### Tumors of the chest wall and pleura; a pictorial review

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Learning objectives

Our objectives are to review and illustrate the pathology of lesions arising from the chest wall and pleura and to outline a method of diagnosing of these lesions according to the imaging findings.
Background

Tumours of the chest wall represent a heterogeneous group of lesions. They can be benign or malignant and can be divided into those of bony and those of soft tissue origin. They may be either primary or metastatic and may invade the chest wall from other structures as lung, pleura, mediastinum, or breast.

Benign tumors of the chest wall:

Arising from the skeletal (ribcage)

- Osteochondroma

Osteochondromas are usually thought of as benign bone tumor although they are more correctly thought of as developmental anomalies. Osteochondromas develop during childhood but once formed remain for the rest of the individual's life. They are most frequently found incidentally. They are usually sporadic, but can be part of hereditary multiple exostoses (also known as diaphyseal aclasis) or Trevor disease (also known as dysplasia epiphysealis hemimelica). Malignant transformation occurs in the cartilage cap, but is uncommon in sporadic solitary osteochondromas.

- Chondroma

The differentiation between chondroma and chondrosarcoma is impossible on clinical and radiographic findings. Microscopically, the benign chondroma and low grade malignant chondrosarcoma may look identical. Therefore, all chondromas must be considered malignant and should be treated by wide excision.

- Fibrous dysplasia

Fibrous dysplasia is a congenital process manifested as a defect in osteoblastic differentiation and maturation, with progressive replacement of normal bone with immature woven bone. It is found predominantly in children and young adults. The condition is often an incidental finding and is usually painless. It commonly presents as a solitary lesion. When multiple lesions are present, it is usually a part of Albright syndrome (multiple bone cysts, skin pigmentation, and precocious sexual maturity in girls) and is associated with polyostotic fibrous dysplasia.
Ribs are the most common site of monostotic fibrous dysplasia.

Sarcomatous de-differentiation is occasionally seen (less than 1%) and is more common in the polyostotic form.

- **Histiocytosis X**

  Histiocytosis X is a disease involving the reticuloendothelial system and includes eosinophilic granuloma, Letterer-Siwe disease, and Hand-Schuller-Christian disease.

  Eosinophilic granuloma primarily occurs in older children and young adults, with a male preponderance with a male to female ratio of 2:1.

- **Aneurysmal bone cyst**

  An aneurysmal bone cyst is a benign expansile tumour-like bone lesion composed of numerous blood filled channels.

  Aneurysmal bone cysts are primarily seen in children and adolescents.

  Although often primary, they can be secondary to an underlying lesion (e.g. chondroblastoma, fibrous dysplasia, giant cell tumor, osteosarcoma).

  In the chest wall, the most common sites of involvement are the posterior elements of the spine.

- **Giant cell tumor**

  Giant cell tumors consist of vascular sinuses that are lined or filled with abundant giant cells and spindle cells. These tumors are typically solitary but also may occur simultaneously or metachronously in multiples.

  The tumors typically manifest at age 21-40 years, after closure of the epiphyses, and are more common in women than in men.

**Arising from soft tissue:**

- **Lipomas**
Typically lipomas present in adulthood as a soft painless mass. These are likely to have been present for many years, and may change size with weight fluctuation.

Most lipomas that originate in the chest wall are deep lipomas, which tend to be larger and less well circumscribed than superficial lesions.

- **Neurogenic tumors**

  Schwannoma and neurofibroma are by far the commonest type of neurogenic tumour in adults.

  **Schwannomas**

  Schwannomas (also known as neurilemomas or neurinomas) are benign encapsulated neoplasms of schwann cells. They arise eccentrically from their parent nerve.

  Most schwannomas are solitary and sporadic, however multiple schwannomas are characteristic of neurofibromatosis type 2.

  **Neurofibromas**

  Three types of neurofibromas have been described: localized neurofibroma (the most common form), diffuse neurofibroma and plexiform neurofibroma (diffuse involvement of a long nerve segment and its branches, pathognomonic of neurofibromatosis type 1, usually occur in early childhood and have potential for malignant transformation).

- **Cavernous haemangiomas**

  Cavernous hemangiomas are composed of multiple dilated, thin walled tortuous vessels. They typically manifest at birth or before the age of 30 years and are typically cutaneous in location, large, and poorly circumscribed, and they can be locally destructive. Noncutaneous location is uncommon.

- **Elastofibroma dorsi**

  Elastofibroma dorsi is a benign soft-tissue tumor with a characteristic location and imaging appearance. It is more frequently seen in older women, with a reported female predilection of 5-13:1.
Elastofibroma dorsi is classically located in the infrascapular regions, deep to the serratus anterior and latissimus dorsi musculature. Unilateral masses have a slight right-sided predilection, but up to 60% of elastofibromas are bilateral.

**Malignant tumors of the chest wall:**

**Arising from the skeletal (ribs) cage**

**Primary**

- **Solitary and Multiple Myeloma**

Solitary myeloma and multiple myeloma are plasma cell tumors that manifest, respectively, as a single mass or with diffuse marrow involvement. Solitary myeloma is diagnosed in patients at a mean age of about 50 years, in contrast to multiple myeloma, in which the age range at manifestation is 50-70 years. Solitary myeloma may progress over time to multiple myeloma.

- **Chondrosarcoma**

Chondrosarcomas are malignant cartilaginous tumours that usually arise in the costochondral junction or in the sternum. Two peak periods of prevalence have been identified; the first, at less than 20 years of age, and the second, at more than 50 years of age. These tumors occur twice as often in men as in women. Most commonly appear as a slowly growing mass that has been painful for several months.

All tumors arising in the costal cartilages should be considered malignant.

Chondrosarcomas are either primary, arising de novo, or secondary and arise from a pre-existent cartilagenous mass (osteochondroma or enchondroma).

- **Osteosarcoma**

Osteosarcomas are malignant bone forming tumours that are more malignant than chondrosarcomas and have a less favorable prognosis. Osteosarcomas can be either primary or secondary. Primary osteosarcoma typically occurs in young patients with 75% occurring before the age of 20. Secondary osteosarcoma occurs in the elderly, usually
secondary to malignant degeneration of Paget's disease, extensive bone infarcts or post radiotherapy for other conditions.

- Ewing's sarcoma

Ewing sarcomas of the chest wall are seen predominantly in children and young adults. These tumours may either arise in the osseous structures of the chest wall (ribs, scapula, sternum of clavicle) or less frequently in the soft tissues of the chest. Ewing sarcoma of the chest wall develops either as a solitary mass or as multiple masses with an eccentric growth pattern. It often originates in a paravertebral region and extends through the vertebral foramina.

Metastatic lesions

Skeletal metastases are common. Although the diagnosis is often straightforward (in most cases the diagnosis of metastatic disease is already known), sometimes no known primary exists or they may mimic benign disease or other primary malignancies; then a bone biopsy can allow usually definitive diagnosis.

The major route of spread of tumour to bone is hematogenous, although lymphatic spread is also seen. Regardless of the route of spread, metastases lead to both bone loss and bone formation, in varying amounts.

Arising from the soft tissue:

Primary

- Malignant fibrohistiocytoma

Malignant fibrohistiocytoma is most frequently seen in elderly patients. It usually presents as a painless, slowly growing mass. It may be more common after chest wall irradiation. The tumor typically originates in deep fascia or skeletal muscle. These tumours tend to be invasive and spread into adjacent muscle groups, which explains the high recurrence rate after resection. Involvement of underlying bone is also not unusual.

- Aggressive fibromatosis
Aggressive fibromatosis or desmoid tumor is an infiltrative lesion with an intermediate proliferative tendency and with a tendency to local invasion and recurrence but without metastasis. Extensive chest wall resection is usually required. The shoulder is the most frequently affected area. These tumours are most commonly seen in young patients. Their exact aetiology remains uncertain, however, trauma, endocrine disorders and genetic factors have been implicated.

- **Rhabdomyosarcoma**

Rhabdomyosarcomas are high-grade sarcomas characterized by skeletal muscle differentiation. In general they are found in young patients and present as rapidly growing masses.

- **Liposarcoma**

Liposarcoma is an uncommon malignant tumor of fatty tissue. Liposarcomas are typically found in adults.

- **Leiomyosarcoma**

Leiomyosarcomas are extremely rare malignant neoplasms that originate from smooth muscle cells and may be considered the malignant counterpart of a leiomyoma. These tumors are frequently painful and typically occur in adulthood.

- **Lymphoma**

Chest wall lymphoma is rare; usually the tumour extends directly into the anterior chest wall from the mediastinum in patients with aggressive disease.

Extranodal diffuse large B-cell lymphoma, the primary lymphoma type most frequently found in the chest wall, manifests in a multinodular or diffuse infiltrative pattern. An increased incidence has been described in individuals who have undergone either orthopaedic surgery with metallic implants or organ transplantation with immunosuppressive treatment and in patients with AIDS.

- **Malignant peripheral nerve sheath tumours**
Malignant peripheral nerve sheath tumours are malignant forms of neurofibromas and schwannomas. They typically present in adults. They can either arise de-novo or de-differentiate from an existing neurofibroma or schwannoma. They can be associated with neurofibromatosis type I or previous irradiation. It is an aggressive tumour that carries an extremely poor prognosis.

**Secondary lesions that can involve the chest wall**

- **Metastatic**

Metastatic lesions to the chest wall are uncommon and usually are only seen in patients with extensive metastases elsewhere.

- **Direct invasion to the chest wall**

Tumours arising from the pleura can either be benign or malignant, and they may be either primary or metastatic.

**Benign tumors of the pleura**

- **Solitary fibrous tumor of the pleura**

Solitary fibrous tumor of the pleura, also known as pleural fibroma, is a benign pleural based tumour. It usually presents in adults. The majority of tumors tend to be benign and slow growing. Usually they are asymptomatic and discovered as an incidentally on a routine chest radiograph.

Asbestos exposure is not an association.

- **Benign mesothelioma**

It is a rare, benign form of mesothelioma. Benign pleural mesotheliomas usually arise from the visceral pleura on a stalk and project into the pleural space, although sessile attachment to the pleura may also occur.
Malignant tumors of the pleura

Primary

- **Mesothelioma**

Pleural mesothelioma in general is an aggressive malignant tumour. There is a strong association with exposure to asbestos fibres. There is characteristically a long latent period between exposure and development of the tumor. The increased risk occurs 20 years after the first exposure and continues to increase for many years thereafter.

Mesothelioma can be either localized or diffuse. Diffuse mesotheliomas are nearly always malignant, while only 30% of localized mesotheliomas are malignant. Pleural effusions are seen in the vast majority of patients at some stage during their disease. The prognosis is poor.

- **Fibrosarcoma** (uncommon)

- **Liposarcoma** (uncommon)

Secondary lesions

- **Metastases**

- **Direct invasion of tumors to the pleura**
Findings and procedure details

We review the diagnostic imaging features of the most common tumors arising from the chest wall and pleura giving particular attention to findings that may contribute to differential diagnosis.

Tumors of the chest wall:

OSTEOCHONDROMA

These tumors occur with particular frequency at the costochondral junction.

On plain film and CT, the cartilage cap is variable in appearance. It may be thin and difficult to identify, or thick with rings and arcs of calcification and irregular subchondral bone. CT is better able to demonstrate medullary continuity and the cartilage cap.

MRI is best at assessing cartilage thickness, presence of oedema in bone or adjacent soft tissues and visualising neurovascular structures in the vicinity.

The cartilage cap of osteochondromas appears the same as cartilage elsewhere, with intermediate to low signal on T1 and high signal on T2 weighted images.

Suspicion for malignancy. Pain at the lesion site, bone erosion or destruction, new cortical irregularity, continued growth after skeletal maturity has been reached, soft tissue component and a cartilage cap of over 1.5 cm in thickness is suspicious for malignant degeneration.

Key findings

Well-defined bone lesion with continuity of cortical and medullary bone with the site of origin (usually costochondral junction) with a cartilaginous apical cap.

GIANT CELL TUMOR
Thoracic giant cell tumors often arise in subchondral regions of the flat and tubular bones of the chest wall, including the sternum, clavicle, and ribs.

**Plain radiographs and CT** of these tumors show eccentric osteolytic lesions accompanied by cortical thinning and expansion.

**MRI.** Tumors typically appear as areas of low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Fluid-fluid levels are less commonly seen in these tumors than in aneurysmal bone cysts.

*Key findings*

Tumor arising in subchondral regions of the flat and tubular bones (sternum, clavicle, ribs), in a patient with epiphyses closed, showing cortical thinning with or without fluid-fluid levels.

**LIPOMA**

Lipomas are typically sharply circumscribed ovoid masses with homogeneous imaging characteristics of fat.

**CT.** Appearances on CT are characteristic demonstrating low density (typically approximately -65 to -120 HU).

**MRI.** Lipomas present T1 and T2 high signal and saturate on fat saturated sequences.

**Contrast enhancement.** After iv contrast administration, no or minimal enhancement is seen.

On ultrasound, lipomas appear as variably echogenic masses (they can be either hyperechoic, isoechoic, hypoechoic or of mixed echogenicity).

**Suspicion for malignancy.** Imaging features that favour a diagnosis of malignant transformation to liposarcoma include size greater than 10 cm, presence of a non-fatty soft tissue component, thick or nodular septae, absence of uniform signal loss on fat-suppressed MRI or evidence of invasion.
Key findings

Well circumscribed ovoid masses with homogeneous imaging characteristics of mature fat tissue with little or no septation.

(Fig.1-5)

BENIGN PERIPHERAL NERVE TUMORS

SCHWANNOMAS

Radiographs do not usually depict small schwannomas, but bone erosion or scalloping can occasionally be seen.

CT. Schwannomas on non-contrast CT appear as smooth, round lesions, either isodense or hypodense to chest wall muscle. Adjacent bone remodelling may be seen.

Contrast enhancement. Small tumours show homogeneous intense enhancement; larger tumours may show heterogeneous enhancement.

The larger a schwannoma is, the more likely it is to show heterogeneity because of cystic degeneration or haemorrhage.

MRI. At MRI schwannomas have signal intensity equal to or greater than muscle on T1-weighted images. T2-weighted imaging reveals a higher signal than T1 often heterogeneous, intermediate to high signal intensity when compared with adipose tissue.

Suspicion for malignancy. Malignant schwannomas have similar imaging findings, but often have associated abnormalities including pleural effusions, pleural nodules and metastatic pulmonary nodules. A rapid size increase, especially in neurofibromatosis should raise suspicion for malignancy.

The nerve from which the tumor originated can often be seen along one side of the mass.

Extreme pain that often accompanies percutaneous biopsy is further evidence of the neural origins of the tumor.
NEUROFIBROMAS

Neurofibromas are typically smoothly marginated, round or oval-shaped masses. Displacement of adjacent structures rather than invasion is seen.

CT. Neurofibromas have a low muscle-like attenuation on non-contrast CT.

Contrast enhancement. They show variable enhancement post contrast.

The MRI features include uniform low signal similar to muscle on T1, a hyperintense rim and central area of low signal ("target sign") may be seen on T2 weighted images; this is thought to be due to a dense central area of collagenous stroma. Although this sign is highly suggestive of neurofibroma, it is occasionally also seen in shwannomas and malignant peripheral nerve sheath tumours.

Avid or heterogenous enhancement is seen following intravenous administration of gadolinium.

Plexiform neurofibromas appear on CT and MRI as large multilobulated and conglomerated masses extending along nerves and nerve branches.

Suspicion for malignancy. Rapid growth on interval imaging and irregular borders are suspicious for malignancy (although imaging criteria are generally considered unreliable).

Key findings

Well-defined lesion in a extraskeletal location causing rib erosion without destruction is suspicious for schwannoma or neurofibroma.

"Target sign" is suggestive for neurofibroma.

(Fig.6-12)

CAVERNOUS HAEMANGIOMAS
They are typically cutaneous in location, large, and poorly circumscribed, and they can be locally destructive.

**Radiographs** may show a soft-tissue mass, which occasionally is associated with pressure erosion on adjacent bone.

**CT** scans show a soft-tissue mass with heterogeneous low levels of attenuation due to the fatty, fibrous, and vascular tissue elements of the mass. CT is more sensitive than plain radiography in detecting phleboliths, which are present in approximately 30% of cavernous hemangiomas.

**MRI** T1 and T2-weighted MR images typically reveal areas of high signal intensity in the mass. On T1-weighted images, intramuscular cavernous hemangiomas manifest as poorly marginated masses with signal intensity similar to that of skeletal muscle. Wispy or coarse linear areas of high signal intensity are common and thought to be caused in part by the presence of stagnant blood in cavernous or cystic spaces. On T2-weighted images, these tumors are well marginated and have high signal intensity compared with that of subcutaneous fat. Signal intensity voids caused by rapidly flowing blood also can be seen. At gradient echo, the presence of phleboliths may show blooming artefact.

Show marked **enhancement** post contrast.

**key imaging**

Soft tissue lesion (most commonly cutaneous) presenting phleboliths and marked vascular enhancement.

**ELASTOFIBROMA DORSI**

Elastofibroma dorsi is classically located in the infrascapular regions, deep to the serratus anterior and latissimus dorsi musculature.

**Ultrasound** demonstrates a lesion with a multi-layered pattern of hypoechoic linear areas of fat deposition intermixed with echogenic fibroelastic tissue.

**CT.** These masses typically appear as poorly defined soft-tissue mass with attenuation similar to that of the adjacent skeletal muscle, with a layered appearance on CT.
On MRI, a mass of low signal similar to muscle is seen, interspersed with linear high signal on T1 and T2 weighted images (fatty component). Although the borders of these masses are relatively well defined, no capsule can be identified.

Mild enhancement is seen post administration of contrast.

**Key findings**

Uni or bilateral lesions located in the infrascapular regions presenting a layered appearance due to intersected fatty component within fibrous tissue.

(Fig.13-14)

**AGGRESSIVE FIBROMATOSIS**

An infiltrative pattern is more common in young patients, whereas a nodular pattern is more frequent in adults. The tumor is usually confined to the musculature and adjacent fascia, but encasement of adjacent nerves and vessels also may occur. Infiltration of overlying subcutaneous tissue is uncommon, and although the lesion may cause pressure erosions on adjacent bones, bone invasion is unusual.

CT density can vary depending on the tumor composition, including the collagen content and amount of solid or necrotic tissue present. Lesions with a higher solid tissue component have greater attenuation and enhancement.

MRI. Their appearance is accounted for by their dense cellularity. On T1-weighted MRI images, tumors have signal intensity less than or equal to that of muscle. On T2-weighted images they have variable signal intensity. Differences in signal intensity between different tumor components, between asynchronous multicentric tumors, and between primary and recurrent lesions may be caused by a combination of variations in cellular contents, amount of collagen, water content of the extracellular space, and vascularity.

Most tumors will demonstrate enhancement following administration of intravenous contrast.

**Key findings**
Aggressive fibromatosis has no specific radiological findings, however it should be suspected in a young patient with tumor constricted to the musculature, showing either well or ill-defined margins.

**SOLITARY AND MULTIPLE MYELOMA**

**Solitary myeloma** of bone manifests radiologically as a multicystic expansile mass or purely osteolytic focus without expansion. Extraosseous solitary myeloma, which manifests as a nonspecific soft-tissue mass, progresses less frequently to multiple myeloma.

**Multiple myeloma** has two main diffuse patterns:

- numerous, well circumscribed lytic bone lesions (more common)

- generalized osteopaenia (less common), often associated with vertebral compression fractures / vertebra plana.

**Radiographs.** A skeletal survey is essential in not only the diagnosis of multiple myeloma, but also in assessing response, and pre-empting potential complications (e.g. pathological fracture). The vast majority of lesions are purely lytic, sharply defined / punched out with endosteal scalloping when abutting cortex.

**CT.** does not have a great role in the diagnosis of disseminated multiple myeloma, however it may be useful to determine the extent of extra-osseous soft tissue component in patients with a large disease burden.

At **MRI**, tumors show low signal intensity on T1-weighted images and high signal intensity on T2-weighted images.

Contrast-enhanced MRI may be an effective means of monitoring the response to therapy.

The main differential is that of widespread bony metastases. One finding that favour the diagnosis of bony metastases over that of multiple myeloma is more commonly affect the vertebral pedicles rather than vertebral bodies.
**Key findings**

Diffuse osteolytic change in association with a soft-tissue rib mass can be helpful in suggesting diagnoses multiple myeloma.

**CHONDROSARCOMA**

In general these tumours arise in the costochondral junction or in the sternum and are multilobulated (due to hyaline cartilage nodules) with central high water content and peripheral enchondral ossification.

Imaging findings vary somewhat with different sub types but do have some general features.

**Radiographs.** Bone destruction, irregular contours, and intratumoral calcification are characteristic but variable features. The degree and type of calcification may vary; images may show rings and arcs, flocculent or stippled calcification, or dense calcification. Moth eaten appearance or permeative appearance in higher grade tumours.

**CT.** can show chondroid matrix calcifications, endosteal scalloping and cortical breach. The better-differentiated chondrosarcomas appear on CT scans as well-defined, densely calcified soft-tissue masses.

**MRI.** T1-weighted MR images show lobulated masses with signal intensity similar to that of muscle, and T2- weighted MR images show masses with signal intensity equal to or greater than that of fat. Gradient echo shows blooming of mineralised / calcified portions.

**Enhancement** after administration of intravenous contrast material typically is heterogeneous, especially at the periphery.

**Key findings**

Multilobulated tumor arising in costal cartilages showing chondroid matrix calcifications in association with a soft-tissue mass.

**METASTATIC BONE LESIONS**
Skeletal metastases invariably incite a mixture of bone resorption and bone formation and can thus take on one of three patterns, depending on the dominant process: lytic, sclerotic or mixed lytic and sclerotic metastases.

Additionally, metastases can have different morphological characteristics: diffuse, focal or expansile.

MRI is highly sensitive to replacement of normal bone marrow.

When no history of malignancy is present, but lesions are multiple in an elderly patient, the main differential is multiple myeloma.

*Key findings*

Multiple bone lesions and primary known malignancy.

(Fig.15-19)

**METASTATIC SOFT TISSUE LESIONS**

Should also be suspected in a patient with history of malignancy.

(Fig.20-21)

**DIRECT INVASION OF THE CHEST WALL**

(Fig.22-24)

**Tumors of the pleura:**

Extrapulmonary masses usually appear as lesions convex towards the lung and are usually sharply defined. Pleural lesions classically form an obtuse angle where the mass meets the chest wall whereas parenchymal lesions classically produce an acute angle.
However, sometimes differentiation between intra and extrapulmonary mass may not be evident.

(Fig.25-34)

SOLITARY FIBROUS TUMOR OF THE PLEURA

Radiographs. Solitary fibrous tumor of the pleura presents as a pleural based mass, it tends to be relatively circumscribed and can sometimes be lobulated. Pedunculated lesions can change position and appearance with respiration or with a change in position on serial radiographs.

Calcification, rib destruction, and pleural effusions are typically not associated features.

CT. The tumor tends to have soft tissue attenuation on unenhanced scans. The size of the lesion will strongly affect its appearance on computed tomography: smaller lesions usually appear as homogeneous, well-defined, rarely lobulated masses forming obtuse angles against the pleural surface. Large lesions appear inhomogeneous and connected at acute angles. Intrallesional calcifications (punctate, linear or coarse) associated with areas of necrosis may be recognised in larger lesions.

MRI. Due to the fibrous component, signal characteristics tend to be low to intermediate signal at T1-weighted MR images and low signal on T2-weighted MR images (thought to be due to high cellularity and abundant collagen), however areas of necrosis and myxoid degeneration can have high signal.

MR may also show necrotic, haemorrhagic and cystic components in better detail if these entities are present.

Solitary fibrous tumor of the pleural show relatively homogenous intense enhancement on contrast enhanced scans. Non-enhancing areas may be present corresponding to necrosis, myxoid degeneration, or hemorrhage within the tumour. A pediculer attachment may also be seen.

*Key findings*

Well defined pleural based mass without rib destruction or pleural effusions.
MESOTHELIOMA

Diffuse mesotheliomas.

Plain film. Chest radiographs are of limited utility and are non-specific, demonstrating a pleural opacity which may extend around and encase the lung. Reduction in volume of the affected hemithorax is common resulting in shift of the mediastinum towards the lesion.

CT is the most commonly used modality for the assessment of mesothelioma and is able to stage the disease accurately in most patients. The appearance is that of a soft tissue attenuation nodular mass which spreads along pleural surfaces including into pleural fissures and often creating a pleural rind. Calcification is seen in 20% of cases which usually represents engulfed calcified pleural plaques rather than true tumour calcification. Sarcomatoid variants may demonstrate osteosarcoma or chondrosarcomatous components which may also be calcified. Rib destruction or extension beyond the lateral and anterior margins of the chest wall may be evident. Mediastinal lymph node enlargement and pleural effusion may also be seen.

Key findings

Soft tissue attenuation nodular mass which spreads along pleural surfaces with or without pleural effusion in a patient with history of exposure to asbestos.

Localized malignant mesotheliomas

CT. It has appearances reminiscent of a solitary fibrous tumour of the pleura.

Mesotheliomas have a predilection for direct invasion of adjacent structures (chest wall, diaphragm and mediastinal content) but also frequently metastasise to the contralateral lung and local nodes. To confidently predict chest wall invasion the extrapleural fat plane should be seen to be infiltrated and / or direct extension in bone or muscle identified. Presence of a pericardial effusion suggests transpericardial extension.
MRI. Although not routinely used, may have a role in refining the staging and better delineating the extent of the disease in surgical candidates especially with regard to chest wall and diaphragmatic invasion. The lesion tends to be iso to slightly hyperintense compared to muscle at T1- weighted MR images and iso to hyper intense on T2- weighted MR images.

Enhancement usually present after iv contrast administration.

Key findings

Pleural mass which can be locally aggressive in a patient with history of exposure to asbestos.

METASTASES OF THE PLEURA

Should be suspected in a patient with history of malignancy and pleural thickening or nodules. Pleural effusion may also be present.

(Fig.44)
Fig. 1: Fig 1-4. Lipoma in a 78-year-old woman. Axial unenhanced CT scan shows a large (7 x 3 x 2.7 cm) supraclavicular fatty lesion, extending anterior to the intercostal muscles on the left side. The lesion has homogeneous low density equal to fat. There is no evidence of thick or nodular septae within the lesion. The lesion was removed and no evidence of malignancy was found.

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Fig. 2: Fig 1-4. Lipoma in a 78-year-old woman. Sagittal T1-weighted image shows a large (7 x 3 x 2.7 cm) supraclavicular fatty lesion, extending anterior to the intercostal muscles on the left side. The lesion has homogeneous signal intensity equal to fat in all sequences and saturates homogeneously on fat saturated sequences. There is no evidence of thick or nodular septae within the lesion. The lesion was removed and no evidence of malignancy was found.

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**Fig. 3**: Fig 1-4. Lipoma in a 78-year-old woman. Axial T1-weighted image without (above) and with (below) fat saturation shows a large (7 x 3 x 2.7 cm) supraclavicular fatty lesion, extending anterior to the intercostal muscles on the left side. The lesion has homogeneous signal intensity equal to fat in all sequences and saturates homogeneously on fat saturated sequences. There is no evidence of thick or nodular septae within the lesion. The lesion was removed and no evidence of malignancy was found.

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Fig. 4: Fig 1-4. Lipoma in a 78-year-old woman. Coronal T1-weighted image (on the left) and STIR image (on the right) shows a large (7 x 3 x 2,7 cm) supraclavicular fatty lesion, extending anterior to the intercostal muscles on the left side. The lesion has homogeneous signal intensity equal to fat in all sequences and saturates homogeneously on fat saturated sequences. There is no evidence of thick or nodular septae within the lesion. The lesion was removed and no evidence of malignancy was found.

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**Fig. 5:** Subcutaneous lipoma in a 54-year-old-man. Ultrasound image shows a homogeneous well defined ovoid mass isoechogenic to the surrounding subcutaneous fat.

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**Fig. 6:** Fig.6-10. Shwannoma in a 40-year-old woman. Frontal chest radiograph shows a large partially well-defined mass in the left side suggestive of being an extrapulmonary lesion. Adjacent bone remodelling is also seen.

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Fig. 7: Fig.6-10. Shwannoma in a 40-year-old woman. Axial contrast-enhanced CT scan shows a large well-defined extrapulmonary mass in the left chest wall enhancing heterogeneously. The presence of heterogeneous attenuation indicates cystic degeneration and haemorrhage. The tumor causes bone remodelling of the adjacent sixth and seventh ribs due to slow growth of the tumor.

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Fig. 8: Fig.6-10. Shwannoma in a 40-year-old woman. Axial contrast-enhanced CT scan shows a large well-defined extrapulmonary mass in the left chest wall enhancing heterogeneously. The presence of heterogeneous attenuation indicates cystic degeneration and haemorrhage. The tumor causes bone remodelling of the adjacent sixth and seventh ribs due to slow growth of the tumor.

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Fig. 9: Fig.6-10. Schwannoma in a 40-year-old woman. Sagittal contrast-enhanced CT scan shows a large well-defined extrapulmonary mass in the left chest wall enhancing heterogeneously. The presence of heterogeneous attenuation indicates cystic degeneration and haemorrhage. The tumor causes bone remodelling of the adjacent sixth and seventh ribs due to slow growth of the tumor.

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Fig. 10: Fig.6-10. Shwannoma in a 40-year-old woman. Ultrasound images show a heterogeneous solid-cystic mass with mild Doppler signal. Patient complained of extreme pain during the percutaneous biopsy - highly suggestive of a neural origin of the tumor.

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**Fig. 11:** Fig 11-12. Swannoma in a 39-year-old man. Axial (above) and coronal (below) contrast-enhanced CT scan shows a large well-defined extrapulmonary mass in the right chest wall enhancing heterogeneously. The presence of heterogeneous attenuation indicates cystic degeneration and haemorrhage.

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**Fig. 12:** Swannoma in a 39-year-old man. Axial T1-weighted image (left) and coronal T2-weighted images (right) show a large well-defined extrapulmonary mass in the right chest wall. The tumor appears as an area of heterogeneous signal intensity greater than muscle on T1-weighted images and heterogeneous high signal intensity on T2-weighted images. There is tumor infiltration of the twelfth vertebral body.

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**Fig. 13:** Bilateral elastofibroma dorsi in a 46 year-old man. Axial T1-weighted image (above), T2-weighted image (middle) and STIR image (below) show a relatively well defined bilateral mass of low signal intensity similar to muscle in all sequences, interspersed with linear high signal on T1 and T2 weighted images due to fatty component that suppress in fat-suppressed sequences. The lesions are located in the infrascapular regions, deep to the serratus anterior and latissimus dorsi musculature.

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**Fig. 14:** Fig.13-14. Bilateral elastofibroma dorsi in a 46 year-old man. T1-weighted image pre (above) and post (below) contrast administration show a relatively well defined bilateral mass of low signal intensity similar to muscle in all sequences, interspersed with linear high signal on T1 and T2 weighted images due to fatty component that suppress in fat-suppressed sequences. Moderate enhancement is seen post administration of contrast. The lesions are located in the infrascapular regions, deep to the serratus anterior and latissimus dorsi musculature.

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**Fig. 15:** Lung carcinoma bone metastasis in a 69-year-old man. Axial T1-weighted image (at the upper left), sagittal T2-weighted image (at the upper right) and axial contrast-enhanced CT scan (bottom) show a lytic lesion with soft tissue component of the ninth vertebral body causing canal stenosis.

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**Fig. 16:** Fig.16-18. Carcinoma bone metastasis in a 69-year-old man. Frontal chest radiograph shows lysis of the posterior seventh rib on the left side due to metastatic disease.

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Fig. 17: Fig.16-18. Carcinoma bone metastasis in a 69-year-old man. Axial contrast-enhanced CT scan shows a heterogeneous lytic lesion with soft tissue and cystic component and contrast enhancement of the posterior seventh rib on the left side due to metastatic disease.

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Fig. 18: Fig.16-18. Carcinoma bone metastasis in a 69-year-old man. Sagittal T1-weighted image (upper left), T2-weighted image (upper middle), STIR image (upper left) and contrast enhanced T1-weighted image shows a heterogeneous lytic lesion with soft tissue and cystic component and contrast enhancement of the posterior seventh rib on the left side due to metastatic disease.

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Fig. 19: Carcinoma bone metastasis in a 67-year-old man. Axial contrast-enhanced CT scan shows a lytic lesion with soft tissue component of the second costal arch on the left side due to metastatic disease.

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Fig. 20: Fig.20-21. Metastatic chest wall lesion in a 59-year-old man. Axial contrast-enhanced CT scan shows a left pulmonary hilium lesion extending into the mediastinum consistent with carcinoma (a). A small lesion (12 mm) is also depicted at the subcutaneous fat, anterior to the pectoralis major muscle, in the right chest wall (b). The lesion increased in size (17 mm) (c) and needle biopsy diagnosed a metastases from carcinoma. The lesion reduced in size after chemotherapy (7 mm) (d).

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Fig. 21: Fig.20-21. Metastatic chest wall lesion in a 59-year-old man. US image shows a homogeneous ill defined round mass hypoechoogenic to the surrounding subcutaneous fat.

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Fig. 22: Fig.22-24. Pancoast tumor with chest wall invasion in a 75-year-old man. Axial contrast enhanced CT scan shows a Pancoast tumor on the right side with direct invasion of the chest wall.

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**Fig. 23:** Fig.22-24. Pancoast tumor with chest wall invasion in a 75-year-old man. Sagittal T2-weighted image (on the left), T1-weighted image (on the middle) and STIR image (on the right) show a Pancoast tumor on the right side with direct invasion of the chest wall.

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**Fig. 24:** Fig. 22-24. Pancoast tumor with chest wall invasion in a 75-year-old man. Axial T1-weighted image shows a Pancoast tumor on the right side with direct invasion of the chest wall.

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Fig. 25: Fig. 25-27. Lung carcinoma in a 42-year-old woman. Frontal and lateral chest radiograph show a large lesion (15 x 10 x 12 mm) in the right hemithorax, forming acute angles where the mass meets the chest wall, indicating a pulmonary origin of the mass.

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Fig. 26: Fig. 25-27. Lung carcinoma in a 42-year-old woman. Unenhanced axial CT scan shows a large heterogeneous lesion (15 x 10 x 12 mm) in the right hemithorax, forming acute angles where the mass meets the chest wall, indicating a pulmonary origin of the mass.

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Fig. 27: Fig. 25-27. Lung carcinoma in a 42-year-old woman. Unenhanced coronal CT scan shows a large heterogeneous lesion (15 x 10 x 12 mm) in the right hemithorax, forming acute angles where the mass meets the chest wall, indicating a pulmonary origin of the mass.

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**Fig. 28:** Lung carcinoma in a 70-year-old man. Unenhanced axial CT scan shows a small lesion in the right hemithorax, forming acute angles where the mass meets the chest wall, indicating a pulmonary origin of the lesion.

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Fig. 29: Fig.29-30. Lung carcinoma in a 77-year-old woman. Axial contrast enhanced CT scan shows a lesion in the left hemithorax, forming both obtuse (superiorly) and acute angles where the mass meets the chest wall, in this case difficult to conclude the pulmonary origin of the lesion.

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Fig. 30: Fig.29-30. Lung carcinoma in a 77-year-old woman. Coronal (left) and sagittal (right) contrast enhanced CT scan shows a lesion in the left hemithorax, forming both obtuse (superiorly) and acute angles where the mass meets the chest wall, in this case difficult to conclude the pulmonary origin of the lesion.

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**Fig. 31:** Pleural lesion in a 48 year-old woman. Axial T2-weighted image (above) and axial unenhanced CT scan (below) show a sharply defined lesion in the left hemithorax, convex towards the lung and forming an obtuse angle where the mass meets the chest wall, indicating a pleural origin of the mass.

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**Fig. 32:** Pleural lesion in a 78 year-old woman. Axial unenhanced CT scan shows a sharply defined lesion in the right hemithorax, convex towards the lung and forming an obtuse angle where the mass meets the chest wall, indicating a pleural origin of the mass.

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Fig. 33: Fig.33-34. Benign reactive angiomatous pleural tumor in a 31-year-old woman. Unenhanced axial CT scan shows a sharply defined pleural lesion in the anterior aspect of the right hemithorax. There is mild remodelling of the adjacent bone and a small calcification within the lesion.

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**Fig. 34:** Fig.33-34. Benign reactive angiomatous pleural tumor in a 31-year-old woman. Unenhanced axial CT scan shows a sharply defined pleural lesion in the anterior aspect of the right hemithorax. There is mild remodelling of the adjacent bone and a small calcification within the lesion.

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**Fig. 35:** Fig. 35-36. Solitary fibrous tumor of the pleura in a 67 year-old-man. Axial contrast-enhanced CT scan shows an apical paramediastinal pulmonary nodule on the right side consistent with lung carcinoma. A well-defined pleural-based mass that enhances homogeneously is also seen postero-basally on the right side (fig 36). Needle biopsy was performed to exclude metastatic disease and the diagnosis was consistent with a solitary fibrous tumor. Pleural effusion is also noted on the right side.

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Fig. 36: Fig. 35-36. Solitary fibrous tumor of the pleura in a 67 year-old-man. Axial contrast-enhanced CT scan shows an apical paramediastinal pulmonary nodule on the right side consistent with lung carcinoma (fig 35). A well-defined pleural-based mass that enhances homogeneously is also seen postero-basally on the right side. Needle biopsy was performed to exclude metastatic disease and the diagnosis was consistent with a solitary fibrous tumor. Pleural effusion is also noted on the right side.

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**Fig. 37:** Fig.37-40. Malignant mesothelioma in a 82-year-old man. Frontal and lateral chest radiograph show a large pleural effusion on the left side.

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Fig. 38: Fig.37-40. Malignant mesothelioma in a 82-year-old man. Axial contrast-enhanced CT scan shows a large pleural effusion in the left side. A pneumothorax (due to previous pleural puncture) is also noted.

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**Fig. 39:** Fig.37-40. Malignant mesothelioma in a 82-year-old man. Axial contrast-enhanced CT scan shows a large pleural effusion in the left side causing collapse of the adjacent lung and mild pleural thickening. A pneumothorax (due to previous pleural puncture) is also noted.

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Fig. 40: Fig.37-40. Malignant mesothelioma in a 82-year-old man. Axial contrast-enhanced CT scan shows a large pleural effusion in the left side causing collapse of the adjacent lung and mild pleural thickening. A hiatal hernia and pneumothorax (due to previous pleural puncture) are also noted.

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Fig. 41: Fig. 41-43. Sarcomatoid variant of malignant mesothelioma in a 77-year-old man. Frontal and lateral chest radiograph show a large pleural effusion on the right side.

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Fig. 42: Fig.41-43. Sarcomatoid variant of malignant mesothelioma in a 77-year-old man. Axial contrast-enhanced CT scan shows a large pleural effusion on the right side causing collapse of the adjacent lung. No significant pleural thickening was noted in this case.

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Fig. 43: Fig. 41-43. Sarcomatoid variant of malignant mesothelioma in a 77-year-old man. Axial contrast-enhanced CT scan shows a large pleural effusion on the right side causing collapse of the adjacent lung. No significant pleural thickening was noted in this case.

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**Fig. 44:** Pleural metastases in a 80-year-old man. Axial contrast enhanced CT scan shows small pleural based soft tissue nodules in the left side consistent with metastatic disease of lung carcinoma. Pleural effusion on the left side is also noted.

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Conclusion

Tumors of the chest wall and pleura vary widely in pathology. An adequate knowledge of its typical location and distinctive radiological findings is necessary to suggest an accurate radiological diagnosis and will be crucial in the therapeutic decision-making process.
References


