LOCALIZATION OF THE PLACENTA BY MEANS OF A RADIO-ACTIVE ISOTOPE

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Introduction

For the purposes of a study of the human placental blood flow it became necessary to be able to locate the placenta in the intact uterus so that maternal placental blood might be obtained for examination. The various methods available were considered, but each had drawbacks which made them unsuitable. It seemed reasonable however, to try whether a radio-active isotope with a short half-life could be injected into the blood stream, in the hope that the vascular placenta would be detectable by the use of a Geiger counter. The method of locating the placenta described in this article is simple and for its purpose reasonably accurate.

Review of the Literature

Amniography. In 1930 Menees, Miller and Holly described a method of amniography to mark out by contrast the placental site. This method was used with a fair amount of success and Burke (1935) reported 75 cases in which this had been done. Apart from the relative inaccuracy of the method, there were two main disadvantages. First, that intrauterine death of the foetus occasionally occurred, and second, that the contrast medium used was an irritant and sometimes induced labour. This latter point can be to some extent overcome today by the use of newer non-irritant contrast media such as 'Myodil.'

Intravenous Placentography. Erhardt (1932) reported the use of intravenous thorium dioxide which in the experimental animal outlined the maternal placental circulation fairly well, but there was a grave risk of foetal death with this method, and maternal side-effects were often of an undesirable nature. Vaso-selectan has also been

used in this way but Olsson (1941) reported dangerous sequelae to its use and the method is not considered safe.

Cystogram. Ude and Urner (1937) described a method of demonstrating the position of the low-lying placenta by injecting 60-80 ml. of diluted sodium iodide solution into the bladder, previously emptied by catheterization. The presenting part is then pressed down into the pelvis and lateral and antero-posterior radiographs are taken. In this way a filling defect can often be demonstrated where placenta praevia exists, but this method is of value only in detecting the low-lying placenta, and where the placenta is thin, as indeed is sometimes the case in placenta praevia, it may be useless.

Soft-tissue Radiography. Snow and Powell (1934) described a method of demonstrating the placental site by means of soft-tissue radiography and many workers have used this method with reasonable success. For instance, Dipple and Brown (1940) reported 262 cases in which a soft-tissue shadow, believed to be the placenta, was demonstrated in 236. Confirmation of the placental position was obtained in 53 cases by Caesarean section and the prediction was correct in all these cases. Chassar Moir (1944) pointed out however that there were many fallacies in the soft-tissue method; that liquor and placenta were equally radio-permeable so that a soft-tissue shadow might be interpreted as placenta when in fact only liquor was present in that position, and every obstetrician will have personal experience of such cases. Reid (1949) described 252 cases in which this method was used and found that his prediction was correct in 41 out of 42 cases where the placental site was actually seen on Caesarean section. Chassar Moir recently has drawn attention

to the value of the semi-supine position in lateral radiography in an attempt to demonstrate that the foetal head might be displaced forward by a posterior placenta lying over the sacral promontory.

Recently (Leriche *et al.* (1952)) attempts have been made to demonstrate the placental site by means of the injection of a radio-opaque substance into the aorta, the resulting arteriogram showing a network of vessels in the placental bed. This technique is very promising, though at present there are few workers competent to carry it out. In fact all the work done up to the present has been concerned with the radiological diagnosis of placenta praevia.

Method

The method described here depends on the fact that the placenta is essentially a pool of blood and, therefore, represents a local accumulation of Na^{24} so long as the bulk of the isotope remains in the circulation. However, since the administered Na^{24} rapidly diffuses out of the vascular system (Burch, Reaser and Cronvich, 1947), useful observations can only be obtained within a few minutes of injection. For advice as to dosage I am indebted to Dr. Constance Wood, Director of the M.R.C. Radiotherapeutic Research Unit, Hammersmith Hospital.

With the patient in her ordinary bed in the ward, approximately 50 microcuries of radioactive sodium Na^{24} , in the form of 5-20 ml. of sterile isotonic saline (depending on the age of the sodium) is injected into a suitable antecubital vein. After allowing about thirty seconds for the Na^{24} to mix in the blood stream, radioactivity measurements are made over the abdominal region. For this purpose a portable apparatus is used, consisting of a counter tube without lead shield but with the window screened to prevent entry of β particles, in conjunction with a counting rate meter. A mains-operated instrument has also been found to be satisfactory, though not so convenient.

The counting rate over the area of the uterus and other abdominal organs is measured with the end of the counter tube in contact with, and with the axis normal to, the skin. From time to time the counter is placed over the heart, and the observed reading taken as a reference level. The counting rate over the fundus of the uterus is about one-half to two-thirds of that observed over the heart, and is slightly higher on the right side owing to the radiation from the liver. The observed counting rate decreases rapidly towards the lower uterine pole, and over the lower segment of the uterus it is only one-fifth of that over the heart, provided the placenta is not low-lying.

When the placenta is situated on the anterior

wall of the uterus its site is indicated by a region where the counting rate is considerably higher than that over the uterus generally, and is almost equal to that observed over the heart. If such a region is not found, it is concluded that the placenta is located on the posterior wall. In cases of posterior location where the placenta is not centrally situated, it is usually possible to find out on which side it lies by differences in the counting rate; but the counting rates observed will be considerably lower than that found over the heart because the intensity of radiation detected varies inversely as the distance of the source from the counter.

The actual position of the placenta was subsequently determined by Caesarean section, manual removal, or free aspiration of blood from the supposed placental site. In some cases, where free aspiration had been obtained, the placental site was confirmed by one of the other methods. In the case of complete posterior position of the placenta, where there was no part to be detected on the anterior wall of the uterus, no attempt at aspiration could be made, and the case was discarded as not suitable for our purposes.

Radiation Dosage

Radioactive sodium administered intravenously is known to be rapidly distributed in a uniform manner in the extracellular fluid throughout the body (Burch *et al.*, 1947). Assuming uniform distribution, and neglecting loss by excretion, the total radiation dose received by the tissues of both mother and foetus when $1\mu\text{C}$ of Na^{24} per kilo body-weight is used can be shown to be approximately 0.1 equivalent roentgens (Marinelli, Quimby and Hine, 1948). This is the currently accepted maximum permissible daily dose (Medical Research Council, 1949) and also compares very favourably with the estimated radiation dose received by the patient when the placenta is located by radiological methods. Martin (1947) estimates a skin dose of the order of 10 roentgens per exposure, while the ovaries, and presumably the foetus, received 0.1 to 0.5 roentgen as a result of a single radiograph.

Results

We have now attempted to locate the placenta in 255 cases, and have confirmed our prediction as correct in 125 of these, while in 14 cases the prediction was wrong. Confirmation of the prediction was obtained in three ways: some patients underwent Caesarean section because of their obstetric condition; others required manual removal of the placenta; and in a third group, where the placenta was predicted as anterior, aspiration of the supposed placental bed with a

syringe and needle after procaine infiltration produced a characteristic sample of blood. So striking was the correlation between the results of aspiration and the position of the placenta seen at Caesarean section that we came to regard free aspiration of blood as definite evidence that the placenta was situated in that region (see Table III). In the remainder (116 cases) no confirmation of the prediction was obtainable, the patient delivering normally without bleeding, and aspiration of blood not being feasible because of the posterior position of the placenta.

TABLE I
PLACENTAL LOCALIZATION BY MEANS OF NA²¹

Total number of cases	255
Correct	125
Incorrect	14
Not proven	116

Of those predictions proven as correct, 73 were confirmed at Caesarean section, 38 by aspiration, and 14 at manual removal of the placenta.

TABLE 2
CONFIRMATION OF PREDICTIONS

Correct	125
Caesarean section	73
Aspiration	38
Manual removal	14
Incorrect	14
Caesarean section	8
Aspiration	4
Manual removal	2

TABLE 3
CORRELATION BETWEEN PREDICTION BY ASPIRATION AND
CONFIRMATION BY CAESAREAN SECTION

Total	22 cases
Correct	21 ..
Incorrect	1 case

Recently we have discovered a source of error in prediction. It sometimes happens that during injection there is some slight spill into the tissues surrounding the vein. This acts as a strong source of radiation, and as the counter reaches the fundus, abnormally high readings are obtained because of proximity to this source. It is therefore our practice now to place the counter over the site of injection to check that this has not occurred, before scanning the uterus.

Though this method was developed purely for research purposes, it was natural to hope that it might usefully be applied to the diagnosis of placenta praevia. Even with the limitations of the present technique, it has sometimes been possible to show, by virtue of abnormally high readings over the lower part of the uterus, that the placenta was implanted low down, and with experience it has proved possible to obtain an approximate idea

of the position of even a posterior placenta. The method was tried in 43 cases of antepartum haemorrhage, and in all these cases the lower uterine segment was explored digitally under anaesthesia subsequently. In 23 of these cases the placenta was predicted as anterior fundal, with a clearly defined lower margin above the lower uterine segment, and examination under anaesthesia failed to reveal a placenta praevia, although soft tissue radiography and also the Chassar Moir method had both predicted a posterior placenta praevia. In 6 cases we failed to predict placenta praevia when this existed (this may have been due to extra venous spill which was not recognized). In 2 cases we wrongly predicted placenta praevia. In 7 cases we predicted placenta praevia, which was subsequently confirmed by vaginal examination under anaesthesia. There were 5 tests unsatisfactory for various reasons such as extra venous spill or defective apparatus. It is interesting to note that where in a case of antepartum haemorrhage a normally situated placenta was predicted, an accuracy of 86 per cent. was obtained. A negative prediction then is of considerable value.

TABLE 4
CASES OF ANTEPARTUM HAEMORRHAGE

Total number of cases	..
Normal situation predicted and confirmed	..
Placenta praevia not diagnosed	..
Placenta praevia wrongly predicted	..
Placenta praevia predicted and confirmed	..
Test unsatisfactory	..
Failures	..
Correct	32 i.e. 75 per cent

Discussion

The method described is simple, and the procedure can be carried out at the bedside with a minimum of apparatus. Though at first the findings were uncertain, as our experience grew we found the accuracy increasing. At present, in the absence of a recording counter, a high degree of concentration is required on the part of the operator to collate mentally all the readings obtained in the space of two or three minutes; this we hope will be made easier by using a counter which provides an objective record of the readings and the position of the counter when each is obtained; the record can then be studied at leisure.

It is apparent that in its present state the method can only be regarded as an adjunct to the ordinary methods of diagnosis of placenta praevia, but it should be possible to improve its accuracy and therefore its usefulness. When the placenta is anterior, its outlines can usually be clearly demonstrated, a sharp drop in readings occurring

when the counter moves from placenta to uterine muscle only.

Summary and Conclusions

The various methods of localization of the placenta have been briefly reviewed.

A method using radio-active sodium has been described.

The results obtained in 255 cases have been presented.

It is concluded that this method is a useful adjunct to the older radiological methods of diagnosis of placenta praevia, and that it is of value in enabling samples of maternal placental blood to be obtained.

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THE RADIOLOGICAL LOCALIZATION OF THE PLACENTA

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During the latter half of pregnancy plain films of the abdomen show the foetus surrounded by a homogeneous soft tissue shadow which represents uterine muscle, placenta and liquor amnii; the radiographic density of these tissues being identical, special methods have been developed to determine the situation of the placenta.

Methods Employed

1. Amniography

The first attempt to localize the placenta radiographically was made by Menees, Miller and Holly in 1930. They found that the injection of strontium iodide solution through the abdominal wall into the uterine cavity increased the radiographic density of the liquor and revealed the placenta as a crescentic thickening of lesser density on the uterine wall.

Reports of foetal death following the use of strontium led to a search for a less toxic contrast medium; Uroselectan B was used in 10 patients by Kerr and Mackey (1933) and by Burke (1935) in 75 patients; no ill effects were observed in either mother or baby, although in many cases

labour commenced within a short time of injection.

Insertion of the needle through the abdominal wall is a further source of danger, damage to the placenta, cord or foetus having been reported in some cases.

2. Intravenous Placentography

In animal experiments Ehrhardt (1932) and Katsuya (1932) were able to differentiate the placenta from the surrounding tissues following the intravenous injection of thorium dioxide, a radio-opaque substance which is taken up by the placental reticulo-endothelial cells. Unfortunately, thorium is a radioactive substance and is generally considered too dangerous to use as a contrast medium.

In 1939, Ehrhardt was able to identify the placenta in animals as an opaque shadow following the intravenous injection of the phenyl and ethyl esters of tri-iodo-stearic acid. Olsson (1941) employed the same contrast medium in human hepato-lienography (for which it was originally intended), but considered it to be unsafe owing to the dangerous reactions which occurred in some of his patients.