyses.

3 Results

With our suction cup method, transcutaneous recordings were successfully performed in 39 cases of the total 49 cases, as good a result as for Weber's suction method (table I).

Table I. Quality of recordings according to method

Method	good fixation (%)	unsuccessful (%)
Suction (n = 49) (this report)	39 (79)	10 (21)
Suction (n = 19) (*T. WEBER)	15 (79)	4 (21)
Glue (n = 21) (*T. WEBER)	14 (67)	7 (33)

(*T. WEBER et al 1979)

Examples of actual measurements of tcpO₂ (figure 4), tcpCO₂ (figure 5), or both tcpO₂ and tcpCO₂ (figure 6) are shown with the cardiogram in normal cases. In figure 4 the levels of tcpO₂ were 16–25 mmHg; in this case the level at the end of monitoring was 20 mmHg. In contrast to the transcutaneous measurements,

oxygen tension in the umbilical artery was 16 mmHg and that in the umbilical vein was 25 mmHg.

It the same way, tcpCO₂ was 40–56 mmHg (figure 5). In another case (figure 6), according to simultaneous tcpO₂ and tcpCO₂ was 22–28 mmHg and tcpCO₂ mas was 55–60 mmHg.

Comparison of the pO₂ value measured transcutaneously (tcpO₂) with the pO₂ value of the umbilical artery (uapO₂) showed a significant positive correlation with a correlation coefficient of 0.78 (p < 0.01, n = 24) (figure 7). The correlation coefficient between tcpO₂ and pO₂ of the umbilical vein (uvpO₂) was 0.74 (p < 0.01, n = 16) (figure 8). Transcutaneous pCO₂ values (tcpCO₂) were closely correlated with pCO₂ values of the umbilical artery (uapCO₂): the correlation coefficient between them was 0.79 (p < 0.01, n = 21) (figure 9).

These results confirmed the reliability of our methods for the measurements of tcpO₂ and pCO₂.

Fetal scalp tcpO₂ monitoring during labor can be useful for the diagnosis of fetal distress; therefore it was applied to the management of the delivery of infants with arrhythmia, for example

Figure 4. Cardiogram and tcpO₂ level during normal labor.

Figure 5. Cardiotocogram and tcpCO₂ level during normal labor.

Figure 6. Cardiotocogram and tcpO₂/pCO₂ monitoring during normal labor.

Figure 7. Correlation between tcpO₂ and puaO₂
tcpO₂: Transcutaneous oxygen tension
puaO₂: Oxygen tension in the umbilical artery.

Figure 9. Correlation between tcpCO₂ and puaCO₂
tcpCO₂: Transcutaneous carbon dioxide tension
puaCO₂: Carbon dioxide tension in the umbilical artery.

Figure 8. Correlation between tcpO₂ and puvO₂
tcpO₂: Transcutaneous oxygen tension
puvO₂: Oxygen tension in the umbilical vein.

AV-block. Because they usually show bradycardia, it is difficult to diagnose fetal distress of the fetus only from the fetal heart rate pattern.

Figure 10 shows a transabdominal fetal electrocardiogram for an infant in the 30th week of gestation. Since the P wave and QRS wave of the fetal ECG are not correlated with each other, the tentative diagnosis was AV-block of the fetus. The records of tcpO₂ and CTG at delivery in the 39 weeks of pregnancy in the same case are also

shown in figure 11. The FHR remained continuously around 80 bpm; the tcpO₂ value was between 30 and 40 mmHg. The fetus was delivered soon after the measurements, with a birth weight of 2919 g, and an Apgar score of 9-9. He was uncompromised and was discharged six days later.

Figure 11 shows a transabdominal fetal electrocardiogram for an infant in the 19th week of pregnancy. The P wave and QRS wave are correlated with each other, and the P waves occur randomly; hence, supraventricular arrhythmia was suspected. TcpO₂ and CTG at the delivery in the 41st week of pregnancy in the same case are also shown (figure 11, below). The FHR was about 70 bpm throughout the measurements; the tcpO₂ value was above 20 mmHg. When the fetal vertex descended to the outlet, tcpO₂ decreased to 9 mmHg, then oxygen in high concentration was administered maternally to the fetus and a vacuum extraction was performed. The infant's weight was 3255 g, his Apgar score was 8-9, but he was complicated with severe heart anomaly (VSD, PS and tricuspid valve atresia) and died five days after birth. TcpO₂ monitoring reflected fetal well-being more closely than FHR monitoring in both cases.

Whenever CTG indicated early deceleration (for example in figure 12) transcutaneous oxygen tension did not change and carbon dioxide tension was stable or increased a little during and after

Figure 10. Transabdominal EKG (30 W) above, and cardiotocogram and tcpO₂ monitoring during labor (39 W) (below).

Figure 11. Transabdominal EKG (19 W) (above), and cardiotocogram and tcpO₂ monitoring during labor (41 W) (below).

Figure 12. Cardiotocogram and tcpO₂/pCO₂) monitoring during labor. There were early decelerations. TcpO₂ level varied from 24 mmHg to 36 mmHg. TcpCO₂ level was stable.

Figure 13. Cardiotocogram and tcpO₂/pCO₂ monitoring during labor. There were variable decelerations, where after the tcpO₂ decreased from 40 to 20 mmHg and the tcpCO₂ increased from 48 to 78 mmHg.

deceleration. In contrast, in cases of variable deceleration, the fetal pO₂ value decreased from 40 mmHg to 20 mmHg and the pCO₂ value rose from 48 mmHg to 78 mmHg; as soon as the fetal heart rate decreased from 140 bpm to 80 bpm, then vacuum extraction was performed (figure 13).

In table II, the tcpO₂ value and tcpCO₂ value are compared with fetal heart rate patterns on the CTG (early decelerations and variable decelerations and sinusoidal pattern). We could

observe no rule between early deceleration and variable deceleration from the point of view of the absolute value of pO₂ and pCO₂.

However, in the early deceleration group, tcpO₂ levels were stable, and tcpCO₂ was also stable or rose a little with progress of labor (open circle in figure 14). There were no situations in which tcpO₂ levels increased and tcpCO₂ decreased simultaneously. By contrast, tcpO₂ decreased and tcpCO₂ increased in the variable deceleration group (closed circle in figure 14).

Table II. FHR patterns and tcpO₂/pCO₂

Early deceleration					
Case	pO ₂ (mmHg)		pCO ₂ (mmHg)		uapH
1	34–42	—	52–54	—	7.28
2	15–29	—	32–36	—	7.28
3	35–42	—	48–61	△	7.34
4	17–21	—	28–38	△	7.29
5	17–21	—	40–48	—	7.30
6	8–20	—	72–84	△	7.26
7	25–30	—		—	7.30
8*	12–16	—		—	7.18
9	8–22	—		—	7.34
10	8–16	—		—	7.27
11*	28–30	—		—	7.18
12	22–30	—		—	7.25
13*	8–20	—		—	7.21
14	18–30	—		—	7.35
15		—	52–64	△	7.26

Variable deceleration					
case	pO ₂ (mmHg)		pCO ₂ (mmHg)		uapH
1	13–18	▽	47–49	△	7.20
2	20–40	▽	48–78	△	7.24

△ Increase associated with progress
▽ Decrease associated with progress
— Fluctuations

Figure 14. FHR patterns and tcpO₂/pCO₂ monitorings.

4 Discussion

We found a positive correlation between tcpO₂ during the last minutes before delivery and the oxygen content of the umbilical artery (figure 7) and vein (figure 8), and between the tcpCO₂ during the same period and carbon dioxide tension of the umbilical artery (figure 9). Therefore, fetal scalp tcpO₂ and tcpCO₂ reflect the oxygen tension and the carbon dioxide tension in the fetal central vessels. In the present series, transcutaneous blood gas levels were not studied in association with blood gas from the fetal cord blood sample; however, the mean transcutaneous blood gas value was similar to the mean fetal blood gas value published in other literature [4, 25, 26].

According to LÖFGREN [10], there are many factors which may influence the recording of tcpO₂ levels. If the electrode on the fetal scalp is pressed by the bony pelvis or the soft part of the birth canal, the fetal scalp capillaries are also compressed, resulting in a decrease in the tcpO₂ level. O'CONNER et al [14] have named this phenomenon the "tonsure effect". Moreover, with development of a caput succedaneum, correlation coefficients between the transcutaneous blood were lowered for tcpO₂ (LÖFGREN, 1977) [9] and tcpCO₂ (SCHMIDT and SALING, 1985) [19], and as a result unreliable recordings were given. Our technique of applying the electrode with a vacuum gave 76% successful recordings, as good a result as in WEBER's reports [26]. Whether suction or glue is used makes no difference to tcpO₂ levels in newborn infants (LÖFGREN, 1981) [10].

In spite of the limitations of fetal transcutaneous blood gas monitoring, we can see a possibility of better management of high-risk pregnancies in the method of transcutaneous blood gas monitoring. An infant with fetal bradycardia was delivered by Cesarean section. But not all fetuses with fetal arrhythmia need to be sectioned, because some of them are infants with transient AV-block only, and are not complicated with congestive heart failure. As shown in figure 10 and 11, transcutaneous blood gas monitoring can reduce unnecessary Cesarean section for such fetuses with fetal arrhythmia.

Secondly, we investigated fetal transcutaneous blood gas monitoring, focusing on its potential bearing on fetal heart rate patterns. In a cardiotocogram (figure 4) showing a normal FHR pattern, we can see fetal oxygen tension rising

with intrauterine pressure and falling with reduced pressure, the same as for tcpCO_2 (figure 5) [8]. In another case (figure 13), we can see early deceleration, after which the fetal oxygen tension rises a little, as mentioned above, with labor contractions, and transcutaneous carbon dioxide tension is stable during recording. Other decelerations demonstrated in figure 12 are accompanied by a decrease of fetal pO_2 and a increase of pCO_2 . In another there is no deceleration, oxygen tension decreases, and later we can see a case of increase in pCO_2 and decrease in pO_2 with variable deceleration [8].

These two results imply that early decelerations result from an increase of intracranial pressure with vagotonic reaction and are innocuous, while variable deceleration is demonstrated in a case with cord compression, which indicates a more serious condition than early deceleration does. In addition, as shown in figure 12, it is demonstrated that in some situations fetal heart rate monitoring alone is inadequate to evaluate the fetal condition.

As E. SALING [16] pointed out, continuous CO_2 measurements can be misleading, in cases where in spite of steadily increasing metabolic acidity (lactate increase), the elimination of well diffusing CO_2 may be faster than its increase in the blood, what is called an O_2 conserving adaptation of fetal circulation. The pH values would fall, because the total acidity keeps on increasing, but the pCO_2 would not increase adequately. Up to now, like SALING, we have not yet observed such cases. As shown in figure 14 and table II,

tcpO_2 is normal, and hypercapnea in the fetus was observed in the early deceleration group. According to THOMSEN [25], the decrease of pH often seen during the second stage of labor is partially explained by maternal CO_2 accumulation induced by the maternal bearing down effort. By contrast, at the beginning of the second stage of labor, a fetomaternal pCO_2 gradient was observed. Thus, fetal hypercapnea in our case is, at least to some extent, associated with the bearing down effort.

As mentioned above, there are many problems associated with fetal scalp transcutaneous blood gas monitoring during labor. But this report has demonstrated the advantages of clinical use of the method for scalp transcutaneous blood gas monitoring in the fetus.

5 Conclusions

1. In management of delivery of a fetus with bradycardia, tcpO_2 monitoring is more useful than CTG.
2. Transcutaneous monitoring during labor aids in interpreting questionable CTG.
3. $\text{TcpO}_2/\text{pCO}_2$ simultaneous monitoring did not directly demonstrate acidosis, but could provide evidence that both decrease of oxygen and increase of carbon dioxide indicate fetal distress, though hypoxia is not necessarily equal to acidosis and hypercapnea is not always due to hypoxia.

Abstract

Continuous measurements of fetal scalp transcutaneous pO_2 (tcpO_2) and pCO_2 (tcpCO_2) monitoring were performed for 49 patients for the purpose of the evaluation of the fetal well-being. The equipment used was transcutaneous pO_2/pCO_2 monitor Micro Gas 7640 (KONTRON, Switzerland), which was inserted through the vagina and attached to the fetal head with a suction ring. Blood was taken from the umbilical vessels and pO_2 and pCO_2 values were analyzed. The correlation coefficient between pO_2 in the umbilical artery and tcpO_2 was 0.78 ($p < 0.01$), and that between pCO_2 in the umbilical artery and tcpCO_2 was 0.79 ($p < 0.01$).

Relationships between the transcutaneous blood gas analysis and FHR patterns were discussed. Increase of pCO_2 and decrease of tcpO_2 was observed in the cases of variable deceleration, not observed in the case of early deceleration.

FHR patterns don't always indicate fetal condition, for example in the case of fetal arrhythmia, especially fetal bradycardia. But tcpO_2 monitoring of the fetus affected fetal arrhythmia during labor aids diagnosis of fetal distress by FHR patterns, especially in the case of fetuses affected by fetal bradycardia.

Keywords: Fetal arrhythmia, fetal distress, fetus, transcutaneous carbon dioxide, transcutaneous oxygen.

Zusammenfassung

Nichtinvasive kontinuierliche, transcutane pO₂- und pCO₂-Messung beim Feten unter der Geburt

Die routinemäßig eingesetzte Methode zum fetalen Monitoring ist bislang auf die Analyse der Herzfrequenzkurve beschränkt. In der vorliegenden Studie wurde eine neu entwickelte tcpO₂/CO₂-Elektrode (28) zur kontinuierlichen Messung unter der Geburt eingesetzt und ihre klinische Brauchbarkeit diskutiert. Bei 49 Feten wurde mit Beginn der Spontangeburt der tcpO₂ und tcpCO₂ gemessen und aufgezeichnet. Die Elektrode wurde via Vagina am fetalen Scalp mit einem Saugring (Abb. 2) befestigt. Auch aus der Umbilikalarterie wurden Blutproben entnommen und der Säure-Basen-Status analysiert.

Der Vergleich der transcutan gemessenen pO₂-Werte (tcpO₂) mit den pO₂-Werten aus der Umbilikalarterie (uapO₂) zeigte eine signifikante positive Korrelation mit einem Koeffizienten von 0,78 ($p < 0,01$, $n = 24$; Abb. 7).

Auch die transcutan gemessenen pCO₂-Werte (tcpCO₂) waren eng mit den pCO₂-Werten in der Umbilikalarterie (uapCO₂) korreliert: der Koeffizient betrug 0,79 ($p < 0,01$, $n = 21$; Abb. 9).

Das tcpO₂-Monitoring aus dem fetalen Scalp unter der Geburt kann bei der Diagnose eines fetalen Distress nützlich sein. Es wurde daher bei Feten mit Arrhythmien, z. B. auf Grund eines AV-Blockes eingesetzt. Abb. 10 zeigt ein transabdominal abgeleitetes fetales EKG eines Kindes mit AV-Block. Der tcpO₂-Wert lag bei der Geburt zwischen 30 und 40 mmHg und der Apgar-Score betrug 9–9. Abb. 11 zeigt ein transabdominal abgeleitetes EKG von einem Kind mit supra-ventrikulärer Arrhythmie. Mit Tieferwerden des Kopfes fiel der tcpO₂ auf 9 mmHg und es wurde eine Vakuum-

extraktion durchgeführt. Die Apgar-Werte lagen bei 8 und 9. Das Kind hatte jedoch eine schwere Herzmißbildung und starb 5 Tage post partum. In beiden Fällen wurde der fetale Zustand durch die tcpO₂-Messung besser wiedergegeben als durch das FHR-Monitoring. Tab. 3 vergleicht die tcpO₂- und tcpCO₂-Werte mit dem fetalen Herzfrequenzmuster im CTG. Bei Frühdezele-rationen waren die tcpO₂-Spiegel stabil. Auch der tcpCO₂-Spiegel war unverändert oder stieg nur geringfügig mit Voranschreiten der Geburt (offener Kreis in Abb. 14). Eine Erhöhung der tcpO₂-Spiegel mit simultanem Abfall der tcpO₂-Werte wurde nicht beobachtet. Im Gegensatz dazu waren bei den variablen Dezele-rationen fallende tcpO₂- und ansteigende tcpCO₂-Werte zu verzeichnen (geschlossener Kreis in Abb. 14). Diese Ergebnisse zeigen auch, daß Frühdezele-rationen harmlos sind, während variable Dezele-rationen auf einen ernstzunehmenden Zustand hinweisen.

In der vorliegenden Arbeit werden die Vorteile des transcutanen Blutgas-Monitoring aus dem fetalen Scalp dargelegt.

Schlußfolgerungen:

1. Bei der Geburtsleitung eines Feten mit Bradykardie ist das tcpO₂-Monitoring hilfreicher als das CTG.
2. Das transcutane Monitoring unter der Geburt erleichtert die Interpretation zweifelhafter CTG's.
3. Das simultane tcpO₂/pCO₂-Monitoring zeigt zwar direkt keine Azidose an, jedoch liefert der O₂-Abfall und der CO₂-Anstieg den Hinweis auf ein echtes fetales Distress. Darüberhinaus ist eine Hypoxie nicht notwendigerweise mit einer Azidose assoziiert und eine Hyperkapnie geht nicht immer auf eine Hypoxie zurück.

Schlüsselwörter: Fet, fetale Arrhythmie, fetales Distress, transcutanes CO₂, transcutanes O₂.

Résumé

Surveillance au cours du travail de la pO₂ et de la pCO₂ transcutanées fœtales en continue de façon non invasive
Jusque récemment, la méthode utilisée en routine pour surveiller le fœtus s'est limitée à l'évaluation du rythme cardiaque fœtal. Dans cette étude, une électrode nouvellement réalisée à tcpO₂/CO₂ (28) a été mise en place pour enregistrer en continue pendant la travail et son efficacité clinique est discutée ici.

On a surveillé la tcpO₂ des fœtus en cours de travail chez 49 patientes spontanément en travail. L'équipement utilisé est un moniteur à pO₂/pCO₂ transcutanées. L'électrode pO₂/pCO₂ est mise en place par voie vaginale et attachée au scalp fœtal par un anneau ventouse (fig. 2). Les prélèvements sanguins respectifs sont prélevés dans l'artère utérine. Ces échantillons sont analysés à l'aide d'un appareil de laboratoire Acide-Base ABL – 3 –.

La comparaison des valeurs de la pO₂ mesurée par voie transcutanée (tcpO₂) avec les valeurs de la pO₂

dans l'artère ombilicale (vapO₂) montre une corrélation positive significative avec un coefficient de corrélation de 0,78 ($p < 0,01$, $n = 24$) (fig. 7).

Les valeurs de la pCO₂ transcutanée (tcpCO₂) sont étroitement corrélées aux valeurs de la pCO₂ de l'artère utérine (vapCO₂) = le coefficient de corrélation entre elles est de 0,79 ($p < 0,01$, $n = 21$) (fig. 9).

La surveillance de la tcpO₂ au scalp fœtal en cours de travail peut être utile pour le diagnostic de souffrance fœtal. C'est ainsi qu'on l'a mise en œuvre pour la prise en charge de la naissance d'enfants présentant une arythmie, par exemple un bloc AV. La fig. 10 montre un électrocardiogramme fœtal direct transabdominal provenant d'un enfant chez lequel le diagnostic de bloc AV fœtal était posé. Lors de l'accouchement, les valeurs de la tcpO₂ étaient comprises entre 30 et 40 mm Hg. Sur score d'Apgar était de 9–9, et il allait bien. La fig. 11 montre un électrocardiogramme fœtal direct transabdominal en provenance d'un enfant atteint

d'arythmie supra-ventriculaire. Lorsque la tête fœtale était descendue à la partie basse, la tcpO₂ a chuté à 9 mm Hg et une extraction par ventouse a été effectuée. Son score d'Apgar était de 8–9, mais des complications survinrent avec de graves anomalies cardiaques et il est décédé 5 jours après la naissance. La surveillance de la tcpO₂ a reflété le bien être fœtal beaucoup plus étroitement que la surveillance du RCF dans les 2 cas.

Dans le tableau III, les valeurs de la tcpO₂ et de la tcpCO₂ sont comparées avec les enregistrements du RCF sur le CTG. Dans le groupe des décélérations précoces les taux de pCO₂ sont stables, et la tcpCO₂ est stable également ou s'élève légèrement avec l'évolution du travail (cercle ouvert dans la fig. 14). Il n'y a pas eu de situations dans lesquelles les taux de tcpO₂ se sont élevés et les taux de tcpCO₂ se sont abaissés simultanément. En contraste, la tcpO₂ diminue et la tcpCO₂ s'élève dans le groupe des décélérations variables (cercle fermé, fig. 14).

Mots-clés: Arythmie fœtale, dioxyde de carbone transcutané, fœtus, oxygène transcutané, souffrance fœtale.

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