Physiology of isolated long-term variability of the fetal heart rate

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Ten singleton third trimester fetuses exhibiting isolated long-term variability of the fetal heart rate were studied with a single Doppler transducer actocardiograph in conjunction with real-time ultrasonography. Each of these studies revealed repetitive clustered bursts of fetal breathing movements during the acceleratory phases and apneic episodes during the deceleratory phases of this fetal heart rate pattern, respectively, in the absence of other fetal movements. This observation may explain the physiology of isolated long-term variability of the fetal heart rate. (Am J Obstet Gynecol 1993;169:113-5.)

Key words: Long-term variability, fetal breathing movements, ultrasonography

Episodes of isolated long-term variability of the fetal heart rate (FHR) with absent short-term variability and absent FHR accelerations are frequently encountered during nonstress testing and labor. These episodes usually last up to 15 to 20 minutes, do not fulfill the criteria for a reactive nonstress test, and at times are referred to as psuedosinusoidal FHR.[1] These FHR patterns are distinguished from sinusoidal FHR by not fulfilling the six strict criteria of the sinusoidal FHR of Mondanlou and Freeman.[2] Such episodes of isolated long-term variability (or pseudosinusoidal FHR patterns), which may be regarded as a variant of the normal FHR, presented us with the opportunity to investigate the physiology of pure long-term variability of the FHR.

Recently nonstress testing and simultaneous processed Doppler signals objectively recording fetal movements have been used during antepartum testing. With a commercially available actocardiograph and real-time ultrasonography, we evaluated fetal activity in association with isolated long-term variability of the FHR in an attempt to reveal the underlying mechanism of this hitherto unexplained component of the FHR.

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Material and methods

Between March 15, 1992, and June 16, 1992, 10 uncomplicated singleton gestations with isolated long-term variability of fetal heart rate patterns were studied. This was defined as the presence of long-term fluctuations in FHR with cyclicity of 3 to 5 per minute and an amplitude from 5 to 20 beats/min with absent short-term beat-to-beat variability or FHR accelerations. All patients were nonlaboring and were placed in the left lateral supine position. FHR and fetal activity were obtained with the Toitu Fetal Actocardiograph MT-430 (Toitu, Tokyo) with a single Doppler transducer. Real-time ultrasonography was performed to confirm the type of fetal activity registered simultaneously by the actocardiograph. Paper speed of the actocardiograph was 3 cm/min. All observations lasted 20 minutes.

Results

Mean maternal age was 30.4 ± 5.2 years, median gravidity was 3 (range 1 to 9), and median parity was 1 (range 0 to 8). Mean gestational age at the time of antepartum testing was 37 weeks, 5 days ± 1 week, 6 days. Each patient was examined once. Mean gestational age at delivery was 39 weeks, 3 days ± 1 day. Mean birth weight was 3482 ± 760 gm. Apgar scores of all 10 infants at 5 minutes were ≥8. Each of the described examinations, performed during a period in which an FHR pattern with isolated long-term variability was obtained, revealed clustered bursts of fetal activity on the actocardiograph opposite the acceleratory phase of the FHR (Figs. 1 and 2). These were confirmed by real-time ultrasonography as fetal breathing movements in the absence of any other fetal movement (rolling, limb extension or flexion). Intermittent apneic

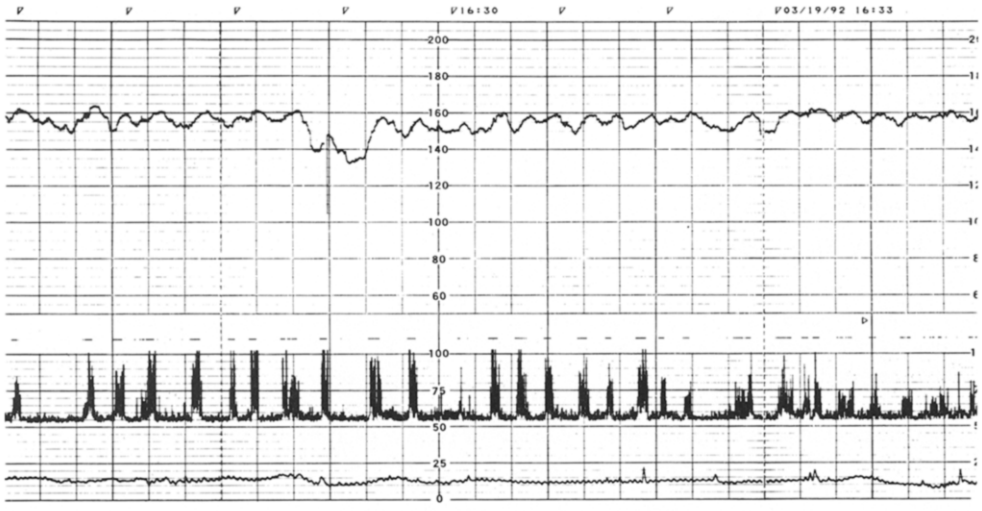

Fig. 1. FHR at 39 weeks, 6 days of gestation. Note isolated long-term variability FHR pattern. Opposite each acceleratory phase of the FHR is cluster of fetal breathing movements confirmed by real-time ultrasonography. Toitu Actocardiograph MT-430 (Toitu, Tokyo). Paper speed 3 cm/min.

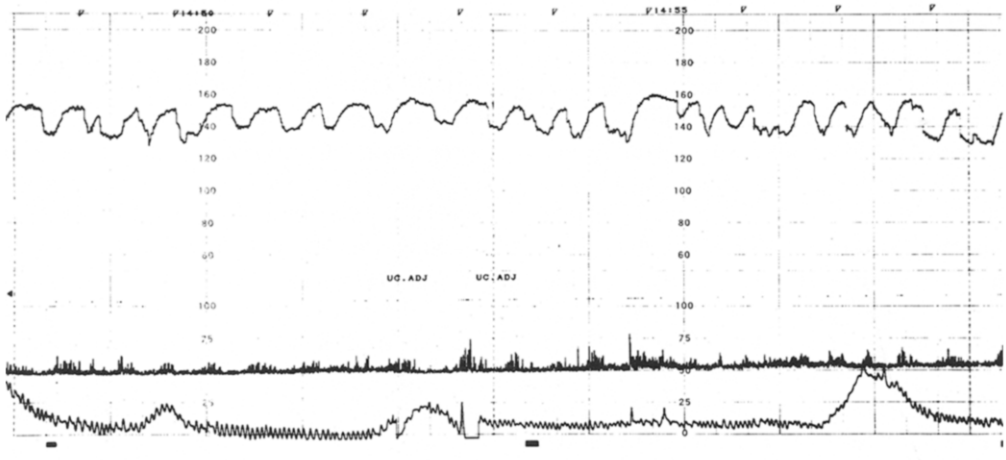

Fig. 2. FHR at 38 weeks' gestation. Isolated long-term variability FHR pattern with greater amplitude than previous figure. Clustered fetal breathing movements are marked opposite acceleratory phases of FHR. Toitu Actocardiograph MT-430 (Toitu, Tokyo). Paper speed 3 cm/min.

periods occurred opposite deceleratory phases of the FHR.

Comment

Vintzileos et al.[1] in 1986 in a study of the relationship of FHR accelerations, fetal movements, and fetal breathing movements established an association between FHR accelerations and fetal breathing movements.[3] These authors noted fetal breathing movements alone in 13.2% (13 of 98) of FHR accelerations. This association concurred with the clinical observation of fetal breathing movements as a sign of fetal well-being. In our cases, similar to previous reports, fetal breathing movements were depicted by the actocardiograph.[4, 5] We confirmed the fetal breathing movements as such in our study by real-time ultrasonography. Furthermore, we observed that the fetal breathing movements consistently occurred opposite the acceleratory phases of isolated long-term variability FHR patterns (Figs. 1 and 2).

We submit that it is repetitive cyclic bursts of fetal breathing movements (in the absence of other fetal movements) and associated intermittent FHR accelerations that give rise to the isolated long-term variability of the FHR. The changing duration of the fetal breathing movements produces the different frequency and

possibly the changing amplitude of the isolated long-term variability FHR patterns. In the presence of fetal body or limb movements, the associated FHR accelerations may mask this component of the FHR. This observation would be similar to sinus-arrhythmia (i.e., tachycardia noted during inspiration, a phenomenon more frequent in young adults and children). This concept was suggested by Berestka et al.[4] describing an FHR pattern that, like ours, did not meet strict criteria for sinusoidal rhythm and was thought to represent respiratory sinus arrhythmia. Similar observations have been reported previously in association with rhythmic fetal sucking and mouthing.[3, 6, 7] It is our opinion that episodes of isolated long-term variability of the FHR are not of pathologic origin and that the term "pseudosinusoidal" should be reconsidered.

It is unclear what precipitates cyclic bursts of fetal breathing movements in the healthy fetus. We have on two separate occasions ultrasonographically documented this pattern of cyclic fetal breathing movements during labor with this FHR pattern after intravenous administration of nalbuphine hydrochloride, a synthetic narcotic analgesic (with central nervous system mediated actions), yet most of these episodes occur spontaneously.

It is suggestive that the compromised anemic fetus exhibiting a pure sinusoidal FHR may demonstrate continued automative periodic and precisely timed cycles of fetal breathing movements caused by tissue hypoxia of the medullary cardiac and breathing centers in the absence of other fetal movements. This occurrence, if substantiated, would be similar to the periodic breathing pattern known as Biot's breathing. This type of breathing involves a fixed tidal volume, as opposed to Cheyne-Stokes, in which tidal volume waxes and wanes and is associated in the adult with congestive heart failure. We are currently further studying the interrelationships between rhythmic fetal breathing movements and rhythmic FHR patterns.

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