یکی از مهم‌ترین سلاح‌های بیماری‌های قلبی، استفاده از مگنتوکاردیوگرافی (MKG) است. در این مقاله، درک عمیق‌تری از مکانیزم‌های مغناطیسی (Dipole) شکم مادرباند ثابت می‌شود. شبکه‌های قلبی به عنوان تاثیرگذاری از این روش، می‌تواند بهبود بیماری‌ها را بهبود بخشند. دسترسی به QRS نشان می‌دهد که QRS مادرباند به‌طور خودکار و به‌طور آنلاین تشخیص بودن قلبی را می‌تواند افزایش نماید. این درباره ارتفاع‌های و تغییراتی در بخش کلیدوارنده ۱- مگنتوکاردیوگرافی

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چکیده:

علت بیماری‌ای از مارک و میروها در جنین در زمان قبل از تولد ناشناخته مانده است. از این رو ضرورت معرفی روش مؤثری بینظیر بررسی سلامت جنین مشخصاً در سه ماهه سوم بارداری احساس می‌شود. روشهای بررسی قلب کودکان و بزرگسالان، از جمله اکوکاردیوگرافی، در زمان بارداری نیز بکار گرفته می‌شود. الکتروکاردیوگرافی یکی دیگر از روشهای تشخیصی است که بکار گرفته می‌شود ولی از این جا که تیپ موج P تقریباً غیرممکن می‌نماید لذا عملکرد تشخیص بیماری‌هایی که امکان درمان مؤثر آنها وجود دارد (مانند آرتیمی) کارایی جنین ندارد. متاسفانه یکی از دلیل‌های افرادی که این روش اخیر مورد استفاده قرار می‌گیرد ظاهر شدن لایه عایق کندک‌های (Vernix Caerosa) جنین است که در هفته‌های بیست و هفتم ظاهر و در اواخر هفته سی و دوم کم از بین می‌رود. مگنتوکاردیوگرافی یکی از روش‌های جدید است که با استفاده از مگنتومتر، میدان‌های مغناطیسی (MKG) شکم مادرباند ثابت می‌شود. در یک مطالعه پیش‌بینی با استفاده از این روش، ما از مادرانی که در هفته ۳۰-۴۰ بارداری بودند ثبت عمل آوردهای کمکسکس QRS نسبت به قلب جنین، مادری برایی از MKG مادر را با QRS ارتباط با استفاده از آنالیز QRS و T و P موج در ۴ مادرباند مطالعه قرار گرفتند. استحراح شد. اگر نشان دهنده ارتفاع‌های ۰ و QRS می‌تواند هیپوکسمیک بودن جنین را نشان دهد. این تکنیک می‌تواند نقطه عطفی در بررسی سلامت قلب جنین باشد.
FETAL HEART ASSESSMENT BY MAGNETOCARDIOGRAPHY:
A PILOT STUDY

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ABSTRACT
Fetal magnetocardiograph (fMCG) provides a new non-invasive technique for monitoring fetal cardiac wellbeing during the last 10 weeks of pregnancy. Using a single channel second order SQUID gradiometer located over the maternal abdomen we have successfully recorded QRS complexes in 9 of 11 subjects from 30-40 weeks gestation and full PQRST complexes in all 4 subjects in whom off-line averaging techniques were applied.

Key Words: 1) Magnetocardiography 2) Fetal Heart 3) Non-invasive techniques 4) Pregnancy

INTRODUCTION
There is an urgent need to reduce the unexplained antepartum stillbirth rate which now accounts for the majority of all stillbirths in different countries. Many tests have been proposed to aid detection of the loss of critical fetal reserves, but the "ideal" test which would have to be simple, non invasive, reliable and predictive has not yet been discovered. Current methods of fetal monitoring during the last trimester of pregnancy have limitations in the prediction of outcome. At present the most commonly used biophysical examining of fetal wellbeing is cardiotocography (CTG). A Reactive CTG tracing has been claimed to be a reliable indicator of satisfactory fetal condition, whilst decreased heart rate variability is associated with fetal acidemia and perinatal loss (5). Biophysical profile scoring (a combination of CTG with ultrasonic assessment of liquor volume, fetal breathing movements and tone has been shown in several studies to have a close relationship with perinatal outcome and this method of assessment is now extensively

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used. Its major disadvantages are that it does not measure fetal/placental reserve and that it is a technique wholly dependent on the skill and experience of the ultrasonographer. Serial growth measurements by ultrasound scanning has the disadvantage that weeks have to pass before the static trend is clear, often too late for optimal management.

Analysis of the fetal Electrocardiography (fEKG) waveform during labour has been suggested for fetal surveillance as animal studies have demonstrated ST segment elevation and peaked T waves with resultant increase in the T/QRS ratio (8) associated with hypoxia, although visualisation of the T wave may be difficult. Preliminary clinical reports have been disappointing, in that statistically significant relation was found between T/QRS ratios in labour and fetal hear rate abnormalities on the CTG (5,6).

Antenatal fetal Electrocardiography (fEKG) has been recorded using rectal, vaginal, cervical and abdominal electrodes, but only the QRS complex has reliably detected and therfore analysis has concentrated on R-R intervals and variance. In addition the amplitude of the fetal complexes diminishes from 27-32 weeks gestation, probably because of the insulating properties of the vernix caseosa on the fetal skin (7). In all reported fEKG there is a large inter and intra-individual variability related to the variability of fetal presentation and the heterogeneity of the volume conducting pathways.

An alternative to antenatal fEKG is fMCG, where the magnetic field set up by the current density of the intracellular electrical activity of the heart is detectable noninvasively over the maternal abdomen. This is unaffected by the insulating properties of the vernix and the tissue conductivity heterogeneity. The first adult magnetocardiogram (MCG) recording was reported by Baule and McFee (2), Kariniemi et al (4) recorded the first fMCG which is an order of magnitude smaller in amplitude than the adult MCG. For that reason studies have concentrated on the QRS complex and heart rate variability as a method of fetal surveillance rather than the full MCG complex. They did not report the detection of the P and the T wave. Dunajski and colleagues (3) has reported a single averaged fMCG with a full PQRST complex.

We report the results of fMCG recordings in 11 normal pregnancies from 30-40 weeks gestation. Subjects were recruited with informed consent and local ethical committee permission.

METHODS

Since the discovery of superconductivity by Kamerlingh Onnes in 1911, this phenomenon has found several important
application. The application described here is the use of superconductive magnetometers for measuring weak biomagnetic fields. Superconductive devices work only at low temperature; such a temperature is usually maintained with the aid of liquid helium. Storage and use of liquid helium requires special thermally isolated dewars. The name “superconductivity” refers to a specific physical property that the electrical resistance of a material is identically zero below the critical temperature. Superconducting Quantum Interference Device (SQUID) magnetometers have been used for biomagnetic studies since 1970.

Subjects were placed semi-reclining on an adjustable bed in our 4×4×3.5 m eddy current shielded room (1). The presentation of the baby and the approximate location of fetal heart was determined by auscultation. The top of a single channel neuromagnetometer (BTI Model 60, San Diego, California) was placed in a position of maximum QRS signal over the maternal abdomen. The neuromagnetometer output was amplified further and analogue bandpass filtered (0.03-100Hz), single pole high and low pass) using a PAR Model 113 preamplifier. Recordings were made in two separate ways. Sequential 9 second epochs were stored on a personal computer via an analogue-to-digital processor board. At the same time several segments of 5 minutes duration were stored on a high quality FM tape recorder for subsequent off-line analysis using the motor unit potential averaging algorithm of a clinical EMG system (medelec MS60, Woking U.K.). Both an automatic trigger with a peak detection algorithm and a manual trigger were used, the latter when there was substantial baseline drift. The number of averages required to define the full PQRST complex varied from 15 to 100 depending on the signal to noise ratio. In some subjects we varied the magnetometer location and were able to detect the alterations of field polarity related to the orientation of the vectors of the cardiac components.

RESULTS & DISCUSSION

In a series of pilot experiments, we completed the successful unaveraged recording of fMCG in 9 of 11 pregnant women from 30 to 40 weeks gestation with all subjects demonstrating QRS complexes (Fig 1a), with occasional P wave detection (Fig 1b). With care in choosing sensor placement, maternal MCG signals were either absent from recordings or easily distinguished from fetal signals. Using off-line averaging techniques we detected P and T wave in all 4 subjects in whom this technique was applied, Fig 2. This technique has
several implications. It provides for the first time an accurate method of fetal cardiac surveillance at a gestation time where other methods such as the fEKG are unavailable. The recording of the full fMCG complex allows calculation of measures thought in the intrapartum EKG to relate to hypoxia, e.g.

the T/QRS ratio. Finally the size of the R wave amplitudes, 4-8pT, were within the potential sensitivity range high temperature SQUIDS (running on liquid nitrogen) which would make this technique much more widely available in clinical practice.

**Fig. 1** Unaveraged fMCG: a. 30 weeks b. 37.5 weeks

**Fig 2:** a. fMCG (55 averages), 37.5 week pregnancy b. fMCG (17 averages), 37.5 week pregnancy changed sensor location
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