A radiological appraisal of the paravertebral shadow in diseases of the spine and mediastinum

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Introduction

THE PARAVERTEBRAL SHADOW is that area bounded medially by the lateral border of the thoracic vertebrae and laterally by the paraspinal line. The left paraspinal line is frequently observed in frontal radiographs of the dorsal spine as a thin vertical line running parallel to the vertebral column. It represents the reflection of the posterior mediastinal pleura between the vertebral column and the descending aorta (fig. 1). The fact that this portion of the mediastinal pleura is tangential to the incident rays in frontal views of the chest and dorsal spine makes it visible as a sharply defined line shadow, clearly contrasted against the neighbouring lung (fig. 2). Its radiological anatomy has been discussed by Lachman (1942), Brailsford (1943), Billing (1946) and Knutsson (1955). Because of a slight shift of the right mediastinal pleura across the midline at its reflection in the posterior mediastinum, the right paraspinal line is prevertebral in situation (Cimmine and Snead 1965) and is therefore less well defined.

In a survey of 54 normal subjects, Doyle, Read and Evans (1961) found the width of the left paravertebral shadow to be less than 6 mm. in nearly all their patients below 45 years of age. Above the age of 45, the width of this shadow varied from 0 – 19 mm. They postulated that the increase in width of the shadow with advancing age was most likely due to the presence of marginal oesteophytes which displace the mediastinal pleura laterally (fig. 3). Another likely factor was the dilatation and elongation of the descending thoracic aorta (fig. 4).

Because of the intimate relationship of the paravertebral shadow to the spinal column, sympathetic chains, descending aorta azygos and hemiazygos venous systems and lung parenchyma, any pathological change in these structures invariably causes an alteration in position, shape, density and width of the paravertebral shadow. In this paper, we will discuss some conditions affecting the dorsal spine and mediastinum with particular reference to the paravertebral shadow.

Case 1

R.A., a 60-year-old male Indian, presented with a history of progressive abdominal swelling for two years. He was a known alcoholic for 20 years. Examination disclosed gross ascites with pitting oedema of both legs. The neck veins were engorged and prominent tortuous collateral veins were seen extending from neck to groin on either side. The direction of blood flow was downwards. There was evidence of cardiac enlargement and basal crepitations were heard in the left chest. The clinical diagnosis was liver cirrhosis with superior vena caval obstruction.

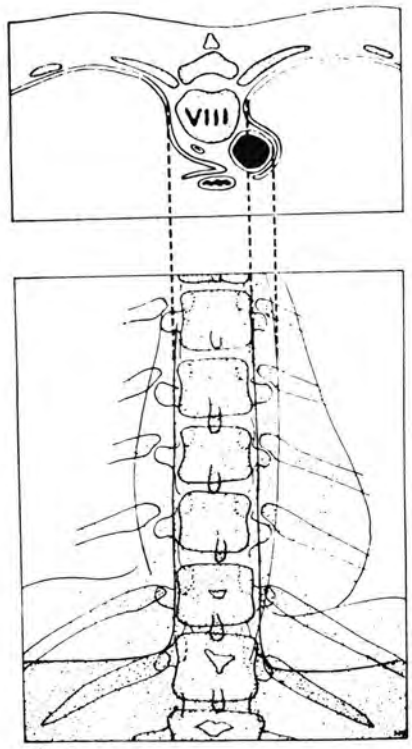

Fig. 1

Upper: Cross section through the posterior mediastinum at the level of the eighth thoracic vertebra. Lower: Diagram taken from a roentgenogram depicting the posterior portions of the visceral and/or parietal pleura as lines along the vertebral column. Dotted lines indicate anatomical substrates of pleural lines and aortic lines in cross section. (From Lachman, E., in Anat. Rec., vol. 83, 1942.)

The chest X-ray showed mild left ventricular enlargement. The lung fields were clear apart from a moderate left basal effusion. The superior mediastinum was widened and a penetrated view revealed widening of the left paravertebral shadow. A superior venocavogram confirmed the clinical diagnosis (fig. 5). There were extensive lateral thoracic and intercostal collaterals draining in the direction of the inferior vena cava and a rather prominent azygous vein. The latter, together with the prominent left paravertebral shadow, accounted for the widening of the mediastinum. The etiology of the superior vena caval obstruction was thought to be due to an idiopathic thrombosis although a fibrosing mediastinitis was also considered.

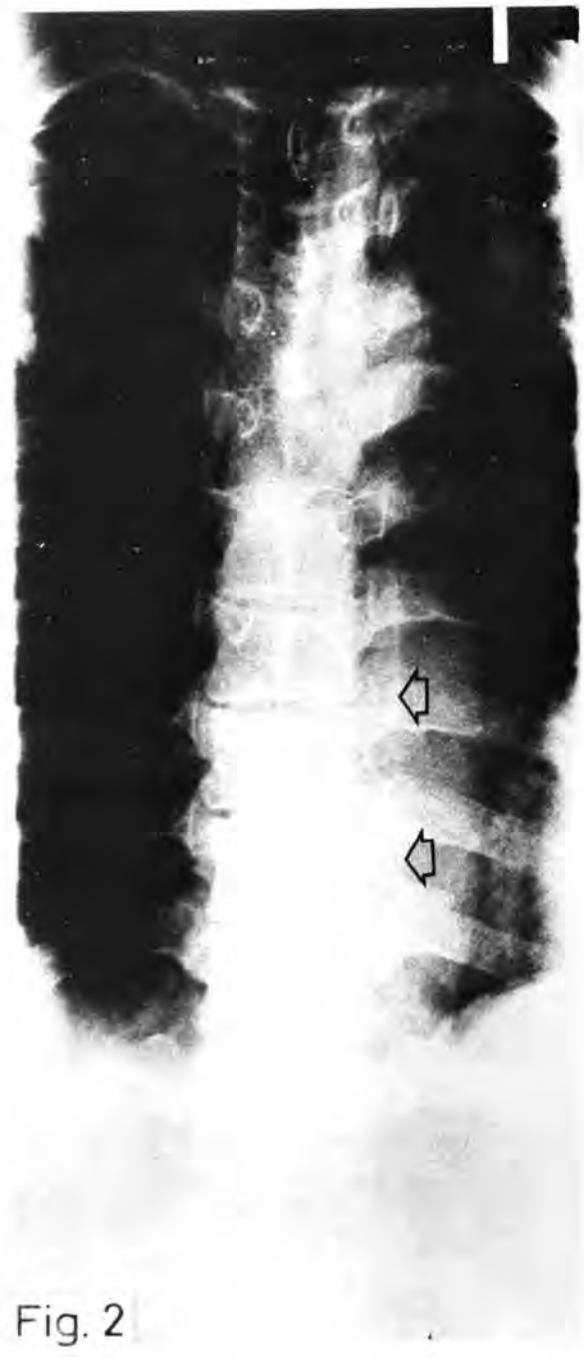

Fig. 2

Normal appearance of the left paraspinal line (arrows).

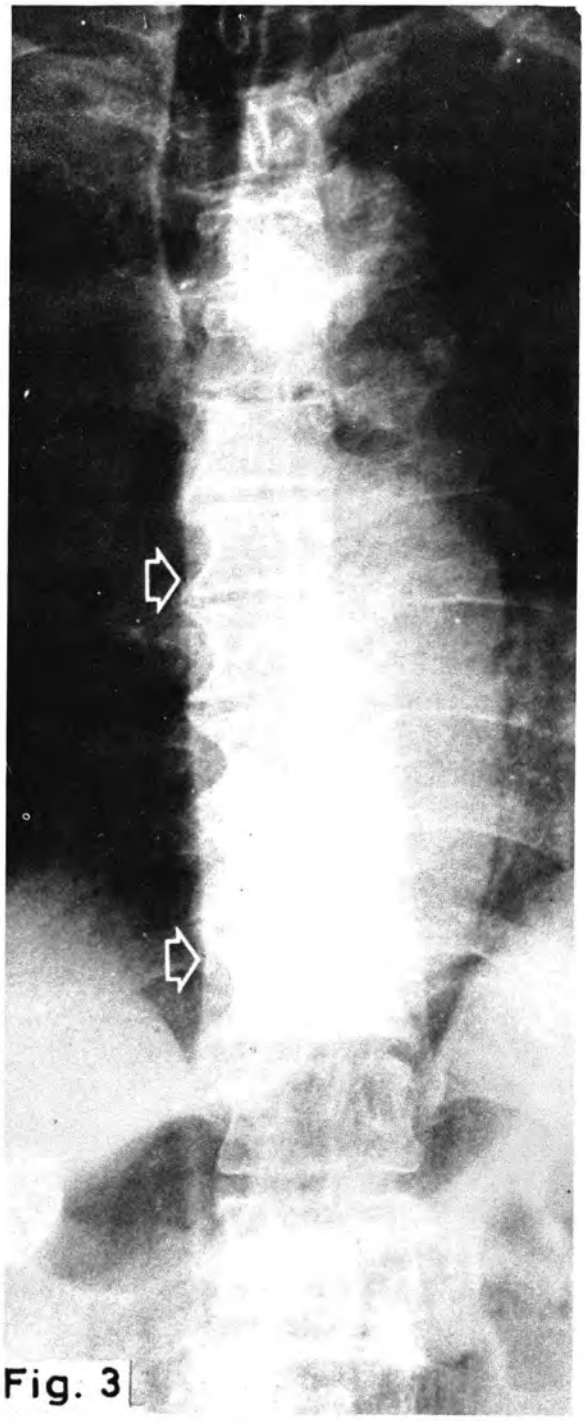

Fig. 3

Marked osteophytic lipping in the lower dorsal spine has resulted in lateral displacement of the right paraspinal line (arrows).

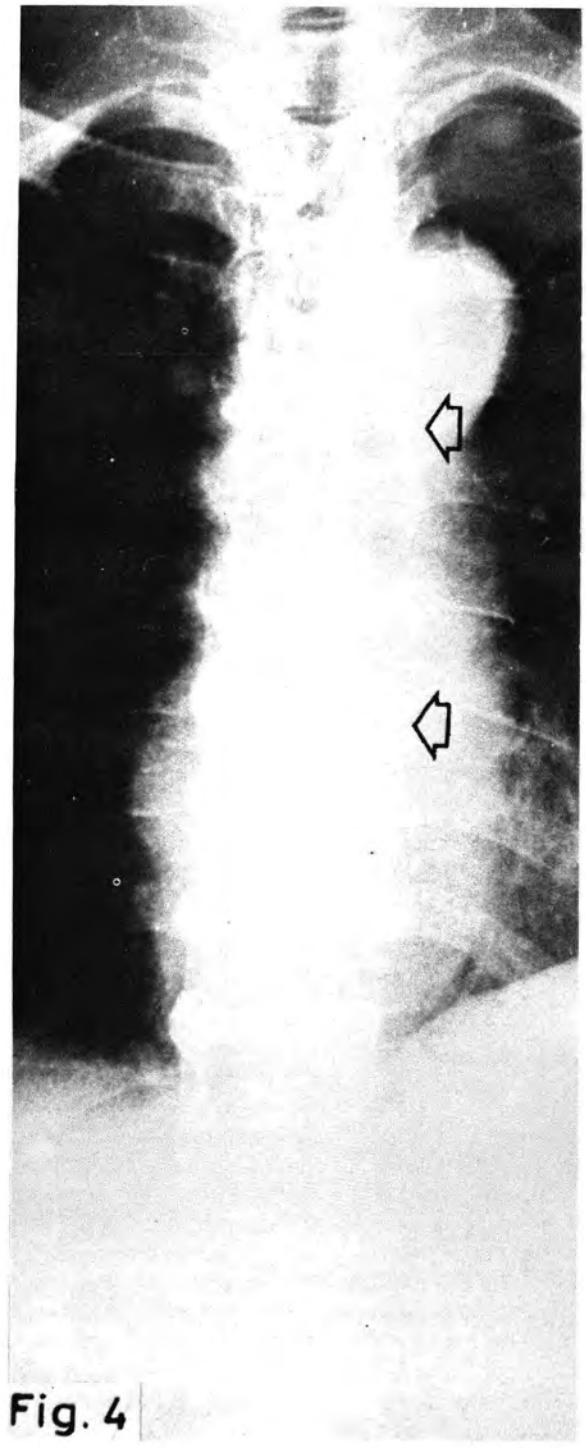

Fig. 4

An unfolded aorta has caused widening of the left paravertebral shadow (arrows).

Superior venocavogram shows obstruction of the superior vena cava and subclavian veins. Notice the huge lateral thoracic veins. Widening of the left paravertebral shadow is shown (arrows), most probably the result of a left mediastinal effusion associated with the left pleural effusion.

Comments

The width of the left paravertebral shadow is, on the whole, increased in patients with portal hypertension. This widening is believed by some to be due to dilatation of the left hemiazygous vein which lies just posterior to the descending aorta. Doyle et al, however, performed post-mortem intraosseous costal venograms on cirrhotic patients with portal hypertension and demonstrated that the opacified left hemiazygous vein did not consistently conform to the lateral margin of the left paravertebral shadow on the radiograph. They concluded that the widened left paravertebral shadow could be a summation of pathological changes inherent in the disease itself, namely excessive fluid retention in the mediastinum and dilatation of the left hemiazygous vein. An increase in width of the left paravertebral shadow, therefore, does not invariably mean a dilated hemiazygous vein. In the case presented, the widening could most likely be explained by the presence of a mediastinal effusion since a moderate collection of pleural fluid was obviously shown at the time of the venogram.

Case 2

C.K.L., a 26-year-old male Chinese, sustained a gun-shot wound in his upper chest posteriorly. The bullet penetrated his back in the region of the left scapula and lodged in the upper dorsal spine. Subsequent to this, he became paraplegic. X-ray examination of the spine confirmed the presence of a bullet in the body of D4. There was obvious paravertebral widening, notably in the superior mediastinum. The swelling had a well defined convex right margin. An area of consolidation was also noted in the left upper zone, due probably to lung contusion. The tracheal shadow appeared normal. An emergency laminectomy was performed to remove the bullet. Extravasated blood and exudates were noted in the paravertebral region and these were thought to be due to the result of tearing of small vessels. Post-operatively, the patient made a gradual recovery. The paravertebral shadow decreased rapidly in size and was no longer apparent two weeks after the operation.

Fig. 6

Haemomediastinum has resulted in widening of the right superior mediastinum and the left paravertebral shadow (arrows). Notice the bullet in the body of D4.

Comments

In this case, the injury was essentially confined to the vertebral body of D4 and the muscular tissues covering the back. Hence, the mediastinal widening

was actually a reflection of the reactive changes in the pre and paravertebral soft tissues. This abnormal radiological appearance was no longer apparent soon after haemostasis had been secured. The fact that the tracheal shadow in this patient was noted to be straight implied that no significant pressure was exerted on the mediastinal structures and thus a good prognosis.

True traumatic haemomediastinum, particularly the result of aortic rupture, carries with it a grave prognosis. Sandor (1967), reviewing a series of 16 cases, noted that four patients succumbed ultimately as a result of shock, severe mediastinal compression and exsanguination, despite a correct diagnosis in every case. Initially, there was marked bilateral widening of the superior mediastinum with well defined convex outer margins. If the patients survived for more than 72 hours, there was a tendency for the mediastinal shadow to be less well defined. A decrease in size was noted as a result of dispersion and absorption of the haematoma. The dimension of the haematoma in some cases was enormous, extending from the clavicular level down to the leaves of the diaphragm. One notable feature in the series was that of deviation of the supracarinal portion of the trachea towards the right. This invariably meant increased pressure within the mediastinum from partial or complete traumatic rupture of the aorta. Daily portable radiography of the chest, therefore, is mandatory in assessing the progress of the mediastinal and paravertebral shadows and the position of the tracheal shadow in relation to the mediastinal mass.

Case 3

T.S.T. was a 15-year-old male Chinese who sustained a fracture of his right femur in April 1970. He was seen a month later and was discovered to have a warm tender swelling at the site of injury. X-ray of the right femur showed a pathological fracture with a "sun-ray" type of periosteal reaction and evidence of soft tissue invasion (fig. 7). A needle biopsy of the mass revealed the histopathology to be consistent with Ewing's sarcoma. Chest X-ray was normal but a repeat examination on 29.6.70 showed opacification in the right upper zone and a nodular density in the right mid-zone, the appearances being in keeping with secondary pulmonary deposits. There was also widening of the right paravertebral shadow but its significance was not fully appreciated until later (fig. 8). Despite deep X-ray therapy, his condition deteriorated and a repeat chest X-ray on 11.8.70 disclosed an obvious paravertebral swelling on either side ex-

Fig. 7

Pathological fracture of right femur with sun-ray periosteal reaction invading neighbouring soft tissues. Proven case of Ewing's sarcoma.


Fig. 8

Chest X-ray of Case 3. Notice the right paravertebral bulge in the mid-dorsal region (arrows).


Fig. 9a

Chest X-ray of Case 3 showing further widening of the paravertebral shadow on either side (solid arrows). Open arrows indicate pulmonary deposits.

tending from D5 to D11 (fig. 9a). Antero-posterior view of the dorsal spine disclosed collapse of the bodies of D6, D7, D8, D9 and D10 (fig. 9b). His condition deteriorated further, and he died on 23.9.70.

Comments

With a biopsy proof of Ewing's sarcoma of the presenting lesion in the right thigh, the vertebral lesions with enlarged paravertebral shadows were most certainly due to the same disease process. Whether these vertebral osteolytic lesions represent metastases from the initial lesion in the thigh or independent multicentric foci could not be definitely established on purely radiological grounds. The secondary pulmonary deposits appearing concomitantly with the vertebral destruction seem to favour the former.

Ewing's sarcoma with metastases to the spine was reported by Hamilton (1940), Swenson (1943) and Epstein (1969). The latter reported two verified cases, one of which presented with a large left paravertebral swelling immediately adjacent ot a partially destroyed seventh thoracic vertebra. The cases recorded in the literature showed involvement of one to two vertebrae. Radiologically, Case 3 is unique in that the multiple vertebral involvement from D6 to D10 and the extensive fusiform paravertebral shadowings are salient features reminiscent of spinal tuberculosis. By the same token, an osteolytic type of pyogenic spondylitis must be included in the differential diagnosis.

A few words on the appearance of the paravertebral shadow in two other conditions affecting the spine may be relevant here. Hodgkin's Disease is known to give rise to a paravertebral shadow in about 6% of cases, according to Witten, Fayos and Lampe (1965). A peculiar feature here is the predeliction for the lower left paravertebral space. If the right side is ever affected, the widening is usually noted in the mid-dorsal region.

In middle-aged patients, presenting with osteoporosis, vertebral destruction and a paravertebral swelling, spinal myelomatosis has to be considered (fig. 10). According to Jackson (1968), a paravertebral soft tissue mass is uncommon in vertebral myelomatosis. Garret (1970), on the other hand, reported its presence in all his three cases. The same author noted persistence of these shadows despite clinical improve-

Fig. 9b

Antero-posterior view of dorsal spine shows multiple vertebral collapse with widening of paravertebral shadows (arrows).

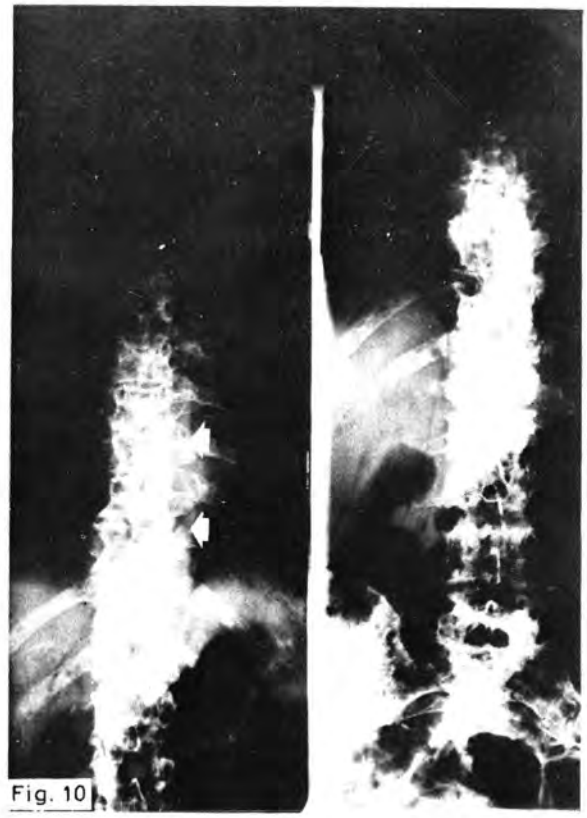

Fig. 10

Diffuse spinal myelomatosis. Arrows indicate slight paravertebral bulging in the left mid-dorsal region.

ment following Endoxan and deep X-ray therapy. According to Epstein (1969), paravertebral shadow widening is usually associated with extensive vertebral destruction with subsequent extension of the deposits into the adjacent soft tissues. An important differential point from other metastatic spinal carcinoma is the relatively infrequent destruction of pedicles in myelomatosis although the vertebral bodies may be collapsed (Jacobson, Poppel, Shapiro and Grossberger 1958; Jackson 1968).

Case 4

P.V.G., a 39-year-old female Indian, presented with increasing pain over the upper dorsal spine for one year. A few weeks prior to admission, she noticed radiation of pain round her chest. Examination showed a toxic looking patient. There was stiffness and tenderness on palpation of the dorsal spine. X-ray of the chest and dorsal spine disclosed a fusiform

paravertebral shadow extending from D2 to D7 (figs. 11a & b). The bodies and transverse processes of D3 and D4 appeared sclerotic. The intervertebral disc spaces, however, were not diminished. The diagnosis was chronic pyogenic osteomyelitis of the upper dorsal spine with paravertebral abscess formation. Exploration at D4 level revealed a thick-walled abscess cavity which was incised and evacuated. Histopathological examination of the evacuated material confirmed the presence of chronic pyogenic osteomyelitis. The post-operative X-rays showed a decrease in the width of the paravertebral shadow.

Case 5

L.L., a 47-year-old Indian man, presented with a history of a discharging sinus in the right flank and swelling in the right iliac fossa for more than one year. The sinus developed following an operation for a lump in the right flank.

On examination, he was emaciated and anaemic, and had a thoracic kyphosis. There was a swelling in the right flank and a tender swelling in the right iliac fossa. The clinical diagnosis was tuberculosis of the spine. A radiograph of the chest was normal. A lateral view of the dorsi-lumbar spine showed a gibbus at D11, resulting from vertebral destruction of the bodies of D12, D11 and D10. The antero-posterior projection showed some calcific densities in the paravertebral region compatible with old abscess formation. A more penetrated view of the spine confirmed the

Fig. 11a

Chest X-ray shows obvious bilateral paravertebral bulge (arrows).

Fig. 11b

Dorsal spine of same patient confirms the size and extent of the paravertebral shadows (arrows). Note the increased density of the affected vertebral bodies and appendages, particularly of D3 and D4.

massive vertebral collapse and widening of the left paravertebral shadow (fig. 12). Calcified debris were noted at the D11/D12 interspace. These findings confirmed the clinical diagnosis of tuberculosis of the spine.

Subsequently, drainage of the paravertebral abscess was carried out followed by sequestrectomy and bone grafting. The histopatholigical findings of the curretted material were consistent with tuberculosis of the spine. Post-operative X-rays disclosed progressive decrease in size of the paravertebral swelling.

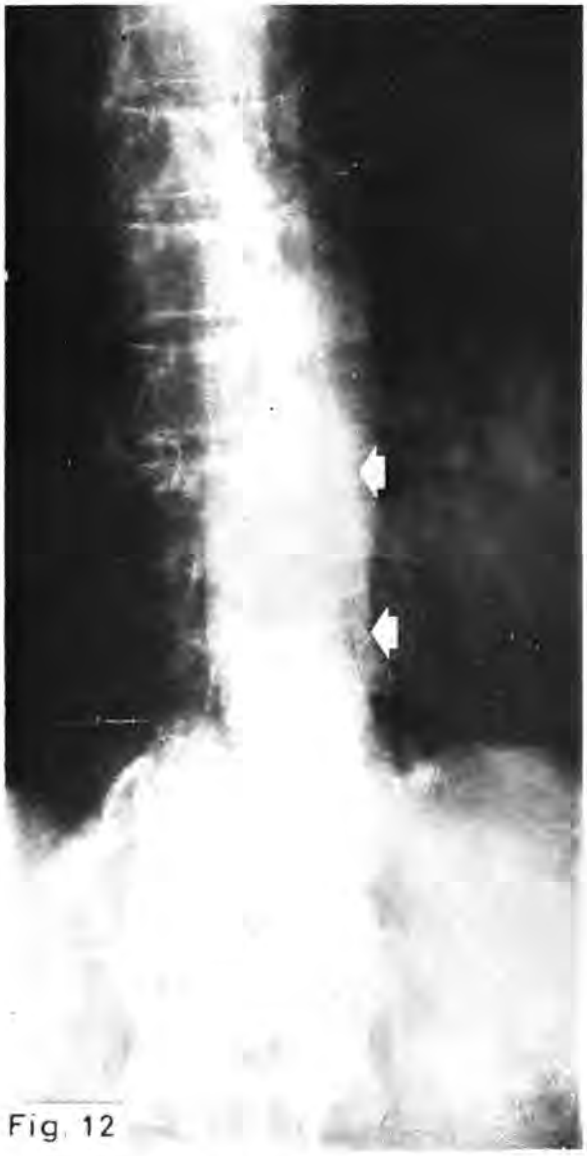

Fig. 12

Antero-posterior view of lower dorsal spine of Case 5 shows obvious vertebral destruction of D10 – D12. Arrows indicate left paravertebral bulge due to abscess formation.

Comments

In pyogenic infection of the thoracic spine, accumulation of inflammatory exudates in the paravertebral region would lead to a lateral displacement of the paraspinal line. This displacement is more obvious on the left and has been regarded as an early sign in dorsal spinal osteomyelitis by Millard (1963). A common observation with widespread infection is loss of definition and widening of the posterior mediastinal shadow. This is caused by localisation of the abscess in the anterior surfaces of the vertebral bodies and appendages. From here, the pus is able to track forward and also laterally into the posterior extrapleural spaces. In the pre-antibiotic era, the outcome of these conditions would most likely be empyema formation and suppurative pericarditis (Solomon and Bachman 1943). The appearance of the spine in chronic pyogenic infection is usually one of increased density due to the adequate time afforded for regeneration of osseous tissues before the patients finally come to the physician or surgeon because of severity of symptoms and a definitive diagnosis made. Equally significant is the complexity of clinical manifestations which may be referred to the abdomen, hips and lower limbs. False assumption of its rarity nowadays is another factor that is attributable to frequent failure of recognition of its exact nature until the disease process has gained a reasonable foothold on the already weakened vertebral column. Careful inspection of the width and outline of the mediastinum, preferably supplemented by a penetrated view, is essential if such conditions are to be recognised early.

In this community, differentiation from spinal tuberculosis still poses a problem to the radiologists. Middlemiss (1961) remarked on the relatively small paravertebral bulge in pyogenic or non-specific spondylitis. Its extent was said to be notably less than that of spinal tuberculosis. Hodgson, Wong and Yau (1969) also pointed out the importance of recognising the discrete appearance of the paravertebral shadow in pyogenic infection. However, the size of the paravertebral abscesses cannot be considered an accurate differential point between the two conditions as their appearances are in many ways dependent on the resistance of the patient and the virulence of the invading organisms. Nevertheless, Hodgson et al attached significance to this point in the assessment of activity of spinal tuberculosis. There seems to be a

direct proportion between the size of the abscess and the activity of the disease. The appearance of the involved vertebral bodies and appendages offer clues in differential diagnosis. Spinal tuberculosis, being a predominantly destructive process, presents more consistently with osteolysis and resultant collapse because of the invasive nature of the lesion, the whole process taking several months before X-ray changes are apparent. On the other hand, vertebral sclerosis is usually the rule with chronic pyogenic spondylitis. However, in fulminating pyogenic infection, vertebral destruction and disc space narrowing can appear in a matter of a few weeks.

Discussion

From the comments made in each of the case reports, it is clear that widening of the paravertebral shadow is only a single feature out of a number of important radiological signs manifested by each disease entity. Its ease of detection on a plain film necessitates its identification in all antero-posterior views of the dorsal spine. In a penetrated frontal view of the chest, it should be sought for particularly behind the cardiac shadow.

Its clinical significance in the early diagnosis of pyogenic osteomyelitis has been discussed. Pyogenic osteomyelitis of the spine is notorious for its protean manifestations which make its diagnosis elusive at times. Hence, in all cases of suspected pyogenic spinal osteomyelitis, the paravertebral shadow should be diligently examined.

The paravertebral shadow assumes prognostic significance in cases of mediastinal haematoma. A mediastinal bulge causing a supracarinal deviation of the tracheal shadow signifies increased mediastinal pressure and although the management is generally one of conservatism, surgical decompression may be indicated. The general outlook, however, remains grave.

The paravertebral shadow is also valuable in assessing response to medical or surgical treatment. In the cases described, the paravertebral shadow is noted to decrease in size with surgical treatment. This is particularly important in spinal tuberculosis where progressive bulging of the shadow, despite intensive medical treatment, invariably means active disease that can only be arrested by surgical decompression. This is also true with pyogenic spondylitis. In the case of Hodgkin's Disease being treated with radiotherapy, a favourable response to treatment would be indicated by a decrease in the size of the swelling. The situation, however, is quite the contrary in myelomatosis where clinical response to radiotherapy or chemotherapy is not reflected in the appearances of the paravertebral mass. A more useful index in such cases appears to be the degree of recalcification of the vertebrae.

Finally, one must be cautious of an apparent spontaneous decrease in size of the paravertebral abscess, particularly in children. In spinal tuberculosis, it often means pointing of the abscess through the pleura into the neighbouring lung tissues and bronchi. Other organs, in which the abscess may penetrate, include the aorta, oesophagus and the peritoneal cavity (Hodgson et al). Rarely, pus from pyogenic vertebral osteomyelitis may spread to involve the lung parenchyma and two cases have been reported by Lorimier, Haskin and Massie (1966) of young infants in which the primary manifestations were respiratory distress and a posterior mediastinal mass on chest X-rays. Fever or systemic toxicity was not apparent until radiological signs had become obvious.

Summary

1. The radiological anatomy of the paravertebral shadow is reviewed.
2. A series of cases illustrating the clinical significance of the paravertebral shadow in diseases of the spine and mediastinum are presented.
3. Its diagnostic and prognostic value is briefly discussed.

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