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Sarcoidosis: A multi-systemic disease with non-caseating granulomas. Sarcoid is an idiopathic disease thought to be inhalational with unknown antigen. Both sarcoid and tuberculosis are inhaled first, then go from lymphatics to other sites of the body.

Cardiac sarcoidosis:

About 5% of sarcoid cases have cardiac involvement. Cardiac involvement increases mortality risk.

What are some typical imaging manifestations of sarcoidosis on cardiac MRI?

Increased myocardial T2 signal with delayed gadolinium enhancement in the mid or epicardial portions of the left ventricular myocardial wall in a non-coronary distribution. Cardiac sarcoidosis rarely involves the right ventricle or the papillary muscles. Cardiac sarcoid granulomas can also cause myocardial aneurysms as well.

Delayed enhancement of sarcoidosis can be in any location of LV and can appear to be diffuse, patchy, nodular and/or linear. Most commonly sarcoid enhancement will be in the mid-myocardial or subepicardial regions.

What can be done to confirm cardiac sarcoidosis if imaging manifestations are suggestive?

Endomyocardial biopsy to evaluate for caseating granulomas in the myocardium.

What nuclear medicine study can be performed for evaluation of cardiac sarcoidosis?

Dedicated FDG PET/CT of the heart.

What patient preparation is necessary prior to cardiac FDG PET/CT for evaluation of carciac sarcoidosis and why is patient preparation necessary?

The patient must have a low carbohydrate diet the day before the scan and fast overnight to switch the cardiac metabolism to free fatty acid metabolism to suppress normal cardiac glucose uptake. If normal cardiac glucose uptake is suppressed, only portions of the heart involved with sarcoidosis should take up the FDG. This allows you to unmask the sarcoidosis from the normal cardiac FDG uptake. Additionally, IV heparin can be administered as part of patient preparation prior to scanning as this may also suppress noral cardiac glucose uptake.

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What are common entities that can cause epicardial delayed enhancement on MRI?

Sarcoidosis, myocarditis, Chagas disease.

What are common entities that can cause delayed enhancement of the mid myocardial wall?

Amyloid, sarcoid, hypertrophic cardiomyopathy

What are common entities that can cause subendocardial delayed enhancement?

Myocardial infarction/scar if vascular distribution (ischemic cardiomyopathy) and amyloid if non-vascular or diffuse distribution.

Can you have cardiac sarcoidosis without lung involvement of sarcoidosis?

Yes. However, if you see mediastinal/hilar adenopathy and see characteristic myocardial delayed enhancement I would think of sarcoid until proven otherwise for board exams. "Hilar plus heart equals sarcoid".

Can cardiac sarcoidosis cause a restrictive cardiomyopathy?

Yes. Differential for restrictive cardiomyopathy includes sarcoid, amyloid, Loeffler's eosinophilic endocarditis, hemochromatosis.

How can one differentiate between cardiac sarcoidosis and myocarditis on cardiac MRI?

These can look identical on cardiac MRI so the best way to differentiate is by presence of coexistent lymphadenopathy/lung disease of sarcoidosis and patient history. If you see coexistent lymphadenopathy/lung disease think sarcoid. If you don't see these then differential includes sarcoid and myocarditis.

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Pulmonary Sarcoidosis:

Sarcoidosis typically presents with what type of pulmonary nodule pattern: perilymphatic, random, or centrilobular?

Sarcoid typically presents with perilymphatic nodules.

What are typical early and late imaging characteristics of pulmonary sarcoidosis?

Early: Upper lobe predominant perilymphatic nodules. Lambda sign of mediastinal/hilar lymphadenopathy (1-2-3 pattern) which is bilateral hilar and right paratracheal lymphadenopathy.

Late: Upper lobe fibrosis, traction bronchiectasis.

Does end-stage pulmonary sarcoidosis present with honeycombing?

Classically, no. Classis sarcoid is lack of honeycombing despite end stage lung disease elsewhere.

What superimposed disease process can form in patients with end stage pulmonary sarcoidosis?

Aspergillomas can commonly form in cavities in lungs of patients with end stage sarcoidosis.

Besides CT imaging or chest radiographs the Lambda sign can also be shown on what type of nuclear medicine scan?

Gallium 67 scan. Degree of uptake on gallium scan has been shown to correlate with disease activity and severity. Gallium uptake is about 90% sensitive for active pulmonary sarcoidosis and scans will be negative with inactive sarcoidosis. Gallium can therefore also guide site of biopsy for highest yield.

What is another sign on a Gallium scan (extrapulmonary) that is classic for sarcoidosis?

Panda sign: Uptake in the lacrimal glands, nasopharynx, and parotid glands that looks like the ears, eyes and nose of a panda's face.

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What is the CT galaxy sign of pulmonary sarcoidosis?

Upper lobe predominant masses with satellite perilymphatic nodules. The masses are a conglomerate of nodules that have coalesced.

What are typical age/demographic characteristics that you would expect for sarcoidosis on a board exam?

20-40-year-old person, most classically an African American female (but not exclusively). But if they give you this history and show you a chest CT you should already be considering the possibility of sarcoid. Most sarcoid patients will become symptomatic prior to 40 years old.

What organ is the most commonly affected in sarcoidosis?

Lungs

What are some laboratory values that are typical of pulmonary sarcoidosis?

Elevated ACE levels, hypercalcemia.

How many stages of pulmonary sarcoid are there?

4 stages including a stage 0

What are pulmonary imaging manifestations for each stage on a CXR?

Stage 0: Normal on chest radiograph

Stage 1: hilar/mediastinal nodes only (50% of cases present here)

Stage 2: Parenchymal disease plus hilar/mediastinal nodes (30% of cases)

Stage 3: ONLY parenchymal disease (nodes burned out)

Stage 4: End stage pulmonary fibrosis with irreversible scarring and distortion. This is also termed progressive massive fibrosis (other causes include silicosis and TB)

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What is the treatment for end-stage pulmonary sarcoidosis?

Pulmonary transplant

Can sarcoid recur after pulmonary transplant?

Yes, sarcoid is perhaps the most common disease that can recur after pulmonary transplant, perhaps in up to 35% of cases.

Is sarcoidosis on the differential for fibrosing mediastinitis?

Yes, although histoplasmosis is the most classic cause of fibrosing mediastinitis, other causes include sarcoid, TB, radiation.

Does pulmonary sarcoidosis typically have uptake on FDG PET/CT?

Yes, sarcoid inflammation causes FDG uptake and is a cause of a false-positive FDG scan in the lungs along with other infectious/inflammatory processes to include TB, fungal infection, rheumatoid nodules, etc.

Can sarcoid cause tracheal thickening?

Yes, typically of the circumferential type, NOT the cartilaginous type. If you see circumferential tracheal thickening with lymphadenopathy and upper lobe predominant perilymphatic nodules you should think of sarcoidosis as the cause. Differential diagnosis of circumferential tracheal thickening includes amyloidosis (bulky calcified nodules and/or cysts with nodular septal thickening) and granulomatosis with polyangiitis (cavitary pulmonary nodules with pulmonary hemorrhage). TB and IBD also on differential.

What is the association of sarcoidosis with cigarette smoking?

Cigarette smoking actually decreases the incidence of sarcoidosis (and hypersensitivity pneumonitis).

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Neurosarcoid

Tip: Neurosarcoid has been termed a "great mimicker" in the brain. The imaging appearances of neurosarcoid will commonly be nonspecific for sarcoid versus other entities so you need to remember differential diagnoses for various brain findings, many of the common hypothetical scenarios you may encounter on board exams are reviewed here. Remember that neurosarcoid can look like just about anything in the CNS. In general, if they show you a brain finding plus bilateral hilar/mediastinal lymphadenopathy sarcoid should be high on your differential on board exams.

Neurosarcoidosis of the brain:

What is the most common imaging manifestation of neurosarcoid in the CNS?

Probably multiple enhancing dural-based masses. Other common presentations include a thickened infundibular stalk, lesions (nodular and/or diffuse) along pial surface, cranial nerve enlargement/enhancement, parenchymal masses.

What percentage of neurosarcoid patients will have an abnormal chest radiograph?

About 90% of neurosarcoid patients will have an abnormal chest radiograph at time of neurosarcoid presentation. On board exams if they show you a CNS finding plus an abnormal chest radiograph you need to consider sarcoidosis.

What percentage of patients with sarcoid will have symptomatic CNS involvement?

About 10% of sarcoid patients will have symptomatic CNS involvement. Up to perhaps 50% of all sarcoid patients will have CNS findings on autopsy.

What is the most commonly affected cranial nerve in patients with neurosarcoidosis?

Facial nerve involvement is most common in patients with neurosarcoid. Bilateral facial nerve palsy should make you think of potential neurosarcoidosis and this may happen in up to 1/3 of neurosarcoid patients.

Basilar meningitis on board exams should make you think of sarcoidosis versus what other entity?

Basilar meningitis should make you think of sarcoid versus tuberculosis. If you have basilar meningitis and hydrocephalus think tuberculosis. Note that these entities can also cause secondary CNS vasculitis which would present on imaging with beading of the CNS vessels and possible focal vascular occlusion.

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Sarcoidosis can also present with diffuse dural enhancement. What are other differential considerations for diffuse dural enhancement?

Diffuse dural enhancement should make you think of intracranial hypotension (diffuse dural enhancement, enlarged cavernous sinus, sagging brainstem), dural metastatic disease, post-operative state, sarcoidosis (typically somewhat nodular).

What are common entities you should consider when you see a thickened pituitary stalk on MRI?

Lymphocytic hypophysitis (idiopathic), eosinophilic granulomatosis, sarcoid, pituitary adenoma

What are common differential diagnoses for sellar/parasellar lesions you should remember for board exams?

A helpful mnemonic for sellar/parasellar lesions ins “satchmoe”

S-sarcoid, sellar tumor (adenomas)

A-aneurysm

T-teratoma or TB

C-craniopharyngioma, chordoma, cleft cyst (Rathke)

H-hypothalamic glioma, hamartoma of tuber cinereum

M-meningioma, metastasis

O-optic nerve glioma

E-eosinophilic granuloma, epidermoid/dermoid/teratoma

Sarcoid granulomas in the hypothalamus can cause diabetes insipidus. What are clinical manifestations of diabetes insipidus and what is the underlying mechanism of DI?

Classic symptoms of diabetes insipidus are polyuria and polydipsia due to resistance to or deficiency of antidiuretic hormone (ADH). With neurosarcoid this would be a central CNS process related to ADH deficiency rather than resistance which is due to peripheral causes (commonly chronic renal issues, pregnancy, lithium use)

Besides neurosarcoidosis what are other entities that can cause central diabetes insipidus?

Differential considerations for central DI include malignancy (craniopharyngioma and germinomas most common primary lesions, also metastatic disease), TB, LCH, trauma, neurosarcoid.

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Neurosarcoidosis is commonly treated with what therapy?

Corticosteroid therapy is a mainstay of neurosarcoid treatment. You may see decreased or resolved enhancement of CNS lesions following steroid treatment.

Neurosarcoidosis in the spine/spinal cord:

-Most common in elderly

-Most common in cervical or thoracic spinal cord

-Can look like just about anything—enhancement/enlargement of cord in any location

Neurosarcoidosis in head and neck:

-Sarcoid can involve basically any structure including eyes, ears, sinuses, airways, vessels, glands, etc.

What head and neck sites are most commonly involved with sarcoid?

Orbital involvement probably most common. Most typically extra-ocular including optic nerve and/or lacrimal involvement but ocular involvement/uveitis is also possible.

What is the panda sign?

Bilateral lacrimal, bilateral parotid, and physiologic nasopharyngeal uptake can show the “panda sign” on gallium 67 nuclear medicine imaging.

What are other differential considerations for the “panda sign”?

Besides sarcoidosis you should also think of Sjogren’s disease and lymphoma.

What are differential considerations for bilateral lacrimal gland enlargement?

Think Sjogrens disease, sarcoid, lymphoma.

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Sarcoid involvement of the thyroid most commonly looks like what on imaging?

Thyroid enlargement with nonspecific thyroid nodules. May also have co-existent cervical lymphadenopathy. Need biopsy to differentiate from other entities.

What is the top cause of calcified lymph nodes in the head and neck region?

The top cause is mycobacterium. Other common causes include sarcoid, treated lymphoma, metastases from various cancers including thyroid cancer.

Abdominal and pelvic sarcoidosis:

True/False: Sarcoidosis can involve any abdominal organ?

True. Based on my best guess they may be most likely to show you liver lesions because these are often well-depicted on imaging. If you see a liver lesion (or any solid organ abdominal lesion and/or peritoneal lesion) and a mediastinal/hilar lymphadenopathy sarcoid needs to be included in your differential diagnosis for the board exam question. Isolated solid organ abdominal disease without thoracic manifestations of sarcoid is rare.

True/False: Sarcoidosis can cause cirrhosis and portal hypertension.

True, in setting of chronic liver sarcoidosis. If you are ever encountered with a question asking whether sarcoidosis can do basically anything the answer is yes for board exams.

If sarcoidosis involves abdominal solid organs what is the most common imaging manifestation?

Sarcoid granulomas will most commonly manifest as numerous small mas-like nodules/masses. These may coalesce and you may see larger nodules on a background of numerous smaller nodules. You can also see diffuse organ enlargement to include hepatomegaly and splenomegaly with a heterogeneous parenchymal pattern with or without discrete nodules.

What other entities can present similarly to sarcoidosis in the abdomen and pelvis?

Lymphoma, metastatic disease, mycobacterial and fungal infections.

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Gastric sarcoid can present with the appearance of linitis plastica. What is linitis plastica and what other disease processes can cause result in this appearance?

Linitis plastica of the stomach typically results from diffuse gastric adenocarcinoma involving the submucosal stomach causing diffuse thickening of the gastric wall. Differential considerations include metastatic disease, lymphoma, granulomatous disease to include Crohn's disease and gastric amyloidosis and sarcoidosis. On a barium fluoro study you see inability of the stomach to distend and loss of the gastric mucosal folds. On CT you will see diffuse gastric wall thickening with possible peri-gastric lymphadenopathy.

Sarcoidosis of the kidney can result in what laboratory abnormalities on blood and urine analysis?

Renal sarcoidosis can cause hypercalcemia and hypercalciuria along with renal calculi. The physiology is complex and likely beyond the scope of the ABR Core exam. In severe cases, renal failure can result from severe granulomatous nephritis.

Can sarcoidosis affect the testes?

Yes. Sarcoid can involve the testes and epididymis and may manifest as hypoechoic lesions. Differential considerations again include lymphoma, metastatic disease and other granulomatous diseases.

**Note that sarcoidosis can also cause abdominal and pelvic lymphadenopathy (FDG avid) as well as peritoneal nodularity and even ascites formation. Biopsy is necessary with these findings to confirm sarcoidosis and exclude malignancy.

Sarcoidosis is one potential cause of medullary nephrocalcinosis. What are other potential causes of medullary calcinosis?

A mnemonic for medullary calcinosis that is commonly out there is "HAM HOP"

H: hyperparathyroidism

A: acidosis (renal tubular acidosis)

M: Medullary sponge kidney

H: Hypercalcemia/hypercalciuria (sarcoid and milk-alkali syndrome)

O: oxalosis

P: Papillary necrosis

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Note that medullary calcinosis is way more common than cortical nephrocalcinosis. Causes of cortical nephrocalcinosis are broad but include renal ischemic injury, renal transplant rejection, infection, chronic glomerulonephritis, nephrotoxic drug injury, Alport syndrome, many other causes.

Also note that calcinosis of the renal pyramids has it's own differential diagnosis to include renal tuberculosis, sickle cell disease, Lasix over-use, renal papillary necrosis, hyperuricemia which has it's own broad differential diagnosis.

Musculoskeletal sarcoid:

What are common MSK findings of sarcoid?

Sarcoid can involve any bone but the small bones of the hands and feet are more commonly affected. On board exams, pay attention for sarcoid to be shown as lucencies in the mid and distal phalanges of the 2nd/3rd digits of the hand, enchondroma-like lesions with a lytic lacelike pattern. You can see soft tissue thickening of the fingers as well "sausage digits".

Sarcoid can present with multiple lytic lesions. What are other differential considerations for multiple lytic lesions?

A mnemonic for multiple lytic lesions that is commonly out there is POEMS.

P: Pagets of hyperparathyroidism

O: Osteomyelitis

E: eosinophilic granuloma

M: metastasese(think thyroid, renal primaries), Multiple myeloma

S: Sarcoid

POEMS is not all inclusive but it does remind you of many common entities and is an actual word which for me helps me to actual remember it unlike other mnemonics that exist such as "FEEMHI". You can look that one up on your own, if interested.

What is a potential complication of lytic sarcoid lesions in the bones?

Pathologic fractures can occur due to the bony osteolysis. These may not heal well so you may see chronic bone collapse and poor bony alignment following pathologic fractures.

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What are differential considerations for a sausage digit?

First, I would think of psoriatic arthritis with sausage digits (think of this first before sarcoid or other causes). Other potential causes include sarcoid, sickle cell anemia, TB, gout, osteomyelitis among other etiologies.

Can sarcoid cause arthritis?

As I said before, sarcoid can do just about anything so the answer is yes. Sarcoid arthritis is most common in women <40 years. This will typically affect multiple joints and may present with joint pain, swelling, and erythema. Sarcoid arthritis usually resolves on its own within 6 months of onset but chronic sarcoid arthritis can occur but is rare.

What is Lofgren syndrome?

Lofgren syndrome is a form of acute systemic sarcoidosis manifesting with polyarthritis, erythema nodosum (painful nodular red rash, most commonly on the shins), fevers and bilateral hilar adenopathy. Don't confuse this with Loffler syndrome which is pulmonary eosinophilia. Lofgren syndrome is most common in women <40 years. Polyarthritis is often symmetric and most commonly manifests in the ankles but can affect any joints. Lofgren syndrome is so specific for sarcoid that you may not need to biopsy to confirm the disease if you have this spectrum of symptoms. Take note that Lofgren syndrome is one of the ONLY specific manifestations of sarcoidosis.

What are differential considerations for erythema nodosum?

Many but common considerations include post-infectious state (strep common), TB, sarcoid, IBD, pregnancy, drug reaction, or paraneoplastic manifestation of leukemia/lymphoma.

Can sarcoid affect the muscles?

Yes, you can see single or multifocal muscular sarcoidosis. Look for soft-tissue masses versus diffuse infiltrative lesions in the muscles, most common in lower extremeties due to granulomatous muscular infiltration.

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What are cutaneous manifestations of sarcoidosis?

Broad spectrum of manifestations that include nodules, plaques, papules, etc. Those specifics are unlikely to be tested on radiology board exams. However, remember erythema nodosum can be seen with sarcoidosis along with other entities, as above. You can have lupus-like rashes around the eyes/nasolabial folds with sarcoidosis.

General:

What are common therapies to be aware of for sarcoidosis?

For mild manifestations no therapy may be given. Steroid treatment is the main therapy for most cases. More severe cases may use various immune modulating drugs and end-stage sarcoid may require organ transplantation.

Do we monitor sarcoid patients with imaging? If so, how?

There are no definite guidelines for monitoring sarcoid patients with imaging but many patients will have a chest radiograph every 6 months or so along with clinical follow-up/monitoring to check PFTs, renal function, calcium levels, EKG. etc.