بررسی سلامت قلب جنین با استفاده از مگنتوکاردیوگرافی

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چکیده:

علت بسیاری از مرگ و میرها در جنین در زمان قبل از تولد ناشناخته مانده‌است. از این رو ضرورت معرفی روش مؤثری بمنظور بررسی سلامت جنین مخصوصاً 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 تشخیص است که بکارگرفته می‌شود ولی از آن جا که ثبت موج P تقریباً غیرممکن می‌نماید لذا عملاً برای تشخیص بیماریهایی که امکان درمان مؤثر آنها وجود دارد (مانند آریتمی) کارآئی چندانی ندارد. متأسفانه یکی از در دلائلی که این روش اخیر مورد استفاده قرار نمی‌گیرد ظاهر شدن لایه عایق کننده‌ای *(Vernix Caerosa)* اطراف جنین است که در هفته‌های بیست و هفتم ظاهر و در اواخر هفته سی و دوم کم کم از بین می‌رود . مگنتوکاردیوگرافی *(fMKG)* یک روش جایگزین است که با استفاده از مگنتومتر، میدانهای مغناطیسی *Dipole*های قلبی جنین از سطح شکم مادر ثبت می‌شود. در یک مطالعه پیلوت با استفاده از این روش، ما از مادرانی که در هفته ۴۰-۳۰ بارداری بودند ثبت بعمل آوردیم. کمپلکس *QRS* همیشه قابل ثبت بود و گاهی نیز با اوج P همراه بود. با کمی دقت در موقعیت *Sensor* نسبت به قلب جنین، *MKG* مادر براحتی از *fMKG* قابل تشخیص بود از طرفی با استفاده از آنالیز *off-line* موج P و T در ۴ مادری که مورد مطالعه قرار گرفتند استخراج شد. از آنجا که داشتن ارتفاع T و *QRS* می‌تواند هیپوکسیک بودن جنین را نشان دهد . این تکنیک می‌تواند نقطه عطفی در بررسی سلامت قلب جنین باشد.

کلید واژه‌ها: ۱- مگنتوکاردیوگرافی ۲- قلب جنین ۳- روشهای غیر تهاجمی ۴- بارداری

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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 diffrent 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 inva -sive, 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 liqour 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 doesnot measure fetal/placental reserve and thatit is a techinque 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 properites 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 mangnetocardiogram (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 Kanerlingh Onnes in 1911, this phenomenon has found several important

application. The application described here is the use of superconductive magnetome -ters 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. Supercon -ducting 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 ausculation. The top of a single channel neuromagneto-meter (BTi Model 60, San Diego, California) was placed in a position of maximum QRS signal over the maternal abdomen. The meuromagneto -meter 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 easilydistin -guished 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.

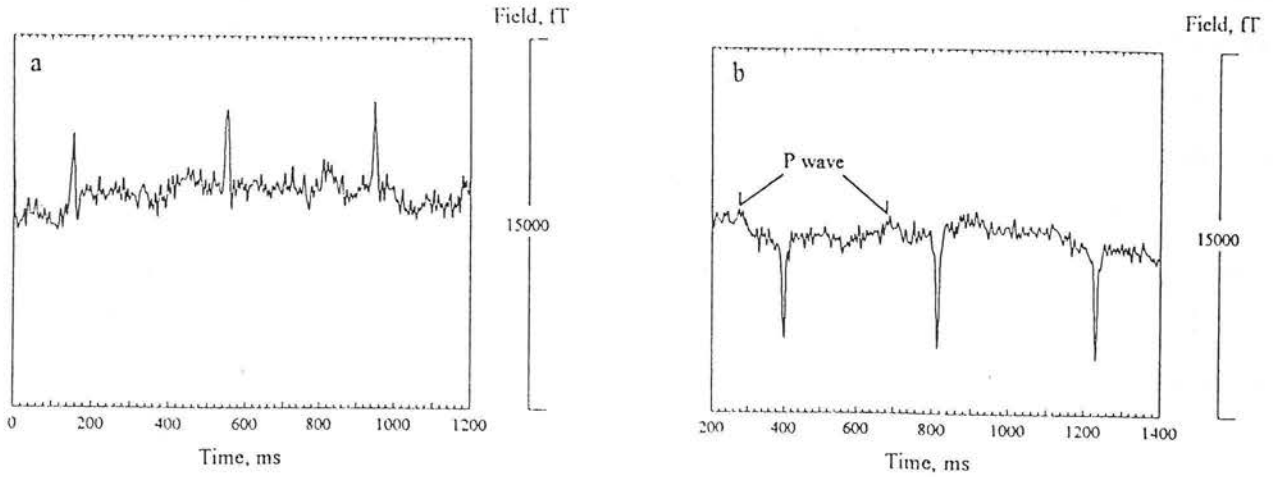

Fig. 1 Unaveraged fMCG: a. 30 weeks b. 37.5 weeks

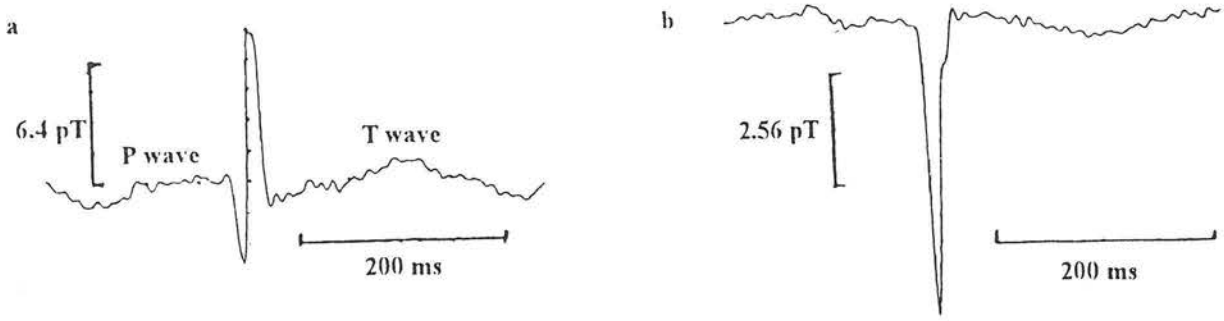

Fig 2: a. fMCG (55 averages), 37.5 week pregnancy b.fMCG (17 averages), 37.5 week pregnancy changed sensor location

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