STERNAL LESIONS: Pictorial essay.

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INTRODUCTION:

- Sternal abnormalities are commonly seen in clinical practice.

- In addition to the numerous anatomical variations and congenital anomalies, the sternum and sternoclavicular joints can be affected by various pathological conditions such as trauma, infection, tumors, degenerative and inflammatory changes.

- This study aims to demonstrate and illustrate such conditions, as the knowledge of its characteristics and imaging findings are essential for correct diagnosis and patient management.
DISCUSSION:

- Sternum injuries are common and should be properly recognized and characterized; using different imaging methods we will illustrate the variations of normality, congenital abnormalities and characteristic radiographic findings of sternal lesions highlighting: psoriatic arthritis, inflammatory osteitis, SAPHO syndrome, neoplastic, traumatic and degenerative lesions.
**ANATOMY:** **STERNUM:** Flat bone, with 3 parts:

* **MANUBRIUM:** superior central (jugular) notch and 2 lateral fossae that articulate with the clavicles. Also articulates with the 1° and 2° ribs and the body of the sternum.
  
  - **Attachments:** sternohyoideus, sternothyroideus, subclavius, pectoralis major, transversus thoracis and sternocleidomastoideus muscles.

* **BODY OF THE STERNUM:** articulates with the manubrium, xiphoid process and with the 2° through 7° ribs.
  
  - **Attachments:** transversus thoracis and pectoralis major.

* **XIPHOID PROCESS:** cartilaginous or ossified / fused to the sternal body.
  
  - **Attachments:** rectus abdominis, diaphragm and transversis thoracis.
STERNAL LESIONS

ANATOMY: STERNUM:

*STERNOCLAVICULAR JOINT: synovial joint, connects the axial skeleton to upper extremity.

- **Components:** anterior sternoclavicular, interclavicular and costoclavicular ligaments, articular disk and articular cavities.

*MANUBRIOSTERNAL JOINT: synchondrosis covered with hyaline cartilage and separated by a disk of fibrocartilage (dorsal and ventral ligaments), forming the sternal angle.

- Conversion to synovial joint in 30% (disk absorption) / Ossification of the disk in 10% (synostosis).

*XIPHISTERNAL JOINT: synchondrosis, usually ossifies to form a synostosis.
STERNAL LESIONS

**ANATOMY: STERNUM:**

*ATTACHMENTS:*

1. SUBCLAVIUS
2. STERNOCLEIDOMASTOIDEUS
3. PECTORALIS MAJOR
4. RECTUS ABDOMINIS
5. STERNOHYOIDEUS
6. STERNOTHYROIDEUS
7. TRANSVERSUS THORACIS
8. DIAPHRAGM and TRANSVERSIS THORACIS

- JUGULAR NOTCH
- CLAVICULAR NOTCH
- 1st RIB ARTICULATION
- 2nd RIB ARTICULATION
- STERNAL ANGLE
- TRANSVERSE RIDGES
- COSTAL NOTCHES
STERNAL LESIONS

*SPectrum of the sternal lesions:

I. CONGENITAL ABNORMALITIES / ANATOMICAL VARIANTS
II. DEGENERATIVE CHANGES
III. TRAUMA
IV. TUMORS
V. INFLAMMATORY CHANGES
VI. INFECTION
VII. OTHERS
**I. CONGENITAL ABNORMALITIES / ANATOMICAL VARIANTS:**

*CASE 1: PECTUS EXCAVATUM:* most common congenital deformity of the sternum.
- Sternum is displaced posteriorly and, as a consequence, the ribs protrude anteriorly.
- Genetic component (**45% familial**)
- May result in decreased cardiac stroke volume and decreased total lung capacity.

*TILTED STERNUM:* sternum that is oriented obliquely, determining unilateral irregularity / asymmetry of the chest wall

15-years-old male patient: (A) Lateral chest radiograph; (B) Sagittal CT image; (C) Axial CT image: showing vertical orientation of the anterior aspect of the ribs and the depressed (**red arrows**) and tilted sternum (**white arrow**).
PECTUS INDEX: axial CT/MR: dividing the transverse diameter of the chest by the anteroposterior diameter. *Normal*: 2.56 (+-0.35). *Surgical*: > 3.25.

**CASE 2: PECTUS EXCAVATUM TREATMENT:**

15-years-old male patient: Axial CT image before (A) and after (B) 5 minutes of vacuum; (C) Posteroanterior chest radiograph image; (D) CT reconstruction: showing the depressed sternum (with a pectus index of 5.1 before and 3.9 after the vacuum) and the vacuum bell system where a suction cup is used to create a vacuum at the chest wall.
I. CONGENITAL ABNORMALITIES / ANATOMICAL VARIANTS:

*CASE 3: PECTUS CARINATUM:
- The sternum in pectus carinatum is displaced anteriorly.
- More than 30% are associated with scoliosis; 25% familial.
- Clinical manifestations include exercise intolerance / shortness of breath.

*PECTUS INDEX : 1.42-1.98.
I. CONGENITAL ABNORMALITIES / ANATOMICAL VARIANTS:

*CASE 4: STERNALIS MUSCLE:

- Uncommon anatomic variant.
- Superficially and perpendicular to the pectoralis major muscle, parallel to the sternum.
- Runs from the infraclavicular region inferiorly to the caudal aspect of the sternum.

*Reports of the sternalis muscle simulating breast nodules in mammography.

56-years-old male patient: (A) Axial CT image, (B) Coronal CT reconstruction and (C) Sagittal CT image showing bilateral sternalis muscle (red arrows).
II. DEGENERATIVE CHANGES:

*CASE 5: OSTEOARTHRITIS: STERNOClavicular JOINT:

- Most common abnormality affecting the sternoclavicular joint.
- Also occur in the manubriosternal joint.

95-years-old female patient. (A) Sagittal; (B) Coronal and (C) Axial CT images: showing degenerative changes in right sternoclavicular joints with bone sclerosis, narrowing of the joint space and gas within the joint space (red arrows).
II. DEGENERATIVE CHANGES:

*CASE 6: OSTEOARTHRITIS: COSTOSTERNAL JOINT:

81-years-old male patient. (A) Axial MRI T1-WI; (B) Axial MRI STIR WI; (C) Coronal CT image; (D) Axial CT image: showing degenerative changes in the right costosternal joint with osteophytes and sclerosis in CT images *(white arrows)*, and soft-tissue swelling of the joint and intra-articular effusion in MRI *(red arrows)*.
II. DEGENERATIVE CHANGES:

*CASE 7: OSTEOARTHRITIS: MANUBRIOSTERNAL JOINT:

71-years-old male patient. (A) Sagittal CT image and (B) Coronal CT image: showing degenerative changes in the manubriosternal joint with sclerosis of both articular surfaces and a subchondral cyst on the body of the sternum (red arrows).
III. TRAUMA:

**CASE 8: STERNAL FRACTURE:**

- High-energy trauma – most commonly on the sternal body.
- **IMPORTANT:** high frequency of associated injuries: pulmonary and cardiac trauma, craniocerebral injuries, ribs, thoracic and lumbar spinal fractures.

52-years-old female patient after a motor vehicle accident. (A and C) Coronal and (B) Sagittal reconstruction CT images: showing manubrium fracture with soft tissue swelling (red arrows).
IV. TUMORS:

*CASE 9: METASTASIS:
- Most common neoplasms of the sternum: METASTASIS.
- Direct infiltration or hematogenous spread.
- Common sources: lung, breast, thyroid, kidney, colon and hematologic malignancies.

62-years-old male patient with multiple myeloma. (A) Axial, (B) Coronal and (C) Sagittal CT images: showing a large ill-defined lytic lesion in the manubrium (red arrows). Another lesion with the same characteristics is seen in the 6th left lateral costal arch (white arrow), with cortical destruction.
**IV. TUMORS:**

*CASE 10: METASTASIS:*

- Appearance may be lytic (multiple myeloma) or blastic/sclerotic (prostate or breast cancer).

69-years-old male patient with thymic carcinoma and myeloproliferative disease. (A) Axial, (B) Sagittal and (C) Coronal CT images: showing a multiple blastic lesions in the sternum (red arrows).
IV. TUMORS:

*CASE 11: OSTEOSARCOMA:*

- More commonly in older patients.
- Secondary malignancy following radiotherapy.

22-years-old female patient who previously underwent radiation therapy. MRI images: (A) Axial T2-WI; (B) Axial T1-WI; (C) Coronal T1-WI; (D) Coronal T2-WI; (E) Coronal enhanced T1-WI; (F) Sagital T1-WI; (G) Sagittal T2-WI; (H) Sagittal enhanced T1-WI: showing an osseous lesion with mixed signal /predominantly hyperintense on T2-WI with heterogeneous enhancement after intravenous contrast administration (red arrows).
IV. TUMORS:

*CASE 12: PLASMACYTOGRAM:

- Localized proliferation / solitary mass of neoplastic monoclonal plasma cells.
- Diffuse proliferation: MULTIPLE MYELOMA

70-years-old female patient with multiple myeloma. CT images: (A and B) Axial, (C and D) Coronal and (E and F) Sagittal reconstructions: showing an intramedullary expansile lesion of the sternum with cortical bone erosion (red arrows).
V. INFLAMMATORY CHANGES:

*CASE 13: CRYSTAL INDUCED ARTHROPATHY:

- **GOUT**: rare: typically well marginated paraarticular erosions, and appositional bone deposition with expansion of bone ends
- **PSEUDOGOUT**: CALCIUM PYROPHOSPHATE DIHYDRATE CRYSTAL DEPOSITION: *occasional*: typically chondrocalcinosis and tophaceous pseudogout formation.

93-years-old female patient. (A and B) Axial CT images: showing crystal deposition in the sternoclavicular joint (red arrows).
V. INFLAMMATORY CHANGES:

*CASE 14: SERONEGATIVE ARTHRITIS: PSORIATIC ARTHRITIS:

- Seronegative arthritides may affect the manubriosternal and sternoclavicular joints.
- **Common radiographic findings**: Erosions or fusion of the manubriosternal joint and sternoclavicular joint hyperostosis.

35-years-old female patient with psoriatic arthritis. MRI Sagittal (A) T1-WI, (B) T2-WI and (C) enhanced T1-WI: showing cortical erosion of the manubriumsternal joint with cortical bone sclerosis (low signal intensity on both T1 and T2 images: white arrows) and joint enhancement after intravenous contrast administration (red arrow).
V. INFLAMMATORY CHANGES:

*CASE 15: SAPHO SYNDROME:

- **SAPHO**: synovitis, acne, palmoplantar pustulosis, hyperostosis, and osteitis
- Wide spectrum of aseptic neutrophilic dermatoses with aseptic osteoarticular lesions.
- The sternoclavicular joint is most frequently affected (65%-90%).

52-years-old female patient with psoriatic arthritis. MRI Coronal (A) T1-WI, (B) T2-WI and (C) enhanced T1-WI: showing joint erosion and bone marrow edema of the sternoclavicular joint (**red arrows**) and an arthrosynovial cyst (**white arrow**).
V. INFLAMMATORY CHANGES:

*CASE 16: TIETZE SYNDROME:*
- Painful costochondritis of unknown cause – *mainly in young women.*
- Characterized by mineralized and swollen costal cartilage.

30-years-old female patient with left sternoclavicular joint pain. CT (A) Sagittal, (B) Coronal and (C) Axial images: showing mineralized and sclerotic bone of the left sternoclavicular joint (red arrows).
V. INFECTION: IATROGENIC

**CASE 17: POST STERNOTOMY:**

- Primary osteomyelitis of the sternum is uncommon.
- Related to intravenous drug abuse, immune deficiency states, hemoglobinopathy.

78-years-old female patient with secondary osteomyelitis after median sternotomy and myocardial revascularization. CT (A-B) Sagittal and (C-D) Axial images: showing erosive changes of the sternum (white arrows), soft tissue edema and fluid collection (red arrows).
V. OTHERS: POST OPERATORY

*CASE 18: STERNOTOMY DEHISCENCE:
- Complications after sternotomy is rare.
- Include: dehiscence, nonunion, secondary osteomyelitis /mediastinitis.

78-years-old female patient with 20 days history of sternotomy and myocardial revascularization. CT (A and B) Coronal and (C) Axial images: showing sternal dehiscence with displacement of the wires (red arrows).
V. OTHERS:

**CASE 19: MYONECROSIS:**

- Myopathy involving infarcted muscle.

24-years-old male patient with sternal pain after exercise. MRI (A and B) Axial T1-WI, (C) Coronal T-WI and (D) Coronal enhanced T1-WI showing heterogeneous peripheral enhancement with central necrosis of the pectoralis major sternal insertion (red arrows).
V. OTHERS:

**CASE 20: PAGET DISEASE:**

- Chronic skeletal disorder characterized by abnormal and excessive remodeling of bone.
- Abnormal osseous resorption/apposition: variable clinical and imaging manifestations.

75-years-old male patient with Paget disease. (A) Coronal and (B) Sagittal CT images: showing mixed lytic and sclerotic changes involving the stenum. Classic findings include: osteolysis, trabecular coarsening, cortical thickening, and osseous expansion (red arrows).
CONCLUSION:

*To achieve accurate and timely diagnoses that facilitate the management and appropriate treatment, radiologists should be familiar with the appearances of the diseases that may affect the sternum.


