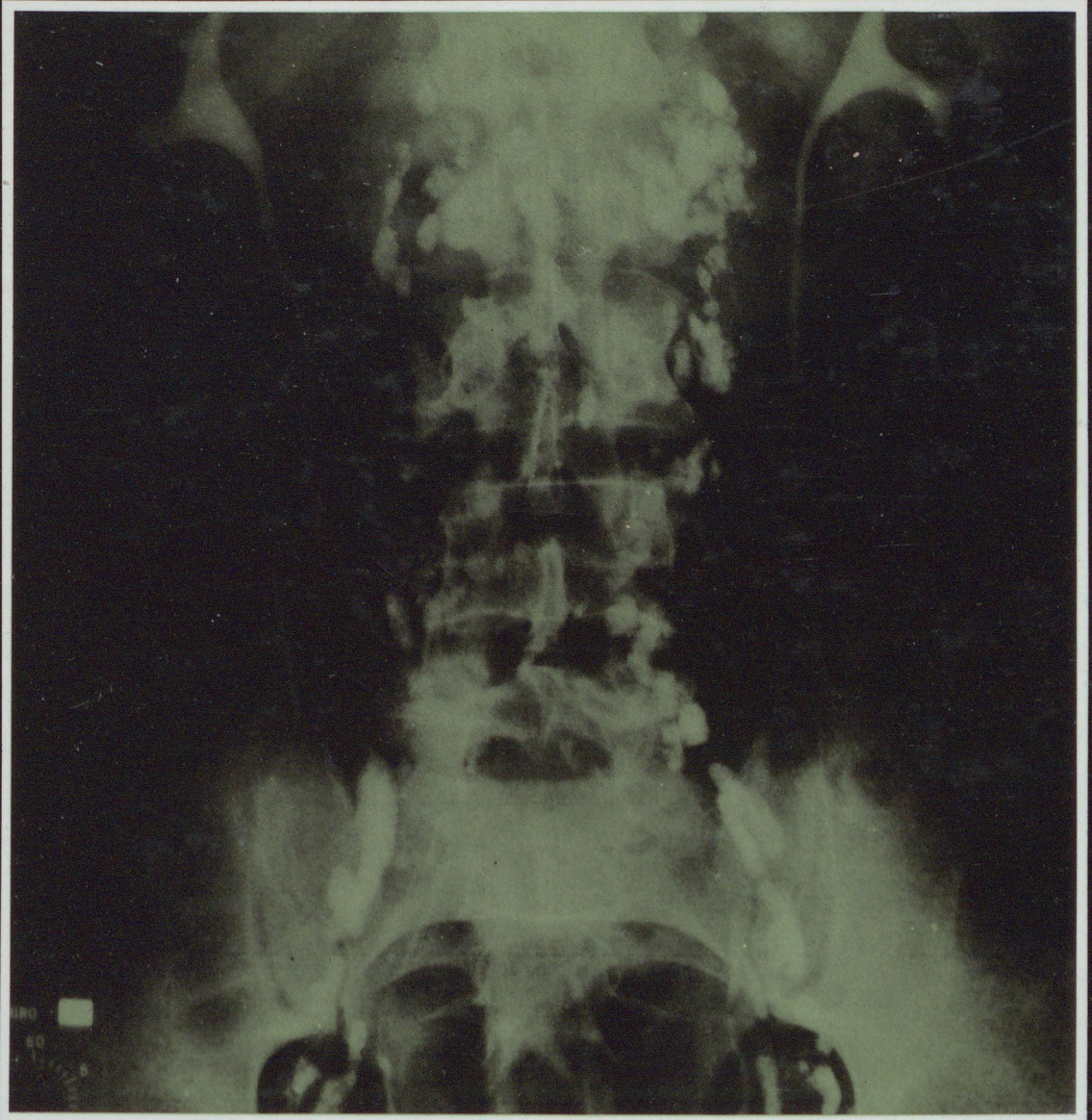


LYMPHOGRAPHY IN UROGENITAL DISEASES

D. Frang and A. Babics



Akadémiai Kiadó, Budapest

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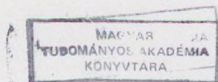


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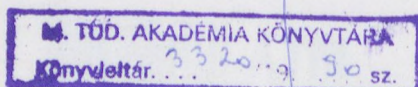
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FOREWORD

The more malignant disease is in the medical limelight, the greater the need for its reliable classification and staging, because these form a basis for uniform, objectively grounded treatment planning, assessment of prognosis, and comparison of therapeutic results.

As a result of world-wide efforts, the TNM classification (UICC 1978) was created for this purpose (van der Werf-Messing 1980). Experience has shown that it is especially difficult to determine the state of the regional lymph nodes. This fact is very important because metastases in these nodes greatly influence the selection and extent of treatment in individual cases. It follows that we rather often make mistakes in the staging of tumours and in judging their curability. There are also uncertainties about choosing between curative and palliative treatments.

In the 1960s the use of lymphography became widespread; it was then considered to be a method which greatly decreased the likelihood of such error and uncertainty, especially in regard of tumours of the lower part of the body and of the lymphoreticular system. Although small tumours cannot always be detected in the lymph nodes and not every pelvic and retroperitoneal lymph node can be revealed by contrast media, it is indisputable that in the past two decades X-ray lymphography has been an important technique for the diagnosis and prognosis of malignant tumours.

The clinical application of lymphography was made possible by Kinmonth who in 1952 developed a suitable method for revealing the human lymphatic vessels. At first such examinations used water-soluble contrast media, mainly to investigate oedema of unknown origin in the limbs. Once lymphography became increasingly important in the diagnosis of tumours, clinical investigations aimed at better visualization of lymphatic vessels and lymph nodes came to the fore. In 1961, Sheehan et al. greatly improved the method by injecting oily contrast medium into the lymphatic vessels. Since then several monographs have covered the theoretical and practical aspects of lymphography (Fuchs 1965, 1968; Meessen 1972; Röder 1974).

In some cases, more valuable topographical and diagnostic information may be gained if lymphography is supplemented with cavography, sometimes angiography, and always with urography. This book is concerned exclusively with the diagnostic and prognostic value of lymphangiography and lymphadenography performed by administering contrast medium directly into the lymphatic vessels between the toes

of both feet. This method gives information about the inguinal pelvic and retro-peritoneal lymph nodes.

The monograph is based on experience gained from the lymphography of about 600 patients, examined mainly for tumours. In our opinion, this method is still an important aid to tumour diagnosis, aside from ultrasound tests, computerized tomography (CT) and isotope lymphography. Lymphography may be performed when there is no possibility of ultrasound examination. Pathological changes in normal-sized lymph nodes can be demonstrated only by this procedure. It is also suitable for the evaluation of the therapeutic effects.

Our aim is to discuss our present views on the lymphography of malignant tumours. The atlas will assist physicians engaged in diagnostic oncology and lymphography in applying the method, in achieving informative results and in evaluating their findings.

D. Frang

A. Babics

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HISTORICAL SURVEY

Probably Hippocrates (460–377 B.C.), Aristotle (384–322 B.C.), and the prominent anatomists of the Alexandrian school: Herophilus (ca. 300 B.C.) and Erasistratus (ca. 250 B.C.) knew of parts of the lymphatic system; this is suggested by their notes on ‘white blood’, vessels filled with ‘colourless fluid’, and intestinal vessels ‘containing milk’. Nevertheless, its importance as a vascular system independent of the arteries and veins had not been discovered at that time. Thus their observations were forgotten for almost 2000 years.

Only the break from mediaeval scholasticism and religious dogma in the European Renaissance made possible the anatomical studies on human bodies and living animals which were preconditions for the rediscovery of the lymphatic system.

The honour of that finding belongs to Asellius (1581–1626) who, in 1622 in Milan, during the dissection of a dog found accidentally a ‘wonderful white bundle’ from which, to his surprise, a milky liquid was discharged. When William Harvey (1578–1657) discovered the blood circulation, attention was drawn to Asellius’ *vasa lactae*. In the following decades this was confirmed as an independent vascular system. In 1661, Jean Pecquet described in the dog the *cisterna chyli* and the thoracic duct along the liver; he called the latter *ductus chyliferus*. Olaf Rudbeck (1653) of Sweden knew about the lymphatic valves but their discovery was claimed by Ruyschius (1712) some 50 years later. Rudbeck’s famous rival, the Copenhagen anatomist Bartholin, gave the system its name which is still valid – *vasa lymphatica*. Attempts to review the literature on the lymphatic system and lymph nodes lead into a labyrinth of descriptions concerning their anatomy and topography. There are various topographical and terminological accounts of the course of the lymphatic vessels and the location of the lymph nodes; such potential for anatomical variation is not found in any other organ or system. In the past 100 years the nomenclature has been changed several times: the Basel nomenclature in 1895, the Jena nomenclature in 1935 and the Paris nomenclature in 1955 added further complications, because nowadays the textbooks and atlases of anatomy use these three nomenclatures, sometimes alternately or mixed together.

THE PHYSIOLOGY OF THE LYMPHATIC SYSTEM

In the absence of lymphatic circulation we would die within 24 hours. The role of the lymphatic system is to carry materials of large molecular mass and protein from the interstitial fluid back to the circulation. It also plays a part in the destruction of bacteria; the lymph nodes filter out and destroy bacteria that reach the lymphatic circulation. The lymphatic system is also a route for the dissemination of tumours. At first the lymph nodes are able to destroy tumour cells present in small numbers. With a greater invasion of cells, metastatic tumours develop in the lymph nodes (Rusznýák et al. 1969).

The lymphatic capillaries originate from the interstitium and run in a central direction. Almost every organ has lymphatic conveyance; the uppermost layer of the skin, the central nervous system, the deep layers of the peripheral nervous system, the endomysium, and bone are the exceptions. They have so-called paralympathic channels in which the interstitial fluid can circulate. For example, the paralympathic spaces of the skin become visible during angiography for oedematous conditions. From the paralympathic system in general the lymph is carried to the lymphatic system; from the paralympathic system of the brain the collected lymph gets into the cerebrospinal fluid. The lymph collected from the body enters the vascular system in the left venous angle via the thoracic duct, although there may also be a direct connection between the lymphatic and venous systems in the pelvic and abdominal regions. Lymphatic vessels from the right arm, head, neck and from a part of the right side of the thorax open into the right venous angle. Every hour 100 ml of lymph enter the blood circulation via the thoracic duct, and 20 ml via other routes.

The lymph is the interstitial fluid carried by the lymphatic vessels. Ninety per cent of the material filtered from the arterial capillaries is reabsorbed into the venous capillaries, and 10% enters the lymphatic capillaries. The ingredients of the lymph are the same as those of the interstitial fluid of the organ from which it originates. This fluid becomes concentrated because the lymphatic vessels are able to filter water and electrolytes. Proteins and other substances of large molecular mass cannot enter the venous capillaries. However, these large molecules can get into the intralymphatic space between the endothelial cells of the lymphatic capillaries. There are so-called anchoring filaments between these endothelial cells; their valve-like motion opens or closes the gaps between the cells and directs the material into the lymphatic capillaries. The capillaries have valves which allow the fluid

to flow only in a central direction. In the large lymphatic vessels such valves are found 1 mm apart; in the smaller ones they are closer to each other.

Normally, the pressure of the interstitial fluid is -0.84 kPa (-6.3 mm Hg). If the interstitial pressure exceeds this value, the interstitial fluid flows into the lymphatic capillaries. The following factors may increase the flow to the interstitium: increased arterial capillary pressure, decreased colloid-osmotic pressure of the plasma, increased capillary permeability.

The lymphatic pump helps the fluid in the lymphatic capillaries to move in the central direction. The function of a lymphatic region between two valves is autonomous: if in a given region the amount of fluid increases, the wall of the lymphatic vessel is stretched, which causes contraction; as a consequence of the increased pressure the valve is opened and the lymph flows to the next valve. External factors may also lead to the contraction of the lymphatic vessels. Such factors are organ movements, muscular contractions and arterial pulsations which compress the neighbouring tissues.

The common iliac and lumbar lymph nodes are separated by a transverse straight line at the level of the 4th-5th lumbar intervertebral space. In the oblique picture this transverse line is projected onto the lower part of the body of the 4th lumbar vertebra. The lumbar lymph nodes extend along the 4th lumbar vertebra to the level of the aortic hiatus.

The retroperitoneal lymphatic vessels follow the course of the large blood vessels even when these have positional anomalies. The lymph nodes also follow arterial vessels or the winding course of the veins. Thus their points of reference to the skeleton are also changed. There are considerable differences in number and size between the lymph nodes of the different regions and on the two sides of the body.

If the lymph nodes are very small, their number and the number of the lymphatic vessels is larger, while there are less of them if they are bigger. Anatomical and radiographic data are indispensable for the exact localization of disease and for surgical procedures. The anatomical facts are supported mainly by the works of Cusco and Marcell (1901), Rossignol (1932) and Kellgren (1967). For details see Fig 1 and Table 1.

LYMPHATIC VESSELS OF THE LOWER LIMB

The lower limb has a prefascial and a subfascial lymphatic system. In the prefascial system, anterior and posterior lymphatic vessels may be distinguished. There is only a one-way connection between the two systems, in the subfascial to prefascial direction, because of the valves in the connecting lymphatic vessels.

For bipedal lymphography the vessels of the anterior prefascial system (bundle) are used, from which the retroperitoneal vessels run from the dorsum of the foot cranially in front of the outer ankle, then, reaching the medial side of the knee, divide in two and run on the medial side of the thigh towards the inguinal lymph nodes. In this region there are 8-16 lymphatic vessels.

Aside from rare exceptions, the posterior lymphatic vessels, running subfascially on the thigh, are not relevant to lymphography.

TOPOGRAPHY AND X-RAY ANATOMY OF THE INGUINAL, PELVIC AND RETROPERITONEAL LYMPHATIC SYSTEMS

Lymphography reveals the state of the lymphatic circulation, the connections between groups of lymph nodes numerical and topographical variations in the lymph nodes, and the course of the lymphatic vessels. However, a few lymph nodes in the pelvis and the retroperitoneum cannot be made visible by lymphography. Without complementary angiography, the detailed position of the lymphatic system in relation to the large vessels can only be estimated. Therefore, the different groups of lymph nodes should be distinguished on the lymphogram schematically, without regard to any variations. The inguinal and iliac lymph nodes are separated from each other by a straight line drawn between the anterior superior iliac spine and the pubic tubercle, corresponding to the course of the inguinal ligament. The border between the external iliac and common iliac lymph nodes runs along the internal iliac (hypogastric) artery originating from the common iliac artery. On the anteroposterior picture this is projected onto the vertical line drawn through the middle of the sacro-iliac joint, while on the oblique picture it is at the height of the promontory.

The common iliac and lumbar lymph nodes are separated by a transverse straight line at the level of the 4th-5th lumbar intervertebral space. In the oblique picture this transverse line is projected onto the lower third of the body of the 4th lumbar vertebra. The lumbar lymph nodes extend from the 2nd lumbar vertebra to the level of the aortic hiatus.

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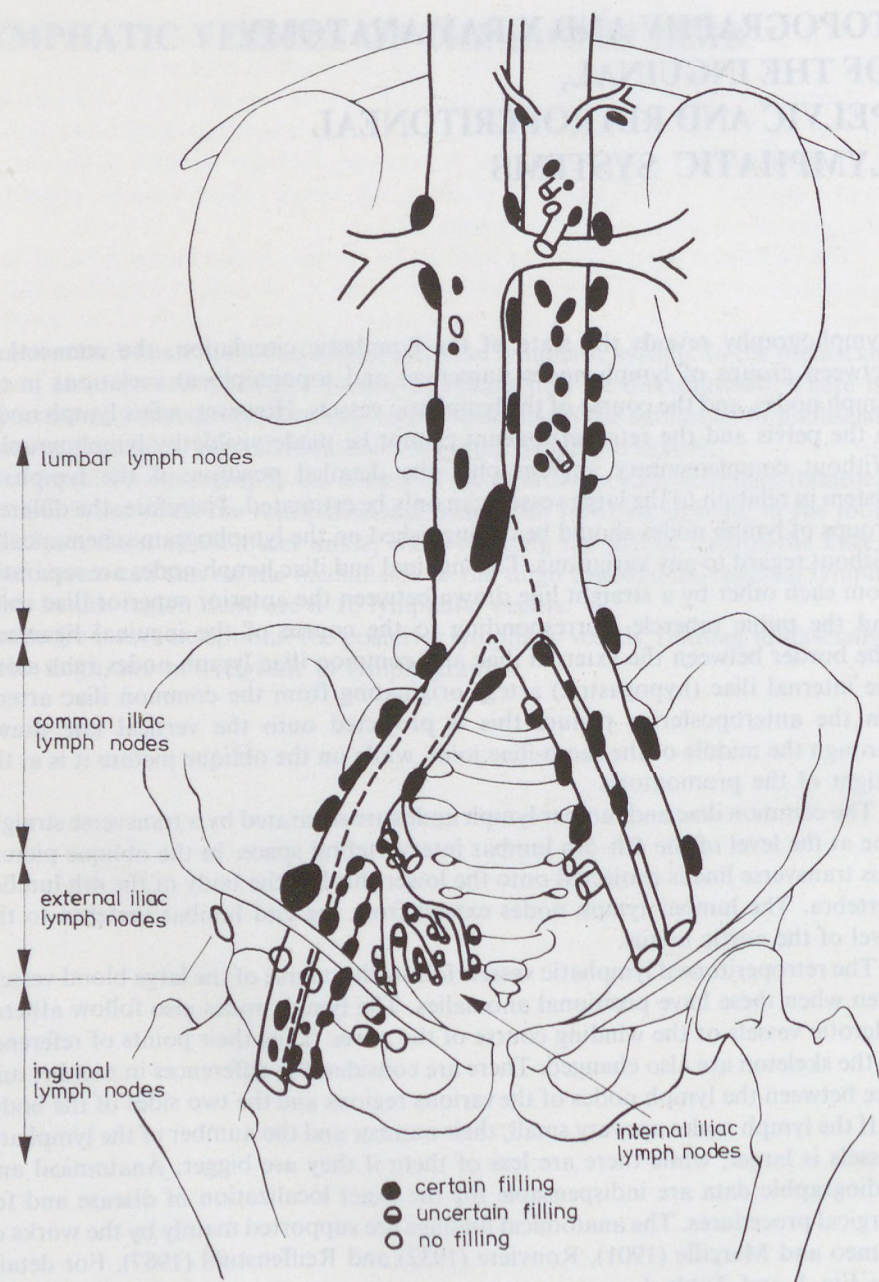
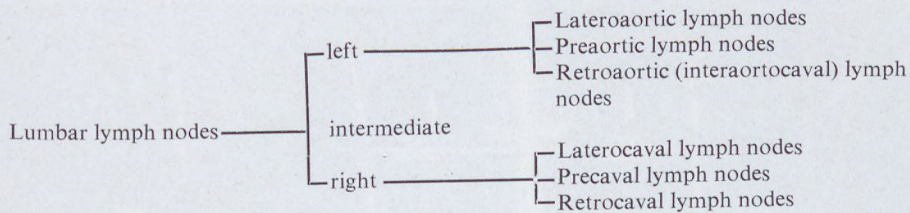


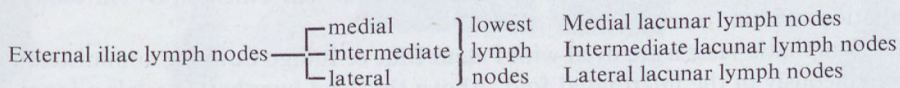
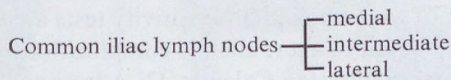
Fig. 1. Topography of the inguinal and retroperitoneal lymph nodes (according to the suggestions of the International Society of Lymphologists)

Table 1

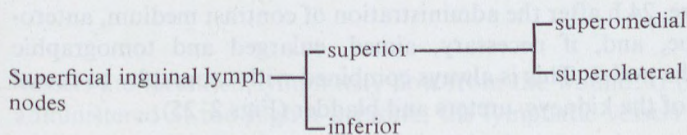
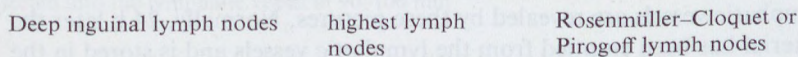
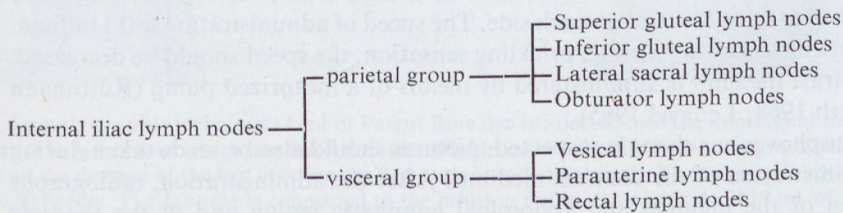
Nomenclature of the retroperitoneal and inguinal lymph nodes



Inferior diaphragmatic lymph nodes



The highest lymph nodes of the intermediate and medial groups are the interiliac lymph nodes



THE LYMPHOGRAPHIC EXAMINATION

The examination of adult patients does not require any special preparation. On the day preceding the examination, foods which cause intestinal distension should be avoided so that the intestines will be as free of gas as possible. Sensitivity tests are usually not performed, but one should be prepared to avert allergic complications caused either by the dye or the contrast medium (Sandosten-Calcium, Di-Adresone; intubation within reach).

The lymphatic vessels are dyed with Patent Blue or Indigo Carmine administered subcutaneously in the interdigital fold. Above the dyed lymphatic vessels a longitudinal or transverse cut is made under local anaesthesia, observing the rules of surgical asepsis. The lymphatic vessel is prepared and cannulated. Lipiodol Ultrafluid is used as the contrast medium, usually in a dose of 0.1 ml/kg body weight, but at most 8–10 ml on each side. The speed of administration is 0.1 ml/min. If the patient reports a burning, prickling sensation, the speed should be decreased. The contrast medium is administered by means of a motorized pump (Rüttimann and Wirth 1968; Lengyel 1985).

If a lymphovenous shunt is suspected, pictures should also be made taken during the administration of the contrast medium! After the administration, radiographs are taken of the inguinal and abdominal lymphatic region and of the thoracic duct; the lymphatic vessels are revealed by these pictures. Normally, 24 h later the contrast material has been emptied from the lymphatic vessels and is stored in the lymph nodes. Therefore, 24 h after the administration of contrast medium, antero-posterior, semi-oblique, and, if necessary, aimed, enlarged and tomographic pictures are made of the nodes. This is always combined with urography to reveal possible displacement of the kidneys, ureters and bladder (Figs 2–25).

COMPLICATIONS OF LYMPHOGRAPHY

Contrary to expectation, lymphography, though performed with an oily contrast medium, does not have too many complications. According to Koehler (1967), among 1800 examinations, one may lead to death. The complications may be local or general.

Local complications If surgical asepsis is not observed during the operation, suppuration of the wound, and separation of the scar may occur. If the lymphatic

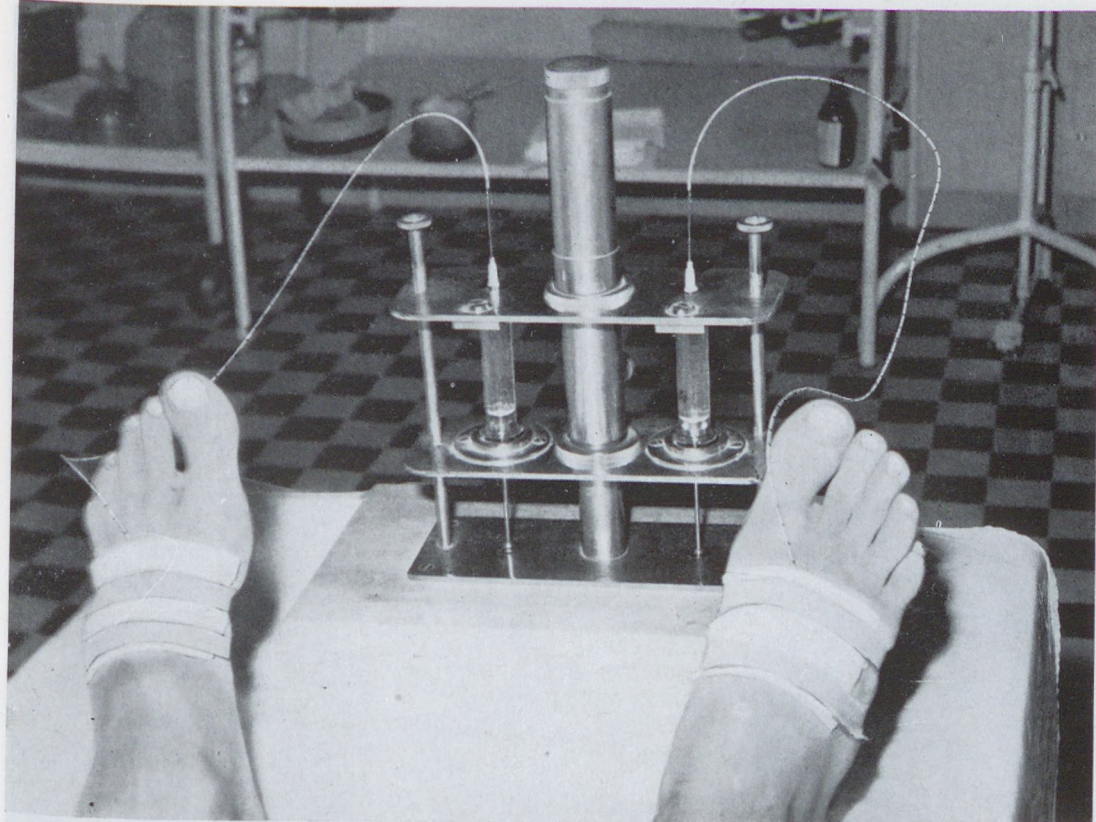


Fig. 2. Lymphographic technique: 1 ml of Patent Blue dye is injected into the interdigital fold on the dorsum of the feet. The lymphatic vessels are filled and identifiable in 10–15 min. Then a longitudinal or transverse cut is made on the dorsum of the feet between the first and second metatarsals. The lymphatic vessel is cannulated with a No. 20 needle. The cannula is connected to the infusion pump. On each side 8–10 ml of Lipiodol Ultrafluid are injected into the lymphatic vessel in 90–100 min

vessels are lacerated, lymph may flow from the wound. If the contrast medium is administered at too high a pressure, the lymphatic vessels may rupture. Lymphangitis may also develop from too rapid administration or the chemical effect of the contrast medium. In the lymph nodes a foreign-body reaction to the medium may be encountered.

General complications Allergic reactions may be caused by the anaesthetic, the Patent Blue dye, or by the contrast medium. Therefore, as stated above, one should always be prepared to avert such a complication.

If there is a lymphovenous shunt or the storage capacity of the lymph nodes is decreased, oily contrast medium can enter the pulmonary circulation. This causes multiple embolism and leads to infarctive pneumonia. Iodine-containing contrast medium entering the systemic circulation may cause embolism in the brain, liver

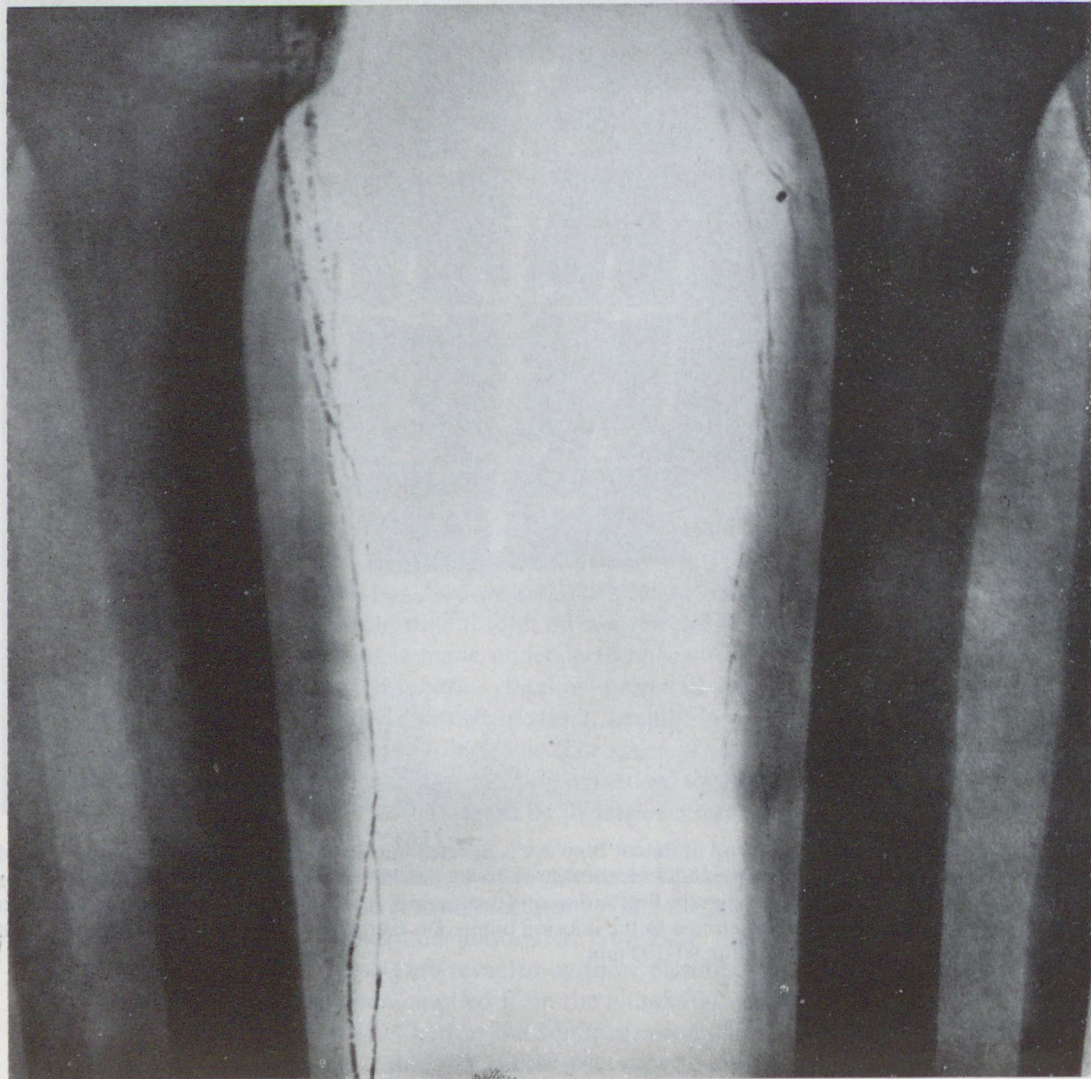
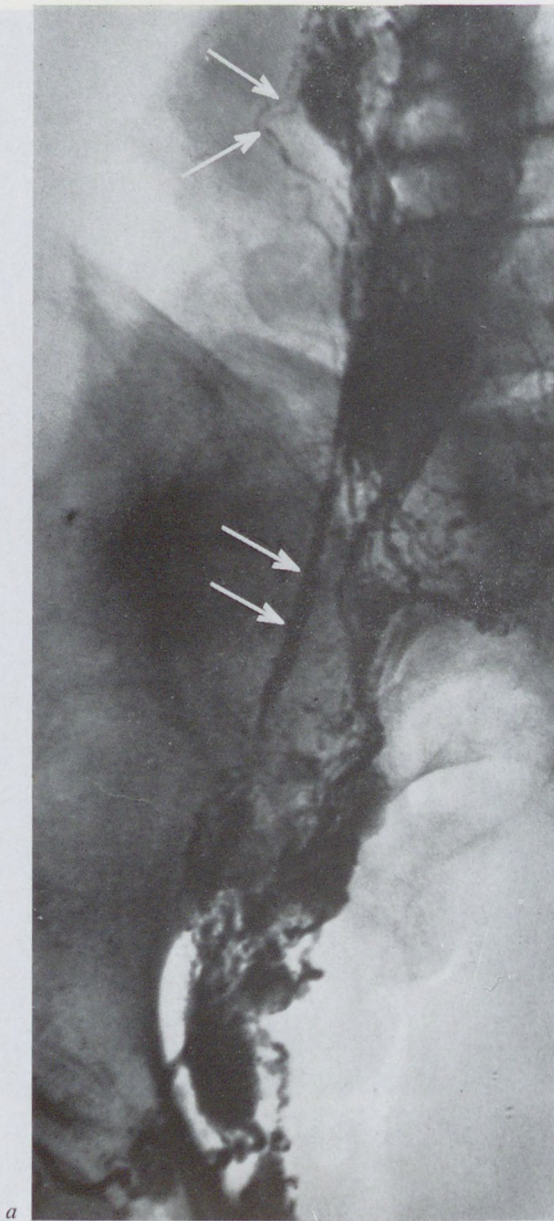


Fig. 3. Lymphography: the lymphatic vessels running on the medial side of the leg are filled via the cannulated dorsal lymphatic vessels of the foot

and kidneys. In the thyroid gland, the bound iodine may induce goitre. Therefore it is essential to administer only a previously determined amount of contrast medium, at low pressure. During administration the patient should be kept under observation. If a lymphovenous shunt is suspected the examination should be immediately stopped.



Fig. 4. Lymphography: the lymphatic vessels coming from the leg run on the medial side of the thigh



a

Fig. 5a. Anastomoses (arrowed) between lymphatic vessels are found even under normal conditions. With ipsilateral anastomoses the lymphatic vessels avoid one or two lymph nodes or lymph node groups

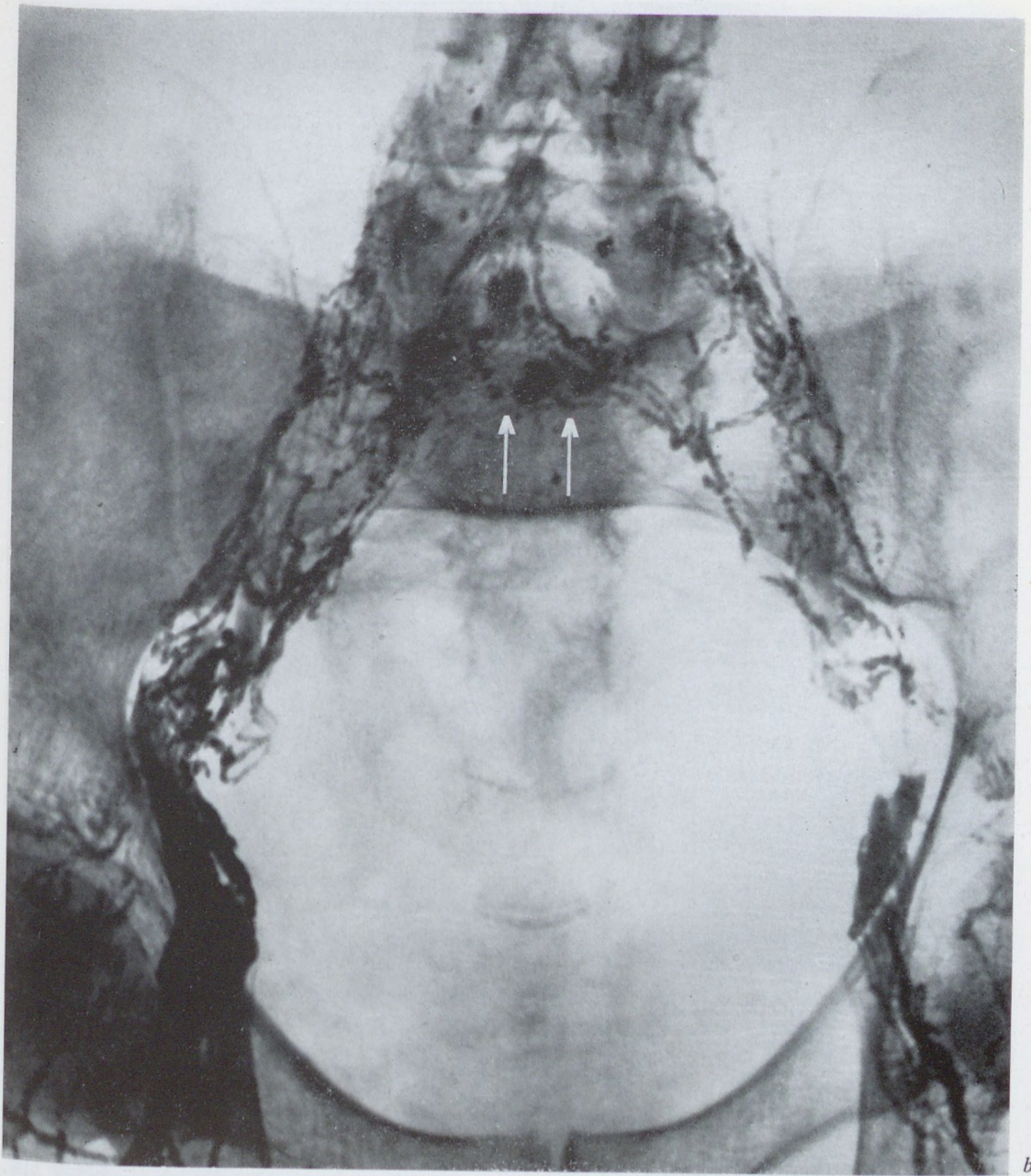


Fig. 5b. Anastomoses (arrowed) between the right and left lymphatic trunks are most abundant in front of the sacral bone in the lower lumbar region

Fig. 7. Lymphography. The contrast medium is carried through the femoral lymph nodes to the lumbar and pelvic lymphatic vessels (which run along the external iliac and common iliac arteries). It reaches the para-aortic lymphatic vessels, then flows to the thoracic duct.

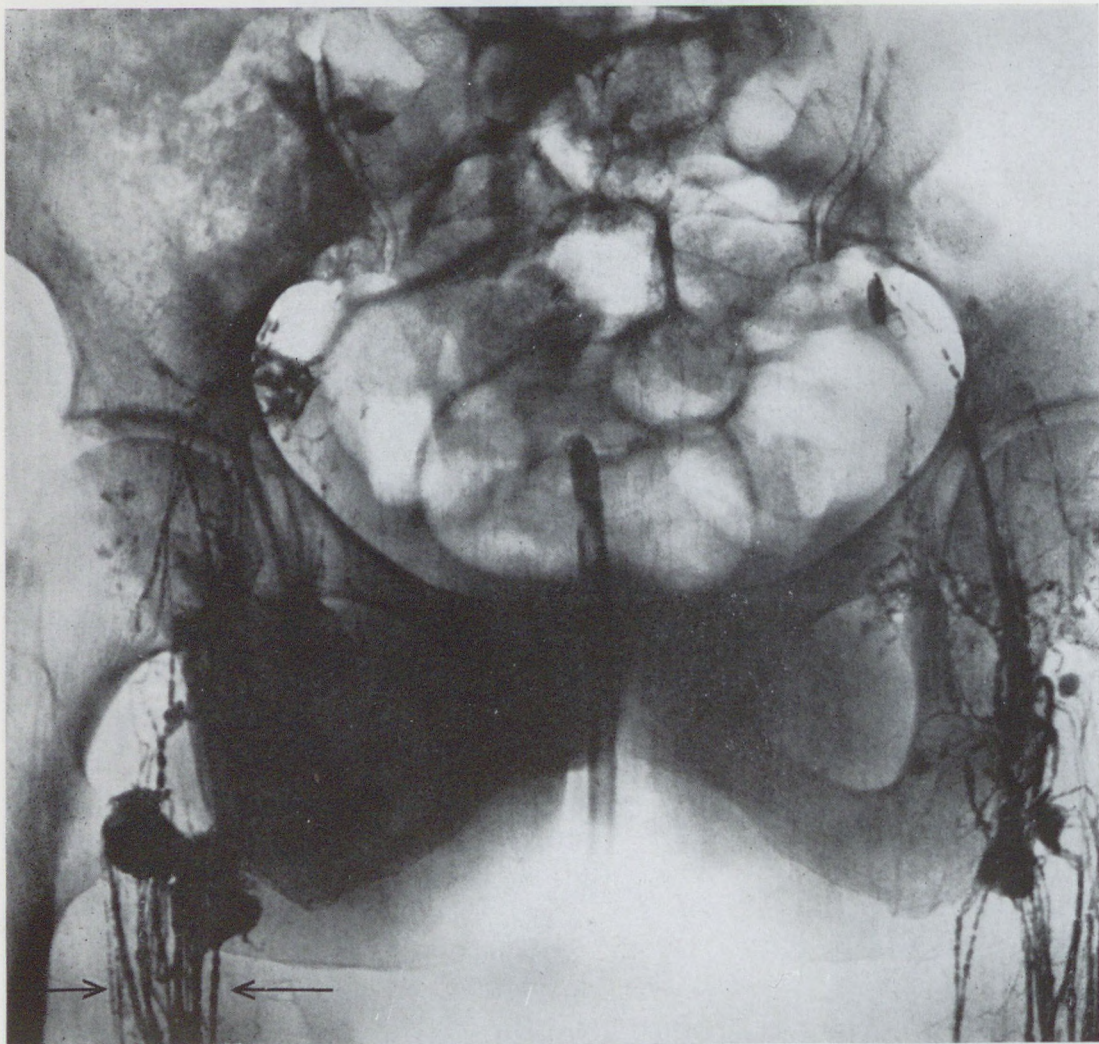


Fig. 6. About 8-16 lymphatic vessels run to the lymph nodes in the femoral region (there is a catheter in the bladder)



Fig. 7. Lymphography: the contrast medium is carried through the femoral lymph nodes to the lumbar and pelvic lymphatic vessels (which run along the external iliac and common iliac arteries). It reaches the para-aortic lymphatic vessels, then flows to the thoracic duct



a

Fig. 8a. This lateral picture reveals the lymphatic trunks that are projected onto the bones in antero-posterior pictures



b

Fig. 8b. In an oblique picture the lymph nodes around the spine may be evaluated more precisely

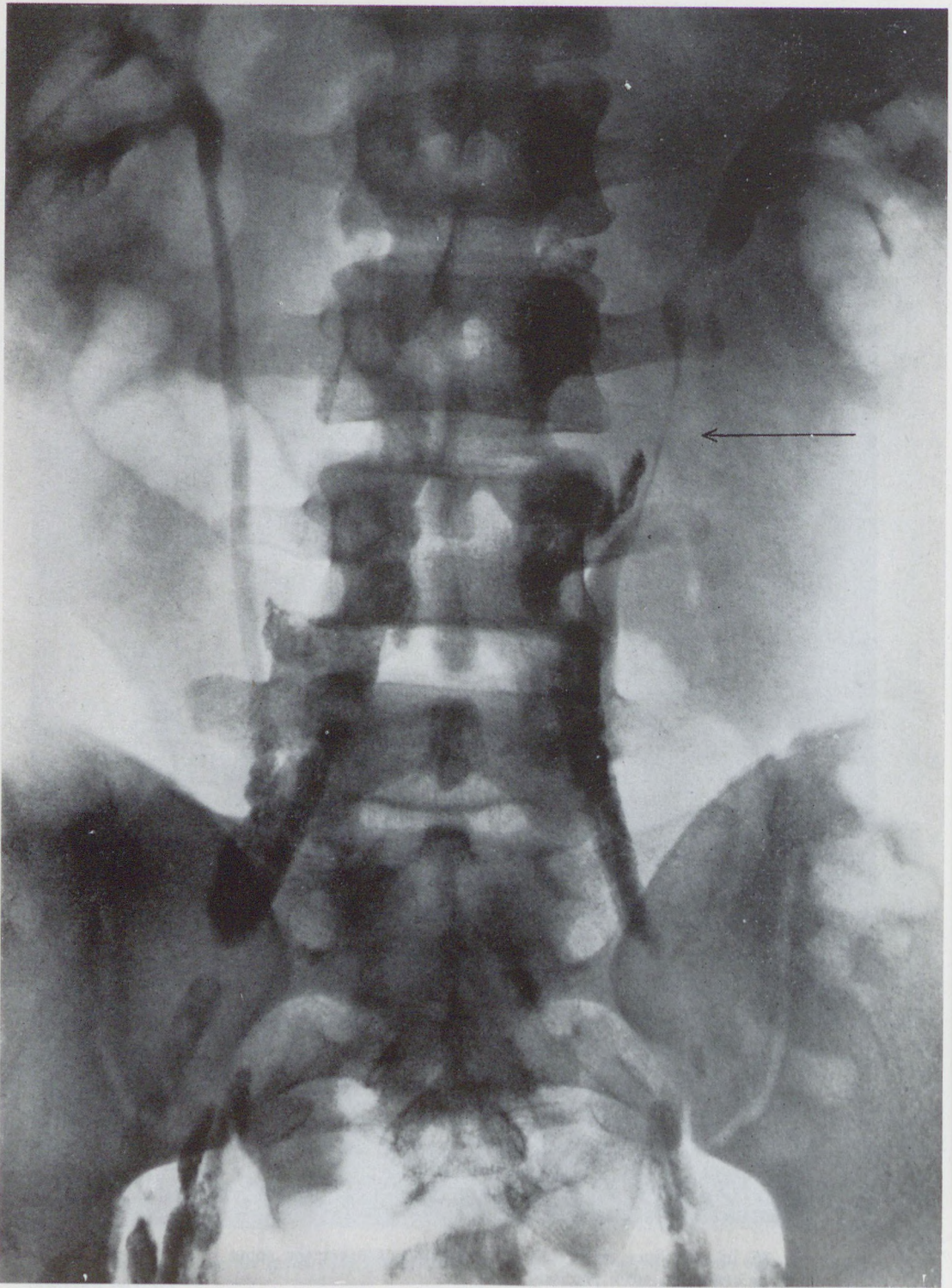


Fig. 9. Dislocation or compression of the ureter (arrow), as revealed by urography performed simultaneously with lymphography, is an indirect sign of a metastasis

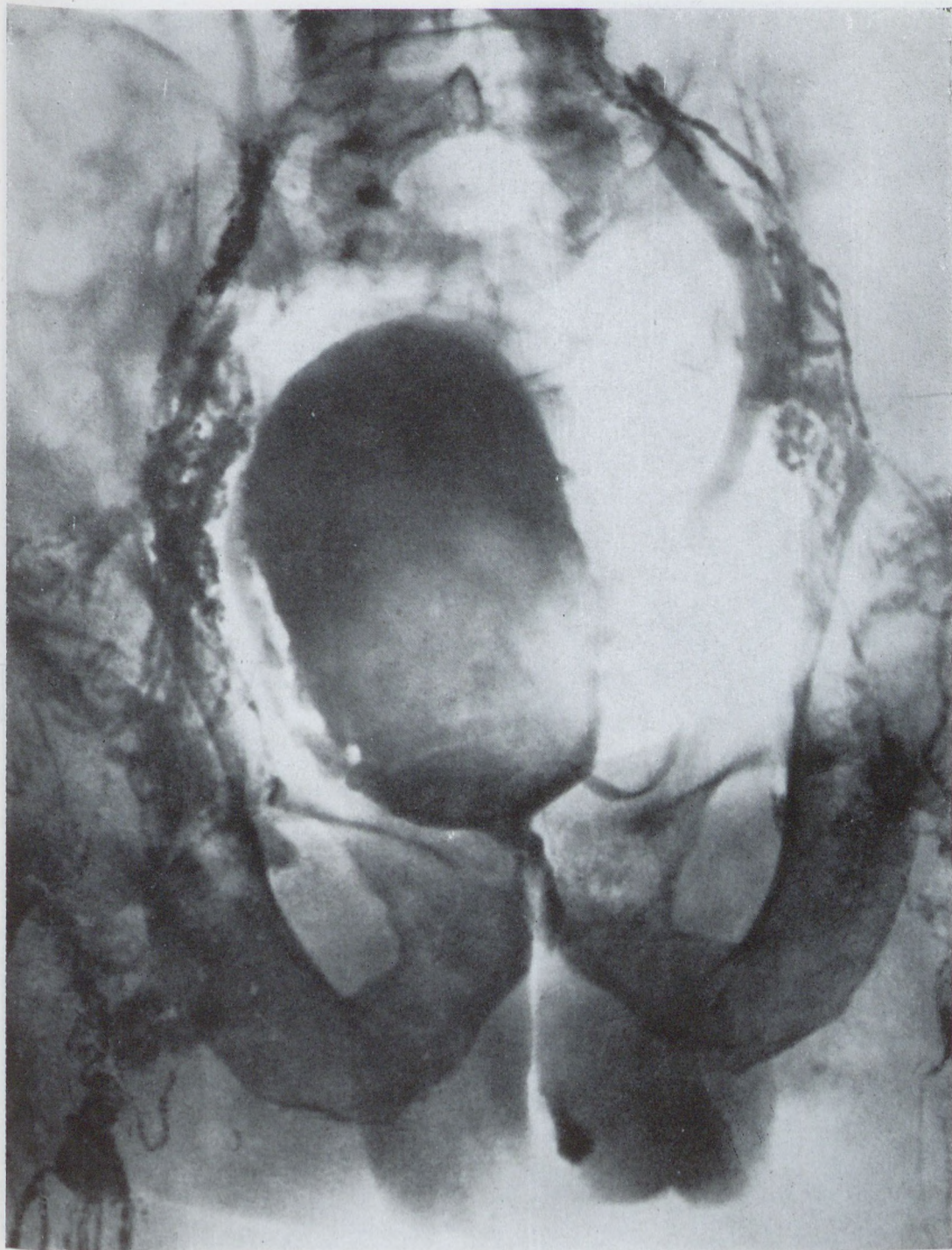


Fig. 10. Lymphography performed simultaneously with cystography. The possible pelvic propagation (dislocation of the lymphatic vessels) of a tumour from the bladder and other pathological changes are revealed

a

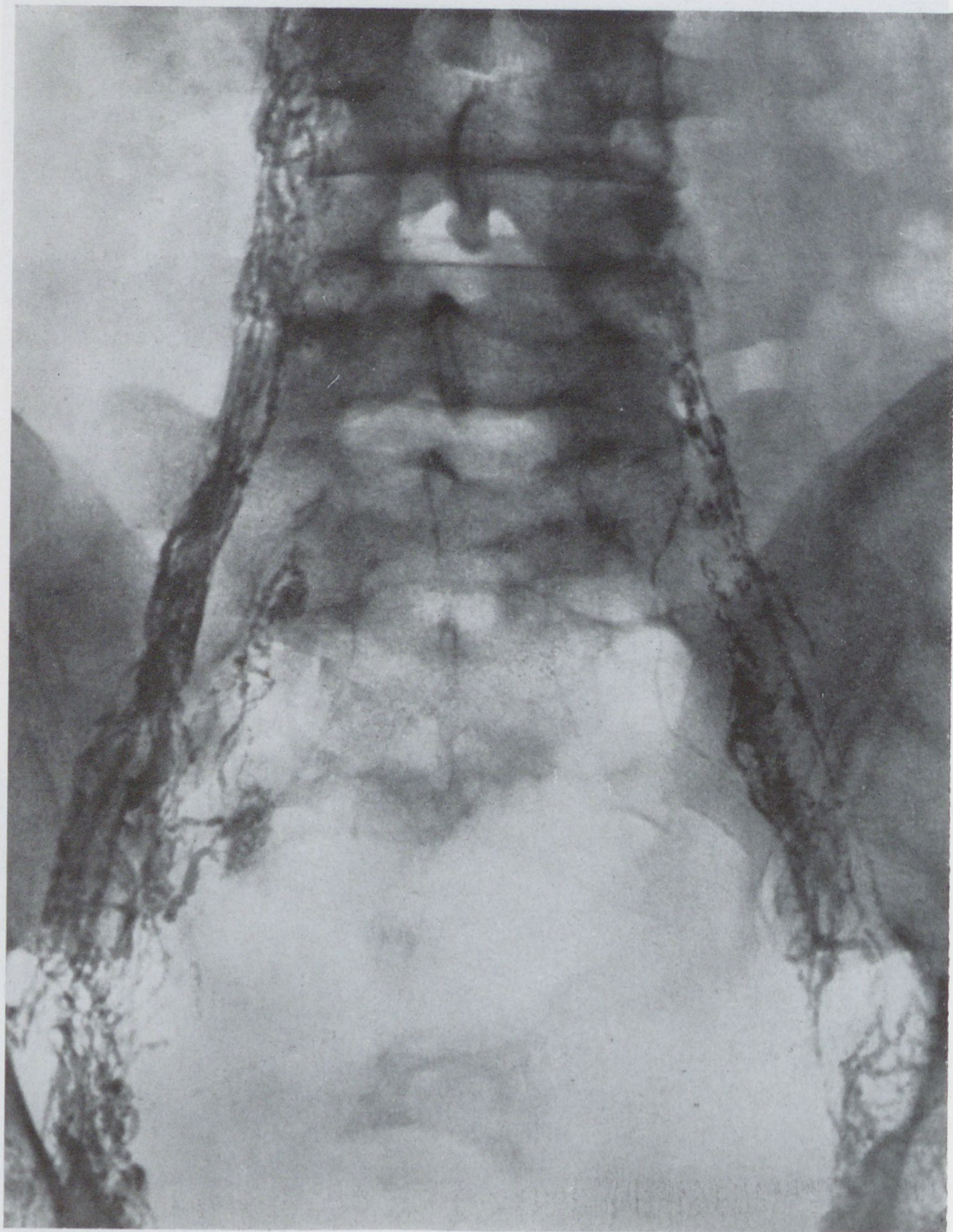


Fig. 11a. The diameter of an intact lymphatic vessel is about 1–3 mm on the lymphangiogram



Fig. 11b,c. The flow of the lymph towards the thoracic duct is promoted by the densely distributed valves, which are seen as small constrictions on the X-ray

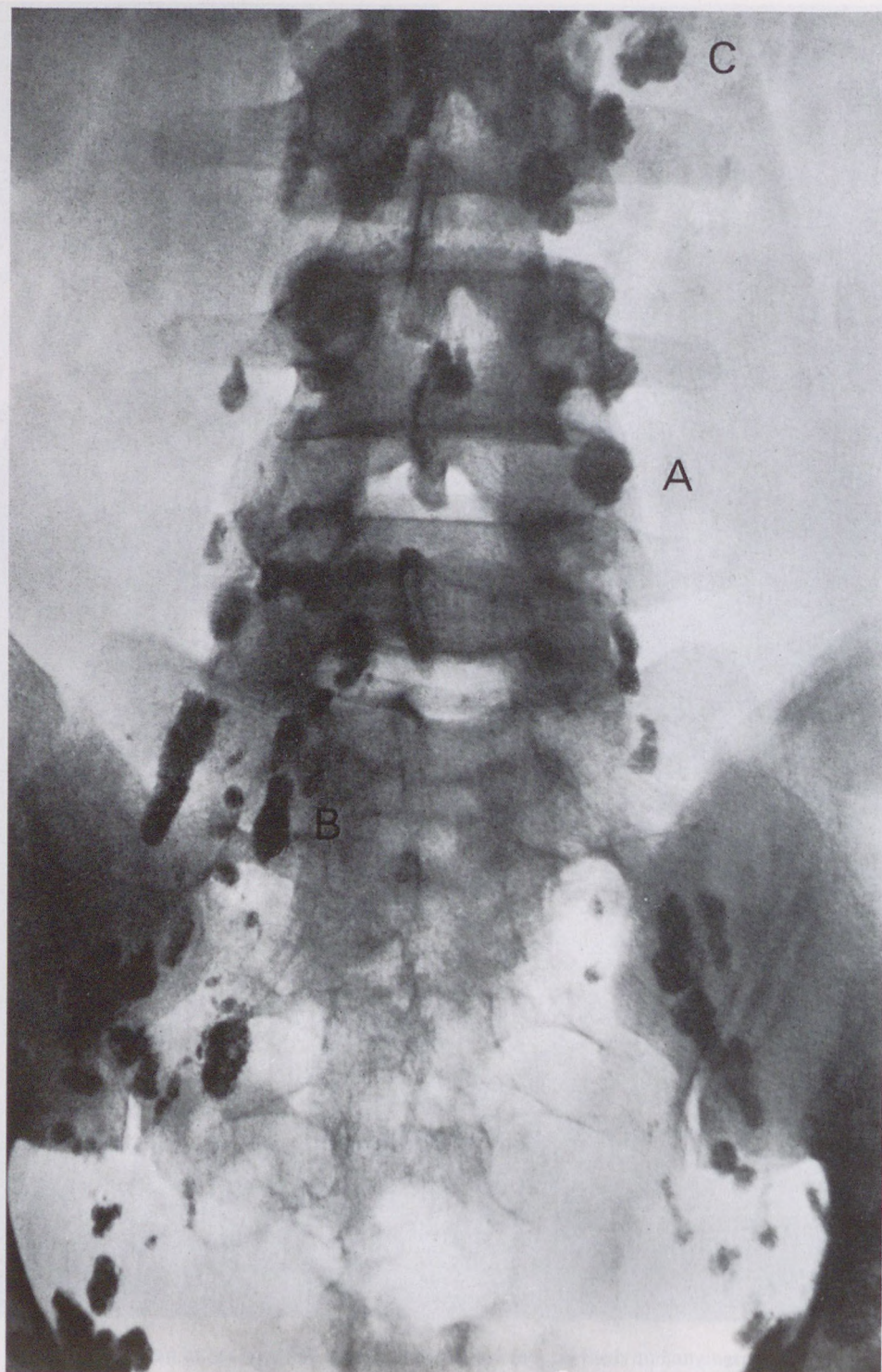
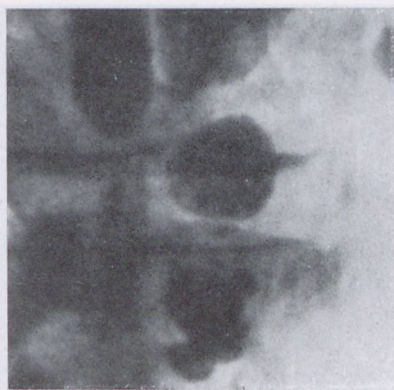


Fig. 12. Lymphography: variations in size and shape of intact lymph nodes (see detailed pictures in Fig. 12a-c; p. 31)

a



b



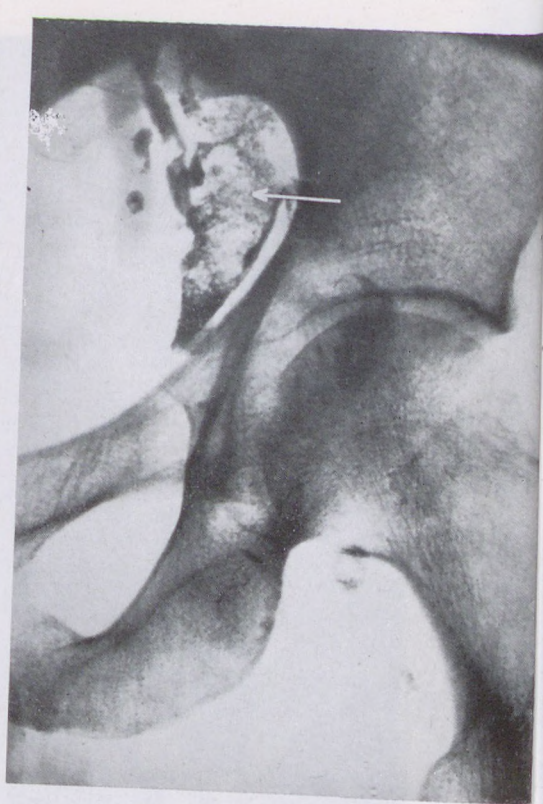
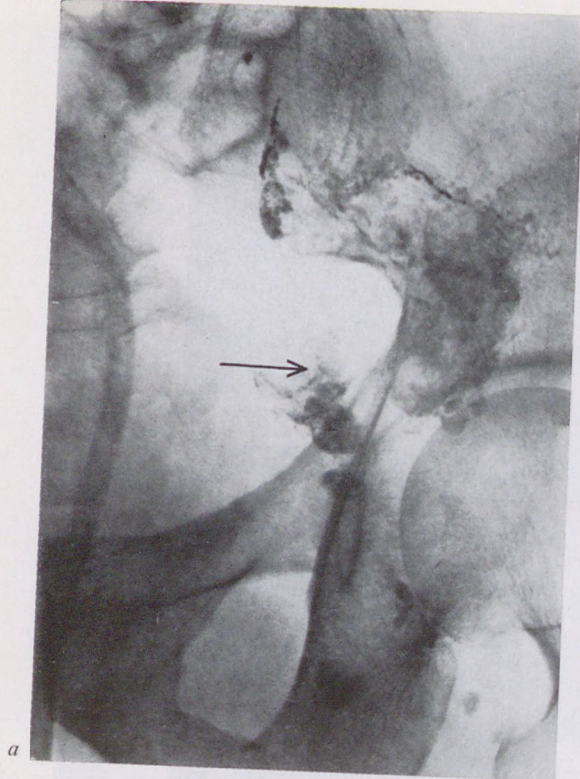
c



c



Fig. 12a. round; b: bean-shaped or oval; c: lobulated lymph nodes



a

Fig. 13a: Irregular, blurred filling defect (arrow) in a lymphograph of a lymph node. b: Severe destruction of a lymph node (arrow) in an advanced case of cancer (the metastasis spreads from the periphery of the lymph node towards its centre)



Fig. 14. Lymphography: contrast medium is sometimes carried even to the supra- or subclavicular lymph nodes via the collateral network through the diaphragm

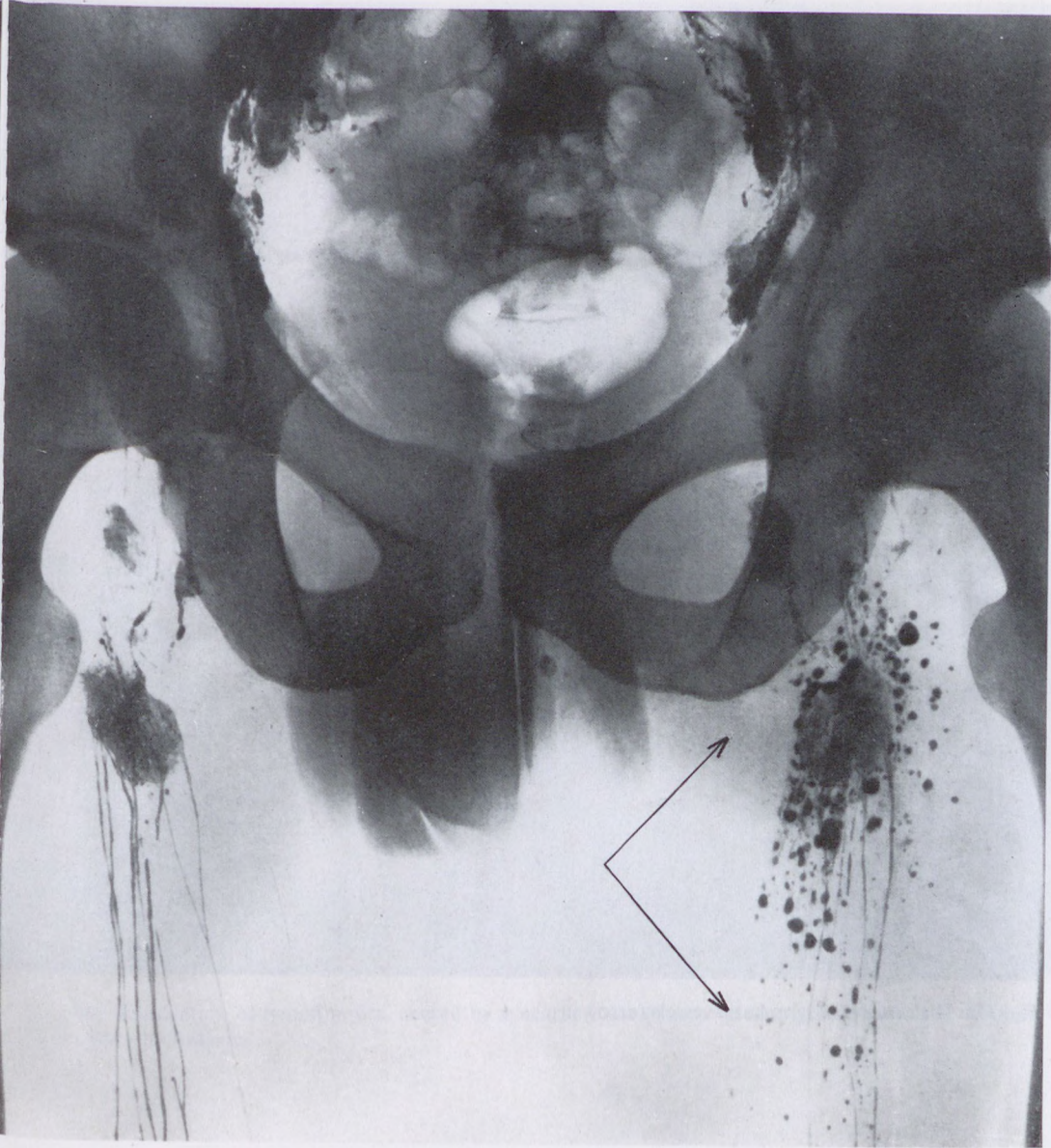


Fig. 15. 23-year-old male: condition after lymphadenectomy because of testicular tumour. Control lymphography performed 2 years after lymphadenectomy. In the left external inguinal region the 'caviar sign' is seen (arrows) in the region of the excision

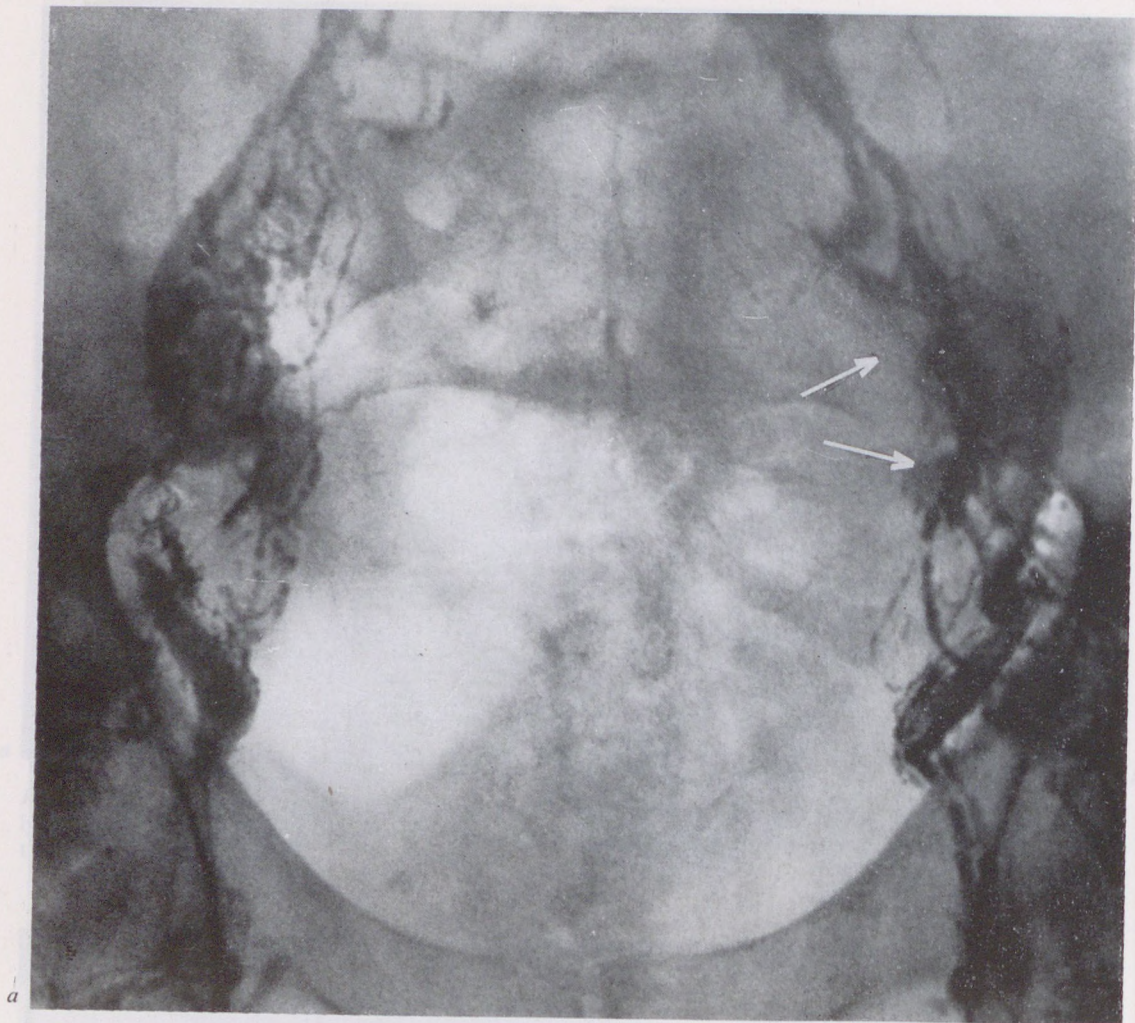
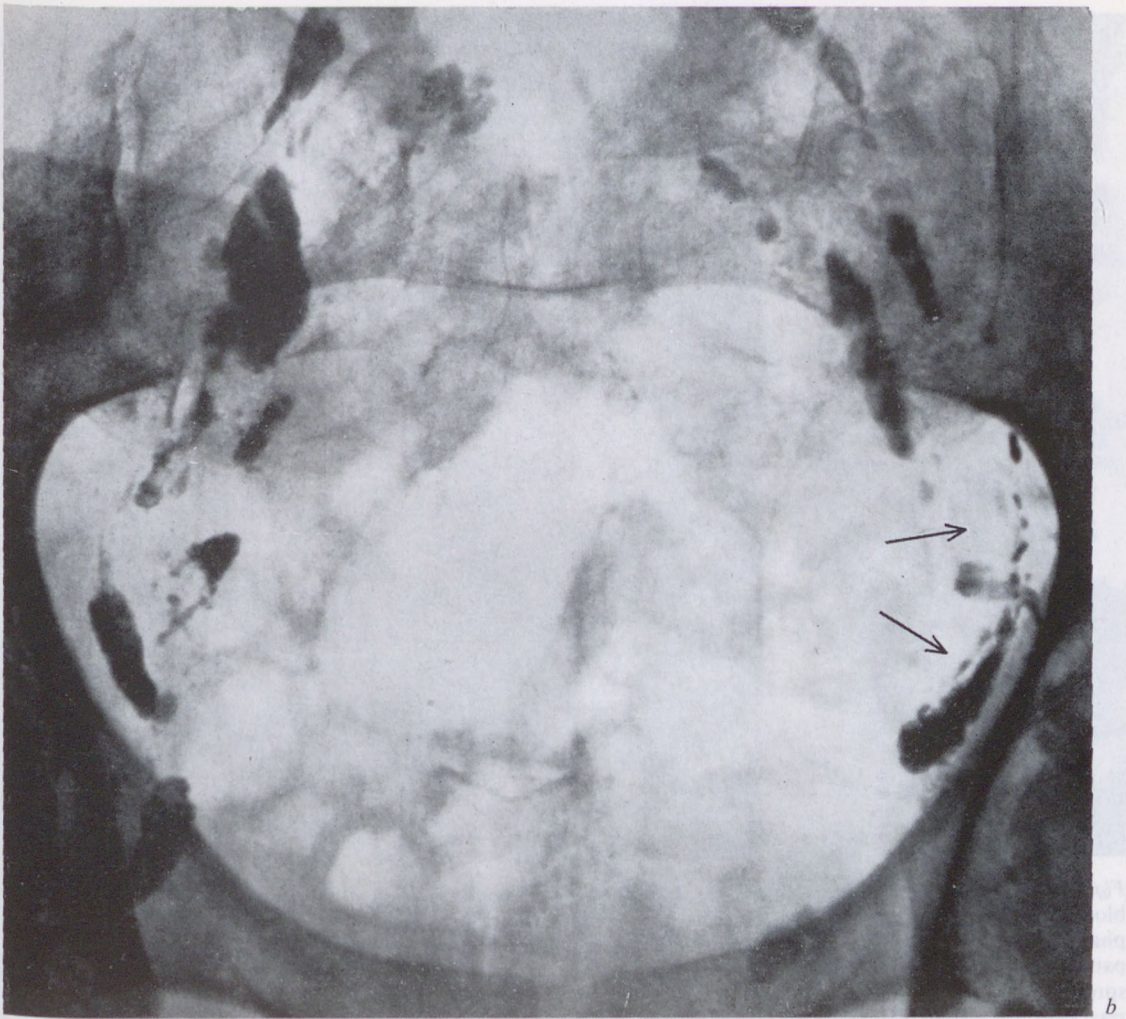


Fig. 16a. Dislocation of lymphatic vessels (arrows)



b

Fig. 16b. Dislocation of lymph nodes, caused by a nearby mass (e.g. metastatic lymph node; tumorous or inflammatory infiltration)

Fig. 16c. Stagnation of the contrast medium (arrows). If the lymphatic vessels are occluded by a pathological process, greater or smaller dilations develop distal to the occlusion, the lymphatic vessels becoming tortuous. Sometimes the lymph nodes are considerably enlarged, but only slightly damaged. The most reliable sign of the pathological process is that contrast medium may be found in the lymphatic vessels on the X-ray taken 24 h later (normally it would already be stored in the lymph nodes).

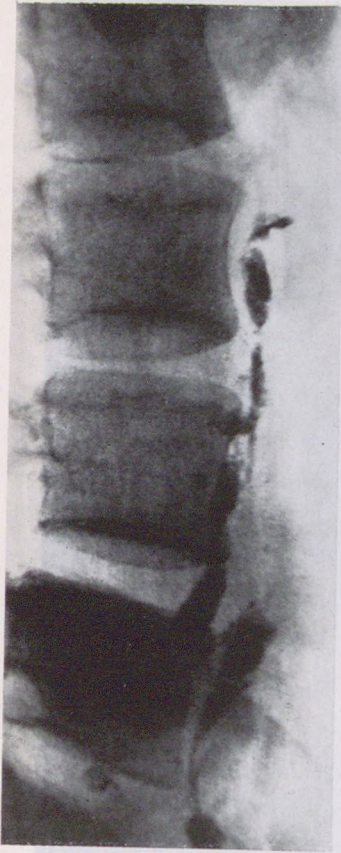


Fig. 17. Lymphogram showing a blockage or stoppage. The lymphatic vessels are closed by a pathological process (e.g. tumour spread) and the flow of the contrast medium is hindered

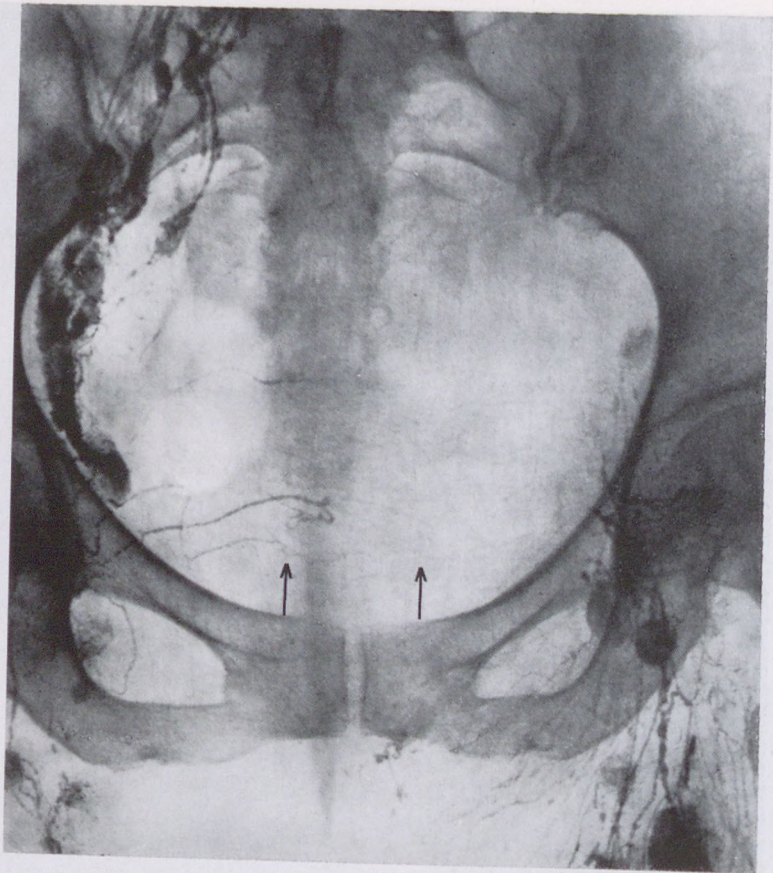


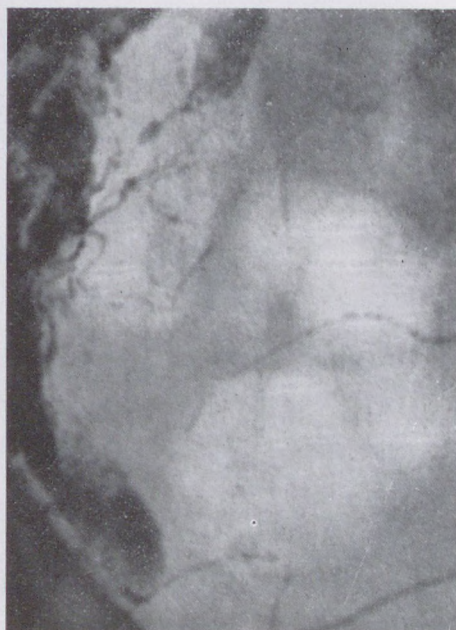
Fig. 18. In pathological cases collateral lymphatic vessels may be filled. The cause is hindrance of the central flow of lymph by tumorous infiltration. It is usually seen together with other changes such as lymphatic stagnation and blockage



Fig. 19. Stagnation of the contrast medium (arrows). If the lymphatic vessels are occluded by a pathological process, greater or smaller dilatations develop distal to the occlusion, the lymphatic vessels becoming tortuous. Sometimes the lymph node is considerably enlarged, but only slightly damaged. The most reliable sign of the pathological process is that contrast medium may be found in the lymphatic vessels on the X-ray taken 24 h later (normally it would already be stored in the lymph nodes)



a



b



c



d

Fig. 20a-d. Contrast medium in the lymph nodes in the 24-h picture is a sign of stagnation



a



b



c



d

Fig 21a-d. Various forms and degrees of lymph-node destruction



Fig. 22a, b. In haematological diseases, e.g. leukaemia and lymphogranulomatosis, the lymph nodes become enlarged and display a coarse granular filling pattern which is characteristic of the different diseases. These are lymphadenograms of a patient with chronic lymphocytic leukaemia

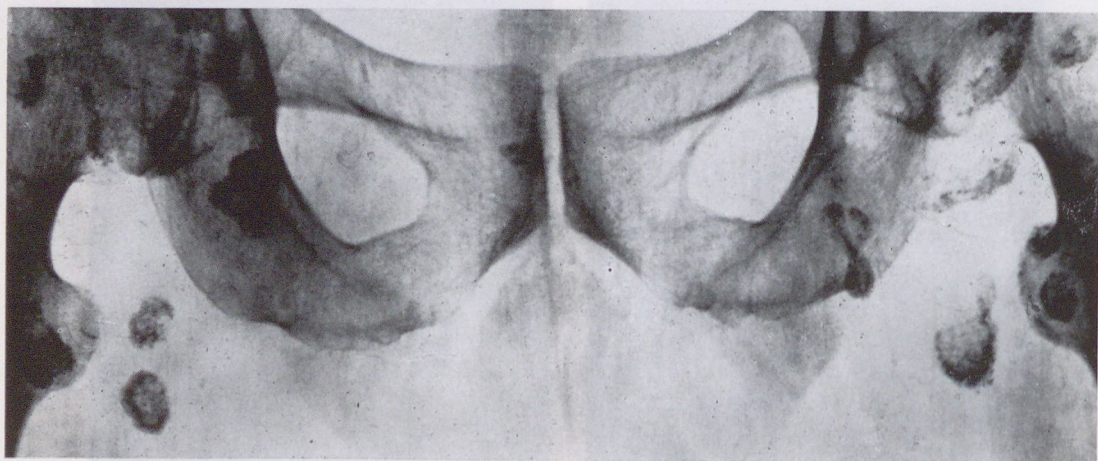


Fig. 23. Uneven filling, mostly a lack of central filling, in the femoral lymph nodes, does not indicate tumour metastasis. In the majority of cases, a metastatic filling defect proceeds from the peripheral sinus toward the centre of the lymph node



Fig. 24. 48-year-old male: admitted because of elephantiasis of the penis and scrotum for several years. In the right inguinal region the lymphatic vessels are dilated. On the left side (arrow) only one, normal sized, lymphatic vessel is filled in the iliac chain. There are no pathological alterations in the region of the upper urinary pathways (see Fig. 25a,b)



a

Fig. 25a,b. Same patient as in Fig. 24: in the inguinal, iliac and para-aortic regions on both sides, large lymph nodes are filled, in which reactive hyperplastic filling defects are seen



Fig. 25b

NON-TUMOROUS LYMPH-NODE CHANGES

Lipomatosis A filling defect is revealed in the lymph nodes, but in the filling stage the lymphatic vessels passing through may be well visualized (Fig. 26a, b).

Reactive hyperplasia The lymph nodes are moderately enlarged; the marginal sinuses are intact. The contrast medium is stored in larger droplets than usual. The enlarged follicles are seen as 1–3 mm filling defects (Fig. 27).

Acute lymphadenitis The change is similar to reactive hyperplasia; lymphography is contraindicated.

Chronic lymphadenitis The contrast medium is stored in irregularly arranged large droplets because of the fibrosis from chronic inflammation (Fig. 28).

Tuberculosis The lymph nodes are moderately enlarged; blurred filling defects are seen. The enlarged lymph nodes may form an irregular conglomeration (Figs 29–30).

Sarcoidosis The structure of the lymph nodes is opened. At first the lymph nodes are enlarged, but they become smaller as scarring develops.



a



b

Fig. 26. Lipomatosis. *a*: In the lymphangiographic phase the normal lymphatic vessels passing through are well visualized. *b*: There is a large filling defect in the inguinal lymph nodes



Fig. 27. Reactive hyperplasia: the contrast material is stored in the form of large droplets



Fig. 28. Chronic lymphadenitis: lymph node with a loose vesicular structure and intact margins

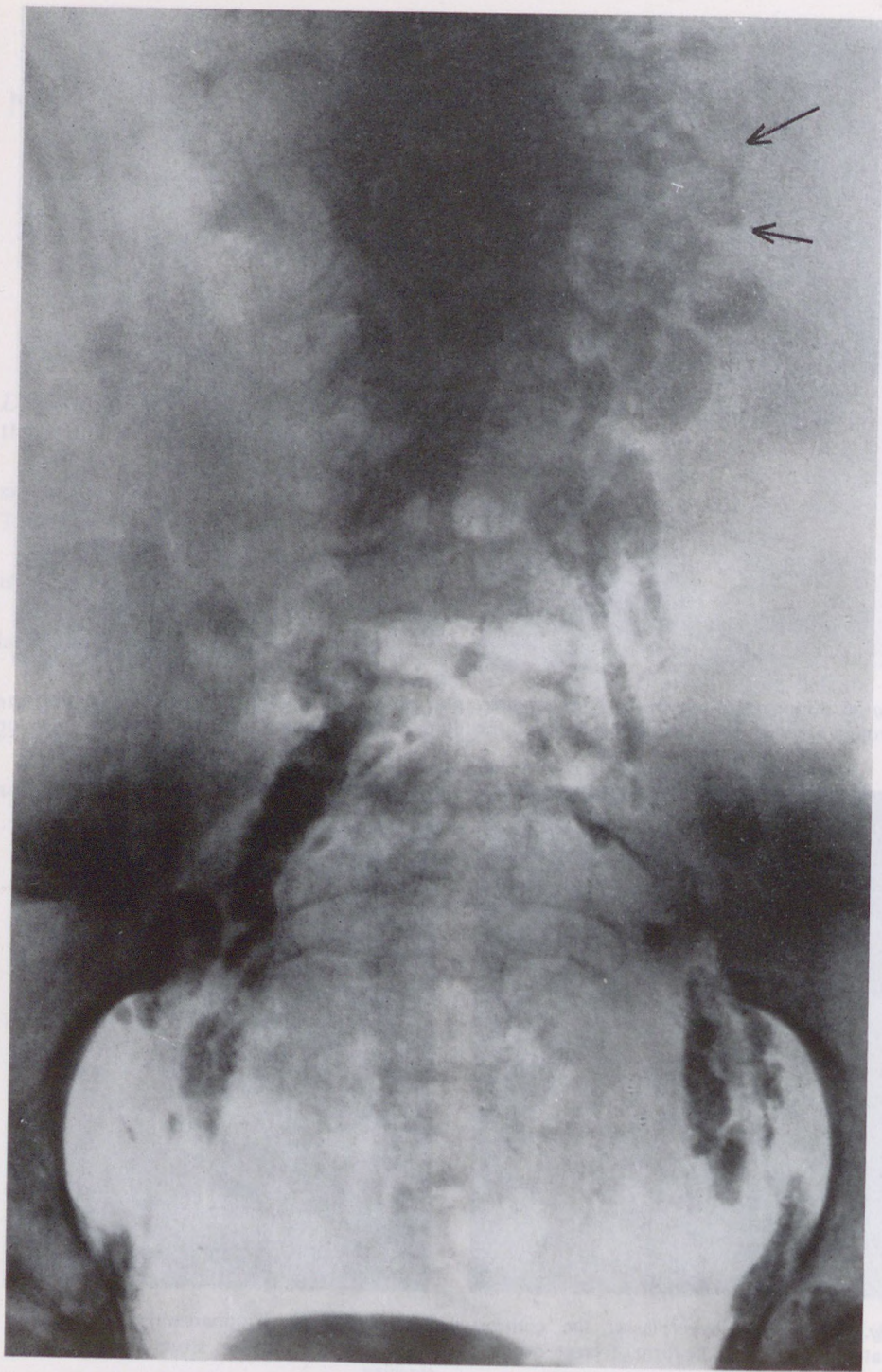


Fig. 29. 20-year-old patient: 2 years ago the left kidney was removed because of tuberculosis. On the left side, the regional lymph nodes of the kidney form an irregular conglomeration (arrows); the shape of the lymph nodes is conspicuously irregular

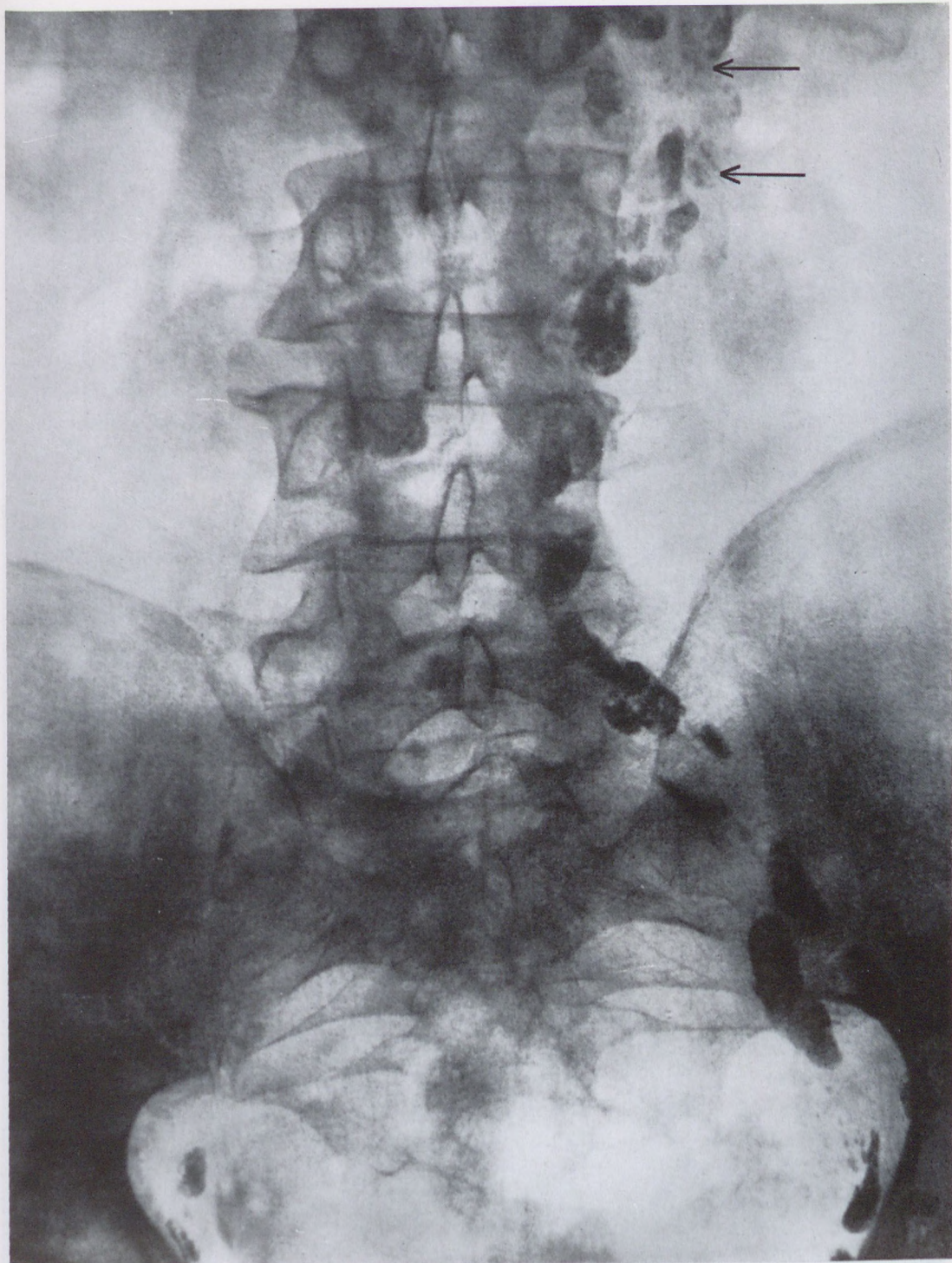


Fig. 30. 68-year-old patient: tuberculosis of the left kidney. The regional lymph nodes of the left kidney are incompletely filled, in some cases only their outline is discernible (arrows)

THE THORACIC DUCT

Details of the topographical anatomy at the thoracic duct were revealed by Jossifow (1930), Rouvière (1932) and Shdanow (1959). The possibility of lymphographic presentation of this main lymphatic vessel by means of an oily contrast medium was reported by Arnulf and Boely (1961). Later, there were further studies on the X-ray anatomy and pathological changes of the thoracic duct and the lymph nodes connected to it (e.g. Weissleder 1964; Hidden and Florent 1966, Winkler et al. 1977, Molnár 1978).

In the fetus, the thoracic ducts have a bilaterally symmetrical position: the persistence and growth of one of the embryonal ducts and the atrophy of the other may create variations in the course of the remaining duct. Generally the duct on the left side persists. In some cases of bipedal lymphography the thoracic duct is also filled (Fig. 31).

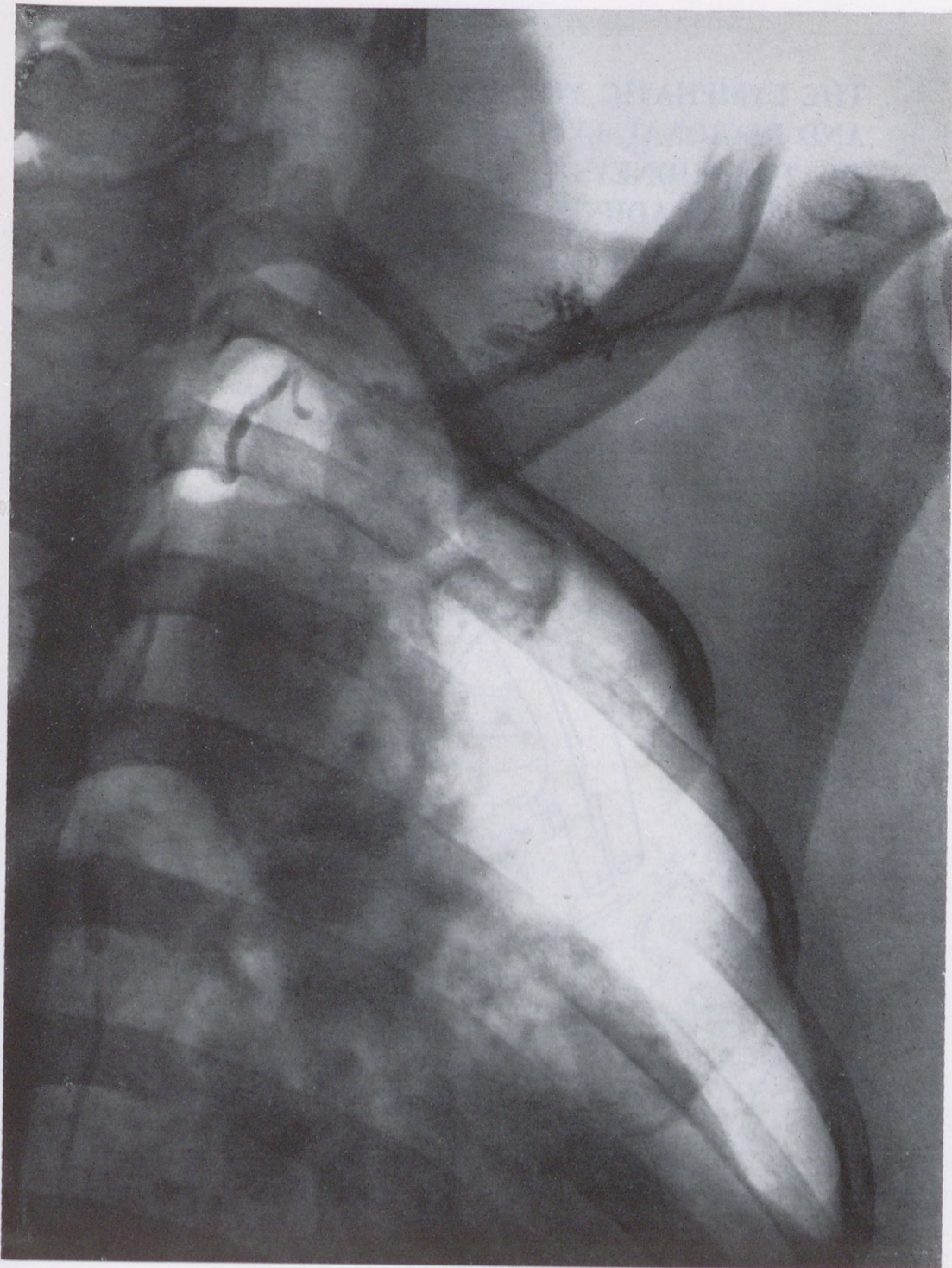


Fig. 31. Thoracic duct and lymph nodes filled in the supraclavicular region (normal variation)

THE LYMPHATIC VESSELS AND REGIONAL LYMPH NODES OF THE KIDNEYS AND THEIR ADIPOSE CAPSULES

The kidneys have a rich lymphatic circulation (Babics and Rényi-Vámos 1955, 1957). The smaller lymphatic vessels accompany the interlobular and the arcuate arteries (Rényi-Vámos 1950). The interlobular lymphatic vessels are arranged into 4-5 lymphatic vessels and follow the collecting tubules.

The lymphatic vessels leave the renal parenchyma via the hilus in the perihilar adipose tissue and, passing through the renal lymph nodes, reach the lumbar lymph nodes.

According to their site, the lumbar lymph nodes may be laterocaval, pre- and retrocaval, between the aorta and the vena cava, on the right side of the aorta, pre- and retroaortal, and on the left side of the aorta. For details *see* Fig. 32.

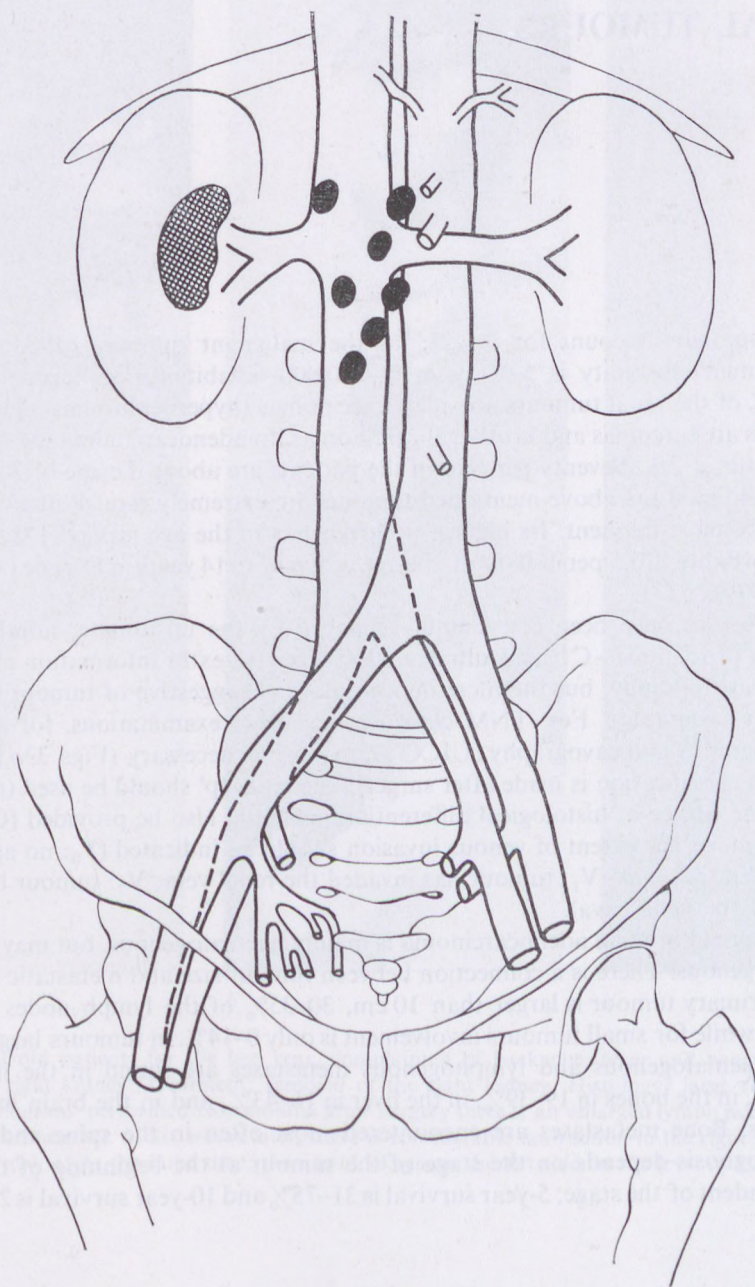


Fig. 32. Regional lymph nodes of the kidneys: right lateroaortic lymph nodes; preaortic lymph nodes; retroaortic lymph nodes

RENAL TUMOURS

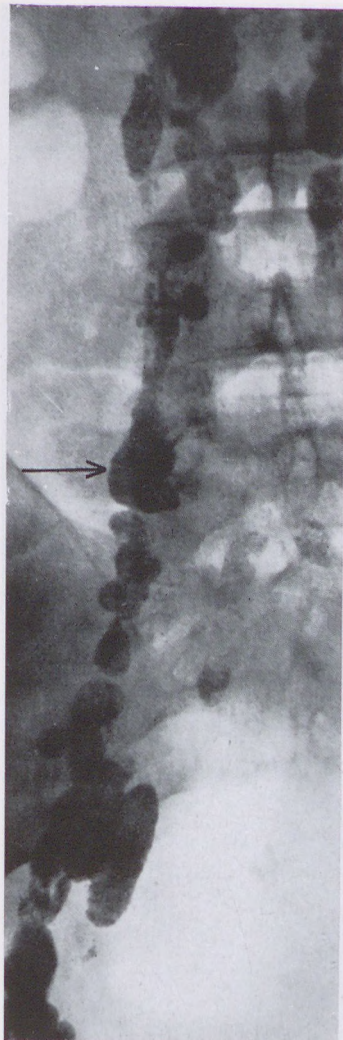
Renal tumours account for 0.5–2% of the malignant tumours of adulthood. The annual morbidity is 5–10 cases in 100,000 inhabitants of Europe. About 75–85% of the renal tumours are adenocarcinomas (hypernephromas). The other tumours are sarcomas and urothelial carcinomas. In adenocarcinoma the male–female ratio is 2:1. Seventy per cent of the patients are above the age of 70 years.

In childhood the above-mentioned tumours are extremely rare, Wilms' tumour being the most frequent. Its highest occurrence is in the age group of 0–4 years. The morbidity is 0.5 per 100,000 in the age group of 0–14 years in Europe (Ammon et al. 1979).

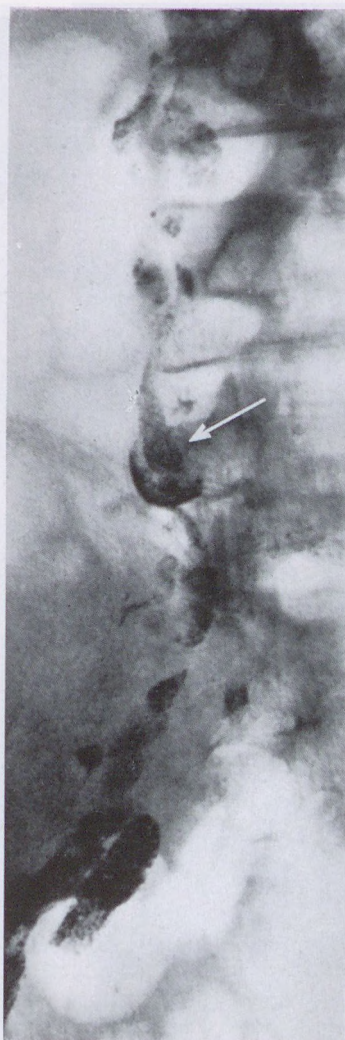
Our tactics have been considerably changed by the up-to-date, non-invasive imaging procedures—CT and ultrasound. These give extra information and may replace angiography, but the most important signs suggestive of tumour are still given by urography. For TNM classification, other examinations, for example lymphography and cavography (UICC 1978), may be necessary (Figs 33*a,b,c*–36).

When classification is made after surgery, the letter 'p' should be used (pT, pN, pM). The degree of histological differentiation should also be provided (G₁, G₃). Furthermore, the extent of venous invasion should be indicated (V₀: no apparent tumour in the veins; V₁: tumour has invaded the renal vein; V₂: tumour has also invaded the vena cava).

The spread of renal adenocarcinoma is mainly haematogenous, but may also be lymphogenous. There is a connection between tumour size and metastatic spread; if the primary tumour is larger than 10 cm, 30–35% of the lymph nodes are involved, while for small tumours involvement is only 0–14%. In tumours larger than 5 cm haematogenous and lymphogenous metastases are found in the lungs in 40–67%, in the bones in 19–39%, in the liver in 16–43%, and in the brain in 6–14% of cases. Bone metastases are encountered most often in the spine and pelvis. The prognosis depends on the stage of the tumour at the beginning of therapy. Independent of the stage, 5-year survival is 31–75% and 10-year survival is 25–53%.



a



b



c

Fig. 33. 24-year-old patient: for the last year, complaining of backache, fever and haematuria. Diagnosis: tumour of the right kidney. Treatment: removal of the right kidney. Histology: large round-cell sarcoma. *a:* In the lymphogram performed two months after surgery there is an enlarged lymph node of the right side at the level of L4 (arrow). *b:* Six weeks later, there is considerable destruction in the right para-aortic lymph-node chain (arrow). *c:* At the same time, there is blockage on the left side, at the level of L3 (arrow)

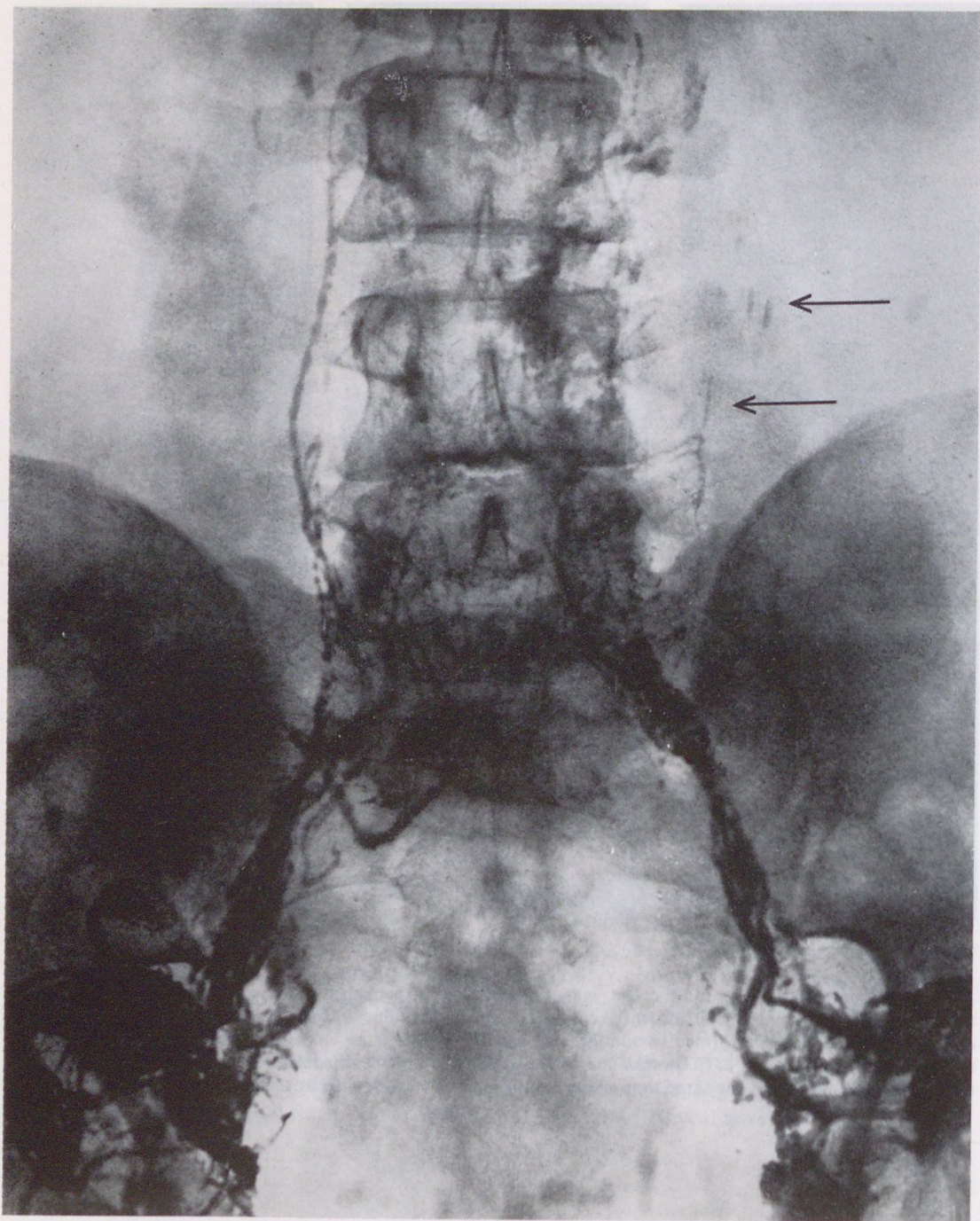


Fig. 34. 63-year-old patient: haematuria following a two-month period of fever. Diagnosis: hypernephroma on the left side. Interrupted filling (arrows) of the lymphatic system in the left lumbar region

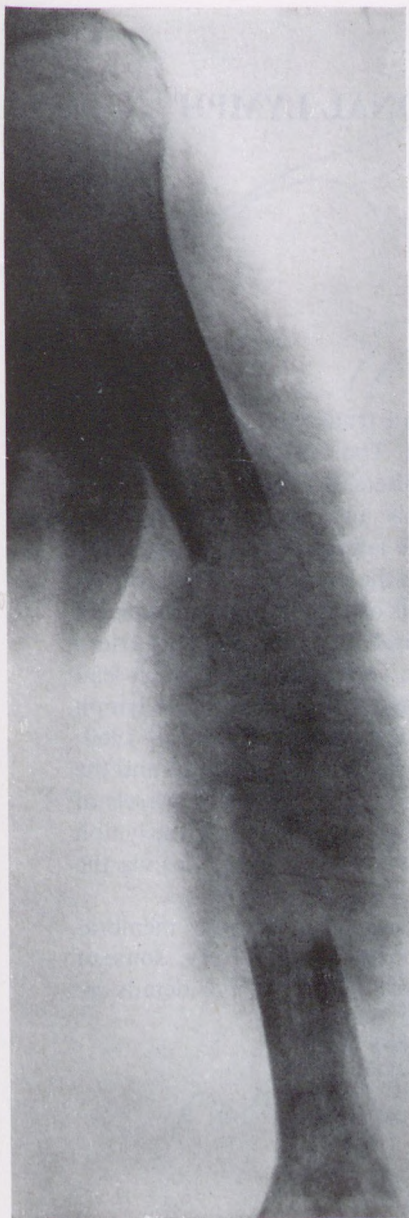


Fig. 35. 52-year-old patient: huge osteolytic metastasis on the diaphysis of the left humerus. Histology: metastasis of hypernephroma (see Fig. 36)

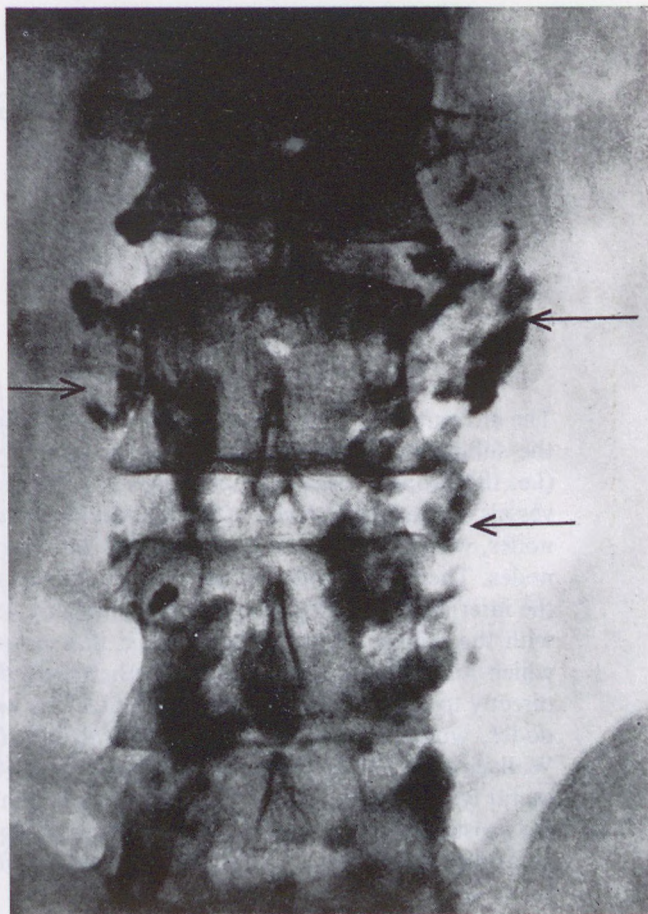


Fig. 36. Same patient as in Fig. 35: hypernephroma; on both sides in the lumbar region there are defectively filled, irregular lymph nodes (arrows)

LYMPHATIC VESSELS AND REGIONAL LYMPH NODES OF THE BLADDER

The efferent lymphatic vessels of the bladder originate from three networks: from the submucous, muscular and extramascular layers. The vesical and perivesical (i.e. the proper vesical) lymph nodes are the first filters. The efferent lymphatic vessels of the anterior wall of the bladder open into the anterior and lateral lymph nodes, while those of the posterior wall pass into the lateral and posterior lymph nodes. The lymph nodes of the bladder connect with the parietal lymph nodes of the internal iliac artery. The efferent lymphatic vessels of the internal iliac connect with the lymph nodes of the external iliac artery and the common iliac artery which are the secondary filters. Furthermore, there are connections which lead directly to the inferior and superior gluteal, as well as to the common iliac lymph nodes, without involving the paravesical ones (Fuchs 1968; Fuchs et al. 1969; Wallace et al. 1977). There is also a connection between the vesical fundus and the sacral lymph nodes. These lymphatic vessels join the efferent lymphatic vessels of the prostate, seminal vesicle and the rectum. According to some authors, the lymph from the vertex of the bladder is conveyed to the umbilical lymph nodes via the presumed (Lüning et al. 1976).

The lymphatic vessels of the pars prostatica urethrae and of the pars membranacea urethrae reach the lymph nodes beside the internal iliac artery, some of them going directly to the lymph nodes of the external iliac chain. For details *see* Fig. 37.

Fig. 34. 53-year-old patient, histiocytosis following a two-month period of fever. Histiocytosis, hypernephroma on the left side, enlarged lymph nodes of the lymphatic system in the left lumbar region.

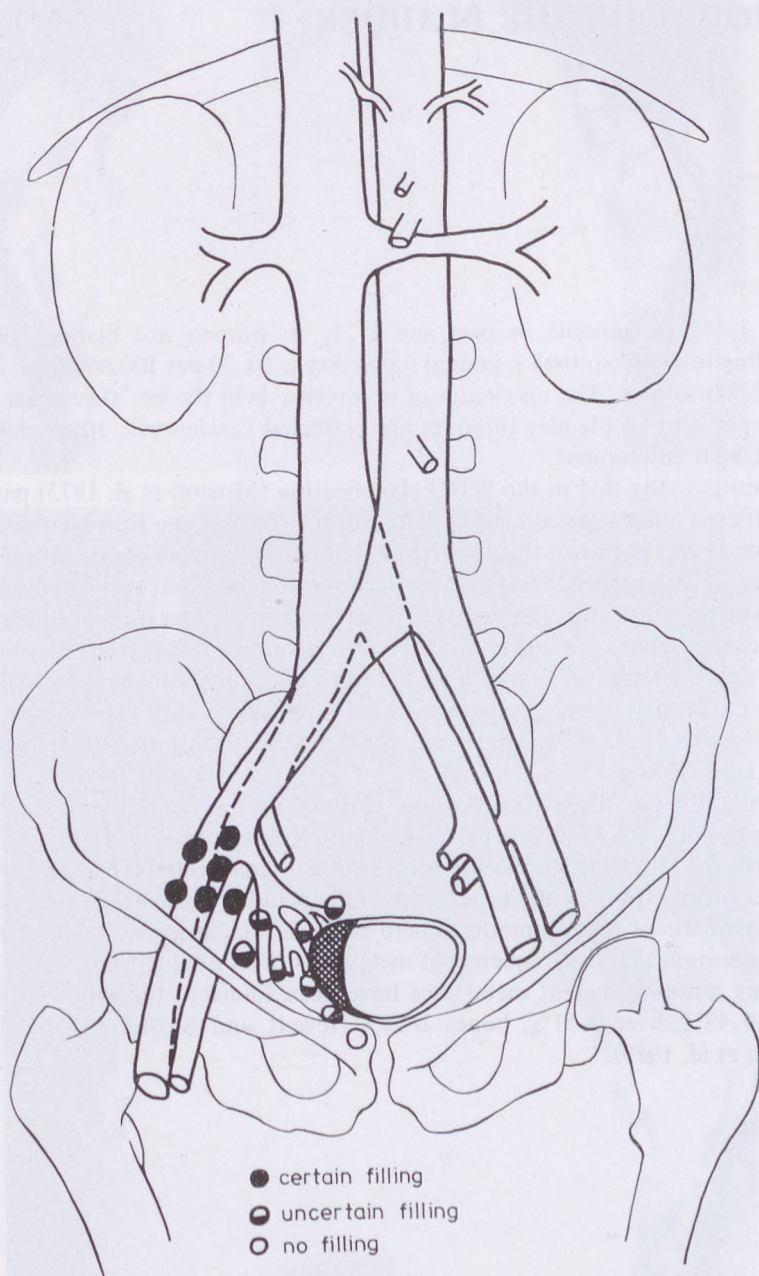


Fig. 37. Regional lymph nodes of the bladder: superficial lateral external iliac lymph nodes; deep lateral external iliac lymph nodes; medial external iliac lymph nodes; obturator lymph nodes; lateral vesical lymph nodes; anterior vesical lymph nodes

TUMOURS OF THE BLADDER

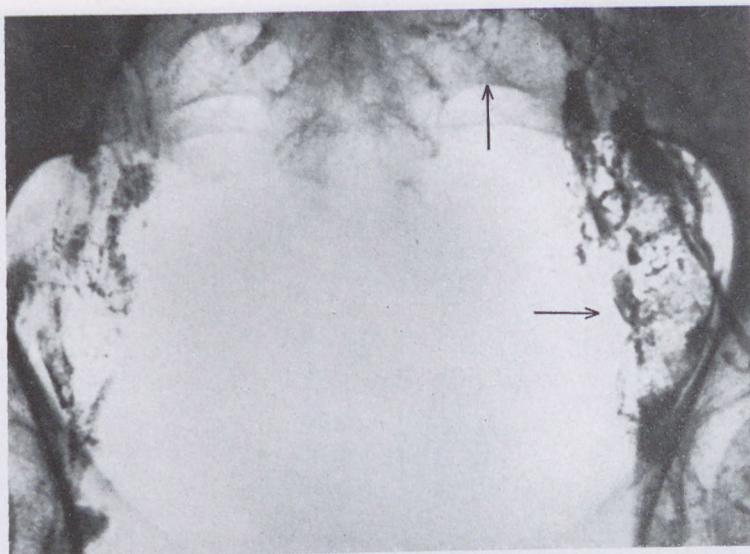
About 3–5% of tumours in men and 1–2% in women are bladder tumours. According to world statistics, annual morbidity is 10–20 per 100,000 men, and 2–7 per 100,000 women. The maximum of occurrence is in the 60–70-year age group. Ninety per cent of bladder tumours are epithelial carcinomas, 10% adeno- and planocellular carcinomas.

It is noteworthy that in the WHO classification (Mostofi et al. 1973) papilloma is considered anaplastic carcinoma without invasion. In the European literature, histological verification of the invasive character of a tumour is a condition for the diagnosis of carcinoma. This difference accounts for the better survival rates shown in the American statistics. In the diagnosis of invasive bladder tumours and regional lymph node changes, the up-to-date, non-invasive methods present new possibilities. In clinical diagnosis first of all CT, ultrasound, then bimanual palpation performed under anaesthesia, cystography, and cystoscopy with biopsy have proved useful (Mayor et al. 1963; Higgs and MacDonald 1968; Lang 1968; Hall 1980; Jeffrey et al. 1981).

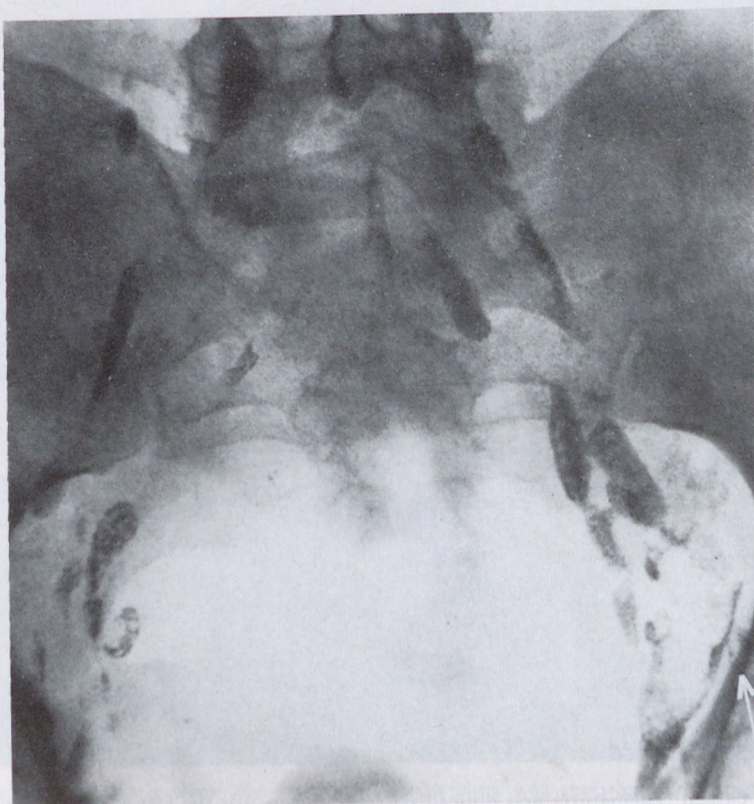
To establish the TNM classification, chest X-ray, skeletal scintigraphy, lymphography (Figs 38*a,b*–49) and pelvic angiography are necessary. Urinary cytology is suitable for following the disease process in patients treated for bladder tumour.

Direct propagation through the layers of the bladder to the neighbouring organs is characteristic of these tumours. There is a relationship between the size of the primary tumour and the frequency of metastases (Elke et al. 1976*b*).

During autopsy, distant metastases have been found in the following organs: lungs 18–47%, liver 9–51%, bones 2–55% (Jewett and Strong 1946; Zyb 1976; Ammon et al. 1979).



a



b

Fig. 38. 50-year-old patient: papillary bladder carcinoma diagnosed six years ago. *a:* The filling of the lymphatic system is interrupted in the pelvis (arrows) and in front of the sacral bone collateral lymphatic vessels may be seen. *b:* On the left side there is an enormous filling defect (arrow) penetrating the pelvic lymph nodes from the periphery. On the right side only a few lymph nodes are filled (the others are infiltrated or occluded by the tumour)

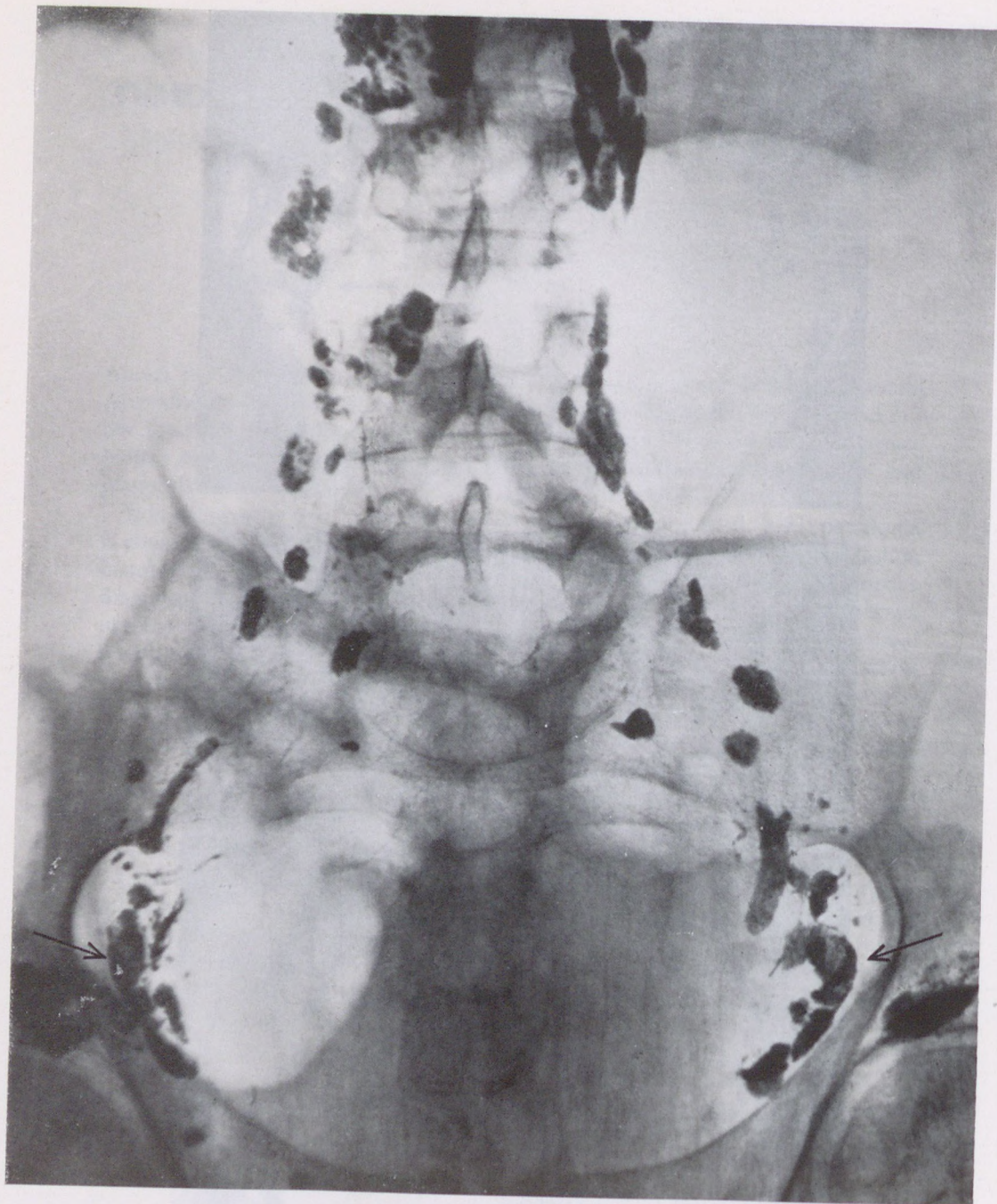


Fig. 39. 67-year-old patient: haematuria first noticed six months ago; for the last week haematuria with clots has been observed. Diagnosis: bladder carcinoma. There is a filling defect in the lateral lymph nodes of the iliac chain on both sides, proved to be metastatic at autopsy

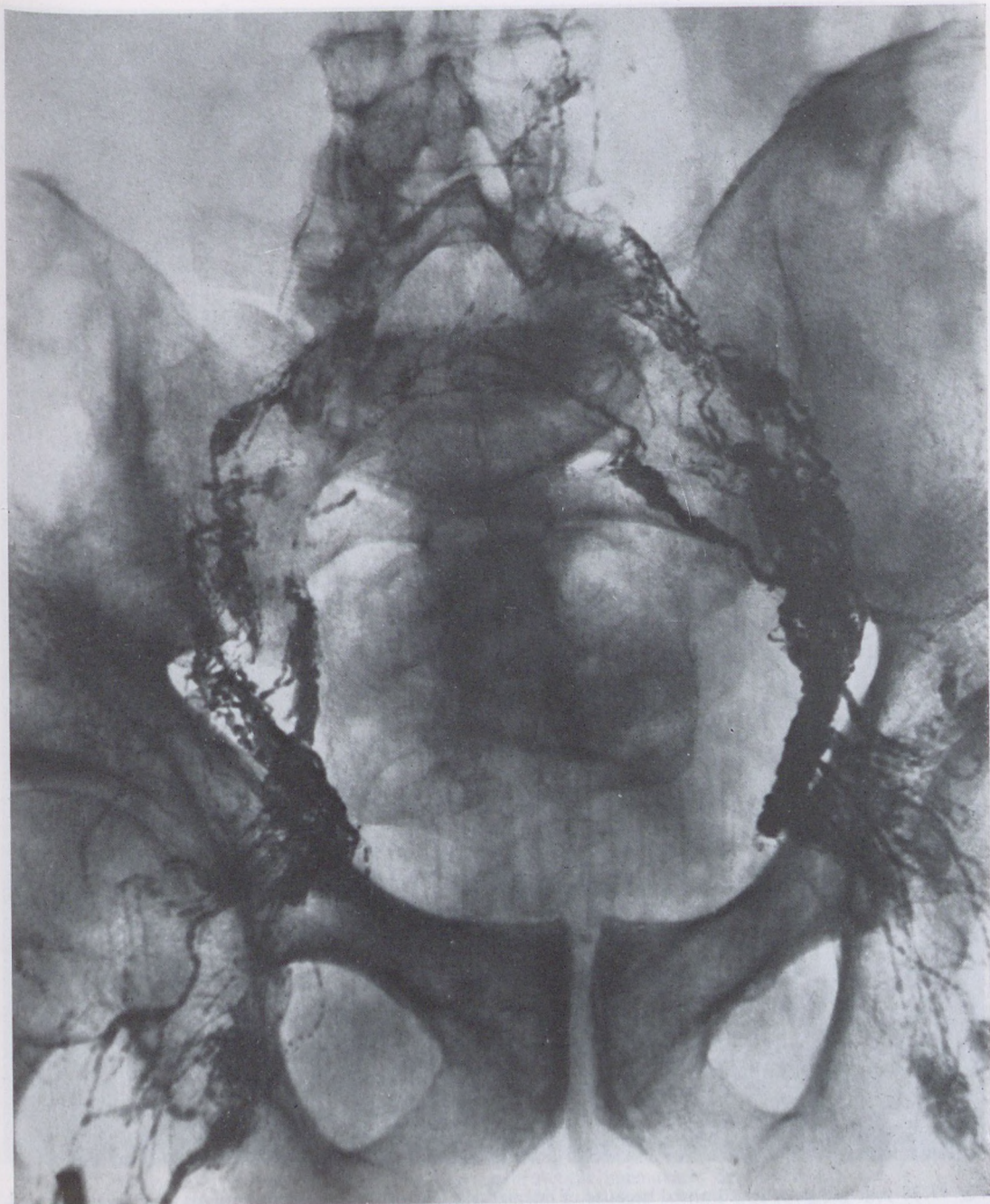


Fig. 40. 61-year-old patient; a week ago haematuria with clots was reported. Diagnosis: bladder tumour. There is a block in the right lumbar lymphatic chain; as a consequence of stagnation, dilated collateral vessels are seen in front of the sacral bone

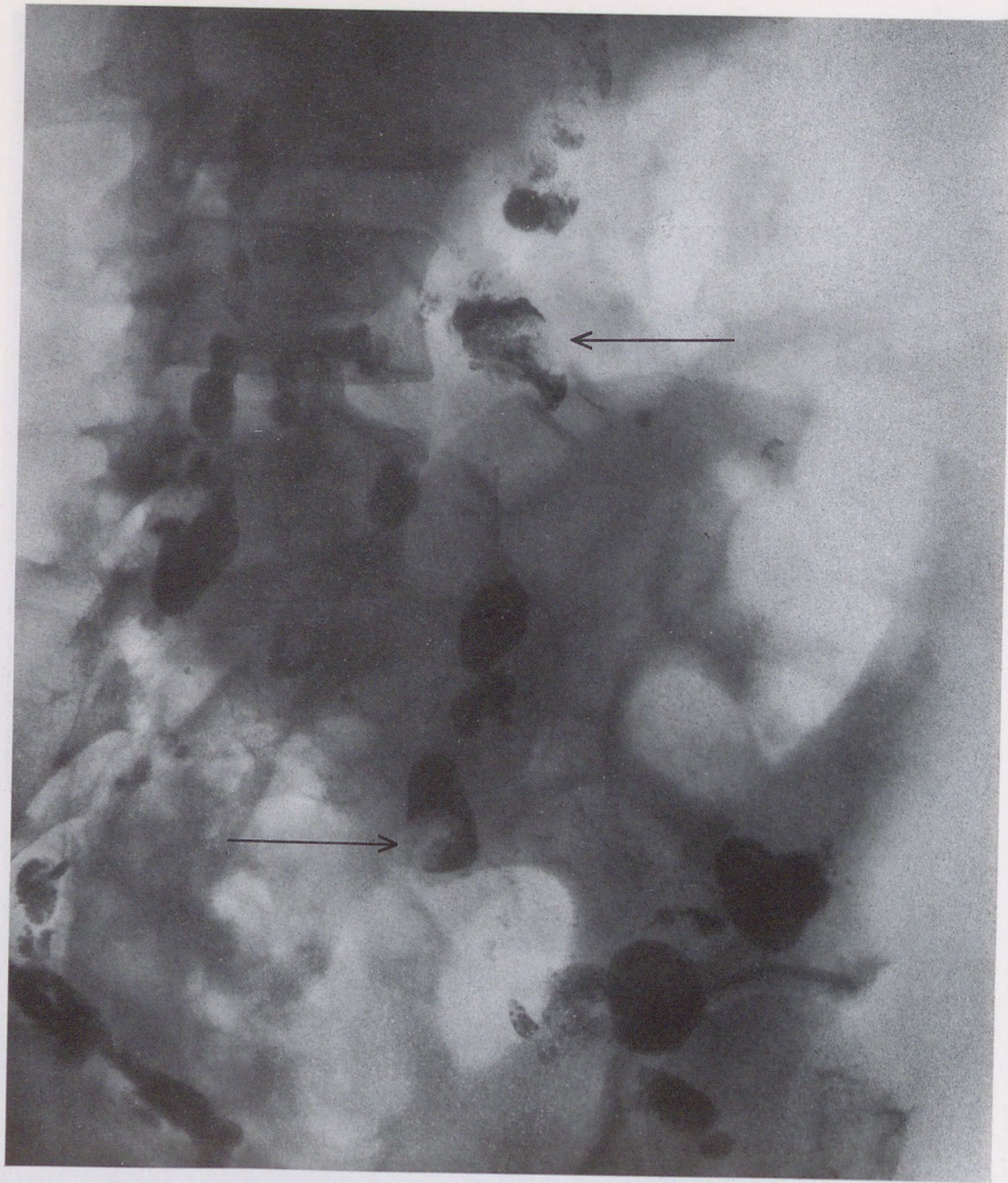


Fig. 41. 38-year-old patient: admitted because of haematuria. Cystoscopy revealed a tumour which was biopsied. Histology: uroepithelial carcinoma. Cystectomy and Coffey's operation were carried out; bilateral hydro-nephrosis developed. On the left side filling defects of metastatic origin are seen in the lymph nodes of the iliac and para-aortic chain (arrows). In the neighbouring lymphatic vessels the contrast medium is stagnating

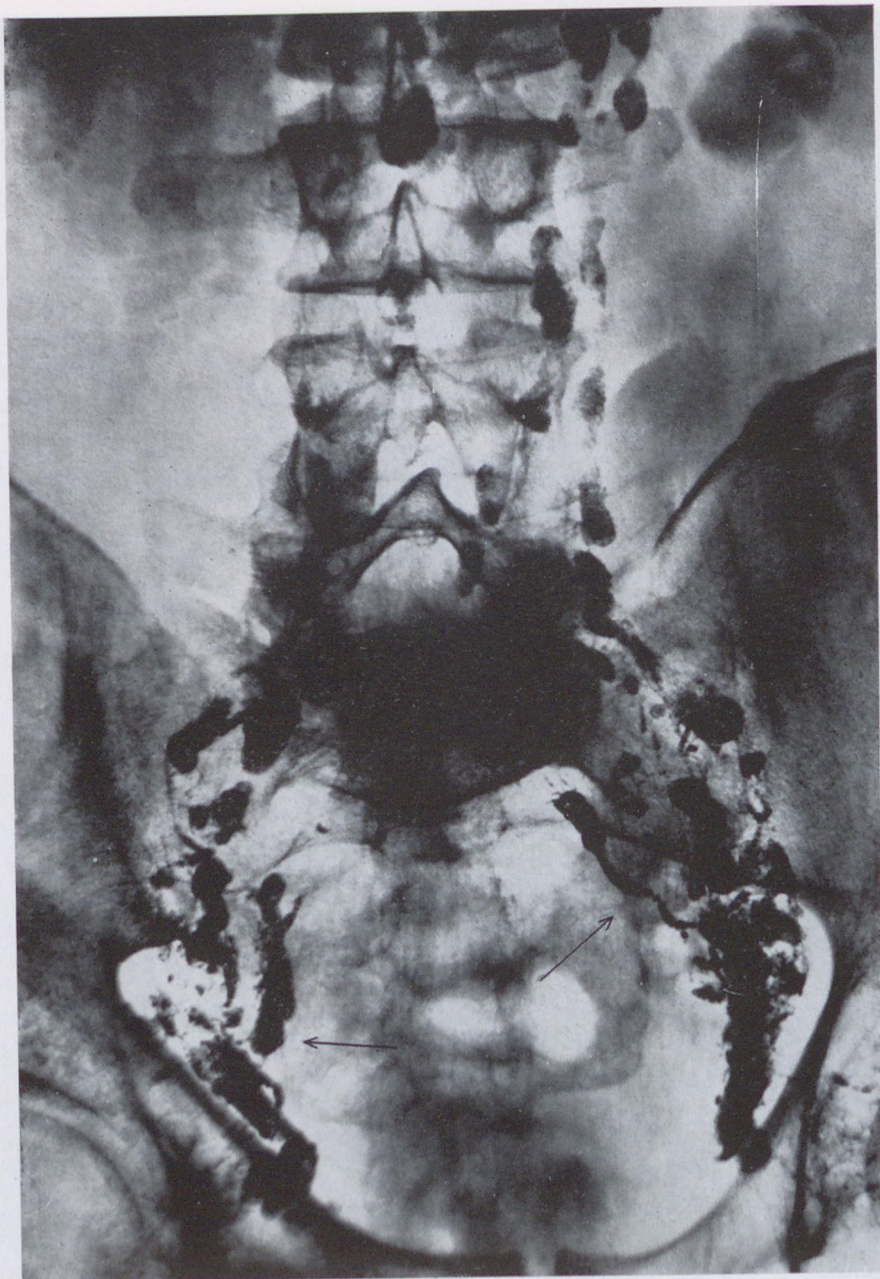


Fig. 42. 64-year-old patient: a week ago macroscopic haematuria developed. On the base of the bladder a walnut-sized tumour with a necrotic surface was revealed by cystoscopy. Destroyed lymph nodes are seen in the right iliac chain, while on the left side there is stagnation in the lymphatic vessels (arrows)

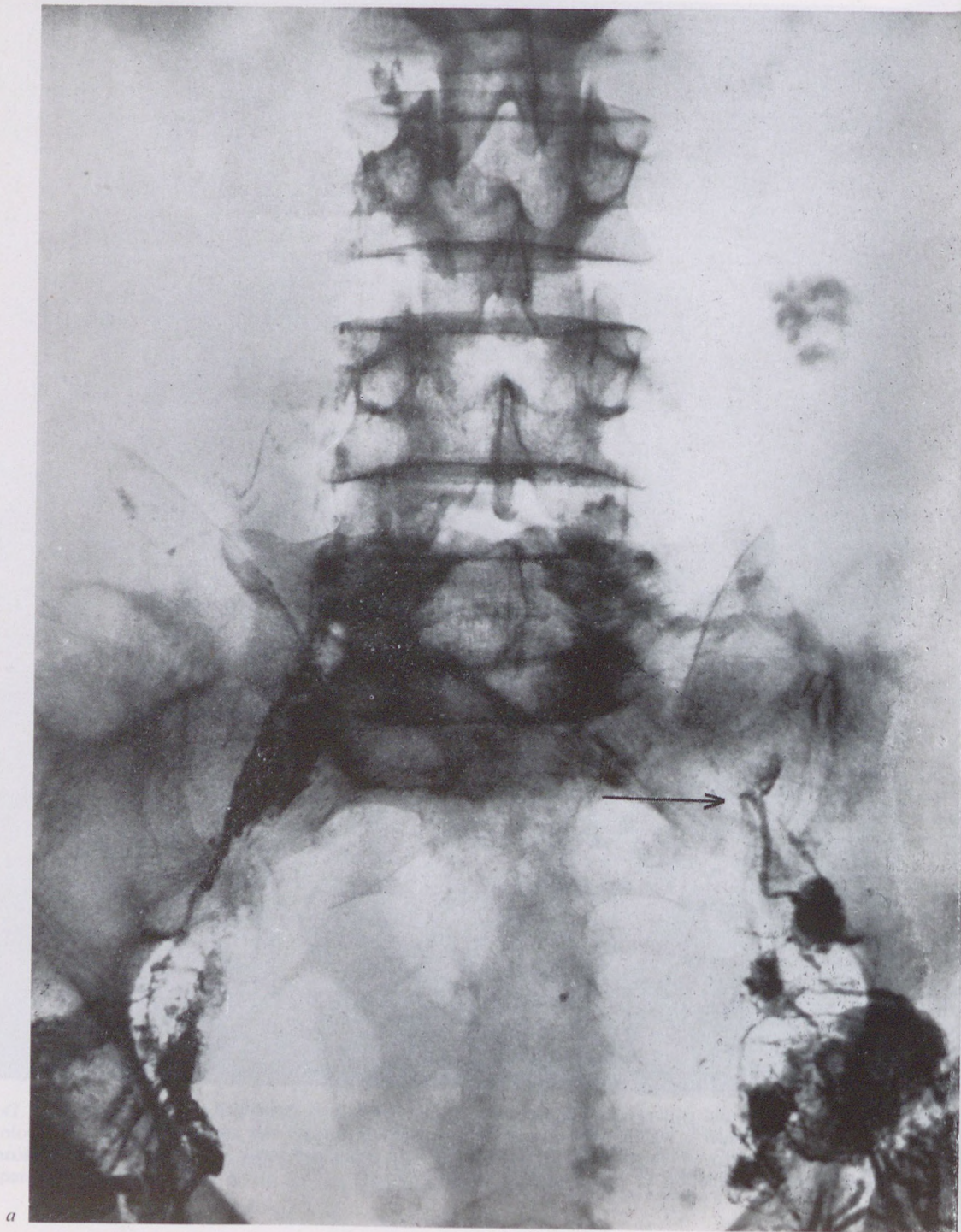


Fig. 43a. 68-year-old patient: haematuria with clots observed two weeks ago. Diagnosis: bladder tumour. Blockage in the left iliac chain, at the height of the terminal line (arrow)

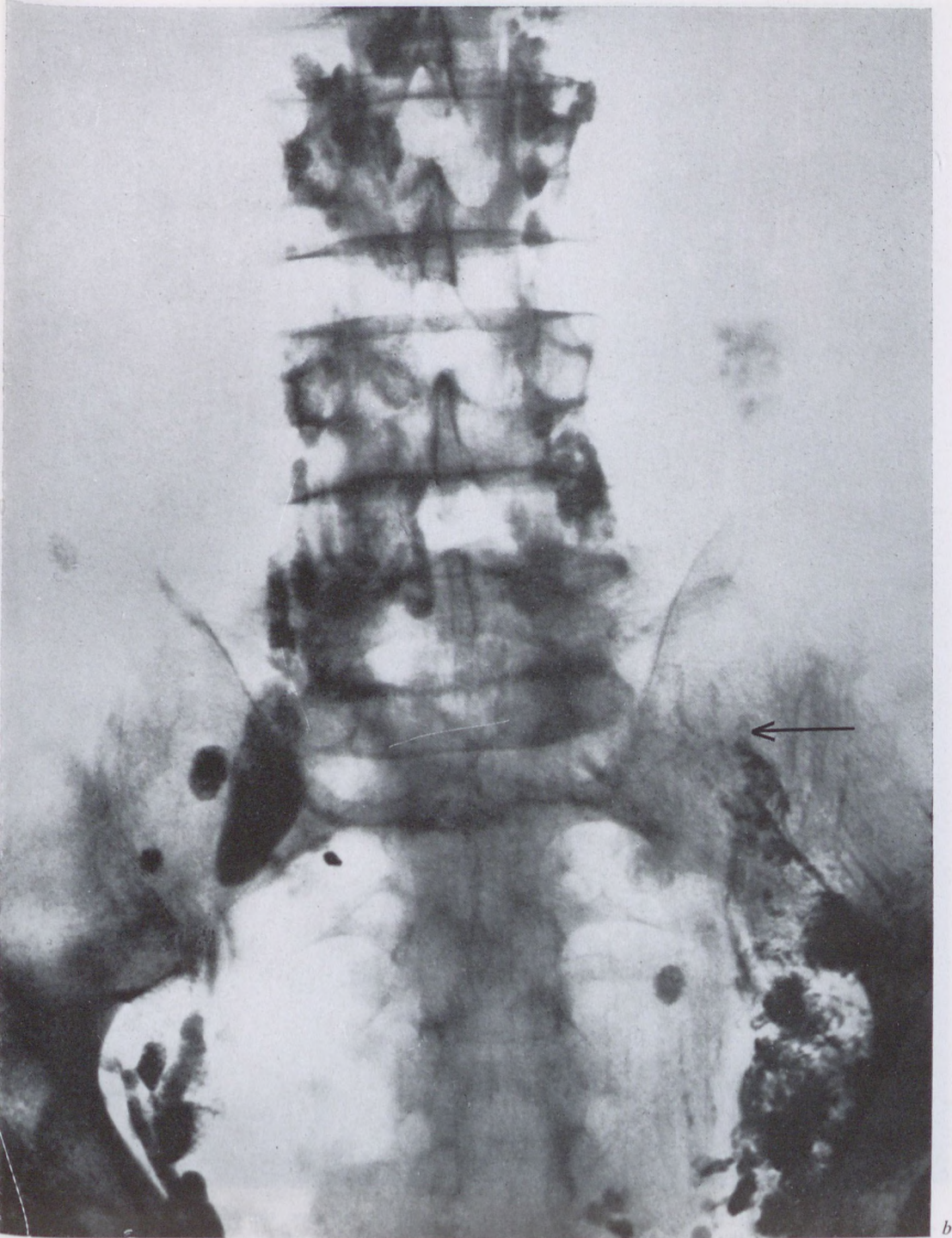


Fig 43b. Below the block the filling of the lymphatic vessels is still visible even 24 h later (arrow). On the left, calcified lymph nodes in the paravertebral region



Fig. 43c, d. Tomograms: although the view is not as good as in the AP view, the contours of the lymph nodes located in different layers can be satisfactorily evaluated



d

Fig. 43d

a

Fig. 44a. 67-year-old patient: haematuria first observed two months ago. Diagnosis: bladder tumour. The majority of the lymphatic vessels in the presacral region are occluded; the contrast medium is carried by a collateral toward the pelvic brim



b

Fig. 44b. 24 h later the lymphatic vessels around the iliac lymph nodes on the left side (arrows) are still filled (stagnation)

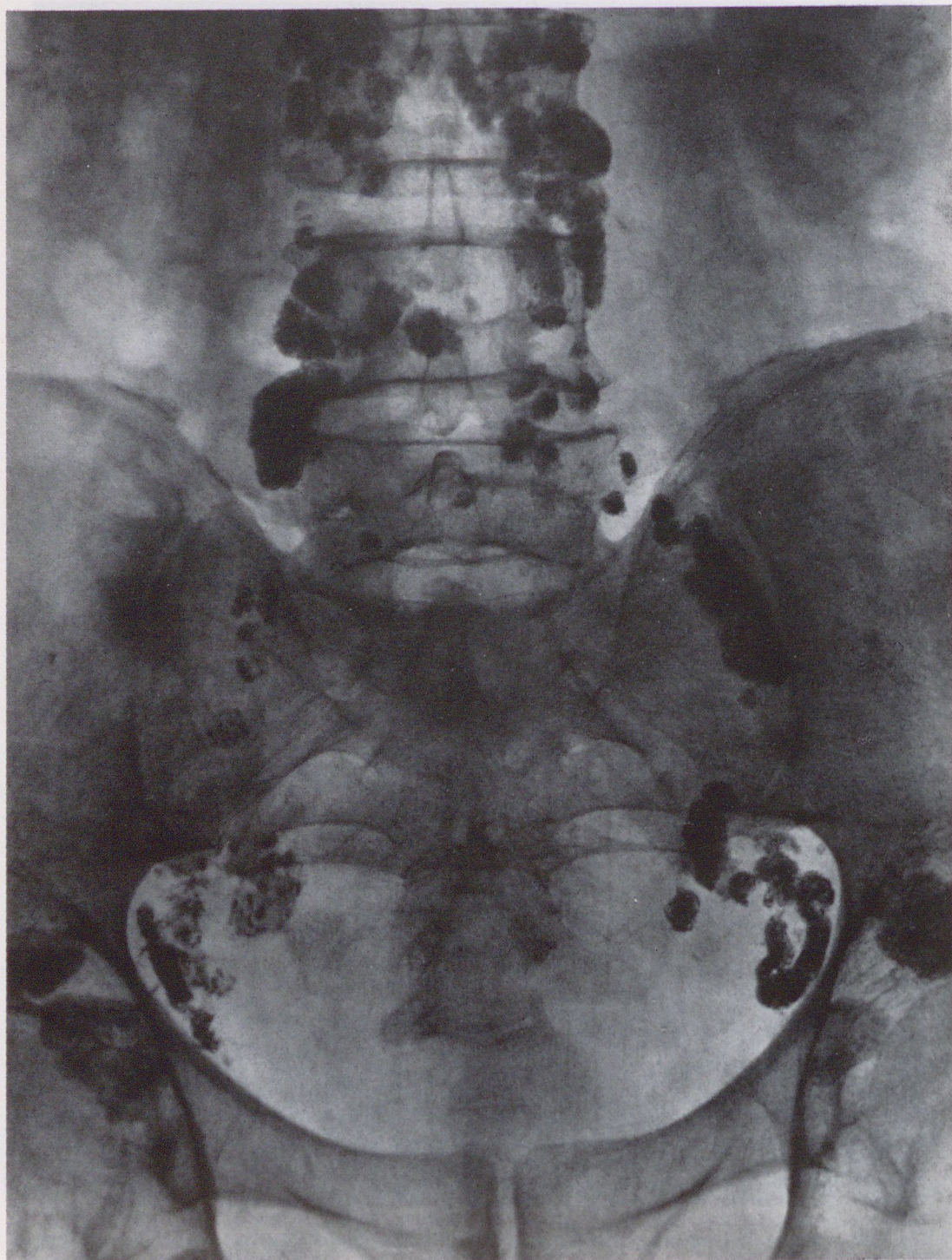


Fig. 45. 61-year-old patient: frequency of micturition and haematuria for the last one-and-a-half years. Diagnosis: bladder tumour. Lymphadenographic phase: extensive filling defects in the lymph nodes of the right iliac chain

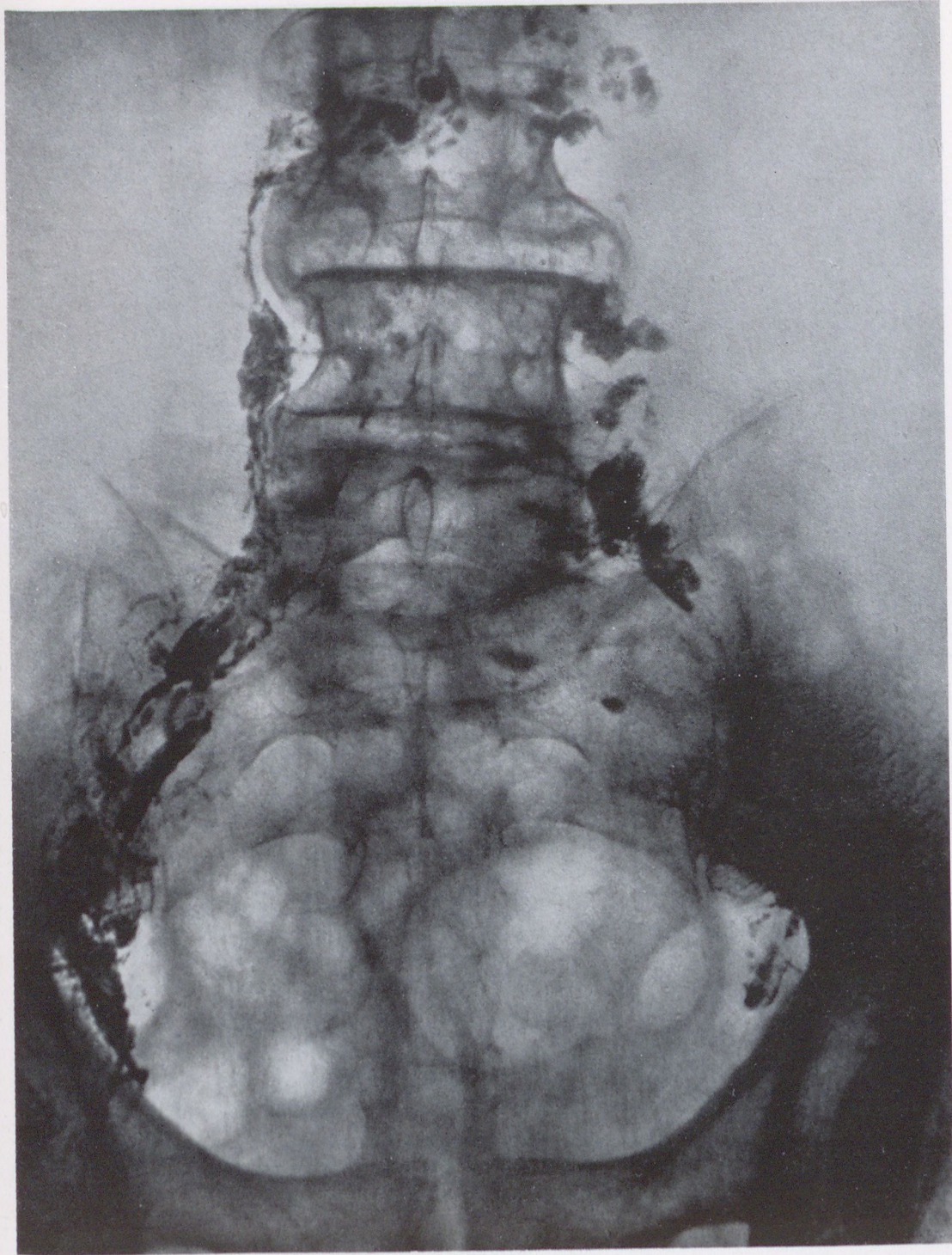


Fig. 46. 73-year-old patient: dysuria for the last three years. Suprapubic cystotomy two years ago. Diagnosis: bladder tumour. Histology: papillary carcinoma. On the right side there is stagnation along the lymphatic vessels. The majority of the iliac lymph nodes on the left are not filled (a sign of tumour propagation). A year ago Coffey's operation was performed because the tumour has spread from the left side of the bladder to the periosteum of the sacral bone



Fig. 47. 54-year-old patient: frequency of micturition for the last year; haematuria in the last six weeks. Diagnosis: bladder carcinoma, grade III. In the left iliac chain dilated lymphatic vessels are revealed displaying an arched lateral dislocation (arrow)

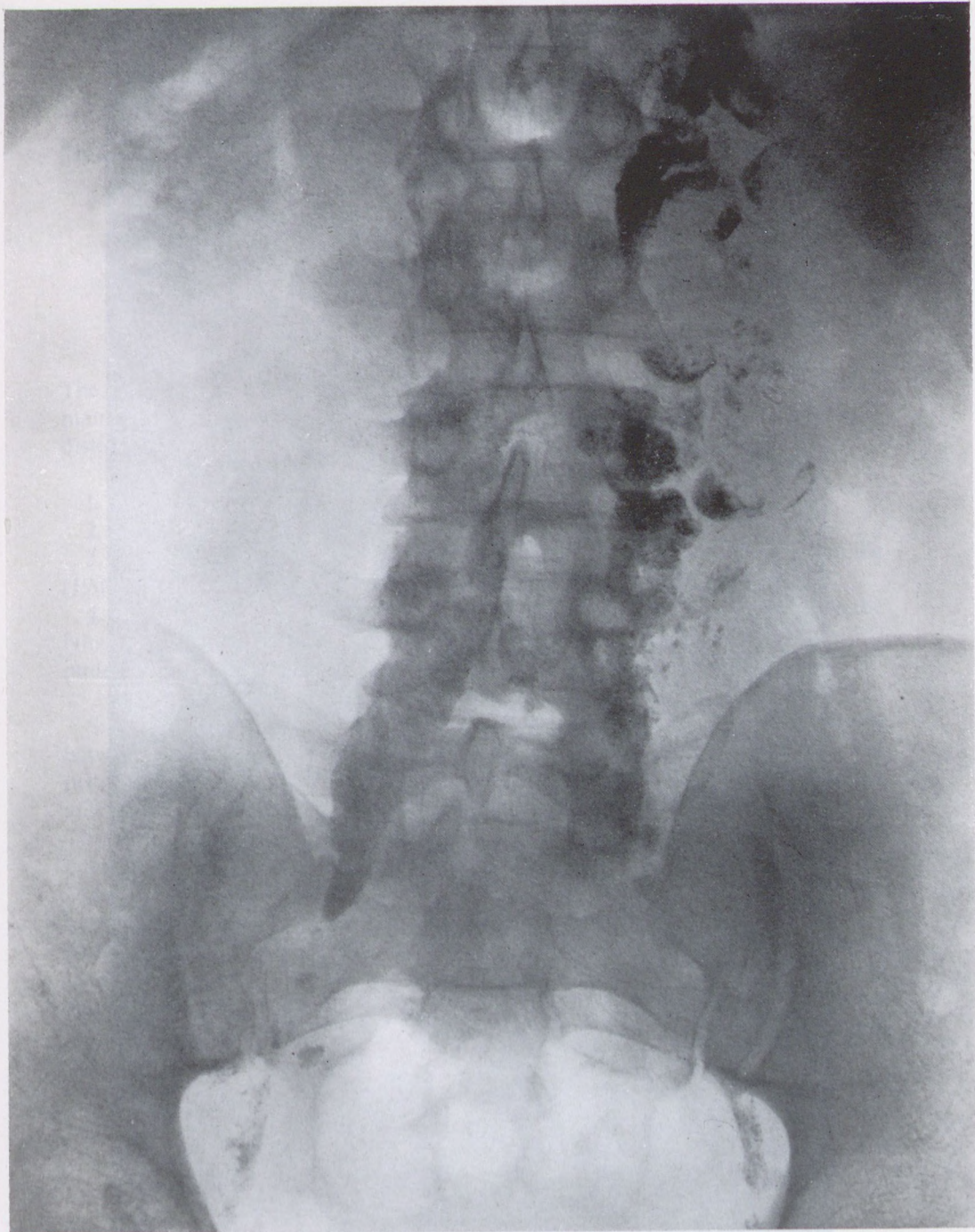


Fig. 48. 53-year-old patient: admitted because of massive haematuria. Diagnosis: bladder carcinoma. In the right iliac chain damaged lymph nodes of normal size may be seen. In the left para-aortic chain there is a huge conglomeration of lymph nodes with large filling defects



Fig. 49. 42-year-old patient: admitted because of repeated haematuria. Diagnosis: bladder carcinoma. In the right iliac region an enormous conglomeration of metastatic lymph nodes may be seen. The stagnation in the lymphatic vessels is considerable even 24 h later

LYMPHATIC VESSELS AND REGIONAL LYMPH NODES OF THE PROSTATE

The lymphatic vessels of the prostate run along the arteries supplying the gland, mainly to its dorsal surface and base. Four groups of lymphatic vessels may be distinguished (Franks 1953; Smith 1966; Buttler et al. 1971), namely those:

1. running to the external iliac artery;
2. following the prostatic artery and opening into the external iliac artery;
3. running dorsal to the promontory, which, according to Cuneo and Marcille (1901), belong to the medial common iliac lymph nodes;
4. leading to the lateral sacral lymph nodes, and from the anterior surface to the lymph nodes located along the internal iliac artery, at the origin of the internal pudendal artery.

Small lymph nodes are also found dorsal to the prostate. There are anastomoses between the lymphatic vessels of the bladder, rectum and seminal vesicle. The primary lymph nodes of the prostate are located periprostatically, perirectally and perivesically, as well as along the external iliac artery (Frischbier 1972). These lymph nodes can be made visible only partially or not at all by bipedal lymphography. Besides, there are direct connections to the lymph nodes of the common iliac artery which are well visualized by lymphography. Therefore it is necessary to complement lymphography with CT and sonography. Transrectal sonography is also an important complementary procedure. Nevertheless, it should be emphasized that these examinations do not enable evaluation of metastases in small lymph nodes, and differentiation between lymph nodes enlarged by tumours and those enlarged reactively (Jentsch et al. 1977; Wesirow et al. 1977; Whitmore 1983). For details see Fig. 50.

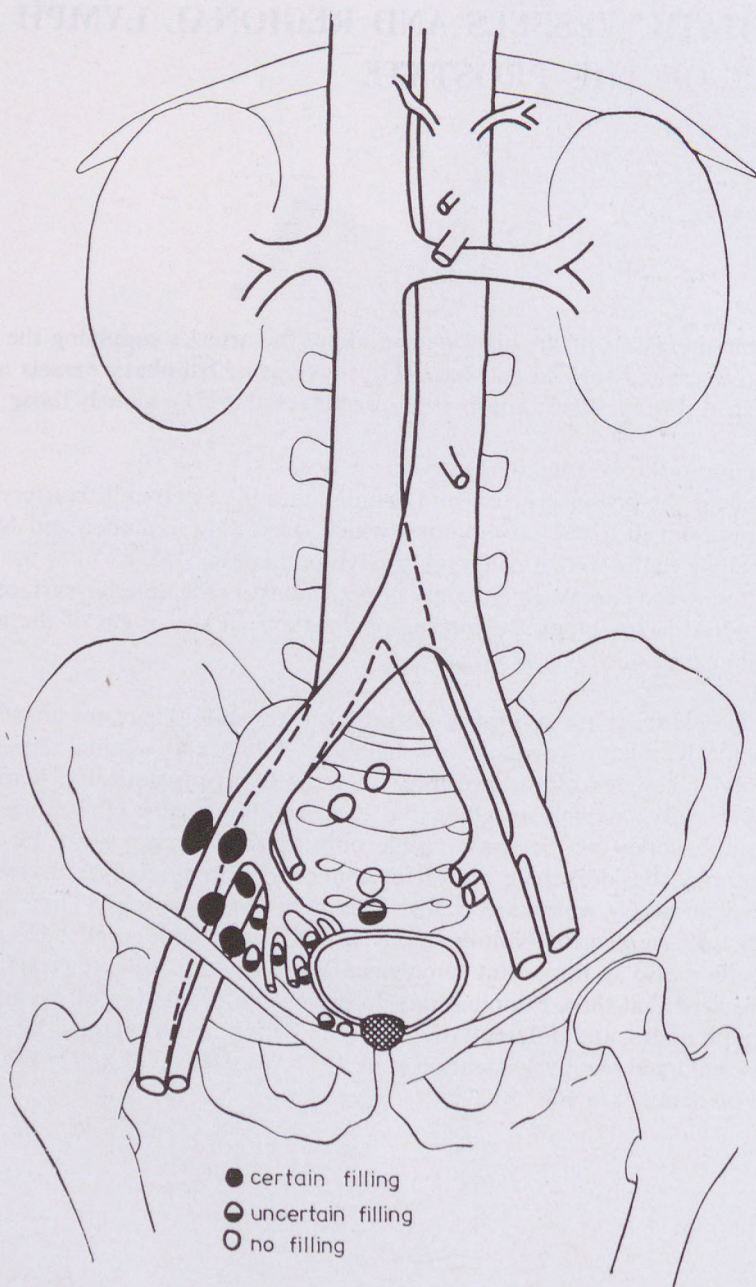


Fig. 50. Regional lymph nodes of the prostate: superficial lateral external iliac lymph nodes; deep lateral external iliac lymph nodes; medial external iliac lymph nodes; obturator lymph nodes; sacral lymph nodes; lateral vesical lymph nodes; anterior vesical lymph nodes; haemorrhoidal lymph nodes

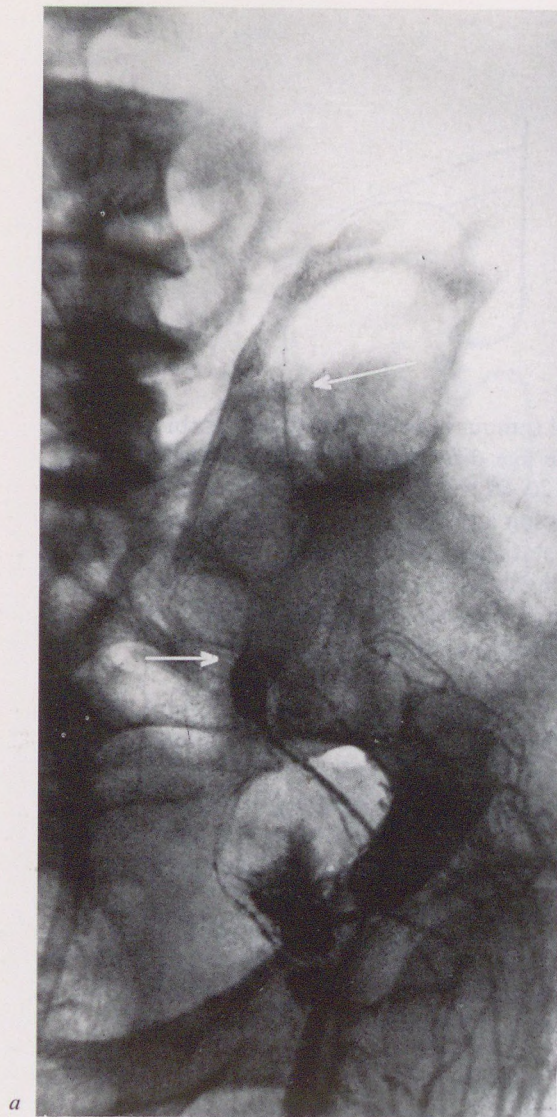
PROSTATIC CARCINOMA

This is the most frequent malignant urological tumour in men. The annual morbidity shows great differences according to the age distribution and frequency of autopsies in various countries; it is generally 20–60 per 100,000. It is the cause of death in as many cases as carcinoma of the colon and rectal cancer together, and thus it comes second or third in mortality statistics after bronchial carcinoma (BRD Statistisches Bundesamt 1978). According to pathological examinations, the frequency of occurrence increases with age – above the age of 70 years it may reach 50–70%. Fifty per cent of the tumours are clinically occult (Lutzeyer and Schiffer 1970; Hanash et al. 1972; Breslow et al. 1977).

TNM classification is desirable for uniform staging (UICC 1978). It is important to determine the pT, pN and pM stages, as clinical staging often underestimates the extent of the tumour (Dahl et al. 1974; Ray et al. 1976). At least the following examinations should be performed for TNM staging: clinical check-up, urography, cystoscopy, biopsy, lymphography, chest X-ray, skeletal X-ray, biochemical determinations. When examining the skeleton, scintigraphy should be combined with radiography.

In cases where classification is performed on the basis of surgery [transurethral resection (TUR), enucleation], the letter 'p' (post-surgical) should be used. As well as the extent of the tumour, the degree of histological differentiation should also be given (G_1 – highly differentiated; G_2 – moderately differentiated; G_3 – not or only slightly differentiated).

The regional lymph nodes of the prostate are located around the external iliac, internal iliac and common iliac arteries. The first metastases of the prostatic cancer are found here (Figs 51a,b–58).



a



b

Fig. 51. 69-year-old male: recurrent haematuria for the last two years. The prostate gland was the size of a small apple, of gritty consistency, and not tender. Diagnosis: prostatic neoplasm with pulmonary metastasis. *a*: On the lymphangiogram there is a block in the left iliac region (arrows). *b*: The adenogram reveals extensive destruction of the lymph nodes and stagnation in the lymphatic vessels (arrows)

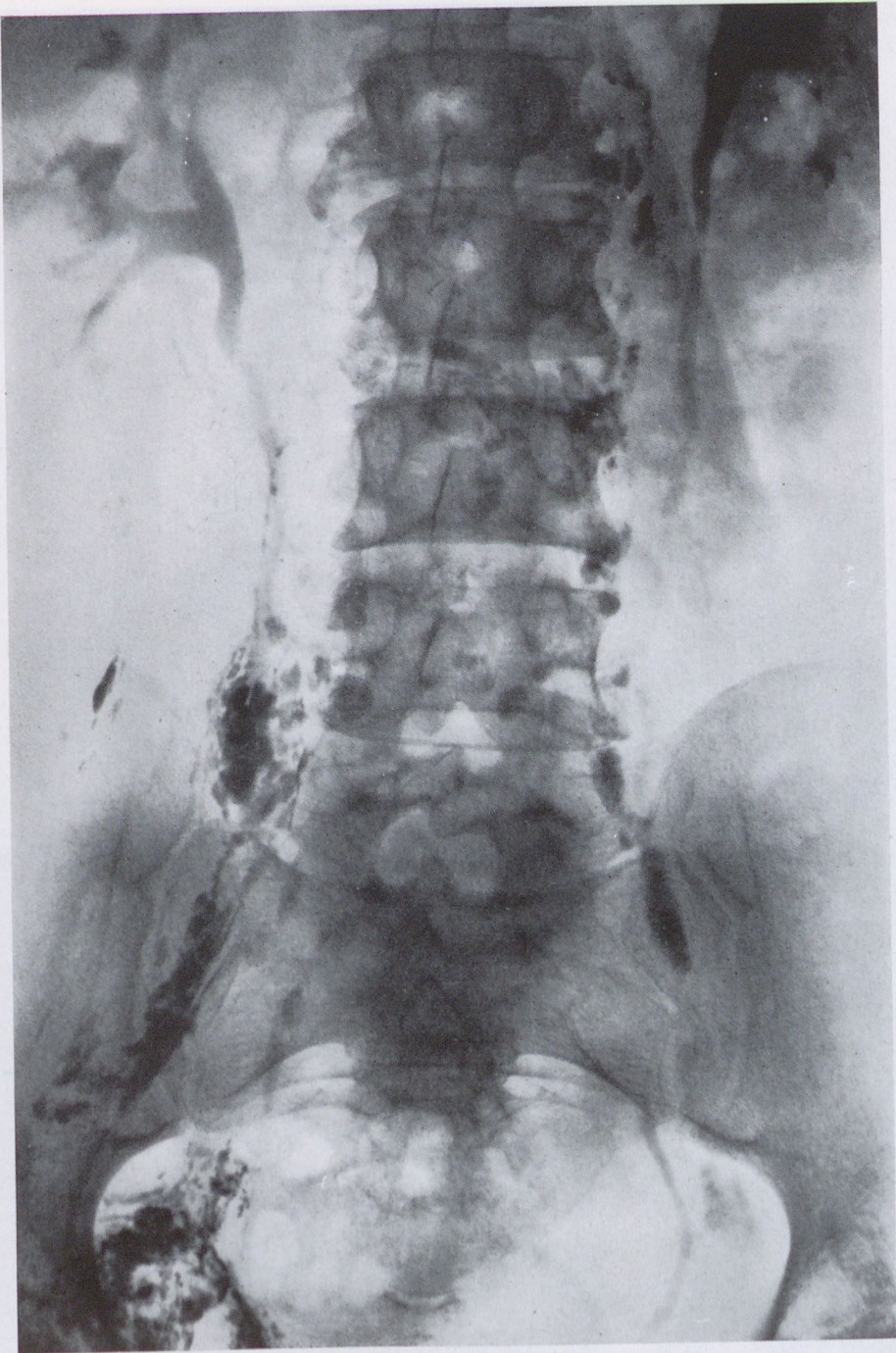


Fig. 52. 63-year-old male: dysuria for the last month. The prostate was the size of a small apple, hard and knotty. Diagnosis: prostatic carcinoma. On the right side the chain of the lymph nodes is completely obliterated. The contrast medium stagnates in the lymphatic vessels and the collaterals are filled. On the left the chain of the lymph nodes is interrupted in the iliac region. Metastatic lymph nodes are seen in the lumbar region (urography combined with lymphography)

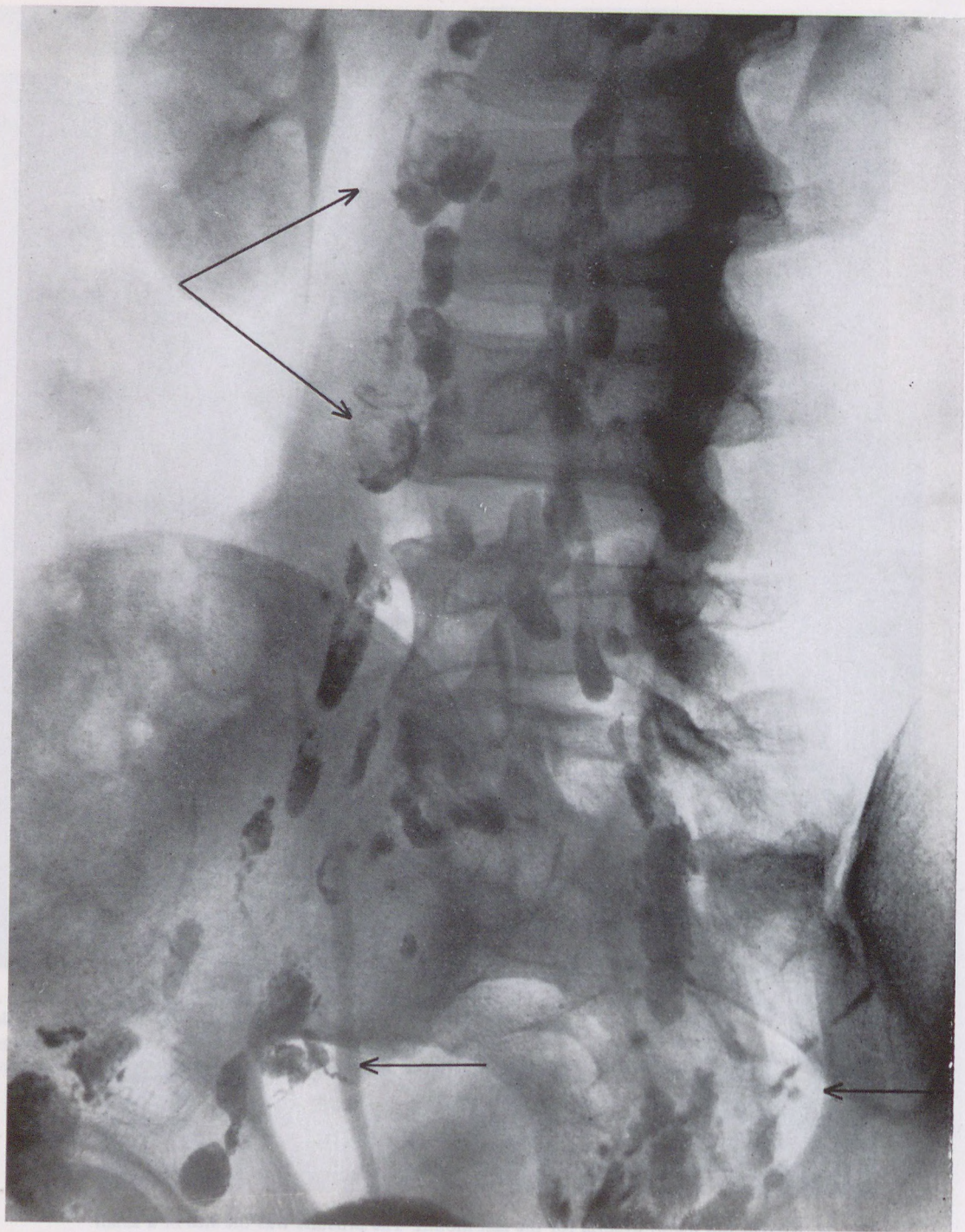


Fig. 53. 59-year-old male: complete urinary retention. The prostate was walnut-sized and gritty. Diagnosis: prostatic carcinoma. In the right iliac chain there is stagnation in the lymphatic vessels. In the lumbar chain large metastatic lymph nodes are seen. In the left iliac region the collateral lymphatic vessels are filled (all arrowed)

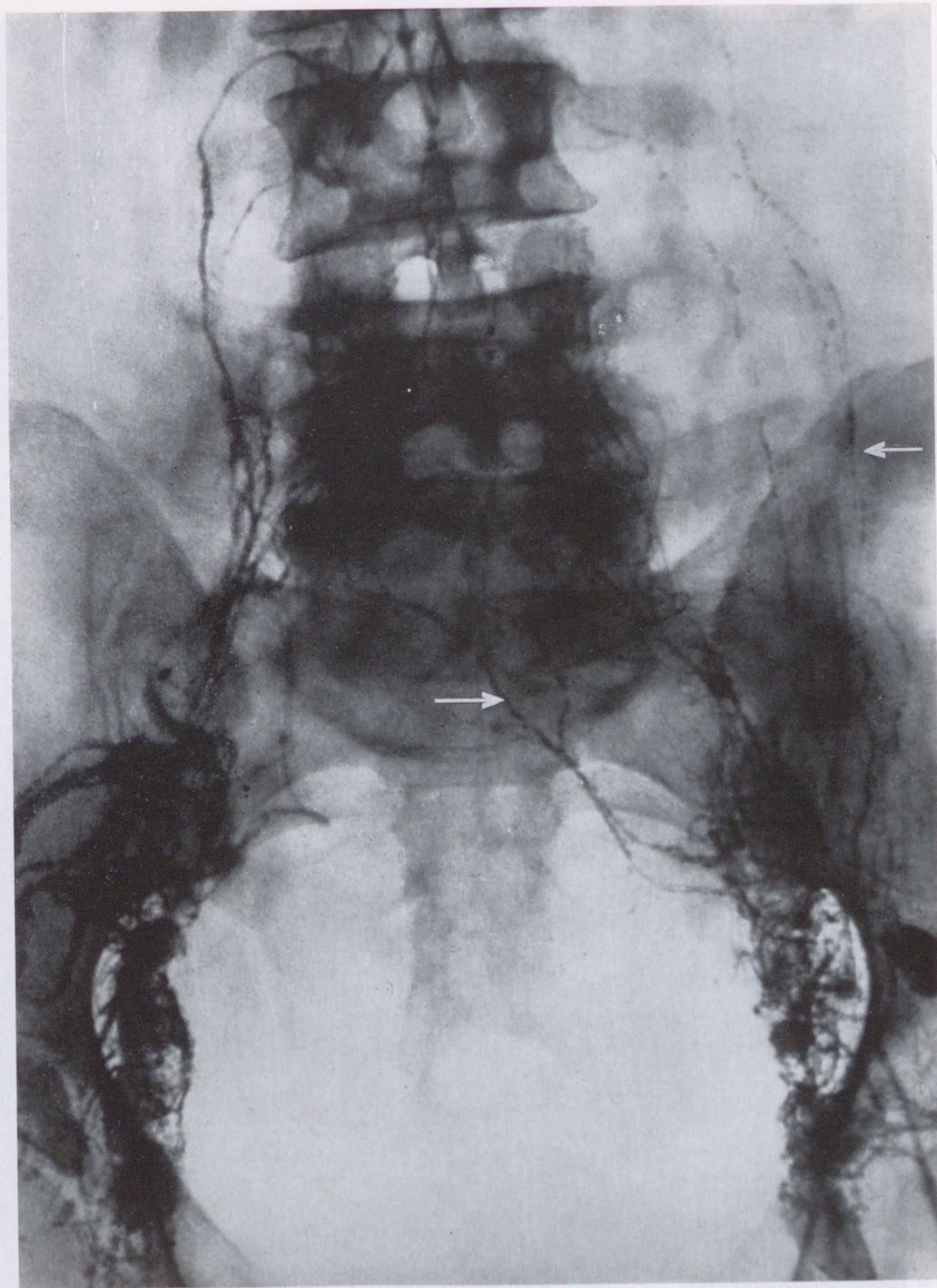
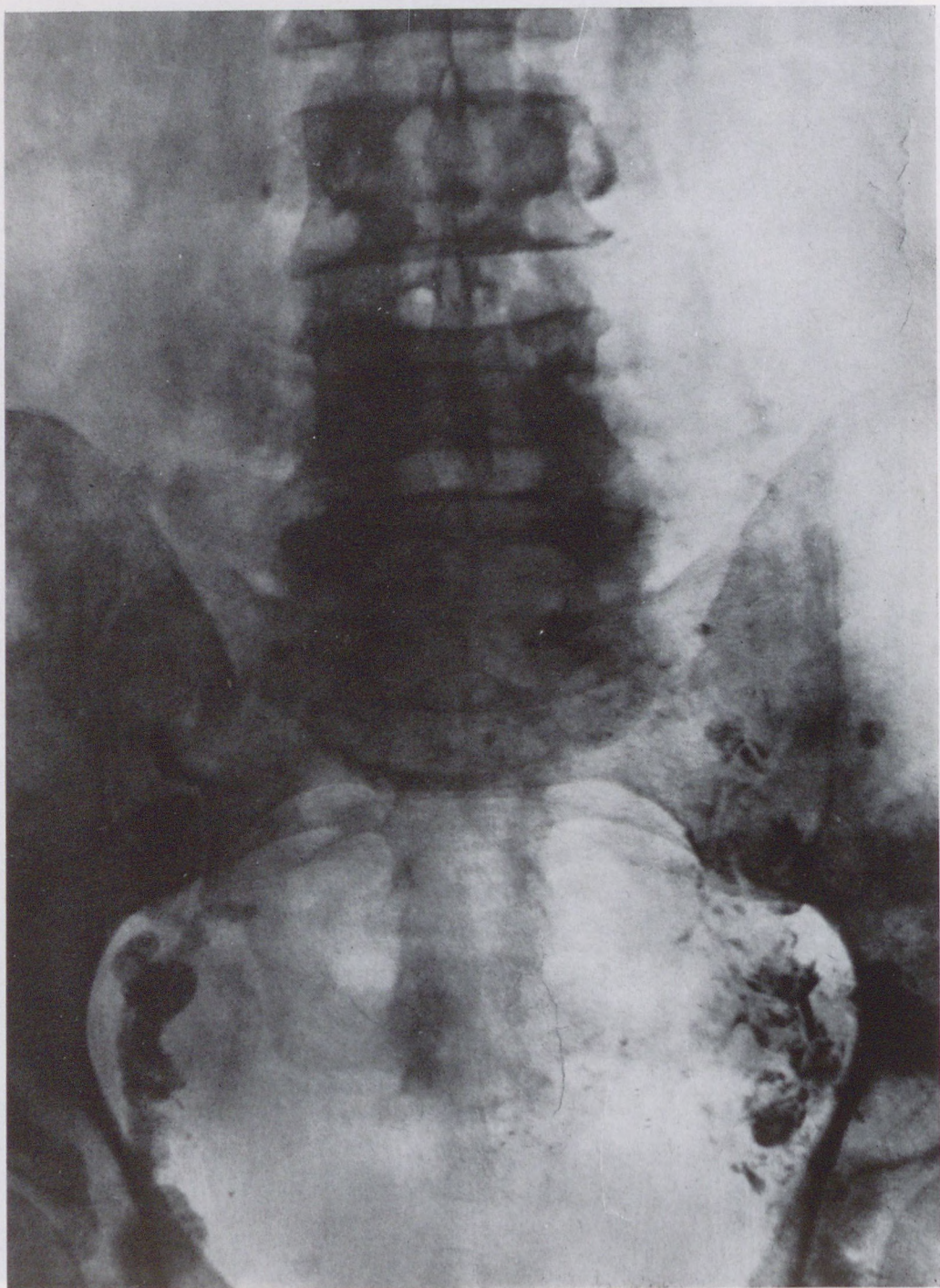


Fig. 54a. 59-year-old male with a hard knot in a walnut-sized prostate. Diagnosis: prostatic tumour. Dilated crossing lymphatic vessel (lower arrow); on the left side, collateral lymphatic vessels in the lumbar region (upper arrow)



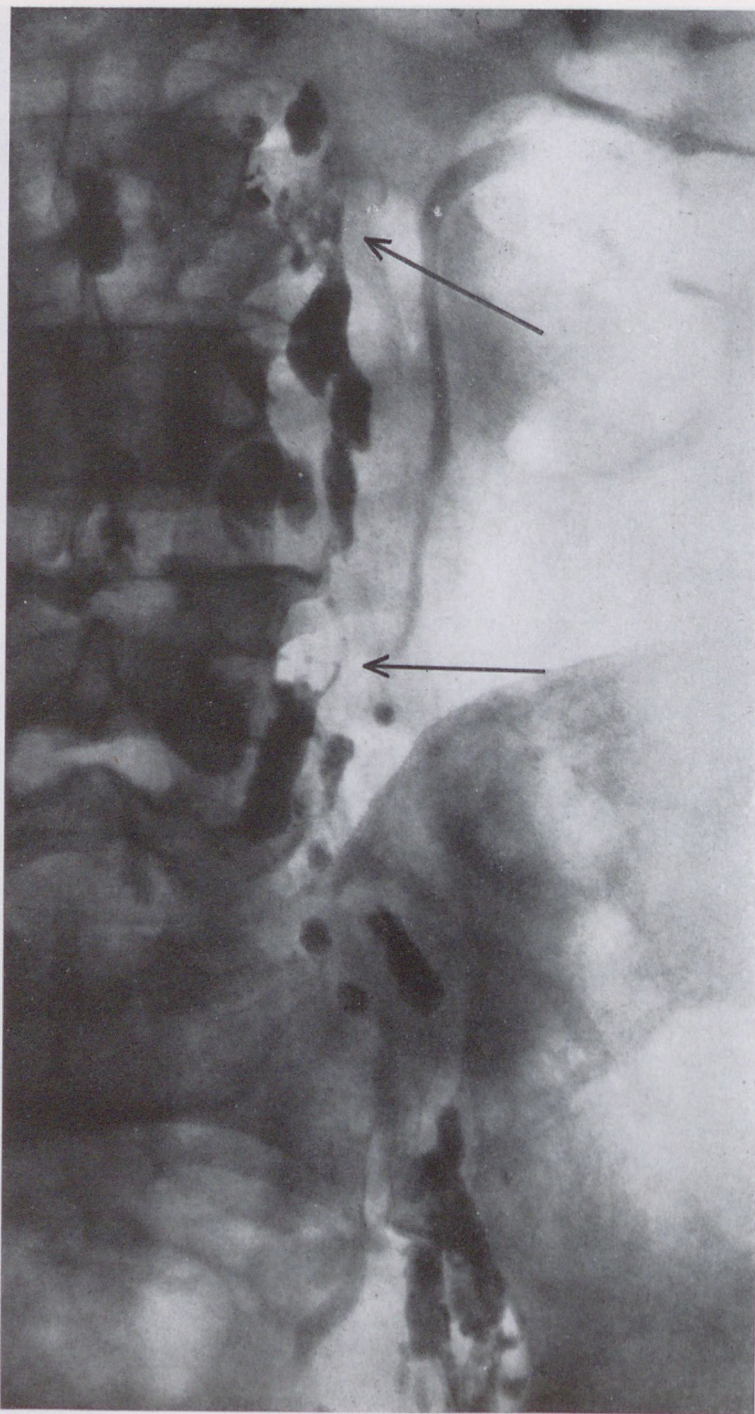
b

Fig. 54b. On the left side, complete destruction involving every lymph node



a

Fig. 55a. 69-year-old male: a year ago, after dysuria, complete urinary retention. Finding the prostate on palpation raised the possibility of tumour. Histology of biopsy: adenocarcinoma of the prostate. Ultrasound examination revealed metastases in the liver. On radiographs, there were multiple metastases in the pelvic bones. The patient did not consent to surgery. Picture shows that in the left external iliac chain the lateral lymph node (arrow) is considerably enlarged (47×28 mm) with non-homogeneous filling defects. In the afferent lymphatic vessels stagnation is seen



b

Fig. 55b. On the left side in the para-aortic chain, at the level of L4, there is a large bean-sized lymph node, the lateral part of which shows only a shell-like filling (lower arrow). At the level of L2 lymph nodes with non-homogeneous filling defects are seen (upper arrow), indicating metastasis



a

Fig. 56a. 75-year-old male: in 1981 (8 years ago) transurethral resection was performed because of prostatic adenoma causing dysuria. Histology: adenocarcinoma. Skeletal scintigraphy: negative. Therapy: orchidectomy + vasectomy, Cytonal; Dienoestrol. Lymphogram shows that from the deep inguinal lymph nodes of the left side collateral lymphatic vessels run to the deep inguinal lymph nodes of the right side (lower arrows). The lymphatic vessels in the left external iliac chain show an arch-like deviation (upper arrow). There is no filling in the lymphatic vessels cranial to this site. Collateral lymphatic vessels run to the contralateral and mesenteric lymph nodes



b

Fig. 56b. In the left iliac chain there is a 45×25 mm metastatic lymph node. In the surrounding lymphatic vessels the contrast medium is stagnating (arrow)

Fig. 57a. 59-year-old male with a prostatic tumour. In the course of one year lymphography was performed three times. In this first picture filling is incomplete on the right side, due to a technical error. On the left the lateral iliac lymph node is large, but no other changes are seen. There is urographic contrast medium in the bladder

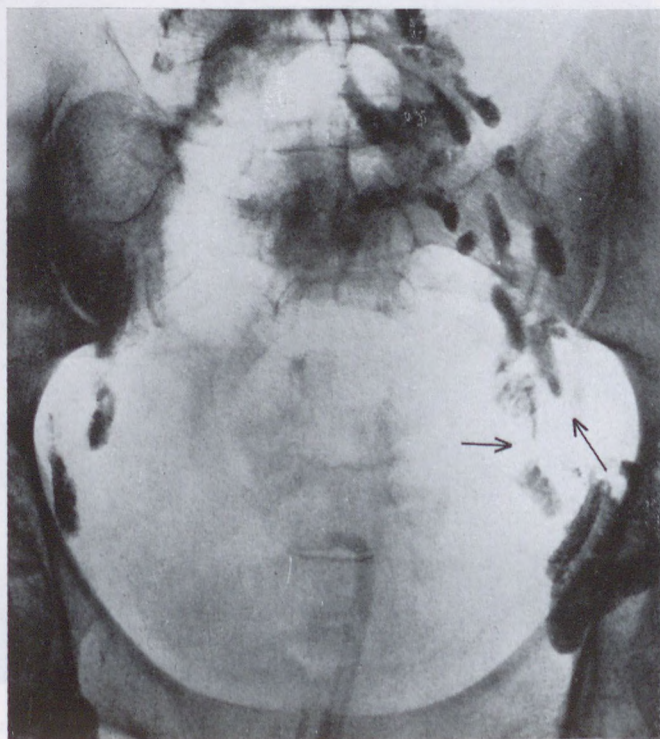
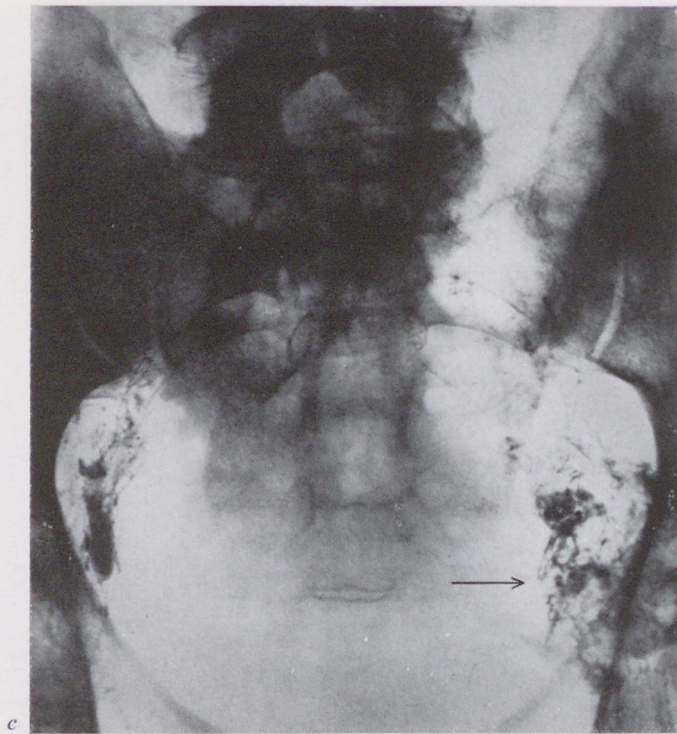
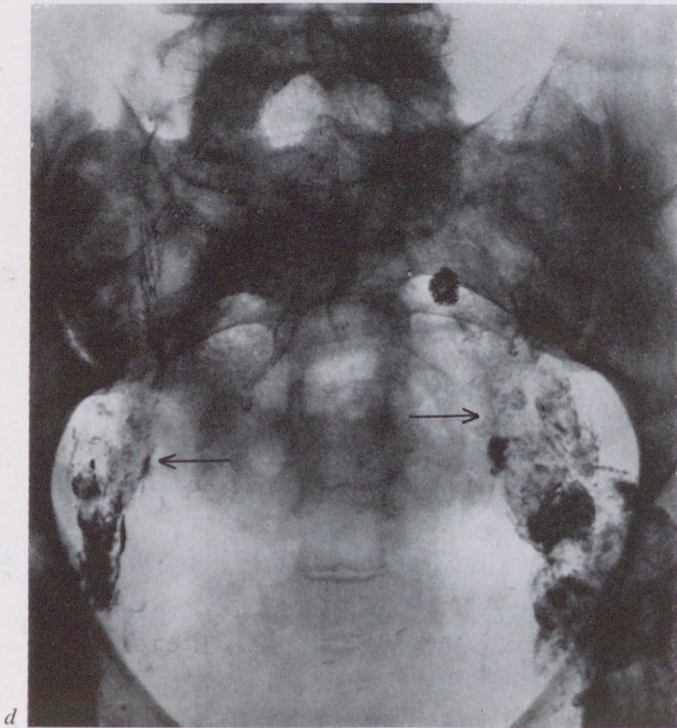


Fig. 57b. Six months later tumorous destruction is seen in two iliac lymph nodes (arrows)



c

Fig. 57c. One year after the first lymphography, convoluted, irregular lymphatic vessels are filled in the lymphangiographic phase (arrow)



d

Fig. 57d. In the adenographic phase, advanced destruction is seen on both sides (arrows); The lymph node does not resemble that in the original picture

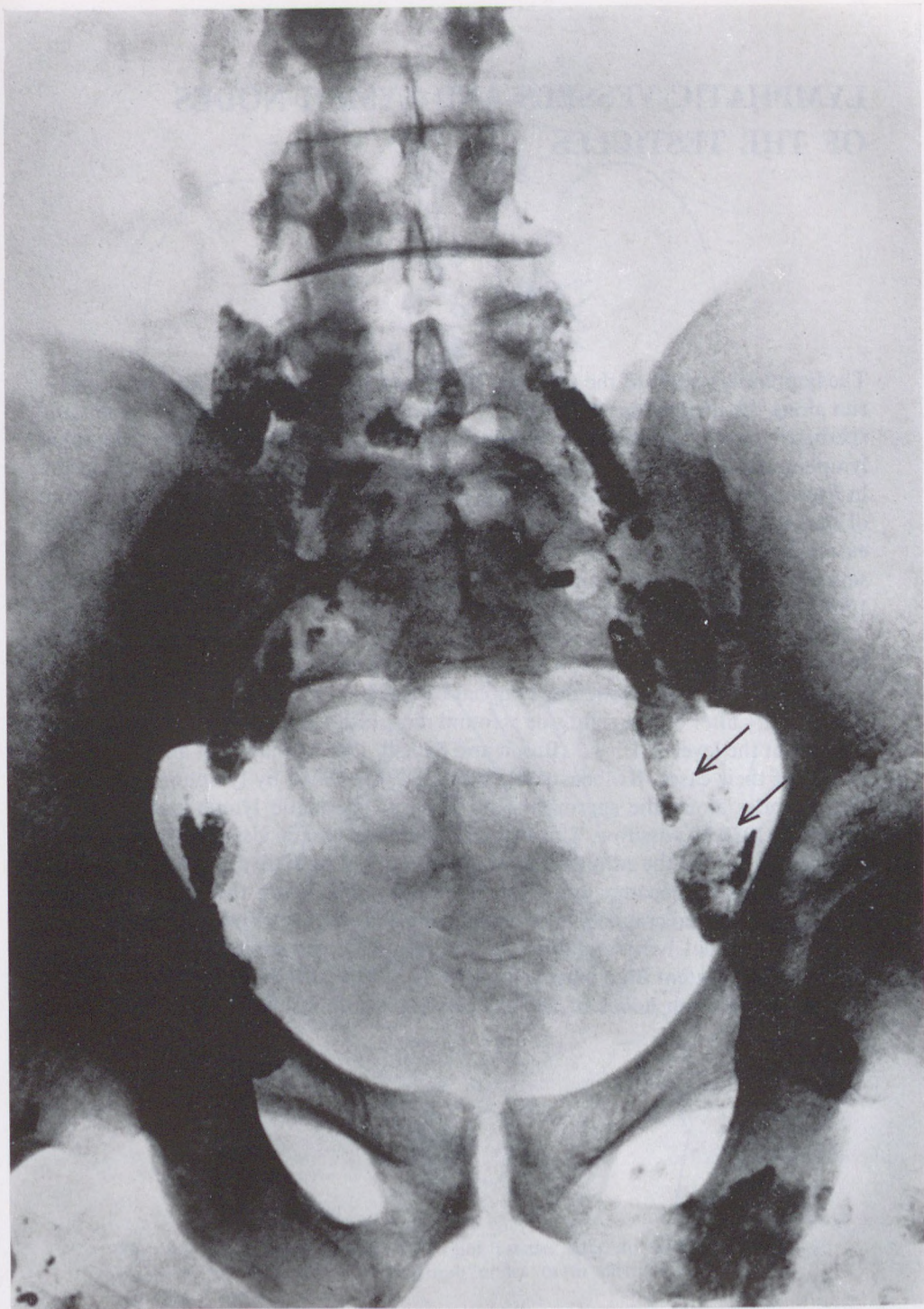


Fig. 58. 71-year-old male: complete urinary retention after dysuria for six months. The prostate was the size of a small apple and a cartilage-like knot could be palpated in it. Diagnosis: prostatic carcinoma. There is extensive destruction in the lymph nodes of the left iliac chain (arrows)

LYMPHATIC VESSELS AND LYMPH NODES OF THE TESTICLES

The lymphatic vessels of the testicles—a number varying between four and eight—run along the internal spermatic artery and vein. At the crossing of the ureter and spermatic vessels the lymphatic vessels divide; they then run medially to the lumbar lymph nodes. On the right they run to the lymph nodes located beside the aorta and in front of the aorta and vena cava; on the left to those located beside and in front of the aorta. Some lymphatic vessels, following the deferent duct, reach the medial external iliac lymph nodes. A direct connection between the testicles and the superficial inguinal lymph nodes can be revealed but rarely (Cuneo and Marcille 1901; Rouvière 1932; Kubik 1967).

There may be pathological alterations in the mediastinal and supraclavicular lymph nodes without the involvement of the abdominal lymph nodes.

The majority of the testicular lymphatic vessels go to the lumbar lymph nodes. The primary filter on the right side is found most often at the level of L2, and on the left side at the level of L1–L3 (Busch and Sayegh 1963; Chiappa et al. 1963, 1966). In one of their cases, Kolbenstvedt et al. (1979) revealed by lymphography small lymph nodes along the spermatic cord (internal spermatic lymph nodes), as described in 1930 by Jossifow. This primary filter is not made visible by bipedal lymphography, only by the administration of the contrast medium directly into the large lymphatic vessels accompanying the spermatic cord. From these primary filters the lymph is carried cranially and medially into those lymph nodes which are made visible by bipedal lymphography. In the prepared spermatic cord, each lymph vessel dyed by Patent Blue must be punctured so this method is not used routinely. The regional lymph nodes of the testicles are at the level of L1–L3. For details see Fig. 59.

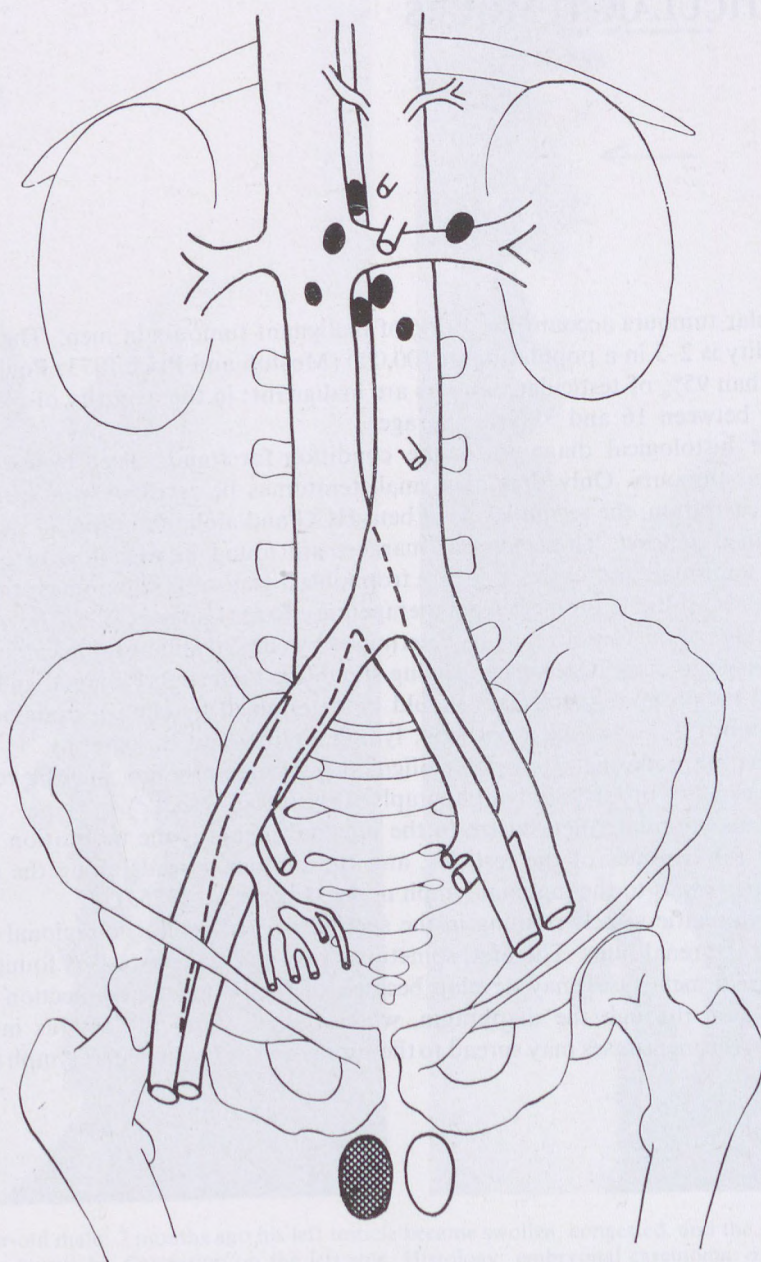


Fig. 59. Regional lymph nodes of the right testicle: lateroaortic lymph nodes; preaortic lymph nodes; aortic lymph nodes (with direct afferent pelvic lymphatic vessels)

TESTICULAR TUMOURS

Testicular tumours account for 1–2% of malignant tumours in men. The annual morbidity is 2–3 in a population of 100,000 (Mostofi and Price 1973; Pugh 1976). More than 95% of testicular tumours are malignant; in the majority of cases they appear between 16 and 35 years of age.

Exact histological diagnosis is the condition for standardized evaluation of testicular tumours. Only thus may small teratomas be revealed in a seminoma. Before castration, the serum levels of beta-HCG and alpha-fetoprotein should be determined at least. These tumour markers are found in pathological quantity only in teratomas and in the very rare trophoblast giant-cell seminomas; therefore they are also suitable for measuring therapeutic effects (Lange et al. 1977).

The stage of the tumour may be determined by clinical and histological findings; in primary tumours, histological staging should be preferred. Regional and juxta-regional lymph node metastases should be determined by clinical examinations: ultrasound, CT, excretory urography, lymphography and cavography.

The lymph node metastases of malignant testicular tumours may be revealed with a certainty of 70% by lymphography (Figs 60a,b–71a,b,c).

Testicular tumours metastasize to the inguinal region if the infiltration breaks through the capsules of the testicles, and the tumour spreads along the scrotal lymphatic vessels to the inguinal lymph nodes (Elke et al. 1976a).

The lymphatic vessels running in the spermatic cord reach the regional lymph nodes at the renal hilus. The first, sometimes very early, metastasis is found here. Mediastinal metastases may develop because of the lymphatic connection to the mediastinum through the diaphragm, while via the thoracic duct (as in other tumours) the metastases may spread to the supra- and infraclavicular lymph nodes.

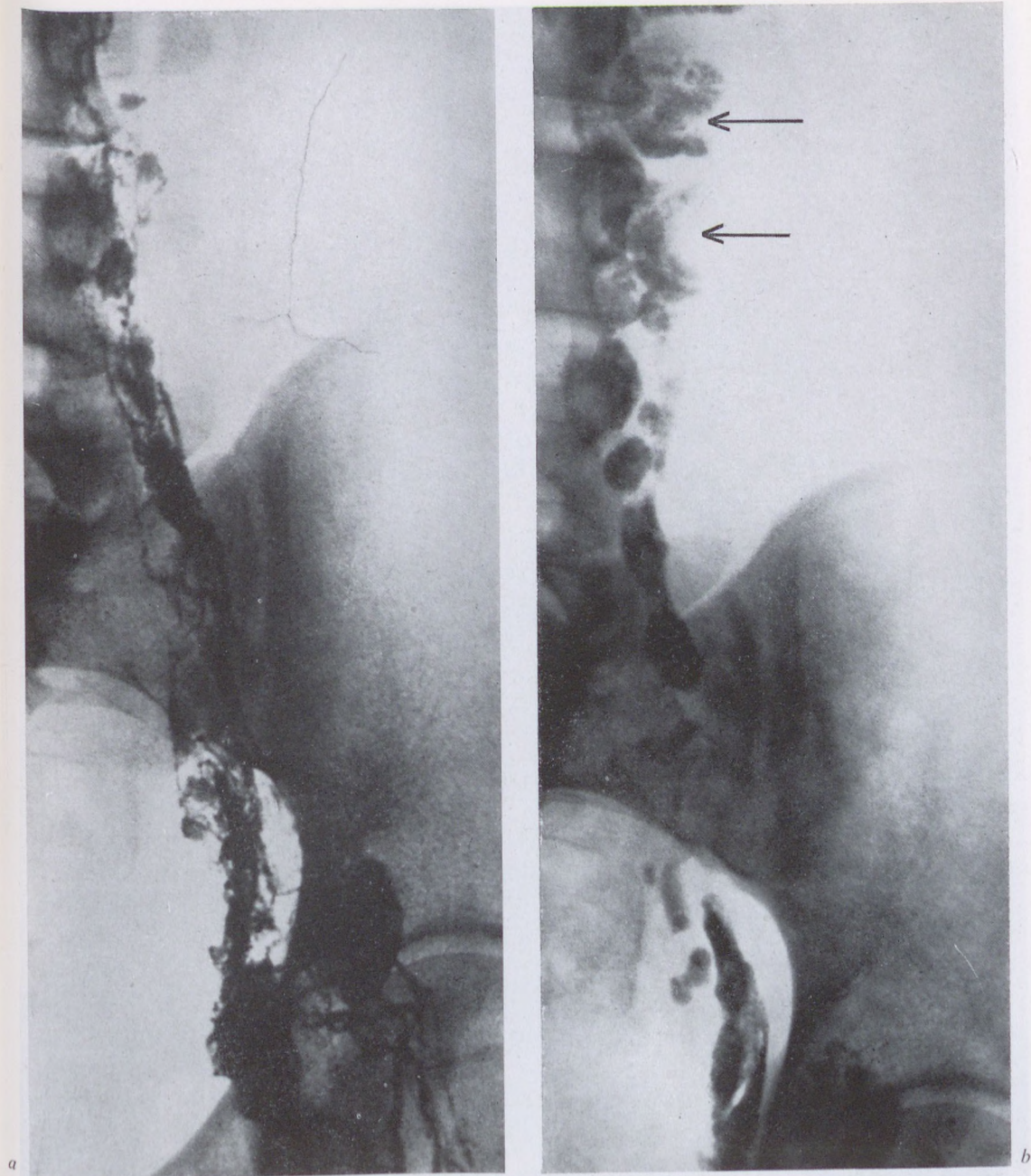


Fig. 60. 29-year-old male: 7 months ago his left testicle became swollen, congested, and the size of a goose egg; he lost 4 kg body weight. Castration on the left side. Histology: embryonal carcinoma. *a*: The lymphangiographic picture reveals stagnation in the lymphatic vessels below the lumbar region. *b*: The lymphadenographic phase shows filling defects in the lymph nodes at the level of L2-L3 (arrows)

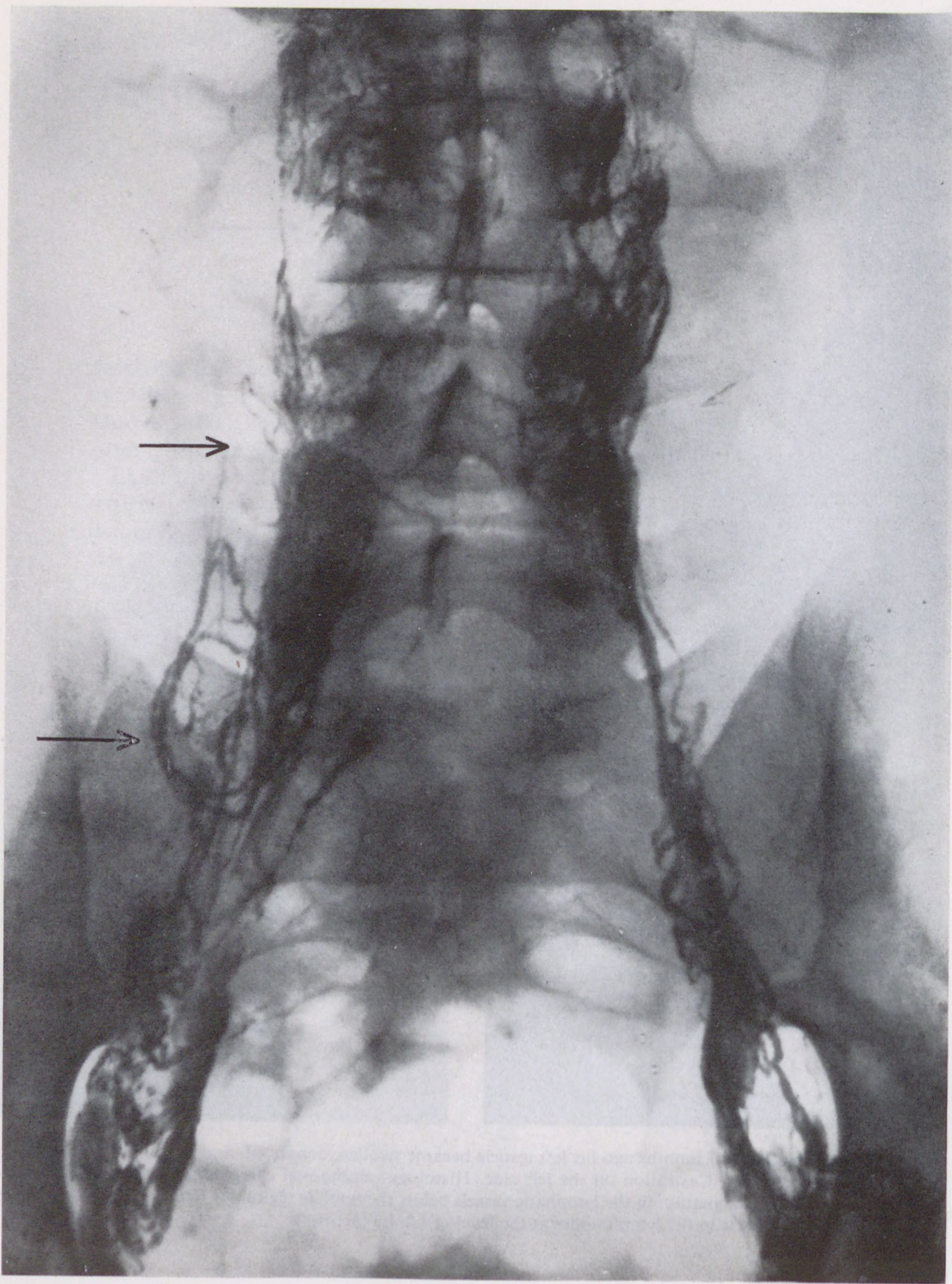


Fig. 61a. 32-year-old male; 3 months ago his left testicle became enlarged. Diagnosis: seminoma. Lymphangiogram shows collateral lymphatic vessels in the right lumbar region (lower arrow). Above them there are several discontinuities along the lymphatic vessels (upper arrow)

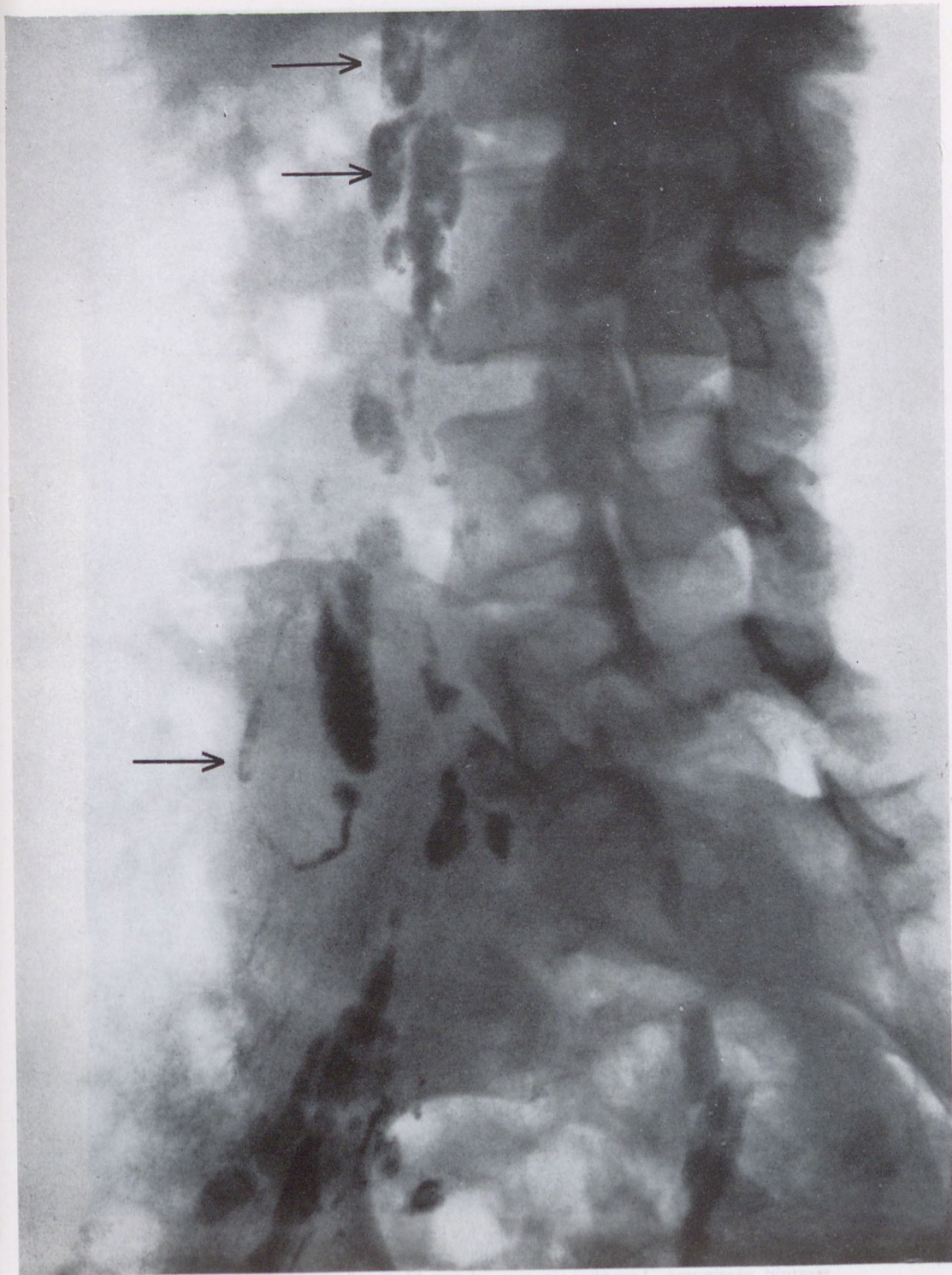
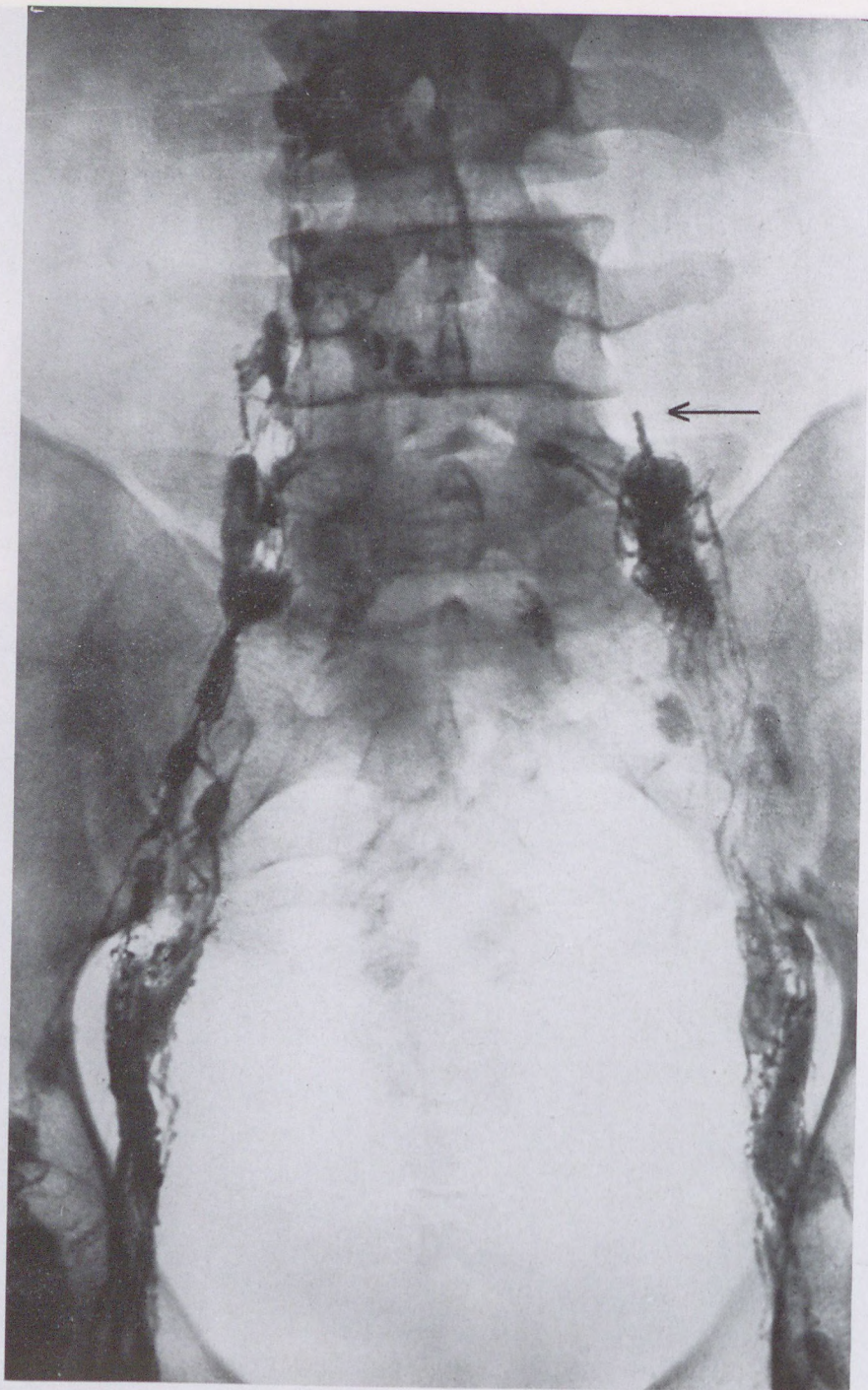
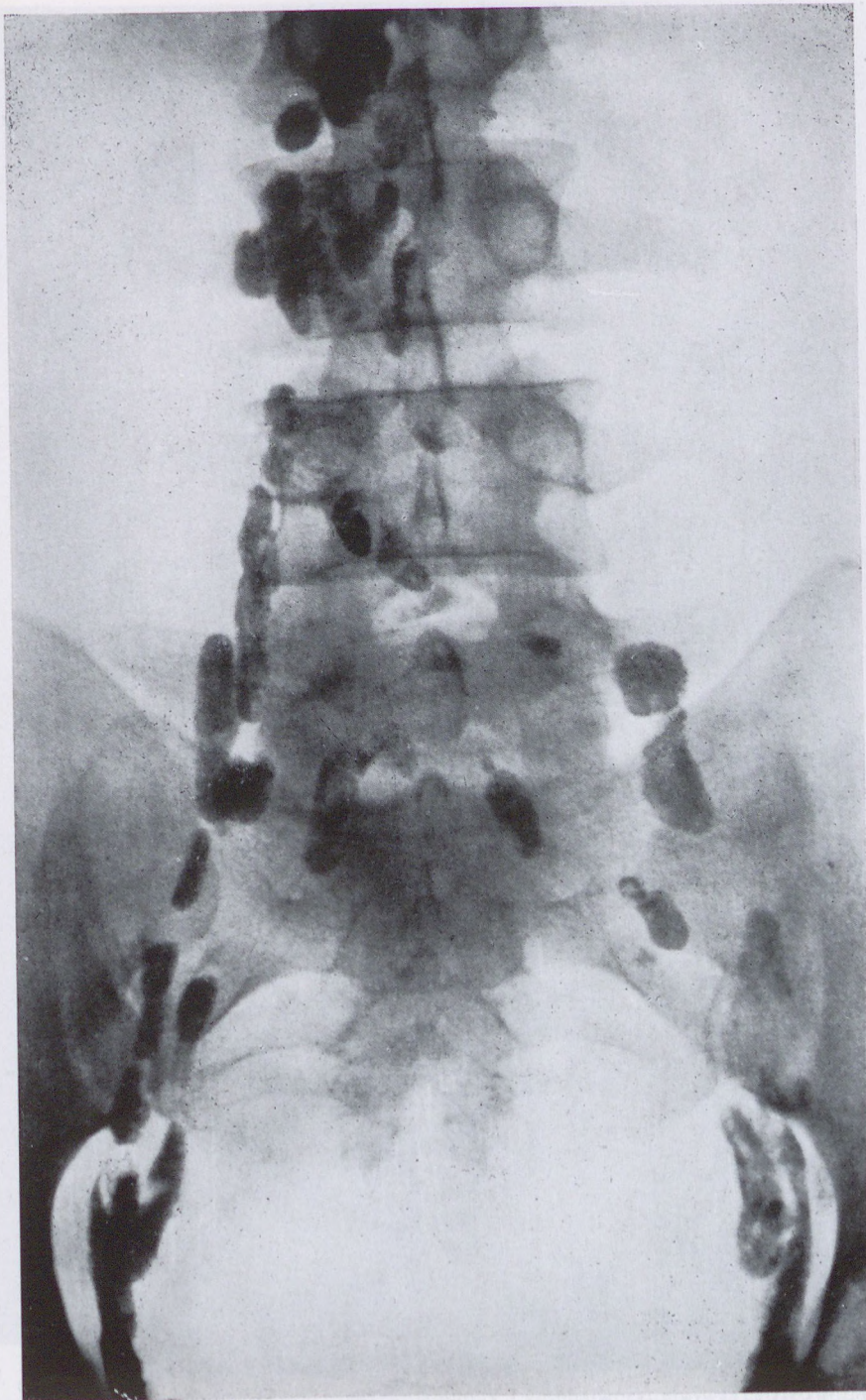


Fig. 61b. In the lymphadenographic phase the contrast medium has stagnated in the collateral lymphatic vessels (lower arrow). In the lumbar lymph nodes irregular filling defects are seen (upper arrow)



a

Fig. 62a. 22-year-old male; 2 months ago his left testicle became enlarged. There was a palpable fist-sized mass in the left lumbar region. Histology of the excised testicle: teratoid carcinoma. Lymphangiogram shows blockage at the level of L5 (arrow)



b

Fig, 62b. On the left side the para-aortic lymph nodes cannot be seen



Fig. 63. 31-year-old male: 2 years ago, painless swelling developed in the right testicle. High-level castration was performed. Histology: seminoma. The patient received telecobalt irradiation. In the right iliac region lymphatic vessels dilated to about 4 mm are seen (lower arrow), which are sharply occluded at the level of S1. The considerably dilated lymphatic vessels running laterally from the inguinal region are filled (upper arrow)



Fig. 64. 29-year-old male: castration because of a testicular tumour on the right side. Histology: embryonal carcinoma. The tumour markers were within normal limits. Lymphadenectomy was carried out. Histology of the lymph nodes: embryonal carcinoma. a: Urography does not yet reveal stagnation in the upper urinary tract. b: There is an enormous conglomeration of metastatic lymph nodes in the left para-aortic chain

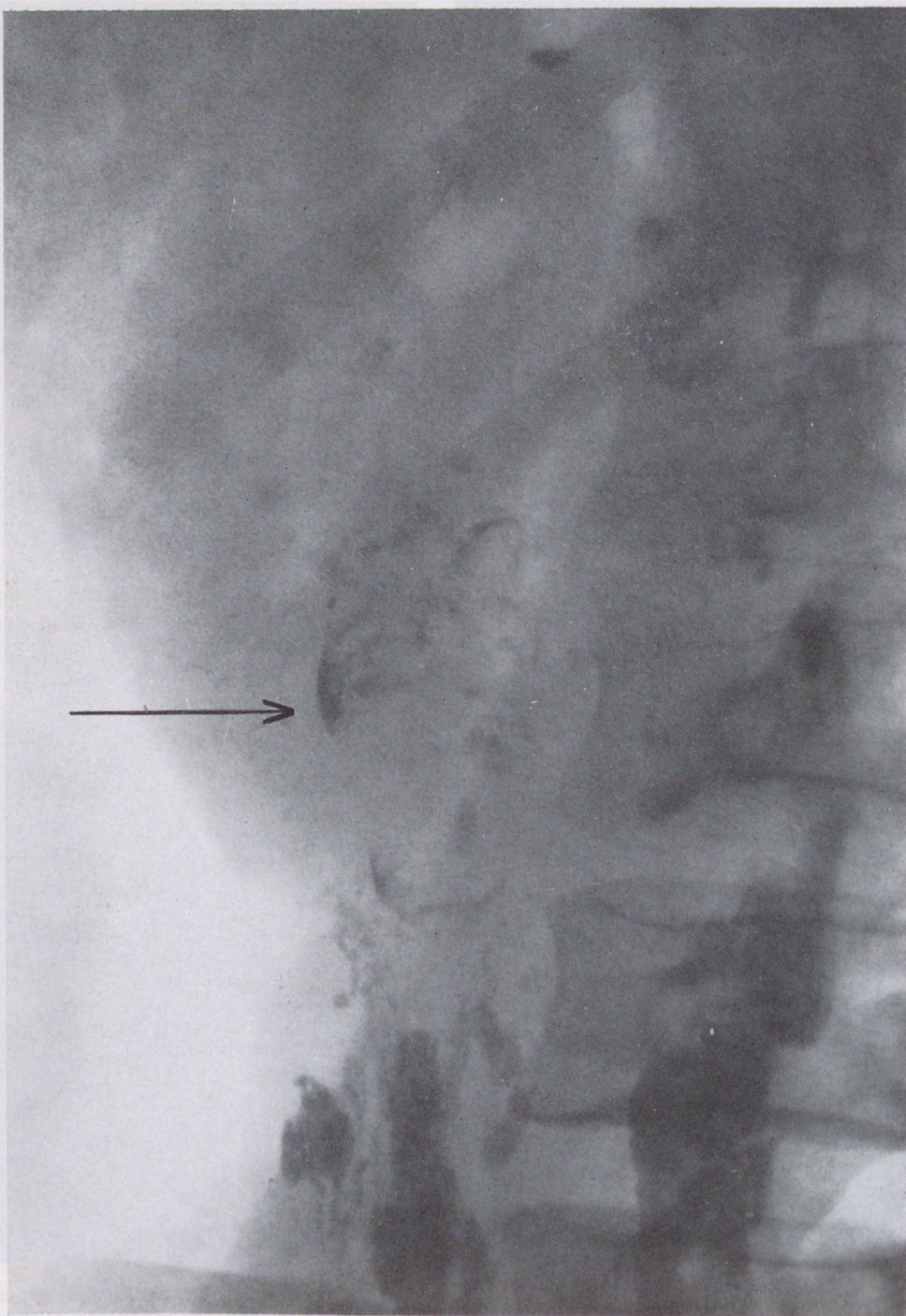


Fig. 65. 41-year-old male: castrated because of a testicular tumour on the left side. Histology: seminoma + embryonal carcinoma. Menotest: negative; alpha-FP: 12 $\mu\text{g/l}$; beta-HCG: negative. There were multiple metastases in the lungs; combined chemotherapy was given. In the right para-aortic chain there is a large conglomeration of metastatic lymph nodes which contain contrast medium only in spots (arrow). In the afferent and efferent lymphatic vessels stagnation can be seen

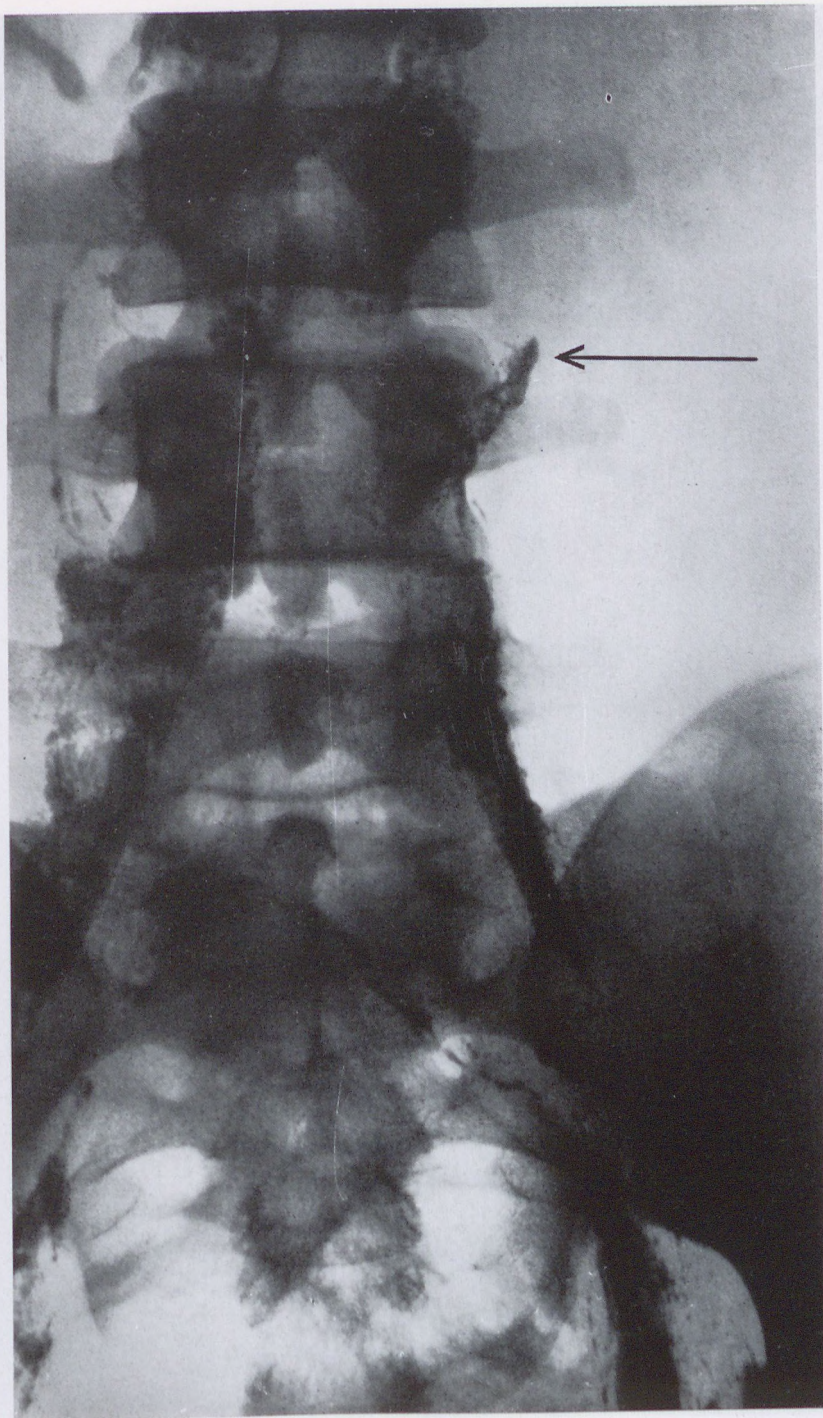


Fig. 66. 20-year-old male: high-level castration on the left side because of testicular tumour. Histology: embryonal carcinoma. Alpha-FP: $11 \mu\text{g/l}$; beta-HCG: 20 IU/l. Surgery: lymphadenectomy. Metastases were found in the para-aortic lymph nodes. On the left side the lymphatic vessels turn around at the level of the upper margin of L4 and run toward the opposite side (arrow)

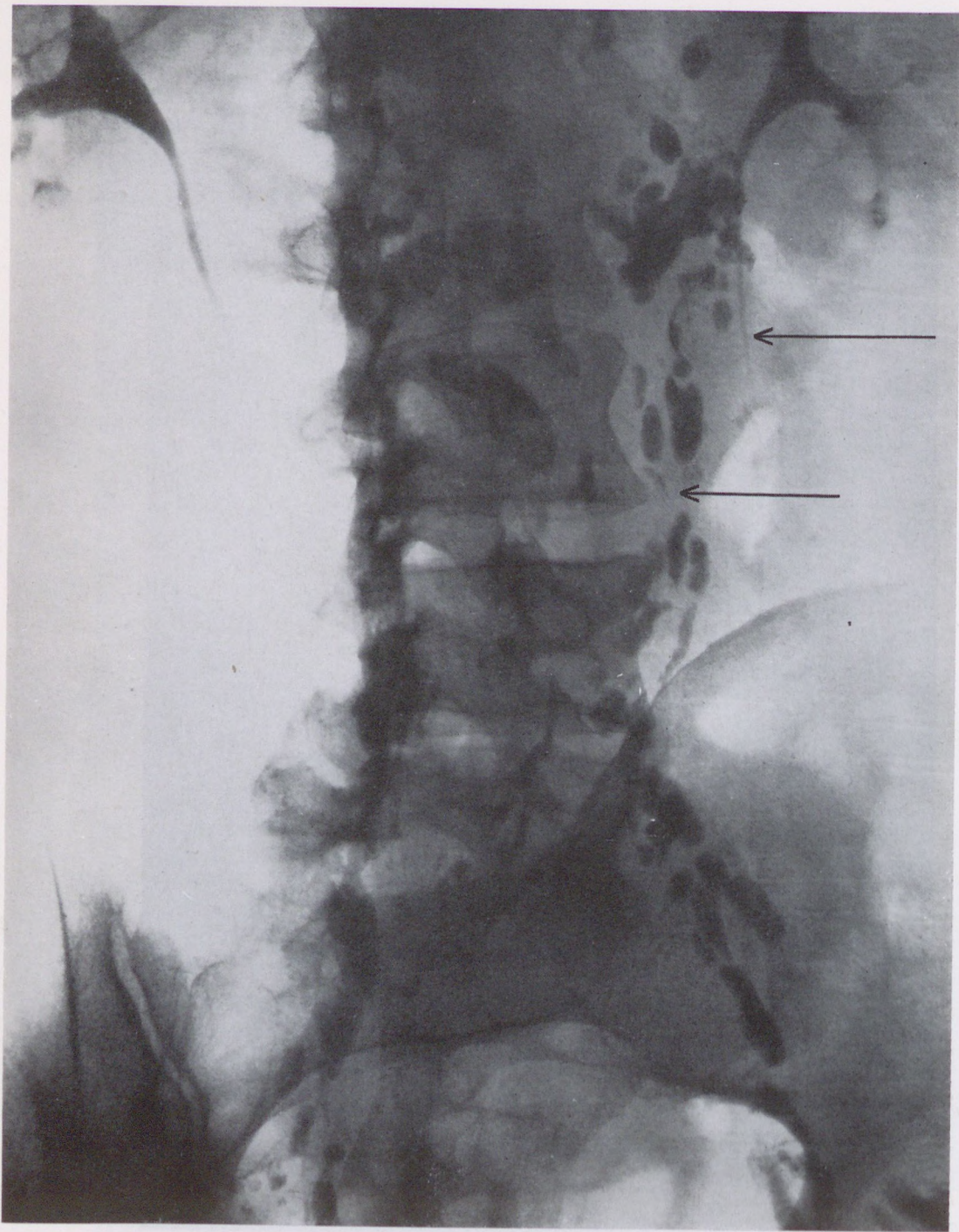


Fig. 67. 41-year-old male: castration on the left side and implantation of testicular prosthesis because of testicular tumour. Histology: seminoma. One telecobalt irradiation (dose 31 Gy) was administered. In the left para-aortic chain at the level of L2 there is a lacunar filling defect (lower arrow) in a large lymph node. At the level of the intervertebral space between L2 and L3 there is a bean-sized lymph node which reveals only a strip-like filling at its periphery (upper arrow), indicating a metastasis (urography combined with lymphography)

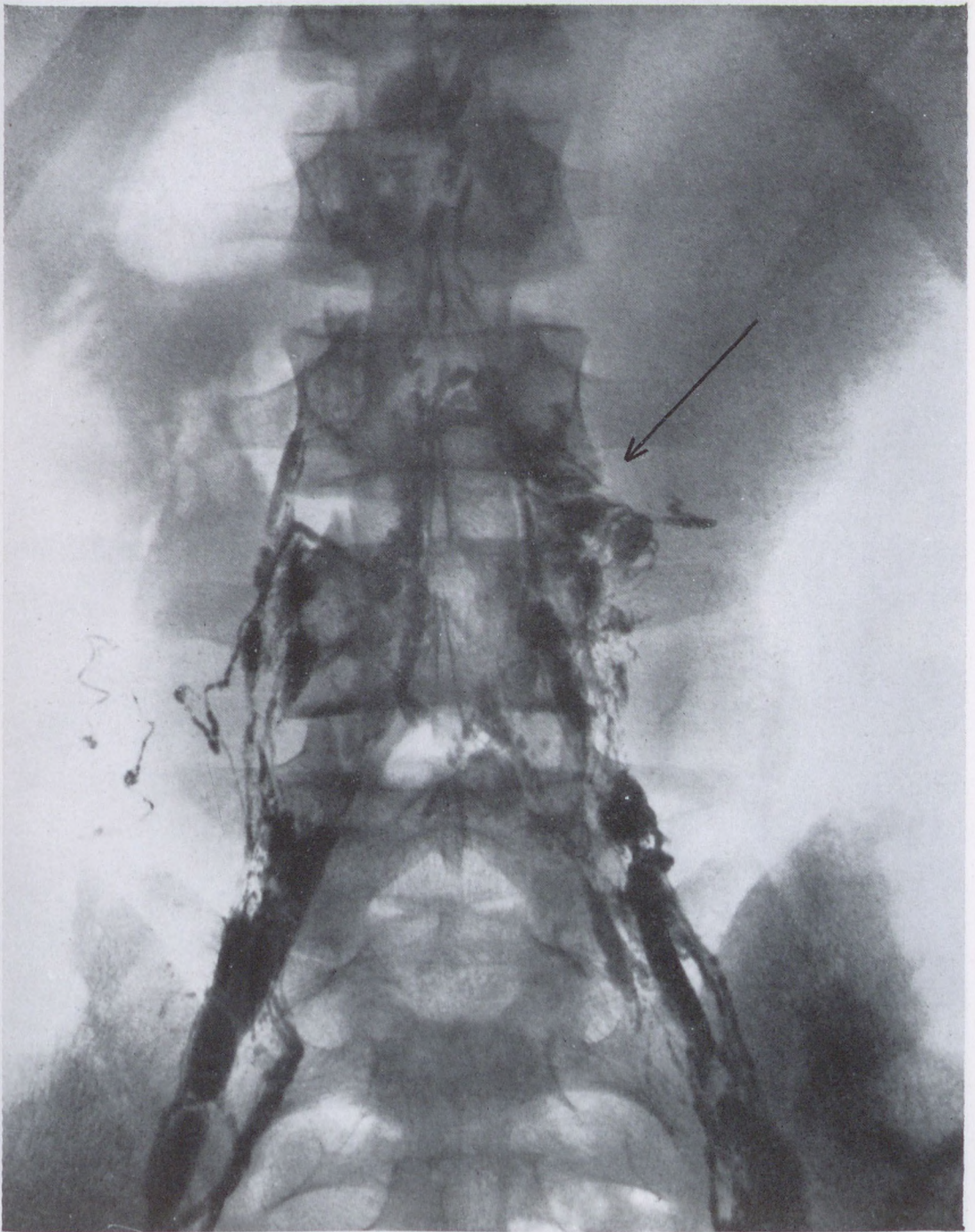
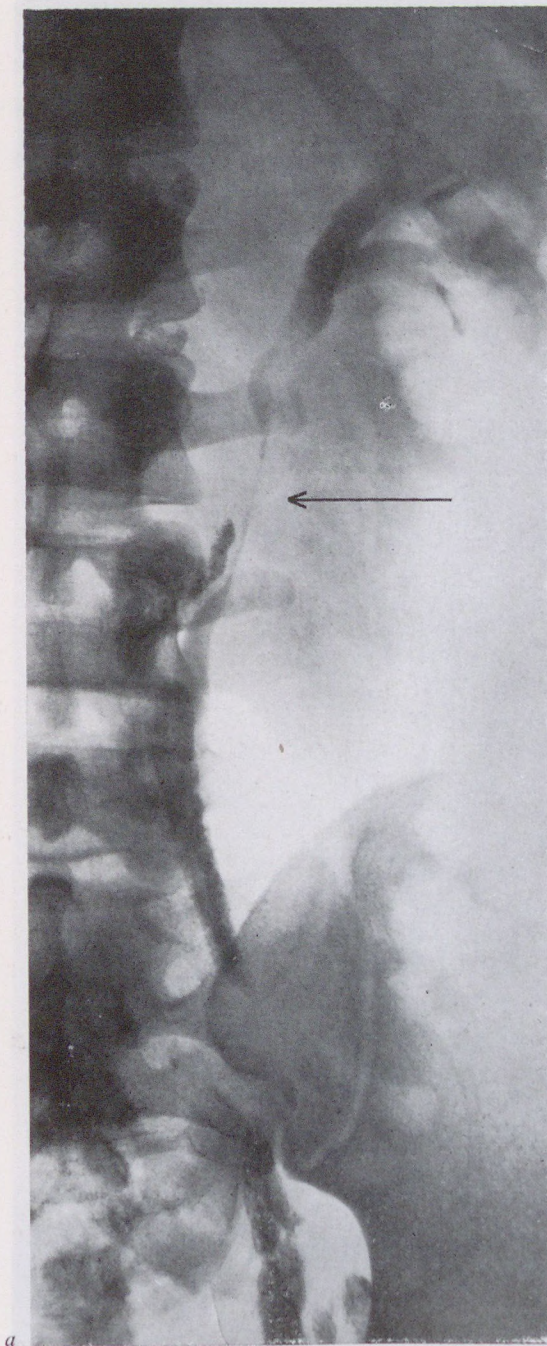
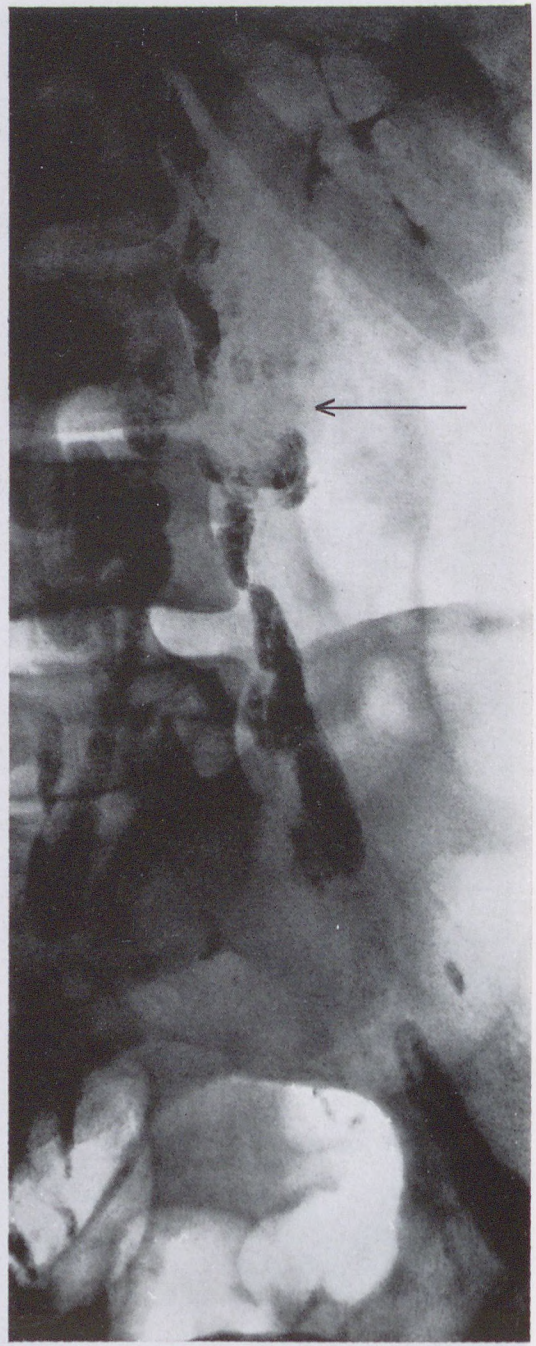


Fig. 68. 28-year-old male: a year ago, castration on the left side because of testicular tumour. Histology of the excised testicle: myxofibrosarcoma. The patient was admitted to our department because of a retroperitoneal tumour and 'silent' kidney on the left side. In the left para-aortic chain, at the level of L3, the lymphatic vessels (arrow) run partly to the opposite side and partly, forming an arch, to the lower pole of the kidney. The left kidney was removed and the retroperitoneal tumour was extirpated. Histology: the tumour was considered the metastasis of the testicular lesion



a



b

Fig. 69. 20-year-old male: testicular tumour. *a*: On the urogram the left ureter shows a slight, laterally arched dislocation at the level of L3 (arrow). *b*: At this level metastatic lymph nodes are visible; these have a loose structure and moth-eaten filling defects (arrow) (the picture was taken while the patient was slightly turned to the left)

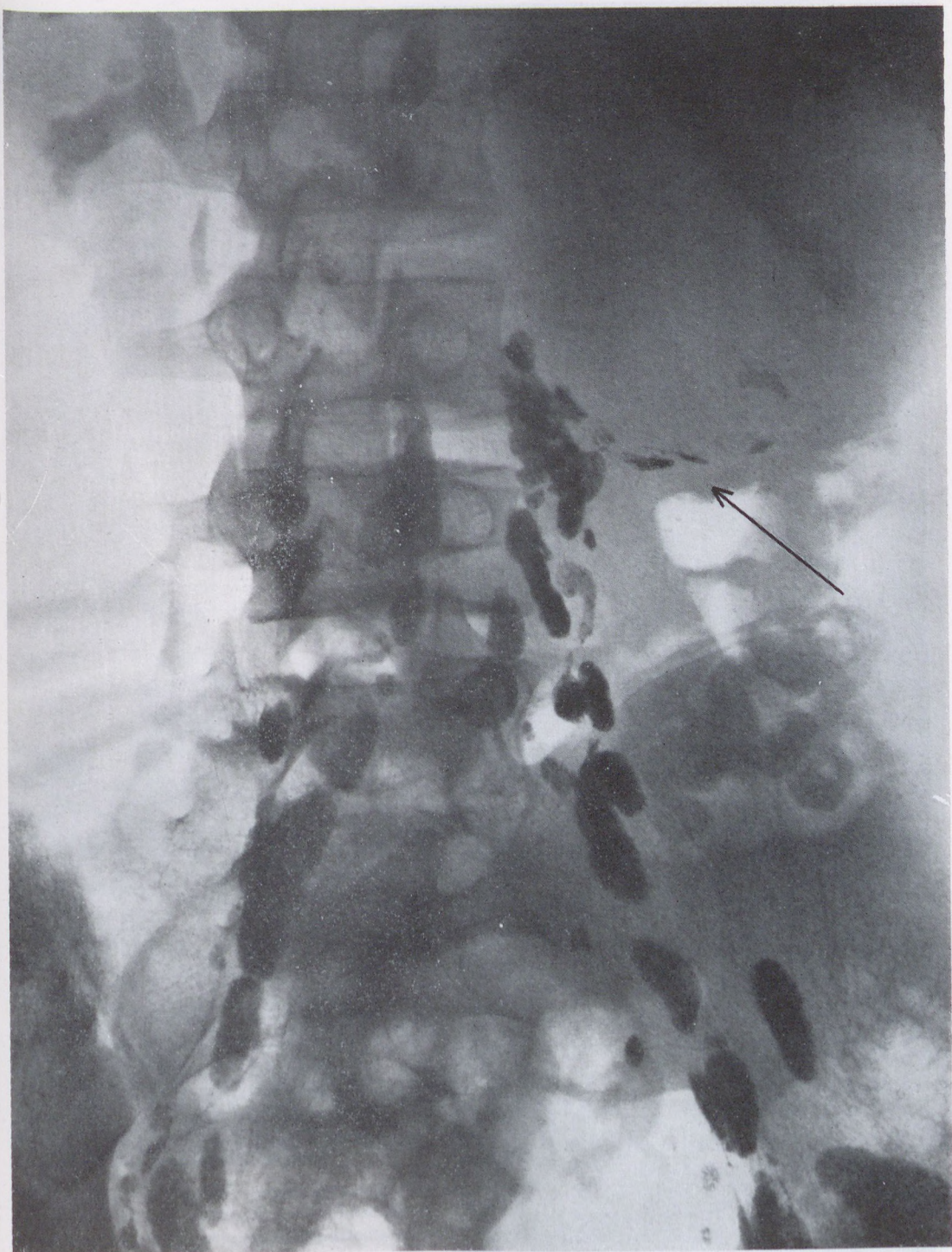
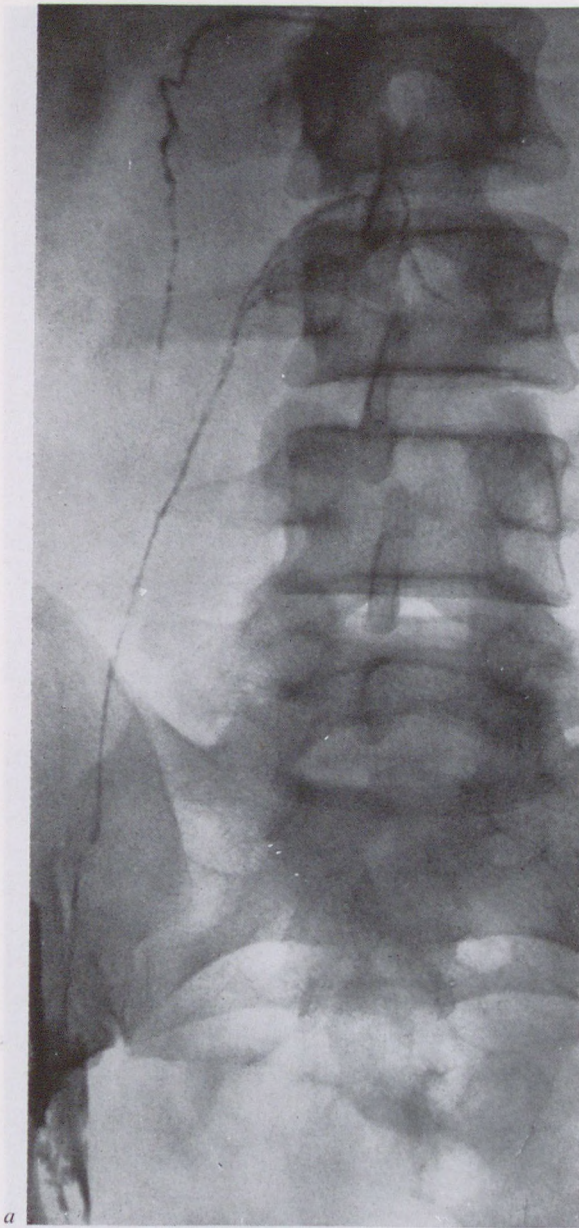
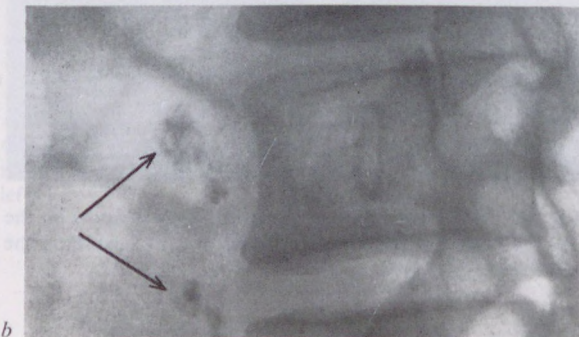


Fig. 70. 28-year-old male: testicular tumour. On the left side the contrast medium is stored only in spots by the lymph nodes at the level of L3 (arrow). The left ureter is involved and the left kidney has not excreted the urographic contrast medium (urography combined with lymphography)

Fig. 71a. 40-year-old male: testicular tumour. Testicular lymphography: the lymphatic vessels filled from the direction of the spermatic cord run to the lymph nodes at the level of the renal hilus, avoiding the iliac and lumbar lymphatic region



a



b

Fig. 71b. Lymphadenogram: there are filling defects in the so-called sentinel lymph nodes (arrows)

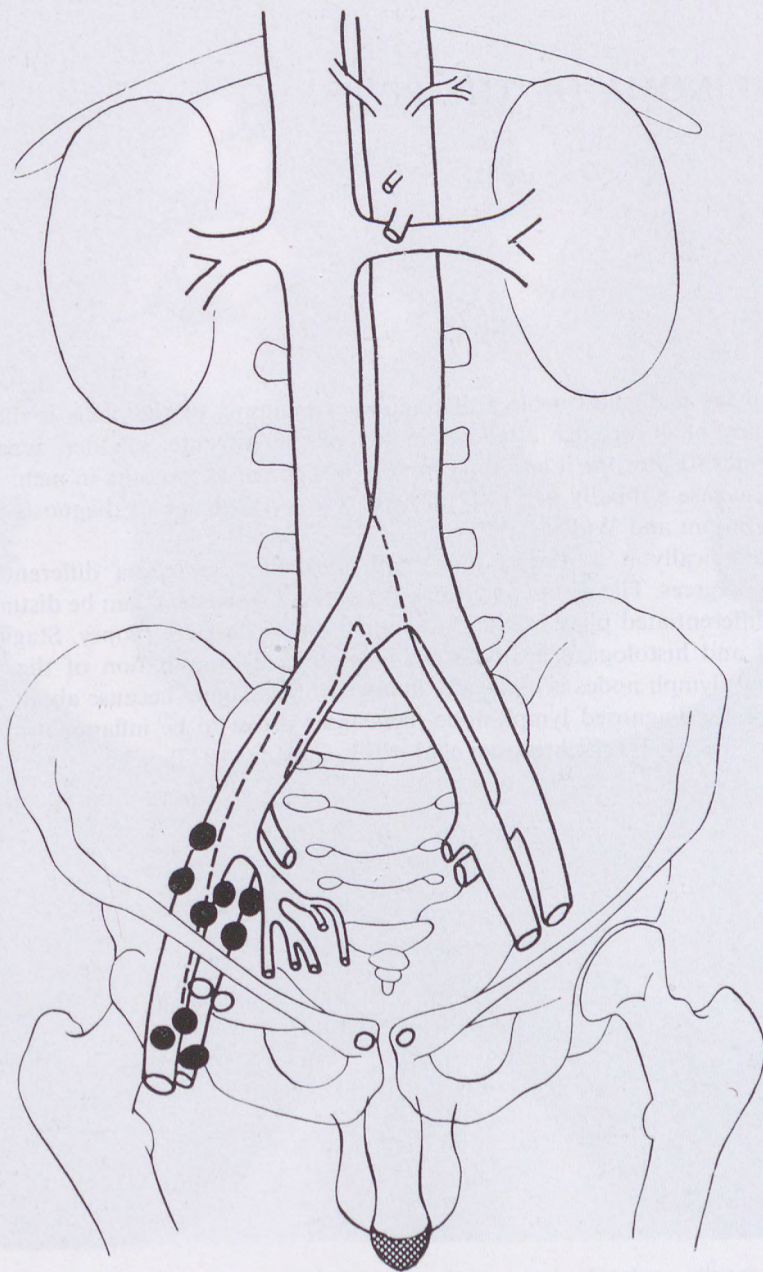


Fig. 71c. Bipedal lymphography reveals stagnation in the lymphatic vessels running to the sentinel lymph nodes on the right side (lower arrow) and in those of the right iliac chain. In the lymph nodes of the right lumbar chain at the level of L2-L3 there are filling defects indicating metastasis (upper arrow)

THE LYMPHATIC SYSTEM AND REGIONAL LYMPH NODES OF THE PENIS

The lymphatic vessels of the skin of the penis connect with the lymphatic vessels of the scrotum and perineum. They run on both sides to the superomedial superficial inguinal lymph nodes. The lymphatic vessels of the penis form a plexus in front of the symphysis which often contain one or two small lymph nodes (Rouvière 1932). In contrast, Cuneo and Marcille (1901) reported their opening into the deep and lacunar lymph nodes. A connection to the internal iliac lymph nodes is considered a rare variant. The lymphatic vessels of the cavernous bodies form an anastomosis with the plexus in front of the symphysis, then run subcutaneously to the right and to the left and reach the superomedial inguinal, in some cases even the deep inguinal and lacunar lymph nodes. The numerous anastomoses between the lymphatic vessels provide a bilateral connection both in the superficial and in the deep system.

Thus the lymphatic vessels of the penis run mainly to the superomedial superficial and deep inguinal lymph nodes, which reveal only uncertain filling during lymphography, but also to the internal iliac (superior gluteal) lymph nodes, which show constant filling. For details *see* Fig. 72.



- certain filling
- no filling

Fig. 72. Regional lymph nodes of the penis: deep inguinal lymph nodes; medial superficial superior inguinal lymph nodes; superficial lateral external iliac lymph nodes; deep lateral external iliac lymph nodes; medial external iliac lymph nodes; pubic lymph nodes

CARCINOMA OF THE PENIS

Among the malignant urological tumours, carcinoma of the penis is the last in frequency of occurrence after carcinoma of the prostate, bladder, renal pelvis and ureter. In Europe it accounts for 5% of malignant tumours in men. There is one new case annually per 100,000 men. The average age at diagnosis is 55–60 years (Bloom and Wallace 1971).

Histologically it is almost always planocellular carcinoma differentiated in varying degrees. The giant condyloma (Buschke–Löwenstein) can be distinguished from differentiated planocellular carcinoma only in a large biopsy. Staging is by clinical and histological examination. Histological examination of the regional (inguinal) lymph nodes is especially important for staging because about 50–60% of clinically diagnosed lymph-node metastases prove to be inflammatory hyperplasias (Figs 73–75) (Lichtenauer et al. 1973; Cabanas 1977).

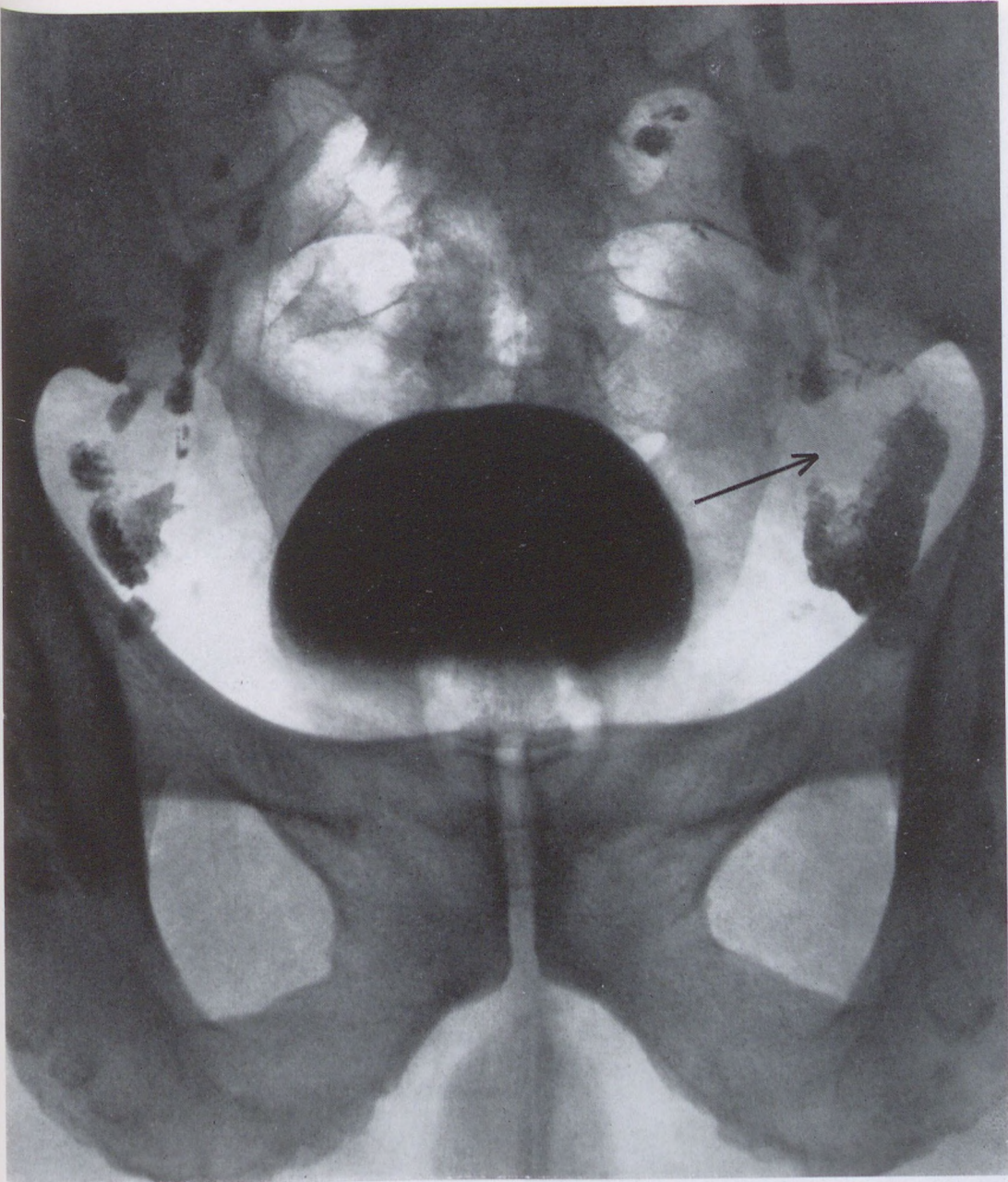
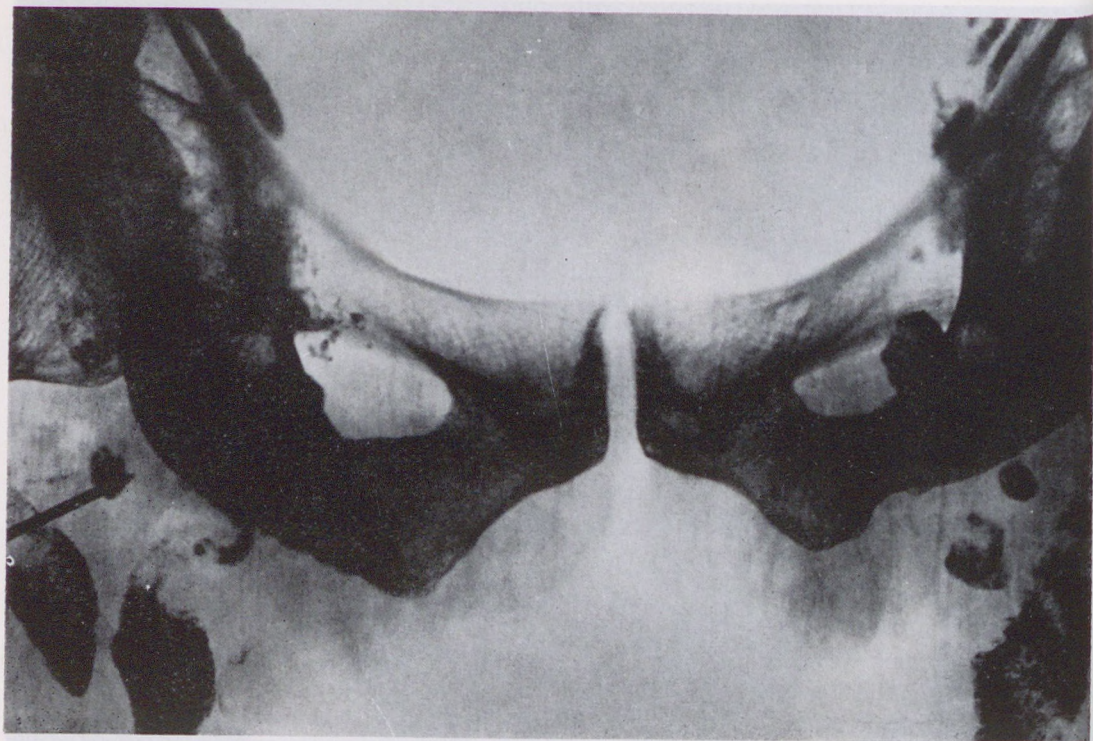
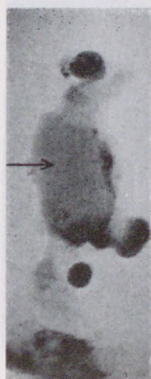


Fig. 73. 38-year-old male: 4 years ago a penile tumour was removed. Histology: planocellular carcinoma. Postoperative irradiation was administered; 2 years later, repeat excision because of recurrence. After another year amputation of the penis and bilateral extirpation of the inguinal lymph nodes were performed. In the left external iliac chain, in a lymph node measuring 35×22 mm, there is a medial metastasis revealed as a large filling defect (arrow)

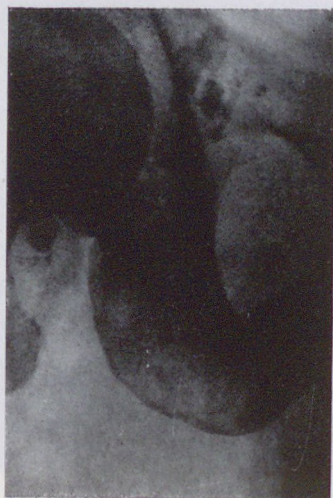
Fig. 75 65-year-old male: tumour of the rectum. In the radiographic phase the irregular coil of lymphatic vessels projected onto the lateral border of the rectum.



a



b



c



d



e

Fig. 74. 71-year-old male: tumour of the penis. *a*: In the inguinal region on both sides enlarged lymph nodes were palpable; their sites were marked with markers placed on the skin. *b, e*: radiographs of surgical preparations — mainly from the right side — show the destruction well. *c*: The palpable mass on the right side does not contain contrast medium (it is infiltrated by the tumour), but the appearance of lymph nodes surrounding it is suggestive of destruction. *d*: The marked lymph nodes on the left side seem to be intact; surgery supported this view



Fig. 75. 69-year-old male: tumour of the penis. In the angiographic phase the irregular coil of lymphatic vessels projected onto the ischiac bone is conspicuous (arrow)

MALIGNANT TUMOURS OF THE FEMALE GENITAL ORGANS

VULVA

Some 2–5% of female genital carcinomas are tumours of the vulva. They may appear on the labia majora, in their cutaneous part, in the interlabial fold, labia minora, clitoris, around the orifice of the urethra, on the mons pubis, and perianally. They have four characteristic forms: papillary, ulcerative, nodular, and subcutaneously spreading infiltrating carcinoma. The growth of the tumour may be circumscribed or diffuse. Histologically, planocellular carcinomas are the most frequent, but basal-cell, transitional and anaplastic carcinomas are also encountered. They are very malignant, metastasizing at an early stage. They may spread intracutaneously or in the subcutis to the whole vulva, the vestibulum, perineum and the pelvic bones. In the deeper layers they may give metastases to the inguinal regions where ulceration often occurs. Haematogenous metastases are found in the liver, lungs and brain. Lymphogenous metastases appear first in the deep inguinal lymph nodes, less often in the superficial ones. They may spread also to the hypogastric and iliac lymph nodes. Rarely, metastases are also found in the contralateral lymph nodes. For details *see* Fig. 76.

VAGINA

Vaginal tumours account for 1–2% of all female genital tumours; 35% originate from the upper, 4% from the middle, 44% from the lower third of the vagina, while 17% have a multicentric origin. They are most frequently keratinizing or less mature, non-keratinizing planocellular carcinomas, and less frequently adenocarcinomas. They infiltrate early, spreading from the anterior wall to the bladder, and from the posterior wall to the rectum; with this spread fistulas often develop. Tumours originating from the lower third give metastases mainly to the inguinal lymph nodes, while those originating from the middle and upper thirds, spread via the iliac and hypogastric lymph nodes to the retroperitoneal ones. Rarely sarcomas may also develop in the vagina: they are round-cell, spindle-cell, polymorph or giant-cell sarcomas, and they ulcerate at an early stage.

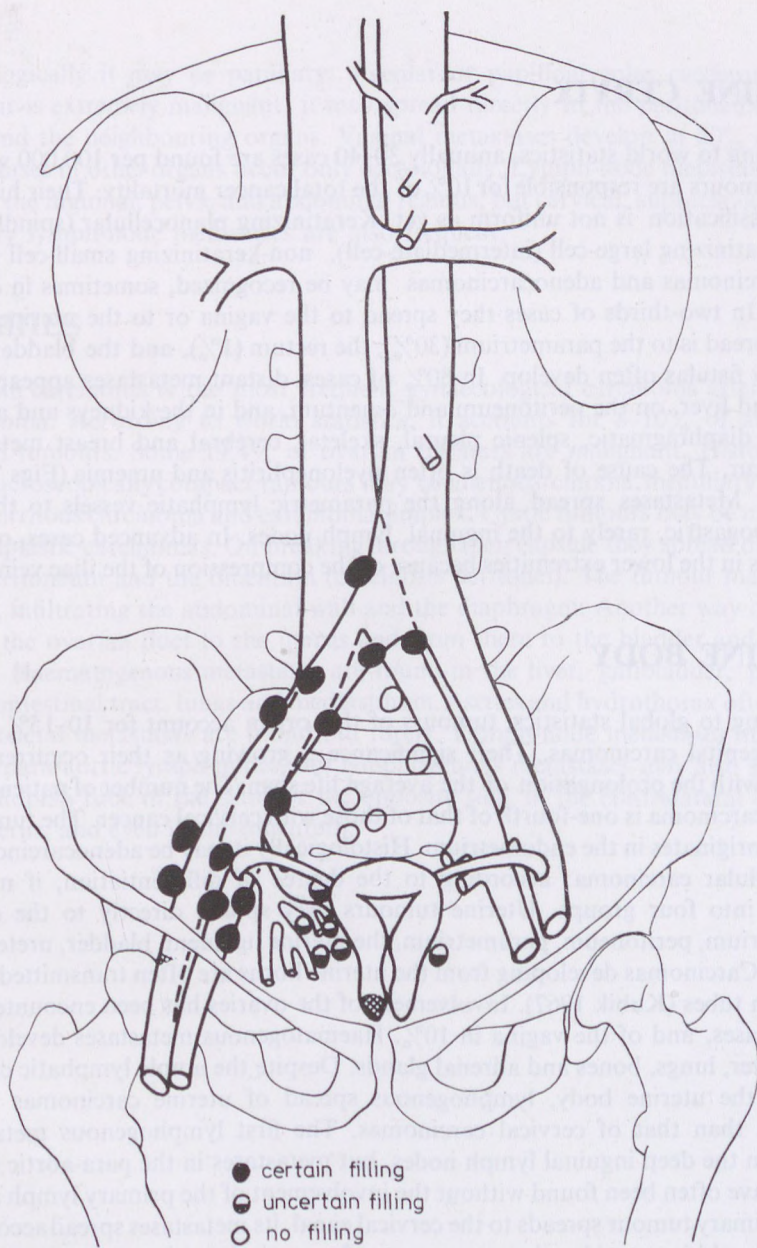


Fig. 76. Regional lymph nodes of the female genital organs; superficial lateral external iliac lymph nodes; deep lateral external iliac lymph nodes; medial external iliac lymph nodes; obturator lymph nodes; inferior gluteal lymph nodes; superior gluteal lymph nodes; sacral lymph nodes; subaortic lymph nodes; medial common iliac lymph nodes; lateral common iliac lymph nodes; aortic lymph nodes

UTERINE CERVIX

According to world statistics, annually 30–40 cases are found per 100,000 women. Such tumours are responsible for 10% of the total cancer mortality. Their histological classification is not uniform as yet. Keratinizing planocellular (spindle-cell), non-keratinizing large-cell (intermediate-cell), non-keratinizing small-cell (basal-cell) carcinomas and adenocarcinomas may be recognized, sometimes in combination. In two-thirds of cases they spread to the vagina or to the uterine body. Early spread is to the parametrium (30%), the rectum (1%), and the bladder (4%), whereby fistulas often develop. In 80% of cases, distant metastases appear in the lungs and liver, on the peritoneum and omentum, and in the kidneys and adrenal glands; diaphragmatic, splenic pleural, skeletal, cerebral and breast metastases also occur. The cause of death is often pyelonephritis and uraemia (Figs 77a,b,c–78a,b). Metastases spread along the parametric lymphatic vessels to the iliac and hypogastric, rarely to the inguinal, lymph nodes. In advanced cases, oedema develops in the lower extremities because of the compression of the iliac vein.

UTERINE BODY

According to global statistics, tumours of this organ account for 10–15% of the female genital carcinomas. Their significance is growing as their occurrence increases with the prolongation of the average life span. The number of patients with uterine carcinoma is one-fourth of that of those with cervical cancer. The tumorous process originates in the endometrium. Histologically it may be adenocarcinoma or planocellular carcinoma; according to the degree of differentiation, it may be divided into four groups. Uterine tumours may spread directly to the cervix, myometrium, peritoneum, parametrium, the uterine ligament, bladder, ureters and rectum. Carcinomas developing from the uterine horns are often transmitted to the fallopian tubes (Kubik 1967). Involvement of the ovaries has been encountered in 5% of cases, and of the vagina in 10%. Haematogenous metastases develop late in the liver, lungs, bones and adrenal glands. Despite the ample lymphatic circulation of the uterine body, lymphogenous spread of uterine carcinomas is less frequent than that of cervical carcinomas. The first lymphogenous metastases appear in the deep inguinal lymph nodes, but metastases in the para-aortic lymph nodes have often been found without the involvement of the primary lymph nodes. If the primary tumour spreads to the cervical canal, its metastases spread accordingly and should be considered as metastases of a cervical carcinoma.

APPENDAGES

Carcinoma of the fallopian tube is rare; according to world statistics it accounts for about 0.5–1% of all genital tumours. In one-third of the cases it is bilateral.

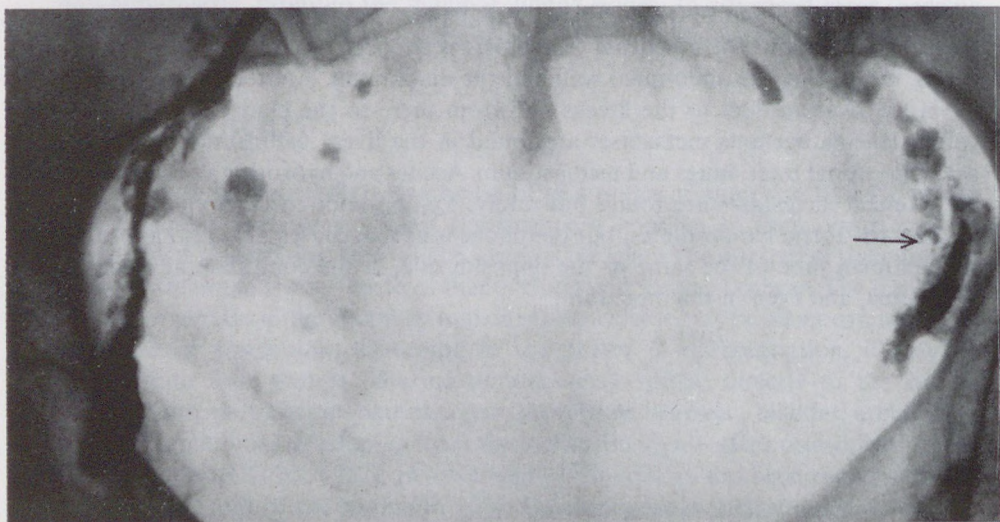
Histologically it may be papillary, alveolar or papilloalveolar carcinoma. This tumour is extremely malignant: it may spread directly to the peritoneum, omentum and the neighbouring organs. Vaginal metastases develop in 60% of cases; metastases in other organs occur only occasionally. Lymph-node metastases develop in the inguinal, pelvic and abdominal regions, but cervical, supraclavicular and axillary lymph-node metastases are also frequent.

OVARIES

Ovarian carcinoma is the most frequent gynaecological carcinoma after cervical carcinoma. According to world statistics, it accounts for 8–10% of all female genital tumours. Some 19.4% of ovarian tumours are malignant. Histologically the macroscopically compact tumours may be adenocarcinoma, medullary carcinoma, scirrhous carcinoma and carcinoma simplex. Cystic tumours may be medullary or anaplastic carcinomas. On breaking through their capsule they spread directly to the peritoneum and the omentum (carcinosis peritonei). The tumour may fill the pelvis, infiltrating the abdominal wall and the diaphragm. Another way of spread is via the ovarian duct to the uterus and from there to the bladder and sigmoid colon. Haematogenous metastases are found in the liver, gallbladder, pancreas, gastrointestinal tract, lungs and mediastinum. Ascites and hydrothorax often develop. Skeletal metastases are found but rarely. Lymph-node metastases may occur in the para-aortic lymph nodes, but lymphogenous metastases may also appear in the fallopian tube of the same or the opposite side, in the contralateral ovary, in the uterus, and even in the omentum.



a

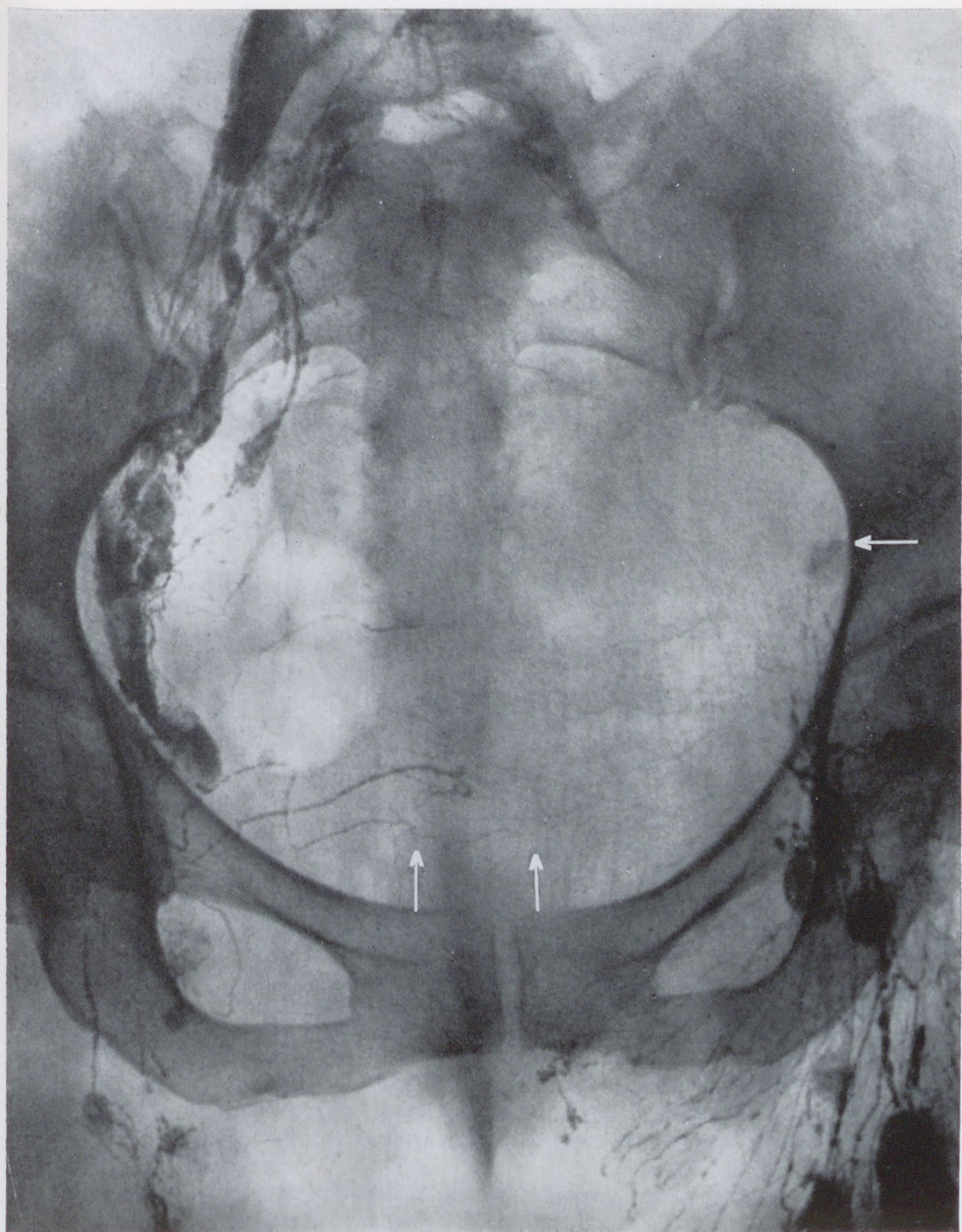


b



c

Fig. 77. 53-year-old female: a year ago complete extirpation of the uterus was performed because of carcinoma of the uterine cervix which had compressed the left ureter. At present the right ureter is compressed. There is a ureterovaginal fistula on the left side. *a*: In the lymphangiographic phase, loop-like collaterals are seen. *b*: In the lymphadenographic phase, mainly on the left side, moth-eaten iliac lymph nodes (arrow) are revealed. *c*: In the left supraclavicular region several lymph nodes are filled; above the 2nd rib there is a round lymph node with a suspicion of destruction



a

Fig. 78a. 53-year-old female: 3 years ago complete extirpation of the uterus was performed because of a tumour. Postoperative X-ray and radium irradiation. At present there is a stone-hard mass above the vaginal stump, reaching the left lateral thoracic wall. In this lymphangiogram a block (upper arrow) is revealed at the level of the head of the left femur; below it an unusually large number of lymphatic vessels is filled, and a collateral pelvic lymphatic network runs to the opposite side (lower arrows)



Fig. 78b. In the lymphadenographic phase there is stagnation in the lymphatic vessels below the block, the lymph nodes are swollen and they are much larger than those on the contralateral side (arrows)

LYMPHOMAS

Lymphomas, the malignant diseases of the lymph nodes themselves, may be divided into two large groups – Hodgkin's and non-Hodgkin's lymphomas.

HODGKIN'S DISEASE (LYMPHOMA SOLIDUS/LYMPHO-GRANULOMATOSIS)

The general symptoms are weight loss, nocturnal perspiration and itching. The diagnosis is based on histological examination, usually of an excised superficial, enlarged lymph node. Non-palpable lymph nodes may be examined by lymphography, ultrasound and CT. The advantage of lymphography is that it can reveal pathological changes in lymph nodes of normal size. Manifestations in other organs may be examined by CT, ultrasound and laboratory methods. The enlarged lymph nodes may be palpated during physical examination. Laboratory tests should be for serum values as well as for hepatic and renal function. Dermal sensitivity tests include DNCB (dinitrochlorobenzene) and the demonstration of intradermal antigens. In some cases the diagnosis is based on bone-marrow biopsy. In the past, staging laparotomy was done in positive cases to establish the degree of involvement of the mesenteric lymph nodes. Nowadays ultrasound and CT are increasingly taking the place of laparotomy.

Clinicopathological classification (according to Kaplan 1972)

- I. The disease is manifested in one lymph node or one extralymphatic organ.
- II. Lymph node involvement in two or more regions and one extralymphatic organ, or one or more lymph nodes are involved on the same side of the diaphragm.
- III. The involvement of the lymph nodes in a region on both sides of the diaphragm which may also be accompanied by changes in the spleen or an extralymphatic organ.
- IV. Diffuse alteration of one or more extralymphatic organs or tissues with or without the involvement of the lymph nodes.

In this classification the presence or absence of general symptoms is denoted by the letters A and B, respectively.

Histological classification (according to Rye)

- Lymphocytic type; best therapeutic results;
- nodular sclerosis; favourable prognosis;
- mixed type;
- lymphocyte depletion; worst prognosis.

The clinicopathological and histological classification are closely interrelated. The treatment of choice in stages I-III/A is usually radiotherapy. In stages III/B-IV combined cytostatic treatment is undertaken. Some advise chemotherapy or combined treatment from stage II/B onward.

MALIGNANT NON-HODGKIN'S LYMPHOMAS

This group includes lymphosarcoma, reticulosarcoma and macrofollicular lymphoblastoma (giant follicular reticulosis; Brill-Symmers' disease). Immunologically, multiple myeloma (Kahler's disease) and macroglobulinaemia also belong in this group.

The classification of malignant non-Hodgkin's lymphomas is still much debated. Rappaport's classification (1966) is the most widely accepted - it is based on morphological appearances. Lennert (1981) and Stein (1976) distinguish, according to cell type, T and B groups (thymic or bone-marrow origin). These cells may be demonstrated by immunological and enzymohistochemical methods. Non-Hodgkin's lymphomas exhibit a range of malignancy. They may originate from a part of the lymphoreticular system and spread at an early stage.

Clinically such tumours may appear as enlargements of the lymph nodes, liver or spleen. With bone-marrow involvement, foci of bone rarefaction may be seen. The blood picture is either normal, or the number of lymphocytes and monocytes is increased (lymphocytic leukaemia; monocytic leukaemia). Examination of the mouth, throat and skeletal system is indispensable to the physical examination. Among the laboratory tests, determination of serum albumin, globulin, immunoglobulin, alkaline phosphatase, uric acid and urea is essential. Lymphography is important for the examination of retroperitoneal lymph nodes (Figs 79a,b-80a,b), although these may also be studied by ultrasound and CT. The skeletal system is examined by means of traditional radiography and ^{60}Ga scintigraphy. The spleen and liver are investigated by $^{99\text{m}}\text{Tc}$ scintigraphy. The mediastinum may be examined by bidirectional chest X-ray and tomography. Staging laparotomy should also be undertaken.

Radiotherapy is the primary choice of treatment. In advanced cases cytostatic treatment should be carried out, occasionally combined with radiotherapy.



a

Fig. 79a. 69-year-old patient: chronic lymphatic leukaemia for the last five years. Urological examination because of backache. In the adenographic phase the enlarged lymph nodes, in particular the femoro-inguinal ones, display a coarse, knotty filling

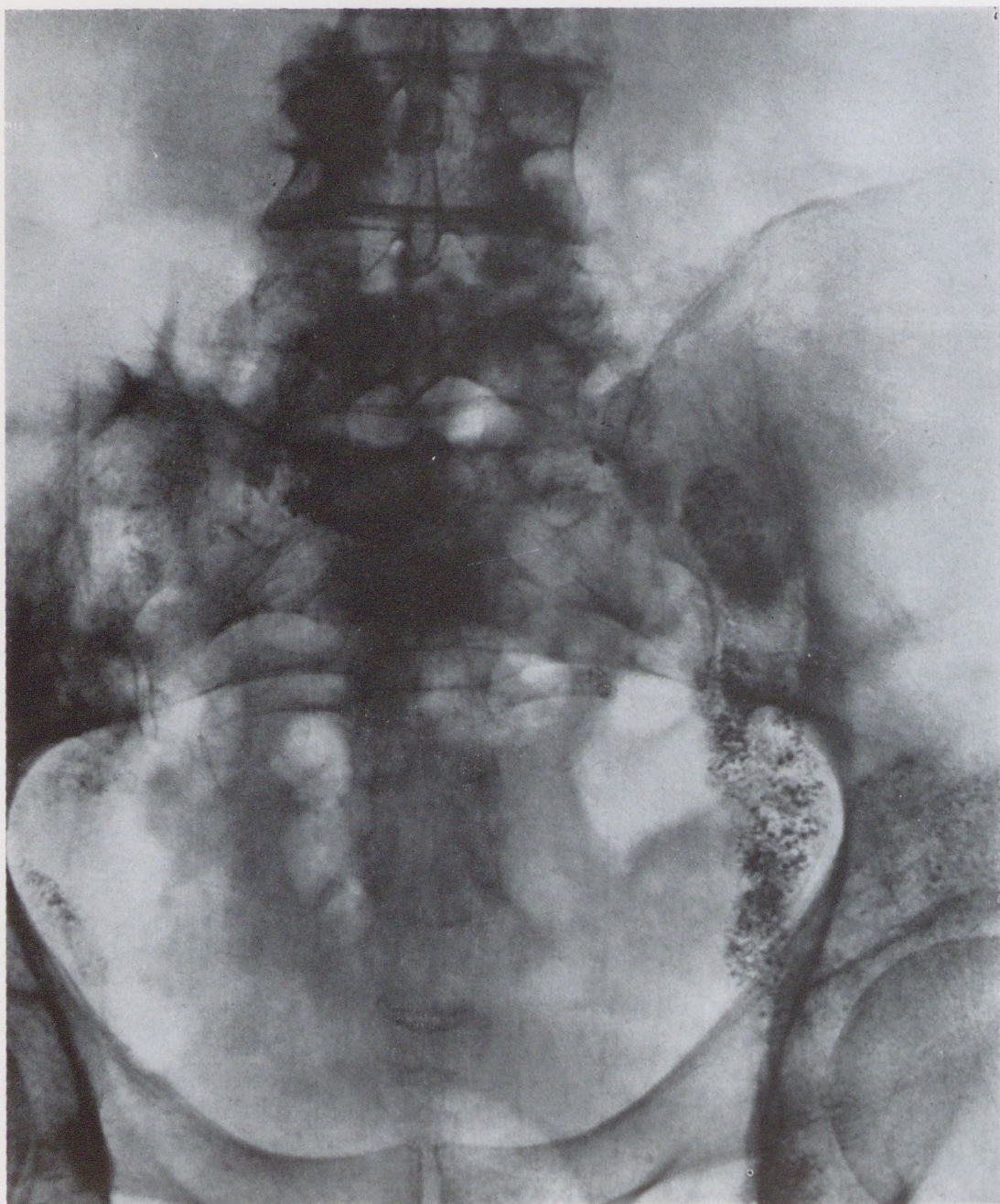


Fig. 79b. Picture taken a week later. In the late adenographic phase the coarse, cloddy structure has become more distinct, mainly in the left iliac region



a

Fig. 80a. 71-year-old male: castration because of a testicular tumour on the left side. Histology: non-Hodgkin's lymphoma. Menotest: negative; alpha-FP: 5 μ g/l. In this lymphangiogram of the inguinal and iliac regions of both sides 'more than usual' dilated, meandering lymphatic vessels are filled. In the left iliac chain the contrast medium has been extravasated

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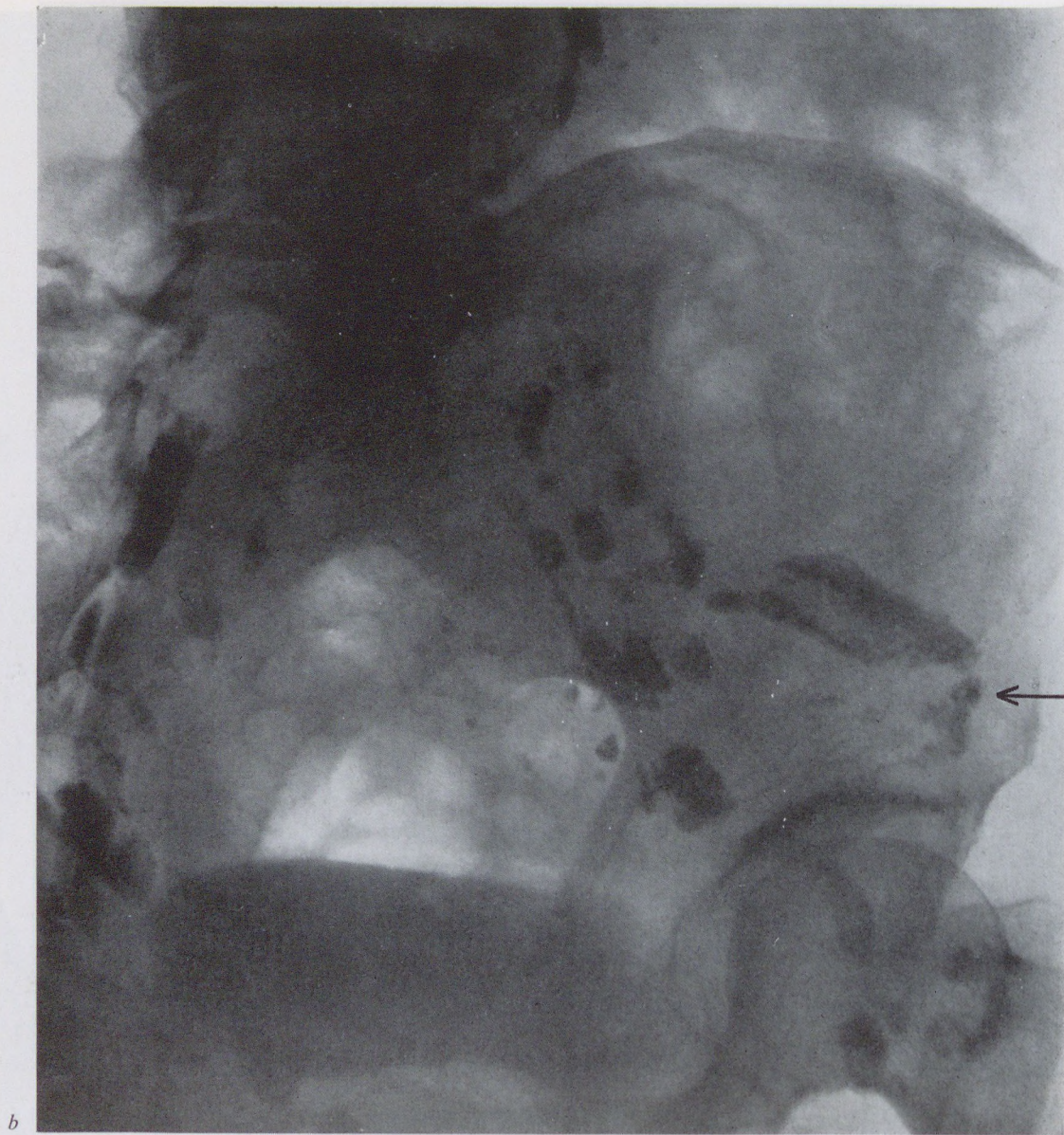


Fig. 80b. In the lateral lymph node of the left iliac chain large metastatic filling defects are seen. There is stagnation in the lymphatic vessels crossing in front of the sacral bone (arrow)

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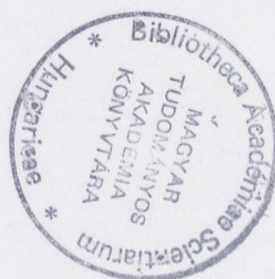
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Probably Hippocrates and Aristotle must have known about the lymphatic system, the 'white blood'. Nevertheless, radiological visualization, i.e. lymphography, has become a clinical examination only in the middle of this century.

Besides sonography and computed tomography, lymphography provides an important aid in diagnosing urogenital tumours and in following up the effectivity of therapy.

The atlas summarizes the experience on the lymphographies of about 600 patients examined mostly because of tumour, and is intended primarily for physicians and urologists dealing with lymphography.

After outlining the lymph circulation and lymphography, mainly the lymphatics and tumours of the kidneys and their adipose capsules, the bladder, the prostate, the testicle, the penis and the female genitals are discussed with ample illustrations.



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