Sounding out the womb

Ultrasonics is offering physicians increasingly accurate views of fetal growth and abnormalities

by Joan Lynn Arehart

High-frequency sound made its debut as a diagnostic tool in North American medicine some 15 years ago. Today it is a well established clinical service. Yet medical ultrasonics is still undergoing rapid definement and ever-wider applications in various clinical settings. Ultrasonics has particularly captured the imagination of innovators in some half-dozen medical specialties. One of the foremost is obstetrics.

One of the reasons ultrasonics is making it big in this field is that the technique has given no evidence to date of harming the fetus. Several weeks ago, for example, two London researchers—Mary Lucas and Mary Mullarkey of University College—reported that ultrasound, as now applied, does not hurt fetal chromosomes (SN: 11/27/71, p. 359). A similar diagnostic tool—X-rays—cannot make the same claim to safety. Some fetuses exposed to X-rays early in the pregnancy have suffered birth defects. Thus physicians are trying to avoid taking X-rays of the womb except in keenly critical situations.

Another reason ultrasonics is gaining acceptance in obstretrics is that it is offering ever greater accuracy in recording events in the womb. Four kinds of diagnoses made on 521 pregnant women gave an accurate reading 96 to 100 percent of the time, Ross Brown, ultrasonologist at the University of Oklahoma Medical Center, reported in the Nov. 28 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. Still another reason that ultrasonics has caught the fancy of obstetrics researchers is that it appears to offer vast possibilities for probing a world previously sealed off from medical inquiry—the womb, and the life tumultuously unfolding within it. Ultrasound does an admirable job at penetrating the lavers of downy tissue in the womb—considerably better, for the most part, than X-rays, electrocardiograms, encephalograms or chemical assays. As one fetal ultrasonics physician puts it, "The womb is a perfect water tank. Sound travels beautifully through it."

Several kinds of ultrasound are currently being applied to the womb. One technique is called "A Mode-B Mode ultrasound," or "time motion." A transducer, which converts sound waves reflected from the monitored tissue into electrical energy, is placed on a strategic area of the mother's abdomen. A crystal in the transducer picks up the energy emitted from the target area, and vibrates at about two million cycles a second. (The highest pitch the human ear can hear is 20,000 cycles a second.) The ultrasound cycles are then recorded on an oscilloscope screen until a picture of the area under investigation is built up. The finished picture is called an "echogram." It is a two-dimensional display of womb echoes.

Another ultrasound approach used on the womb is the Doppler technique. A transducer is placed on the target area over the womb. The physician listens for a change of pitch; such changes give him the fetal heart rate, say, or blood flow in a placental vessel. The ultrasonologist, like a musician, must train himself to detect subtle changes in pitches.

Still another, even more elegant technique—a sort of "B Mode time scanner"—actually sounds out motion in the womb and reflects the activity, motion picture style, on an oscilloscope—sort of a "shadows on the sheet" effect. There are only several of these ultrasound machines on the North American continent. One is at the Montreal General Hospital. "We have seen twins fighting in the womb," a staff member of the hospital's ultrasound department says.

Three or four major applications are currently being made with these various techniques, says University of Oklahoma's Brown. One is to follow and to chart fetal growth and development weekly or even biweekly during the fetus's nine-month voyage to life. Echograms first reveal a gestational sac at about eight weeks; a placenta appears at about 14 weeks; then a fetal head, heart, abdomen and other body parts. During the second trimester ultrasound shows the head growing at a steady rate, about two millimeters a week. Head growth slows down in the third trimester. Echograms taken of fetal growth toward the end of pregnancy can prove especially valuable for delivering babies of diabetic mothers. Such babies must be delivered after exactly 36 weeks' development or run the risk of being stillborn. X-rays have been used in the past to detect when a fetus has completed 36 weeks of development but X-rays have depended on visualization of the end of the thigh bone, and the end is not always visible in some infants. The thigh bone is not a necessary marker for ultrasound.

Ultrasound is also being used to determine the exact position and orientation of the placenta itself. This is especially vital when a physician plans to withdraw amniotic fluid from the womb; it is even more so when fluid is to be withdrawn and the mother has Rh negative blood. Ultrasound is likewise proving useful for detecting multiple births.

Ultrasonologists have these applications for monitoring normal womb and fetal conditions down so pat, in fact, that they are now turning their attention more to detecting fetal abnormalities and placental difficulties that might put the fetus at risk. Kenneth Gottesfeld, a leading fetal ultrasonologist at the University of Colorado Medical Center and also a practicing obstetrician, is currently focusing on babies small for their gestational age, on fetuses from mothers with Rh negative blood and on detecting various fetal organs with echograms. "I have seen fetal kidneys," he says, "and even multiple cysts on the kidneys from one fetus." In these and other ultrasound frontier probings, Gottesfeld is coming up with some intriguing discoveries. For example, he has noted that fetal risk often correlates with a thickening of the placenta. Also, that when the growth of the fetal head and chest lag behind the gestational norm, the fetus may not be getting enough nutrition from the placenta. Within the past two or three

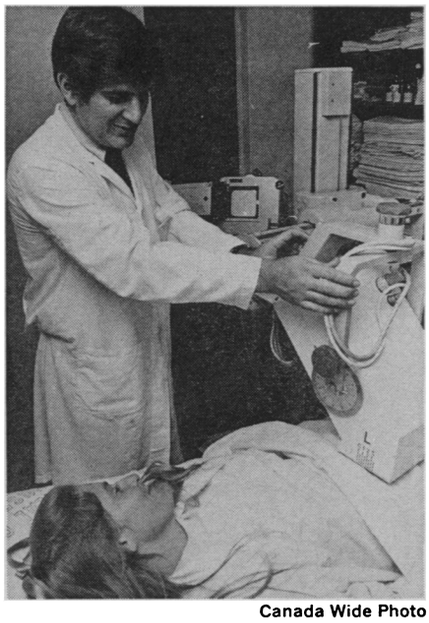
months Gottesfeld has also observed, with ultrasound, five uteruses overloaded with fluid at about 20 to 24 weeks gestation. In each of these cases the fetus died several weeks after diagnosis of this uterine difficulty. Gottesfeld is now contacting other physicians in the Denver area, to see if they too might have noted a correlation between gestational difficulties at 20 to 24 weeks and fetal death several weeks later.

Gottesfeld is also trying to determine the fetus's sex by looking at the genital region of echograms. "But no luck here yet." he says.

Fred Winsberg, a radiologist at the Montreal General Hospital, can identify, with motion picture ultrasound, the fetal heart and aorta (main artery from the heart), fetal intestinal loops and the bladder. Using this technique in conjunction with the conventional A Mode-B Mode ultrasound. Winsberg has in 13 cases also successfully estimated the output of blood from the left ventricle of the fetal heart. The average left ventricle output per heart stroke, he has found, is less than 30 to 40 drops of blood. Winsberg reported these results, among others, at a meeting of the American Institute of Ultrasound and Medicine, held in Denver in October. He has not yet detected congenital heart disease in the fetus with ultrasound. He believes such detection is theoretically possible, since it has been done in newborns, but would probably not yet be practical.

Winsberg has also used motion picture ultrasound to detect some of the complications of Rh disease in the fetus. In this event a mother with Rh negative blood builds antibodies to the Rh positive blood of her baby. The antibodies somehow manage to cross the placental barrier and destroy the fetus's red blood cells; fluid accumulates in the fetal abdomen. It is this latter phenomenon that ultrasound picks up.

Researchers in Brooklyn are using ultrasound to detect placental abnormalities that might put the fetus at risk. Mitsunao Kobiashi, an obstetrician-ultrasonologist at the Downstate Medical Center in Brooklyn, says his department is currently able to diagnose cases of placental "mole"—in which the placenta becomes malignant and can kill the fetus; placental previa—in which the placenta obstructs the birth canal; and placental bleeding. Perhaps most dramatically his department has collected over a hundred cases correlating an ill-defined or low-positioned gestational sac or placenta with subsequent spontaneous abortions. These criteria, Kobiashi says, allow an ultrasonologist to predict with good accuracy whether a woman will abort.



Canada Wide Photo

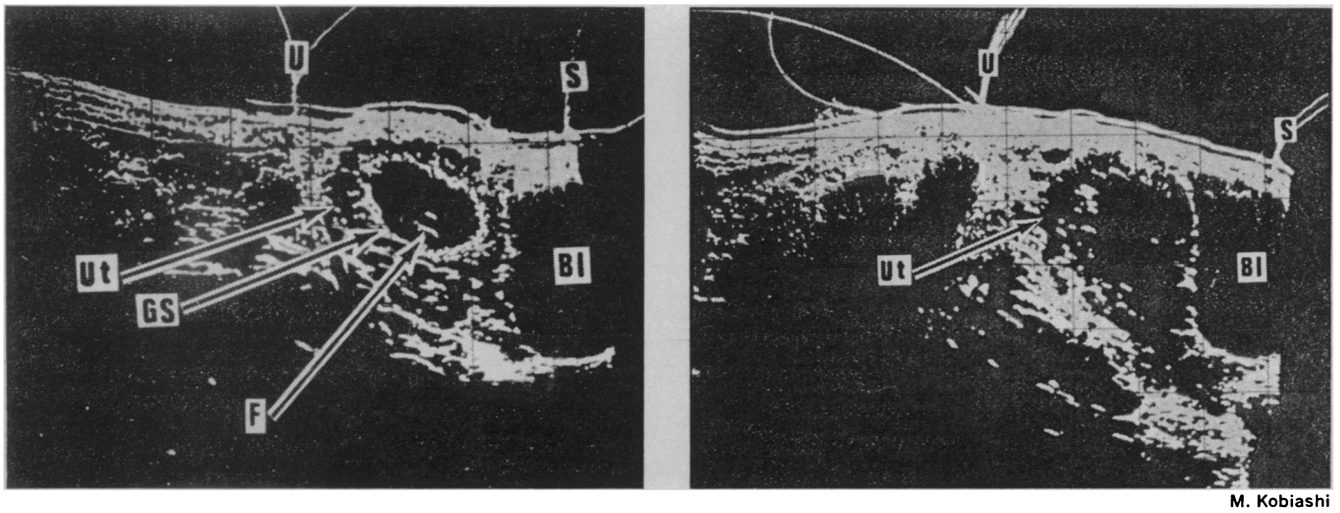
Winsberg using ultrasound device.

Lejos von Micsky of St Luke's Hospital Center in New York City reports still other placental-fetal irregularities that can be diagnosed with ultrasound. They include the presence of an ovarian cyst that might complicate pregnancy, or an incomplete abortion or missed abortion. Another irregularity is toxemia of pregnancy. In toxemia the placenta is not able to deliver the normal amount of oxygen to the fetus, causing fetal growth to slow down. Ultrasound can pick up this growth retardation. Then, if the fetus is far enough along, the obstetrician may want to induce labor.

In view of all these advances, enthusiasts of obstetric ultrasonics see the field getting bigger and bigger. "Business is booming," von Micsky declares.

"We may be switching from A Mode-B Mode ultrasound to holography within several years," Gottesfeld reports. "Holography, which can be performed with either ultrasound or laser light, would give a three-dimensional picture of womb phenomena rather than a two-dimensional one." More and more ultrasonic scans can be handled by automation. More and more obstetricians are becoming aware of hospital ultrasound departments and taking advantage of them. Yet obstetric ultrasound isn't running altogether unchecked. One limiting factor is the cost of equipment, especially when hospital administrators are swamped with pressing financial demands from other areas of the hospital. Also, more physicians must be trained to interpret ultrasound results. And regardless of how popular obstetric ultrasound diagnosis might become, it will probably never totally usurp other comparable diagnostic techniques. Obstetricians generally prefer to call upon one or more techniques in making a diagnosis —ultrasound and amniotic tap, say, or ultrasound and radioisotopes. This way they can cancel out chances of error with any one technique.

Even with some tampering, though, ultrasonics will undoubtedly play an increasingly vital role in obstetric diagnosis, by offering obstetricians evermore accurate and sensitive tune-ins to fetal development. □



M. Kobiashi

Normal pregnancy (l.), 10 weeks. Gestational sac (GS) well defined. Not the case in abnormal pregnancy (r.)