ARTIFICIAL PNEUMOPERITONEUM

as a Radio-diagnostic Measure.

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MAIN CONTENTS.

INTRODUCTION

A serious obstacle to the development of Radio-diagnosis as applied to the elucidation of diseases of the abdominal viscera, has always been encountered in the practical impossibility of securing adequate differentiation of their shadows.

The anatomical relationships of the Diaphragm and subjacent parenchymatous organs are such as to preclude any sharp contrasting shadows being obtained on the X-ray plate.

The close apposition of the heart, diaphragm, liver, spleen, and upper poles of the kidneys produces, on an ordinary skiagram, a large confluent shadow, the constituents parts of which are always difficult, and often impossible, to apportion with certainty to individual organs.

The fact that the liver, containing a greater thickness of tissue than, for instance, the spleen, naturally casts the denser shadow is offset by its shape and oblique position, which allows the shadow to become progressively less dense towards the phriphery, the line of demarkation being consequently lost.

The subphrenic space has hitherto been a region exceedingly difficult to demonstrate satisfactorily, and all but the grossest lesions tended to escape detection.

The contour of the diaphragm can be studied from its thoracic side, but its under surface, as also the upper surface of the liver, is lost in the general shadow. A projection from this shadow on the thoracic aspect could be due either to an

abnormality in the diaphragm itself, or in the liver. We have, in most cases, no means at our disposal whereby this question could be cleared up.

The spleen is closely applied to the parietes, and its outer aspect does not show sufficiently well on the X-ray plate to be of any value from a diagnostic point of view. Enlargement of the organ must be very considerable before definite evidence to that effect appears on a skiagram.

While the kidneys can usually be demonstrated, provided the technique employed be correct, contrast is often so poor that any departure from the normal is liable to lead to confusion. This difficulty is sometimes encountered in cases in which it is essential that the exact situation of the kidney, if present, should be indicated, or its absence established with certainty.

Attention to technical detail will eliminate doubt in many cases, but in a considerable proportion the element of uncertainty remains. Obese or badly prepared patients provide some of these problems. The Radio-diagnosis of gall stones and gall bladder disease has hitherto been an exceedingly intricate problem.

Knox. (1) Describes a series of experiments which prove that the majority of gall stones are less dense to X-rays than a very moderate thickness - 2cm - of liver tissue, and that a smaller percentage are actually less dense than bile; these being composed almost purely of Cholesterin. He lays stress, however, on the fact that the average mixed gall stone, with its

considerable calcium content, should be capable of demonstration, as the super-position of its shadow on that of the liver must cause sufficient intensification to define the stone. He describes an elaborate technique to deal with these cases, and mentions theimportance of demonstrating any pathological condition of the gall bladder which may be present. T he proportion of cases, however, in which a definite diagnosis could be given does not appear to have been large.

Several American authors claim to show gall stones, if present, in a varying, but almost uniformly large proportion of cases:

Pfahler. (2) Claims successful positive results in 50% of cases.

Cole. (3) Reports 75% correct positive diagnoses in a series of 16 cases. He also states that of a collection of gall stones examined by him 54% were practically pure cholesterin, and 80% cast a shadow less dense than bile.

Case. (4) Reports successful positive diagnoses in 50 % of a large series of cases.

Later (5) he states that it is now possible to show diseased conditions of the gall bladder ~~and~~ 85% of cases.

Caldwell (6) Remarks that "It is possible to obtain suspicious shadows in the gall bladder area of any normal person if enough plates are taken"

George & Leonard (7) State that it is only in the event of definite pathological changes having taken place that the gall bladder outline can be shown on an X-ray plate.

The problem of correct differentiation of shadows applies also in the case of abdominal tumours, where the image obtained on the X-ray plate tends to be poorly defined, on account of lack of contrast.

The value of a method which would facilitate the demonstration of the gall bladder, whether healthy or diseased, is readily appreciated.

Urinary calculi are generally sufficiently opaque to show on an Xray plate taken with any method if due attention to technical accuracy is paid. In cases however where the renal outline is indistinct difficulties may arise in connection with differntial diagnosis. It may, for instance, be impossible to determine whether a suspicious shadow is just outside or just inside the kidney shadow, unless stereoscopy were resorted to, or multiple exposures were made from different angles.

Another likely source of confusion is mal-position of the kidney.

THE ORIGIN AND DEVELOPMENT OF THE NEW METHOD.

The difficulties quoted above led investigators to apply methods, the value of which had been previously recognised, in connection with the Radiological examination of other localities, to the diagnosis of abdominal disease.

In 1902, Kelling, (8) published a paper dealing with direct visual examination and study of the O esophagus, stomach, and abdominal cavity. The technique employed by him depended

largely on distension, by liquid or gas, of these parts.

Beclère (9), in 1910 advocated the routine inflation of the stomach and colon for the radiological examination of the lower surface of the liver and gall bladder area. He claimed a fair degree of success for the method, the organs being well outlined in some cases, and showing distinctly the changes in shape and surface contour which had occurred in two cases.

In 1910 also, was published the first communication of Jacobaeus, (10), of Stockholm, in which he discusses the application of the principle of Cystoscopy in the examination of the serious cavities. He published some results he had obtained in this connection which seemed promising. The cavity in question was inflated with gas, and the cystoscope introduced, either through an existing channel, or through the cannula used in the process of inflation. His researches were confined to the pleural and peritoneal sacs.

Further results were embodied in a later communication on the subject (11), in which he describes the successful diagnosis of metastatic carcinomatous nodules in the liver, and general carcinosis of the peritoneum and intestines.

He also details some experiments performed on the cadaver, which suggested that the risk of damaging the intestines with the trocar was not a serious one.

Godwin (12), In 1912, related his experiences, extending over a period of 4 years, in distending the abdominal cavity with oxygen gas, as a post-operative therapeutic measure. He recommends the practice as a routine procedure after abdominal operations, and claims the following advantages for it :-

a) It serves to prevent adhesions.

b) It is a useful therapeutic agent in Tuberculous Peritonitis.

c) It ~~has~~ is probably ~~been official~~ beneficial in General Septic Peritonitis.

d) It counteracts negative abdominal pressure, especially after the removal of large intra-abdominal tumours, and thereby lessens post-operative shock, nausea, and vomiting.

He states that oxygen gas is not irritating to the peritoneum.

Lorey, (13), In 1912, described a case in which the abdomen after paracentasis for ascites, was inflated with oxygen gas. These skiagram showed with startling clearness the irregularities on the diaphragmatic surface of the liver.

Le Page, (14), In 1912, suggested inflation of the stomach as a diagnostic measure, which might help in the recognition of diseased conditions of that viscus, and serve to detect pericardial exudates. He discusses the gas inflation of joint cavities for radio-diagnostic purposes, and concludes that the procedure constitutes a considerable advance on previous methods.

Rist & Maingot, (15), In 1912, in a paper on Artificial Pneumo-thorax as a therapeutic measure, described the radioscopic appearances found in such cases, and stated that diagnosis was facilitated.

Weber, (16), In 1913, mentioned that the method suggested itself to him when he noticed how clearly the protruding mass of an enlarged prostate was rendered visible in a case in which the bladder was inflated with oxygen gas. He

undertook a series of investigations on the cadaver, which led him to the conclusion that the following organs and parts were rendered clearly visible:-

a) The whole of the liver, spleen, and gall bladder region

b) The wall of the stomach and large intestine, if inflated with air.

c) The pyloric portion of the stomach, and parts of the small intestines, without opaque content.

d) The bladder ~~colon~~ if filled with urine.

e) The ordinarily inaccessible subphrenic space

f) Many intra-abdominal tumours.

A number of skiagrams are reproduced, illustrative of the above points. The author further emphasises the fact that there is no actual danger of perforating the bowels; even in the cadaver this did not occur.

In 1913 ~~Urilehs~~ Ulrichs, (17), described a number of cases in which gas inflation was used in radio-diagnosis of affections of the knee-joint. He gives a number of illustrations showing loose bodies ("gelenkmausen") in the knee-joint, loose semi-lunar cartilages, early tuberculosis, and other joint affections with unusual clearness. No ill effects were observed in a large number of cases subjected by him to this procedure.

Another account of oxygen inflation of the peritoneal cavity as a routine procedure after abdominal operation was given by Bainbridge, (18), in 1913. He had applied this practice in 125 laparotomies, without ill effects in any case, and considers that good results are obtained in the prevention

of adhesions and post-operative shock. No mention is made of radiography.

Rautenberg, (19), published, in 1914, a paper which he had read at the German Congress of Internal Medicine some time previously (20). He had employed the method of oxygen inflation in cases of ascites, after tapping, with encouraging results as regards the demonstration of surface irregularities of the liver and spleen.

On this occasion he remarked that, "There seem to him to be many reasons against the general introduction of this method in cases uncomplicated with ascites." He appears to have modified this opinion, however, as in the paper quoted he suggests that the method would be found useful in the demonstration of the organs beneath the diaphragm.

Meyer Betz, (21), 1914. Gives an account of the method, utilised in connection with radiological diagnosis of abdominal tumours. He states that it is generally possible, with this method, to determine the anatomical relationship of such tumours, and to ascertain their starting point.

In 1917 Rautenberg (22) published some further results, including an account of some experiments conducted with the object of ~~obtaining~~ ascertaining of what, if any, risks were attached to puncture of the abdominal wall. Cases of primary and secondary carcinoma of the viscera and peritonial are illustrated.

Dandy, (23), described in 1918 some cases of hydrocephalus, in which air had been injected into the cerebral ventricles for radio-diagnostic purposes. The skiagrams

reproduced show with remarkable clearness the outlines of the ventricles.

In 1918 Goetze, (24), published what he termed "a new method". He describes a somewhat elaborate technique, and stated that in a long series of cases no undesirable after-effects were encountered.

He described the radioscopic appearances of the viscera in the gas-filled abdomen, and stated that "it is obvious that the regions adjacent to the parietes of the abdomen are especially suitable for demonstration with gas inflation".

The differential diagnosis of various conditions and regions is described, and a number of illustrative plates are shown. He considers the method to be one of great practical importance and utility.

In 1919 Schmidt (25) gave an account of the method as practised by him in a number of cases. He considers the risk to be negligible, and states that oxygen does not produce irritation of the peritoneum, any more than it does in the pleura when used therapeutically. He has never seen a case in which the bowel was punctured, or the peritoneum infected. He gives some illustrative plates, showing with great clearness tumours, gall stones, new growth of liver, and adhesions to the parietes. In connection with the last mentioned condition, he says that the definite diagnosis secured in these cases enabled severe pain to be relieved by a relatively simple operation.

During the last 2½ years oxygen inflation for radiodiagnostic purposes has been investigated in other countries, notably in America.

Stewart, (26), describes a case of compound fracture of the skull, in which air had found its way into the cerebral ventricles. These cavities are shown distinctly outlined on the skiagrams reproduced.

Stein & Stewart (27), in a paper on their experiences, state that with oxygen inflation they were enabled to make a satisfactory diagnosis in a number of cases in which it would not otherwise have been possible. They recommend "the wide extension of the method in a variety of cases in gynaecological and general abdominal surgery."

Pfahler, (28), describes and illustrates some cases in which air was injected into the bladder for the diagnosis of tumour growths in that viscus. The plates reproduced show clearly several such tumours, of bladder and prostate, and a diverticulum of the bladder. He states that the method may often supplement cystoscopy, or even replace it in cases where bleeding obscures the view. "It is easy, safe, and less painful than cystoscopy."

Stein & Stewart (29), in a further account of their investigation into the method, record 37 cases of inflation of the peritonial cavity, without any unfavourable after effects. They express themselves as convinced of the value of the method, especially in the differential diagnosis of such cases as splenic enlargement or hypernephroma. The procedure would be justified, in their opinion, if only to save exploratory operation, by clear-

ing up an obscure condition. They mention the risk of general dissemination of a local infection due to mechanical breaking down of localising adhesions. They show plates illustrating tuberculous adhesions, pelvic tumour, and enlargement of spleen and liver.

von Teubern (30), reports 22 cases in which the examination was carried out according to an established routine, and the patients sent home immediately after deflation. The cases all did quite well, and complained of no inconvenience or pain afterwards. He did not succeed in demonstrating the healthy gall bladder, but describes three cases in which the viscus was recognisably enlarged and pathological. Inflation of the stomach and colon was resorted to in combination with peritoneal inflation in certain cases. He concludes that "the method, in the hands of an expert, is a real acquisition in radio-diagnosis; it is, however, not to be recommended as a routine for abdominal examination, and is preferably reserved for cases in which the result with the usual method has proved unsatisfactory."

Alessandrini, (31), considers the method essentially practical, simple, and safe. He describes a case in which, during the induction of artificial Pneumo-thorax, the gas, through an error in technique, found its way into the abdomen, with surprising results when a skiagram was taken.

Schittenhelm, (32), recommends inflation of the colon and stomach, either alone or in combination with oxygen inflation of the peritoneal cavity, for the diagnosis of pathological conditions of the digestive tract. He has seldom succeeded in

demonstrating the normal gall bladder, but states that the pathological viscus is generally to be made out.

Rautenberg, (33), gives a further account of the development of method in his hands. His results have been uniformly encouraging, and he strongly recommends the use of gas inflation in all obscure and difficult abdominal conditions. A number of cases are illustrated by plates demonstrating the separation of organs, and the definite contrast obtained. He quotes success in the following variety of cases :-

1) Cirrhosis of liver, with much enlarged spleen and contracted liver in one case, and both organs enlarged in another. Surface irregularities were well seen in both cases.

2) Adhesions of the liver to the anterior abdominal wall. Much pain was caused by the distension, and the liver did not fall away from the diaphragm.

3) Ptosis of the liver - this condition being generally diagnosed clinically.

4) Secondary malignant nodules in the liver and diaphragm.

5) Enlarged, pathological gall bladder, in one case containing a number of gall stones, which did not show on the skiagram.

6) Enlargements of liver and spleen due to new growth, hydatid cyst, and "pseudo-leukaemia".

He remarks that "it is best if in these cases the clinician is his own radiologist", and emphasises the safety and simplicity of the methods.

Faschung-Bauer & Eisler, (34), record a number of cases subjected to the procedure without any consequent trouble. The contra-indications they describe as "self-evident," and the technique simple and generally applicable. A description is given of normal and pathological radioscopic and

radiographic appearances in a number of cases, illustrating the ease with which regions, hitherto inaccessible, can be seen. The results in gall bladder cases were not so encouraging, and they state that in their experience, the demonstration of the gall bladder seldom succeeds.

Roberts, (35), considers the risk of the procedure to be negligible, and undesirable after effects were not encountered in a number of cases observed by him. The size and contour of all the solid organs in the abdominal cavity can be successfully demonstrated, and calculi, whether urinary or biliary, readily shown. He suggests that tumours of the stomach, colon, and bladder may be rendered visible by combining oxygen inflation of the peritoneum with inflation of these cavities. The pelvic organs, abdominal tumours generally, the lumbar vertebrae, psoas abscess, and intestinal adhesions are instanced as being easier to show than with the ordinary methods.

The differential diagnosis between empyema and subphrenic abscess is also quoted as being rendered easier of solution, while such conditions as obturator hernia might be recognised.

TECHNIQUE.

Preparation. This is in general similar to that of the ordinary radiographic examination of the abdomen. To ensure satisfactory results preparation should begin at least 48 hours before examination. The bowels should be well cleared out on two successive nights. Presence of gas in the intestine, which is so liable to give rise to conflicting and unequal shadows,

should be avoided. For this reason castor oil or other vegetable purgative is better than salines or calomel. A soap and water enema is given the evening before the examination, and a rectal tube may be inserted before, and left in situ for some time after the inflation. No food should be given on the morning before the examination, apart from a cup of weak tea some hours before. Faschungbauer and Eisler (34) recommend the administration of a small dose of morphia subcutaneously as a preliminary.

The bladder should be emptied immediately before inflation.

Inflation.

Apparatus. This consists of the oxygen containing cylinder, and the conducting tube to the needle. A tap on the cylinder is controlled by the assistant. The gas is led from the cylinder through a rubber tube to a net-covered rubber bag of known capacity, with a control tap distal to the cylinder. The bag is first filled with gas, and the tap on the cylinder then turned off. This allows of measurement of the volume of gas used, due allowance being made for heat expansion. From the bag the gas may be led directly to the puncture needle, or, preferably through a glass tube containing a filtering plug of sterilised cotton wool. Rautenberg (33) and Goetze (24) mention that this precaution is probably unnecessary. Roberts (35) introduces a chamber containing an electric light bulb, for the purpose of warming the gas.

Faschungbauer (34) von Teubern (30) Rautenberg (33) all employ the apparatus as used for the induction of pneumo-thorax,

with manometric attachment for indicating pressure; this, however, ~~was~~ is probably an unnecessary elaboration.

The needle best suited for the purpose is the standard Lumbar puncture needle with obturator. Some workers employ special needles; von Teubern (30) uses a needle with lateral openings, and mentions two cases in which "preperitoneal emphysema" occurred, due to the use of a needle too short for the purpose. Goetze (24) uses a special automatic needle, in which a recoil spring withdraws the trocar from the cannula, immediately the pressure on the top of the needle is released by the instrument slipping through the peritoneum. This allows oxygen to enter at once, and prevents the aspiration of air into the abdomen during the phase of negative pressure created during expiration.

He also obtains his oxygen under pressure by using the principle of displacing the gas with a "head" of water out of a flask.

The site of puncture generally selected, unless local conditions contra-indicate it, is a spot in the middle of the left rectus muscle, about 1" below umbilicus and to the left of the middle line. Some writers prefer the middle line, halfway between symphysis pubis and umbilicus.

The choice of site must depend on the individual case. The skin is painted with Tinct. Iodi., and a hypodermic needle is inserted down to the posterior layer of the sheath of the rectus muscle, and the track anaesthetised ~~and~~ with a solution of Novocain or other local anaesthetic. The lumbar puncture needle is now slowly pushed down the same track. The instru-

ment can be felt to "hesitate" as it reaches the fascial sheath. When the posterior rectus sheath is reached care must be exercised not to let the needle pierce the fascia too suddenly. It is slowly and firmly pushed in till it can be felt to pierce this layer, and for about ¼ inch deeper, before the trocar is removed. The needle is now attached to the rubber tube, and the inflation is commenced, slowly, to allow the viscera time to adapt themselves to the altered conditions. Adhesions may cause varying degrees of pain, especially if attached to the anterior abdominal wall; indeed, pain may be so intense that it may be necessary to detach the tube from the trocar, and allow some of the gas to escape.

The quantity of gas to be used will depend on the build of the patient, and generally varies from 2 to 4½ litres. In cases where the inflation is performed after paracentesis for ascites, a larger quantity may be used. Goetze (24) advises that the degree of inflation should be such as to cause a positive pressure of about 20 m.m. of water. Schmidt (25) mentions that there may be danger of gas entering the capillaries if the intra-abdominal pressure were raised too high.

In general, the inflation should be carried to a point when the abdomen is distinctly "dome" shaped.

The liver dulness, according to Roberts (35) begins to disappear when an average quantity of 500 c.c. of gas has been introduced.

The cannula is now removed, as it promises to interfere with examination in various positions; although Schmidt (25)

recommends that it be left in position, to obviate re-introduction for deflation.

The sensations experienced by patients with a gas distended abdomen vary within wide limits. The majority complain of little beyond a sensation of fullness, and a pain in the right shoulder, which is to be ascribed to the dragging, on its ligamentous attachments, of the liver. This may be controlled, if it becomes severe, by raising the foot of the table. The tendency is, in nearly ever case seen, for this pain to pass off after about 10 minutes, if the patient is kept at rest in the recumbent position. Sometimes pain in the back and sides is experienced. The examination is undertaken ½ to one hour after inflation, the interval serving to accustom the patient to the condition.

All movements of the patient necessitated by the requirements of the examination should be deliberate. It was noticed in several cases, that, as a result of injudicious haste in changing the position of the patient, pain was caused, and faintness, with a feeble, rapid pulse, supervened, due to disturbance of the Splanchnic sympathetic. Ordinarily the pulse rate remains unaffected, and the blood pressure, in 3 of the 4 cases in which it was investigated, was found to be raised slightly (about 5 m.m. Hg. average). In the fourth case there was a slight drop, from 115 m.m. Hg. to 112 m.m. Hg. This patient had complained of fairly severe pain.

After the examination it is best to deflate the abdomen, the needle being inserted in the same place, and the gas allowed to escape. Pain and discomfort, if present, disappear at once if

this is done, and a number of Out-Patients examined in this way were allowed to go home the same day, with instructions to go to bed for 24 hours. No case has reported pain or discomfort that could in any instance be ascribed to the inflation.

The gas may be left in the abdomen, in which case it will be absorbed in from 5 to 8 days. In one case radiographed 11 days after deflation, a distinct residuum was found, a definite zone of separation being observed between the liver and diaphragm.

Faschungbauer & Eisler (34) state that the diseased peritoneum may require as much as four weeks to absorb all the gas.

It was observed that the liver dullness did not return after deflation for three or four days.

Examination.

If the inflation be not done on the radiographic couch, as is preferable, the patient must be carried to the radiographic room.

A general radioscopic examination in all the positions required in the individual case should always be undertaken. The information obtained in this way concerning the range of respiratory excursion of the organs is often of great significance.

In general the aim of the examiner is to get the particular organ he wishes to investigate surrounded by the gas. To attain this end, the patient's position must be so arranged

as to bring the organ in question into the highest horizontal plane. As the erect posture appears to cause much discomfort, and even pain, it is an open question whether it is justifiable to insist on the position.

All the Continental authors examine in this position, except von Teubern (30), who thinks that the disadvantages outweight any possible advantage that could be gained by its use.

A. Standard position.

1. Prone (a) X-ray tube below couch.)
(b) " " above ") Radiation
2. Supine (a) " " below couch) vertical.
(b) " " above ")

3. Lateral, left or right, x-ray tube on one or other side of couch; radiation horizontal

4. Right or left lateral Trendelenberg, with foot of the table raised. X-ray tube in front or behind; radiation horizontal.

5. Erect position. X-ray tube behind or in front; radiation horizontal.

6. Knee-elbow position - as in 1 and 2.

Variations in these positions are adapted to suit individual cases.

B. Radioscopic Appearances.

It is important to realise that the mechanical effect of a positive gas pressure in the abdominal cavity tends to modify considerably the shape, position, and the range of movement of the different organs. In order to appreciate any departure from the normal, therefore, it is essential that the

diagnostician should be familiar with the changed appearance of the screen image.

The usual target screen distance used in these cases is 60 c.m. This would give, for the average size of patient, a distortion coefficient of about 10% for an organ situated somewhere about the mesial plane.

The most favourable position for a general view of the viscera is the Prone.

The separation of the liver and spleen from the diaphragm is very marked. The diaphragm is seen as a thin, arched line, a variable distance above the domed liver shadow. The liver descends, rotates forwards slightly, and hangs by its ligaments, which latter are sometimes visible on the X-ray plate as narrow lines, if they happen to be more or less "end on" to the central ray.

The consistency of the liver causes it to lose its shape, the angle of curvature of the dome becoming appreciably sharper. The organ consequently appears to become narrower and longer.

The respiratory excursion of the diaphragm is decreased, and, probably as a consequence, the range of movement of the liver is also restricted. The costo-phrenic angle of the right pleura, ordinarily partially hidden by the dome of the diaphragm, is better seen.

The spleen is displaced downwards quite as much as the liver, and also mesially, so that it comes to lie over the upper pole of the left kidney, giving rise to a confluent shadow. Its parietal surface is much flattened. Rautenberg (33) des-

cribes how the organs could be seen swinging by their ligamentous attachments in guinea pigs inflated by him, when the animals were shaken.

The kidneys are displaced downwards, and seldom reach higher than the 11th rib, whether patient be erect or recumbent. They also seem to be considerably nearer the middle line. This is largely due to the fact that they are rotated forwards, the hilus constituting the fulcrum. The hilus is generally invisible, being end-on with the organ.

The pelvic organs are not easily seen on the screen, but are easily demonstrated on the X-ray plate, with correct posturing. The intestines, collapsed and compressed by the positive gas pressure, can be seen to occupy the lowest plane in any position of the patient. The gas always collects in the highest part, and if either the stomach or colon be inflated they will project from the general mass of intestines, and can then be well seen. The patient is best examined for the erect posture by being made to sit up, with the legs hanging over the side of the table, the tube being either in front or behind. Less discomfort is thereby occasioned.

Examination of Special Areas, with ~~the~~ a consideration of some factors in differential diagnosis.

1. Diaphragm and subphrenic space. The positions suitable for the examination of this area are

a) Erect.
b) Prone
c) Supine

The diaphragm is seen as a narrow arched band, moving with respiration.

"Centring" of the X-ray beam is best carried out under observation on the fluroescent screen. In the upright position small collections of fluid may sometimes be seen in the pleural cavity in cases of pleurisy, which would not have been possible to show with the ordinary method of examination. Irregularities of the diaphragm caused by secondary growths or adhesions are easy to see, and it can be appreciated that the diagnosis of transdiaphragmatic hernia would be rendered a simple matter, especially if the stomach were inflated with CO_2 or filled with an opaque substance. Subphrenic abscess should be readily distinguished from empyema, as the position of the diaphragm is always clearly indicated. In this connection however, it may be mentioned that the former condition, if acute, may prevent inflation because of the pain occasioned, in addition to the theoretical risk attached to the procedure in all localised infective abdominal lesions. Goetze (24) mentions that "the lower end of the oesophagus and cardiac end of the stomach, parts normally hidden, are revealed. Administration of an opaque substance in suspension should prove of value in the recognition of pathological conditions of these organs". The unnatural conditions created by the dragging of the liver would, however, largely discount the value, from the physiological point of view, of the results obtained. Goetze also mentions that early dry pleurisy may be recognised by observing the so-called "paradoxical" respiratory movement of the diaphragm.

2. Liver and Spleen. The positions for the demonstration of these organs are similar to those described for the previous area. Adhesive perihepatitis and perisplenitis may be presumed to exist if any case either or both of these organs are seen to have remained in their normal positions.

Generally, a clear view is obtained of the entire organ, and surface irregularities or change of shape or size can be instantly recognised.

Rautenberg (33) gives the depth of the image of the right lobe of the liver at 60 cm. target-screen distance, as 25 cm. andthe spleen as 9 x 4½ cm.; these figures representing a 10% enlargement due to "distortion".

Tumour growths in or attached to these organs are much more easily diagnosed in the inflated abdomen.

3. Gall Bladder Region. The prone or supine positions are suitable for the demonstration ~~for~~ of this area, with the X-ray tube below or above the table, according to individual predilection. If, however, the case be one of suspected gall-stones, a special modification of the standard positions is advisable. This consists in an alteration of ~~an~~ the angle which the lower edge of the liver makes with the "central ray".

If the supine be the position selected, the tube should be above the patient, and the "central ray" should make an angle of about 15° with the vertical plane, pointing upwards between the 11th and 12th ribs, about 3 inches ~~above~~ from the tips of the spinous processes. The patients shoulders must be raised about 5 inches by means of blocks or cushions, and the trunk flexed to

the left. The effect of this "posturing" is to throw the gall bladder clear of the lower border of the liver. An extension tube with a compression diaphragm would be of assistance in order to secure sharp definition.

This is generally described as the "Karl Beck position". The attitude is however a difficult one for the patient to maintain. If the supine position is the one chosen, the foot end of the table must be raised about 6 inches. An air cushion is then placed beneath the patient's hips. This produces a degree of lordosis, and has substantially the same effect in protruding the gall bladder from under cover of the liver as the "Karl Beck" position. The trunk should be flexed to the left.

An advantage possessed by the lateral position is that tube centring can be done under screen observation, and a smaller diaphragm opening may be used, cutting off a large percentage of "secondary radiation". The lateral view, with the patient lying on the back, is also necessary in gall stone cases, to determine in which antero-posterior plane a suspicious shadow is situated.

The rotation of the liver has the effect of increasing the distance of the gall bladder from the anterior abdominal wall; which fact must be kept in mind in the interpretation of results. Some of the best results were obtained with the patient supine, and radiation vertical.

Conflicting opinions are expressed on the subject of the radiological demonstration of the gall bladder. Hitherto most writes on the subjects have expressed themselves as un-

certain about the value of the method as an aid in the demonstration of the normal gall bladder. Goetze (24) however mentions that even if the gall bladder be invisible, it can usually, if normal, be shown as such by a process of exclusion. Pericholecystitis is shown by adhesions, or inferred by observing distortion of the organ. Thickening of its wall or hydrops reveals the viscus clearly. He claims generally to have reached a "satisfactory conclusion".

Faschungbauer and Eisler (34) state that inflation provides no special advantage in the diagnosis of gall bladder disease, and that in any case, the demonstration of the gall bladder, whether diseased or not, relatively seldom succeeds. The number of cases examined by them for gall stones or gall bladder disease was, however, small.

The concensus of opinion is, however, that the pathological gall bladder is better shown by inflation than otherwise, and that by observing the size, shape and relations of the organ valuable information is obtained regarding its condition.

The commonest variety of gall stone, composed largely of cholesterin, casts such a faint shadow that it requires very careful investigation of the gall bladder area to locate it. It generally shows, if present, as a faint ring with a lighter centre, or simply as a light area without a ring - the so-called "negative shadow". Where a number of stones exist, a "pattern" shadow is produced which is more easily located. Examples of these varieties are illustrated in the plates.

4. Kidney Area. The abdominal distension ~~khx~~ deprives the examination of this region of ~~of~~ the assistance of compression, which can only be employed to a very moderate degree. The positions best adapted for the examination of the kidney area are:

(1) Prone, with the tube below the table;

(2) Supine, with the tube above the table.

The lateral position may occasionally be found useful. Exposure must be short, and the patient must stop breathing either at full inspiration or full expiration. If a suspicious shadow be observed on a plate taken at the end of expiration, another exposure is made while the breath is held at end of inspiration, to provide data for the localisation of such shadows. The kidneys will be noticed to move less than normally during respiration. The modification of the kidney shadow as regards shape and position, described above, must be remembered when interpretation is undertaken. Goetze (24) mentions how, in a case of floating kidney examined in the lateral position, with a horizontal radiation, the organ was observed to creep slowly out of the field of vision, slipping over the ~~vertical~~ vertebral column and becoming lost in the general dark shadow of the lower side. He also draws attention to the fact that the shadow of a normal kidney or spleen may sometimes be observed projecting beyond the shadow of a tumour mass, when such growth was suspected to be originating in one or other of these organs.

Pyelography used in combination with inflation often gives good results, collargol, thorium citrate, or other non-irritating opaque solution being used to fill the ureter and

pelvis of kidney if required. Stereoscopy combined with either or both of above methods may prove useful in clearing up a doubtful shadow.

The Alimentary Canal. The stomach may be distended by the administration of measured quantities of the solutions of bi-carbonate of soda and tartaric acid, with the consequent evolution of CO_2. The colon is inflated with the ordinary Higginson Syringe.

With the patient lying on the back, these organs can be studied in the lateral view, the radiation being horizontal in direction, when they will be seen to project into the gas "field". Peristaltic waves can be seen and gross distortion of the viscus may be observed.

Goetze (24) claims that inflation, combined with the opaque meal, gives good results in the diagnosis of pathological conditions of the lower end of the oesophagus and cardiac end of the stomach. The opaque enema, combined with inflation, may also be found useful in diagnosis of new growth or "kinks" of the colon.

The method would not seem to be applicable to the small intestine. Portions of this tube may certainly be filled with gas, but it is rarely possible to determine its position with reference to the rest of the tube. The omentum and mesentary if projected forwards by inflating of the colon may sometimes be seen in the lateral view.

6. Pelvic Organs. For the demonstratuon of these parts the patient must be placed in a position which would allow the intestines to drop out of the cavity of the pelvis,

which becomes filled with gas. The foot of the couch is raised about 9 inches, and the central ray should make an angle of 60° ~~or 60°~~ with the long ~~access~~ axis of the body, pointing downwards, with the tube above. This gives a general view of the pelvic contents, and the uterus and adnexa can generally be recognised, as also may tumour growths, if they do not entirely fill the pelvis; also the bladder if inflated with air or fluid. The uterus may be seen displaced to one or other side by tumours, or from other causes.

The prone position with the X-ray tube below the table may also be used.

In the lateral "Trendelenberg" position the patient is turned on one or other side, and the tube is either in front of or behind the patient. This allows the gas to collect in the highest part, where the structures ~~is~~ present have their outlines emphasised, while the lower half of the cavity is dark.

The condition of the peritoneum can be investigated in a number of positions, according to the part requiring examination. By arranging the patient's position accordingly, any selected part of the membrane may be brought into the highest plane of the field. Adhesions and secondary nodules are easily demonstrated, as is also tuberculous peritonitis. Occasionally, in cases where a small quantity of fluid is present, the fluid level may be made out in a dependent part.

The lesser sac of the peritoneum has not so far been demonstrated.

General principles of technique concerning exposure in these cases does not differ in any material respect from that practised in ordinary cases. As the patient is not able to hold his breath for any length of time without much discomfort, and compression cannot be used to an extent likely to be effective, the exposure should be as short as is compatible with the production of a satisfactory negative. A moderately soft tube, with a current of about 25 to 30 m.a. for 4 to 6 seconds should fulfil all ordinary requirements where the patient is of average build. Accuracy of centreing and the reduction of secondary radiations to a minimum, are desiderata which have been referred to before. The former is easier of attainment if the "tube under the table" method be employed, because screen observation can be relied upon for correct adjustment of apparatus. The latter requirement is met by the use of a small diaphragm sitting as circumstances will allow, with the tube below method, or by means of (opaque) extension tubes in the overhead method.

It is often an advantage to be able to vary the distance between target and plate when the ascending ray is used. A table which can be elevated about 6 to 8 inches is therefore a convenience. The increased distance must naturally be taken into account in determining exposure time.

It is also convenient to have attached to the tube-holder in the overhead method a pointer to indicate the direction of the central ray.

RISKS AND CONTRA-INDICATIONS.

Risks.

1. Infection.

No cases are on record in which as a result of paracentesis for purposes of oxygen inflation, the peritoneum has been infected. The writers on the subject are unamimous in respect of the safety and simplicity of the method, and the small ~~difficulty~~ degree of discomfort and pain occasioned by it.

The experiments of Weber (16) and Rautenberg (33) on the cadaver and on animals show that even in the lifelsss intestine, puncture does not readily occur. The probability is that the living bowel would recede before the needle, if it is slowly and firmly introduced. A small puncture, would as suggested by Roberts (35) ~~would~~ almost certainly give rise to no deleterious after-effects. Stein and Stewart (29) state that the possibility of conveyance of pathogenic organisms by the oxygen stream is a very remote one.

2. Puncture of Blood Vessels.

In the area described as the usual one chosen for the puncture there are normally no vessels of any size in the abdominal wall. It is conceivable that a mesenteric vessel may be injured, but by keeping good control of the needle to prevent sudden slipping in when the point passes through the peritoneum, the risk would also seem to be minimized. No case is on record of such an event having occurred.

3. Emphysema, may occur locally through the site of the puncture. This would interfere with the radiographic technique

and results, by ~~moving~~ causing confusing shadows, and constitutes another reason for not delaying the examination unduly, and for subsequent deflation. No serious or even particularly undesirable results are to be anticipated if emphysema does occur.

In the series of 47 cases no instance of this development has been encountered. The occurrence of perperitonial emphysema due to the use of too short a needle has been referred to (von Teubern).

Contra-Indications.

1. Cases of serious involvement of the lung by disease. The vital capacity is already appreciably decreased by the abdominal distension, and to superimpose this handicap on a ~~patient~~ patient with already existent respiratory embarrassment is probably unjustifiable.

2. Cardiac and Circulatory Causes.

a) Breach of compensation

b) Angina pectoris

c) Arterio-sclerosis and hyper-piesis.

The positive intra-abdominal pressure appears likely to prove undesirable in all these cases, and the degree of inflation that could be carried out with safety would probably be too small to be of much value to be an aid ~~to~~ in diagnosis. This would especially seem to apply to cases of Angina pectoris and breach of compensation.

4. Acute Inflammatory affections of Peritoneum.

The danger, referred to above, of general dissemination of a localised infective condition, is a serious enough one to

cause the radiologist to refrain from application of this diagnostic method to such a condition as Subphrenic abscess.

The degree of inflation might be regulated to avoid wider separation of the liver than what would suffice to reveal the pressure of an abnormal shadow, but the matter has not, so far, been investigated.

5. Hernia.

This does not constitute an absolute contra-indication in ~~abscess~~ cases where a retentive appliance can be used. A case was seen lately where an appliance, and even pressure by hand, did not succeed in preventing the entry of gas into a scrotal sac, the ~~whose pressure~~ Presence of which was unsuspected by the operator. Ventral Hernia is easier of control.

6. Advanced Pregnancy.

In these cases the only feasible sites of puncture ~~is~~ are in areas where there are other factors to consider, ~~in~~ such as risk of puncturing organs, etc.

7. Adhesions.

The puncture will not be undertaken in the vicinity of an old operation wound. In general the wisdom of puncturing cases in which an abdominal operation had been performed for an inflammatory condition of the bowel and peritoneum, is open to doubt on account of the frequency with which adhesions of bowel or omomentum to the parieties is met with. The pain which is liable to be caused by inflation also tends to limit the sphere of usefulness of the method where adhesions are present.

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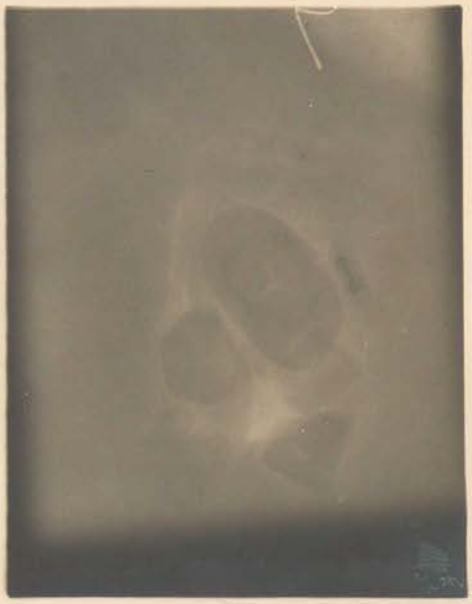


AN EXPERIMENTAL OBSERVATION.

The following experiment was undertaken with the object of ascertaining whether a body with a coefficient of absorption equal to, or lower than that of animal tissue, could be rendered more clearly visible on the X-ray plate, when imbedded in such a tissue, by surrounding it with a gaseous envelope in situ. For this purpose gall stones, imbedded in beef, were used. In his experiments conducted on similar lines, Knox (1) found, as already referred to, that the majority of gall stones caused "negative" shadows, both under artificial conditions, and when radiographed ~~in-situ~~ in the human body. The "negative" character of the shadow was, naturally, only relative, and it appeared to be a ~~national~~ natural expectation that, if the stone were surrounded by a medium with a much smaller coefficient of absorption than itself, its shadow would, by contrast, be much emphasised.

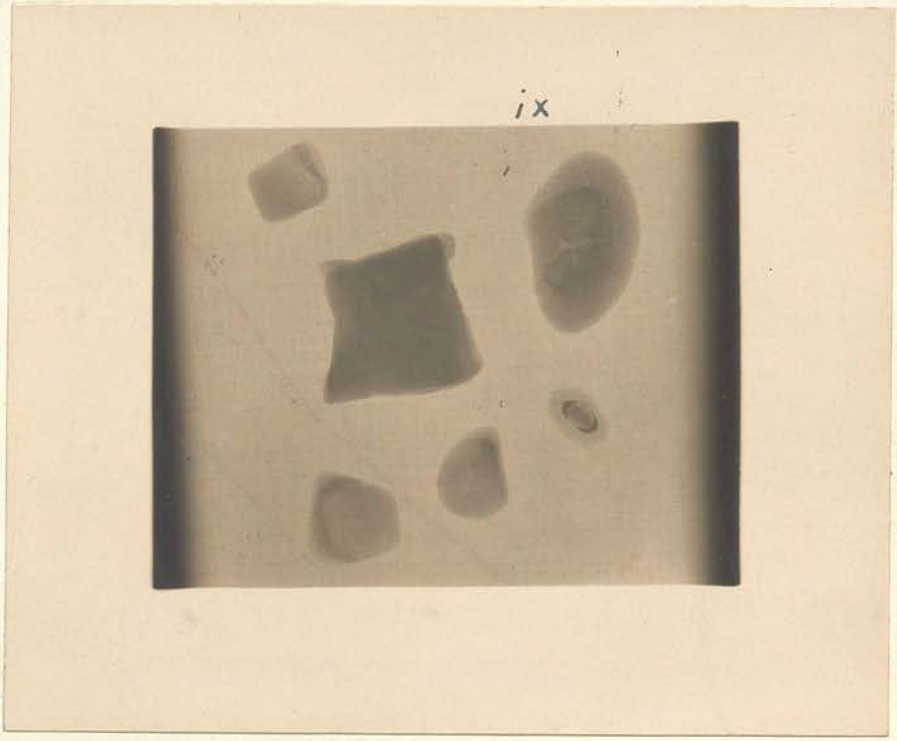
Five gall stones of different sizes were selected, one of them obviously containing a considerable percentage of opaque material (calcium salt). They were placed on a slice of beef steak one inch thick. On top of this was then placed another equally thick slab of beef. The X-ray plate was placed on rests one inch above the surface of the beef, and the exposure made. The instrumental setting remained the same for the whole series of exposures, viz: 6 m.a. in secondary, with 5 inch alternative spark gap. The first series of exposures were made through two and three inches of beef respectively, and for one, two, and three seconds successively.

The stones were next placed in a small bag of thin animal membrane, which was inflated to about one third of its capacity with air, replaced on the lowest slab of beef, and a similar series of exposures to the first repeated.

TABLE.	Thickness of Beef.	Exposure Time.	Surrounding Medium.
Fig. 1.	2 inches	1 second	Beef
" 2.	2 "	1 "	Air & Beef
" 3.	2 "	2 "	Beef
" 4.	2 "	2 "	Air & Beef
" 5.	3 "	2 "	Beef
" 6.	3 "	2 "	Air & Beef
" 7.	3 "	3 "	Beef
" 8.	3 "	3 "	Air & Beef
" 9.	Stones radiographed separately with a cube of beef for comparison.	Exposure one second.	

The plates were developed simultaneously, in the same dish, and for the same length of time, to secure uniformity. The respective pairs, with the same thicknesses of muscular tissue and similar exposures, but in one case surrounded by air and in the other not, were them reproduced side by side on the same print, the printing time being again identical for each pair. In the case of the single plate, a piece of beef was cut to a thickness corresponding to the longest vertical depth of the largest gall stone, and exposed together with the gall stones for one second.

It will be noticed that the shadows of the stones, in the first series, tend to merge into that of the muscular tissue, whereas in the second series the outlines of the stones remain quite distinct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in the case of those stones obviously surrounded by air. In the first series also, the stones are indicated by definitely "negative" shadows, except in the case of the small stone with the large calcium content, whereas in the second series the shadows have actually assumed a "positive" character.

The explanation of this fact on a physical basis does not appear to be at all obvious.

DESCRIPTION OF A NUMBER OF CASES ILLUSTRATED BY PLATES.

Plates 1 to 6 are reductions intended to give a more or less general view of the inflated abdomen. The remainder are natural sized prints from the original negative, reduction being avoided for preservation of detail.

Case 1, plate 1.

This illustrates the usual appearance of the upper part of the abdomen with the spleen, kidneys and liver, the last partially out of the field. The view is a posterior one. The enlarged spleen with a nodular outgrowth on its parietal surface, is well seen lying apparently over the upper pole of the left kidney.

The downward displacement of all the organs is noticeable. The diagnosis of the splenic condition was not confirmed. The patient was treated by irradiation and the spleen decreased in size and the outgrowth disappeared, as was proved by subsequent examination.

Case 2, plates 2 & 3.

These posterior views show a greatly elongated right lobe of the liver (Riedels Lobe). In plate 3 the table was raised 6 inches and the decrease in size of the image is well shown. The ascending colon is inflated with air. The elongated lobe of the liver was diagnosed clinically as a tumour growth.

Case 3, plate 4.

Right lateral view. The patient was lying on the left side, and the ray was vertical (tube below table). The intestines had sunk into the left flank, and show partly in front of the rounded swelling in the lower part of the abdomen. If a horizontal ray had been used with the patient lying on the back, the intestines would have sunk out of sight leaving the tumour outline clear.

The case was one of a large ileo-psoas abscess.

Case 4, plates 5 & 6.

Posterior views at different levels. The case was one of idio-pathic dilatation of the colon. In both plates the greatly dilated large bowel can be seen. In plate 5 there is a curious projection from the outer border of the left kidney due to a faecal mass in the colon. In plate 6 the large bowel is shown inflated with air, demonstrating how the walls of the tube show up.

Case 5, plates 7 & 8.

Plate 7 was taken before inflation, on deep expiration. The technique in this case was faulty, as the left kidney shadow is altogether invisible. The dark shadow above the crest of the ileum on the right side is not in the usual kidney area. The outline of the organ is indicated, but not definitely enough to be diagnostic

~~diagnosis~~. Plate 8 was taken after inflation, in inspiration. The shadow is now seen to be situated within the shadow of the displaced kidney, and to have descended, probably with the respiratory descent of the kidney, although this is not clear from the plates. The centreing varied in the two cases.

A phosphatic calculus was removed at operation. The variations in density of the kidney shadow are due to gas in the intestines.

Case 6, Plates 9 & 10.

Technique varied considerably in regard to exposure and centring in these two plates. When a suspicious shadow is observed radioscopically the routine has been to make two successive exposures, one in full inspiration, the other at end of expiration, to ascertain the "respiratory excursion" of the shadow relatively to that of the kidney. Plate 9 was taken in the inspiratory position before inflation, plate 10 in expiratory after inflation.

In spite of having to allow for this "compensatory" shift, the shadows of the calculi will be seen to be lower in the second plate than in the first, and nearer the middle line. The outline of the kidney shadow is very indistinct in plate 9, and, much better seen in plate 10.

The condition of the last rib (apparently a mal-united fracture) will be noticed. The calculi were removed from the kidney at operation.

Case 7, plates 11 and 12.

In the first plate, taken before inflation, the kidney shadow cannot be made out.

On the second plate, taken after the peritoneal cavity and lower bowel had been inflated, the outline of a large tumour can be seen. The effect of the gas in the bowel is shown by the variations in degree of density over the upper part of the tumour shadow.

The diagnosis was "Compound Cystic Kidney". The ~~turn over~~ tumour was distinctly palpable.

Case 8, plates 13 and 14.

This was a case of gall stones; the kidney displacement being unsuspected. The clear outline, as well as the modification of the profile of the organ, characteristic of the inflated abdomen, can be seen.

The gall bladder is visible, apparently enlarged, and a suggestion of a "negative shadow" is seen in plate 14, which also shows the stomach containing an opaque meal.

Several gall stones were removed at the operation.

Case 9, plates 15, 16 & 17.

The first two plates show the greatly enlarged gall bladder from both points of view. In the anterior view, plate 15, it is noticeable how intestinal gas content causes confusing shadows. In plate 16 a negative shadow is seen nearer the lower pole of the gall bladder. Plate 17 shows the gall bladder after removal. The negative shadow is well shown near the lower pole, with the characteristic ring formation well marked. Two other faintly positive shadows can be made out near the former.

Three medium sized gall stones were removed at operation.

Case 10, plates 18, 19 & 20.

These three plates, of a case of gall stones, illustrate

the views obtained from three angles. In the posterior view the shadows are seen in the kidney area, and in the anterior view the kidney is not seen. The lateral view serves to prove that the stones are in a plane anterior to the kidney. The lighter centres of the shdadows with the resulting ring formation is well seen. The gall bladder outline is best seen in plate 18. The patient could not sit up; hence plate 20 was taken lying on the side with the radiation vertical. At the operation a number of gall stones were removed.

Case 11, plates 21, 22 & 23.

In this case, although the gall bladder is shown in all the views, no shadows either negative or positive can be made out. Several medium sized stones were removed at the operation. As in the former case the plate showing the anterior view reveals the fact that there is often a considerable degree of blurring, loss of detail, and confusion due to the presence of gas in the intestines, although in both cases the patients were lying on their backs, when the intestines sink into the flex.

The marked difference in level between the two kidneys in this case will be noticed.

Case 12, plates 34 & 35.

The gall bladder is seen in both plates. In the posterior view the viscus can be seen to be much enlarged, but in the anterior view it is mostly hidden by the overhanging right lobe of the liver. No appearance indicating the presence of gall stones is discernible. At the operation two fair sized stones were found, one of which was in the neck of the bladder.

Case 13, plates 26 & 27.

The gall stones in this case are better seen on the plate showing the posterior view; the gall bladder being also faintly indicated in this view, whereas its outline is lost in the anterior view. In plate 27 the gall bladder partly overlies the right kidney. If some of the stones' shadows had not shown beyond the kidney shadow, a lateral view would have been required to establish their nature. Tube shift, or posturing of the patient might have served a similar purpose. The shadows have clear centres with ring formation. After removal the stones were found to have an appreciable calcium content.

Case 14, plates 28 & 29.

These two lateral views, of the same case, demonstrate the difference brought about by inflation as observed from this angle. Plate 29 was slightly over-exposed as compared with 28. On the latter the organs are quite indistinguishable, while in the former the anterior abdominal wall, the liver, and the greatly distended gall bladder are well seen. These two plates were taken with the patient occupying exactly the same position, for purposes of comparison.

The case was unfortunately lost sight of.

Case 15, plate 30.

The gall bladder can be seen under the lower margin of the liver, apparently not much enlarged. There is no local variation in the density of the shadow to suggest the presence of a calculus. At the operation a large oval gall stone consisting almost entirely of cholesterine was removed.

Case 16, plate 31.

The clinical diagnosis in this case was "gall-stones". The gall bladder is distinctly seen to be enlarged, but no indication of gall stone can be made out. No gall stones were found at operation, ~~although~~ but the walls of the viscus were thickened by disease.

Case 17, plates 32 & 33.

This case had been treated by irradiation for sarcomatous growth of the axilla, which had disappeared. The plates here reproduced were taken when suspicion arose, some months later, of a recurrence in the abdomen. Both plates were over-exposed. In the anterior view, (plate 32) the lower margin of the liver is very indefinite, but the irregular dark shadow can be made out lower down, near the vertebral column. The second plate shows better the relation of the shadow to that of the lower edge of the liver. The diagnosis was hyper-nephroma. On the plates taken before inflation no shadow could be made out. The case was lost sight of.

Case 18, plate 34.

This case illustrates the wide separation of the spleen from the diaphragm, and the fact that the latter organ is visible as far as the lateral margin of the vertebral column. The case was examined for evidence of adhesions to account for persistent pain in this area. An operation for perforated gastric ulcer had been performed about a year previously. The thickening of the pleura over the base of the left lung was diagnosed clinically. No adhesions can be seen. The subse-

quent ~~growth~~ progress of this case could not be traced.

Case 19, plates 35, 36 & 37.

This was a case of abdominal tumour of uncertain nature and origin. On the plates taken before inflation of the abdominal cavity, it showed as a large ill-defined dark mass. The plates here reproduced show clearly its outline and limits, and prove that it was not connected either with the liver or right kidney, which facts could not be established clinically. The case was not operated on.

Case 20, plate 39.

The shadows of the kidney and spleen are obscured by a large round of shadow with regular margins. The mass is apparently continuous with the liver. In the plate taken before inflation the limits of the growth could not be defined. At operation a large new growth was found, growing from the under surface of the liver. The condition proved to be inoperable, and the patient died a few days after operation. Post mortem the growth was found to be carcimona, apparently primarily in the gall bladder.

Case 21, plates 40 & 41.

In the posterior view, plate 41, a large shadow is seen extending downwards from the under surface of the liver, hiding the shadow of the right kidney. In the lateral view an ovoid shadow is seen below the liver, to the under surface of which it seems to have moulded itself. At the operation it was found to be a hydatid cyst growing from the under suface of the liver.

Case 22, plate 42.

In this plate a large mass, apparently continuous with the liver, is seen filling up the abdominal cavity. Its rounded regular margin is well shown, separated from the abdominal wall by a zone of gas. The nipple-shaped process towards the lower end of the field was palpable externally. The diagnosis in this case was not established. No operation was undertaken, and the patient was lost sight of.

Case 23, Plates 43, 44 & 45.

These three views of the pelvis illustrate the effect of the gas content of the cavity on the radiographic result. The antero-posterior views, with the patient prone shows the uterus displaced to the right side by a tumour mass occupying the greater portion of the left half of the pelvis. The adnexa are visible. The other two views illustrate the gravitation effect of the gas, only the structures in the upper part of the field being outlined in each case, due to the collection of oxygen in the highest plane of the cavity. The tumour was a dermoid cyst.

Case 24, Plates 46, 47 & 48.

This tumour - an ovarian cyst - filled the pelvis when the patient was lying on the back, with the result that the outline of the growth is lost., (see plate 46.) The cyst seems to have dropped to the lower portion of the field and partly out of the pelvis, in the two lateral views, allowing the gas to accumulate in the upper part, with the resultant clearness of outline. A band is seen on the left side, stretching from the cyst to the side wall of the pelvis.

At the operation the cyst was found to be growing from the left side, and to be of the multilocular variety. An uncommon feature in these growths was the lobulation of the mass.

Case 25, plates 49 & 50.

These two views shows the difference caused by the presence of gas in the pelvis. Plate 49 (a posterior view) shows the appearance before inflation, and plate 50 (an anterior view) that after inflation. A large indefinite shadow shows in each case on the left side, partly out of the pelvis. In the second view the gas has enabled sufficient contrast to be secured to show up the right side of the pelvis, whereas in the other the cavity is uniformly dark. The case was one of ovarian cyst. The angle of the pelvis varied markedly in the two exposures.

CONCLUSION.

It would appear to be fairly well established that no actual intensification of shadows on the X-ray plate need be looked for, despite the result of the experiment described on page 35 et seq., by the process of surrounding an organ with gas. What is obtained, however, by this means is a demarkation of the edge of such an organ, where the edge would, on account of close apposition to, or overlapping with, other structures of equal or greater density, have been lost. Any value that the method possesses as, a clinical/diagnostic measure, is dependent on this factor. We are thereby enabled :-

a. To judge of the shape, contour and size of the organs,

b. To locate them in cases where their position is abnormal,

c. To recognise various pathological processes.

The difficulties connected with the radiographic demonstration of the liver and spleen in their entirety, have hitherto ~~have~~ almost been insuperable, and pathological conditions affecting their parietal surfaces have perforce remained obscure. Splenic enlargement needed to be very considerable in extent before indisputable evidence to that effect could be read from a skiagram. This difficulty, ~~is mainly~~ it may be claimed with justice, has been solved to a large extent by the method of gas inflation of the peritoneal cavity. The diagnosis of a number of pathological processes, dependant on a delineation of one or other of these organs, has been simplified.

The clear picture obtained of the subphrenic space and ~~diagram~~ diaphragm leads to the confident expectation of progressing in the recognition of diseases of this difficult region.

The claims of various American authors notwithstanding, the positive diagnosis of gall stones and gall bladder disease would seem to have made ~~this~~ dis. proportionately slow progress. The shadows of the stones, if present, tended to be so faint that they were generally lost in that of the liver, especially if the confusing effects of gas in the intestine were superadded.

The viscus itself could seldom be shown on the plate, unless very markedly altered by disease.

The inflation method is of undoubted value in assisting to render visible the gall bladder. Indeed it may be stated that, with proper technical precautions, the normal viscus should generally be seen on the plate. With the field thus confined by the delineation of the gall bladder, gall stones should be seen in a larger proportion of cases. Adhesions to surrounding organs, with consequent deformation, is often recognised when present.

While the method is of use in the investigation of cases in which the actual position of a kidney, difficult to make up with the ordinary method, has to be determined, it does not appear to be of much value in the demonstration of urinary calculi generally. When the kidney outline is discernible, nothing is to be gained by inflation. Neither can the ureter be shown, and the bladder is easily filled with gas per urethram, if necessary for radiographic purposes.

While it is certain that the female generative organs and tumour growths in the pelvis are capable of demonstration with this

method, no special advantages can be claimed for it as compared with the ordinary clinical methods of investigation of these cases.

In dealing with the digestive tract also, the clinician would be better served by the use of the opaque meal method. The walls of the stomach and colon can certainly be rendered visible if these portions of the tract are separately inflated in combination with peritoneal distension, but it is open to grave doubt if any information of real value would be gained. There is no evidence to support the expectation that carcinoma of the large intestine would be rendered manifest at an earlier stage than otherwise.

The scope of the usefulness of the method may be summed up as comprising :-

1. Lesions of the diaphragm, subphrenic space, liver and spleen, where the zone of separation produced by the gas reveals the whole of such area or organ.

2. Gall stones and other gall bladder lesions, in which the fact that the size and form of the viscus can be studied often provides data of great diagnostic significance.

3. The determination of the exact position of the kidney, in doubtful cases.

4. Abdominal tumours, the anatomical relationships of which can often be traced.

5. Adhesions of the viscera to the parietal peritoneum.

Finally, while the method is not at present recommended as a routine procedure, and its indiscriminate use in cases of intra-abdominal disease is to be deprecated, it must be conceded that it records an undoubted advance in radio-diagnosis.

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The writer wishes to take this opportunity to tender his thanks to Dr. N. S. Finzi, Medical Officer in Charge of X-ray Department, St. Bartholomew's Hospital, for permission to use clinical material from the Department.

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CASE 1, PLATE 1,

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 2, PLATE 2.

Oxygen inflation. Posterior view. Target plate distance 50 cm. Patient prone; radiation vertical.

CASE 2, PLATE 3

Oxygen inflation. Posterior view. Target plate distance 62½ cm. Patient prone; radiation vertical.

CASE 3, PLATE 4.

Oxygen inflation. Right lateral view.

Patient lying on left side; radiation vertical.

CASE 4, PLATE 5.

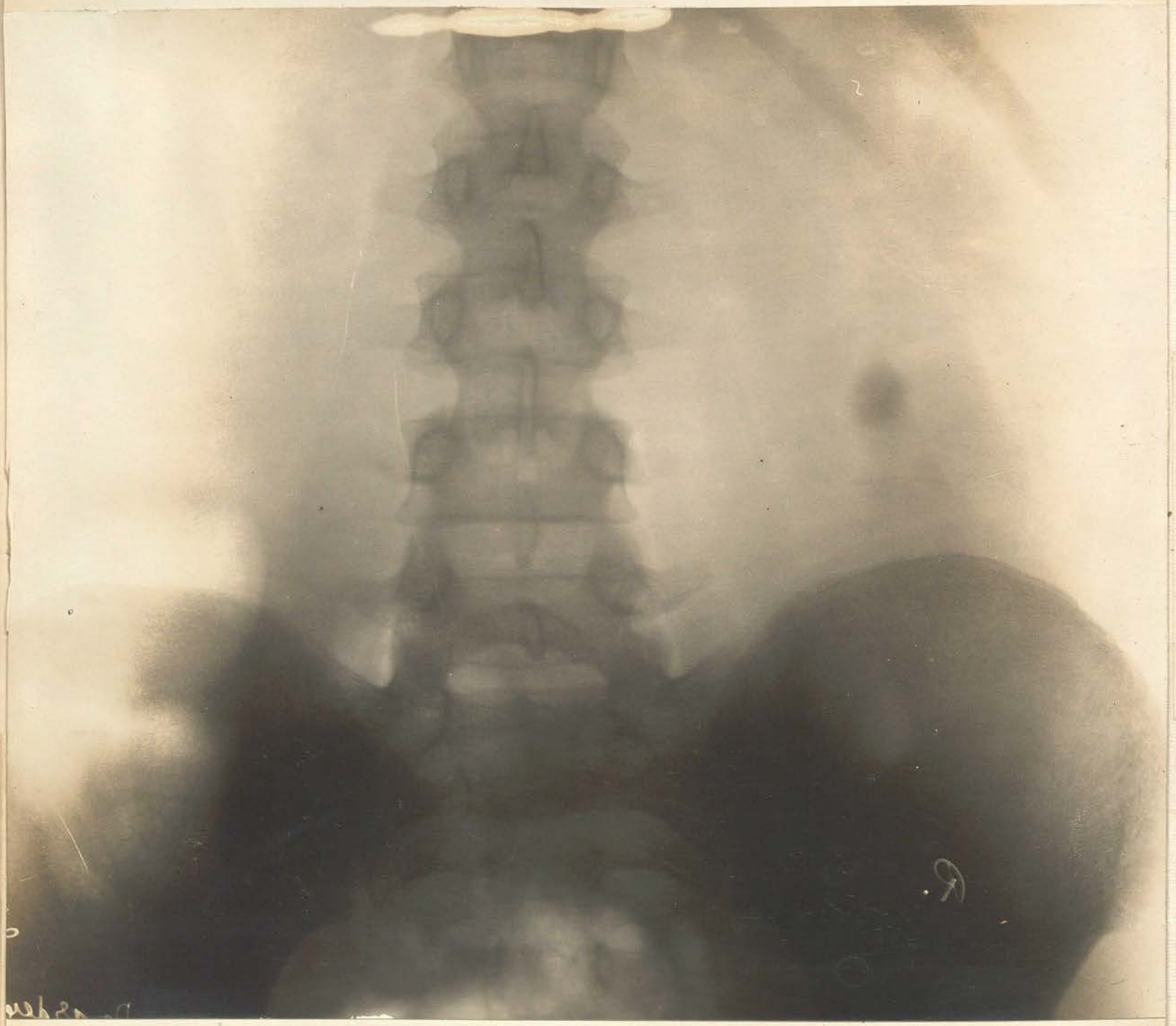
Oxygen inflation. Posterior view. Tube centring upper border of second lumbar vertebra.

Patient prone; radiation vertical.

CASE 4, PLATE 6.

Oxygen inflation. Posterior view. Tube centring at middle of third lumbar vertebra.

Patient prone; radiation vertical.



CASE 5, PLATE 7.

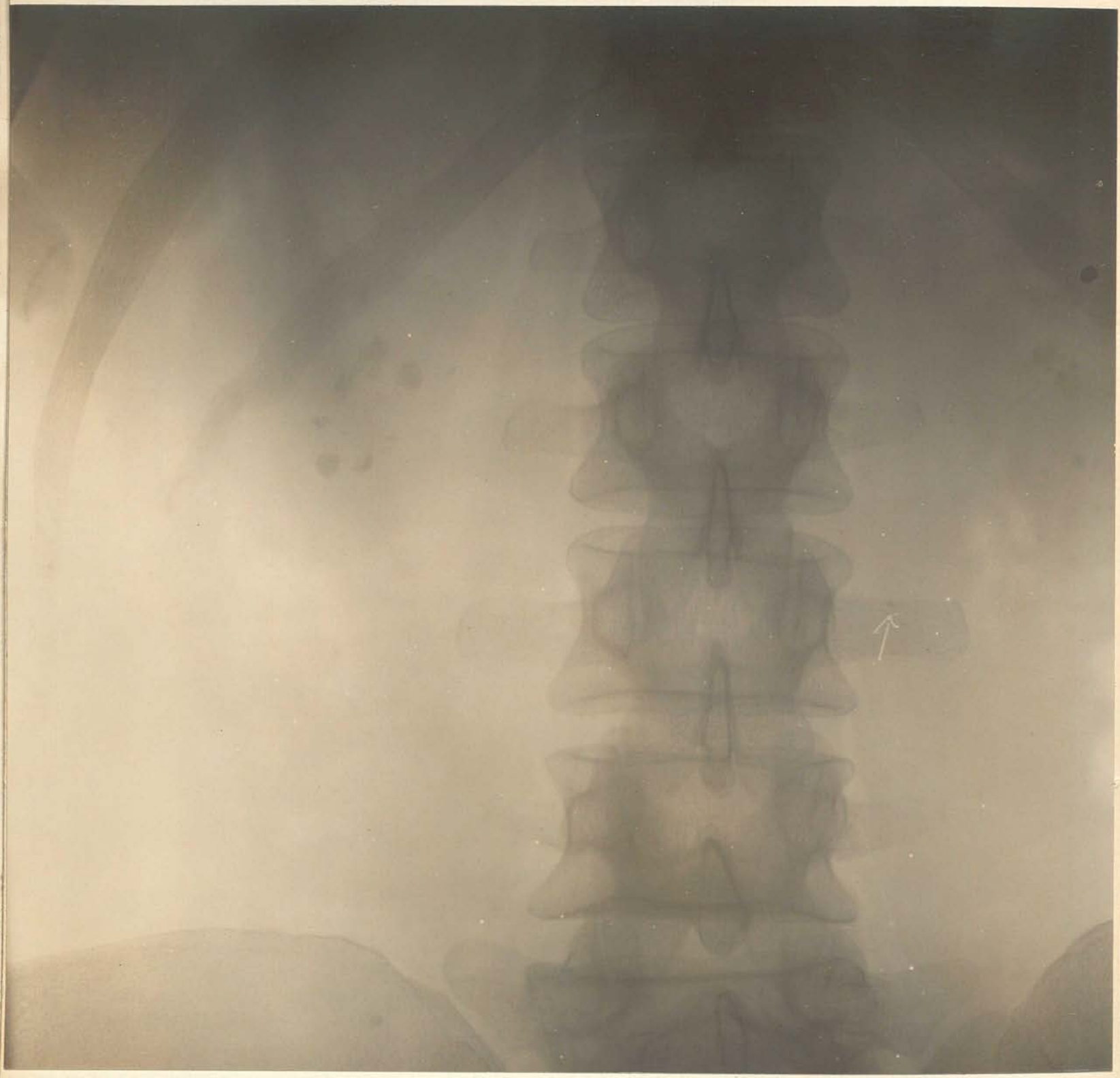
Before oxygen inflation. Posterior view.

Patient prone;. radiation vertical.

CASE 5, PLATE 8.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.



CASE 6, PLATE 9.

Before oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 6, PLATE 10.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 7, PLATE 11.

Before oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 8, PLATE 12.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 8, PLATE 13.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 8, PLATE 14.

Oxygen inflation and barium meal. Posterior view.

Patient prone; radiation vertical.

CASE 9, PLATE 15.

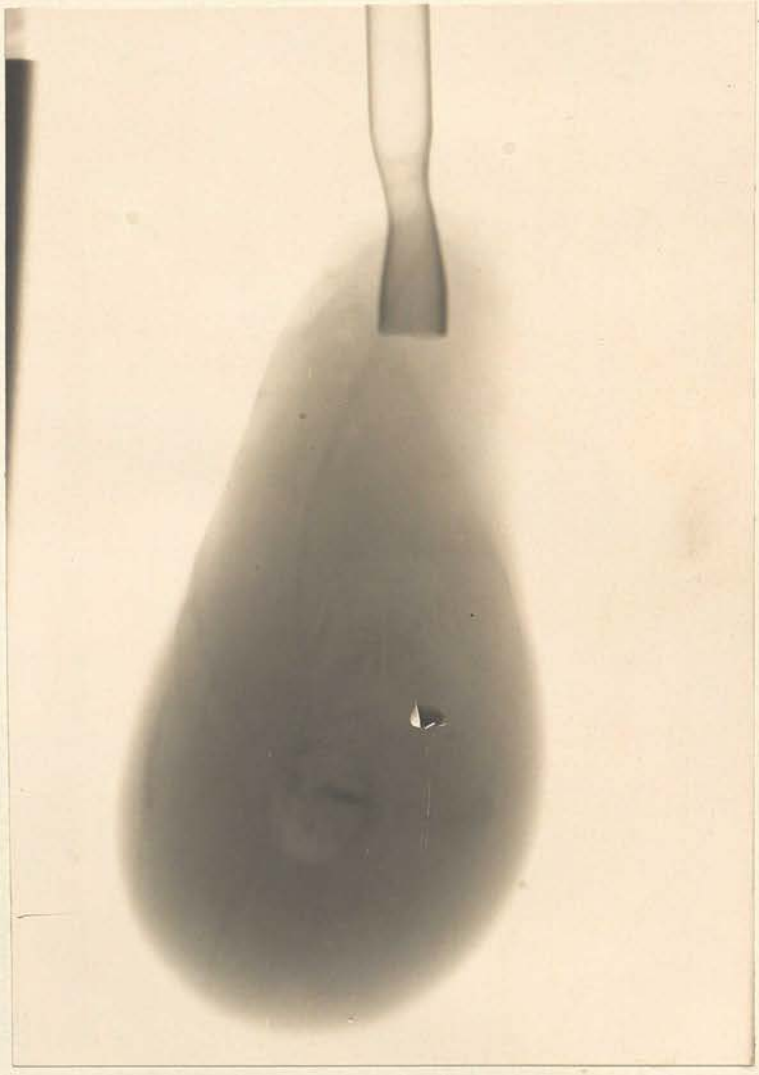
Oxygen inflation. Anterior view.

Patient supine; radiation vertical.

CASE 9, PLATE 16.

Oxygem inflation. Posterior view.

Patient prone; radiation vertical.



CASE 9, PLATE 17.

Gall bladder containing gall stones (plate damaged)

CASE 10, PLATE 18.

Oxygen inflation. Anterior view.

Patient supine; radiation vertical. (plate broken)

CASE 10, PLATE 19.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 10, PLATE 20.

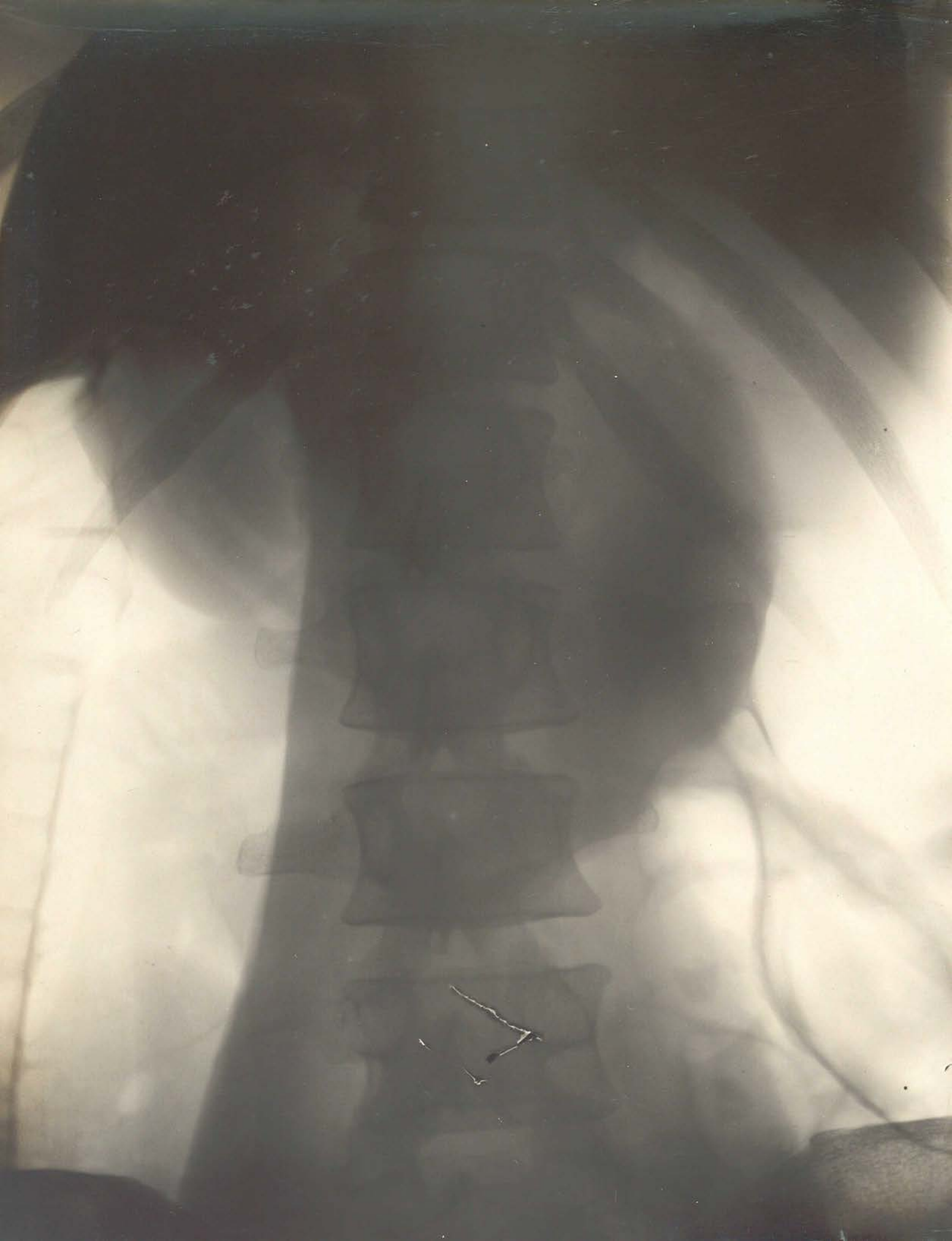
Oxygen inflation. Right lateral view.

Patient lying on left side; radiation vertical.

CASE 11, PLATE 21.

Oxygen inflation. Anterior view.

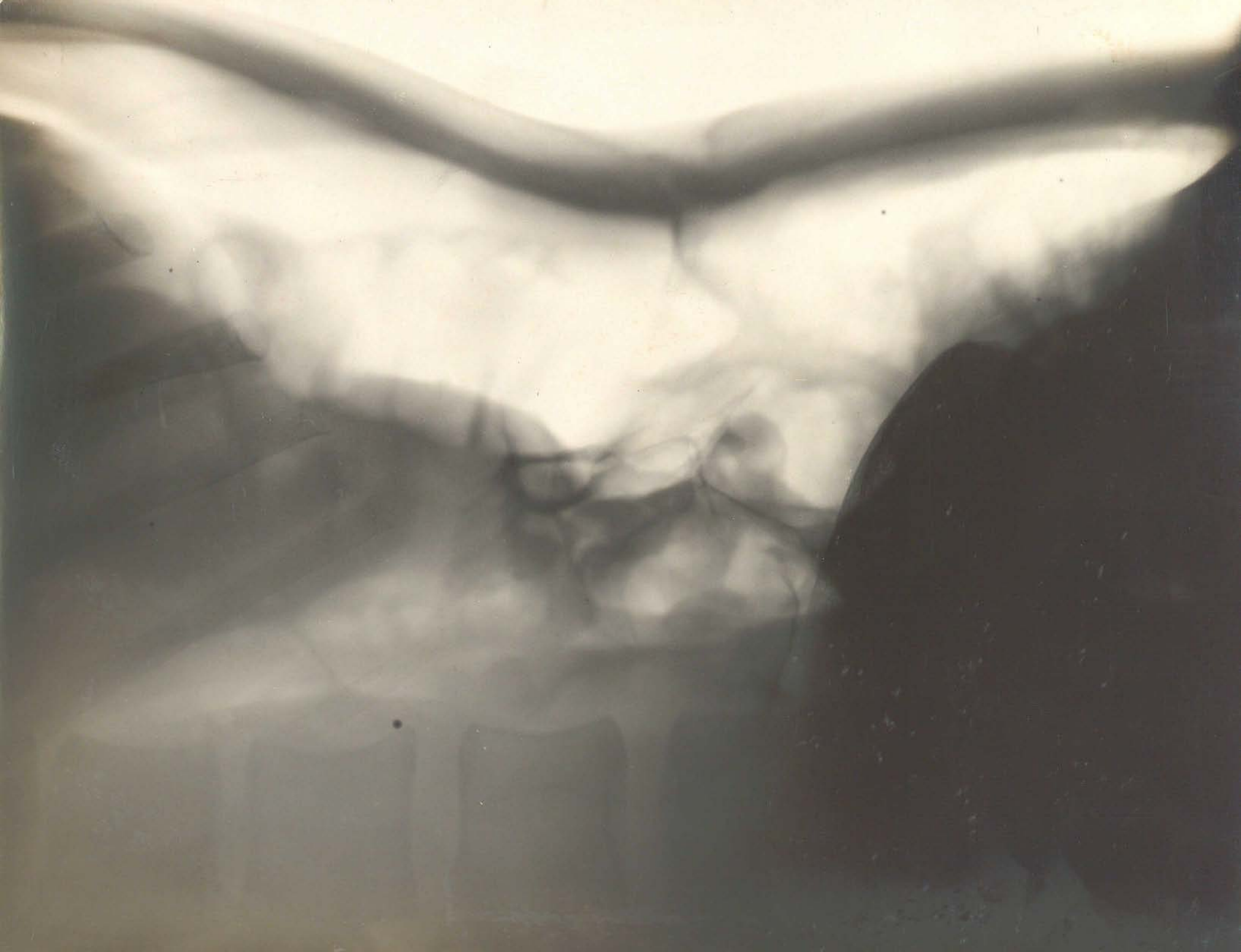
Patient supine; radiation vertical.



CASE 11, PLATE 22.

Oxygen inflation.

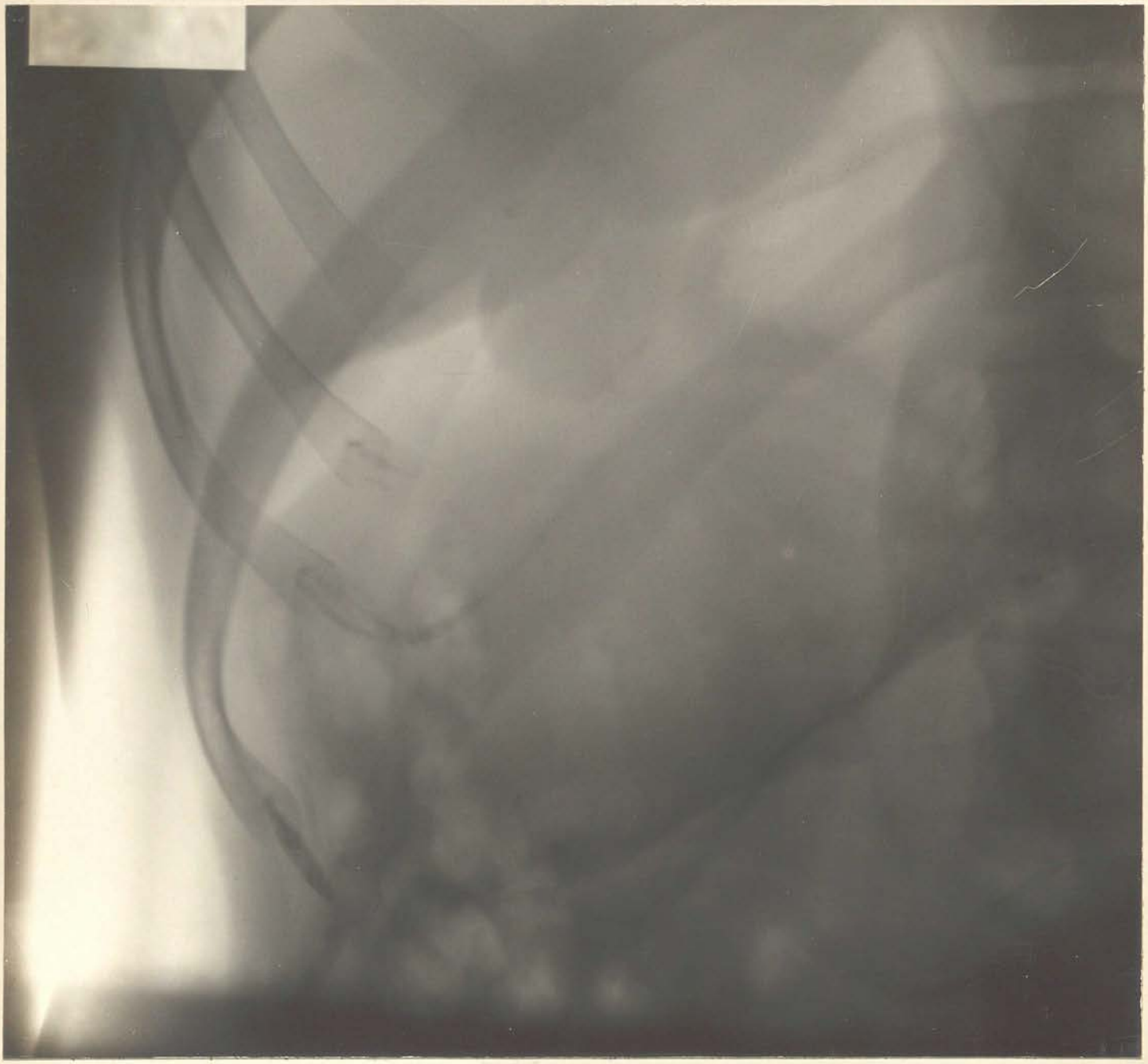
Patient prone; radiation vertical.



CASE 11, PLATE 23.

Oxygen inflation. Right lateral view.

Patient supine; radiation horizontal.



CASE 12, PLATE 24

Oxygen inflation. Anterior view.

Patient supine; radiation vertical.

CASE 12, PLATE 25.

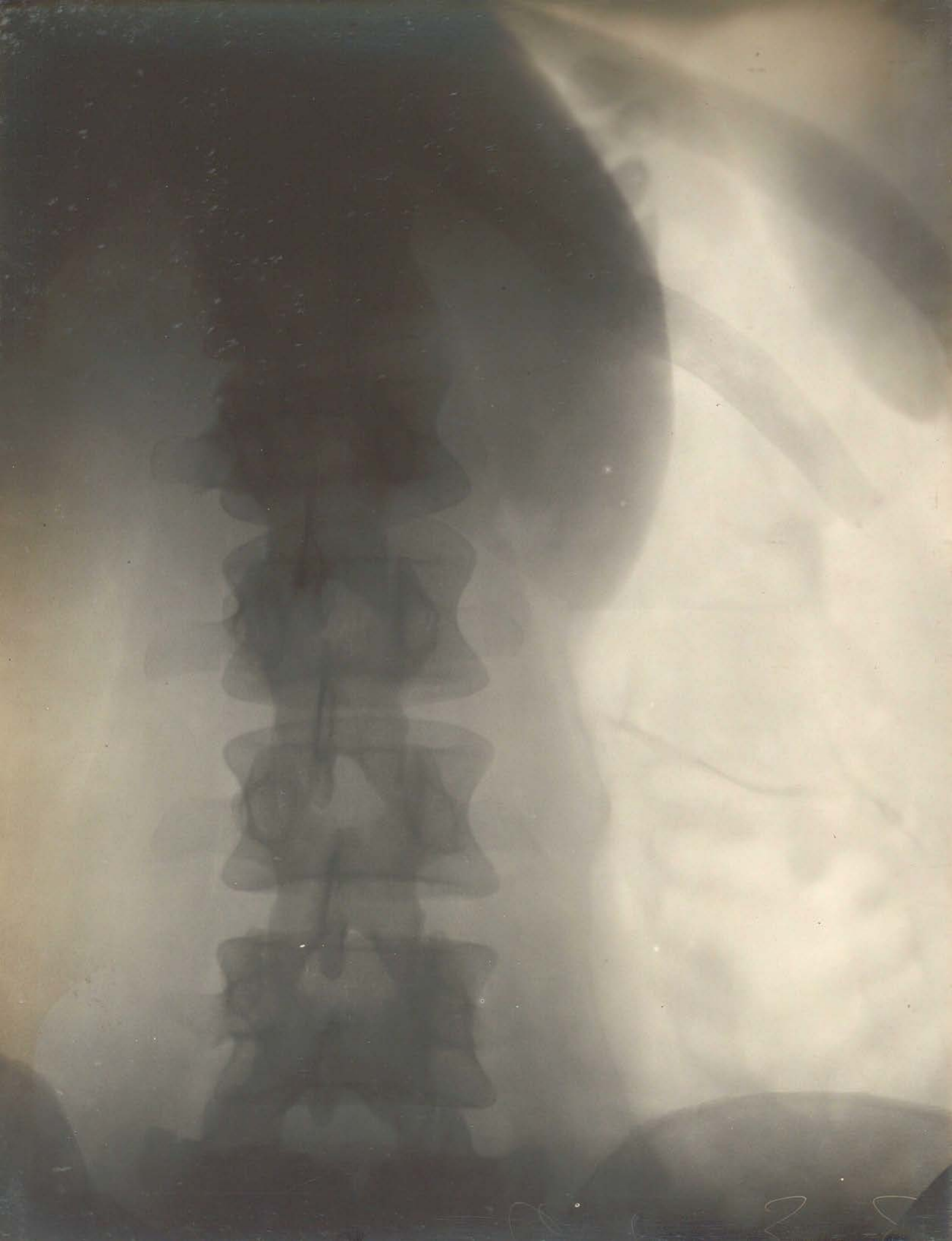
Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 13, PLATE 26.

Oxygen inflation. Anterior view.

Patient supine; radiation vertical.



CASE 13, PLATE 27

Oxygen inflation. Posterior view.

Patient supine; radiation vertical.

CASE 14, PLATE 28.

Before oxygen inflation. Right lateral view.

Patient supine; radiation horizontal.

CASE 14, PLATE 29.

Oxygen inflation. Right lateral view.

Patient supine; radiation horizontal.

CASE 15, PLATE 30.

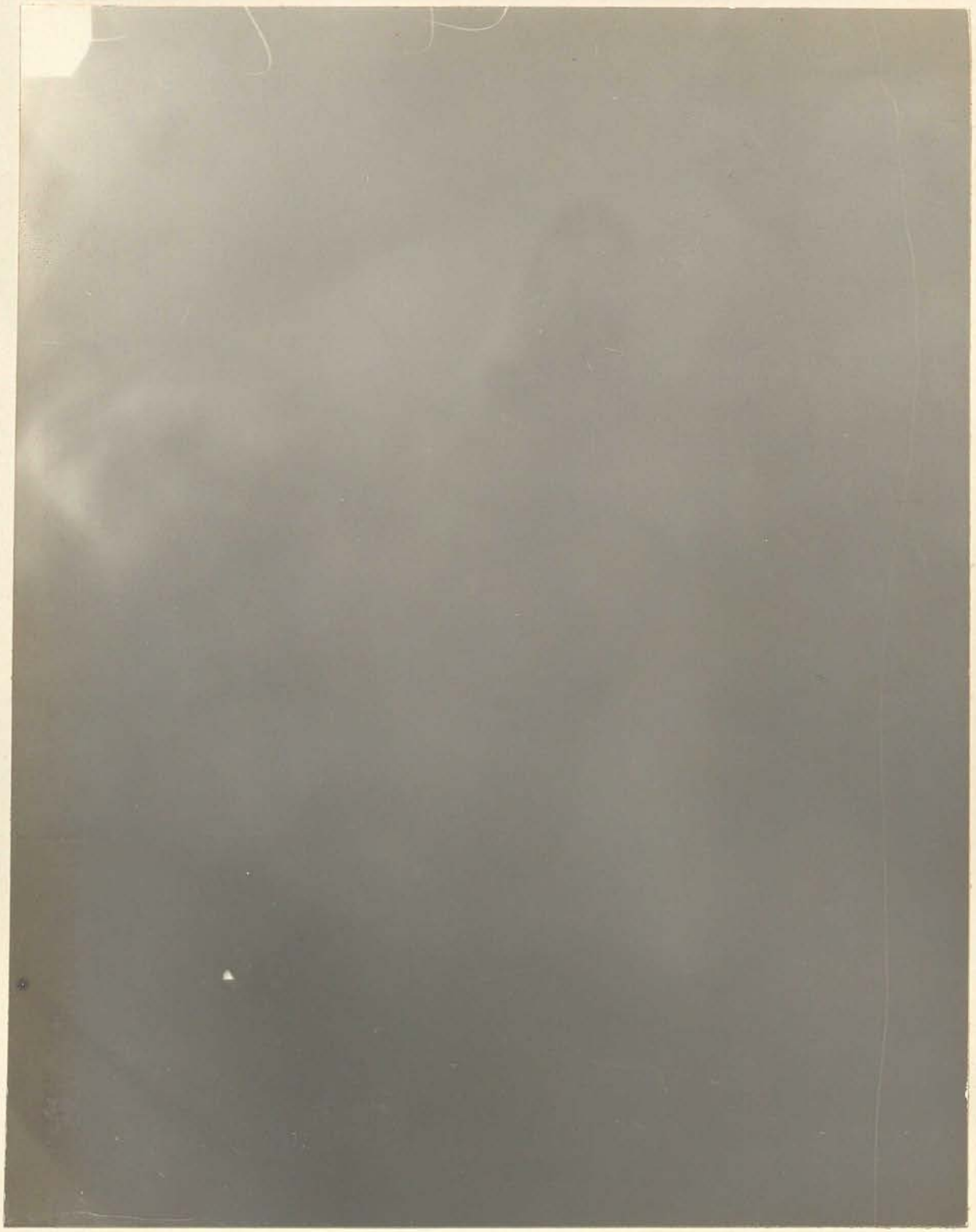
Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 16, PLATE 31.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.



CASE 17, PLATE 32.

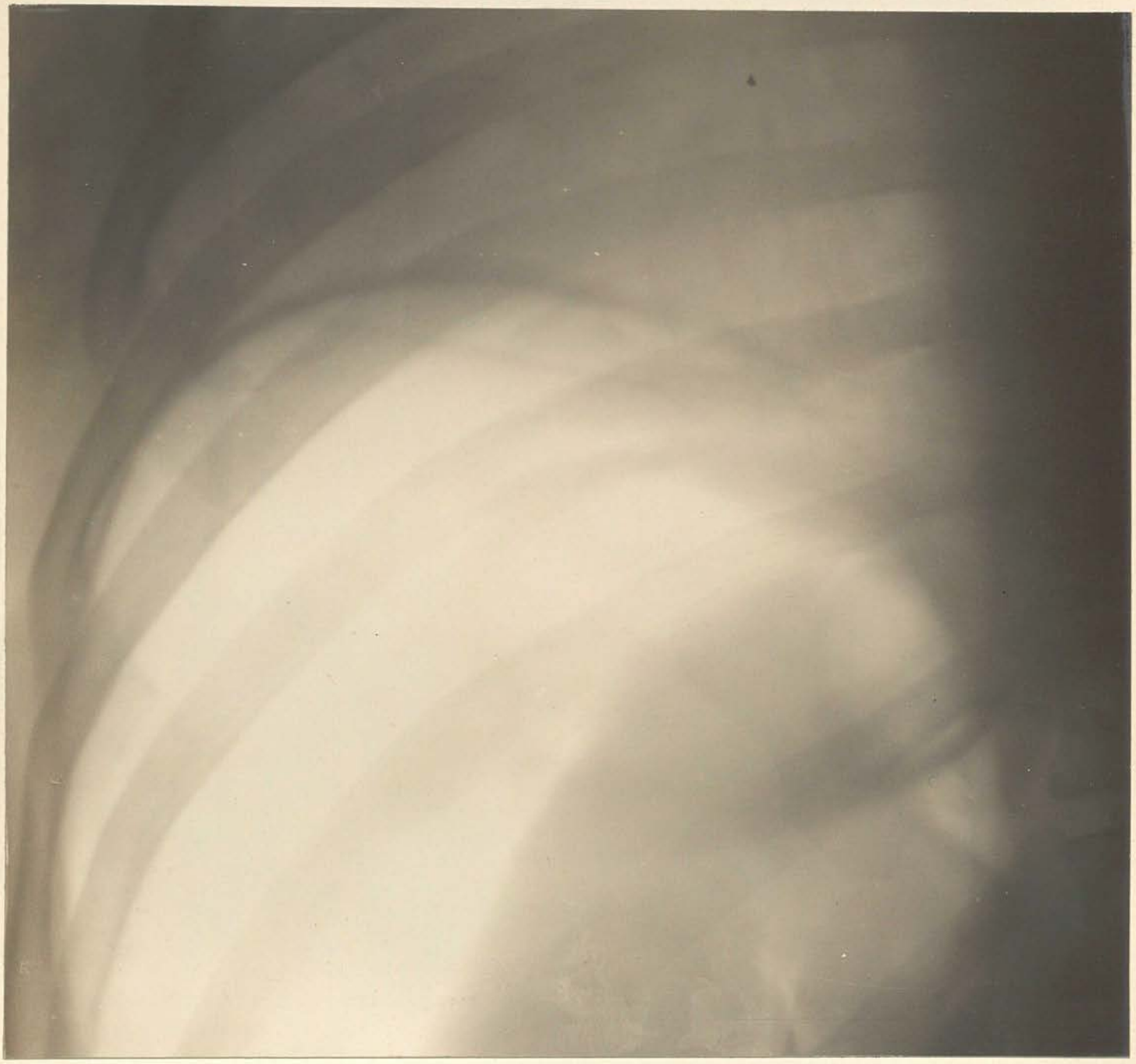
Oxygen inflation. Anterior view.

Patient supine ; radiation vertical.

CASE 17, PLATE 33.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.



CASE 18, PLATE 34.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 19, PLATE 35.

Oxygen inflation. Anterior view.

Patient supine; radiation vertical.

CASE 19, PLATE 36.

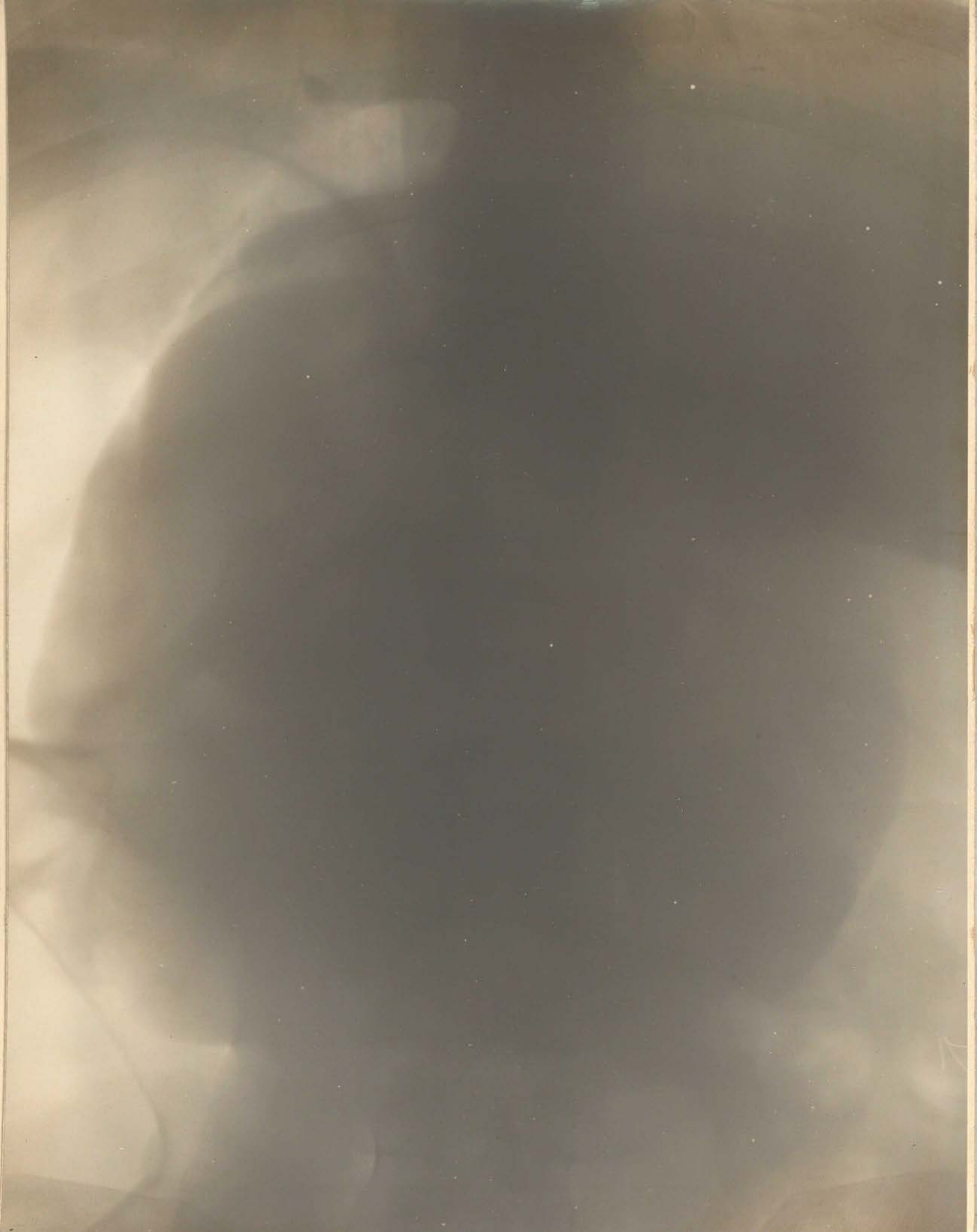
Oxygen inflation; . Posterior view.

Patient prone; radiation vertical.

CASE 19, PLATE 37.

Oxygen inflation. Right lateral view.

Patient lying on left side; radiation vertical.



CASE 20, PLATE 38.

Oxygen inflation. Posterior view.

Patient prone; radiation vertical.

CASE 21, PLATE 39.

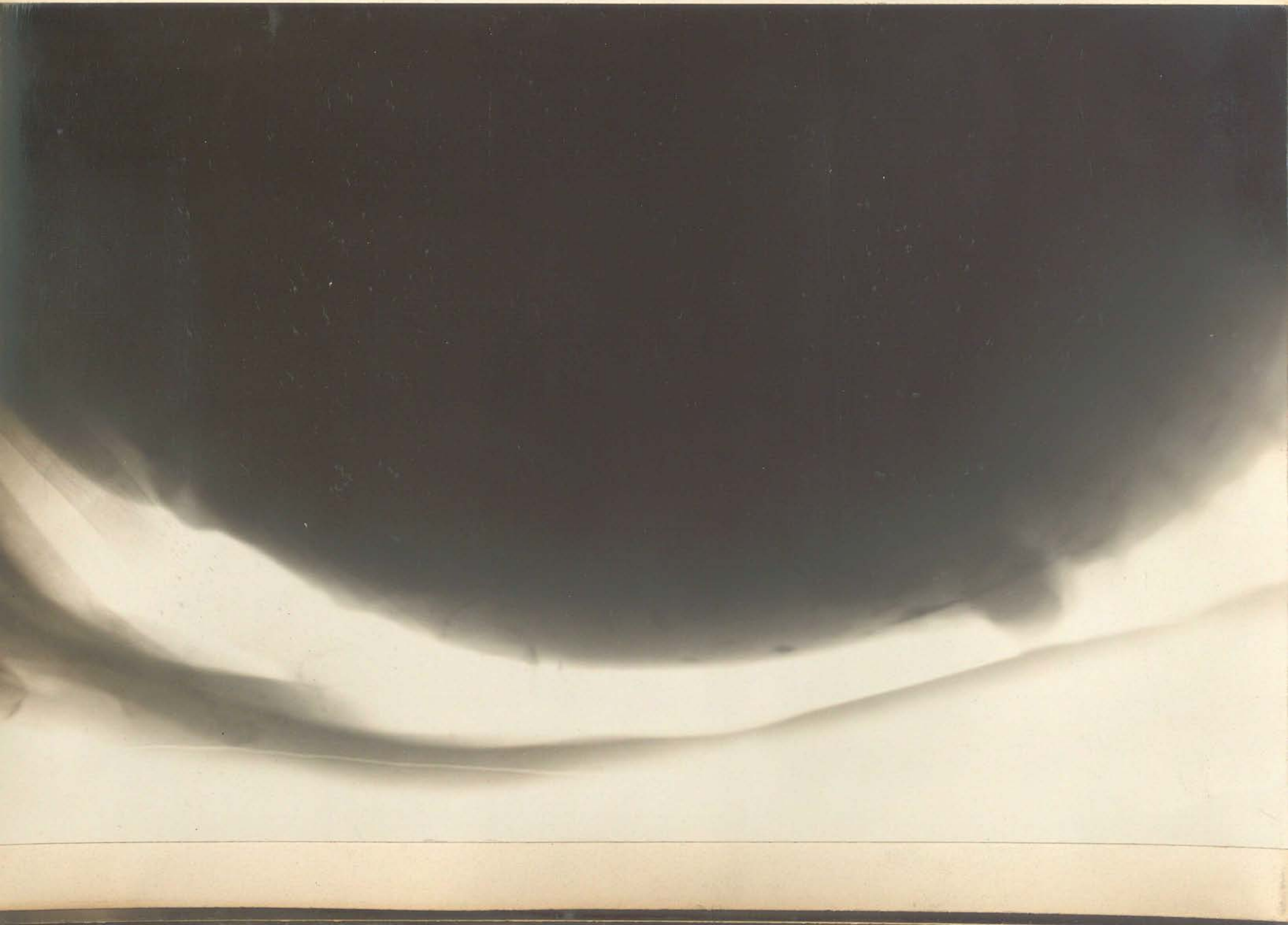
Oxygen inflation. Posterior view.

Patient supine; radiation vertical.

CASE 21, PLATE 40.

Oxygen inflation. Right lateral view.

Patient supine;. radiation horizontal.



CASE 22, PLATE 41.

Oxygen inflation. Left Lateral view.

Patient supine; radiation horizontal.

CASE 22, PLATE 42.

Oxygen inflation. Posterior view.

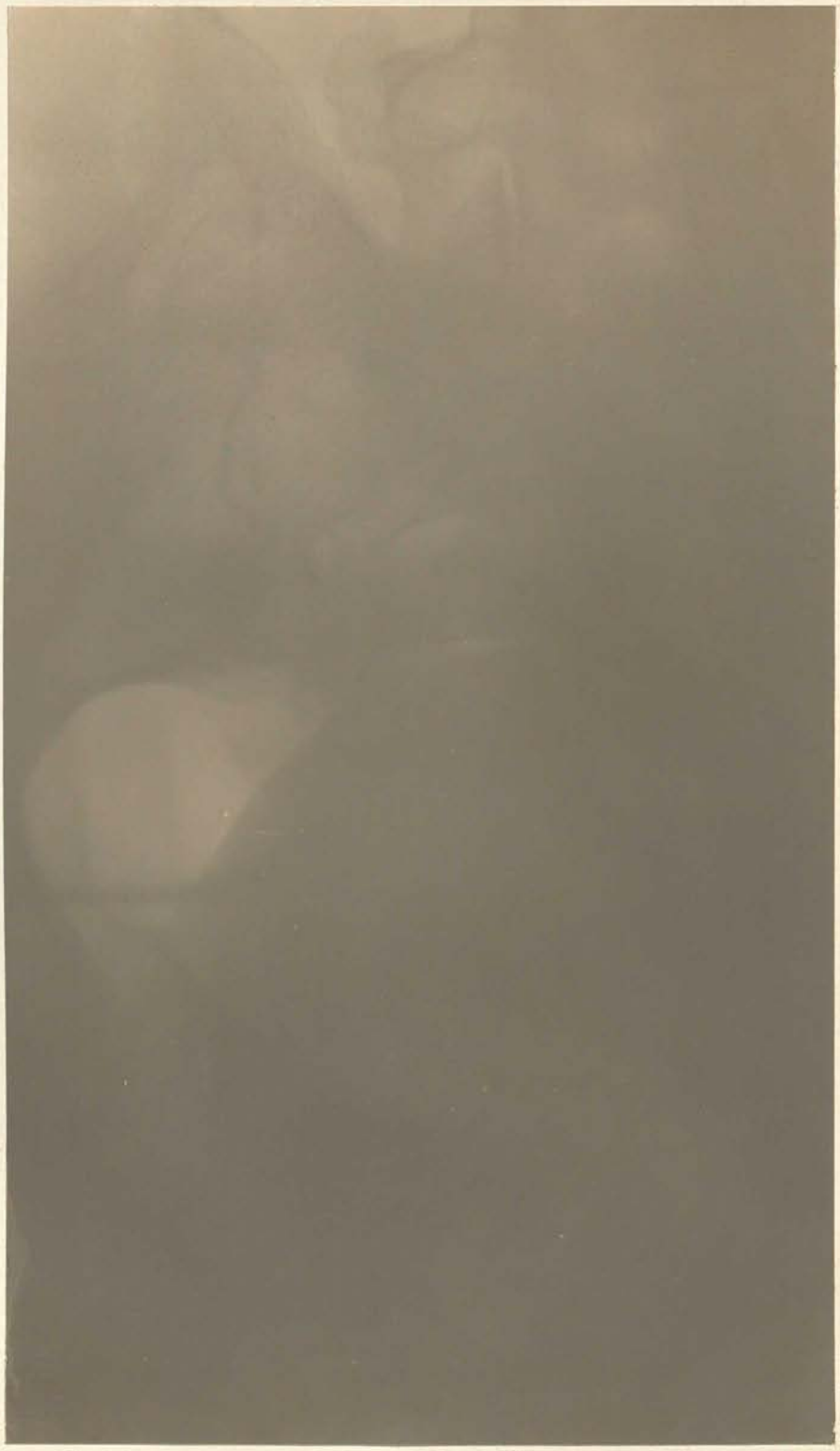
Patient prone; radiation vertical.

CASE 22, PLATE 43.

Oxygen inflation. Posterior view.

Patient in left lateral Trendelenberg position.

Radiation horizontal.



CASE 22, PLATE 44.

Oxygen inflation. Posterior view.

Patient in right lateral Trendelenberg position.

Radiation horizontal.

CASE 23, PLATE 45.

Oxygen inflation. Anterior view.

Patient supine. Radiation vertical.

CASE 23, PLATE 46.

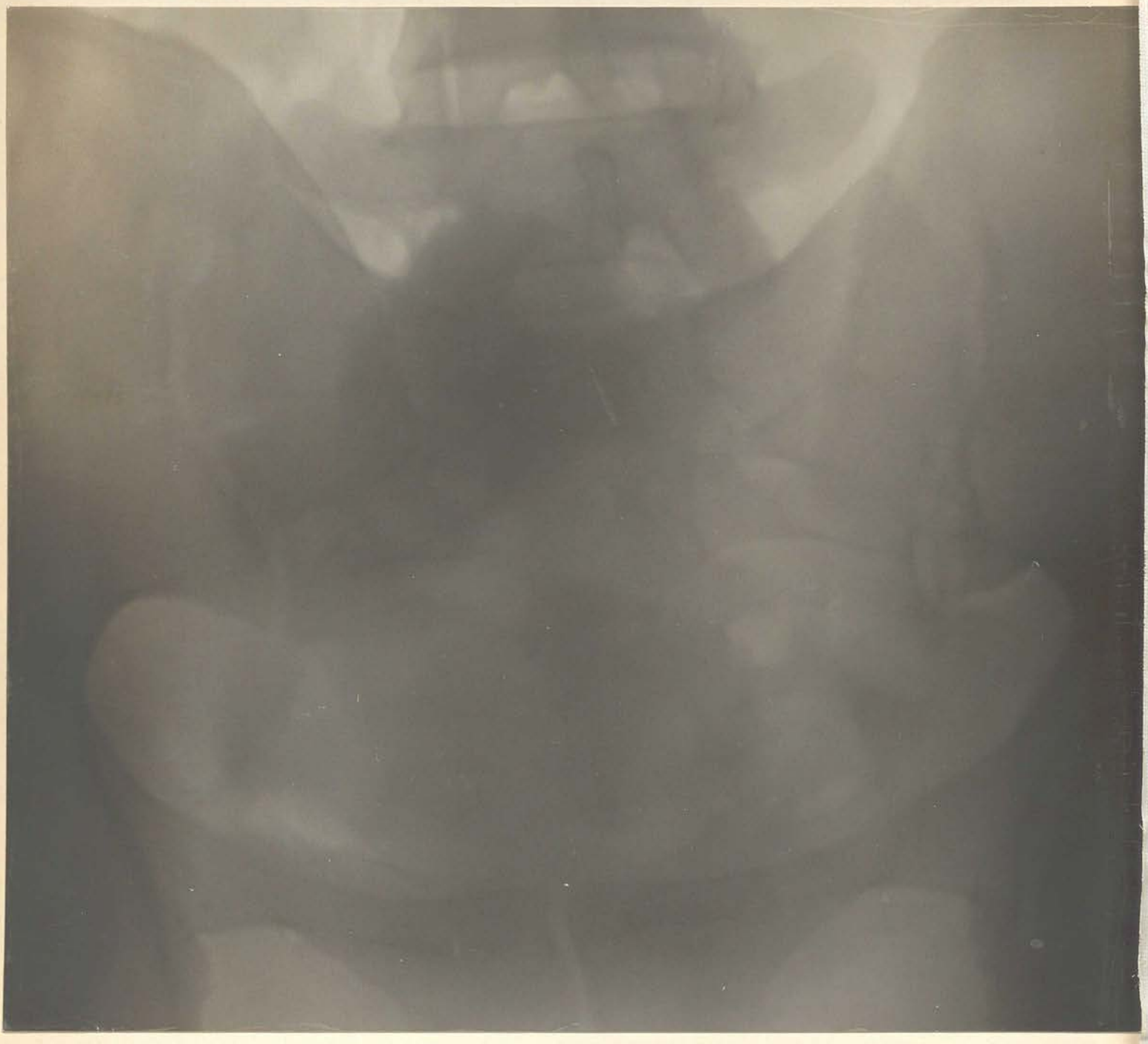
Oxygen inflation. Left lateral Trendelenberg position. Radiation horizontal.

CASE 23, PLATE 47.

Oxygen inflation. Anterior view.

Right lateral Trendelenberg position.

Radiation horizontal.



CASE 24, PLATE 48.

Before oxygen inflation. Posterior view.

Patient prone. Radiation vertical.

CASE 24, PLATE 49.

Oxygen inflation. Anterior view.

Patient supine; radiation vertical.