Combined one- and two-dimensional ultrasound system for monitoring fetal breathing movements

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Summary
A combined one- and two-dimensional ultrasonic system for monitoring respiratory movements in the human fetus has been developed. A real-time cross-sectional image of the fetal chest at the level of the fetal heart can be obtained, and a time motion recording of fetal respiratory movements can then be written on a strip-chart recorder. Combining the features of one-dimensional and two-dimensional systems produces an accurate means of investigating fetal breathing movements.

Introduction
Fetal breathing movements were first observed with simple physical equipment at the end of the last century. Since 1971 several reports have been published on monitoring breathing movements in the human fetus with ultrasonic systems. We describe here the features of a combined one- and two-dimensional ultrasonic system, explain the investigation technique, and present some clinical results.

The system
For the study of human fetal breathing movements a multiscan system with a 20-element linear array transducer is used. By fast electronic switching a two-dimensional cross-sectional image is built up with a repetition rate of 50 images per second. The ultrasound image is displayed on a television screen via a line converter. The converter uses real-time processing to obtain a high line density image consisting of 157 lines per frame. A detailed description of the multiscan system and the line converter can be found elsewhere. With two thumbwheel switches each of the displayed lines can be selected and the ultrasound data from the selected line can be used for a time motion recording. This line selection technique gives the investigator vital information on the position of the selected ultrasonic beam in relation to the scanplane (fig 1). The special time gain compensation enables the operator to eliminate echoes and subsequently to differentiate between various moving structures within a certain area.

Investigation technique
The multielement transducer is positioned on the patient's abdomen and a real-time cross-sectional image of the fetal chest at the level of...
the fetal heart is obtained. Fetal breathing movements are recognised immediately in the two-dimensional image. By using the special time gain compensation breathing movements can easily be differentiated from movements in adjacent structures, fetal body motion, and maternal breathing. The real-time two-dimensional imaging enables the investigator to adjust the position of the transducer to ensure that the line to be selected for time motion recording is perpendicular to that part of the fetal chest wall showing maximum breathing movements. The time motion recording and the maternal electrocardiogram (ECG) are written together on a strip-chart recorder. The two-dimensional images of the fetal breathing movements are registered on a videorecorder.

Clinical results

We have made 25 recordings so far, each lasting for 10 minutes. All the pregnancies were normal; they lasted from 32 to 40 weeks. Fetal breathing movements were observed during about 90% of the time. The registered movements were often shallow, although sometimes a displacement of the chest wall up to 7 mm was observed.

Fig 2 shows two images of a cross section of the fetal chest at the level of the fetal heart, one expanded (2 a) and the other (2 b) contracted.

Fetal breathing movements show an irregular pattern and usually have a frequency of 30-90 cycles per minute. Fig 3 shows a time motion recording of breathing movements together with maternal ECG.

Discussion

The clinical significance of breathing movements in the human fetus is still unknown, although depressed fetal breathing from mothers under heavy sedation1 and during fetal distress2 has been observed. Ultrasound offers the best technique for studying these breathing movements.

We believe that the best results can be obtained only with a system that combines the excellent structure recognition of a two-dimensional real-time system with a high line density image and the time motion recording of a one-dimensional system.

References