

Localization of Placenta in Scanning by In^{113m} Radiopharmaceuticals

On Koo Cho, Ki Keun Oh, Chang Yun Park, Byung Sook Choi

Department of Radiology and Nuclear Medicine

Chang Hwan Ha, Soon O Chung and Hwun Mo Kwak

Department of Obstetrics and Gynecology, Yonsei University College of Medicine, Seoul, Korea

ABSTRACT

Placenta previa is a common grave complication of late pregnancy, usually manifested clinically by painless antenatal vaginal bleeding. Digital and rectal examinations are dangerous, due to the possibility that profuse hemorrhage from the vagina may result. Various radiological examinations have been performed in placenta previa for diagnosis and localization. However radioisotopic methods are superior due to safety, simplicity and a lower radiation dose, both fetal and maternal, compared to plain radiography. Among radiopharmaceuticals, In^{113m} (transferrin for blood pool scan) is useful, giving more satisfactory results without any complications or untoward reactions.

In our series of 88 cases from March 1971 to April 1975, In^{113m} placental scan was performed and analysed in 62 cases which were confirmed by clinical follow up and the results are as follows:

- 1) Maternal age pattern. Mothers 31~35 years were 20/62 or 30.6%.
- 2) Maternal gravida pattern. All were multipara except 8 cases of primipara.
- 3) Gestational maturity on scan. 40/62 or

64% were before 36 weeks or less in maturity.

4) On scan analysis Placenta previa was confirmed in 36/62 cases or 58%.

5) Fetal maturity. On delivery most were full term, 42/62 or 67.7%.

6) Vaginal delivery was done on cases where placenta was localized in the upper uterine segment, except for three who had fetal malpresentation and congenital anomaly of the maternal pelvis.

All patients of placenta previa had cesarian section, except 5 cases with a minor degree of placenta previa.

7) Two cases showed false negative, which suggests 97% accuracy in the screening test of placenta previa by scan, which is a similar result to other reports.

Only 4 cases of false positive discrepancy were noted.

INTRODUCTION

To localize the presence of placenta previa in antenatal bleeding during pregnancy is very important in order to decide the treatment and prognosis of the patients. Digital vaginal examination in placenta previa is dangerous due to the profuse hemorrhage which may result.

For the safe diagnosis of this serious diseases a variety of radiological studies have been developed to localize the site of placenta attachment. There are many radiological procedures such as soft tissue placentography, amniography, and pelvic arteriography. However as a simple, safe and accurate method, radiopharmaceutical localization is most promising.

Browne and Veall first demonstrated the placenta could be outlined by the use of Na^{24} (1950). After that other radiopharmaceuticals were developed for use, I^{131} -HSA (Weinberg, et al., 1957) and Cr^{51} -RBC (Paul, et al., 1966). To reduce the radiation dose to the fetus and for better resolution of images, radiopharmaceuticals with a short half life and no beta ray emission are being used such as $\text{Tc}^{99\text{m}}$ (McAfee, et al., 1967) and $\text{In}^{113\text{m}}$ (Stern, et al., 1967). These are superior to other radiopharmaceuticals for localization of the placenta. Among them $\text{In}^{113\text{m}}$ has an advantage because there is no concentration in the bladder and labelling with albumin is not necessary. In our series we used $\text{In}^{113\text{m}}$ as a scanning agent and obtained satisfactory results. We are reporting this data with a review of the literature.

MATERIAL AND METHODS

1) Material

From March 1971 to April 1975, 88 patients of clinically suspected placenta previa were referred for placenta blood pool imaging by scan. Among these, 62 cases were able to be followed clinically and were analysed for placenta scan of antenatal bleeding.

2) Method

$\text{In}^{113\text{m}}$ was eluted with 0.04 N hydrochloric

acid (PH 1.3) from a sterile Sn^{113} - $\text{In}^{113\text{m}}$ generator. In this sterile eluate, gelatin 20% 1 ml was added to PH 2.5 $\text{In}^{113\text{m}}$. A volume of eluate containing 2~3 mci of $\text{In}^{113\text{m}}$ -chloride was administered and immediately examination was begun. All patients were examined with a Picker Magna Scanner 500 with a 5 inch crystal detector. The patients were placed in supine position and anterior and lateral views were taken routinely.

The position of the symphysis pubis and anterior superior iliac spine were marked in all cases. Patient preparation was not necessary. Scan speed was 100cm/min and time consumption of two anterior and lateral scans was about 20~25 minutes.

RESULTS

Maternal age pattern shows that the child bearing age group of 31~35 years was 30.6% (Table 1).

Among the 62 cases, except for 8 primigravida, all were multigravida women (Table 2).

Gestational maturity on scan. Most were in

Table 1. Maternal Age Pattern

Ag	No. of Case	Percent
21~25	17	27.4%
26~30	18	29 %
31~35	20	3.6%
36~40	7	13 %

Table 2. Maternal Gravida Pattern

Gravida	No. of Case	Percent
1	8	13 %
2	17	27.4%
3	12	19.3%
4	9	14.5%
5	3	4.9%
>5	13	21.8%

Table 3. Gestational Maturity on Scan

Weeks of gestation	No. of case	Percent
Under 25	3	4.9
25~29	6	9.7
30~33	15	24.2
34~36	16	25.8
37~38	12	19.3
39~40	5	8.1
Over 40	5	8.1

the third trimester (69.3%) from 30~36 weeks (Table 3).

Placental localization on scan was interpreted by the markings of the iliac spine and symphysis pubis with relation to the uterine wall activity. Placentas located above the iliac spine level, mostly in the uterine fundus and body, were interpreted as in the upper uterine segment or normal location. If the placenta was located mostly below the iliac spine and the lower portion of placenta activity was curving toward the pelvic center a short distance from the symphysis pubis, placenta previa was considered.

Upper uterine segment placenta was diagnosed in 40.3% on scan and the distribution was nearly even between that right and left sides.

Further localization was anterior, middle and posterior by the attachment of the placenta in the uterine wall.

Placenta previa was suspected in 58.0% and placenta previa marginalis in 7 cases, placenta previa partialis in 8 and totalis of placenta previa in 21 cases. Abruptio placenta was considered present in 1 case (Table 4).

In most patients diagnosis was confirmed by clinical follow up or double set up examination. The results of the study of fetal maturity on delivery showed that most were full term, 67.7% (Table 5).

Table 4. Analysis of Placenta on Scan

Position of Placenta	No. of cases	Percent
Upper uterine segment	25	40.3
Lt. side	14	
Midlateral	5	
Anterolateral	3	
Posterolateral	6	
Rt. side	11	
Midlateral	3	
Anterolateral	6	
Posterolateral	2	
Placenta Previa	36	58.0
Low lying	0	
Marginalis	7	
Partialis	8	
Totalis	21	
Abruptio Placenta	1	1.7

Table 5. Fetal Maturity at Delivery

Weeks of gestation	No. of case	Percent
Under 25	3	4.8
25~29	1	1.7
30~33	5	8.1
34~36	8	12.9
37~38	11	17.7
39~40	20	32.3
over 40	11	17.7
Unknown	3	4.8

Table 6. Mode of Delivery

Mode	Placental Location
NSVD 23	Upper Uterine segment 18
	Placenta Previa, Other types 5
Forcep 2	Upper Uterine segment 2
C/S 34	Upper Uterine segment 3*
	P.P. Totalis 16
	P.P. Other types 15
Unknown 3	Upper Uterine segment 1
	P.P. Totalis 2

* 2: Malpresentation of fetus

1: Congenital anomaly of pelvis

Vagina delivery was performed on cases of upper uterine segment placenta, except for three who had malpresentation of the fetus or

Table 7. Comparison Between Placenta Scanning and Final Diagnosis

Site of placenta	No. of case on scan	No. of Confirmation		
		True	False	Discrepancy
Upper Ut. Segment	25	24	1	0
Placenta previa	36	32	0	4
Low lying	0	0	0	0
Marginalis	7	6	0	1
Partialis	8	8	0	0
Totalis	21	18	0	3
Abruptio placenta	1	0	1	0
Total number	62	56	2	4
Percent	100%	91%	3%	6%

congenital anomaly of the maternal pelvis. All placenta previa cases had Cesarean section, except for 5 cases with a minor degree of placenta previa (Table 6) with eventual fullterm delivery.

One abruptio placenta by scan was determined to be placenta previa partialis with necrosis (Table 7) when scan and final diagnosis were compared.

Two completely missed false negative cases were found from the screening study of the scans and accuracy of placenta scanning was thus 97.0% (Table 8).

Table 8. Practical Errors in Scan Finding

Scan finding	Confirmed Dx.
Upper uterine segment 1	P.P. marginalis
Abruptio placenta 1	P.P. marginalis
P.P. marginalis 1	Low lying placenta
P.P. totalis 3	Low lying placenta
	Low lying Placenta + Placenta Succenturiata
	P.P. Partialis

DISCUSSION

Placenta previa is a common and grave complication of late pregnancy, usually manifest clinically by painless vaginal bleeding occurring occurring in 0.5% of all pregnancies (Eastman

and Hellman, 1972). It occurs commonly in the aged multigravida. Its diagnosis is very important to decide the treatment and prognosis.

1) Diagnostic method

Vaginal and rectal digital examinations are dangerous in placenta previa, because profuse bleeding may result from the detachment of blood clots with further separation of the placenta by the examining fingers.

For the safe diagnosis of this serious disease, a variety of radiological procedures were developed. The soft tissue placentogram was investigated by Snow and Powel 1934 but there was considerable radiation exposure to the fetus noted, about 100~2,000 mrad, and over all accuracy of the soft tissue technique was 80% (Thaidigsman & Schulman, 1964—78%, Verco 1964—77.5%), and it was possible to interpret it only after 34 weeks of gestation. Moreover in the presence of obesity, hydramnious and multiple pregnancy, the interpretation of placenta previa was complicated and there was a high incidence of failure.

Pelvic arteriography (Dos Santos, et al., 1931) and amniography (Menes, et al., 1930) show an adequate accuracy rate but there is much radiation exposure and possibility of th-

rombosis. Thermography (Johnson, et al., 1966) shows a poor accuracy rate of 50% and can not detect the posterior lying placenta. To overcome these disadvantages, various pharmaceuticals of placenta scanning agents were investigated. Previously used Na^{24} , I^{131} -HSA and Cr^{51} were reported to be simple and safe and the accuracy of placenta localization was encouraging but image resolution was not adequate and hence only gross estimation of size and shape was possible. $\text{Tc}^{99\text{m}}$ has 6 hours of half life and lack of beta emission reduces radiation to the fetus, with good resolution of images in the placenta blood pool and an adequate energy level of 140 Kev and external detection is excellent and it is possible to interpretate in the early gestational period. Disadvantages of $\text{Tc}^{99\text{m}}$ are that it requires tagging to albumin and there is bladder accumulation of activity from urinary excretion. $\text{In}^{113\text{m}}$ has a half life of 1.7 hours and no beta radiation and a multimillicurie dose of administration is possible with good image on scan. Also with 390 Kev of high energy gamma ray photons it permits detection of posteriorly lying placentas. Radiation dose is meagre, only about 4~5 mrad, to the maternal and fetal tissue per 500 microcurie.

It is the same as the naturally estimated background of radiation from the environment. Compared with a plain abdominal exposure dose of 100 mrad the difference is significant with much less radiation exposure. Other advantages are that there is no urinary excretion and bladder accumulation as with $\text{Tc}^{99\text{m}}$, there is no need of patient preparation and it gives an accuracy rate of more than 95% from our series as well as from other reports.

2) Interpretation of the scan findings of placenta

Clinically placenta previa is classified by degree into 4 types. Placenta previa totalis is a severe form with complete covering of the cervical internal os by the placenta. When partially covered it is placenta previa partialis. When with the examiner's finger the lower portion of placenta can be palpated but does not extend to the level of cervical internal os, It is defined as low lying placenta. In placenta previa marginalis, the lower portion of the placenta is at the margin of the cervical os.

Fundal implantation (Fig. 1) and total placenta previa (Fig. 2) are easily differentiated but diagnosis of minor degree of placenta previa is equivocal. Whenever a significant centrad curvature of the placental lower margin is found near the level of the symphysis pubis, placenta previa partialis is suggested and we found this method to be adequate (Fig. 3). The diameter of the internal os is 10cm when fully dilated. Thus if the placenta clearly terminates more than 5cm from the site of the undilated internal os, the possibility of placenta previa marginalis is excluded.

Low lying placenta extends caudad along the uterine wall but does not curve significantly toward the center of the pelvis.

In general the internal os is lying behind the symphysis pubis at the level of ischial spine but it is not always the same.

3) Diagnostic accuracy and error in placenta scan

Among 62 cases of placenta scan, 2 cases of false negative were found. These were thought to be in the upper uterine segment but turned out to be placenta previa partialis

from scan. One was located deeply to the lower portion of iliac spine along the uterine wall. It was straight and the centrad curve was not significant. After double set up examination it was confirmed as placenta previa marginalis. It did not correspond to the findings of a minor degree of placenta previa marginalis.

However from Sinnathuray's report, during progressive labor the placenta may change position. The second false negative case had the placenta divided in two sections and showed poor central activity.

From the findings above it was thought to be an early detachment of the placenta as both frontal and lateral scans showed corresponding poor activity in the center. After surgery it turned out to be placenta previa partialis and the center of cold uptake area was found to be placental necrosis (Fig. 4).

Among the suspected placenta previa, out of 36 cases 32 case corresponded to the degree of placenta previa shown by scan.

Only 4 cases were found to have false positive discrepancy, with insertion of the placenta different from the placenta scan group. Among these, one case from scan was thought to be placenta marginalis and was later found to be low lying placenta. These two are still difficult to differentiate. The scan error showed uterine wall activity higher than the average case and no distinctive difference in the margin of placenta activity. The other case of minor error, which from scan showed placenta previa totalis turned out to be low lying placenta with accompanied placenta succenturiata of an accessory lobe, unreported in the literature.

The major error from scan was when frontal scan showed increased activity at the lower iliac crest and crossed the midline. However

lateral scan did not correspond and two separate upper and lower areas of activity were found in relation to the center of the iliac crest (Fig. 5).

Placenta succenturiata is an anomaly of the placenta with a part separate from the main placenta only connected to the vascular bed. Hence lateral scan is essential for these cases.

For the placenta previa diagnosis, accuracy is as high as 97%. However for details of classification, accuracy rate is 91% which is also relatively high. Other reports give 91.3% (Urbanek and Graf, 1971) and to 97.6% (Lowen, 1973) for gross placenta previa diagnosis.

However for details in type classification of placenta previa, relatively high accuracy is reported, from 90.2% (Lowen, 1973) to 96% (Sharf and Oettinger, 1971) (Table 9).

As to fetal maturity on delivery, 42/62 of 67.7% were 37~40 weeks (full term) while on scan 40/62 of 64.6% were under 36 weeks of gestation.

This discrepancy is due to the fact that minor degrees of placenta previa can continue to full term without fetal mortality.

In major degrees of placenta previa, after scan interpretation surgical treatment is performed to avoid maternal morbidity and it is important to stress the value of placenta scan.

Table 9. Comparison of Accuracy

Author	Year	No. of case	Accuracy
Huddleston, et al.	1969	41	92.6
Urbanek and Graf	1971	150	90.3(91.3)
Sinnathuray	1972	60	95.0
Sharf and Dettinger	1972	79	96.0
Johnson, et al.	1972	100	94.0(97.0)
Lowen	1973	250	90.2(97.6)
Yonsei University	1975	62	91.0(97.0)

CONCLUSION

Among 88 pregnant women who complained of antenatal vaginal bleeding, placental scan with $\text{In}^{113\text{m}}$ was performed, and analysis of 62 were made as follows:

For pregnant women, the largest age group was 31~35 years (30.6%) and 69.3% were in the 3rd trimester, at 30~38 weeks of gestation; 54 cases were multiparous and 8 cases primiparous.

There were 38 cases of placenta previa, 61.3%, but only 36 cases were diagnosed by placenta localization scan. However this indicates that the accuracy of the method for preliminary examination may be as high as 97%.

Even in early gestation, prior to 30 weeks, it is possible to diagnose placenta previa among suspected pregnant women. Thus preliminary placental scan (with $\text{In}^{113\text{m}}$ transferrin for blood scan) is a valuable method.

REFERENCES

- Browne, J., Veall, N.: *Method of locating the placenta in the intact human uterus by means of radioactive sodium*. *J. Obst. Gynec.*, 57: 566-568, 1950.
- Dos Santos, R., Lamas, A.C. and Caldas, J.P.: *Arteriographie des membres et de L'aorte abdominale*. Paris, Masson & Cie, 1931.
- Eastman, J.J., Hellman, L.H.: *Obstetrics*. 14th edition, New York, Appleton, 1972.
- Huddleston, J.E., Mishkin, F.S., Carter, J.E.: *Placental localization with Indium 113m*. *Radiology*, 91:587-90, Mar. 1969.
- Johnson, P.M., Bragg, D.G. and Scirra, J.J.: *Placental localization; A comparison of radiopharmaceutic and thermographic methods*. *Am. J. Roentg.*, 96:681-89, 1966.
- Johnson, P.M., Chao, S., Goodwin, P.N.: *Initial evaluation of Indium 113m as an agent for placental blood pool imaging*. *Radiology*, 92: 625-26, Mar. 1969.
- Johnson, P.M., Chao, S., Reilly, J.A.: *Placental imaging with Indium 113m, results in 100 patients*. *Radiology*, 103:859-64, May 1972.
- Lowen, W.: *Radioactive placentography using Indium 113m*. *Australas Radiol.*, 17:56-60, Mar. 1973.
- McAfee, J.G., Stern, H., Fueger E., et al.: *Rapid scintiphotography placental localization utilizing free $\text{Tc}^{99\text{m}}$ pertechnete*. *J. Nucl. Med.*, 8:773-84, 1967.
- Menes, T.O., Miller, J.D. and Holly, L.E.: *Amniography*. *Am. J. Roentg.*, 24:363, 1930.
- Paul, J'D., Jr., Gahres, E.E., Albert, S.N., et al.: *Placental localization using Cr^{51} tagged erythrocytes*. *Obst. Gynec.*, 9:96, 1966.
- Sharf, J., Oettinger, M.: *Blood pool imaging of placenta with short lived radioisotopes*. *OB GY.*, 38:602-11. Apr. 1972.
- Sinnathuray, T.A.: *Placental localization with radioactive isotope Indium 113m in man age of antepartum hemorrhage*. *Int. Surg.*, 57:712-20, Sept. 1972.
- Snow, W. and Powell, C.V.: *Roentgen visualization of the placenta*. *Am. J. Roentg.*, 31:37, 1934.
- Stern, H., Goodwin, D., Scheffel, A., et al.: *Indium 113m for blood pool placental scanning*. *Nucleonics*, 25:62-68, 1967.
- Thaidigsman, J., Schulman, H.: *Placenta localization using radioactive I^{131} -tagged human serum albumin*. *Obst. Gynec.*, 23:757, 1964.
- Urbanek, J., Graf, M.: *Placental scanning using $\text{Tc}^{99\text{m}}$ albumin and ionic Indium 113m*. *J. Nucl. Med.*, 12:825-7, Dec. 1967.
- Weinberg, A., Rizzi, J., McMams, R. and Rivera, J.: *Localization of the placental site by radioactive isotopes*. *Obst Gynec.*, 6: 692, 1957.



Fig. 1. Anterior Scan.

Placenta is in left upper uterine segment on the fundus: normal.

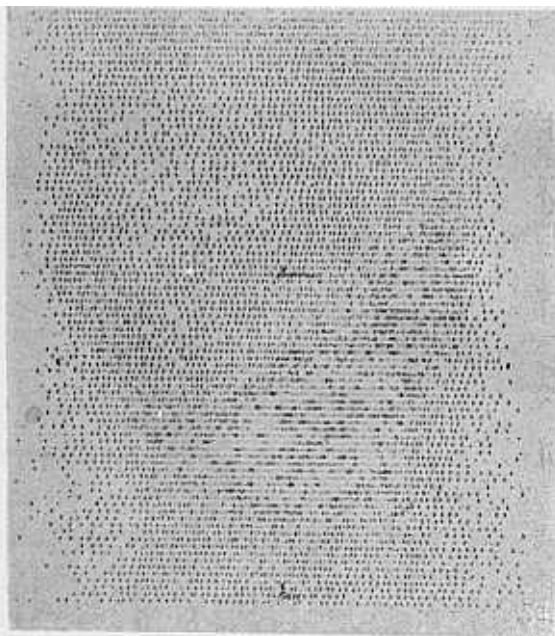


Fig. 2. Placenta previa totalis.

Placenta is in left lower uterine segment covering cervical internal os.

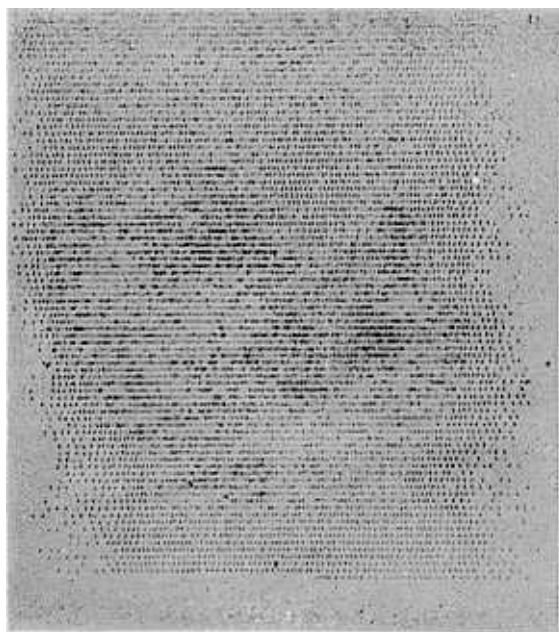


Fig. 3. Placenta previa partialis.

Note, Lower uterine segment with significant centrad curvature of the lower placental margin.

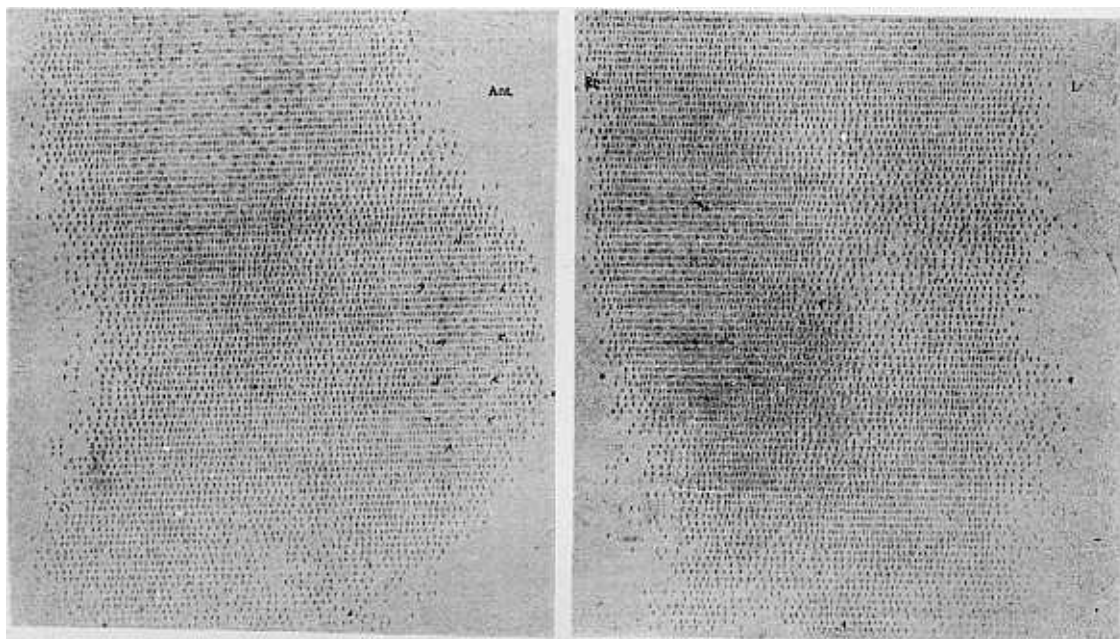


Fig. 4. Placenta previa partialis.

Note, central necrosis on the mid portion of placenta.

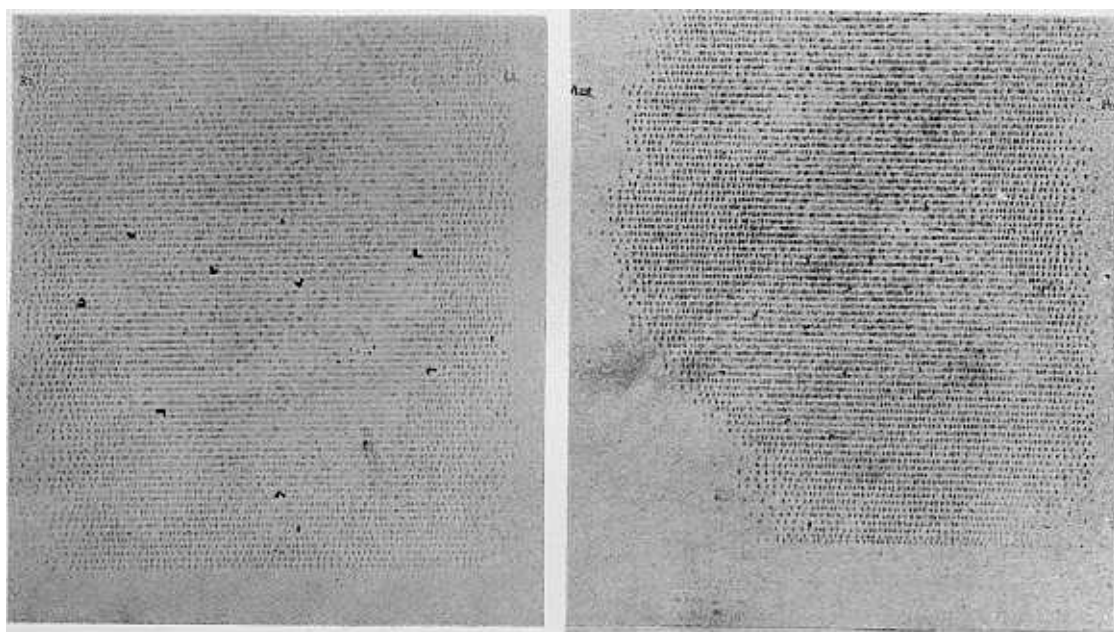


Fig. 5. Low lying placenta with placenta succenturiata.

Note, anterior scan in increased activity on the lower uterine segment with the midline crossed. From lateral scan low lying placenta on the mid-line with accompanied placenta succenturiata on the anterior lower portion.