Radiologic Assessment of scapular region: US, MDCT and MR features

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Learning objectives

1) Describe the normal anatomy of the scapular region on US, MDCT and MRI imaging.
2) Review the spectrum of findings of various disease processes involving the scapula.
3) Propose a differential diagnosis of scapular injury.
Background

SCAPULAR ANATOMY

The scapula (shoulder blade) is a flat, broad and triangular bone, lies obliquely over the posterior aspect of the chest wall at the first seven ribs.

Consists of two surfaces, three borders and three angles.

The anterior or costal surface is concave (subscapular fossa), within the interserrato-scapular space make up the slippage area of the scapular thoracic joint. The dorsal surface is convex, and is divided into two unequal areas by a shelf like projection, the spine, with the smaller supraspinal fossa above and the larger infraspinous fossa below. The spine of the scapula is continued laterally through a wide apophysis: the acromion which articulates with the clavicle.

There are three scapular borders: upper edge ends in the supraspinous or spinoglenoid notch which runs the suprascapular nerve, just medial to the base of the coracoid process. The medial edge to the insertion of the rhomboid muscles and lateral or axillary edge where attach teres major and minor muscles and the long head tendon of the biceps (infraglenoid tubercule)

There are three angles in the scapula: superior angle, inferior and lateral angle. The lateral angle has three important anatomical structures: the glenoid cavity is a convex articular surface that articulates with the humeral head (glenohumeral joint), the neck of the scapula and coracoid process

IMAGING TECHNICHES

The evaluation of scapular region begins with careful inspection of available plain X-ray. These may provide valuable clues to the cause of the scapular disease, but in most cases, however, further evaluation of it requires cross-sectional imaging with US, MDCT an MR.

X-ray plain

The humero-scapular region can be evaluated on anteroposterior radiographs obtained with the arm in neutral position.
However this technique is sometimes limited by the overlap of the humeral head. As special screenings are performed. The projection transescapular or shoulder girdle and provides a true lateral projection of the shoulder, and an oblique view of the proximal humerus. It is done with the patient standing with the injured hand resting on the table with the arm slightly radiological abducted. Injuries to the acromioclavicular joint are evaluated with anteroposterior projection obtained with a tube head angulation of 15° radiographic tube.

**US Technique**

The US equipment suitable for scapular region imaging are those equipped with 3.5-, 5-, 7.5-, or 10-MHz linear, convex, and sector transducers. During the US examination, patients can be scanned in a sitting or prone position. The probe is moved in transverse or longitudinal positions along the scapular dorsal surface. The approach to anterior or costal surface is not available.

A higher frequency (5- or 7.5-MHz) transducer provides better resolutions of near structures. Otherwise, a 3.5-MHz transducer is more suitable for visualization of deeper lesions. A linear or convex transducer usually has a broad view of the field and is better than a sector scanner for screening. A high-frequency (preferably 10-12-MHz) linear transducer is better to show the spine, the supraspinous or spinoglenoid notch and the muscles.

**CT**

Multislice CT (MDCT) has added advantages for musculoskeletal imaging, including volume imaging, the ability to acquire multiplanar reconstructions (MPRs) with near isotropic viewing, three-dimensional (3D) images and thick slice (wedge) MPRs that mimic conventional radiographs. A volumetric image set with isotropic properties can be obtained in a single acquisition with a 0.5-mm slice width.

All these are achieved following a single data acquisition without the need for gantry angulation.

The CT is an fast acquisition imaging technique that allows anatomical knowledge of the scapular region, characterizes the nature, the size, the dependence of the injury and values the bone involvement.

**MR**
MRI has shown considerable advantages in the exploration of the scapular region. This mode is particularly effective for the visualization of soft tissue abnormalities, traumatic events such as labral tear, deep knowledge of the properties of an injury, bone disease characterization of tumor and its extension. From the technical point of view must be taken into account that the muscles of the region are oriented escpular multiple orthogonal axes, so that the study in oblique planes is much more effective. Plans of study are the oblique coronal (along the long axis of the supraspinatus muscle belly), the oblique sagittal (perpendicular to the path of the supraspinatus muscle) and axial. Sagittal planes are useful to appreciate the morphological changes of the acromion.

The pulse sequences T1 show structural anatomy. The pulse sequences proton density and T2 provide the information necessary to evaluate the patologua of the joint spaces, bones and capsuloligamentous structures (rotator cuff). You can complete the study with DP sequences with fat saturation before and after administration of gadolinium to optimize the characterization of some suspicious lesions

**SCAPULAR REGION INJURY**

The scapula is usually involved by benign disease, and frequently diagnosed as incidental finding in asymptomatic patients.

We present the different shoulder pathology, showing illustrative examples diagnosed in our center.
Fig. 1: SCAPULAR ANATOMY

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Fig. 2: SCAPULAR ANATOMY

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Imaging findings OR Procedure details

SCAPULAR REGION INJURY

BENIGN PATHOLOGY

Pathogenesis diversity allows us to differentiate between congenital processes, trauma, infectious - inflammatory, metabolic and degenerative.

The congenital elevation of the scapula (Sprengel deformity) may be unilateral or bilateral. It is characterized by the appearance of a small shoulder elevated and rotated with the lower edge pointing to the spine. Sometimes there is a connection between the high scapula and vertebrae of bone omovertebral. Existe creating a strong partnership with the Sd. Klippel-Feil syndrome, scoliosis and fusion of the cervical or thoracic vertebrae.

On the other hand the scapula fractures account for 3% of the injuries of the shoulder girdle and 5% of all fractures of the shoulder. Usually secondary to direct trauma from traffic accidents or falls from heights.

They are classified according to their anatomical location. Only 10% of the total are intra-articular, are those that affect the glenoid. Frequently conservative management, except in floating shoulder, intra-articular fractures and displaced fractures.

Infectious disease are represented by the osteomyelitis of the scapul. It is a rare clinical entity. The time from symptom onset to hospitalization is few days. Clinical symptoms are pain and total functional incapacity of the upper extremity. The diagnosis of osteomyelitis of the scapula was established on the basis of imaging, sometimes de X-ray is normal so ultrasound, CT scan and MRI confirm it.

Langerhans Cells Histiocytosis or eosinophilic granuloma is a non-neoplastic proliferation characterized by granulomatous reticular cells. Usually occurs in children aged 1 to 15 years. The most common sites are the flat bones, spine, skull and long bones. These are lytic lesions, polyostotic, which may show an aggressive look like with destruction of cortical bone and soft tissue mass. On MRI most often display a focal lesion surrounded by a large area of alteration of signal due to a reaction of soft tissue and bone marrow, with low signal intensity on T2 is considered to correspond to bone marrow edema or parts soft due to the flare phenomenon.
Metabolic disorders such as hyperparathyroidism make up radiological changes affecting the scapular region such as permeable well-defined lesions secondary to subchondral bone resorption. There is also a generalized osteopenia that mimic these lesions appear more aggressive. It is interesting in these cases look for other signs of bone resorption (for example in the fingers that provides tunneling aspect) look for the skull with salt and pepper images and bone cystic lesions (brown tumors)

Paget disease can also involve the scapula like the pelvis. Characteristic radiographic findings are thickening of the cortex and the increase of the affected bone with a trabecular pattern of cancellous bone

Also the degenerative pathology involve the scapular region. The shoulder impigement syndrom occurs when the supraspinatus tendon and subacromial bursa are chronically entrapped between the humeral head and the acromion. Generally caused by the proliferation andsubacromial osteophyte formation and degenerative changes of the humeral tuberosities.

Patients with scapular pain may show an impigement syndrom of the suprascapular nerve that is located in the supraspinous or spinoglenoid notch, at the superior border of the supraspinous fossa. In this location the suprascapular nerve may be compressed by a ganglion or entrapped, secondary to thickening of the suprascapular ligament.

NEOPLASM OF THE SCAPULAR REGION

In terms of tumor pathology, it can be divided into benign tumors and malignant tumors

BENIGN TUMORS

Bone tumors

Osteochondroma

Is the most common primary benign neoplasm of the scapula. Usually, it is a single lesion located on the anterior surface of the scapular body like a osteocartilaginous exostosis.

The radiologic presentation of osteochondroma characterized depending on whether the lesion is pedunculated with a narrow pedicle or, sessile with a broad base of implantation
in the cortex. The most important feature is the long continuity of the cortical bone with the cortex of osteochondroma.

Others important features are calcifications in the stem of the osteochondroma and the cartilaginous cap thickness ranging from 1mm-3mm, which is displayed on MRI as a cap of high intensity in gradient echo sequences and T2.

Osteochondroma complications include compression of nerves or blood vessels, fracture through the lesion and malignant transformation to chondrosarcoma exceptionally.

**Aneurysmal bone cyst**

Accounts for 6% of primary lesions of bone. It occurs in children younger than 20 years old. Histologically consists of multiple sinusoids filled with blood, alternating with more solid areas. Multicystic eccentric insufflation involves the bone with a thin shell of periosteal response.

The approach with plain radiography may be sufficient. But the use of MDCT allow us to assess the cortical bone and fine internal septa, so as to show liquid-liquid levels. MRI findings are quite characteristic: well-defined lesion, lobulated edge, cystic cavities with fluid levels - liquid, multiple internal septa and a low-intensity rim surrounding intact injury.

**Giant cell Tumor**

Aggressive lesion characterized by a highly vascularized tissue containing stromal cells and osteoclasts. They affect women between 20 - 40 years old.

Radiologically displayed an osteolytic lesion with a margin of sclerotic and narrow-transition in the absence of periosteal reaction.

There is usually soft tissue mass, so the CT and MRI play an important role.

The treatment is surgical curettage with bone graft.

**Elastofibroma dorsi**

Elastofibromas are benign soft tissue tumours mostly of the infrascapular region between the thoracic wall, the serratus anterior and the latissimus dorsi muscle with a prevalence of up to 24% in the elderly. The pathogenesis of the lesion is still unclear, but repetitive microtrauma by friction between the scapula and the thoracic wall may cause the reactive hyperproliferation of fibroelastic tissue.

In gross examination, elastofibrom is composed of alternating fatty and fibrous tissue planes. The sonographic appearance of elastofibroma dorsi consists of arrays of
interspersed linear or curvilinear hypoechoic stands against an echogenic background. A multilayered appearance has been described also on CT and MR imaging similar to the appearance seen at sonography. On the basis of the CT and MR imaging appearance, the linear hypoechoic strands visible sonographically appear to correspond to the largest islets of fat entrapped within the mass. In conclusion the echogenic background corresponds to the bulk of fibroelastic tissue.

**MALIGNANT NEOPLASM**

Malignant Fibrous histiocytoma

Primary bone tumor of the appendicular skeleton, can occur at any age [1]

Radiological features are inespecific include a lytic lesion with cortical destruction and soft tissue mass. It mimic fibrosarcoma.

On MR imaging of malignant fibrous histiocytoma, images often show only heterogeneously increased signal intensity on T2-weighted sequences Treatment options are similar to those used for osteosarcoma.

**Osteosarcoma**

Frequent malignant neoplasm of the scapula. Occurs 11 and 30 years old. Both chondroblastic and osteoblastic types have been reported.

Radiological feature include an amorphous, osteoid tumor and bone density with bulky soft-tissue masses.Often show an invasive aspect.

**Chondrosarcoma**

The most common malignant neoplasm of the scapula. Chondrosarcoma is a malignant bone tumor produce cartilage. Its main radiological features are: an expansive lesion, disruption of the bone, annular calcification and comma-shaped tumor matrix, thickening of the bone cortex, and the presence of soft tissue mass.

There is a form of primary chondrosarcoma is the periosteal chondrosarcoma. It has the same radiological features central chondrosarcoma. As a lesion that appears on the surface of the bone to be distinguished from periosteal osteosarcoma.
**Ewing Sarcoma**

Ewing's sarcoma frequently site in the lower extremities and pelvis but it is also seen in the scapular body. Age limits of 5-30 years, while in children affects the long bones, in adults committed to the flat bones. From the radiological point of view is very permeable lytic injury with big soft tissue mass. Periosteal reaction are frequent finding.

**Multiple myeloma**

Tumor originated in the plasma cells in the bone marrow. Tumor is most common primary malignant bone. Occurs between 50 - 70 years of age. From the radiological point of view is well-defined lytic lesions. Invasive pattern is rare or permeable. If there is diffuse infiltration are diagnosed with MRI.

**Metastatic disease**

They are the most common malignant bone tumors, so it should always be taken into account even in the differential diagnosis. By frequency breast cancers, lung and prostate are responsible for most of the metastasis. Osteolytic lesions can be radiologically as in the case of neoplasms of the kidney, lung, breast, thyroid and gastrointestinal tract, or osteoblastic lesions and prostate tumors.
Fig. 3: SCAPULAR FRACTURE

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**Fig. 5: INTRAGLENOID FRACTURE**

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Fig. 4: FLOATING SHOULDER

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Fig. 6: EOSINOPHILIC GRANULOMA

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Fig. 7: EOSINOPHILIC GRANULOMA

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Fig. 8: EOSINOPHILIC GRANULOMA

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Fig. 15: GIANT CELL TUMOR

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**Fig. 16: GIANT CELL TUMOR**

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Fig. 13: OSTEOCHONDROMA

MDCT images demonstrate that the “nodule” arises from the left scapula, and it has typical features of an osteochondroma. Note also multiple lytic metastatic lesions in dorsal vertebrae (not seen on chest film).
Fig. 12: OSTEOCHONDROMA

34 y-o woman with breast carcinoma. PA chest film shows a small nodular lesion in the left hemithorax. On the lateral projection it is superimposed on the anterior margin of dorsal spine. A lung nodule was suspected.

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Fig. 10: OSTEOCHONDROMA

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Fig. 9: OSTEOCHONDROMA

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Fig. 17: GIANT CELL TUMOR

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Fig. 22: METASTATIC DISEASE

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Fig. 21: METASTATIC DISEASE

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Fig. 20: CHONDROSARCOMA

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Fig. 19: CHONDROSARCOMA

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Fig. 18: CHONDROSARCOMA

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Fig. 14: PAGET

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Fig. 11: OSTEOCHONDROMA

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Fig. 23: METASTATIC DISEASE

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Conclusion

The scapula is a flat bone that may have multiple types of pathology, both benign and malignant. It is necessary to know the different pathological processes and radiological manifestations of disease, that allow us to make the proper differential diagnosis and to propose an appropriate management.
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The Floating Shoulder: A Biomechanical Basis for Classification and Management

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