Lymphology 4 (1982) 132–142

Conventional Roentgen Diagnosis of Mediastinal Lymphadenopathy. Review article (Part one)

K.F.R. Neufang, D. Beyer, P.E. Peters

Radiologisches Institut der Universität Köln (Prof. Dr. G. Friedmann)

Summary

Although CT has significantly improved the imaging of space occupying mediastinal processes, it cannot be the first diagnostic step for reasons of cost, capacity and radiation exposure. Therefore the conventional chest examination with biplane films, film tomography and esophagogram continues to be the basic roentgen procedure. The basis of the conventional studies is the analysis of the pleuro-mediastinal interfaces which represent the lateral mediastinal borders. This paper describes the roentgen-morphologic aspects of enlarged lymph nodes in the mediastinal compartments as far as they can be detected with conventional studies. The differential diagnoses are discussed and recognition of early and discrete lesions is particularly emphasized.

In the adult mediastinal space occupying lesions with enlargement of the mediastinal shadow are in more than 25% caused by enlarged lymph nodes (1). One third of all mediastinal masses is of malignant origin (2) and 90% of the masses in the middle compartment are malignant (3). The most frequent diagnoses are primary malignant lymphoma, followed by lymph node metastases.

Both mediastinal and bronchopulmonary lymph nodes must be regarded in context because of their close anatomic relationship and the fact that both anatomic regions most commonly are involved simultaneouly in malignant lymphomas (Hodgkin's disease, Non-Hodgkin-Lymphoma) and in infectious diseases (tuberculosis, histoplasmosis) or diseases of unknown etiology (sarcoidosis, Castleman's disease).*

A polycyclic, curvilinear or lobulated outline of an enlarged mediastinum is typical for lymph node disease, but it is not the only form of roentgen manifestation. A sharp linear lining may be seen as well, thus making the differentiation from other mediastinal masses difficult or impossible (4).

Enlarged mediastinal lymph nodes are the most frequent thoracic manifestation of malignant lymphomas. They can be seen in 67% of Hodgkin's disease, and in 43% of Non-Hodgkin-Lymphomas (5). *Rosenberg* (6) found mediastinal and bronchopulmonary lymph node enlargement in 36% of 1.269 patients suffering from Non-Hodgkin-Lymphomas. The mediastinal lymph nodes are more frequently involved in malignant lymphomas than are the bronchopulmonary nodes or the lung parenchyma.

Infiltration of the lung parenchyma is more common in Hodgkin's disease than in Non-Hodgkin–Lymphomas (11.6% vs. 3.7%), and in most cases is associated with enlarged bronchopulmonary or mediastinal nodes (5). The primary malignant lymphoma of the lung is a rare exception from this rule.

The pattern of mediastinal and bronchopulmonary lymph node enlargement is rather typical in *Hodgkin's disease,* thus facilitating the dif-

*The term of "Lymphoma" is used as synonymous with "lymph node enlargement" because all radiologic imaging modalities only can demonstrate the increase in volume but can give no histologic diagnosis.

0024–7766/82 040132–11 $ 02.00

ferentiation of this condition from sarcoidosis. There is bihilar, mostly asymmetric lymph node enlargement; unilateral lymphadenopathy is uncommon. The paratracheal and subcarinary nodes are as frequently (7) or even more frequently (8) involved than the bronchopulmonary nodes. Lymph node enlargement in the anterior mediastinum and in the retrosternal area is a typical finding (9). The nodular-sclerosing form of Hodgkin's disease is said to have a predelection for the upper part of the anterior mediastinum (4). In 5.5% of 403 patients with this condition paraspinal lymph node involvement could be detected with conventional radiographic methods (10).

Lymph node enlargement in the anterior mediastinum can be rarely seen in *sarcoidosis*. *Bein* and coll. (11) found enlarged lymph nodes present there in only 16% of 62 patients. Bilateral-symmetric enlargement of hilar nodes is typical for sarcoidosis (97%), but in more than 75% there will be an additional enlargement of mediastinal nodes detectable on the conventional film and tomography (11). Isolated enlargement of mediastinal nodes, however, is an exceptional finding in sarcoidosis (12).

The most frequent combination in sarcoidosis is the bilateral enlargement of the bronchopulmonary nodes, the right paratracheal nodes and the nodes in the aortic-pulmonic window. (37%). In 76% there is an affection of the nodes in the aortic-pulmonic window, in 71% of the right paratracheal chain and in 21% of the subcarinary nodes (11). Subcarinal or right paratracheal nodes were never found to be the only manifestation of sarcoidosis in 62 patients (11), but may occur as a rare exception (12).

Infectious lymphadenopathy as seen in tuberculosis and histoplasmosis is predominantly unilateral and in the active stage of disease associated with an infiltration of the lung, which leads to the correct diagnosis. Mediastinal lymphadenopathy may be an additional finding and can occasionally reach considerable dimensions (13). In infants and younger children infectious, predominantly tuberculous bronchopulmonary and mediastinal lymphadenopathy will be more frequent and more extended than in adults (14). Egg-shell calcifications prove the benign character of lymphadenopathy (15).

1. Significance of the conventional roentgen examination

As far as the patient's general condition allows, any thoracic lymphadenopathy deserves histological examination, except when infectious etiology is evident. Diagnostic imaging procedures, therefore, first must show the existence of enlarged thoracic nodes and define their precise location. Afterwards, they are the basis of a non-invasive follow-up investigation under therapy and during the remission phase.

The primary diagnosis and the follow-up studies of thoracic lymphomas continue to be based on the *conventional roentgen studies* including biplane standard chest films, fluoroscopy, barium studies of the esophagus and the conventional film tomogram of the mediastinum.

In fact, *computed tomography* often shows the existence of enlarged nodes in the mediastinum which are too small to be detected with the conventional methods or are located in unfavourable "blind" areas (4) where they cannot be visualized. CT, however, cannot be performed as a routine screening examination because of cost, capacity and radiation exposure. Furthermore, CT cannot differentiate between lymph node enlargement due to a neoplastic infiltration or due to reactive lymphadenitis. This inherent limitation of CT causes differential diagnostic problems, especially if lymph node enlargement is only discrete and calcifications are not present.

Both, CT and conventional film tomography of the hilar region have shown to be unreliable in the preoperative staging of peripheral bronchogenic carcinoma (16–20).

On the other hand, CT has provided a valuable contribution to the knowledge of the normal and pathologic anatomy of the mediastinum, thus improving the interpretation of the standard films.

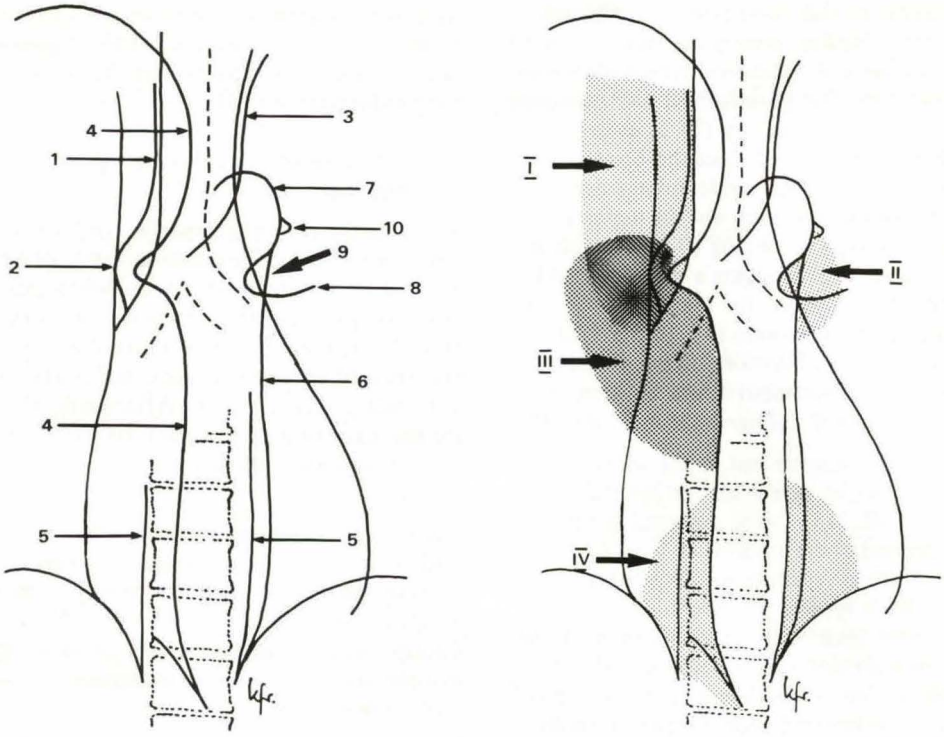

Fig. 1 Pleuro-mediastinal interfaces on the sagittal film (a): 1. right paratracheal stripe, 2. azygos arch (notch), 3. supra-aortic double contour by left subclavian artery and vein. 4. right para-esophageal line, resp. posterior junction line in the supra-azygos and infra-azygos area, 5. right and left para-spinal lines, 6. para-aortic line (descending aorta), 7. aortic arch, 8. aortic-pulmonal-arterial line, 9. aortic-pulmonic window, 10. "aortic nipple". Most frequent localizations of mediastinal lyphadenopathy (b): I. paratracheal lymphoma (demonstrated only on the right), II. enlarged lymph nodes in the aortic-pulmonic window, III. sub- and retrocarinal lymphadenopathy, lymphoma of the right hilum, IV. lymph node enlargement in the posterior inferior mediastinum.

This paper is dealing only with the diagnosis of *mediastinal lymphadenopathy*. Bronchopulmonary and hilar lymphomas are not included. It is our aim to describe the roentgen-morphologic aspects of enlarged lymph nodes in the different mediastinal compartments as far as they can be detected with conventional studies. The differential diagnoses are discussed and recognition of early and discrete lesions is particularly emphasized.

The mediastinum is an anatomic region of nearly homogenous density. Only the tracheal air stripe and the occasionally air containing or artificially barium-stained esophagus are anatomic landmarks within this opaque shadow. Therefore, conventional studies of the mediastinum must be focussed on the analysis of alterations of the pleuro-mediastinal interfaces.

In spite of a considerable variability, the roentgen appearance of the normal mediastinal borders, outlined by the pleuro-mediastinal lines and stripes, may be considered as typical (21). These lines and stripes can be seen if the x-ray beam parallels the mediastinal borders. They can be demonstrated on standard films, spot films, and above all, on tomograms in standard projections. Their imaging is facilitated and improved by the use of aluminium or plexiglas trough filters (22).

Nodes that are located more centrally in the mediastinum and those which are almost nor-

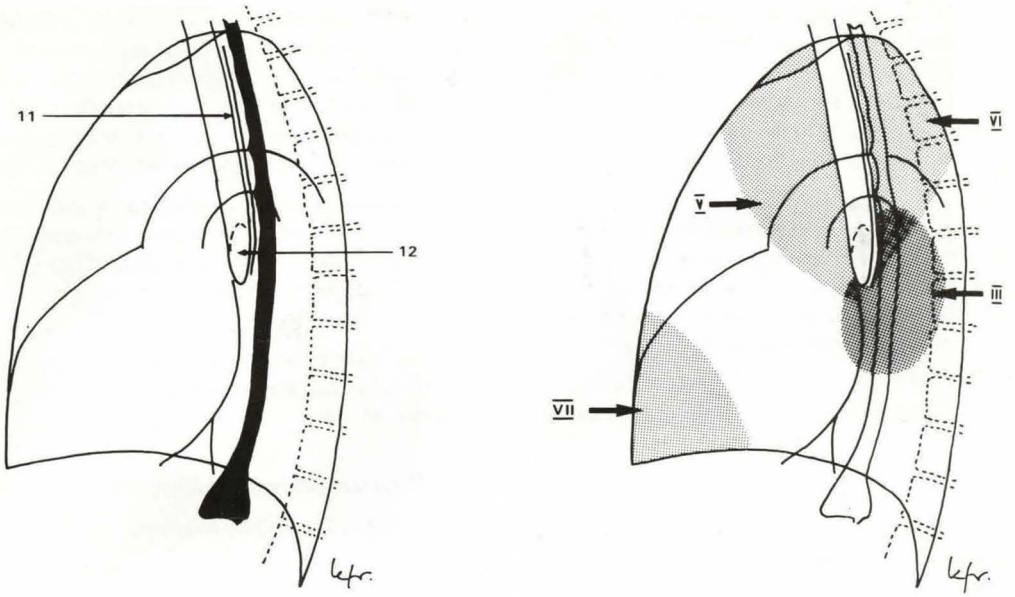

Fig. 2 Lateral view showing the posterior treacheal band (11) and the bifurcation (12). Most frequent localizations of mediastinal lymphadenopathy (b): III. enlarged lymph nodes in the subcarinal and retrocarinal region, V. Lymph node enlargement in the anterior superior mediastinum, VI. Lymph node enlargement in the posterior superior mediastinum, VII. lymphadenopathy in the cardio-phrenic angles

mal in size will be barely detected by the analysis of the pleuro-mediastinal interfaces; they can only be seen on CT (17, 23). From that we can conclude: 1) not all mediastinal lymphomas are detectable with conventional methods; 2) an alteration of mediastinal borders is by no means specific for lymph node enlargement. A number of differential diagnoses must be considered.

2. *Roentgen findings*

2.1 General anatomic considerations

Although anatomically the mediastinum is one single space which is not separated by fascias or comparable structures, for clinical use the mediastinum may be arbitrarily subdivided into an *anterior, middle* and *posterior* and into a *superior* and *inferior* compartment. This subdivision into compartments facilitates the localization and description of mediastinal processes and has become generally accepted (24, 25).

The *anterior mediastinum* lies between the sternum and the vascular structures of the middle mediastinum, as pericardial sac, ascendent aorta, supra-aortic branches and superior vena cava.

The *posterior mediastinum* is located between the posterior tracheal wall and the posterior wall of the pericardial sac anteriorly and the ventral surface of the vertebral bodies posteriorly. The paravertebral space is not included in this compartment.

The posterior and the *middle mediastinum* which contains the remaining structures – trachea, vessels, heart – are subdivided into a superior and an inferior half by a horizontal line thought to run through the tracheal bifurcation.

It is important to remember that these arbitrarily separated compartments in fact freely communicate with each other. This is why gas, fluid and malignancies may spread across the mediastinum. The spread of mediastinal

tumors and lymphomas is similar to the distribution of gas in the "potential spaces" of the mediastinum which can be demonstrated with CT after pneumomediastinography (26). Table 1 gives a synopsis of all possible endothoracic lymph node locations (5, 25, 27), (Fig. 1, 2).

The *anterior mediastinum* may be completely filled by enlarged retrosternal, prevascular, precaval, retrocaval and/or pretracheal nodes (28, 29) which may continue into the visceral compartment of the neck via the thoracic inlet (30).

In the *middle mediastinum* the paratracheal and tracheobronchial lymph nodes may become involved. The *azygos node* is part of the right paratracheal (tracheobronchial) chain. On the left side the *ductus node,* also referred to as "*Engel's* node" in German literature, and the inconstant nodes surrounding the aortic arch, the pulmonary trunk and main arteries are part of *Most's accessory chain* which parallels the left main chain (27, 31). If the pre- and paratracheal nodes are considerably enlarged, the lymphatic tissue in the retrotracheal and para-esophageal area of the posterior superior mediastinum will be involved as well.

The *subcarinal nodes* predominantly extend under the surface of the right main stem bronchus and tend to enlarge dorsally to the carina and caudally along the esophagus. They deform the azygo-esophageal recess and may compress or displace the esophagus in that area.

In the *lower posterior mediastinum* there may be an involvement of the para-aortic and para-esophageal nodes which may extend into the para-spinal space. To this group also belong the retrocrural nodes.

Lymph node enlargement may rarely occur in the para-cardiac angles and along the mammarian arteries.

2.2. Paratracheal lymphadenopathy

2.2.1. Normal roentgen anatomy

The upper mediastinum has a triangular shape in transversal sections with the basis ventrally and the apex dorsally as can be demonstrated on CT (fig. 3c). Consequently, the right upper lobe with its middle and posterior portion deeply indents the mediastinum and fills the right pleural sac extending above the azygos arch. As a result, the sagittal chest film may show on the right border of the mediastinum the shadow of the superior vena cava and the

Table 1 Thoracic lymphadenopathy

	anterior mediastinum	middle mediastinum	posterior mediastinum
superior mediastinum	retrosternal (internal mammarian) prevascular pretracheal	paratracheal tracheobronchial R: azygos node L: ductus node perivascular (in contact with aorta and pulmonary artery)	retrotracheal para-esophageal
inferior mediastinum		subcarinal/retrocarinal (bifurcational) bronchopulmonary pulmonary ligament cardiophrenic angles	para-esophageal para-spinal (intercostal) para-aortic (retrocrural)

(5, 25, 27, 28)

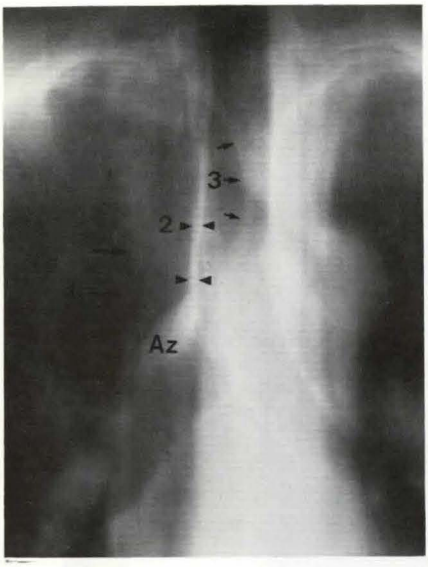

Fig. 3a

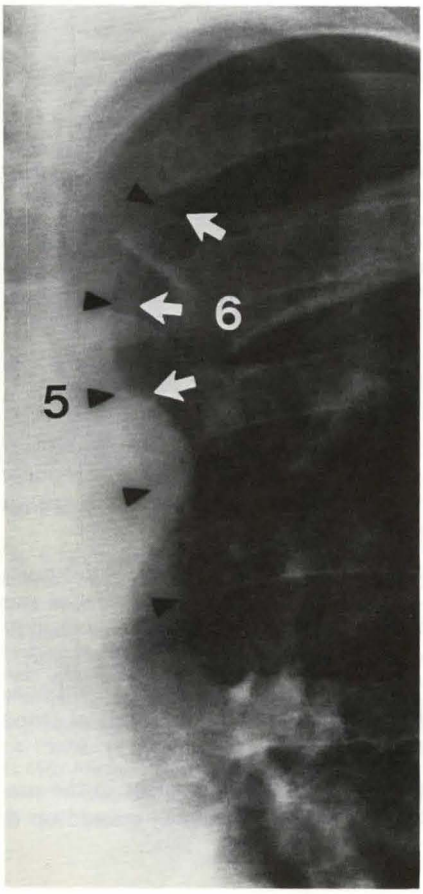

Fig. 3b

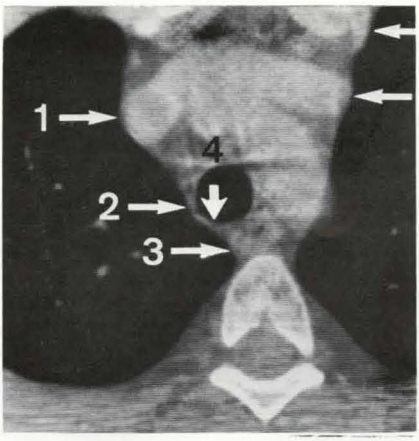

Fig. 3c

Fig. 3 Normal pleuro-mediastinal interfaces in the upper mediastinum. Sagittal views (a, b): 1. superior vena cava, 2. right paratracheal stripe, 3. posterior junction line/right para-esophageal line, 5. para-arterial (left subclavian artery) and aortic-pulmonic line, 6. paravenous line (left subclavian vein). As the CT section (c) demonstrates, the line by the superior vena cava is the most ventral one and the posterior junction line in the most dorsal one, with the right paratracheal stripe inbetween. 4. retrotracheal stripe (lateral view!)

right paratracheal stripe (32–34) as structures of the middle mediastinum and the right para-esophageal line or posterior junction line as an anatomic landmark of the posterior mediastinum (Fig. 3a).

The *right paratracheal stripe* (32–34) can be seen on the sagittal plain film in 76% of all normal persons, the supra-azygeal part of the right para-esophageal line can be detected in 86% of normal persons aged from 18 to 25 years and in 66% of normal persons over 40 years of age (21). The posterior tracheal wall may also partly come into contact with the right upper lobe, thus producing a *posterior tracheal band* (35–38) in the lateral view, which normally does not exceed 5 mm in width. A similarly configurated *tracheo-esophageal band* (37) may result from the contact of the posterior tracheal wall with the adjacent air-distended esophagus; this condition has no pathologic significance.

On the left superior mediastinal border in one half of normal persons a *double contour* can be detected on the standard sagittal chest film;

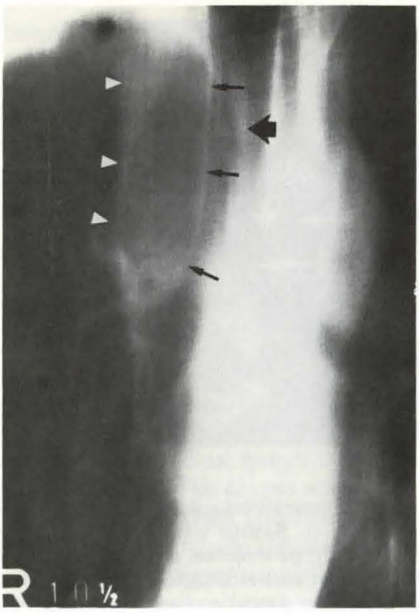

Fig. 4 Massive right paratracheal lymphadenopathy (Non Hodgkin's Lymphoma). There is a widening of the upper mediastinum to the right, the right paratracheal stripe and the azygos arch are obliterated by enlarged nodes that separate the right pleura from these structures. The right lateral contour of the mediastinum ist most probably formed by the superior vena cava which is displaced laterally. As the posterior junction line is still intact (➔), there is no retrotracheal lymph node enlargement

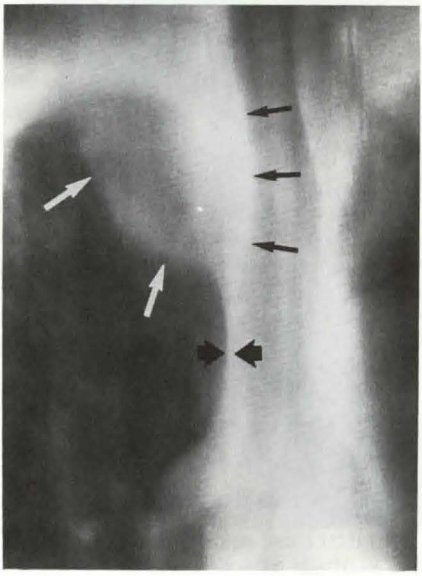

Fig. 5 Mass in the right posterior mediastinum (retrotracheal goiter). The right paratracheal stripe is normal in width and length. As its cranial end forms a sharp angle with the inferior border of the mass, this mass cannot be at the same level as the trachea. It must be situated behind the trachea, because a lesion that at this level (the level of the thoracic inlet) lies before the trachea will have no contact with the pleura and therefore cannot produce a pleuromediastinal line. (The transverse plane through the thoracic inlet parallels the first rib and is tilted so that it is higher posteriorly that it is anteriorly.)

it is formed by the left subclavian vein and artery und must be considered as normal (21, 39), (fig. 3 b).

2.2.2. Pathologic anatomy in lymph node enlargement

Enlargement of the paratracheal or pretracheal lymph nodes including the azygos node is the most frequent pathologic condition in the upper mediastinum. The corresponding roentgen findings are widening of the right paratracheal stripe with curvilinear or polycyclic outlines (fig. 6) or obliteration of the right paratracheal stripe within the widened upper mediastinal shadow (32, 33, 40), (Fig. 4). In this second case the displaced superior vena cava may be the most laterally situated mediastinal structure and may form the straight right upper mediastinal border. If there is an involvement of lympathic tissue in the retrotracheal and para-esophageal region, the right para-esophageal line can no longer be seen.

Above the level of the sternoclavicular junctions, the right paratracheal stripe fades away (fig. 3a). Opposed to the findings in pleural processes (fig. 8), in lymphomas the tomogram will never show a curvilinear continuation of the enlarged right paratracheal stripe with a right apical pleural cap (32).

Isolated lymph node enlargement in the pretracheal area will be frequently missed on the

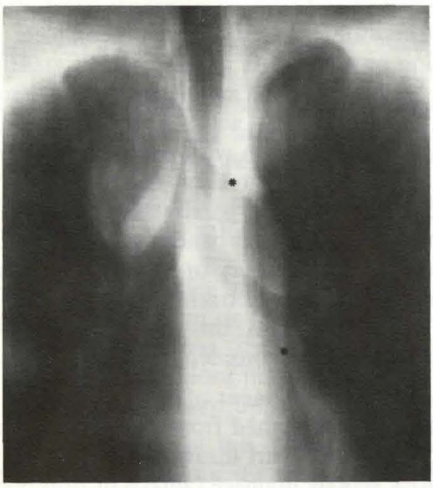

Fig. 6a

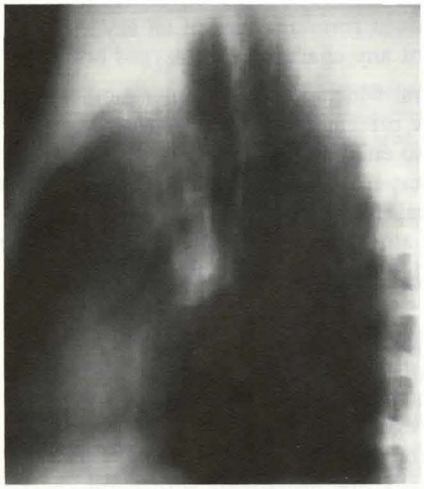

Fig. 6b

Fig. 6 Lymphadenopathy predominantly of the anterior mediastinum and nodular pulmonary involvement in a 24 year old man with Hodgkin's lymphoma. In the sagittal view (a) the right paratracheal stripe is moderately widened. There is a mass laterally to the trachea which is sharply outlined at its inferior but not at its superior aspect. This finding is typical for a mass lying ventral of the trachea and reaching through the thoracic inlet into the cervical spaces, and is confirmed by the lateral tomogram (b) and by CT (not shown). *artifact by the hilum filter

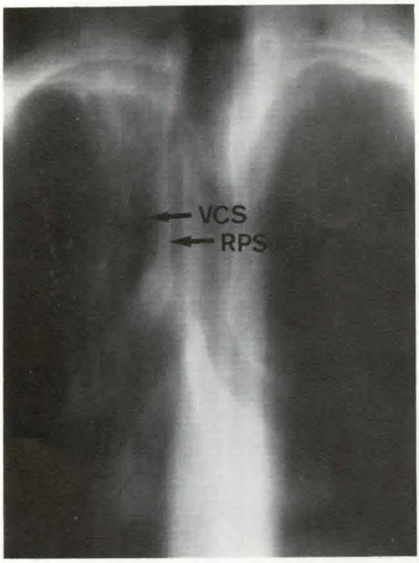

Fig. 7 Fibrosis of the right upper lobe with traction of the hilum and the trachea, and discrete apical pleural thickening after radiation for Hodgkin's disease 4 years ago. Normal right paratracheal stripe (RPS), the lateral contour of the upper mediastinum is made by the superior vena cava (VCS)

sagittal film. The diagnosis is based on the lateral view which may show soft tissue masses in the retrosternal field (fig. 6).

The double contour on the left superior mediastinal border may disappear in left paratracheal lymph node enlargement; comparison with previous films is mandatory.

2.2.3. Differential diagnosis

Widening, obliteration or irregular contour of the right paratracheal stripe may be due to a number of various conditions. Local changes can be simulated by tumors of the anterior or posterior mediastinum, including goiter, and by tortuous vessels in ectactic arteriosclerosis (32), (fig. 5). A tracheal tumor (41) or granuloma after long-time tracheal intubation may also produce a local widening of the stripe.

Fibrosis after medical treatment or irradiation for malignant lymphomas can also cause

Fig. 8 Thickening of the right apical and medistinal pleura due to inactive tuberculosis of the right upper lobe. Widening of the right paratracheal stripe with curvilinear margins and obliteration of the azygos notch. No lymphadenopathy. Similar findings can be obtained in right-sided pleural effusions

Fig. 9 Mediastinal lipomatosis. The whole upper mediastinum is widened but relatively translucent as can be judged from the good delineation of the (non calcified) tracheal wall. Diagnosis confirmed by CT (-120 HE). *artifact by hilum filter

widening of the right paratracheal stripe and must be differentiated from an incomplete remission or relapse. As in this case differentiation between fibrosis and active tumor tissue may be difficult also with CT, follow-up series and comparison with previous films will help to establish the correct diagnosis (32). Widening of the right paratracheal stripe or the tracheo-esophageal band may also be caused by inflammatory or neoplastic diseases arising from the deep tracheo-bronchial system or the esophagus; this possibility must be always taken into consideration.

An isolated enlargement of the azygos node has to be distinguished from a dilated azygos vein, as in right heart insufficiency or anomalous venous drainage (aplasia or thrombotic occlusion of the inferior caval vein with azygos continuation). Films obtained in upright and recumbent position and under *Valsalva* and *Mueller* maneuver will demonstrate changes in form and size of an azygos knob but not any changes of an azygos node.

Bilateral widening of the upper mediastinum will be present if the left paratracheal nodes are also enlarged. This, however, is not as frequent as enlagement of only the right paratracheal nodes, because left paratracheal nodes are less constant (27) and because the potential space seems to be smaller on the left than on the right (26).

The differential diagnoses of bilateral upper mediastinal widening are infectious disease and mediastinal hemorrhage which can be easily excluded on their typical history and symptoms. A widening of the right paratracheal stripe in patients with blunt chest trauma should always rise the suspicion of mediastinal hemorrhage (42). Mediastinal phlebothrombosis will be diagnosed by mediastinal phlebography. Mediastinal lipomatosis predominantly occurs in cases of extreme obesity and is characterized by translucency of the mediastinum caused by fat. Often the outer walls of the trachea can be identified against the fat tissue on the film tomogram. Definitive diagnosis is made by density measurements on CT (fig. 9).

In aortic coarctation the left subclavian artery is a collateral vessel and is dilated. This will also change the left upper mediastinal contour as the aortic arch looses its sharp upper definition and is in straight continuation with the left upper mediastinal border.

Opacifying processes such as pneumonia, atelectasis, tumor infiltration, pleural effusion and fibrosis (Fig. 8) in the adjacent lung or pleura may simulate an enlargement of the upper mediastinum or of the right paratracheal stripe alone. If an azygos lobe is present, these conditions may be confined to this part of the right upper lobe (43).

The second part of this review is to deal with lymphadenopathy in the aortic-pulmonic window (2.3), subcarinal lymphadenopathy (2.4) and lymphadenopathy in the posterior mediastinum (2.5).

References

1 *Lyons, H.A., G.L. Calvy, B.P. Sammons:* The diagnosis and classification of mediastinal masses. I° A study of 782 cases. Ann. Int. Med. 51 (1959) 897

2 *Rau, W.S., W. Wenz, X. Papacharalampous:* Zur Röntgendiagnostik seltener Mediastinal-„tumoren". Radiologe 19 (1979) 528

3 *Joseph, W.L., J.F. Murray, D.G. Mulder:* Mediastinal tumors – problems in diagnosis and treatment. Dis. Chest 50 (1966) 150

4 *Fraser, R.G., J.A.P. Paré:* Diagnosis of diseases of the chest. Vol. III, Chapt. 16: Diseases of the mediastinum. 2nd. Ed. 1977–79 W.B. Saunders Comp. Philadelphia-London-Toronto

5 *Filly, R., N. Blank, R.A. Castellino:* Radiographic distribution of intrathocacic disease in previously untreated patients with Hodgkin's disease and non-Hodgkin's lymphoma. Radiology 120 (1976) 277

6 *Rosenberg, S.A., H.D. Diamond, B. Jaslowitz, L.F. Craver:* Lymphosarcoma: a review of 1.269 cases. Medicine 40 (1961) 31

7 *Fisher, A.M.H., B. Kendall, B.D. van Leuven:* Hodgkin's disease. A radiological survey. Clin. Radiol. 13 (1962) 115

8 *Holesh, S.:* Unusual x-ray appearences in Hodgkin's disease. Proc. R. Soc. Med. 48 (1955) 1049

9 *Fleischner, F.G., C. Bernstein, B. Levine:* Retrosternal infiltration in malignant lymphoma. Radiology 51 (1948) 350

10 *Witten, R.M., J.V. Fayos, I. Lampe:* The dorsal paraspinal mass in Hodgkin's disease. Amer. J. Roentgenol. 94 (1965) 947

11 *Bein, M.E., C.E. Putman, T.C. McLoud, J.H. Mink:* A reevaluation of intrathoracic lymphadenopathy in sarcoidosis. Amer. J. Roengenol. 131 (1978) 409

12 *Parzinger, G., A. Harlacher, G. Henkel, V. Donnersmarck, U. Gulotta, S. Daum:* Isolierte Lymphknotensarkoidose des oberen Mediastinums. Prax. Pneumol. 34 (1980) 687

13 *Morgan, H., K. Ellis:* Superior mediastinal masses: secondary to tuberculous lymphadenitis in the adult. Amer. J. Roentgenol. 120 (1974) 893

14 *Stark, P.:* Eierschalenverkalkung von Lymphknoten – eine seltene Erscheinungsform des Morbus Boeck. Prax. Pneumol. 35 (1981) 440

15 *Ball, F., B. Ströver:* Primärtuberkulose des Kindes – Hinweisende Thoraxröntgenbefunde. Röntgen-Bl. 35 (1982) 30

16 *Faling, L.J., R.D. Pugatch, Y. Jung-Legg et al.:* Computed tomographic scanning of the mediastinum in the staging of bronchogenic carcinoma. Amer. Rev. Resp. Dis. 124 (1981) 690

17 *Mintzer, R.A., S.R. Malave, H.L. Neimann et al.:* Computed vs. conventional tomography in evaluation of primary and secondary pulmonary neoplasms. Radiology 132 (1979) 653

18 *Osborne, D.R., M. Korobkin, C.E. Ravin et al.:* Comparison of plain radiography, conventional tomography, and computed tomography in detecting lymph node metastases from lung carcinoma. Radiology 142 (1982) 157

19 *Underwood, G.H., R.G. Hooper, S.P. Axelbaum, D.W. Goodwin:* Computed tomographic scanning of the thorax in the staging of bronchogenic carcinoma. New Eng. J. Med. 300 (1979) 777

20 *Vock, P., M. Haertel:* Die Computertomographie zur Stadieneinteilung des Bronchuskarzinoms. Fortschr. Röntgenstr. 134 (1981) 131

21 *Neufang, K.F.R., W. Bülo:* Häufigkeit pleuromediastinaler Linien beim Gesunden – Ein Beitrag zur Kenntnis der normalen Röntgenanatomie der Mediastinalgrenzen. Fortschr. Röntgenstr. 135 (1981) 673

22 *Wieder, S., P.L. Adams:* Improved routine chest radiography with a trough filter. Amer. J. Roentgenol. 137 (1981) 695

23 *Harper, P.G., S.G. Spiro, D. Geddes et al.:* Computerized axial tomography in the pretreatment assessment of small-cell carcinoma of the bronchus. Cancer 47 (1981) 1775

24 *Kubik, St., B. Szarvas:* Topographische Anatomie des Mediastinums mit besonderer Berücksichtigung der Querschnittsdiagnostik. Radiologe 21 (1981) 310

25 *Wegener, O.H.:* Ganzkörper-Computertomographie. S. Karger, Basel-München-Paris-London-New York-Sidney 1982

26 *Sone, S., T. Higashihara, S. Morimoto et al.:* Potential spaces of the mediastinum: CT pneumomediastinography. Amer. J. Roentgenol. 138 (1982) 1051

27 *Schmidt, W.:* Die Lymphknoten der menschlichen Lunge, ihre Topographie und postfetale Neubildung. Zschr. Anat. Entw. Gesch. 118 (1955) 391

28 *Berkman, Y.M., B.R. Javors:* Anterior mediastinal lymphadenopathy in sarcoidosis. Amer. J. Roentgenol. 127 (1976) 983
29 *Schnyder, P.A., G. Gamsu:* CT of the pretracheal retrocaval space. Amer. J. Roentgenol. 136 (1981) 303
30 *Oliphant, M., J.F. Wiot, J.P. Whalen:* The cervico-thoracic continuum. Radiology 120 (1976) 257
31 *Fischer, E.:* Lymphknotenvergrößerungen und -verkalkungen am Aortenbogen an der sogenannten Mostschen Nebenkette. Fortschr. Röntgenstr. 106 (1967) 403
32 *Neufang, K.F.R., D. Beyer:* Der rechte paratracheale Streifen – Bedeutung für die Analyse oberer Mediastinalprozesse. Röntgen-Bl. 35 (1982) 90
33 *Savoca, Ch.J., J.H.M. Austin, H.I. Goldberg:* The right paratracheal stripe. Radiology 122 (1977) 295
34 *Savoca, Ch.J., R.C. Brasch, C.A. Gooding, G. Gamsu:* The right paratracheal stripe in children. Pediat. Radiol. 6 (1978) 203
35 *Bachmann, A.L., H.S. Teixidor:* The posterior tracheal band: a reflector of local superior mediastinal abnormality. Brit. J. Radiol. 48 (1975) 352
36 *Daffner, R.H., R.W. Postlethwait, Ch.E. Putman:* Retrotracheal abnormalities in esophageal carcinoma: prognostic implications. Amer. J. Roentgenol. 130 (1978) 719
37 *Palayew, M.J.:* The tracheo-esophageal stripe and the posterior tracheal band. Radiology 132 (1979) 11
38 *Putman, Ch.E., Curtis, A.Mc.B, M. Westfried, Th.C. McLoud:* Thickening of the posterior tracheal stripe: A sign of squamous cell carcinoma of the esophagus. Radiology 121 (1976) 533
39 *Heitzman, E.R.:* The mediastinum. Radiologic correlations with anatomy and pathology. The C.V. Mosby Company, Saint Louis 1977
40 *Mohammed, S.H., L. Fuentes, L.A. Munoz:* Prognostic significance or paratracheal soft tissue in lung cancer. Europ. J. Radiol. 1 (1981) 200
41 *Pinet, F., L. Loire, G. Maret et al.:* Primary tumors of the trachea. A clinical, radiological, and pathological evaluation of 12 cases. Europ. J. Radiol. 1 (1981) 88
42 *Woodring, J.H., C.M. Pulmano, R.K. Stevens:* The right paratracheal stripe in blunt chest trauma. Radiology 143 (1982) 605
43 *Neufang, K.F.R., W. Bülo:* Pleuraerguß beim Lobus venae azygos – Kasuistischer Beitrag zur Differentialdiagnose des verbreiterten oberen Mediastinums. Röntgen-Bl. 34 (1981) 438

Dr. K.F.R. Neufang, Radiologisches Institut der Universität, Zentralklinikum, Ebene 6, Josef-Stelzmann-Str. 9, D-5000 Köln 41