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Unique methods of radiological diagnosis in obstetrics : with emphasis on amniography

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UNIQUE METHODS OF RADIOLOGICAL DIAGNOSIS IN OBSTETRICS,
WITH EMPHASIS ON AMNIOGRAPHY

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I Introduction

Since the discovery of the X-ray and its subsequent adaptation as a diagnostic tool in the field of medicine, roentgenography in pregnancy has come to have an important place in the armamentarium of the obstetrician. Its value in determining the relationships and character of fetal and maternal bony structures is undisputed. However, in complications of pregnancy in which the position, relationship and character of non-osseous structures are important, its value and usefulness have not been as clear cut. It is for this reason that numerous radiologists and obstetricians have proposed various means by which the soft parts of the products of conception might be more clearly defined radiologically.

II Definition

One means by which fetal soft parts, the placenta and the configuration of the uterus may be outlined is by introducing into the amniotic fluid of the pregnant uterus, via the abdominal wall, a miscible radioopaque substance. This, in turn, diffuses throughout the cavity providing a radiographically discernible outline of the structures contained within the amniotic sac as well as those establishing its confines. This technique was given the name, "amniography," by Menees, Miller and Holly.¹

The aim of this paper is to present as adequately as possible a review of the literature pertinent to the subject of amniography as well as a brief look at allied methods of increasing the accuracy of soft tissue roentgenography in pregnancy.

III Amniography in Obstetrics

A. A Review of the Literature

Menees et al¹ first described this method in 1930. These authors used a solution of U.S.P. strontium iodide 1:1 (actual concentration 0.75 gm/cc) as a contrast medium injecting an average of nine to ten cc. in the latter months of pregnancy. They reported twenty-one cases in which there were no injuries or toxic effects to the mother or fetus in normal pregnancies. In a case of placenta previa at the sixth month, the fetus was expelled about thirty hours after injection. The cord was pulsating and the fetus made a few feeble attempts at respiration. The placenta showed a partial separation. It was located low on the anterior wall and may have been perforated in the injection. They felt that the pulsating cord excluded any toxic effect on the fetus. Their films usually showed the location of the placenta by filling defect. However, it was necessary for the placenta to be viewed in profile. Two cases showed the umbilical cord around the neck of the fetus. Sex was determined in four cases by viewing a profile of the scrotum. They found most of the salt to be absorbed in twenty-four hours and greatly decreased in amount in four to five hours.

The initial work by these authors has served as the basis for all later experiments and observations in amniography. In 1932 these authors with Campbell² reported that they observed a distinct outline of soft parts revealing their actual size as an aid in estimation of possible disproportion. In addition, they

felt that amniography offered a precise method of locating the placenta in cases of silent bleeding without the usual dangers attendant on vaginal examination.

Probably the most important early work in amniography, though not the earliest chronologically, was that done by Kerr and Mackay³ in Edinburgh in 1933. At first, they used fifteen grams of strontium iodide in ten patients. Although in most cases no harm resulted, in three patients the fetal heart sounds and fetal movements stopped and, shortly afterwards, a dead fetus was expelled. Their cases differed from those of the early American workers in that they were not examples of normal pregnancy but examples of pregnancy complicated by severe hemorrhage. They found that a reduction in the dosage of strontium iodide did not result in good enough visualization and forthwith changed to Uroselectan B (a complex organic iodide). The latter they felt to be nontoxic and non-irritating and found that twenty cc. injected into the amniotic fluid gave a suitable shadow. They used Uroselectan B in ten cases with no untoward effect on either mother or fetus, except the tendency of the injection to terminate pregnancy. Their cases varied in gestation from twenty-four to forty weeks. In each case there had been severe prepartum bleeding; every child was born alive, though perhaps premature. The four born in the twenty-fourth week did not survive, but the rest lived with no adverse effects.

The location of the placenta was checked in each instance by intrauterine palpation following delivery of the fetus. In the

first two only P-A and lateral films were obtained. The lateral film in the first case was inadequate. The second case was that of twins and only one sac was injected.

These authors differentiated between accidental hemorrhage and placenta previa by observing whether the defect appeared in the upper or lower part of the uterus.

In ten of their cases (50%) injection was followed by labor in a few hours to five days. However, it is impossible to say how many of these cases would still have gone into labor prematurely if injection had been withheld. Surgery was performed in three cases immediately after the diagnosis. These, too, might have gone into labor. They felt that, due to the likelihood of induction of labor the method should be restricted to cases in the latter weeks of pregnancy.

The authors point out several entities which may be mistaken for the placenta: (1) coils of intestine overlapping the uterus; (2) compression of the uterus by surrounding structures; (3) a blood clot between the thin membranes and the wall of the uterus; (4) fibroids; (5) a second ovum within the uterus. Factors which the authors felt might reduce the accuracy of the observations in regard to the exact variety of conditions present are: (1) a placenta which is not exactly edgewise results in a smaller shadow; (2) the placenta may be thinned out at the edges resulting in difficulty in determining placental margins; (3) a blood clot at the edge of the placenta tends to make it appear larger than it really is.

These men felt that all these various hazards in accurate visualization and interpretation could be overcome by taking oblique views as well as the usual A-P and lateral ones.

Adair and Davis⁴, in 1934, studied Skiodan (Abrodil) as a material for use in amniography. They found fifteen to thirty cc. of a 40% solution the best for good visualization. They noted that it disappeared in five days and was not broken up into free iodine. They postulated that it passed through the amnion into the maternal circulation. In addition to the findings of previous investigators these authors pointed out that the skeleton of the fetus stands out more clearly.

On the Continent in 1934, Cetroni and Azzariti⁵ were delving into the possibilities of amniography. They studied X-rays of pregnant uteri from the seventh to the ninth month in twenty-five women following the injection into the amniotic sac of radio-opaque substances. They did not get satisfactory results with potassium and strontium iodide. However, with Uroselectan they obtained good radiographs and no maternal or fetal harm was observed. In two cases in which the opaque substance was injected during labor, the placentas were X-rayed after expulsion. The plates clearly illustrated the vascular system of the placenta. The authors felt that this proved that the opaque substance passed into the fetal circulation.

Back in the United States in 1934, Cornell and Case⁶ reported their adverse experience with the method of amniography. The primary purpose in their study was to evaluate Neoskiodan as a

radioopaque substance for use in amniography. They injected six cases and in each instance punctured the placenta. They injected only patients scheduled for Caesarian section or who were in active labor. In two cases, the puncture penetrated through Schultze's fold in the cord and in one of these it was within one mm. of one of the large fetal vessels. One of the authors states:

"I felt that the risks taken with the mother and baby were too great for me to do anything more with it and I stopped. I was satisfied that Neoskiolan was a good medium to use for differentiation. Unless some new problem presents itself, it would be wise to discontinue intrauterine injections." (Cornell⁶)

This article has subsequently been used by authors as one of the major criticisms of the method under discussion in this paper.

DeLee⁷ as editor of the Yearbook of Obstetrics and Gynecology comments in an editor's footnote in 1934 that he had watched the development of amniography with much interest and concluded that the gain in knowledge does not compensate for the slight danger involved. Again in the 1935 edition⁸ he stated that they had tried out the method extensively at the Chicago-Lying-In Hospital and again asserted the element of danger outweighed the value of the information obtained. DeLee repeated a similar statement on the matter again in 1938⁹ and in 1948¹⁰.

Burke¹¹ in Great Britain, in 1935, reported the use of amniography in twenty-three cases of normal and abnormal pregnancy all near or at term. In seventeen cases the medium utilized was

Uroselectan B. The placenta was visualized in twelve of these. Of the five failures the author attributed four of these to the use of films which were too small (twelve by fifteen inches). Of the ten using larger films (fourteen by seventeen inches) nine were accurate in the diagnosis of placental location. The author used Per Abrodil in three cases. Two of these failed to locate the placenta and in one of these, small films were used. Strontium iodide was used in two cases, one of which showed satisfactory results. In two cases in which fetal death had already occurred, the author injected a solution of barium sulfate. This resulted in a precipitate which was adherent to the fetus, to the walls of the uterus and in general gave poor radiographic visualization.

Burke felt that the interpretation of the roentgenographs obtained in amniography is likely to be difficult only if the placenta is implanted in the upper part of the uterus. In this region the thickness of body tissue requires greater penetration, the shape of the fundus is inconsistent, and intestinal gas shadows are apt to obscure the outline of the amniotic cavity. In the lower part of the uterus, however, there is less thickness of tissue to penetrate, the outline of the lower uterine segment is evenly rounded and there are no extra-uterine structures to cause interference.

This author felt that it was highly significant that the radiological diagnosis was accurate in all cases of placenta previa he investigated. Since the various radioopaque substances used are excreted by the kidneys, he felt it wise to refrain from employing

amniography in the presence of severe renal disease in the mother.

Burke attempted induction with Uroselectan B in twenty-seven cases (postmaturity, 11; contracted pelvis, 5; valvular heart disease, 3; bad obstetrical history, 1; maternal distress, 1; and fetal abnormality, 1). Labor ensued in twenty-six of these, the failure being a case of polyhydramnios.

He reported that he punctured the uterus via the abdomen seventy-five times with no evidence of injury to either mother or fetus. Of two neonatal deaths, one was premature (thirty-fourth week) and the other showed developmental abnormalities. He had three stillbirths: (1) anencephalic, (2) cerebral hemorrhage after a difficult forceps delivery, (3) unexplained even after autopsy which showed no trauma or toxic damage.

This author, who presented the most extensive experience, analysis, and reporting in the literature, concluded that the main value of amniography appeared to be its use for or against delivery by Caesarian section.

In a short report Uzeta¹² presented another view of the value of this method. This author performed intrauterine photography in two pregnant women by injecting twenty to forty cc. of Umbrenal (Uroselectan). Both patients were multiparas with good obstetrical histories. He reported that this injection caused a great disturbance of both of the fetuses, as shown by jerky movements. One of the fetuses died and its mother was in shock for several hours.

In a discussion of the dependability of radiology in obstetrics, Roberts¹³, in 1936, pointed out that the weakness of amniography lies in the fact that unless the outer surface of the uterus happens to be outlined by gas in the bowel it is often a matter of great difficulty to locate precisely the filling defect caused by the placenta. He felt the method gives rise to too great a possibility of radiological misinterpretation to be regarded as universally reliable. He further questioned its applicability to certain cases, such as patients with scanty liquor amni.

Shanks, Kerley and Twining¹⁴, in their text of X-ray diagnosis, cautioned against the attempted puncture of the uterus via the abdominal wall if the latter shows a scar as one might puncture adherent bowel intervening between the two.

Szendi¹⁵ in Hungary, in 1940, reported the injection of contrast substances such as Thorotrast and Uroselectan B into the liquor amni from the first to the sixth month of pregnancy and then took radiographs. He decided that although such embryographic studies are harmless they should not be used extensively.

Utzuki and Hashidzume¹⁶, in 1941, were able to outline all parts of the fetus by means of injection of iodized oil into the amniotic cavity. In addition to the findings of other authors, they were able to demonstrate edema of the newborn and separation of the surface of the skin in dead babies.

Lefebvre, Granjon and Meric¹⁷ reported the injection of opaque material into the amniotic cavity as simple and practically

without danger. They stated that materials of the Per Abrodil or Diodrast type were satisfactory for this purpose.

In 1948, Portes, Lefebvre and Granjon¹⁸ stressed the importance of avoiding a change in intra-amniotic pressure by making sure the volume of liquid injected was equal to that of amniotic fluid withdrawn. They felt this to be an important factor in insuring the safety of the procedure. They also pointed out that the resorption of opaque material makes the process one of amniocystography and that the additional views of the bladder filled with opaque material aids in the diagnosis of low lying placenta.

Reporting on four cases of amniography in 1949, Fabre¹⁹ states that no maternal complications were observed, but that, in each case, injection was followed by the onset of labor within six to twenty-four hours. In addition, this paper reported amniography as being of value for determining the thickness of uterine muscle and the diagnosis of premature rupture of membranes. Fabre used twenty cc. of Tenebryl B for a radioopaque dye.

Perhaps the most enthusiastic report on amniography, in the face of the previous articles as listed above, was that of Savignac²¹, in 1953. This author reviewed the findings of previous workers and added nine cases of his own.

In addition to the findings of previous workers he pointed out that amniography in multiple pregnancies reveals whether they are unamniotic or biamniotic, as well as the presence of a single or double placenta. His films at three hours post-injection

showed: (a) Diodrast is absorbed into maternal circulation even if the fetus is dead indicating that the amniotic membrane is active in absorbing it; (b) If the fetus is alive Diodrast is seen in fetal bowel from which it passes to fetal and then to maternal circulation at a faster rate than in the former instance. Also, fetal gastrointestinal tract anomalies (esophageal or duodenal atresia), though rare, may be demonstrated prior to birth. In addition, withdrawn amniotic fluid may be used for chemical analysis, complement fixation tests and other serological and biological tests.

Since cases of polyhydramnios have such a high percentage of fetal monstrosities, this author felt that this condition was almost an absolute indication for the use of amniography.

Dr. Savignac described carefully the technical factors important in producing accurate and safe results with amniography. He first took a soft tissue X-ray of the fundus to locate the placenta, if possible, although he had punctured the placenta without untoward results. He inserted a twenty-gauge spinal tap needle into the midline of the mother's abdomen in the paraumbilical region within two inches of the navel, being careful to avoid bowel. The author used novacaine in the skin and down to the peritoneum. The point of the needle was aimed into the pool of amniotic fluid just caudal to the chin and in front of the fetal chest wall. Thus, one needs a correct diagnosis of fetal position, as obtained from at least one very recent A-P film for this purpose. The mother's bladder should be empty. Forty cc. of 70% Diodrast are injected after the

withdrawal of an equal or greater amount of amniotic fluid. The patient is then rolled from side to side, cephalad and caudad and allowed to walk around. Films are then taken at the end of one-half hour, A-P, lateral and oblique views. The patient is then sent to her room and requested to refrain from urinating, if possible. Three-hour films of the abdomen are taken.

B. Nine case Reports from the Literature

In Savignac's series of nine cases, he states that he did not produce the onset of labor in any. A summary of these cases follows.

Case I: Normal term pregnancy with excessive bloody show just prior to onset of labor. Both the preliminary films and the amniographic studies showed the placenta implanted high in posterior uterine fundus. No mention of time of onset of labor or condition of fetus at birth is made although the fetus was seen to swallow radioopaque amniotic fluid in utero.

Case II: Multipara at six and a half months, suffering from repeated hemorrhages. Preliminary films did not show placenta but fetus was in transverse position. Amniography demonstrated the placenta in the lower right uterine segment. The patient was sustained with transfusions and a live baby delivered at eight and a half months.

Case III: Admitted at term after painless bleeding (250 cc.). Preliminary roentgenograms showed placenta in upper posterior fundus. Amniography showed presence of rounded tumor

pressing against the amniotic sac at the junction of the middle and distal third of the sac. Delivery was accomplished with difficulty from below. Presence of the tumor was confirmed by the obstetrician.

Case IV: Elderly primipara with no engagement in spite of an adequate pelvis. Amniography showed the placenta high and a tumor was identified in the lower right uterine segment. Caesarian hysterectomy was performed and the fibroid tumor was demonstrated.

Case V: Polyhydramnios, twin pregnancy, suspected fetal death. 60 cc. 35% Diodrast did not give enough contrast. Two weeks later twins were delivered spontaneously, one alive and one stillborn. The author felt the excess fluid should have been removed and 50 cc. or more 70% solution used.

Case VI: Suspected death, term. Plain X-rays were not diagnostic as no definite overlapping of cranial bones was seen. No fetal swallowing or GI activity was seen either at three hours or at twenty hours. The patient was delivered four days later of a dead macerated fetus.

Case VII: This primipara had several episodes of painless vaginal bleeding in the last month of pregnancy. Preliminary X-rays revealed a breech presentation. The placenta was thought to be high on the uterine wall. Three weeks later X-rays showed vertex presentation. Amniography revealed this placenta to be low on right posterior uterine wall, partially covering the internal os. Caesarian section was done and confirmed this location. The amniocystogram was of definite help as it showed the thickness of the soft

tissue of uterine and bladder wall.

Case VIII: Bleeding began at full term with definite and regular contractions. The placenta was found to be in the lower uterine segment. On amniography the needle evidently entered the placenta as at first nothing but blood could be withdrawn. The needle was pushed in up to the hilt and it was thought a mixture of amniotic fluid and blood was withdrawn. The entire 40 cc. of contrast medium was injected and the patient experienced one of the systemic vasomotor types of reactions ordinarily seen with intravenous injections of Diodrast. X-rays showed a pool of Diodrast in the placenta and a half an hour later an excretory urogram of the mother showed a characteristic maternal urinary tract plus duplication of the left ureters.

Spontaneous delivery occurred three days later. The fetus was alive and well and there was partial separation of the placenta which the attending obstetrician felt antedated the attempted amniography.

Case IX: Bleeding and uterine cramps occurred in the seventh month. Simple X-rays showed no definite and reliable placental image. Amniograms showed the placenta high on the left posterior wall of the uterus. The uterine cramps continued and in less than twenty-four hours a live fetus was delivered. The obstetrician was of the opinion that labor was already in progress when amniography was performed. A diagnosis of premature placental separation was made following birth.

The author was apparently not impressed with any tendency for Diodrast to initiate the onset of labor. From his case reports one is inclined to be somewhat suspicious of the rather prompt deliveries in three instances (Cases I, VIII and IX).

C. Amniography by Vaginal Puncture

Another method by which intraamniotic injection has been done was reported by Hewitt²². He inserted a needle through the vaginal wall into the uterus at several points and injected one cubic centimeter of lipiodol at each point. He expected that where there was no placenta the opaque substance would run down the inner surface of the uterus, whereas if the placenta was entered by the needle the opaque substance would be retained in the placental tissue in the form of spherical globules. It was found, however, in practice that the lipiodol did not run towards the cervix when the patient was recumbant but ran backwards towards the sacrum. As a result of this a streak of lipiodol on the inner surface of the uterus might be represented in the radiograph as an irregular dot. Moreover, he found that the opaque substance in the placenta did not always assume a spherical outline. It was, therefore, impossible to say whether the placenta had been injected or not, and consequently whether placenta previa was present or not. One would also question the advisability of injecting lipiodol into an area where it might easily enter either maternal or fetal circulation.

D. Intravenous injection of contrast media

Reid²⁰ in 1949 reviewed the literature on the subject

of intravenous placentography. He stated that there was not at that time any satisfactory contrast medium for direct visualization of the placenta. He reported that thorium dioxide was the first substance to be investigated for this purpose by Ehrhardt²³ (1932) and Katsuya²⁴ (1932). It had already been shown that the liver and spleen shadows could be intensified, following intravenous injection of thorium, the latter being retained by the reticulo-endothelial cells in these organs. For the same reason it was considered likely that the placenta might also be demonstrated radiologically. Such experiments, the author states, were partly successful, but, unfortunately, fetal death often resulted. In any case, further trials would not have been warranted, he felt, in view of the latent danger inseparable from the use of a radioactive substance such as thorium.

He reported that early hopes were unfulfilled in the case of phenyl and ethyl esters of the tri-iodo-stearic acid (also known as Vaso-selectan, Iodosol, etc.)

Ehrhardt (1939)²⁵, in animal experiments only, showed that a satisfactory opaque shadow of the placenta could be obtained following intravenous administration of this medium (Vasoselectan), and that its duration allowed ample time for radiography. Other German workers, Beckerman and Papke (1938)²⁶, used the same preparation successfully in human hepatosplenography, the only ill effects reported being transient side reactions. The safety claimed for this method was challenged by Olsson (1941)²⁷, owing to the dangerous secondary effects which occurred in some of his

patients. At the time of Reid's report intravenous amniography had not yet found a place in obstetric diagnosis.

Rocca and Romussi²⁸, in 1952, demonstrated that amniotic fluid could be made visible by intravenous injection of contrast solutions. (The type used is not mentioned.) They found that the opaqueness of amniotic fluid is much more intense in the first three months of pregnancy than later on; it may be so dense as to make the fetal parts invisible. However, they felt it might reveal several points of interest in connection with the site of the placenta and the shape of the uterus. These authors postulate that the time of the appearance of the contrast medium in the amnion can be used as a measure of the mother's renal function in pregnancy. They found that intravenous pyelography proved to be harmless to the fetus.

IV Other Methods of Clarifying Radiologically Uterine and Intra-Uterine Soft Tissues.

A Aortography in Obstetrics.

Stressing the need for further evaluation, Campbell²¹, in 1951, reported the use of direct abdominal aortography. He injected approximately twenty cubic centimeters of 70% Diodrast or Neolopax through a long eighteen-gauge needle into the upper abdominal aorta. A P-A survey film was made within seven seconds of the beginning of the injection. He used a blood pressure cuff tightened about each thigh to a level which temporarily occluded both femoral arteries. He found that this method demonstrated the limits and position of the placental circulation sufficiently well to permit exclusion of placenta previa. Unfortunately, he does not report any cases in which it was used.

B Pneumoperitoneum.

Spiedel and Turner³⁰ have used the method of pneumoperitoneum for aid in the diagnosis of pelvic and obstetrical abnormalities. They inject one to one and a half liters of filtered carbon dioxide into the peritoneal cavity and utilize the contrast obtained for outlining soft tissue structures covered by peritoneum. They stated they were able to demonstrate pregnancy in its early stages (widening of the lower uterine segment), the fibroid uterus in pregnancy, extrauterine pregnancy, presentation of the fetal head in the lower uterine segment, and various types of placenta previa.

C. Cystography

Ude and Robbins³¹ reported in 1938 a series of cases in which they had used indirect placentography or cystography in the roentgen diagnosis of placenta previa. Their experience with this method had extended over a period of five years and included in seventy-nine cases. They stated that if the roentgenogram revealed a normal fetal part-bladder relationship, placenta previa could be ruled out. However, if the soft tissue shadow were wider than normal it might be: (1) placenta previa; (2) feces and/or gas in the rectum or; (3) a compound or other abnormal presentation. These authors urged a careful correlation of clinical findings with X-rays.

In a series of 100 cases of third trimester hemorrhage in which cystography was used, Beck and Light³² reported the method to be accurate in seventy-nine of eighty-four suitable cases. They considered sixteen cases to be unsuitable due to breech or transverse presentations. In all, twenty-one positive cystograms were obtained and each one had placenta previa demonstrable at the time of delivery. However, there were five cases in which the cystogram was negative but the patients were shown to have placenta previa clinically.

D. Soft Tissue Roentgenography

Perhaps the most widely-used method of determining the location of placental implantation is soft tissue X-ray technique. Snow and Powell³³ reported in 1934 that the placenta could be visualized in 90% of the cases by an ordinary lateral roentgenogram of

the uterus. They used no special technique and stressed the fact that only a reasonable amount of technical accuracy in making exposures was all that was necessary. In his book in 1953 Snow³⁴ made a special effort to point out that amniography offers no advantage over ordinary roentgenography. He reported one case of suspected fetal death in which he had localized the placenta posteriorly by roentgen visualization. Diodrast was injected and could be recognized as such on the film. However, it was his opinion that more information relative to the location of the placenta and the amount of amniotic fluid present was obtained from the preliminary film. His work with such cases indicated that about 50% of the time injections of contrast media tended to collect between the uterus and the placenta, when the latter was located anteriorly, followed by untoward results.

He reports that over 12,000 roentgen studies of pregnancy close to term were carried out by him and his group up to 1949. In this series, using soft tissue technique, the placenta was located, either anteriorly or posteriorly, in 90% of the cases. The findings were checked at operation in many instances over a period of many years. He concludes:

"Since such a simple lateral view of the uterus discloses the placenta, it is irrational to subject the patient to such a dangerous procedure." (Snow³⁴)

V Amniography in the Study of Fetal Physiology

As mentioned above, amniography provides an excellent means by which intrauterine fetal activity may be observed. Since the living fetus actively swallows amniotic fluid the entire fetal gastrointestinal tract is outlined radiographically by rendering the amniotic fluid radioopaque.

A. Respiratory Tract

Amniography has been used by several authors in studying the respiratory activities of the fetus in utero in an attempt to demonstrate whether or not amniotic fluid normally passes into the lung of the fetus prior to delivery, a subject of much controversy among recent workers.

In one of the studies of human embryos, Szendi¹⁵, in 1940, showed that as early as the eighth week of pregnancy fetuses exhibit regular and physiologic movements of the chest, pulmonary activity, swallowing movements and activity of the gastrointestinal tract. In a 26 mm. embryo he demonstrated liquor amni entering the newly-developing lung and gastrointestinal tract.

In 1941 Ehrhardt³⁵ studied human fetuses in the sixth and seventh months of pregnancy. His studies showed no regular demonstrations of Thorotrast shadows in the lungs. In fact, it was frequently absent. In contrast to this was the X-ray demonstration of Thorotrast in the gastrointestinal tract of all living fetuses.

The most carefully reported amniographic studies in human fetal physiology were reported by Davis and Potter³⁶, 1946.

They experimented with two groups of patients. The first group consisted of sixteen women in the first half of gestation in whom therapeutic abortion was indicated. The second group was composed of ten patients at or near term in whom Caesarian section was to be performed. They withdrew amniotic fluid and injected Thorotrast (thorium dioxide). As soon as the cord was tied on the delivered fetus a chest X-ray was taken. In the first group (therapeutic abortions) pregnancy terminated in 30-60 minutes in four. These fetuses showed no Thorotrast in the lungs. The twelve others were terminated 17-52 hours after injection and all showed Thorotrast in the fetal lungs. In the ten cases of delivery by Caesarian section five fetuses showed Thorotrast in the lungs, two showed probable presence and three had no evidence of Thorotrast in the respiratory tract.

The findings presented by Davis and Potter were strongly contested by Windle and Becker³⁷ who stated that the studies lacked adequate controls such as X-rays of the fetus at regular intervals through the intact maternal abdomen. They expressed what seems to be the most logical and sensible opinion regarding intrauterine respiration when they stated that the lung of the normal apneic fetus is apparently in complete atelectasis with unexpanded respiratory bronchioles, alveolar ducts and alveolar sacs. They did find in their studies on human, sheep, goat and guinea pig fetuses (References 37 and 38) the aspiration of amniotic contents and dilation of respiratory passages whenever any factor,

even very slightly, intervenes at operation to alter the blood gas relationship sufficiently to stimulate the respiratory center and initiate respiratory movements in amnio.

B. Gastrointestinal Activity

Using guinea pig fetuses for their experiments, Becker, Windle and Barth³⁹ found that they begin to swallow about the forty-second day of gestation. They noted that the efficiency and speed with which material is propagated through the tract increases progressively with the age of the fetus. Defecation was demonstrated to begin late in fetal life, not before the sixtieth day, as a normal phenomenon. They reported that it has been suggested but not proven that swallowing amniotic fluid may be important from the standpoint of prenatal water metabolism. They pointed out that it is significant that swallowing begins when the growth rate is most rapid. In rabbits at this point efficiency of fluid exchange in the placenta begins to diminish.

Another investigator interested in this branch of fetal physiology was Rosa⁴⁰. In 1951 he reported on the use of 400 ml. of 50% Ambrodyl introduced into the amniotic cavity for the study of fetal deglutition. Serial radiographs showed the fetus swallowing amniotic fluid. From his studies he concluded that the fetus swallows approximately 500 ml. of amniotic fluid per twenty-four hours. Forty ml. of this is excreted again by the kidneys and returned with the urine to the amniotic cavity. The amount that enters into the composition of the interstitial fluids was estimated

at 25 ml. The rest follows the transplacental route via the mother's blood and is excreted by her kidneys. He postulated that a certain amount of amniotic fluid is presumably resorbed by the epithelium in such a way as to re-establish hydraulic equilibrium.

Speert⁴¹ in 1943 studied gastrointestinal activity in four fetal monkeys following the intra-amniotic injection of Thorotrast. He was able to demonstrate gastrointestinal tract activity, but interestingly enough did not find evidence of the normal occurrence of defecation in utero. One suspects he would probably have observed this phenomenon had his study been more extensive.

VI Summary and Evaluation

- A. Cases of human amniography in the literature—See Chart I.
- B. The value of amniography as compared to other methods of roentgenological obstetrical diagnosis.

Amniography was introduced into radiology and obstetrics primarily for the purpose of diagnosis of the complications and abnormalities of pregnancy, and especially placenta previa.

From a technical radiological point of view, using a suitable diffusible contrast medium and the recommended X-ray technique, the roentgenographs obtained give uniformly good results. The placental implantation site is located with a high degree of accuracy. Fetal soft tissue parts are distinctly outlined revealing fetal anomalies and in some instances the location of the umbilical cord and the sex of the fetus. The uterine wall is delineated revealing any gross abnormalities which it may contain such as tumors which might be the cause of malpresentation. Later films outline the fetal gastrointestinal tract as well as the maternal urinary tract due to the excretion therein of contrast medium absorbed from the amniotic fluid. The latter phenomenon adds to the accuracy of diagnosis by opacifying the mother's bladder and thereby demonstrating its relationship to the lower uterine segment.

On the other hand, the dangers and risks involved in gaining this most useful information must be carefully considered. First of all, the very act of introducing a needle through the

abdominal and uterine wall carries with it inherent difficulties. The maternal bowel may be punctured if it intervenes between the two muscular layers penetrated. Very frequently, at least 50% of the time, the placenta is located anteriorly on the inner wall of the fundus and the needle penetration into it may cause rupture of a sinus or sinuses resulting potentially in separation. Furthermore, puncture of the umbilical cord has been reported. (Reference 6) Thus, the danger of fetal hemorrhage is always imminent in this procedure. Infectious organisms may be introduced into this previously sterile culture medium. Last, but not least, is the possibility of the needle penetrating a vital portion of the fetal body. There have been no instances reported of serious injury to the fetus in this manner, although several instances of puncture of fetal skin in innocuous locations have been reported.

Another factor which must be considered in evaluation of this procedure is the advisability of injecting a foreign material into the amniotic fluid. Certainly radioactive substances such as thorium dioxide (Thorotrast) constitute a definite risk, immediate and long-term, both in the mother and in the fetus, due to its collection by and storage in the reticulo-endothelial system. Uroselectan has been very adequately incriminated as causing onset of labor. There is some question in this writer's mind as to whether or not any puncture of the amniotic cavity might not result in a sufficient change in the hydrodynamic equilibrium to initiate uterine contractions and resultant expulsion of the fetus.

With the ever-present possibility of injecting the contrast medium directly into the venous circulation one also runs the risk of a reaction to the substance. With present-day contrast media such as Diodrast this danger can be minimized but not eliminated.

The commonly-used methods of roentgenological diagnosis in pregnancy, soft tissue X-ray and cystography have, in good hands, extremely good accuracy (above 90% with the use of the former method alone) in the diagnosis of the most common problem, placenta previa, and carry little risk. These aids along with the clinical observations and judgment of the well-qualified obstetrician seem to this writer to be most adequate in any obstetrical situation. I am in complete agreement with DeLee^{7, 8, 9, and 10} when he states that the amount of information gained by amniography is not valuable enough to offset the dangers to the mother and child.

Amniography, when used as a research tool in the study of fetal and maternal physiology, is truly valuable only when human lives are not at stake. This situation obtains in laboratory animals and in human pregnancies already scheduled for therapeutic abortion and in the latter case only in the best of hands.

As for the other methods of radiological diagnosis, the methods of intravenous amniography and pneumoperitoneum seem to be worthy of further study. Amniography by vaginal puncture failed in its beginning. Aortography carries its own peculiar dangers, dangers which this writer feels are too great to add to the already perilous situation of a complicated pregnancy.

VII Conclusion:

The experience of eighteen authors with 113 cases of amniography in humans is reported. Nine case reports from the literature are recorded. A brief discussion of the allied methods of roentgenological diagnosis in pregnancy--aortography, pneumoperitoneum, cytography and soft tissue X-ray--is included for completeness. Experience with amniography in fetal physiology and some of the findings obtained thereby indicate the usefulness of the method in this field. Finally, the dangers of transabdominal amniography are presented and compared with the knowledge to be gained and discussed with emphasis on the unfavorable disparity.

CHART I

SUMMARY OF REPORTED CASES OF AMNIOGRAPHY *

Author	No. Cases	Contrast Medium	Radiographic Results	Complications as a result of the procedure
Menees ¹	22	Strontium iodide	Satisfactory	One case of prior hemorrhage, fetus expelled 30 hrs after injection.
Kerr ³	10	Strontium iodide	Satisfactory	3 cases of intrauterine fetal death followed by expulsion.
Cetroni ⁵	25	(Potassium and Strontium iodide)	Unsatisfactory	No maternal or fetal harm.
		(Uroselectan B)*	Satisfactory	
Cornell ⁶	6	Neoskiodan	Satisfactory	In 2 cases cord punctured with no fetal harm. In all, 6 placentas punctured. No toxic effects.
Burke ¹¹	17	Uroselectan	Placenta seen in 12	Induced labor.
	3	Per Abrodil	1 placenta seen	None.
	2	Strontium iodide	1 case good	Likely to prove harmful.
	2	Barium sulfate	Precipitated, gave poor films	Used after fetal death.
Uzeta ¹²	2	Uroselectan	Satisfactory	Fetal distress (2), fetal death (1) and 1 mother in shock.
Fabre ¹⁹	4	Tenebryl B	---	Labor within 6-24 hrs.
Savignac ²¹	9	Diodrast	Excellent	One case had vasomotor reaction to Diodrast.
Snow ³⁴	1	Diodrast	Poor (not as good as preliminary film)	---

*By transabdominal injection.

VIII Bibliography

1. Menees, T. O.; Miller, J. D., and Holly, L. E.: Amniography, Preliminary Report. *Am. J. Roentgenol.* 24:363-366 (Oct.) 1930.
2. Campbell, A. M.; Miller, J. D.; Menees, T. O., and Holly, L. E.: Diagnostic Value of Radiopaque Contrast Media in Gynecology and Obstetrics. *Am. J. Obst. and Gynec.* 24:542-552 (Oct.) 1932.
3. Ferr, J. M. M. and Mackay, W. G.: The Diagnosis of Placenta Previa with Special Reference to Employment of X-rays for this Purpose. *Edinburgh M. J.* 40:21-32 (March) 1933.
4. Adair, F. L. and Davis, M. E.: Amniography with Skiodan (iodine Preparation) Injections; Preliminary Report. *Am. J. Obst. and Gynec.* 26:881-884 (Dec.) 1933.
5. Cetroni, M. and Azzariti, M.: Uber die Amniographie. *Clin. ostet.* 35:449 (Aug.) 1933. (Abstract: DeLee, J. B. and Greenhill, J. P., Editors: Yearbook of Obst. and Gynec., Chicago, The Yearbook Publishing Company, 1934, pp. 51-52.)
6. Cornell, E. L. and Case, J. T.: Neoskiodan in Amniography. *Am. J. Obst and Gynec.* 27:894-896 (June) 1934.
7. DeLee, J. B.: Editor's Notes, Yearbook of Obst. and Gynec., Chicago, The Yearbook Publishing Company, 1934, p. 51.
8. *Ibid*, 1935, pp. 251-252.
9. *Ibid*, 1938, p. 36.
10. *Ibid*, 1948, p. 99.
11. Burke, F. J.: Amniography. *J. Obst. and Gynaec. Brit. Emp.* 42:1076-1106 (Dec.) 1935.
12. Uzeta, H.: Intrauterine Photography. *Rev. cir. Mexico* 6:309 (Mar.) 1935. (Abstract: DeLee, J. B. and Greenhill, J. P., Editors: Yearbook of Obst. and Gynec., Chicago, Yearbook Publishing Company, 1935, p. 251.)

13. Roberts, R. E.: Radiology in Obstetrics: A Consideration of Its Dependability. *Brit. J. Radiol.* 12:97-103 (July) 1936.
14. Shanks, S. C.; Kerley, P., and Twining, E. N.: A Text-Book of X-Ray Diagnosis, London, H. K. Lewis and Company, Ltd., Vol. II, pp. 436-442.
15. Szendi, B.: Weitere Aufklarung der Morphologie und Biologie des Schwangeren Uterus und des Fetallebens mittels Roentgenuntersuchungen (Embryographie) *Arch. Gynak.* 170:429-456, 1940. (Abstract: DeLee, J. B. and Greenhill, J. P., Editors: *Yearbook of Obst. and Gynec.*, Chicago, Yearbook Publishing Company, 1941, pp. 263-264.)
16. Utzuki, A. and Hashizume, H.: Amniographie. *Zentrabl. Gynak.* 65:195-200 (Feb. 1) 1941. (Abstract: DeLee, J. B. and Greenhill, J. P., Editors: *Yearbook of Obst. and Gynec.*, Chicago, Yearbook Publishing Company, 1941, p. 261.)
17. Lefebvre, J.; Granjon, A. and Meric, A.: L'amniographie. *J. radiol. et electrol.* 29:601-605, 1948. (Abstract: Wijsenbeek, I. A., Editor: *Section 10, Obst. and Gynec.*, *Excerpta Medica*, Amsterdam, 1950, 3:6.)
18. Portes, L.; Lefebvre, J. and Granjon, A.: L'amniographie. *Gynec. et Obst.* 47:378-381, 1948. (Abstract: Wijsenbeek, I. A., Editor: *Section 10, Obst. and Gynec.*, *Excerpta Medica*, Amsterdam, 1949, 2:11.)
19. Fabre, M.: Four Amniographies. *Bull. Assoc. Gynec et obst.* 1: 527-528, 1949. (Abstract: Wijsenbeek, I. A., Editor: *Section 10, Obst. and Gynec.*, *Excerpta Medica*, Amsterdam, 1950, 3:423-424.)
20. Reid, F.: Radiological Localization of Placental Site; Normal Implantation. *Brit. J. Radiol.* 22:557-566 (Oct.) 1949.
21. Savignac, E. M.: Amniography, A Valuable and Safe Aid to Obstetrical Diagnosis. *Radiology* 60:545-557 (April) 1953.
22. Hewitt: Quoted by Kerr, J. M. M. and Mackay, W. G. ³
23. Ehrhardt: Quoted by Reid, F. ²⁰
24. Katsuya: Quoted by Reid, F. ²⁰
25. Ehrhardt: Quoted by Reid, F. ²⁰

26. Beckerman and Papke: Quoted by Reid, F. ²⁰
27. Olsson: Quoted by Reid, F. ²⁰
28. Rocca, R. and Romussi, P.: Functional Amniography by Means of Hystero-urography or Pyelography. Riv. Ital. Ginec. 35/5:343-396, 1952. (Abstract: Wijzenbeek, I. A., Editor: Section 10, Obst. and Gynec., Exerpta Medica, Amsterdam, 1953, 6:367.)
29. Campbell, J. A.: X-Rays in Obstetrics. Nebraska M. J. 36:3-7 (Jan.) 1951.
30. Spiedel, E. and Turner, H. H.: The Roentgen Ray Diagnosis of Normal and Abnormal Pregnancies. Am. J. Obst. 7:699-702, 1924.
31. Ude, W. A. and Robbins, O. F.: Roentgen Diagnosis of Placenta Previa, Indirect Placentography. Am. J. Roentgenol. 40:374-42 (July) 1938.
32. Beck, A. C. and Light, F. P.: Use of Roentgen Rays in the Diagnosis of Placenta Previa. New York J. M. 39:1678-1684 (Sept.) 1939.
33. Snow, W. and Powell, C. B.: Roentgen Visualization of the Placenta. Am. J. Roentgenol. 31:37 (Jan.) 1951.
34. Snow, W.: Roentgenology in Obstetrics and Gynecology, Springfield, Illinois, Charles C. Thomas Company, 1952, pp. 187-202.
35. Ehrhardt, K.: Weitere Erfahrungen mit meiner Methode der Intraamnioten Thoriumingelation (fetale Organographie). Zentralb. Gynak. 56:114-120 (Jan. 18) 1941. (Abstract: DeLee, J. B. and Greenhill, J. P., Editors: Yearbook of Obst. and Gynec., Chicago, Yearbook Publishing Company, 1941, p. 264.
36. Davis, M. E. and Potter, E. L.: Intrauterine Respiration of the Human Fetus (with aspiration of amniotic fluid). J. A. M. A. 131:1194-1201 (August 10) 1946.
37. Windle, W. F. and Becker, R. F.: Intrauterine Respiration of the Fetus. J. A. M. A. 133:125 (Jan. 11) 1947.
38. Windle, W. F.; Becker, R. F.; Barth, E. E., and Schulz, M. D.: Aspiration of Amniotic Fluid by the Fetus: Experimental Roentgenological Study in Guinea Pig. Surg. Gynec. and Obst. 69:705-712 (Dec.) 1939.

39. Becker, R. F.; Windle, W. F.; Barth, E. E. and Schulz, M. D.: Fetal Swallowing, Gastrointestinal Activity and Defecation in Amnio. An Experimental Study in the Guinea Pig. Surg. Gynec. and Obst. 70:603-614 (Mar.) 1940.
40. Rosa, P.: The Circulation of Human Amniotic Fluid. Gynec. et Obst. 50/5:463-476, 1951.
41. Speert, H.: Swallowing and Gastrointestinal Activity as Shown in Fetal Monkeys (Roentgenograms) Am. J. Obst. and Gynec. 45:69-82 (Jan.) 1943.