

# ULTRASONICS IN OBSTETRICS AND GYNAECOLOGY

## PART II

### GYNAECOLOGICAL USES

by

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We came to explore these for at least a couple of years before entering the field of obstetrics.<sup>20</sup> The difficulties of the clinical differential diagnosis of truly massive ascites and enormous ovarian cysts and gross obesity challenged us from the first (Figs. 5 & 6). The results were so rewarding that we were driven to continue this line of investigation.<sup>22, 23</sup> The ease with which fluid structures can be differentiated from the more solid ones is well recognised. Hopes however that a ready differentiation could be made between complex tumours which were benign or malignant were never realised and this came as no surprise considering the coarseness and crudity of wavelength of the ultrasonic beam (Fig. 7). Fibromyomata being solid absorb and attenuate ultrasound so that they are less transonic and their posterior, deeper surface may require lower frequencies, e.g. 13 MHz, to reach and demonstrate them (Fig. 8). The demonstrable contours however of an ovarian tumour differ markedly from the absent contours obtainable in ascites, due to the presence of reflecting bowel, floating within collections of fluid. Pulsatile tumours in the abdomen, if lying in front of the aorta, show movement of both the anterior and posterior walls, whereas an abdominal aortic aneurism shows pulsation only of the anterior wall since its posterior wall lies in contact with the vertebral column and neighbouring immobile structures.<sup>25</sup> Splenic and hepatic

enlargements are also demonstrably different from ovarian.

The grossly distended bladder due, for example, to a retroverted gravid uterus, or a pelvic tumour packed below the promontory of the sacrum with resulting urethral elongation and urinary retention, though perfectly transonic, is distinguished from an ovarian cyst since the lower end of it is pointed in the form of a trigone,<sup>15</sup> a phenomenon not seen in ovarian tumours.

It is a pity that the ultrasonic characteristics of blood, pus, urine, ascites and all other biological fluids are not distinguishable since they do not themselves contain reflecting properties. Haemoperitoneum therefore is not diagnosable as such but only as "echo free fluid."

Bowel lesions do not lend themselves well to ultrasonic examination because of gas reflecting interfaces but this in itself may be a helpful differential diagnostic point when confronted with abdominal masses due either to diverticulitis or intestinal malignant disease.

Retroperitoneal tumours may be ultrasonically poorly accessible because of overlying bowel unless coarser frequencies, e.g. 1½ MHz, are used and even so their identification may be uncertain.

Hepatic involvement is always an important matter in differential diagnosis in gynaecology, particularly the possibility of metastatic disease from ovarian carcinoma. Access to the liver is difficult unless

it is grossly enlarged because it requires an upward tilted view under the costal margin and even so, because of being limited to two dimensions only, unrepresentative "slices" of hepatic tissue may be scanned and the echoes from deposits of secondary growth may be missed and when found require expertise to interpret them. Combined with radio scintiscanning however the information is worth seeking.<sup>21</sup> An enlarged liver due to metastatic disease has an irregular shape unlike the wedge shape of hepatomegaly from non-malignant disease (Fig. 9).

It is in the study of abortion in all its varieties, that sonar has much to offer; since, by examining the uterus through a full bladder it is easy to determine whether the uterus is empty or not, or whether it contains an intact pregnancy or retained products of conception from an incomplete abortion.<sup>16</sup> So great is the reliance which we have now come to place upon this that, provided a patient is not actually bleeding heavily, we do not subject cases of abortion to routine curettage unless the presence of retained products indicates it. This has made a very marked difference to our bed usage.

Our biggest disappointments have been in the diagnosis of ectopic pregnancy. In so far as the gestation sac may be seen within the uterus one may be assured that the case is not one of ectopic pregnancy. Otherwise the ultrasonic findings differ every bit as much as the clinical physical signs and depend upon which stage of disease is encountered ranging from the unruptured tubal pregnancy to tubal abortion, with peri-tubal and pelvic haematocele, and frank rupture with acute haemoperitoneum. There may in fact be considerable difficulty in distinguishing between a pelvic abscess and pelvic haematocele and even haemor-

rhage from a corpus luteum.<sup>20</sup> The best that can be said is that sonar may provide an indication for examining the patient by laparoscopy so that in our department mistaken laparotomies for possible tubal pregnancy are now very rare.

#### *Early Pregnancy*

Until we came to use the full bladder as a method of gaining ultrasonic access to the depths of the pelvis,<sup>12</sup> our examination of the gravid uterus was restricted to cases where the uterus was already palpable above the symphysis pubis. However since 1963 to an increasing extent we are able to examine the pregnant uterus from the very early stages of gestation.<sup>13</sup>

The full bladder displaces bowel which would otherwise interfere with the examination and provides an extremely efficient sounding tank with practically no intermediate absorption of ultrasonic energy. The uterus which is not even enlarged can be examined equally well whether retroverted or anteverted.

A gestation sac first appears as a fine white ring, often before the sixth week of gestation (menstrual age) (Fig. 10). The level of nidation can also be observed. In favourable circumstances this should be in the upper segment. A low level of the gestation sac may indicate the imminence or the start of the abortion process.

By the seventh week of amenorrhoea it is usually possible to identify the fetal pole within the gestation sac with certainty (Fig. 11) and even to measure its crown/rump length.<sup>39</sup> This fixes maturity very reliably to within about half a week.

Using the time-motion display method the fetal heart can be picked up from the

sixth week of amenorrhoea onwards<sup>38</sup> (Fig. 4) and if it cannot be found by the end of the seventh week it raises the question that intrauterine fetal death has already occurred and that the ovum is blighted.

The phenomenon of blighted ovum is now recognised as very common, often recurrently so in the woman with a bad history. Some of these cases are due to genetic abnormalities<sup>9</sup> and chromosome karyotyping is always undertaken whenever we can obtain the tissue ultimately passed. Frequently the patient may not even be aware of her conception and may simply think her "period" was delayed. Several signs indicate the diagnosis of blighted ovum in addition to the absence of a demonstrable fetal heart.<sup>27</sup> These are: a poorly formed ring with speckling, or a gestation sac ring which is incomplete. In other cases the ring is consistently empty and no fetal pole can be found in it (anembryonic blighting) and finally, all signs of further growth are absent over the course of a week or more.

If the patient has been examined because of a history of bleeding and a provisional diagnosis made of threatened abortion, the discovery of ovum blighting spares her much unnecessary treatment aimed at conserving the pregnancy and the inevitable disappointment later.

So accurate is the estimate of maturity now in early pregnancy that the information may be vital later on towards its end.

The rate of fetal growth in utero is now clearly well recognised and greatly influences the prognosis.<sup>18</sup>

A diagnosis of twin pregnancy can be made often well before the end of the first trimester (Fig. 12) and the feat of diagnosing quintuplets by sonar at the ninth week at Queen Charlotte's Hospital

in London is now famous.<sup>7</sup>

Occasionally by the eleventh week and more often by the twelfth week of amenorrhoea the fetal head may be identified on B-scanning. From then onwards the fetal head provides the best index of maturity, since the growth is rapid at this stage of pregnancy (Fig. 13).

A common request for sonar examination in early pregnancy is made because the patient appears clinically large for dates. This may be simply a question of mistaken maturity which is easily settled by sonar<sup>8</sup> but even more important is the diagnosis of a complicating pelvic tumour and the ability to distinguish between whether it is due to a fibromyoma and for which the treatment is therefore conservative or due to an ovarian tumour which demands laparotomy in its own right<sup>17</sup> (Fig. 14).

Bleeding in early pregnancy may provide problems in differential diagnosis which sonar does much to resolve. The varieties of abortion have already been mentioned but striking success can be achieved in the diagnosis of hydatidiform mole long before other evidences, such as the passage of vesicles warn the physician of the patient's very great danger.<sup>37</sup> The appearance of hydatidiform mole are those of a clearly transonic speckled mass within the uterus (Fig. 15) which remains transonic with the posterior wall of the uterus still visible on reducing the gain settings of the apparatus by 15 decibels, even though the speckles themselves may be suppressed by this manoeuvre. Furthermore the diagnosis can be confirmed at the very high frequency of 5 MHz, a precaution which should always be undertaken if one is to avoid the mistake which we have made in the past of confusing myxomatous degeneration of a fibromyoma with hydatidiform mole.<sup>14</sup>

PART 1

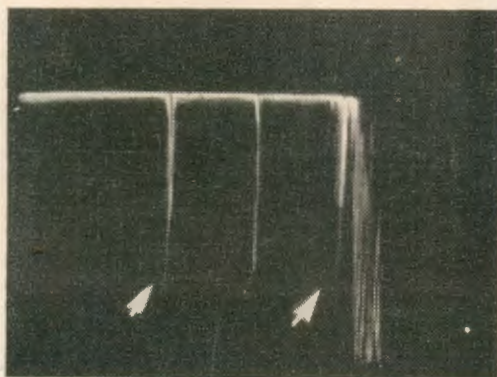


Fig. 1  
Unidimensional A-scan measuring biparietal diameter. Arrow marks indicate parietal eminences. Note intermediate midline echo midway between them.



Fig. 2  
Two-dimensional B-scan display of same biparietal diameter as in Fig. 1.

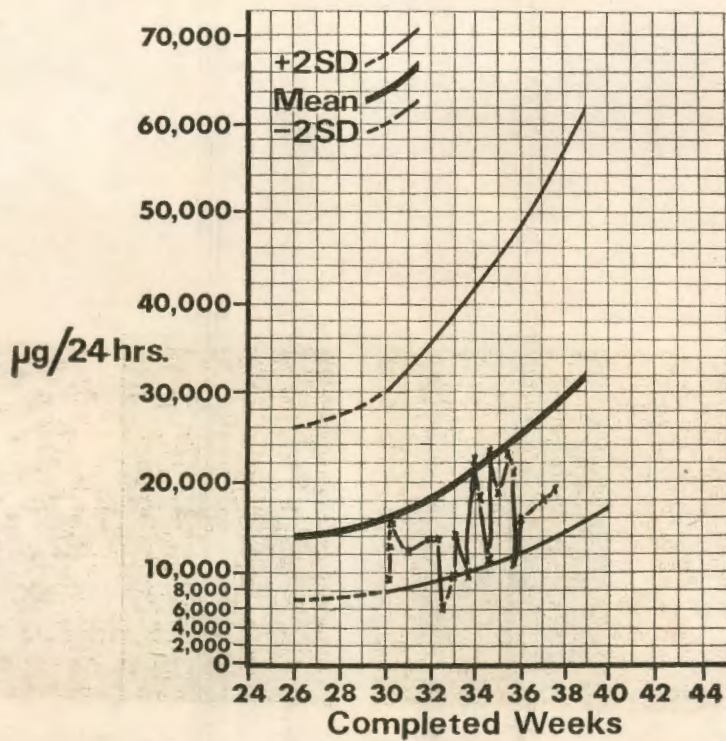
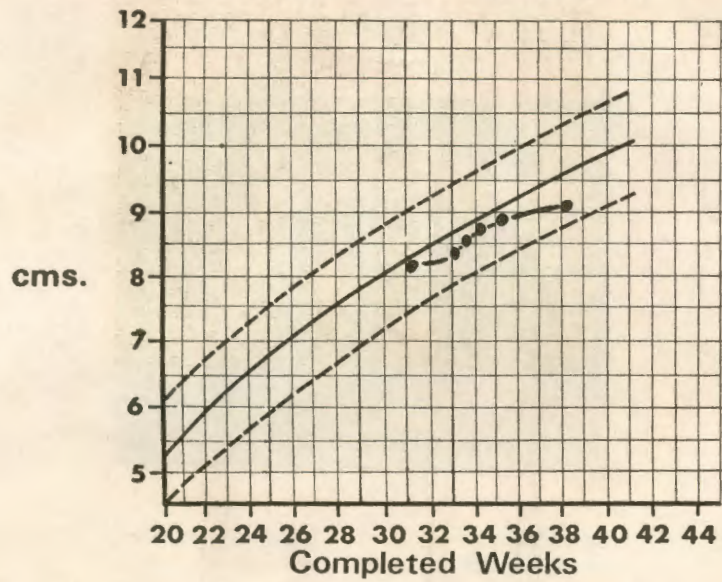


Fig. 3

Combined chart of biparietal growth curve and oestriol excretions in case of elderly primigravida with bad obstetric history of recurrent abortion and infertility.

Note evidence of dysmaturity. Elective Caesarean section. Live, dysmature baby at 38 weeks, Kg. 1.78; has since done well.

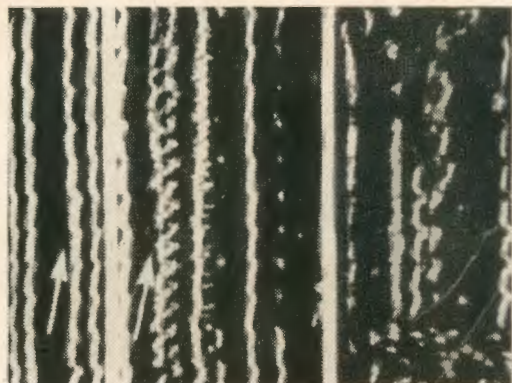


Fig. 4  
Time motion display of fetal heart: Left hand arrow, maternal pulse: Right hand arrow, 7 weeks gestation. (Menstrual age).

PART 2

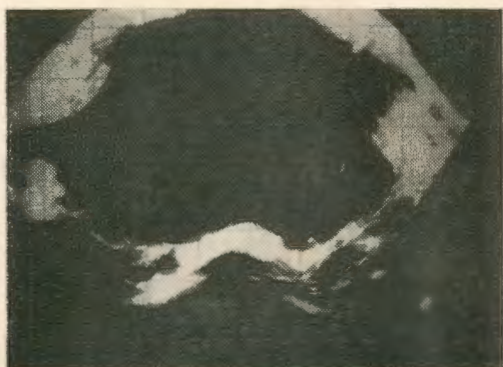


Fig. 5  
Enormous ovarian cyst. This was transonic even at 5 MHz. It looks benign but was in fact malignant. Transverse section.

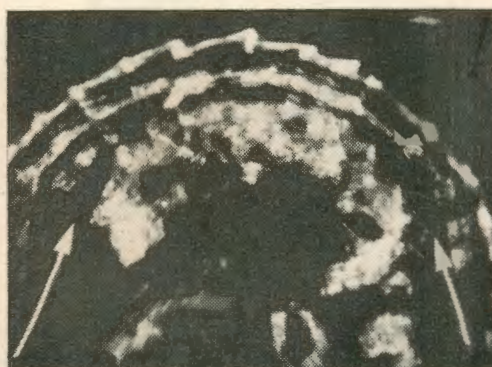


Fig. 6  
Massive ascites. Note free fluid in flanks (arrows). Bowel echoes concentrated in centre. Transverse upper abdominal section.

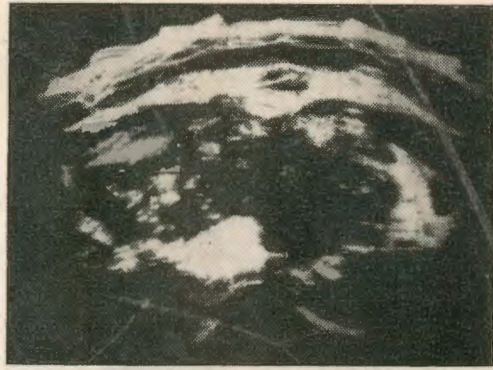


Fig. 7  
Very complex differentiated carcino-sarcoma  
of ovary; transverse section below umbilicus.



Fig. 8 a.  
Fibromyoma (a) easily transonic at  $1\frac{1}{2}$  MHz.

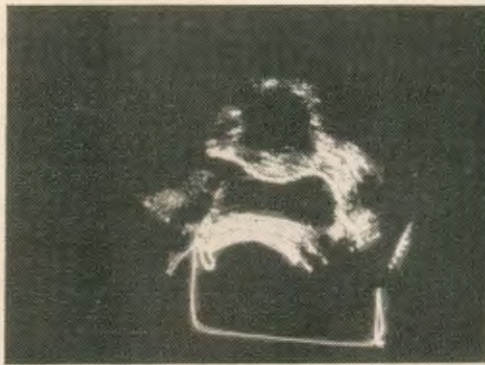


Fig. 8 b.  
Fibromyoma (b) Less so at  $2\frac{1}{2}$  MHz.

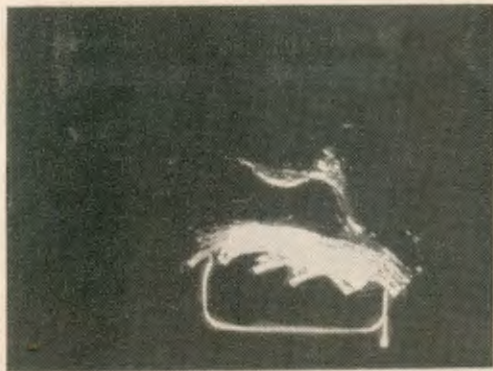


Fig. 8 c.  
Fibromyoma (c) Not at all at 5 MHz.



Fig. 9  
Hepatic metastases. Oblique scan parallel to right costal margin. Primary tumour was ovarian.



Fig. 10  
Same case as Fig. 4. Very early 5 weeks gestation sac in upper part of uterus (arrow).



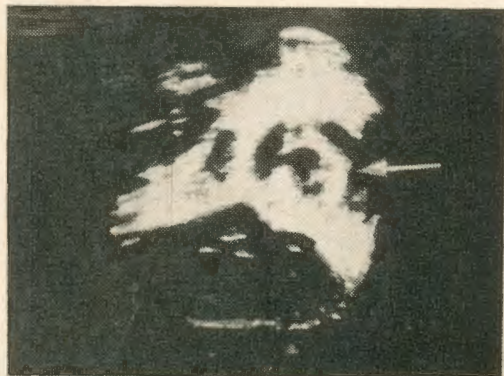


Fig. 11  
Same case as above at 7½ weeks gestation menstrual age. Note fetal pole within sac.



Fig. 12  
Twin gestation sac at 10½ weeks. Note fetal poles within the twin sacs. Had requested termination. Healthy babies 2.78 and 2.8 Kgs, delivered alive and well.



Fig. 13  
Clinical diagnosis was missed abortion but fetal heart identified on time motion scanning. Picture shows twin heads at 13 weeks gestation.



Fig. 14  
Huge ovarian cyst (X). Fetal echoes at 14 weeks within uterus (arrow).

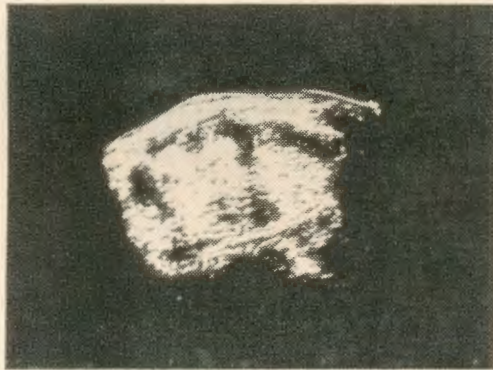


Fig. 15 a  
Hydatidiform mole.  
(a) At 2½ MHz.



Fig. 15 b  
(b) Confirmed at 5 MHz.

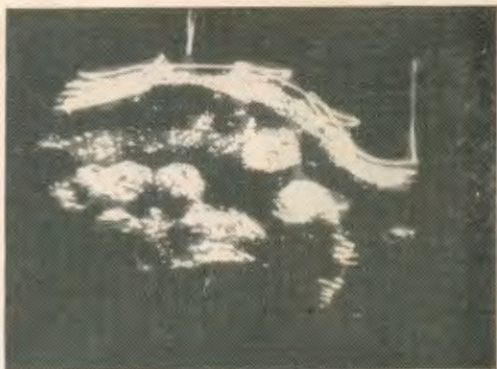


Fig. 16

Anencephalus at 35 weeks. No head could be found. Note blob-like echoes within hydramnios. Placenta is anterior in upper segment.



Fig. 17

Major degree of placenta praevia (arrow) at 32 weeks gestation. Presented as oblique lie; No antepartum haemorrhage. At caesarean section placenta had to be incised to extract fetus.



Fig. 18

Twin heads in later pregnancy. Oblique section.

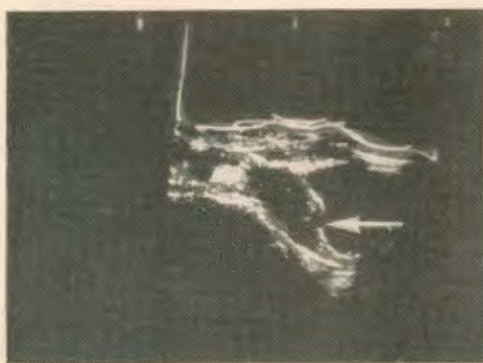


Fig. 19

Dehiscent caesarean section scar (arrow) found 36 days after caesarean section. Examination indicated by continuing postnatal bleeding. Uterus itself is empty.

The diagnosis of fetal abnormality within the first half of pregnancy is only possible in a limited number of instances. For example the inability to find the fetal head raises seriously the possibility of anencephaly (Fig. 16). Spina bifida is almost impossible to diagnose using two-dimensional scanning unless one happens to obtain a particularly lucky sectional view of the vertebral column. Occasionally kidneys can be seen and also urine within the bladder. Hydramnios gives very characteristic appearances of large quantities of fluid with blob-like echoes floating within, presumably due to fetal limbs.<sup>48</sup> The fetal thorax with the pulsating heart within it can be found and distinguished from the possible presence of a fetal head.

When dealing with the possibility of abnormality in early pregnancy the role of sonar is chiefly in its ability to localise the placenta and indicate a safe site for amniocentesis. Placental differentiation can be observed progressively from the tenth week of pregnancy onwards and by the time at which amniocentesis is normally carried out, namely between the 14th and 16th weeks of pregnancy, localisation can be very efficiently determined.<sup>9</sup> This has enormously increased the safety of amniocentesis and reduced the risks of feto-maternal transfusion.

#### *Later Pregnancy*

The presentation of the fetus even in the very obese patient is not difficult since the head can be so easily found. It is recognised by its sharp contour and by the existence of a "mid-equatorial line" believed due to the falx (Fig. 2). Furthermore it contains no pulsating structures unlike the thorax.

Biparietal cephalometry represents the greatest single use of sonar in obstetrics. Not only is it immensely useful in deter-

mining maturity but even more so in studying fetal growth rate. Excepting sudden accidents in pregnancy, it is believed that the fetus that dies from placental subnutrition or insufficiency may give earlier warning of growth retardation. Combined with poor oestrial curves; which we undertake simultaneously, it is possible to recognise life-threatening dysmaturity and to interrupt the pregnancy before intrauterine death occurs. This method of screening fetal growth is applied in all conditions known to interfere with it such as for example hypertensive disease, renal disease, diabetes and in all cases of a bad obstetric history (Fig. 3).

Placentography is the second commonest reason for employing sonar in obstetrics and sonar is generally recognised to provide the method of choice since it is apparently safe, is easily repeatable and can be undertaken at any stage of pregnancy; in fact the earlier, the easier.<sup>24, 29</sup> It is also employed in all cases of antepartum haemorrhage and is singularly successful in identifying placenta praevia (Fig. 17). It is also employed in all cases of unstable lie and always before amniocentesis.

With regard to the diagnosis of placenta praevia it is interesting to observe that the placenta in earlier pregnancy may appear to encroach upon the lower uterine segment and even to cover the os but in some cases, presumably with the taking up of the lower segment, the situation may improve and the placenta towards the end of pregnancy may appear to have "migrated" away from the praevia position. The converse fortunately does not occur and a placenta identified earlier in pregnancy as safely within the upper segment does not later appear as one of placenta praevia.

Our interest is now much concerned with studying the actual structure of the placenta particularly with regard to Rh haemolytic disease, diabetes and any condition likely to influence placental structure size and growth.<sup>22</sup> The Rhesus placenta is certainly very large and thick and ultrasonically more opaque but in making these estimates maturity has to be taken seriously into account since the relative size of the placenta to the conceptus as a whole is greater in earlier pregnancy than at term.

A practical point worth remembering in placentography is to examine when the bladder is moderately full. This helps to indicate the position of the lower segment and facilitates the diagnosis of placenta praevia.

The diagnosis of twins depends in later pregnancy upon the identification of two separate fetal heads (Fig. 18). It is also useful to determine which of the two heads is the larger, that of the first, or of the second-coming twin, since the hazards to the second twin are greatly magnified if it is the larger of the two. The diagnosis of triplets is not so easy because it is difficult to depict all three heads in one two-dimensional plane.

Pelvic tumours associated with pregnancy are a particularly important field of ultrasonic investigation, since the presence of a large uterus in the second half of pregnancy may conceal a tumour particularly in the very obese subject.

In cases who have undergone Caesarean section in a previous pregnancy examination of the scar using the full bladder technique is worth while.<sup>22</sup> This requires very careful scanning from side to side across the whole length of the scar and one is particularly alerted if the posterior surface of the bladder appears to be irregular or puckered (Fig. 19).

Fetal abnormalities can usually only be detected in the case of the fetal head, for example anencephaly, hydrocephalus and microcephaly. Doubtless as refinement in technique improves, spina bifida, cardiac and renal abnormalities will be more readily recognised but, so far, at best sonar may do no more than indicate the need for radiography.

#### *Puerperium*

Cases of secondary postpartum haemorrhage have frequently to be examined by sonar to determine whether or not there are retained secundines. Subinvolution can likewise be differentiated. Often it is very obvious that the apparent failure of the uterus to involute is due to retention of urine, which is easily demonstrated without the need for incurring the risks of catheterisation.

In a few instances we have picked up pelvic tumours in the puerperium which had previously escaped detection during the pregnancy. Cases of Caesarean section undergoing a stormy convalescence are worth examining. It may be found that a large haematoma is associated with the lower segment scar.<sup>19</sup> This can be differentiated by sonar from the bladder in front and the involuting uterus behind and may be seen to track at different levels towards the abdominal wall.

#### *Gray Scaling*

This is a development which is receiving increasing attention. I suspect that the term means many things to many men. Until recently all echo information was provided on an "all or none" basis. That is to say either a white echo dot was visible or it was not. Part of this was due to the need to cut off irrelevant electronic "grass" and partly because of the limited ranges of echoes which could be handled. The pictorial principle is still necessary in

order first to identify the structure for gray scale imaging.<sup>21</sup> Where one wishes for example to examine the texture of the placenta it is therefore first necessary to identify it and then to eliminate many of the search techniques hitherto employed and to widen the range of differentiation so that minor alterations in tissue density and structure can be detected. This is not the same thing as simply producing a fuzzy picture which often goes by the name of gray scaling.

The purpose of gray scaling is really to study tissue texture and this is likely to be most useful in examining the placenta and also the internal structure of the liver. In such an examination there should be no sacrifice in anatomical detail. The technique of scanning has to be very materially altered and we agree that time-exposure photography is to be preferred to storage oscillography.<sup>32, 33</sup> Photographic materials and resolution have to be of the highest quality.

#### *Safety*

It remains to consider the question of safety of this new diagnostic technique particularly in pregnancy where it might be expected that the rapidly growing fetal tissues were the most vulnerable to the onslaught of any type of energy.

The hazards of X-radiology are already well known<sup>42</sup> and by analogy there is a very natural fear that the same may apply to sonar but the latter employs a mechanical as distinct from an ionising type of energy and the biological effects are different. High power ultrasound can indeed produce heating and cavitation but this is not the case with diagnostic sonar. A great deal of work has already been done and the literature has become very extensive on the question of safety but surprisingly little in the way of adverse results has so far been demonstrated.

Teratogenesis and interference with normal development have not so far been found in spite of extensive search<sup>2, 31</sup> and much experimental work has been done on rodents, for example, right through to the second generation in a search for mutagenic effects.<sup>11, 41, 48</sup>

The preliminary reports of chromosome defects emanating from Cape Town<sup>36</sup> turned out to be completely without foundation, when the work was repeated at a number of other centres including our own.<sup>1, 4, 5, 6, 10, 35, 46, 47</sup> Even placental enzyme changes have not been found.<sup>40</sup> High energies can produce damage occasionally in chick embryos at very early stages of gestation before the 13-somite stage exposed at pointblank range.<sup>44, 45</sup> Chick embryo capillaries lying parallel to a beam of standing ultrasonic rays demonstrate concentration and stasis of red cells at nodal points and possibly some endothelial damage<sup>28</sup> but these experimental situations are far removed from clinical usage. Prospective epidemiological surveys are now under consideration by the Medical Research Council but it has to be admitted that so far the whole subject of safety has been far more taken up with conjecture than concrete experimental fact. Present day ultrasonic diagnostic machines use such small levels of energy that they would appear to be safe but the possibility must never be lost sight of that there may be safety threshold levels possibly different for different tissues and that with the development of more powerful and sophisticated apparatus these may yet be transgressed.<sup>34</sup> In the meantime the scope and usefulness of sonar, particularly in obstetrics and gynaecology, is gathering increasing momentum and ever widening acceptance.

*This work is receiving financial support from the Medical Research Council which is gratefully acknowledged.*

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*See Figs. on Art Paper I to VIII*